



House of Commons
Science, Innovation and
Technology Committee

**Legacy – Parliament
2019–24**

Fourth Report of Session 2023–24

*Report, together with formal minutes relating
to the report*

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Science, Innovation and Technology Committee

The Science, Innovation and Technology Select Committee is appointed by the House of Commons to examine the expenditure, administration and policy of the Department for Science, Innovation and Technology, and associated public bodies. It also exists to ensure that Government policies and decision-making across departments are based on solid scientific evidence and advice.

Current membership

[Rt Hon Greg Clark MP](#) (*Conservative, Tunbridge Wells*) (Chair)

[Dawn Butler MP](#) (*Labour, Brent Central*)

[Chris Clarkson MP](#) (*Conservative, Heywood and Middleton*)

[Dame Tracey Crouch MP](#) (*Conservative, Chatham and Aylesford*)

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[Carol Monaghan MP](#) (*Scottish National Party, Glasgow North West*)

[Graham Stringer MP](#) (*Labour, Blackley and Broughton*)

[Christian Wakeford MP](#) (*Labour, Bury South*)

Powers

The Committee is one of the departmental select committees, the powers of which are set out in House of Commons Standing Orders, principally in SO. No. 152. These are available on the internet via www.parliament.uk.

Publication

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Committee staff

The current staff of the Committee are: Ethan Attwood (POST Fellow), Jessica Bridges-Palmer (Senior Select Committee Media Officer), Martha Comerford (Digital Account Manager), Ian Cruse (Second Clerk), Stella-Maria Gabriel (Committee Operations Manager), Arvind Gunnoo (Committee Operations Officer), Dr Faten Hussein (Committee Team Leader (Clerk)), Dr Misha Patel (Committee Specialist), Dr Joshua Pike (Committee Specialist), and Ben Shave (Committee Specialist)

The following staff also worked for the Committee at the time of writing this report: Dr Claire Housley (Former Committee Specialist), Dr Claire Kanja (Committee Specialist). Alan Walker (Senior Researcher - Energy, House of Commons Library) supported the writing of this report.

Specialist Advisers

At the time of writing this report Professor David Rothery (Professor of Planetary Geosciences, The Open University), and Professor Kieth Grainge (Professor of Astrophysics, The University of Manchester) served as Specialist Advisers to the Committee's inquiry into UK Astronomy. Dr Anke Lohmann, (Founder, Anchored In) served as a Specialist Adviser to the Committee's inquiry into Commercialising quantum technologies.

Contacts

All correspondence should be addressed to the Clerk of the Science, Innovation and Technology Committee, House of Commons, London, SW1A 0AA. The telephone number for general inquiries is: 020 7219 2793; the Committee's e-mail address is: commonssit@parliament.uk.

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Chair's foreword

It has been an honour to chair the Committee during what has been perhaps its most consequential period since it was founded.

The current Committee was elected in February 2020 just as the biggest crisis our country has experienced in generations and the greatest peacetime challenge in a century began—the covid-19 pandemic.



Science was central to the life of our nation during the whole pandemic—whether detecting covid-19, modelling its rise, understanding its transmission, assessing the policies to contain it and developing vaccines and treatments.

We conducted weekly sessions of detailed scrutiny of UK and international scientists and policy makers. They were broadcast live and, in some weeks, viewed by millions.

Our joint report with the Health and Social Care Committee Coronavirus: lesson learned to date (HC92) was the result of our 18 months inquiry and made 77 conclusions and recommendations including on pandemic preparedness, lockdowns and social distancing, testing and contact tracing and vaccines.

The UK Covid-19 Public Inquiry will shortly enter its third year. We would be surprised, when it finally concludes, if it reached conclusions that differed markedly from those reached by our joint committee of Members of Parliament at a time and pace in which our recommendations were able to be implemented by policy makers.

Covid-19 was by no means the only subject of our inquiries. Chairing a Committee that has a cross-cutting remit offered us the opportunity to examine and make recommendations on policy across a wide range of areas. We have examined subjects as diverse as the potential of bacteriophages in combatting antimicrobial resistance, insect decline and food security, the role of hydrogen in attaining net zero, new nuclear power, diversity and inclusion in STEM, UK telecommunications infrastructure and 5G technologies, space and satellites, astronomy, the cyber resilience of the UK's critical national infrastructure and the commercialisation of quantum technologies.

The Committee inquired into, and published two reports on the governance of AI, one of the biggest technological transformations of our age. Our interim report published in August 2023, identified 12 challenges to policy makers in this area. Our final report of May 2024, offers further recommendations to the UK Government to ensure our next steps are guided by evidence and comparative global perspectives on AI governance.

We are proud of the work we have carried out during this Parliament. We are a Committee which consists of members of different political parties, but we have found it easy to leave party politics at the Committee Room door. We depended on the contributions from our witnesses and those who submitted written evidence. And we record our gratitude to our dedicated team of clerks, specialists and supporting staff who have worked expertly and with enthusiasm to scope subjects for inquiry, obtain written evidence, summon witnesses, prepare detailed briefs for Members and draft our reports. I and my fellow Members are deeply grateful for their work.

We make this Report formally to the outgoing House of Commons, but it is really addressed to our successors in the new Parliament which will be elected on 4 July. The Government's responses to the subjects that we have examined and the recommendations that we have made should continue to be scrutinised during the next five years, not least to see if the Government did what they said they would. And if they did, what was the effect. No Parliament can bind its successor, but we offer an aide memoire to our successors in the hope that they may be inclined to follow up on our work of what has been a momentous five years.

A handwritten signature in black ink that reads "Greg Clark". The signature is written in a cursive, slightly slanted style.

1 Introduction

1. At the end of the 2019–2024 Parliament, we have taken the opportunity to look back on our work. This Report outlines some of the Committee’s work, progress and impact during this Parliament and sets out areas that may be of interest to our successor committee. It has of course, also given us the opportunity to consider what actions the Government has taken with regard to issues and recommendations raised in our reports and to seek updates and explanations in respect of responses to those reports.

2. Our responsibility is to scrutinise the Department for Science, Innovation and Technology and consequently we examine issues relating to expenditure, administration and policy of the Department and its associated public bodies. This Committee’s responsibility also extends to ensuring that Government policies and decision-making across all departments are based on solid scientific evidence and advice.

3. The table below presents headline figures reflecting the more tangible elements of our work:

| | Session 2019–2019 | Session 2019–2021 | Session 2021–2022 | Session 2022–2023 | Session 2023–2024 | Total |
|------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------|
| Meetings | 4 | 48 | 31 | 45 | 24 | 152 |
| Reports | 0 | 8 | 4 | 9 | 2 | 23 |
| Special Reports | 2 | 3 | 2 | 10 | 1 | 18 |
| Witnesses | 17 | 227 | 96 | 234 | 79 | 653 |
| Inquiries | 1 | 3 | 5 | 9 | 3 | 21 |
| Written evidence | 103 | 513 | 394 | 479 | 109 | 1598 |

4. We have received written and oral evidence for our inquiries from a hugely diverse range of stakeholders, and we are grateful for the time and effort they have taken to contribute to our work. We have also benefitted from having committee staff with strong scientific backgrounds and strong research skills, as they have been able to assist us with the more detailed aspects of our work. One of the principal aims of our work is to ensure that government policy is as well informed and evidence-based as possible, and it is only thanks to the written and oral evidence that we received from stakeholders and the input of our skilled staff and Specialist Advisers, that we can achieve this aim.

5. For this legacy report, we have included work going back to the beginning of the 2019 Parliament up to and including our most recent work, although at the time of Parliament’s dissolution in May 2024, some of our inquiries have not reported, and for some, Government responses have not yet been issued.

6. This report is broken down into chapters, each of which covers a key scientific policy area where the Committee has carried out one or more inquiries or evidence sessions over the course of the Parliament.

2 Health-related inquiries and Covid-19

7. The Committee held several health-related inquiries focusing on the covid-19 pandemic or flowed from it. The first was a joint inquiry with the Health and Social Care Committee on Coronavirus and the lessons learnt. This inquiry highlighted weaknesses and strengths in UK preparedness for the pandemic and during it. A subsequent inquiry into emerging diseases and the lessons learnt from the pandemic, looked into infrastructure, expertise and the relationships required to tackle pandemics, diagnostic and surveillance capabilities particularly, and vaccine manufacture at scale and pace. Covid-19 also underlined the utility and potential of health data to identify the spread of diseases and develop and test medicine and therapies both for public health, and for the UK's life science sector and its wider economy. As covid-19 receded, concerns emerged over the privacy of health data, its ownership and who should benefit from it, as GP data was perceived as being shared without the consent of patients. Our health data inquiry considered how these issues could be resolved.

Coronavirus inquiry

8. At the beginning of the covid-19 pandemic in March 2020, the then Science and Technology Committee and the Health and Social Care Committee began separate inquiries examining the Government's response to the pandemic. In October 2020, the two Committees launched a joint inquiry—*Coronavirus: lessons learnt*—to consider several key issues that emerged during the first wave of the pandemic and identify what lessons can be learnt.

9. The inquiry held eight oral evidence sessions between October and December 2020, with a further three sessions held in January, May and June 2021 and heard from over 50 individuals and organisations. These included the then: Secretary of State for Health and Social Care, Rt Hon Matt Hancock MP, Minister of State for Care, Helen Whately MP, the UK Government Chief Scientific Adviser, Sir Patrick Vallance, the Chief Medical Officer for England, Professor Chris Whitty, and the Deputy Chief Medical Officer, Dr Jenny Harries, and experts on each of our key areas of inquiry. The inquiry also published over 100 pieces of written evidence from individuals and organisations, which supplemented the evidence that the two Committees had collected individually.

10. The inquiry considered a number of themes:

- the country's prior preparedness for a pandemic disease;
- The Government's deployment of 'non-pharmaceutical interventions' such as lockdowns;
- The adoption of testing and contact tracing throughout the pandemic;
- The impact of the pandemic on the social care sector;
- The experience of some communities where the impact of covid-19 fell disproportionately; and
- The research, procurement and initial roll-out of covid-19 vaccines and the use of therapeutics.

Key themes from our work

11. The joint report was published on 12 October 2021,¹ and contained 38 recommendations to the Government and public bodies. It found, among other things, that:

- there was a need for a greater diversity of expertise and challenge—including from practitioners from other countries and a wider range of disciplines, to improve decision making when tackling a public health emergency;²
- there were questions as to whether the Scientific Advisory Group for Emergencies (SAGE) was sufficiently geared towards understanding the economic and/or social consequences of decisions, and whether it was transparent enough;³
- data sharing between different public bodies was too slow, particularly between national and local government;⁴
- a standing capability was required within government, or reporting to it, to scan the horizon for future threats, with adequate resource and counting on specialists with an independence from short term political and administrative pressures;⁵
- delays in creating an adequate test, trace and isolate system interfered with efforts to understand and contain the outbreak, hindered by a failure to utilise academic lab capacity,⁶ during early efforts to scale up testing and contact tracing;
- the Government needed to ensure that the UK Health Security Agency (UKHSA) and local authorities were proactive in preparing for a public health emergency and had the capability and funding to stand up both central surge capacity and locally driven testing and contact tracing within 7 days of a public health emergency being declared;
- vaccine development and deployment were effective and should guide future government practice, especially in relation to flexible teams formed outside of the usual Whitehall administration, including research and industry, working alongside regulators and a dynamic life science leader, that could operate at pace;⁷

1 House of Commons Health and Social Care, and Science and Technology Committees, Third Report of 2021–22, [Coronavirus: lessons learned to date](#), (HC 92; 12 October 2021).

2 House of Commons Health and Social Care, and Science and Technology Committees, Third Report of 2021–22, [Coronavirus: lessons learned to date](#), (HC 92; 12 October 2021), Recommendation 1.

3 House of Commons Health and Social Care, and Science and Technology Committees, Third Report of 2021–22, [Coronavirus: lessons learned to date](#), (HC 92; 12 October 2021), paras 20, 159 160 and 161; House of Commons Health and Social Care, and Science and Technology Committee, [Oral evidence: Coronavirus: lessons learnt](#), (HC 908; 39 November 2022), [Q1581-Q1582](#).

4 House of Commons Health and Social Care, and Science and Technology Committees, Third Report of 2021–22, [Coronavirus: lessons learned to date](#), (HC 92; 12 October 2021), paras 61 and 235.

5 House of Commons Health and Social Care, and Science and Technology Committees, Third Report of 2021–22, [Coronavirus: lessons learned to date](#), (HC 92; 12 October 2021), Recommendation 20.

6 House of Commons Health and Social Care, and Science and Technology Committees, Third Report of 2021–22, [Coronavirus: lessons learned to date](#), (HC 92; 12 October 2021), para 235.

7 House of Commons Health and Social Care, and Science and Technology Committees, Third Report of 2021–22, [Coronavirus: lessons learned to date](#), (HC 92; 12 October 2021), Recommendation 36 and paras 393 and 394.

- clinical trials and the approvals process for vaccines, could have proceeded more quickly, especially through the use of human challenge trials, and needed to be re-assessed particularly in advance of a new deadly pandemic;⁸
- the decision to delay lockdown should have been challenged;⁹
- social care was not given enough priority in the early stages of the pandemic;¹⁰
- health inequalities need to be tackled with an urgent and long-term strategy;¹¹ and
- the UK did not manage the COVID-19 outbreak as well as many other countries.

12. The Government published its response in June 2022.¹² The Government stated in its response that it considered that the report “contains a significant number of factual inaccuracies” which was disappointing, as the response did not elaborate on this claim neither in the introduction, nor in response to each recommendation. The Government accepted in full a minority of our recommendations, notably the recommendations relating to ‘at risk communities’, all of which were accepted.¹³ In the main, our recommendations were partially accepted but the detail of how all or part of a recommendation would be implemented was not always clear from the response.

13. Regarding pandemic preparedness the Committee recommended the need for an independent standing capability which would scan the horizon for future pandemic threats. However, the Government rejected this recommendation stating that “there exist already a range of complementary standing capabilities that aim to identify and assess current and future malicious and non-malicious risks”.¹⁴ In the intervening period, the Government have established the National Situation Centre within the Cabinet Office to merge data, analysis and expertise together for crisis management, and published the UK Government Resilience Framework.¹⁵

8 House of Commons Health and Social Care, and Science and Technology Committees, Third Report of 2021–22, [Coronavirus: lessons learned to date](#), (HC 92; 12 October 2021), Recommendation 37.

9 House of Commons Health and Social Care, and Science and Technology Committees, Third Report of 2021–22, [Coronavirus: lessons learned to date](#), (HC 92; 12 October 2021), Recommendations 12 and 13.

10 House of Commons Health and Social Care, and Science and Technology Committees, Third Report of 2021–22, [Coronavirus: lessons learned to date](#), (HC 92; 12 October 2021), Recommendations 22 to 25.

11 House of Commons Health and Social Care, and Science and Technology Committees, Third Report of 2021–22, [Coronavirus: lessons learned to date](#), (HC 92; 12 October 2021), Recommendation 26.

12 Department for Health and Social Care, [The Government’s Response to the Health and Social Care Committee and Science and Technology Committee Joint Report: Coronavirus: Lessons Learned to Date](#), (CP 690; June 2022).

13 House of Commons Health and Social Care, and Science and Technology Committees, Third Report of 2021–22, [Coronavirus: lessons learned to date](#), (HC 92; 12 October 2021), Recommendations 26 to 33. ‘At risk’ communities included Black, Asian and minority ethnic backgrounds and people with learning disabilities and their families.

14 Department for Health and Social Care, [The Government’s Response to the Health and Social Care Committee and Science and Technology Committee Joint Report: Coronavirus: Lessons Learned to Date](#), (CP 690; June 2022), p 14.

15 [Government to strengthen national resilience](#), GOV.UK, (19 December 2022); Cabinet Office, [The UK Government Resilience Framework](#), (19 December 2022).

14. The Committee recommended that the Armed Forces should have an increased central and standing role in preparing for and responding to emergencies like pandemics. The Government rejected this recommendation noting that it can draw on the Ministry of Defence planning capabilities during crises as required.¹⁶

15. The Government accepted the Committee’s recommendation of establishing a volunteer reserve database so that volunteers who have had appropriate checks can be rapidly called up and deployed in an emergency rather than needing to begin from scratch. In January 2022, NHS England established the NHS Volunteering Taskforce with the overarching aim to “create and sustain a lasting legacy for volunteering”. In June 2023 NHS England published its report and recommendations into the working of the NHS Volunteering Taskforce.¹⁷

16. During the Inquiry, the Committee noted the significant demands that were placed on the NHS during the pandemic. As such the Committee recommended that there was a need for more explicit, and monitored, surge capacity as part of the long-term organisation and funding of the NHS. In response, the Government partially accepted this recommendation indicating that coordination between NHS, NHS organisations and UKHSA exist for surge capacity.¹⁸ The issue of surge capacity was further explored in our Inquiry into Emerging diseases and learnings from covid-19 (see below).¹⁹

17. The Committee recognised that SAGE became a UK-centric body, based on the gathering of the UK’s most accomplished scientist. The Committee recommended that representation should be increased to include a wider range of disciplines, and from other countries especially those which have experienced, or are experiencing, the same emergency. The Government’s response noted the importance of international work and highlighted the participation of UKHSA (formerly Public Health England) in the International Association of National Public Health Institutes (made up of 110 members in 95 countries). The ‘100 Days Mission’ report,²⁰ was highlighted by the Government as an example of collaboration. However, no commitment is made to have more international representation on SAGE, nor engagement with the aspect of the recommendation on a wider range of disciplines being represented on SAGE.

18. The Government stated that lessons from the Vaccine Task Force (VTF) would be learnt and shared beyond the VTF. The Government accepted that a strategic approach should be taken to manufacturing vaccines and noted a £395 million investment to secure and scale up the UK’s manufacturing capabilities and would explore further opportunities to strengthen the UK’s resilience for covid-19 and future emergencies. However, in November 2022, Dame Kate Bingham, who was the VTF Chair (May-December 2020), was highly critical of what she saw as the dismantling of the VTF and the loss of infrastructure and relationships that would be required to develop vaccines at pace if a new pandemic

16 Department for Health and Social Care, [The Government’s Response to the Health and Social Care Committee and Science and Technology Committee Joint Report: Coronavirus: Lessons Learned to Date](#), (CP 690; June 2022), p 19.

17 [NHS Volunteering Taskforce report and recommendations](#), NHS England, (9 June 2023).

18 Department for Health and Social Care, [The Government’s Response to the Health and Social Care Committee and Science and Technology Committee Joint Report: Coronavirus: Lessons Learned to Date](#), (CP 690; June 2022), p 20.

19 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Emerging diseases and learnings from covid-19](#), (HC 506; 28 February 2024), [Qq311-to 314](#) and [Qq318–328](#) [Nicola Newman and Sarah Brampton], [Qq379–386](#) [Professor Dame Jenny Harries]

20 Cabinet Office, [100 Days Mission to Respond to Future Pandemic Threats](#), (12 June 2021).

occurred.²¹ These concerns were a major theme of our inquiry into Emerging diseases and learnings from covid-19, discussed below, and also of a Tony Blair Institute for Global Change report published in January 2024.²²

19. The need for a more anticipative and prepared test and trace response to a pandemic, in place of a reactive short-term horizon of test and trace, even during an emergency, was recommended by the Committee. The Government noted that responding to unexpected events “will remain a critical part of the pandemic response” through a “resilient and scalable infrastructure ... to protect the public from new and existing threats to health”.²³ However, timelines and resourcing for surveillance capabilities to respond to health risks were not set out. In September 2023, the CEO of UKHSA, Dame Jenny Harries, told us that UKHSA held retainer contracts with Berkshire and Surrey Pathology Service and University Hospitals Plymouth laboratories which could support surge testing as required.²⁴ The longevity of these contracts became a significant issue for our inquiry into Emerging diseases and learnings from covid-19, discussed below.

20. The inclusion of specific policies to reduce health inequalities in the Government’s ‘levelling up’ agenda²⁵ is recommended by the Committee. The Committee’s recommendation emphasised the need for a particular focus on ensuring that certain groups, including people from Black, Asian and minority ethnic backgrounds, do not continue to face unequal health outcomes. The Government accepted this recommendation and stated that the commitments in the levelling up White Paper and the Office for Health Improvement and Disparities (part of the Department of Health and Social Care) were looking at tackling the recovery for ethnic minority groups and underlying disparities in the long-term. In December 2021, the final quarterly Minister for Equalities’ report on the unequal impacts of covid-19 was submitted to the Prime Minister,²⁶ and all its recommendations were accepted.

Emerging diseases and learnings from covid-19

21. We launched an inquiry into Emerging Diseases and Learnings from COVID-19 in December 2022.²⁷ Following a report jointly published by our committee and the Health and Social Care Committee on lessons learned from covid-19 and our report on scientific advice in government during covid-19, this inquiry followed up on how lessons were being applied. The inquiry also considered the threat of zoonotic diseases. This inquiry has not reported at the time of Parliament’s dissolution in May 2024.

21 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Coronavirus: lessons learnt](#), (HC 908; 30 November 2022), [Qq1602–1608](#) [Dame Kate Bingham].

22 Tony Blair Institute for Global Change, [A New National Purpose: Leading the Biotech Revolution](#), (January 2024), pp 62–65.

23 Department for Health and Social Care, [The Government’s Response to the Health and Social Care Committee and Science and Technology Committee Joint Report: Coronavirus: Lessons Learned to Date](#), (CP 690; June 2022), p 30.

24 [Letter](#) from Professor Dame Jennifer Harries DBE, Chief Executive Officer, UK Health Security Agency, to the Rt Hon Greg Clark MP and the Rt Hon Steve Brine MP, Chairs of the Science Technology and Innovation and Health and Social Care Committees, (29 September 2023).

25 Department for Levelling Up, Housing and Communities, [White Paper: Levelling Up the United Kingdom](#), (CP 604; 2 February 2022), pp 200–206

26 Equality Hub and Race Disparity Unit, [Final report on progress to address COVID-19 health inequalities](#), (3 December 2021).

27 House of Commons Science, Innovation and Technology Committee, [How prepared is the UK for the next pandemic? MPs launch new inquiry - Committees - UK Parliament](#), (20 December 2022).

Key themes from our work

22. The Committee investigated the current threats of emerging diseases and what causes them. Evidence submitted to this inquiry agreed that the most likely sources of an emerging disease with pandemic potential was zoonotic, and so from an animal source.²⁸ This is because there is no immunity to these diseases in the global population.

23. Respiratory infections represent one of the highest risks of an epidemic or pandemic after emergence and human-to-human spread. However, during our inquiry we were told of the dangers of only focusing on respiratory diseases, due to the potential impact of new variants of diseases like Polio.²⁹

24. Issues surrounding the significant impact of fungal diseases on human health, particularly among immunocompromised individuals, with fungal infections ranking as major contributors to global mortality, was raised in the inquiry. Fungal drug resistance, due to limited antifungal options and continuous exposure of fungi to these drugs, often from agricultural applications of fungicides, emphasised the urgent need for novel treatments.

25. Our inquiry into the antimicrobial potential of bacteriophages and our one-off evidence session on antimicrobial resistance also focused on the threats posed by bacterial infections, and the reduced effectiveness of antibiotics (see below).

26. In addition, the inquiry heard oral evidence on the threat of avian influenza and the risks it poses to humans.³⁰ There are various strains of avian influenza. However, the avian influenza A(H5N1) strain is notable as it spread among birds globally at an unprecedented rate. Despite the United States (US) Centre for Disease Control and Prevention and the World Health Organisation classifying the risk to humans as moderate, a positive case of H5N1 in a human was reported in the US in April 2024, following the detection of H5N1 in cows.³¹ In May 2024, the first human case of H5N1 in Australia was reported, when a child became unwell after returning to Australia from overseas.³² Since January 2003, 889 cases of H5N1 in humans have been reported globally, across 23 countries, with a case fatality rate of 52%.³³

27. During the inquiry, we heard that UK needs to strengthen biosecurity measures to prevent the transfer of the virus to humans, highlighting the precautions taken during the culling of infected bird populations. Significant impact of avian influenza on the population of seabirds and the spread to inland birds were highlighted in our inquiry.

28. Biosecurity measures including personal protective equipment and disinfectants, were deemed to be crucial in addressing outbreaks in commercial poultry settings. Effective application of such measures was highlighted as challenging, thus the reliance on them as a sole solution was not seen as adequate.

28 [EMD0037 – Defra](#); [EMD0008 – Royal Society of Biology](#); [EMD0018 – Malaria No More UK](#).

29 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Emerging diseases and learnings from covid-19](#), (HC 103; 14 June 2023), [Q19](#) [Professor Sir Peter Horby].

30 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Emerging diseases and learnings from covid-19](#), (HC 1303; 21 June 2023).

31 United States (US) Centre for Disease Control and Prevention, [Current H5N1 Bird Flu Situation in Dairy Cows | Avian Influenza](#) (24 May 2024)

32 Australian Centre for Disease Control, [Media release – Human case of bird flu in Victoria](#) (23 May 2024)

33 The World Health Organisation, [Cumulative number of confirmed human cases for avian influenza A\(H5N1\) reported to WHO, 2003–2024](#) (3 May 2024)

29. The Committee heard that messenger ribonucleic acid (mRNA) technology is available for developing vaccinations for avian influenza, however, research is in early stages.

30. The level of preparedness for handling an avian flu outbreak was covered in our inquiry. Evidence highlighted that only two laboratories in the UK could process infected samples, as part of a wider concern of the lack of high-containment level laboratories in the UK. This would limit the surveillance of avian flu in the UK.

31. A One-Health approach was highlighted as important, emphasising the need for research institutes and funders to promote interdisciplinary collaborations. The collaboration between the human health and agricultural sectors and between UKHSA and the Department for Environment, Food & Rural Affairs (DEFRA) in tracking threats. Oral evidence showed that researchers might not always be able to detect diseases before outbreaks occur.

32. The importance of fast and accurate diagnostics was emphasised as a key aspect of responding to pandemics. Therefore, the lack of laboratories with high containment levels is critical to the level of preparedness for emerging diseases and future threats, in general. Concerns around the lack of laboratory facilities were raised following the report from the National Audit Office on the UKHSA's health security campus programme.³⁴

33. The role of key infrastructure for diagnostics and vaccine development in response to covid-19 was critical. However, we heard that facilities like the Lighthouse Laboratories faced closing down, which reduces the diagnostic capacity in the UK. The sale of the Rosalind Franklin laboratory was also emblematic of this issue. The Committee was also told that contracts awarded to National Health Services bodies (NHS) ran out in March 2023.

34. Vaccine development is another aspect of preparation for future threats of emerging diseases, and the importance of equitable access to vaccines and therapeutics was stressed in our inquiry. Collaboration between industry, academia and government was heralded as a success for the Oxford AstraZeneca vaccine for covid-19. The Vaccine Task Force was considered by witnesses as a critical aspect of bringing together the Government, academia, and industry. Therefore, its disbandment was seen as an issue. The UKHSA's Vaccine Development and Evaluation Centre (VDEC) based at Porton Down, was also noted as key for facilitating engagement between academics and industry.

Recommendations for future work

35. *Should our successor Committee wish to further explore emerging diseases and learnings from covid-19, we recommend:*

- *Funding should be made available for diagnostic facilities to uphold contracts, maintain equipment, and run laboratories to allow for fast and accurate diagnoses and aid the surveillance of emerging diseases; and*
- *Ensure the UK Government focuses on multiple vaccine technologies for future pandemics and maintaining collaboration with academia and industry.*

34 National Audit Office, [Investigation into the UKHSA's health security campus programme](#), (28 February 2024).

The Right to privacy: digital data

36. In December 2021 we launched an inquiry into healthcare data privacy and strategy in the NHS. This was motivated by the widespread use of data to inform the public health response to covid-19, the pausing of the General Practice Data for Planning and Research (GPDPR) programme, after data privacy concerns caused widespread public opt-outs, and the subsequent publishing of the Government’s healthcare data strategy, *Data Saves Lives*.³⁵ Written and oral evidence was initially collected from December 2021 to June 2022, followed by further evidence in May 2024 to consider recent developments.

37. The inquiry examined the landscape of technical and regulatory challenges facing the healthcare sector over the handling and use of patient data in the NHS, strategies for ensuring the success of future data endeavours where others have failed, the National Opt-Out and its implications for research, and the potential impact of AI. Findings gathered after the initial evidentiary period examined the progress of the Department for Health and Social Care (DHSC) on the commitments made in *Data Saves Lives*, and the potential for reforming aspects of the public health sector to increase NHS efficiency, improve patient outcomes and create value for the NHS while maintaining public support and strengthening data privacy protections.

Key themes from our work

38. Our inquiry revealed that the landscape of NHS data is fragmented across the regional trusts, with little consistency in format, interoperability and poor integration across the health and care sectors, often leading to inefficient data access mechanisms for clinicians.³⁶

39. Attempts by the NHS to improve the collection, integration and availability of healthcare data through the care.data and GPDPR initiatives resulted in high-profile failures, challenging the foundations of public confidence in the NHS to handle their data securely and ethically. This failure was attributed to poor public engagement and communication,³⁷ a lack of engagement with and support from medical practitioners and organisations such as the British Medical Association (BMA) and Royal College of General Practitioners (RCGP),^{38 39} and the lack of a credible data privacy technical strategy.⁴⁰ These factors precipitated the opt-out of more than 1.2 million adults of sharing their medical data for research and planning purposes across May and June 2021 during the controversy over GPDPR, threatening the utility of the dataset.

40. Additionally, non-proportionality in the demographics of those opting-out had the potential to skew the longitudinal distribution of the remaining data and reinforce existing health inequalities in subsequent research.⁴¹

35 Department of Health and Social Care, [Data saves lives: reshaping health and social care with data](#), (15 June 2022).

36 House of Commons Science and Technology Committee, First Report of Session 2019–21, [The UK response to covid-19: use of scientific advice](#), (HC 136; 8 January 2021), para 109.

37 House of Commons Science and Technology Committee, Oral evidence: The right to privacy: digital data, (HC 1000; 20 April 2022), [Qq79–83](#).

38 British Medical Association, [Statement on GP data for planning and research](#), (11 May 2021).

39 British Medical Association, [BMA calls for delay in roll-out of patient data sharing programme](#), (4 June 2021).

40 A review commissioned by the Secretary of State for Health and Social Care, [Better, Broader, Safer: Using Health Data for Research and Analysis](#), (April 2022), p 86.

41 House of Commons Science and Technology Committee, [The right to privacy: digital data - Oral evidence - Committees - UK Parliament](#), (23 March 2022), Q146.

41. Witnesses for the inquiry were almost unanimous in recognising the benefits of efficient health data sharing. These benefits include improving our understanding of disease, improving diagnosis, ensuring patient safety, development of novel treatments, improving the efficiency of planning NHS services, improving unequal outcomes and access, enhancing productivity, supporting broader social and economic development, and evaluating the effectiveness of NHS policy.⁴²

42. However, much of the utility of health data can be derived from actions that increase exposure to data privacy concerns, namely the use of pseudonymised patient records to preserve the links between comorbidities, and the linking of health data to other administrative data held by other government departments.⁴³ While concerns about this were emphasised by the Association of Medical Research Charities, Liberty and the National Data Guardian, the National Statistician suggested that if the benefits of this were explained to the public, it would receive widespread acceptance.⁴⁴ Public receptiveness to data usage, if a clear public benefit is articulated and the mechanisms for protecting their data are proven, was a consistent theme throughout the inquiry.

43. In response to Professor Ben Goldacre’s report into the use of health data for research and analysis,⁴⁵ the Government published *Data Saves Lives*, a strategy to improve the safety and efficacy of data usage in the NHS. In his report, Professor Goldacre outlined the hazards of using traditionally pseudonymised data and advocated for the implementation of Trusted Research Environments (TREs),⁴⁶ a recommendation which DHSC actioned through the development of the NHS’s Secure Data Environments (SDEs).⁴⁷ Witnesses highlighted the importance of adhering to the Five Safes and the Caldicott Principles by default in data projects.^{48 49}

44. In addition to the SDEs, which provide access to NHS data for external researchers, DHSC is also developing the Federated Data Platform (FDP) to streamline internal NHS planning and logistics.⁵⁰ The awarding of a contract for technology to support the FDP to a private company (Palantir) was met with opposition from MedConfidential and the Doctors’ Association UK who expressed concern that this could undermine public confidence considering the previous reaction to third-party involvement in GPDPR.⁵¹ The system of awarding funding in academia through open and competitive bids to solve problems was highlighted as a particular strength of British research, and was suggested as a superior alternative to either attempts at internal development with inexperienced teams, or the procurement of software to predetermined design specifications.⁵²

42 King’s Fund, [Using data in the NHS: the implications of the opt-out and GDPR](#), (25 May 2018).

43 Department for Health and Social Care, [A plan for digital health and social care](#), (29 June 2022).

44 Professor Sir Ian Diamond (National Statistician at Office for National Statistics) ([DDA0071](#)).

45 A review commissioned by the Secretary of State for Health and Social Care, [Better, Broader, Safer: Using Health Data for Research and Analysis](#), (April 2022).

46 A review commissioned by the Secretary of State for Health and Social Care, [Better, Broader, Safer: Using Health Data for Research and Analysis](#), (April 2022), pp 85–86.

47 Department for Health and Social Care, [Data saves lives: reshaping health and social care with data](#), (15 June 2022), Section 1.

48 ADR UK ([DDA0031](#)); The Royal Society ([DDA0012](#)); Health Data Research UK ([DDA0026](#)); Our Future Health ([DDA0028](#)).

49 National Data Guardian, [The Eight Caldicott Principles](#), (December 2020); National Data Guardian ([DDA0059](#)).

50 NHS England, [NHS Federated data platform](#), (accessed 23 May 2024).

51 Armstrong S., [Palantir gets £480m contract to run NHS data platform](#), *British Medical Journal*, (2023); vol 383, p 2752.

52 A review commissioned by the Secretary of State for Health and Social Care, [Better, Broader, Safer: Using Health Data for Research and Analysis](#), (April 2022), p 103.

45. The Tony Blair Institute seems to be in favour of commercialising access as long as ethical standards are rigidly enforced and pricing models feed value back into the NHS.⁵³ The principle of commercial entities “paying something back” into the NHS was echoed by Understanding Patient Data, the Association of Medical Research Charities and the National Data Guardian,⁵⁴ while medConfidential expressed concern over the use of patient data for secondary purposes.⁵⁵ Attitudinal studies revealed the potential for broad public support.⁵⁶

46. Our inquiry also revealed a severe shortage of digital skills across the NHS,⁵⁷ with several witnesses advocating for programs to professionalise the data analyst position, increase training or further utilise partnerships with third parties.⁵⁸

47. The requirement for modern data infrastructure to be “AI-ready” was noted.⁵⁹ The potential for AI to aid in diagnosis and improved efficiency was contrasted against the risks of “black-box” AI models and the perpetuation of bias.⁶⁰

48. Overall, the current approach to information governance in England was seen as a frequent hindrance to efficient data sharing, with individual GPs and NHS Trusts sharing data controller responsibilities, leading to unclear liabilities, onerous processes of transferring patient records between trusts and an overly cautious approach to data sharing. The system of centralised data governance employed by NHS Scotland was seen as a simpler and more efficient model.⁶¹

Government progress on implementing recommendations

49. While formal recommendations from our inquiry had not been published at the point that parliament was dissolved in May 2024, important progress has been made by DHSC in some policy areas raised during evidence sessions:

- The rollout of the SDEs via 11 sub-national NHS-led SDE teams, linked by the NHS Research SDE Network. While we strongly support the usage of TREs as

53 Tony Blair Institute, [A New National Purpose: Leading the Biotech Revolution](#), Chapter 3, (25 January 2024).

54 Cancer Research UK ([DDA0030](#)) and The Association of Medical Research Charities ([DDA0033](#)); eConsult ([DDA0018](#)); The Open Data Institute (ODI) ([DDA0042](#)); Trilateral Research ([DDA0022](#)).

55 Secondary purposes include for care planning, auditing, medicines development, safety monitoring, research, and policymaking. Open Data Institute, [How well is your country doing on policy for secondary use of health data?](#), (accessed 12 September 2022); British Medical Association, [Requests for disclosure for secondary uses of data](#), (accessed 12 September 2022).

56 National Data Guardian, Understanding Patient Data, Sciencewise and UKRI, [Putting Good into Practice A public dialogue on making public benefit assessments when using health and care data](#), (April 2021), p 53.

57 Department for Health and Social Care, [Independent report Putting data, digital and tech at the heart of transforming the NHS](#), (November 2021).

58 Department for Health and Social Care and NHS England, [A plan for digital health and social care](#), (29 June 2022); A review commissioned by the Secretary of State for Health and Social Care, [Better, Broader, Safer: Using Health Data for Research and Analysis](#), (April 2022), p 103; Tony Blair Institute, [A New National Purpose: Leading the Biotech Revolution](#), Chapter 3, (25 January 2024).

59 NHS, [The NHS Long Term Plan](#), (January 2019), pp 65, 87 and 98; NHS, [The future of healthcare: our vision for digital, data and technology in health and care](#), (October 2018); NHSX, [Artificial Intelligence: How to get it right](#), (October 2019).

60 Joint Committee on Human Rights, Third Report of Session 2019, [The Right to Privacy \(Article 8\) and the Digital Revolution](#), (HC 122; November 2019), pp 25–27; Centre for Data Ethics and Innovation, [Bias in Algorithmic Decision Making](#), (2019); Koene, A, ‘[Algorithmic Bias: Addressing Growing Concerns](#)’, IEEE Technology and Society Magazine, vol 36, (2017), pp 31–32; Obermeyer, Z. et al., [Dissecting racial bias in an algorithm used to manage the health of populations](#), Science, vol 366, (2017), pp 447–453.

61 Tony Blair Institute, [A New National Purpose: Leading the Biotech Revolution](#), Chapter 3, (25 January 2024).

the default mechanism for accessing research data, concerns were raised over the ambition of building 11 regional SDEs, which carries a greater risk of failure and exacerbating existing inefficiencies from the decentralisation of data.

- Similarly, the ambition of the FDP to increase operational efficiency is supported by witnesses. We also support the DHSC’s solicitation of advice on FDP communications from the National Data Guardian, among others, through the National Data Advisory Group (NDAG).⁶² However, despite the contract tender announcement producing only a small increase in public opt-outs, concerns were raised by privacy advocacy groups that this may further erode public confidence.⁶³
- Public engagement activities and the building of supporting groups such as Understanding Patient Data and the NDAG showed progress in the key area of obtaining broad public support. Witnesses emphasised the need to not downplay the risks involved in sharing health data but educate the public on the protections in place.
- The publishing of the Value Sharing Framework to outline the cost model options for data partnerships between NHS entities and private companies, ensuring that developments made using NHS data are available to the public on favourable terms. There remains significant interest in expanding the development of commercial models for generating value from NHS data, which may require the formation of new business units within the NHS.

Recommendations for future work

50. *Should our successor Committee wish to explore the reform of the UK health data strategy, we recommend it considers:*

- *Investigating the replication of the academic model of open and competitive funding to solve problems and develop Privacy Enhancing technologies (PETs) and other critical pieces of data infrastructure as an alternative to internal or contracted software development work;*
- *Recommending a trial comprising an over-resourced, centralised SDE covering a smaller number of trusts to build working templates, develop a skilled workforce and prove the security and privacy approaches to the public and industry. This would aid in obtaining widespread public support by swiftly demonstrating the viability and utility of the SDE model, supporting the success of further projects;*
- *Recommending the implementation of a technical solution for the public to opt back into data sharing, and a targeted campaign to encourage those who have previously opted out to reconsider sharing their health data, now that data protection regulation and technologies have improved and tangible public benefits can be realised;*

62 NHS England, [Meeting minutes - December 2023 - Data Strategy Advisory Panel - NHS Transformation Directorate](#), (December 2023).

63 Armstrong S., [Palantir gets £480m contract to run NHS data platform](#), *British Medical Journal*, vol 383, (2023), p 2752.

- *Recommending the consolidation of the Clinical Practice Research Datalink (CPRD) into the NHS SDE as soon as the latter meets all reasonable user needs, as the CPRD currently provides access to NHS data circumventing the protections of a TRE with significant overlap in functionality and replication of effort;*
- *Recommending the simplification of ethical governance structures to avoid duplication and excessive overlap, and publishing an overview of this system so that all actors know where to obtain guidance;*
- *Investigating the establishment of a single organisation solely responsible for delivering data architecture for public projects. This would assume centralised responsibility for the ongoing data projects by NHS England and other government entities, removing the fragmentation of skills across different bodies and facilitating competitive recruitment;*
- *Investigating the requirements for facilitating the development of AI models within TREs;*
- *Investigating the potential for implementing a shared data controller framework model similar to that used in Scotland, where the burden of data stewardship is removed from GPs and instead rests with NHS Scotland, simplifying data governance structures and facilitating clear and efficient data sharing mechanisms;*
- *Recommending the implementation of real-time audits for quality and completeness of NHS data;*
- *Investigating the potential establishment of an NHS data trust, which manages data and forges external partnerships for health data research, which would then be fed back into the NHS.⁶⁴ This would build upon the principles in NHS England’s Value Sharing Framework for external partnerships, and seek to emulate the success of the BBC’s model of blending public funding with commercial revenue generation to reinvest into the service. Benefits to the NHS of negotiation with research entities could be realised either through direct profit or cost-price access to any treatments developed using NHS data. Advocates argue this would centralise NHS data initiatives, decrease the public funding burden, lengthen funding periods to allow more ambitious planning and confidence, and accelerate the development of novel treatments. However, others argue this would not address the existing challenges facing the healthcare data sector, present more risks to patient autonomy and public acceptance and reduce accountability of organisations using NHS data; and*
- *Investigating the establishment of a research institute focussed on AI medicine. This may be in the form of a new laboratory network across the biological and computational sciences, or as a partnership between relevant existing bodies such as the Francis Crick and Alan Turing Institutes. With a well-established public and private biomedical research sector, the UK is well positioned to take advantage of this burgeoning field and become a world leader in AI medicine.*

64 Tony Blair Institute, [A New National Purpose: Leading the Biotech Revolution](#), Chapter 5, (25 January 2024).

3 Artificial intelligence

51. Appearing at a December 2023 session of the Committee, the Secretary of State for Science, Innovation and Technology (DSIT), Rt. Hon. Michelle Donelan MP, described artificial intelligence (AI) to us as “... a foundational technology that interlinks with all the other technologies”.⁶⁵ The rapid development of AI, and the challenges it has created for policymakers, were the focus of an inquiry we launched in October 2022.⁶⁶

52. This proved fortuitous timing: the following month OpenAI unveiled ChatGPT tool,⁶⁷ the most notable in a series of ‘generative’ AI releases. The increasingly widespread deployment of AI, its consequences, and how policymakers should develop governance frameworks for the technology, were the subject of two landmark reports that we published during the 2019–24 Parliament.

Interim report

53. On 31 August 2023 we published an interim report, which examined the factors behind recent AI developments, highlighted the benefits offered by the technology, and identified ‘Twelve Challenges of AI Governance’ for policymakers. We also examined how the UK Government and other countries and jurisdictions had sought to regulate the development and deployment of AI.⁶⁸ The Government responded to our interim Report in November 2023.

Key themes from our work

54. Our interim report found that since the emergence of so-called ‘large language models’ such as ChatGPT in particular, AI has become a general-purpose, ubiquitous technology—albeit not one that should be viewed as capable of supplanting humans in all areas of society and the economy. AI models and tools can find patterns where humans might not, improve productivity through the automation of routine processes, and power new, innovative consumer products. However, they can also be manipulated, provide false information, and do not always perform as one might expect in messy and complex environments—such as the world we live in.

55. Our interim report identified ‘Twelve Challenges of AI Governance’ that policymakers and the frameworks they design must meet.

- i) **The Bias challenge.** AI can introduce or perpetuate biases that society finds unacceptable.
- ii) **The Privacy challenge.** AI can allow individuals to be identified and personal information about them to be used in ways beyond what the public wants.

65 House of Common Science, Innovation and Technology Committee, [Oral evidence: Governance of artificial intelligence \(AI\)](#), (HC 38; 13 December 2023), [Q771](#) [Rt Hon Michelle Donelan MP, Secretary of State].

66 House of Common Science, Innovation and Technology Committee, [‘Governance of artificial intelligence \(AI\)’](#), (accessed 29 January 2024).

67 OpenAI, [‘Introducing ChatGPT’](#), (accessed 29 January 2024).

68 House of Commons Science, Innovation and Technology Committee, Ninth Report of Session 2022–23, [The Governance of Artificial Intelligence: interim report](#), (HC 1769; 31 August 2023).

- iii) **The Misrepresentation challenge.** AI can allow the generation of material that deliberately misrepresents someone’s behaviour, opinions or character.
- iv) **The Access to Data challenge.** The most powerful AI needs very large datasets, which are held by few organisations.
- v) **The Access to Compute challenge.** The development of powerful AI requires significant compute power, access to which is limited to a few organisations.
- vi) **The Black Box challenge.** Some AI models and tools cannot explain why they produce a particular result, which is a challenge to transparency requirements.
- vii) **The Open-Source challenge.** Requiring code to be openly available may promote transparency and innovation; allowing it to be proprietary may concentrate market power but allow more dependable regulation of harms.
- viii) **The Intellectual Property and Copyright challenge.** Some AI models and tools make use of other people’s content: policy must establish the rights of the originators of this content, and these rights must be enforced.
- ix) **The Liability challenge.** If AI models and tools are used by third parties to do harm, policy must establish whether developers or providers of the technology bear any liability for harms done.
- x) **The Employment challenge.** AI will disrupt the jobs that people do and that are available to be done. Policy makers must anticipate and manage the disruption.
- xi) **The International Coordination challenge.** AI is a global technology, and the development of governance frameworks to regulate its uses must be an international undertaking.
- xii) **The Existential challenge.** Some people think that AI is a major threat to human life: if that is a possibility, governance needs to provide protections for national security.⁶⁹

Second report

56. In the months following the publication of our interim report our inquiry continued, as did debates over how to regulate the development and deployment of AI. These debates often centred around the Twelve Challenges of AI Governance we identified in our interim Report. In May 2024, we published our second Report, which assessed the steps that the UK and other jurisdictions had taken towards implementing regulatory frameworks to govern the development and deployment of AI and offered potential solutions to each of the Twelve Challenges identified in our interim Report. A Government response to our Report is due in July 2024.

69 House of Commons Science, Innovation and Technology Committee, Ninth Report of Session 2022–23, [The Governance of Artificial Intelligence: interim report](#), (HC 1769; 31 August 2023), Summary.

Key themes from our work

57. With a General Election approaching we sought to make our second Report futureproof and believe that our conclusions and recommendations remain applicable to the next Government. We also sought to reflect the uncertainty that exists over many questions that are critical to the future shape of the UK’s AI governance framework: how the technology will develop, what the consequences will be of its increased deployment, whether as-yet hypothetical risks will be realised, and how policy can best keep pace with the rate of development in these and other areas.

58. Our second report examined the current Government’s ‘case for AI’: better public services, high quality jobs and a new era of economic growth driven by advances in AI capabilities. We also examined its intention to pursue the principles-based approach proposed in its March 2023 AI White Paper and examined in our interim report. Five high-level principles—safety, security and robustness; appropriate transparency and explainability; fairness; accountability and governance; and contestability and redress—underpin the Government’s approach and have begun to be translated into sector-specific action by regulators.⁷⁰

59. Our second report considered the current powers, coordination mechanisms and capacity of the UK’s regulators to undertake this work, as well as whether the next Government should bring forward AI-specific legislation. We also revisited the Twelve Challenges identified in our interim report. Although progress has been made in the UK and other jurisdictions, we concluded that these still apply and therefore proposed suggested solutions to each of them. These are summarised below.

- i) **The Bias Challenge.** Developers and deployers of AI models and tools must not merely acknowledge the presence of inherent bias in datasets, they must take steps to mitigate its effects.
- ii) **The Privacy Challenge.** Privacy and frameworks must account for the increasing capability and prevalence of AI models and tools, and ensure the right balance is struck.
- iii) **The Misrepresentation Challenge.** Those who use AI to misrepresent others, or allow such misrepresentation to take place unchallenged, must be held accountable.
- iv) **The Access to Data Challenge.** Access to data, and the responsible management of it, are prerequisites for a healthy, competitive and innovative AI industry and research ecosystem.
- v) **The Access to Compute Challenge.** Democratising and widening access to compute is a prerequisite for a healthy, competitive and innovative AI industry and research ecosystem.
- vi) **The Black Box Challenge.** We should accept that the workings of some AI models are and will remain unexplainable and focus instead on interrogating and verifying their outputs.

70 Department for Science, Innovation and Technology, [A pro-innovation approach to AI regulation](#), (CP 815; 29 March 2023); Department for Science, Innovation and Technology, [A pro-innovation approach to AI regulation: Government response to consultation](#), (CP 1019; 6 February 2024), p 7.

- vii) **The Open-Source Challenge.** The question should not be ‘open’ or ‘closed’, but rather whether there is a sufficiently diverse and competitive market to support the growing demand for AI models and tools.
- viii) **The Intellectual Property and Copyright Challenge.** The Government should broker a fair, sustainable solution based around a licensing framework governing the use of copyrighted material to train AI models.
- ix) **The Liability Challenge.** Determining liability for AI-related harms is not just a matter for the courts—Government and regulators can play a role too.
- x) **The Employment Challenge.** Education is the primary tool for policymakers to respond to the growing prevalence of AI, and to ensure workers can ask the right questions of the technology.
- xi) **The International Coordination Challenge.** A global governance regime for AI may not be realistic nor desirable, even if there are economic and security benefits to be won from international co-operation.
- xii) **The Existential Challenge.** Existential AI risk may not be an immediate concern, but it should not be ignored, even if policy and regulatory activity should primarily focus on the here and now.

Government progress on implementing recommendations

60. The Government welcomed the Twelve Challenges identified in our interim Report,⁷¹ and in its response to the AI White Paper consultation published in February 2024 it committed to implementing one of our principal recommendations: a gap analysis of the UK’s regulators, which would consider not only resourcing and capacity, but whether any regulators require new powers to implement and enforce the principles outlined in the AI White Paper.⁷² Findings from the gap analysis had not been published by the time this report was finalised.

61. On the introduction of AI-specific legislation, a key subject for our inquiry, our interim report concluded that “... there should be a tightly-focussed AI Bill in the new session of Parliament”.⁷³ Ultimately such a Bill was not included in the November 2023 King’s Speech,⁷⁴ but notably the Secretary of State for Science, Innovation and Technology told us in December 2023 that “... the key here is timing. We are not saying that we would never legislate in this space. Of course we would... every Government will have to legislate eventually”.⁷⁵

71 House of Commons Science, Innovation and Technology Committee, First Special Report of Session 2023–24, [The governance of artificial intelligence: interim report: Government response to the Committee’s Ninth report](#), (HC 248; 16 November 2023).

72 Department for Science, Innovation and Technology, [A pro-innovation approach to AI regulation: Government response to consultation](#), (CP 1019; 6 February 2024), p 15.

73 House of Commons Science, Innovation and Technology Committee, Ninth Report of Session 2022–23, [The Governance of Artificial Intelligence: interim report](#), (HC 1769; 31 August 2023), summary.

74 GOV.UK, [The King’s Speech 2023](#), (7 November 2023).

75 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Governance of artificial intelligence \(AI\)](#), (HC 38; 13 December 2023), [Q757](#) [Rt Hon Michelle Donelan MP, Secretary of State].

Recommendations for future work

62. *Should our successor Committee wish to examine the governance of AI, we recommend it considers:*

- *The powers, coordination mechanisms and capacity of UK regulators to respond to the growing prevalence of AI in their sectors;*
- *The case for AI-specific legislation in the UK, and what lessons can be learned from other jurisdictions as they implement their own approaches to AI governance;*
- *The commitments outlined at the AI Safety Summit and AI Seoul Summit, and their implementation by Governments and leading developers;*
- *The current and potential future deployment of AI in the public sector, its benefits and any associated risks;*
- *The potential consequences of widespread AI deployment on current and future employment trends, and how to equip workers of the future with the skills to engage critically with the technology; and*
- *How future administrations respond to the Twelve Challenges of AI Governance highlighted in our interim report.*

4 Digital

63. The Machinery of Government changes in February 2023 led to the creation of the Department for Science, Innovation and Technology and the transfer of digital policy to it, from the former Department for Digital, Culture, Media and Sport.⁷⁶ As digital was a new remit for the Committee during the later stages of this Parliament, the Committee focused its digital enquiry on the cyber security and resilience of the UK’s critical national infrastructure.

Cyber resilience of the UK’s critical national infrastructure

64. The UK has seen in the last few years heightened use of offensive cyber capabilities by state and non-state actors proliferate, exacerbated by Russia’s full-scale invasion of Ukraine. The UK Government’s National Cyber Strategy 2022 and the Government Cyber Security Strategy: 2022–2030 recognised cyber threats to UK Critical National Infrastructure (CNI)—infrastructure whose disruption would have significant national impact—as an area of particular concern.⁷⁷ Digital infrastructure is a keystone in developing critical and emerging technologies within the Science and Technology Framework, and is essential to the UK’s national security under the 2023 Integrated Review Refresh.⁷⁸ Much of the UK’s CNI is underpinned by this digital infrastructure, which must be resilient to cyber-attack if it is to fulfil such fundamental roles in the UK economy.

65. It is in this context that the Committee launched an inquiry into the cyber security and resilience of the UK’s CNI in October 2023.⁷⁹ The Committee received over forty written evidence submissions and heard from eight witnesses during oral sessions.⁸⁰ This inquiry has not reported at the time of Parliament’s dissolution in May 2024.

Key themes from our work

66. The National Cyber Security Centre (NCSC) advised that currently malign actors do not have the intent or capability to significantly disrupt infrastructure within the UK, but that the UK cannot rely on this situation persisting indefinitely. The NCSC in its 2023 Annual Review stated that the UK’s CNI sectors were facing an “enduring and significant threat”.⁸¹ We heard how the UK’s CNI is being targeted by hostile state and state-sponsored actors, but that it is criminal organisations that present the biggest threat to the UK’s CNI.

67. Professor Ciaran Martin, the previous Chief Executive of the National Cyber Security Centre, highlighted that CNI cyber-attacks do not need to be sophisticated and complex

76 GOV.UK, [Making Government Deliver for the British People](#), (7 February 2023).

77 Cabinet Office, [National Cyber Strategy 2022](#), (15 December 2021); Cabinet Office, [Government’s Cyber Security Strategy: 2022–2030](#), (25 January 2022).

78 Department for Science, Innovation and Technology, [The UK Science and Technology Framework](#), (6 March 2023); Cabinet Office, [Integrated Review Refresh 2023: Responding to a more contested and volatile world](#), (13 March 2023).

79 House of Commons Science, Innovation and Technology Committee, [How resilient is UK critical national infrastructure to cyber-attack?](#), (24 October 2023).

80 House of Commons Science, Innovation and Technology Committee, [Cyber resilience of the UK’s critical national infrastructure](#), (accessed 23 May 2024).

81 National Cyber Security Centre, [NCSC Annual Review 2023](#), (14 November 2023).

to disrupt CNI. He explained that the 2021 US Colonial Pipeline ransomware attack was simplistic and targeted a third-party operated administrative system, but still caused a complete shutdown.⁸²

68. We heard that there had been a significant step change in the assessment of Chinese state-sponsored threats to the UK's CNI. Over the course of this inquiry, the United States announced that China has been pre-positioning itself across their CNI with the potential to launch destructive capabilities, the UK Government accused China of being behind malicious cyber campaigns against MPs and the Electoral Commission, and the suggestion that China were behind the hacking of the Ministry of Defence's military personnel data through a third-party operator.⁸³

69. Throughout the inquiry we heard concerns about the increasing attention of malign cyber actors who are targeting attacks on CNI supply chains and interdependencies. Those who gave evidence to the Committee called for the Government to undertake criticalities reviews and undertake supply chain mapping to better understand and thus protect against these threats.⁸⁴

70. Concerns were raised during the inquiry around the levels of cyber literacy in the UK and the impacts this was having on the future development of a skilled workforce needed to protect the UK's CNI. In particular, we heard how there is a lack of skilled talent with knowledge and experience of operational technology, which are often targeted by malign cyber actors as they are typically a legacy product which lack adequate cyber security measures.⁸⁵

71. CNI operators are dominated by the private sector and increasingly use proprietary software and hardware. These technologies are designed and built without taking into consideration their security. A secure by design approach can help address this and is seen by the Government as an essential means of improving the UK's cyber resilience.⁸⁶ However, we heard that currently the adoption of secure by design by industry is limited due to these products having an increased cost, lowering their commercial viability.⁸⁷ The Government could incentivise the market through procuring secure by design products.

72. We welcome the Government's ambitious targets for the UK's CNI to be significantly strengthened to withstand cyber-attacks by 2025, with Government and public sector bodies being resilient to known vulnerabilities and attack methods no later than 2030. However, the implementation and monitoring of these ambitions are vague and need clarification. There is broad consensus that the Government should introduce the proposed

82 BBC News, [US fuel pipeline hackers 'didn't mean to create problems'](#), (10 May 2021).

83 United States Cybersecurity and Infrastructure Security Agency, [PRC State-Sponsored actors compromise and maintain persistent access to U.S. critical infrastructure](#), (7 February 2024); Deputy Prime Minister Rt Hon Oliver Dowden MP CBE, Ministerial Statement, [HC Hansard, \(25 March 2024\), cols 1261 to 1264](#), Sky News, [China hacked Ministry of Defence](#), (7 May 2024).

84 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Cyber resilience of the UK's critical national infrastructure](#), (HC 559; 21 February 2024), [Q6](#) [Professor Ciaran Martin]; [Q33](#) [Professor Sadie Creese].

85 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Cyber resilience of the UK's critical national infrastructure](#), (HC 559; 21 February 2024), [Q41](#) [Siân John].

86 Cabinet Office, [National Cyber Strategy 2022](#), (15 December 2021).

87 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Cyber resilience of the UK's critical national infrastructure](#), (HC 559; 24 April 2024), [Q60](#) [Professor John Goodacre and Mr Richard Grisenthwaite].

reforms to the Network and Information Systems Regulations 2018, to strengthen reporting requirements and bring additional sectors and organisations (including supply chains) into scope.⁸⁸

73. There is also strong consensus that the Government must reform the Computer Misuse Act 1990, to include a statutory public interest defence for professionals conducting legitimate cybersecurity research in the public interest. This would bring the UK in line with other countries such as France and the United States. Sir Patrick Vallance recommended such an amendment to catalyse innovation within the cyber sector. The Government have previously announced consultations into the Act in 2021 and again in November 2023. However, the Home Office stated in its response to the latest consultation that it is considering future work around the statutory public interest defence.⁸⁹

Recommendations for future work

74. *Should our successor Committee wish to examine the cyber security and resilience of the UK’s critical national infrastructure, we recommend it considers:*

- *Following up how the Government is monitoring the emerging threats from nation states, state-sponsored actors, and criminal organisations on the UK’s critical national infrastructure. This should include the threat from pre-positioning;*
- *considering how the Government is protecting and strengthening critical national infrastructure supply chains and interdependencies;*
- *Scrutinising the Government’s ability to meet their targets for the UK’s CNI to be significantly hardened to cyber-attacks by 2025, with all government organisations across the whole public sector being resilient to known vulnerabilities and attack methods no later than 2030;*
- *Exploring how emerging technologies, such as artificial intelligence and quantum computing, may bring both unprecedented opportunities and threats to cyber security and resilience;*
- *Exploring whether there is a need for a general duty for cyber resilience and it would apply to critical national infrastructure;*
- *Investigating Whether the payment of ransoms should be made illegal for critical national infrastructure;*
- *Scrutinising the Government’s work around improving cyber literacy across all levels;*
- *Scrutinising the commercial viability of secure by design technologies; and*
- *Considering the need to update cyber security legislation such as the Network and Information Systems regulation and the Computer Misuse Act 1990.*

88 NCC Group ([CYB0008](#)); Darktrace ([CYB0017](#)); techUK ([CYB0028](#)); Thales ([CYB0033](#)); Institute of Corporate Resilience ([CYB0036](#)).

89 NCC Group ([CYB0008](#)); Darktrace ([CYB0017](#)); CyberUp Campaign ([CYB0023](#)); BT Group ([CYB0041](#)).

5 Energy

75. Our energy-related inquiries during this Parliament focused on two key sources: hydrogen, specifically its role in achieving net zero, and nuclear power.

The role of hydrogen in achieving net zero

76. In December 2020 we launched an inquiry to examine the role of hydrogen in achieving net zero.⁹⁰ Following recommendations from the Committee on Climate Change that the Government develop a strategy for hydrogen use and should aim for largescale hydrogen trials to begin in the early 2020s,⁹¹ the inquiry examined the Government’s plan for delivery.⁹² We assessed the infrastructure required for hydrogen as a Net Zero fuel, and examined progress made so far internationally to determine the viability of hydrogen as a significant contributor to achieving Net Zero. Our Report was published on 19 December 2022,⁹³ and the Government Response was published on 30 March 2023.⁹⁴

Key themes from our work

77. Our report found that if the Government is to meet its Net Zero target by 2050, then hydrogen’s role in the overall decarbonisation strategy should be defined and integrated across the relevant Government departments and public bodies. We recommended a series of decision points up to 2050 be outlined by Government, for each of the policy areas identified in the Ten Point Plan for a Green Industrial Revolution. We also said that the Government should provide more detail about the scientific and technical progress required to deliver on hydrogen’s potential role in achieving Net Zero.⁹⁵

78. Our inquiry identified a clear and growing international interest in uses for low-carbon hydrogen, including green hydrogen—including as a means of energy storage.⁹⁶ We recommended that the Government incentivise increased green hydrogen production capacity by setting a 2030 production target.⁹⁷

79. In addition to energy storage, we examined the increasing interest in hydrogen’s potential use as a source of fuel for various modes of transport, including buses, planes,

90 House of Commons Science, Innovation and Technology Committee, [‘How can hydrogen contribute to net zero? MPs launch inquiry’](#), (accessed 30 January 2024).

91 Committee on Climate Change, [Reducing UK emissions: progress report to Parliament](#), (25 June 2020).

92 HM Government, [The Ten Point Plan for a Green Industrial Revolution](#), (18 November 2020).

93 House of Commons Science and Technology Committee, Fourth Report of Session 2022–23, [The role of hydrogen in achieving Net Zero](#), (HC 99; 19 December 2022).

94 House of Commons Science and Technology Committee, First Special Report of 2022–23, [The role of hydrogen in achieving Net Zero: Government Response to the Committee’s Fourth Report](#), (HC 1257; 30 March 2023).

95 House of Commons Science and Technology Committee, Fourth Report of Session 2022–23, [The role of hydrogen in achieving Net Zero](#), (HC 99, 19 December 2022), para 18.

96 House of Commons Science and Technology Committee, Fourth Report of Session 2022–23, [The role of hydrogen in achieving Net Zero](#), (HC 99; December 2022), paras 65 and 75.

97 House of Commons Science and Technology Committee, Fourth Report of Session 2022–23, [The role of hydrogen in achieving Net Zero](#), (HC 99; December 2022), para 66.

and trains.⁹⁸ However, in the case of domestic heating, we were unconvinced that hydrogen boilers would prove economically viable by 2026, when the Government has said will determine their future role.⁹⁹

80. Overall, we detected a desire on the part of the Government to keep its options open when it came to the deployment of hydrogen in different areas of the economy, pending further market and technological developments. However, we warned that developing the necessary infrastructure and encouraging uptake of hydrogen would inevitably come with a cost, which would have to be met at least in part by investors—who require clarity and certainty in order to proceed.¹⁰⁰ It was this that prompted our calls for greater clarity and increased decision-making from the Government over hydrogen’s future role, which we said would likely be “specific but limited”.¹⁰¹

Government progress on implementing recommendations.

81. Our report made a series of recommendations intended to elicit further decisions from the Government, and to provide increased certainty about hydrogen’s future role. These included:

Decision points

82. Our report recommended that:

The Government should, in the next two months, outline a series of decision points between now and 2050 that will determine the role of hydrogen in the UK, in each policy area identified in the Ten Point Plan for a Green Industrial Revolution. This should be accompanied by an outline of the scientific and technological progress that needs to be made to allow hydrogen to play its part in our energy system.¹⁰²

83. The Government did not accept this recommendation but did point to its commitment to implementing its Hydrogen Strategy and the Net Zero Research and Innovation Delivery Plan.¹⁰³

2030 target

84. Our report recommended that:

The Government should set a 2030 target for green hydrogen production to ensure that full-scale development of green hydrogen is incentivised to

98 House of Commons Science and Technology Committee, Fourth Report of Session 2022–23, [The role of hydrogen in achieving Net Zero](#), (HC 99; December 2022), paras 94, 101, 103, 109–110, and 119.

99 House of Commons Science and Technology Committee, Fourth Report of Session 2022–23, [The role of hydrogen in achieving Net Zero](#), (HC 99; December 2022), para 133.

100 House of Commons Science and Technology Committee, Fourth Report of Session 2022–23, [The role of hydrogen in achieving Net Zero](#), (HC 99; December 2022), paras 177 and 184.

101 House of Commons Science, Innovation and Technology Committee, [Hydrogen is not a panacea for reaching Net Zero, warn MPs](#), (31 January 2024).

102 House of Commons Science and Technology Committee, Fourth Report of Session 2022–23, [The role of hydrogen in achieving Net Zero](#), (HC 99; December 2022), para 18.

103 House of Commons Science and Technology Committee, First Special Report of Session 2022–23, [The role of hydrogen in achieving Net Zero: Government Response to the Committee’s Fourth Report](#), (HC 1257; 30 March 2023), p 1.

take place in the short-term and to make it more likely that the UK develops a green hydrogen production capacity. The Government should be clear whether any targets it sets are for capacity to produce, or are an expectation of how much hydrogen the UK expects to produce and use. The Government should also indicate when grey hydrogen production will be phased out.¹⁰⁴

85. The Government told us that it believed its current planned interventions were “... expected to be sufficient to incentivise and support the decarbonisation or displacement of hydrogen currently produced by steam methane reformation without carbon capture”.¹⁰⁵

Government responsibility and accountability

86. Our Report recommended that:

... the Government should designate or create a single department or agency with responsibility and accountability for delivering cross-departmental Net Zero commitments, including those relating to delivering the hydrogen strategy.¹⁰⁶

87. The Department for Energy Security and Net Zero was created on 7 February 2023.¹⁰⁷

Recommendations for future work

88. *Should our successor Committee wish to examine the role of hydrogen in achieving net zero, we recommend it considers:*

- *Scrutinising Government decision-making relating to the deployment of hydrogen ahead of 2030;*
- *Examining findings from trials of hydrogen in different areas of the economy (e.g. energy storage, transport) and considering whether lessons have been learned and implemented by Government;*
- *Examining what progress has been made in deciding upon the role of hydrogen in domestic heating, and the associated implications for consumers and the UK’s Net Zero target;*
- *Examining what progress has been made in identifying which industrial settings could utilise blue hydrogen ahead of 2050, and the phase-out of grey hydrogen; and*
- *The development of green hydrogen projects at scale in the UK, to ensure that green hydrogen can be produced and become cost-competitive with blue hydrogen.*

104 House of Commons Science and Technology Committee, Fourth Report of Session 2022–23, [The role of hydrogen in achieving Net Zero](#), (HC 99; December 2022), para 66.

105 House of Commons Science and Technology Committee, First Special Report of Session 2022–23, [The role of hydrogen in achieving Net Zero: Government Response to the Committee’s Fourth Report](#), (HC 1257; 30 March 2023), p 6.

106 House of Commons Science and Technology Committee, Fourth Report of Session 2022–23, [The role of hydrogen in achieving Net Zero](#), (HC 99; December 2022), para 165.

107 GOV.UK, [Making Government Deliver for the British People](#), (7 February 2023).

Delivering nuclear power

89. In April 2022 the Government set out its aim to increase domestic energy production in the Energy Security Strategy.¹⁰⁸ As part of this strategy the Government said that it aimed to provide up to 25% of the UK’s electricity through nuclear energy generation, by increasing nuclear capacity from around 5.5 Gigawatts (GW) in 2022,¹⁰⁹ to 24 GW by 2050.¹¹⁰

90. In July 2022 we launched an inquiry to examine how the UK could deliver civil nuclear power generation to achieve the aims of the Energy Security Strategy. We sought views on: what Government support would be required to establish new nuclear projects and ensure that the UK’s electricity supply was not impacted by the high proportion of reactors scheduled for decommissioning; the challenges associated with bringing new technologies such as small and advanced modular reactors (SMRs and AMRs) and to the grid; and how the UK should improve its approach to handling both legacy and new nuclear waste. Our report was published on 31 July 2023,¹¹¹ and the Government response was published on 25 October 2023.¹¹²

Key themes from our work and Government progress on implementing recommendations

Nuclear new build strategy

91. Our report detailed concerns about how the UK could achieve the Government’s aim of up to 24 GW nuclear capacity by 2050 and noted that a substantial new build programme would be required,¹¹³ especially considering the number of scheduled decommissions of the UK’s current reactors that were planned.¹¹⁴ We recommended that the Government publish a Nuclear Strategic Plan, developed in collaboration with the sector, that would provide clarity on the long-term decisions needed to ensure the successful roll-out of new nuclear infrastructure.¹¹⁵ We asked that the Plan include details on which choice of technology, including Gigawatt scale, SMRs and AMRs, that the Government would support and for a detailed timeline for when new projects were expected to be completed.¹¹⁶

92. On 11 January 2024, almost six months after we published our Report, the Government published the Civil Nuclear Roadmap,¹¹⁷ a policy paper with the aim of giving “industry

108 HM Government, [British Energy Security Strategy](#), (7 April 2022).

109 House of Commons Science and Technology Committee, [Oral evidence: Delivering Nuclear Power](#), (HC 626; 2 November 2022), [Q60](#) [Paul Spence].

110 HM Government, [British Energy Security Strategy](#), (7 April 2022), p 21.

111 House of Commons Science, Innovation and Technology Committee, Eighth Report of Session 2022–23, [Delivering nuclear power](#), (HC 626; 19 July 2023).

112 House of Commons Science, Innovation and Technology Committee, Sixth Special Report of Session 2022–23, [Delivering nuclear power: Government Response to the Committee’s Eighth Report](#), (HC 1897; 25 October 2023).

113 House of Commons Science, Innovation and Technology Committee, Eighth Report of Session 2022–23, [Delivering nuclear power](#), (HC 626; 19 July 2023), paras 41–42.

114 House of Commons Science, Innovation and Technology Committee, Eighth Report of Session 2022–23, [Delivering nuclear power](#), (HC 626; 19 July 2023), paras 22–26.

115 House of Commons Science, Innovation and Technology Committee, Eighth Report of Session 2022–23, [Delivering nuclear power](#), (HC 626; 19 July 2023), para 42.

116 House of Commons Science, Innovation and Technology Committee, Eighth Report of Session 2022–23, [Delivering nuclear power](#), (HC 626; 19 July 2023), paras 76–77.

117 Department for Energy Security and Net Zero, [Civil nuclear: roadmap to 2050](#), (11 January 2024).

certainty of the future direction of the UK’s ambitious nuclear programme”.¹¹⁸ The Civil Nuclear Roadmap set out the following commitments on the target mix of technologies and timelines:

- 1) We are committing to explore a further large-scale reactor project beyond SZC [Sizewell C].
- 2) We are committing to deploy SMRs in the UK, unlocking the benefits of modularisation and replication.
- 3) We remain committed to deploying up to 24GW by 2050 and to achieve this aim will aim to secure investment decisions to deliver 3–7GW every five years from 2030 to 2044.
- 4) We will develop a strong government support offer for private sector AMR vendors, following the Alternative Routes to Market consultation.¹¹⁹

93. With regard to SMR technology in particular our report recommended:

The Government should take steps to advance the ability for FIDs [Final Investment Decisions] to be taken before 2029 and provide a detailed timeline of when it expects the winner or winners of GBN’s SMR technology selection process to begin commercially supplying electricity to the UK.¹²⁰

94. In its response to our report the Government said that:

This SMR Technology Selection Process (TSP) will underpin government’s commitment to two nuclear Project Final Investment Decisions (FIDs) during the next Parliament. It will support the government’s ambition to deliver up to 24GW of nuclear power in the UK by 2050. The Government recognises the importance of moving quickly to uphold our energy security and net zero ambitions, and is seeking to deliver the fastest competition of its kind in the world.¹²¹

The Roadmap continued to commit to achieving FID by 2029 and “deliver operational projects in the mid-2030s”.¹²²

Great British Nuclear

95. During the course of our inquiry, a new nuclear body, Great British Nuclear, was established. Although this step was generally welcomed by the sector, a common theme of evidence to our inquiry was ambiguity as to what GBN’s role would be.¹²³ Towards the end of our inquiry the Government brought in legislation, through the Energy Act 2023,

118 HM Government, [Biggest expansion of nuclear power for 70 years to create jobs, reduce bills and strengthen Britain’s energy security](#), (11 January 2024).

119 Department for Energy Security and Net Zero, [Civil nuclear: roadmap to 2050](#), (11 January 2024), p 21.

120 House of Commons Science, Innovation and Technology Committee, Eighth Report of Session 2022–23, [Delivering nuclear power](#), (HC 626;19 July 2023), para 59.

121 House of Commons Science, Innovation and Technology Committee, Sixth Special Report of Session 2022–23, [Delivering nuclear power: Government Response to the Committee’s Eighth Report](#), (HC 1897; 25 October 2023), para 10.

122 Department for Energy Security and Net Zero, [Civil nuclear: roadmap to 2050](#), (11 January 2024), p 22.

123 House of Commons Science, Innovation and Technology Committee, Eighth Report of Session 2022–23, [Delivering nuclear power](#), (HC 626;19 July 2023), paras 43–47.

that defined GBN’s role and announced that it would run a competition to select small modular reactor designs. Despite this, we were still unsure what the long-term remit of GBN was and asked the Government to provide clarity on this.¹²⁴

96. Our report recommended that:

In response to this Report, the Government should set out additional detail on how Government will intersect with Great British Nuclear, including details of Great British Nuclear’s exact remit and funding model, and the formal split of responsibilities with the Department for Energy Security and Net Zero. To aid this, the Government should publish the required secondary legislation that will support the creation of Great British Nuclear. Within this detail, the Government should clearly define what the role for Great British Nuclear will be on supporting new nuclear projects beyond the initial small modular reactors competition, including in relation to gigawatt size projects beyond Sizewell C and deployment of advanced modular reactors when technologically ready.¹²⁵

97. The Government’s Roadmap reiterated that GBN’s initial focus was the technical selection process for SMRs, with the hope of achieving an FID by 2029.¹²⁶ With regard to its future remit, the Roadmap said that “as government’s nuclear programme progresses, GBN will respond and broaden its delivery focus” and that GBN would “advise government on a broad range of industry and sectoral barriers”.¹²⁷

Financing new nuclear

98. We explored the complexities of financing new nuclear, including scrutinising the planned use of the Regulatory Asset Base (RAB) model.¹²⁸ We had concerns about the level of risk that consumers or taxpayers would be forced to take on under the RAB model and asked the Government to provide clarity on this before any contracts for new nuclear are signed under this model.¹²⁹ We recommended that:

It may be the case that the size of capital outlay means that private investors will not repeat a CfD [Contract for Difference] contract for new nuclear, whatever the price. But the lack of alternative choices should not mean that any terms will be acceptable for a RAB financed plant. The Government should make, and disclose, its best estimate of the value of the risk that would be taken on by the public, and a clear plan of how those risks can be managed through incentives during the development, construction and operational phase of the project’s lifetime.¹³⁰

124 House of Commons Science, Innovation and Technology Committee, Eighth Report of Session 2022–23, [Delivering nuclear power](#), (HC 626;19 July 2023), paras 56–59.

125 House of Commons Science, Innovation and Technology Committee, Eighth Report of Session 2022–23, [Delivering nuclear power](#), (HC 626;19 July 2023), para 57.

126 Department for Energy Security and Net Zero, [Civil nuclear: roadmap to 2050](#), (11 January 2024), p 23.

127 Department for Energy Security and Net Zero, [Civil nuclear: roadmap to 2050](#), (11 January 2024), p 23.

128 House of Commons Science, Innovation and Technology Committee, Eighth Report of Session 2022–23, [Delivering nuclear power](#), (HC 626;19 July 2023), paras 186–226.

129 House of Commons Science, Innovation and Technology Committee, Eighth Report of Session 2022–23, [Delivering nuclear power](#), (HC 626;19 July 2023), paras 216–221.

130 House of Commons Science, Innovation and Technology Committee, Eighth Report of Session 2022–23, [Delivering nuclear power](#), (HC 626;19 July 2023), para 220.

As well as:

The Government should publish details of how the estimated savings from using the RAB model for funding Sizewell C were calculated, and provide clarity for the funding structure, by publishing the Heads of Terms for the agreed RAB funding model for that project.¹³¹

99. In April 2024, the Government published its response to a consultation it held between November 2023 and January 2024 on Modifications to the Sizewell C Regulated Asset Base licence.¹³² The proposed modifications would allow Sizewell C to collect revenue through the RAB model and put in place incentives and penalties to drive the efficient construction, commissioning and operation of Sizewell C. The Government will publish the final licence once the modifications have been made.

100. We also recommended that the Government continue to explore which finance models will be suitable for the smaller projects that they may consider:

If a single supplier of SMRs were to be available, either through Government choice or following the Generic Design Assessment process, the CfD auction model will not be suitable. As part of a clear and specific strategy for SMRs, the Government should come to a view quickly on what financial model would be available for the initial deployment and communicate this clearly to developers.¹³³

101. In January 2024 the Government published a consultation on “Alternative routes to market for new nuclear projects”,¹³⁴ which sought views on what steps the Government could take to enable different routes to market for Advanced Nuclear Technologies, including SMRs and AMRs. The consultation ran until April 2024 and the Government are currently analysing the responses. The Government published pre-reading material for a ‘Nuclear Hackathon’ held on 9 April 2024, an event organised with Policy Lab to consider how to speed up the delivery of nuclear projects.

We also made conclusions on the Green Taxonomy:

We welcome the proposed inclusion of nuclear energy generation in the UK Green Taxonomy as it reflects the low-carbon contribution of nuclear power and may make new building projects more attractive to private investors as with other low-carbon energy generators.

The Government should conduct and publish the results of its consultation quickly, and during this time review nuclear energy’s access to the Green Financing Framework with a view to ensuring consistency and addressing the contradiction between the two.¹³⁵

131 House of Commons Science, Innovation and Technology Committee, Eighth Report of Session 2022–23, [Delivering nuclear power](#), (HC 626;19 July 2023), para 221.

132 Department for Energy Security and Net Zero, [Modifications to the Sizewell C Regulated Asset Base licence](#), (updated 8 April 2024).

133 House of Commons Science, Innovation and Technology Committee, Eighth Report of Session 2022–23, [Delivering nuclear power](#), (HC 626;19 July 2023), para 226.

134 Department for Energy Security and Net Zero, [Alternative routes to market for new nuclear projects](#), (11 January 2023).

135 House of Commons Science, Innovation and Technology Committee, Eighth Report of Session 2022–23, [Delivering nuclear power](#), (HC 626;19 July 2023), para 235.

102. Both the Government response to our report and the Civil Nuclear Roadmap stated that the Government would consult on the UK Green Taxonomy,¹³⁶ but as of May 2024 this consultation had not been published.

Plan for nuclear skills

103. Throughout our inquiry, we discovered that the nuclear sector faces a skills shortage due to competition with other highly skilled sectors.¹³⁷ We therefore recommended that as part of its strategic planning, the Government, with the sector, should produce a detailed plan of how it would address the nuclear skills gap, which should include increasing the permeability of the sector to other commercial, engineering, and scientific sectors.¹³⁸

104. On 1 August 2023, just after our report was published, the Government announced the creation of a new Nuclear Skills Taskforce, which would aim to “address how the UK continues to build nuclear skills across its defence and civil workforce”.¹³⁹ According to the Government’s Roadmap, the Nuclear Skills Taskforce was due to publish its first recommendations in early 2024.¹⁴⁰ As of May 2024, no report or recommendations from the Nuclear Skills Taskforce have been published. In a response to a PQ asked on 31 January 2024, the Government said: “a report setting out the Taskforce’s findings and recommendations will be presented to Ministers shortly with publication to follow in due course.”¹⁴¹

Siting of new nuclear

105. A key problem identified in our evidence was that the siting process for nuclear power plants was outdated.¹⁴² The eight sites designated within the energy National Policy Statement (NPS) EN-6 were suitable for GW size reactors, and there was no approved plan in place for siting smaller reactors, such as SMRs and AMRs.¹⁴³ We recommended that the Government should progress the consultation on the new NPS EN-7 for nuclear power, which would cover smaller reactors, and should aim to publish this before its previously stated deadline of early 2025.¹⁴⁴

106. In January 2024, the Government published a consultation on the approach to siting that would be covered in the EN-7.¹⁴⁵ This consultation set out that a different approach

136 House of Commons Science, Innovation and Technology Committee, Sixth Special Report of Session 2022–23, [Delivering nuclear power: Government Response to the Committee’s Eighth Report](#), (HC 1897; 25 October 2023), para 47; Department for Energy Security and Net Zero, [Civil nuclear: roadmap to 2050](#), (11 January 2024), p 42.

137 House of Commons Science, Innovation and Technology Committee, Eighth Report of Session 2022–23, [Delivering nuclear power](#), (HC 626; 19 July 2023), paras 147–185.

138 House of Commons Science, Innovation and Technology Committee, Eighth Report of Session 2022–23, [Delivering nuclear power](#), (HC 626; 19 July 2023), paras 170–171.

139 Ministry of Defence and Department for Energy Security and Net Zero, [New Taskforce to build UK nuclear skills](#), (1 August 2023).

140 Department for Energy Security and Net Zero, [Civil nuclear: roadmap to 2050](#), (11 January 2024), p 57

141 House of Commons, Nuclear Skills Taskforce, (31 January 2024), [PQ 12259](#).

142 House of Commons Science, Innovation and Technology Committee, Eighth Report of Session 2022–23, [Delivering nuclear power](#), (HC 626; 19 July 2023), paras 259–267.

143 Science, Innovation and Technology Committee, Eighth Report of Session 2022–23, [Delivering nuclear power](#), (HC 626; 19 July 2023), paras 259, 264–267.

144 House of Commons Science, Innovation and Technology Committee, Eighth Report of Session 2022–23, [Delivering nuclear power](#), (HC 626; 19 July 2023), para 267.

145 Department for Energy Security and Net Zero, [A National Policy Statement for new nuclear power generation: Consultation on the new approach to siting beyond 2025](#), (January 2024).

to siting was required that would cover SMRs, AMRs and GW scale reactors, with the core aim of “empowering developers to select sites for nuclear development, using criteria set in the NPS, to open up more siting opportunities whilst constraining development in unsuitable areas”.¹⁴⁶ This is in contrast to the current nuclear NPS EN-6, which defines eight sites where nuclear projects could be built. The consultation stated that the Government intended to publish a draft NPS EN-7 for consultation in 2024.¹⁴⁷ As of May 2024, a draft NPS EN-7 has not been published by the Government.

Decommissioning and waste

107. Since 2006, Government policy has been to establish a Geological Disposal Facility (GDF) for the long-term storage of nuclear waste. Despite this, Nuclear Waste Services, which is the body responsible for establishing a GDF, were not at the point of having found a community willing to host a GDF or to be able to conduct the detailed geological investigations required to establish a suitable site for a GDF.¹⁴⁸ The timelines and costs for building a GDF were also uncertain. Having said this, we concluded that despite the lack of a UK GDF in the immediate future, the incremental waste generated by new nuclear power plants should not be a material factor in decisions on approving new gigawatt-scale plants.¹⁴⁹

108. As of May 2024 there have been no further updates on the siting of a GDF.

Fusion

109. Aside from our analysis of the UK’s plans for building its nuclear fission capacities, we explored the status of the UK’s research on fusion. We were pleased to discover that the UK is a leading nation in fusion research and development, with high levels of public investment as well as a thriving cluster of private enterprises in Culham. Although fusion was yet to be commercially viable, breakthroughs have started to be delivered and we therefore recommended that the Government includes fusion as part of a long-term energy plan to give stability to the sector and maintain the confidence of investors and international partners.

Recommendations for future work

110. *Should our successor Committee wish to examine the Government’s approach to delivering new nuclear, we recommend it considers:*

- *Examining what progress has been made towards the Government reaching FID for two new nuclear plants by the end of the next Parliament, including progress made on Sizewell C and progress made towards supporting a Small Modular Reactor (SMR) developer;*

146 Department for Energy Security and Net Zero, [A National Policy Statement for new nuclear power generation: Consultation on the new approach to siting beyond 2025](#), (January 2024), p 17.

147 Department for Energy Security and Net Zero, [A National Policy Statement for new nuclear power generation: Consultation on the new approach to siting beyond 2025](#), (January 2024), p 4.

148 House of Commons Science, Innovation and Technology Committee, Eighth Report of Session 2022–23, [Delivering nuclear power](#), (HC 626;19 July 2023), paras 296–297.

149 House of Commons Science, Innovation and Technology Committee, Eighth Report of Session 2022–23, [Delivering nuclear power](#), (HC 626;19 July 2023), para 297.

- *Scrutinising how the role of Great British Nuclear (GBN) has developed beyond running an SMR competition and if it is bringing value to the nuclear sector;*
- *Examining the ongoing approach to financing new nuclear projects, including the results of the consultation on “Alternative routes to market for new nuclear projects”;*
- *Assessing the work of the Nuclear Fuels Taskforce and progress made towards bridging the nuclear skills gap; and*
- *Reviewing the progress made towards selecting a site for a Geological Disposal Facility (GDF) and whether delivery is on time.*

6 Life sciences

111. During the later stages of this Parliament, the Committee has explored the potential of two often overlooked fields of life science research, bacteriophages (phages) and fungi. After we reported on phages and held an evidence session on fungi, the Government published its latest antimicrobial resistance (AMR) strategy.¹⁵⁰ This included greater emphasis on the potential of phages to tackle AMR, referencing our report, and for the first time noted the threat fungi presented in terms of AMR. Our evidence session on fungi noted both their benefits and potential risks. Our work suggested that more work and investment in both these areas are needed if we are to properly assess them.

The antimicrobial potential of bacteriophages

112. We launched our inquiry into the antimicrobial potential of bacteriophages in November 2022,¹⁵¹ which was informed by a successful pitch to the Committee’s My Science inquiry.¹⁵² It also followed on from an evidence session we held on antimicrobial resistance (AMR) in June 2022.¹⁵³ The starting point for the inquiry was growing concern of the threat caused by growing AMR, the difficulties in developing new antibiotics and the potential of bacteriophages (phages). The latter are viruses that can ‘eat’ bacteria and reduce resistance to antibiotics by removing barriers—biofilms—which have evolved and reduced antimicrobial effectiveness. However, a number of challenges have faced the development of phages which we fully explored.

113. The inquiry sought to explore and understand:

- the global development and deployment of phages and how they are currently being used to fight harmful bacteria;
- the strengths and weaknesses of phages over antibiotics and other alternative anti-microbial techniques and technologies;
- the regulation of phages in the UK, EU and other countries; and
- the challenges and opportunities for developing UK phages.

150 HM Government, [Confronting antimicrobial resistance 2024 to 2029](#), (8 May 2024).

151 House of Commons Science and Technology Committee, [MPs to examine use of bacteria-killing viruses to treat infection](#), (15 November 2022).

152 Our inquiry was a result of the successful pitch to the Committee’s [My Science initiative](#) held in October 2022 by Professor James Ebdon, on behalf of Applied Microbiology International. Our My Science initiative is held each parliament and seeks to provide “an opportunity for the science and technology community and the general public to alert us to topics deserving greater parliamentary scrutiny”. House of Commons Science and Technology Committee, [Future programme: ‘My Science Inquiry’](#), (HC 859; February 2017), para 2.

153 House of Commons Science and Technology Committee, [Oral evidence: Antimicrobial resistance](#), (HC 231; 22 June 2022, [Q1–64](#) [Professor Alison Holmes, Lord O’Neill of Gatley, Dr Kitty Healey, Professor Mark Woolhouse OBE, Dr Seamus O’Brien, Professor Robert Schooley and Dr Peter Jackson]).

We received 47 pieces of written evidence,¹⁵⁴ and heard from 21 witnesses across three oral evidence sessions.¹⁵⁵ We published our report on 3 January 2024.¹⁵⁶ The Government response was published on 1 March 2024.¹⁵⁷

Key themes from our work

114. Our inquiry found that phage safety and effectiveness had been shown using observational clinical studies, but that further research on phage biology and interactions is needed.¹⁵⁸ We also found that phages could also be used to treat bacterial infections in animals, aquaculture, soil and waterways as part of a ‘One Health’ approach to AMR.¹⁵⁹ This suggests that increased investment into phage research will enable more robust studies to be performed and higher quality clinical data gathered and for phages to be used more widely. However, we established that phage research is struggling to obtain this funding. We also found that there is a ‘translation gap’ between phage research and the application of phages in clinical settings, which are also suffering from a lack of funding.¹⁶⁰

115. One of the other key gaps we confirmed is the current absence of a UK manufacturing capability for phages to meet Good Manufacturing Practice (GMP) standards, the standards conventional drugs and therapies must meet to be made available for patients. This is linked to the non-generic nature of phages, which are administered in ‘cocktails’ and ‘personalised’ to the characteristics of individual patients and the bacterial infections they are subject to. This means phages struggle to meet regulations designed for conventional medicines produced to a single formulation and the requirements for clinical trials, which are required for GMP standards.¹⁶¹

116. Without phage GMP manufacturing capacity in the UK, no UK-produced phages have been allowed to be used to treat UK patients. However, we took evidence that highlighted the use of non-GMP phages in other countries on a ‘compassionate’ basis for patients where antibiotics are no longer effective for life-threatening bacterial infections. This includes countries where non-GMP phages are being used because of more permissive regulators (e.g. USA), a magistral approach allows pharmacists to sign off phages for individual patients (e.g. Belgium), or where non-GMP generic production alongside personalised cocktails are permitted (e.g. Georgia).¹⁶² We also learnt that in a small number of cases, non-GMP phages have been imported into the UK, mainly from

154 House of Commons Science, Innovation and Technology Committee, The antimicrobial potential of bacteriophages, [written evidence](#).

155 House of Commons Science, Innovation and Technology Committee, The antimicrobial potential of bacteriophages, [oral evidence transcripts](#).

156 House of Commons Science, Innovation and Technology Committee, First Report of Session 2023–24, [The antimicrobial potential of bacteriophages](#), (HC 328; 3 January 2024).

157 Department of Health and Social Care, [The antimicrobial potential of bacteriophages report: government response](#), (CP 995; 1 March 2024).

158 Microbiology Society ([PHA0015](#)), Antibiotic Research UK ([PHA0020](#)), Dr Gwen Knight and Professor Jodi Lindsay ([PHA0021](#)), Centre for Phage Research at University of Leicester ([PHA0027](#)).

159 WHO, [One Health](#), (accessed 23 May 2024).

160 House of Commons Science, Innovation and Technology Committee, First Report of Session 2023–24, [The antimicrobial potential of bacteriophages](#), (HC 328; 3 January 2024), pp 22–25 and pp 42–43.

161 House of Commons Science, Innovation and Technology Committee, First Report of Session 2023–24, [The antimicrobial potential of bacteriophages](#), (HC 328; 3 January 2024), pp 32–36.

162 House of Commons Science, Innovation and Technology Committee, First Report of Session 2023–24, [The antimicrobial potential of bacteriophages](#), HC 328; 3 January 2024, pp 36–37.

the USA and Belgium, to be used in compassionate cases.¹⁶³ However, the latter process is slow, cumbersome, expensive and unreliable, based on the good will of small laboratories elsewhere. We also concluded that this was perverse as it had led to a situation where non-GMP phages can be allowed from other countries but not the UK, while in some instances delays in imports had led to very ill UK patients travelling abroad to receive phage therapy without significant delays.¹⁶⁴

117. We surveyed the current phage landscape and concluded that phages also lacked infrastructure, such as phage banks, where generic phages could be accessed, and specialist laboratories where specific combinations of phages could be produced and/or gene edited for specific patients.¹⁶⁵ We also detected a lack of awareness amongst doctors regarding the potential use of phages when antibiotics had failed.¹⁶⁶

118. However, we were positive about Innovate UK’s Phage Knowledge Transfer Network. This has brought together phage researchers, clinicians, research funders, SMEs, regulators (e.g. Medicines and Healthcare products Regulatory Agency (MHRA)) and government agencies (e.g. the UKHSA) to address challenges and to exploit the public health and commercial opportunities phages present.¹⁶⁷ We were also excited that phages, as a form of ‘personalised’ medicine, will allow regulatory and manufacturing lessons to be learnt for other similar therapeutics, to streamline and expedite their safe development and deployment.

119. We called for:¹⁶⁸

- Government to consider establishing a small GMP facility on the lines of the Catapult network which provides shared facilities for companies who cannot afford to make the level of investment on their own, including repurposing the Rosalind Franklin Laboratory, which was due to be sold;
- The MHRA and the Department for Health and Social Care (DHSC), and phage researchers to work together to make for a more promising route for phage research to be funded and its products licensed for use;
- The continuing work of Innovate UK’s Phage Knowledge Transfer (KTN) Network to bring phage researchers, companies and regulators together to exchange expertise and knowledge that can develop medical and commercial opportunities;
- Awareness-raising for healthcare students and professionals of the antimicrobial potential of phages where antibiotics have failed or are failing;

163 House of Commons Science, Innovation and Technology Committee, First Report of Session 2023–24, [The antimicrobial potential of bacteriophages](#), (HC 328; 3 January 2024), p 35.

164 Mrs Abigail Halstead ([PHA0022](#)) and Phage UK ([PHA0013](#)).

165 House of Commons Science, Innovation and Technology Committee, , First Report of Session 2023–24, [The antimicrobial potential of bacteriophages](#), (HC 328; 3 January 2024), pp 53–55.

166 Joshua D. Jones et al., [The Future of Clinical Phage Therapy in the United Kingdom](#), *Viruses*, vol 15, no 3, (2023); Microbiology Society ([PHA0015](#)).

167 Innovate UK, [Innovate UK KTN Launches Phage Innovation Network](#), (21 November 2022); House of Commons Science, Innovation and Technology Committee, , First Report of Session 2023–24, [The antimicrobial potential of bacteriophages](#), (HC 328; 3 January 2024), pp 27–29.

168 House of Commons Science, Innovation and Technology Committee, , First Report of Session 2023–24, [The antimicrobial potential of bacteriophages](#), (HC 328; 3 January 2024), pp 56–62.

- Government and its agencies to make a definitive and positive statement on the role of phages in the national approach to anti-microbial resistance (AMR), which is important in research funding decisions and for private investment in commercial phages;
- The MHRA to consider allowing the compassionate use of non-GMP phages produced in the UK for last resort medical cases where other medical approaches have failed or are failing; and
- The MHRA to review how current regulations would govern liability for clinicians and hospitals who use UK non-GMP phages.

Government progress on implementing recommendations

120. The Government response noted that it would increase engagement with phage researchers and clinicians and to help them access funding and support. It said that it would consult later in 2024 on guidance relating to the data that would be required to evaluate applications for clinical trials and licensed phage products, which would lay the ground for a future ‘monograph—directive guidance for medical clinicians—for the compassionate use of phages. These steps, it stated, will both help drive the process toward licensing phages and help clinicians use them before that process is completed.¹⁶⁹

121. The Government said it was sympathetic to calls for the development of a GMP facility for phages and that it would undertake engagement with key stakeholders including relevant funders and research organisations. However, it noted that Development of a GMP phage manufacturing facility in an appropriate location as part of UKHSA’s scientific estate was not a proposal it could commit to funding at present.¹⁷⁰ It also stated, that though UKHSA had expertise to help the development of phages it did not have spare laboratory space, which was despite its subsequent decision to end its lease of the Rosalind Franklin Laboratory, which had received £450mn in public funding.¹⁷¹

122. The Government highlighted the continuing role of the Innovate UK KTN Phage Innovation Network, noting that UKHSA provides the Chair for its scientific advisory board and that the MHRA is working closely with it to understand how it can support phage research and innovation.¹⁷²

Recommendations for future work

123. *Should our successor Committee wish to consider the antimicrobial potential of bacteriophages, we recommend:*

169 Department of Health and Social Care, [The government’s response to the Science, Innovation and Technology Committee’s report: The antimicrobial potential of bacteriophages](#), (CP 995, 1 March 2024), pp 7–8.

170 Department of Health and Social Care, [The government’s response to the Science, Innovation and Technology Committee’s report: The antimicrobial potential of bacteriophages](#), (CP 995, 1 March 2024), pp 14–15.

171 House of Commons Science, Innovation and Technology Committee, [SITC “bemused” by Government claims on lack of specialist laboratory capacity in UK](#), (14 March 2024). See also BBC News, [UK’s first Covid mega lab for sale](#), (9 November 2023).

172 Department of Health and Social Care, [The government’s response to the Science, Innovation and Technology Committee’s report: The antimicrobial potential of bacteriophages](#), (CP 995, 1 March 2024), p 8.

- *Seeking updates on whether the MHRA has produced guidance relating to the data that would be required to evaluate applications for clinical trials and licensed phage products promised in the Government’s response;*
- *Asking for updates on what progress the MHRA is making on producing a future ‘monograph’ - directive guidance for medical clinicians - for the compassionate use of phages;*
- *Regularly tracking the latest phage developments from Innovate UK’s Phage Knowledge Transfer Network, which is bringing about collaboration between phage researchers, companies, research funders and regulators;*
- *Scrutinising whether opportunities for phage research funding, phage infrastructure, including Good Manufacturing Practice (GMP) facilities, and access to specialist laboratories, such as those run by UKHSA, have improved; and*
- *Questioning whether lessons are being learnt from phages that can be applied to similar personalised therapeutics that are not produced to a single formulation.*

Harnessing the power of fungi

124. Fungi are a diverse group of organisms that include yeasts, moulds, and mushrooms. Fungi constitute their own biological kingdom, separate from plants, animals and bacteria, though they are more closely related to animals than plants.¹⁷³ However, only 155,000 species of fungi have been formally named, whilst it is estimated that there are around 2.5 million species of fungi. Therefore, more than 90% of fungal species remain unknown to science.¹⁷⁴

125. The 2018 State of World’s Fungi report published by Royal Botanic Gardens, Kew—home to the world’s largest Fungarium with 1.25 million specimens—identified key knowledge gaps in the understanding of the fungi such as the extent of fungal diversity on the planet, properties and applications of unknown fungi, and the conservation of fungi globally.¹⁷⁵

126. We held a one-off evidence session inquiring into harnessing the power of fungi on 7 February 2024. This session examined why these knowledge gaps exist and how the diverse properties of fungi could be harnessed to improve human health, increase food security, and combat environmental and engineering challenges. We received three written submissions and took oral evidence from six witnesses.¹⁷⁶

173 [Q1](#); Royal Botanic Gardens, Kew [State of the World’s Plants and Fungi](#), (October 2023), pp 14–17; Tuula Niskanen et al., “[Pushing the Frontiers of Biodiversity Research: Unveiling the Global Diversity, Distribution, and Conservation of Fungi](#)”, Annual Review of Environment and Resources, Volume 48 (2023), pp 149–176.

174 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Harnessing the power of fungi](#), (HC 544; 7 February 2024), [Q2](#) and [Q9](#) [Professor Irina Druzhinina]; Royal Botanic Gardens, Kew, [State of the World’s Plants and Fungi](#), October 2023, p 14.

175 Royal Botanic Gardens, Kew, [State of World’s Fungi](#), (September 2018), pp 1–92; Royal Botanic Gardens, Kew (2024) [The Fungarium](#), (accessed 22 May 2024).

176 Science, Innovation and Technology Committee, [Zombie apocalypse or environmental saviours? SITC holds one-off session on the incredible world of fungi](#) (1 February 2024).

Key themes from our work

127. During the evidence session, the Committee heard that there is an under-recognition of the potential emerging threat fungi pose to human health. Professor Matthew Fisher, Imperial College London, informed the Committee that over 6.5 million people annually contract serious fungal diseases, whilst the burden of mortality globally is around 2.5 million. In comparison, malaria kills 600,000, bacterial antimicrobial resistance kills 700,000 and tuberculosis kills 1.3 million.¹⁷⁷

128. Fungicides, which are used in agriculture to control diseases caused by crop pathogens to ensure food security and supply, also pose a growing threat to human health due to increases in antifungal resistance in the environment. We heard that agricultural fungicides, like azoles, have the same mode-of-action as fungicides used in clinical settings, creating resistance and lowering the effectiveness of clinical fungal drugs within humans.¹⁷⁸ As we heard in our inquiry into the antimicrobial potential of bacteriophages, the Government has recognised antimicrobial resistance as a global risk and has committed to international action to tackle this priority issue.¹⁷⁹ The Government’s National Action Plan for tackling antimicrobial resistance currently covers bacterial, viral, fungal and parasitic pathogens.¹⁸⁰ The National Action Plan acknowledges that antifungal resistance in humans is in part being driven by the increasing use of crop protection fungicides. They state that fungicides must be used responsibly to reduce potential risk to public, environment, or animal health but do not set out any targets or actions for reducing the use of antifungals within agriculture.¹⁸¹

129. However, the Committee also heard that many common medical drugs have been developed from fungi or from chemicals or metabolites that fungi produce such as penicillin, statins and cyclosporin. Penicillin alone is suggested to have saved over 500 million lives. It is estimated that fungi therapeutics and derivatives contribute around \$47 billion to the global economy each year.¹⁸²

130. We heard that fungi play an essential role in regulating the biosphere as they are a decomposing organism, breaking down dead and decaying matter and recycling the nutrients into the ecosystem like soils.¹⁸³ Fungi also aid in promoting plant-growth,

177 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Harnessing the power of fungi](#), (HC 544; 7 February 2024), [Q67](#) [Professor Matthew Fisher].

178 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Harnessing the power of fungi](#), (HC 544; 7 February 2024), [Qq74–75](#) [Professor Matthew Fisher and Professor Marc Stadler]; HM Government, [Confronting antimicrobial resistance 2024 to 2029](#), 8 May 2024; Matthew C. Fisher and David W. Denning. “[The WHO fungal priority pathogens list as a game-changer.](#)” *Nature Reviews Microbiology*, volume 21 (2023), pp 211–212; *Financial Times*, [Crop chemicals boost drug resistance of killer fungi, scientists warn](#), (9 January 2024).

179 Science, Innovation and Technology Committee, First Report of Session 2023–2024, [The antimicrobial potential of bacteriophages](#), (HC 328; 3 January 2024), para 6; Office for Health Improvement and Disparities, [Antimicrobial resistance \(AMR\): applying All Our Health](#), (25 April 2022).

180 HM Government, [Confronting antimicrobial resistance 2024 to 2029](#), (8 May 2024).

181 Office for Health Improvement and Disparities, [Antimicrobial resistance \(AMR\): applying All Our Health](#), (25 April 2022).

182 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Harnessing the power of fungi](#), (HC 544; 7 February 2024), [Qq95–96](#) [Professor Matthew Fisher and Professor Marc Stadler]; Professor Irina Druzhinina (Senior Research Leader in Fungal Diversity and Systematics at Royal Botanic Gardens, Kew) ([HPF0003](#))

183 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Harnessing the power of fungi](#), (HC 544; 7 February 2024), [Q3](#) and [Q14](#) [Dr Merlin Sheldrake], [Q30](#) [Professor Katie Field].

improving crop health and yield and as biofertilisers. In addition to fungi being used to promote plant growth and yield, fungi and their products are consumed directly, with the most well-known fungal product being bakers' yeast and the mycoprotein Quorn.¹⁸⁴

131. However, researchers at the University of Exeter have warned in a review published in *Nature* that crop fungal diseases—the biggest cause of crop loss worldwide—were increasing in severity and scale throughout the 20th Century and were a significant risk to global food security.¹⁸⁵

132. Professor Irina Druzhinina, Senior Research Leader in Fungal Diversity and Systematics at Royal Botanic Gardens, Kew, told the Committee how fungi are being used to develop fungal-based materials for packaging and construction.¹⁸⁶

133. We heard from our witnesses that the UK is seen as a world leader in fungal research and expertise and is host to numerous academic centres of excellence for fungal research.¹⁸⁷ However, a recurring theme from the evidence the Committee heard was the length of time for grants available for mycology research. Many funding programmes are focused on short timescales rather than longer timescales needed for agricultural field trials.¹⁸⁸

134. We also heard from Professor Paul Dyer, Professor of Fungal Biology at the University of Nottingham, that the Genetic Technology (Precision Breeding) Act 2023, which was introduced to encourage scientific innovation to unlock the potential of novel technologies, excludes fungi.¹⁸⁹

135. Professor Druzhinina, in her oral evidence to the Committee noted that currently over 90% of the estimated fungi species on Earth have yet to be formally described, whilst Dr Merlin Sheldrake noted that less than 0.2% of global conservation priorities are targeted at fungi.¹⁹⁰ The dominant threats to fungi's conservation come from land-use changes from natural ecosystems to forestry, agriculture or built environment. Additional threats include airborne nitrogen pollution, habitat changes, and temperature and moisture changes.¹⁹¹

136. In their written evidence Dr Sheldrake and Royal Botanic Gardens, Kew called for the adoption of the term 'funga'. Funga is a term used for the fungi of a specific region, habitat, or geological period and is equivalent to the established concepts of fauna and flora. The term was introduced into environmental conservation initiatives by Mexico's

184 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Harnessing the power of fungi](#), (HC 544; 7 February 2024), [Q4](#) [Dr Merlin Sheldrake], [Qq44–45](#) [Professor Paul Dyer].

185 *Nature*, [Address the growing urgency of fungal disease in crops](#), (2 May 2023).

186 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Harnessing the power of fungi](#), (HC 544; 7 February 2024), [Q5](#) [Professor Irina Druzhinina].

187 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Harnessing the power of fungi](#), (HC 544; 7 February 2024), [Q5](#) [Professor Irina Druzhinina].

188 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Harnessing the power of fungi](#), (HC 544; 7 February 2024), [Qq39–40](#) [Professor Katie Field].

189 Precision breeding technologies are those which make targeted genetic changes to produce beneficial characteristics that can occur through traditional breeding and natural processes. The Act does not allow genetic modification (GM) where techniques are used to insert functional DNA from an unrelated species into another species. Professor Paul Dyer (Professor of Fungal Biology at University of Nottingham) ([HPF0002](#)).

190 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Harnessing the power of fungi](#), (HC 544; 7 February 2024), [Q8](#) [Dr Merlin Sheldrake], [Q9](#) [Professor Irina Druzhinina]; Royal Botanic Gardens, Kew, [State of the World's Plants and Fungi](#), October 2023, pp 60–65.

191 Royal Botanic Gardens, Kew, [State of the World's Plants and Fungi](#), (October 2023), p 64.

Secretariat of Environment and Natural Resources, the National Biobank of Thailand, Italy’s Institute for Environmental Protection and Research, and the International Union for Conservation of Nature.¹⁹²

137. The International Union for Conservation of Nature’s (IUCN) Red List of Threatened Species—frequently referred to as the IUCN Red List—is an inventory of the global conservation status and extinction risk of biological species. Until 2015, only one species of fungi had the required data to be allocated a conservation status. As of 2023, 656 fungal species have been allocated a conservation status, with nearly 50% identified as threatened.¹⁹³

Recommendations for future work

138. *Should our successor Committee wish to examine the Government’s approach to fungal research, we recommend it considers:*

- *How the Government and UK Research and Innovation can support research into the antifungal resistance in the environment, animals, and humans, to increase the evidence base;*
- *How the Government and its agencies can support fundamental and applied fungi research in the UK. Additionally, the successor Committee could look at the provisions of funding for long-term agricultural field trials;*
- *How the Government and its agencies should consider ways in which to better communicate the science of fungi and their potential in tackling grand challenges facing society;*
- *The possibility of widening the scope of the Genetic Technology (Precision Breeding) Act 2023 to include fungi; and*
- *How the Government and its agencies could support the development of a UK ‘Red List of Threatened Fungal Species’ to aid in the conservation of threatened UK fungal species.*

Insect decline and UK food security

139. There are increasing concerns that insect numbers and their diversity are declining globally. This threatens biodiversity and essential processes in food production such as pollination, pest and weed regulation. Growing research indicates that intensive farming practices and climate change are driving these changes. However, the scale of the problem in the UK is uncertain.

140. This Inquiry received nearly fifty written submissions and took oral evidence from twenty witnesses, including academics, individuals from insect and environmental charities, the President of the National Farmers’ Union, active farmers, prominent figures in public conservation and the Minister for Nature, Rebecca Pow MP. The Committee

192 Dr Merlin Sheldrake (Biologist and Author at Entangled Life) ([HPF0001](#)); Professor Irina Druzhinina (Senior Research Leader in Fungal Diversity and Systematics at Royal Botanic Gardens, Kew) ([HPF0003](#)); National Geographic, [Why ‘funga’ is just as important as flora and fauna](#), (12 March 2024).

193 International Union for Conservation of Nature Red List of Threatened Species (2024), [IUCN Red List of Threatened Species; Kingdom of Fungi](#), (accessed 22 My 2024).

also visited Rothamsted Research to see the long-running insect monitoring study, the Rothamsted Insect Survey. We also heard from researchers on how their work on both destructive and beneficial insect species for agriculture can have real-world applications for UK farming.¹⁹⁴

Key themes from our work

141. During our inquiry it became evident that there were persistent knowledge gaps in our understanding of insect populations, despite the UK being a leader in this research field. The lack of long-term monitoring programmes for many insect species, and variable and inconsistent data collection methodologies, are hampering the ability to discern long-term trends in insect populations.¹⁹⁵

142. We heard about the need for effective communication around the realities of insect decline alongside measures to address this. We heard that a fatalistic approach risked reducing the chances of changes being made to policy, practices and behaviours.¹⁹⁶

143. Pollinators play a crucial role in securing the UK’s food security. However, less attention has been placed on the role of insects and invertebrates in supporting food production. A diversity of species is key to preserving ecosystems and creating a resilient UK food system. Additionally, it is imperative that the Government addresses food security issues linked to insect decline at the international level. The UK currently imports around 50% of the food it consumes.¹⁹⁷

144. We heard about the need to raise awareness early of the importance of insect species, alongside charismatic species such as the honeybee, to cultivate a greater public passion for entomology (the study of insects). This will enable an increase in the number of experts in the UK.¹⁹⁸

145. Witnesses told us that within the UK, land use change, land management practices and pesticide usage are amongst the largest contributing factors to insect decline. Consequently, the largest influence on achieving the biodiversity targets for insect species outlined in the 2021 Environment Act, could lie in the implementation of agri-environmental policies.¹⁹⁹ The UK has made international commitments to reducing the overall risk caused by pesticides, by at least half, by 2030.²⁰⁰ Whilst we acknowledged that updating the National Action Plan for Sustainable Pesticide Use—the UK implementation plan to achieve these commitments—is a substantial task for the Government, we concluded that this did not excuse the six-year delay in the publication of this crucial policy.

194 House of Commons Science, Innovation and Technology Committee, [Insect decline and UK food security](#), (23 May 2024).

195 Rothamsted Insect Survey ([INS0020](#)); UK Centre for Ecology & Hydrology ([INS0022](#)); The Wildlife Trusts ([INS0027](#)).

196 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Insect decline and UK food security](#), (HC 1239; 7 June 2023), [Qq71—72](#) [Professor Simon Potts]; House of Commons Science, Innovation and Technology Committee, [Oral evidence: Insect decline and UK food security](#), (HC 1239; 12 July 2023), [Q179](#) [Chris Packham].

197 CropLife UK ([INS0035](#)); Dr Alexander Waller (Visiting Professor of Environmental Ethics and Science Education at American University of Sovereign Nations) ([INS0005](#)).

198 Royal Botanical Gardens, Kew ([INS0044](#)); Mr Steve Garland ([INS0004](#)); Buglife ([INS0038](#)).

199 National Farmers’ Union of England and Wales (NFU) ([INS0024](#)).

200 The 15th Conference of the Parties Convention on Biological Diversity, [Kunming-Montreal Global Biodiversity Framework](#), (19 December 2022).

146. We also heard that the statutory targets to halt and reverse species extinction and decline in abundance are ambitious and welcome. However, the exclusion of numerous invertebrate species and in some cases entire groups from the baseline metrics, particularly those vital for UK food security such as predatory beetles, is concerning. Including only 11 species of bumblebee is not an adequate abundance indicator for all 270 (at least) unique UK bee species.²⁰¹

147. Witnesses estimated that approximately half of the Sites of Special Scientific Interest (SSSIs) are not in a good state and are failing to conserve invertebrate biodiversity.²⁰² Protected sites do not exist in isolation and are therefore influenced by the quality of nature in the surrounding environment. Whilst we welcomed the statutory improvements to SSSIs set out by the Environment Improvement Plan, which will go some way to prevent more insect species extinctions, we heard that it is unlikely that these improvements will be sufficient to halt decline in species abundance.²⁰³

Recommendations for future work

148. *Should our successor Committee wish to examine the Government’s approach to insect decline and UK food security, we recommend:*

- *Examining the Government and its agencies’ strategies for sustaining long-term insect monitoring research and initiating new studies to address systemic knowledge gaps;*
- *Scrutinising the Government’s communication methods around the realities of insect decline and the steps that can be taken to tackle the decline;*
- *Exploring whether there is need to develop a National Invertebrate Strategy, building on the successes of the National Pollinator Strategy;*
- *Scrutinising the remit of the National Bee Unit and its work on wild bees;*
- *Monitoring the impact of the new National History GCSE and its role in promoting entomology;*
- *Scrutinising the monitoring and evaluation programme for Environmental Land Management Schemes;*
- *Examining the work of the Initiative in disseminating advice to farmers on implementing Integrated Pest Management strategies; and*
- *Assessing work towards meeting the UK’s international commitments to reducing the overall risk caused by pesticides by at least half by 2030.*

201 The Environmental Targets (Biodiversity) (England) Regulations 2023 ([SI 2023/91](#)), [Schedule 2](#); Rebecca Pow MP (Minister for Nature at Department for Environment Food and Rural Affairs) ([INS0049](#)).

202 Natural England ([INS0037](#)).

203 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Insect decline and UK food security](#), (HC 1239; 12 July 2023), [Q110](#) [Professor Lynn Dicks].

7 Scientific research environments

149. We have investigated two key areas relating to scientific research environments: *Diversity and Inclusion in STEM*, which addresses the societal, economic, and other factors that contribute to the overall levels of diversity and inclusion in science, technology, engineering and maths (STEM) education and research institutes; and *Commercialising research*, which investigates the efficacy of strategies for translating research into commercial success. The environment for scientific researchers from underrepresented backgrounds in STEM have been recurring themes throughout both.

Diversity and Inclusion in STEM

150. In November 2021, we launched our inquiry to examine the extent of underrepresentation of certain groups—such as women, people from ethnic minority backgrounds, people with disabilities and those from disadvantaged socioeconomic backgrounds—amongst those in science, technology, engineering and maths (STEM) roles, and ask what policies the Government, industry and academia could use to address it. We also explored the implications that a lack of diversity in STEM has for the UK’s science and technology sectors in particular, and how effective measures taken to improve diversity within the field have been thus far.²⁰⁴ Our report was published on 24 March 2023,²⁰⁵ and the Government’s response was published on 16 June 2023.²⁰⁶

Key themes from our work

151. Our Report found that whilst the benefits of raising levels of diversity in STEM education, research settings and other workplaces were clear, and the Government’s UK Research and Innovation and other research funders, industry and education leaders have supported and participated in many worthy inquiries, reports and initiatives; progress in addressing underrepresentation has been limited at best. We also concluded that underrepresentation should not simply be viewed as a challenge that would recede over time, as societies become more diverse. We called for the Government, and the education and research sectors to address it as a priority.²⁰⁷

152. As our inquiry progressed, we were increasingly drawn to the importance of education in determining many of the outcomes experienced by pupils from different backgrounds later in life, and as a contributing factor in underrepresentation. The data on STEM subjects uptake and attainment at GCSE and A-level examined as part of our inquiry painted a complex picture. We identified clear differences in take up of STEM qualifications between boys and girls, as well as between and within different ethnic

204 House of Commons Science, Innovation and Technology Committee, [Improving diversity in STEM: MPs launch inquiry](#), (31 January 2024).

205 House of Commons Science and Technology Committee, Fifth Report of Session 2022–23, [Diversity and inclusion in STEM](#), (HC 95; 24 March 2023).

206 House of Commons Science, Innovation and Technology Committee, Third Special Report of Session 2022–23, [Diversity and inclusion in STEM: Government Response to the Committee’s Fifth Report](#), (HC 1427; 16 June 2023).

207 House of Commons Science and Technology Committee, Fifth Report of Session 2022–23, [Diversity and inclusion in STEM](#), (HC 95; 24 March 2023), para 32.

and socio-economic backgrounds.²⁰⁸ We recommended changes to the curriculum, exam subject specification and careers advice, to ensure that all children are able to see themselves in what they learn from an early age.²⁰⁹

153. We found that access, or lack of it, to the separate study of biology, chemistry and physics at GCSE—known as the ‘triple science’ option—was a decisive factor for many pupils in determining whether they study STEM subjects at university and enter the STEM workforce. If the pool of students studying triple science lacks diversity, this will be reflected in STEM settings later in life. We therefore called on the Government to ensure more pupils have access to triple science, or how else it proposes to overcome barriers to pursuing an interest in STEM faced by pupils from certain backgrounds.²¹⁰

154. Beyond education settings, our inquiry underlined the extent to which some STEM researchers faced discriminatory working environments, and the associated negative consequences. We found that whilst this should be viewed as a reflection of inequities that exist elsewhere in society, the process of reducing and ultimately ending such prejudice should be treated as a priority.²¹¹ We examined the working environment for STEM researchers in greater depth as part of our inquiry examining reproducibility and research integrity.²¹²

Government progress on implementing recommendations

155. Our report made a series of recommendations intended to promote greater diversity in STEM education, research and workplace settings. These included:

Curriculum content

156. We recommended that “the national curriculum and exam subject specifications be kept under review and updated where it is appropriate to the context to include more diverse examples, such as female scientists”.²¹³ Similarly, we also said that “... the careers advice and support pupils receive from the earliest years must promote diverse and inclusive role models” and include diverse examples.²¹⁴

208 House of Commons Science and Technology Committee, Fifth Report of Session 2022–23, [Diversity and inclusion in STEM](#), (HC 95; 24 March 2023), paras 70–71.

209 House of Commons Science and Technology Committee, Fifth Report of Session 2022–23, [Diversity and inclusion in STEM](#), (HC 95; 24 March 2023), paras 38 and 44.

210 House of Commons Science and Technology Committee, Fifth Report of Session 2022–23, [Diversity and inclusion in STEM](#), (HC 95; 24 March 2023), para 72.

211 House of Commons Science and Technology Committee, Fifth Report of Session 2022–23, [Diversity and inclusion in STEM](#), (HC 95; 24 March 2023), para 132.

212 House of Commons Science, Innovation and Technology Committee, [Reproducibility and research integrity](#), (31 January 2024).

213 House of Commons Science and Technology Committee, Fifth Report of Session 2022–23, [Diversity and inclusion in STEM](#), (HC 95; 24 March 2023), para 38.

214 House of Commons Science and Technology Committee, Fifth Report of Session 2022–23, [Diversity and inclusion in STEM](#), (HC 95; 24 March 2023), para 44.

157. The Government said in its response to our report that there were no plans to update the curriculum or exam subject specifications,²¹⁵ but that it had begun a “... programme of work to ensure that both primary and secondary aged children have multiple opportunities to meet inspiring role models from a range of backgrounds”.

Increased uptake of maths

158. In January 2023 the Prime Minister, Rt. Hon. Rishi Sunak MP, set out his ambition “to move towards all children studying some form of maths to 18”,²¹⁶ but also ruled out compulsion at A-level and said that additional options would be available to students. Our Report called on the Government to set out further detail of how it intended to deliver on this ambition and recommended “... as an alternative to compulsion the introduction of a requirement for pupils who do not continue with a STEM subject post-16 to take the Advanced Mathematical Support Programme or a Core Science course”.²¹⁷

159. In October 2023 the Prime Minister, Rt. Hon. Rishi Sunak MP, announced that the Government would introduce an ‘Advanced British Standard’, which would replace current post-16 qualifications and include maths in some form for all students.²¹⁸

160. In May 2024 the Prime Minister, Rt. Hon. Rishi Sunak MP, announced an open competition offering grant funding of up to £6 million over the next three years to establish a new National Academy for Mathematical Sciences.²¹⁹

Teaching recruitment

161. Our Report welcomed the roll-out of a national scheme where the Government partnered with the engineering sector to increase the number of Initial Teacher Training recruits with industry experience. We recommended that subject to evaluation, the scheme “... be expanded to bring more STEM professionals into classrooms to help teach other subjects where there are shortages” of teaching staff.²²⁰ The Government told us that it would continue to expand the scheme and keep under review potential options to replicate it across other subject areas.²²¹

Recommendations for future work

162. *Should our successor Committee wish to consider levels of diversity and inclusion in STEM, we recommend it considers:*

215 House of Commons Science, Innovation and Technology Committee, Third Special Report of Session 2022–23, [Diversity and inclusion in STEM: Government Response to the Committee’s Fifth Report](#), (HC 1427; 16 June 2023), p 19.

216 GOV.UK, [Prime Minister’s speech on building a better future](#), (4 January 2023).

217 House of Commons Science and Technology Committee, Fifth Report of Session 2022–23, [Diversity and inclusion in STEM](#), (HC 95; 24 March 2023), paras 88–89.

218 GOV.UK, [A world-class education system: The Advanced British Standard](#), (4 October 2023).

219 GOV.UK, [UK offer £6m to organisations to help creation of a new UK National Academy dedicated to maths](#), (7 May 2024).

220 House of Commons Science and Technology Committee, Fifth Report of Session 2022–23, [Diversity and inclusion in STEM](#), (HC 95; 24 March 2023), para 112.

221 House of Commons Science, Innovation and Technology Committee, Third Special Report of Session 2022–23, [Diversity and inclusion in STEM: Government Response to the Committee’s Fifth Report](#), (HC 1427; 16 June 2023), p 24.

- *Examining whether the trends in STEM education, particularly in subject uptake and attainment, as well as the delivery of STEM curriculum content, have changed since the Committee’s inquiry, and the potential reasons for this;*
- *The role that neurodiverse people play in the STEM ecosystem, whether they are over-represented compared to other sectors, the reasons for this and the benefits that their participation can deliver; or*
- *Scrutinising the implementation of UKRI’s first equality, diversity and inclusion strategy, its impact on the wider research sector, and to what extent findings from the Research and Innovation workforce survey have been made meaningfully useful across different departments, non-departmental bodies and the wider STEM sector.*

Commercialising Research

163. In May 2024, the Committee held a one-off evidence session on the commercialisation of research.²²² We considered the role of commercialising research in realising the ambitions of the UK to be a science and technology superpower.

Key themes from our work

164. The Committee considered the experience of CEOs in starting up, spinning out and scaling up companies. The UK’s strength as a place of high-quality research and opportunities for innovation was notable. However, the access to early phase and second phase funding (between seed and series funding) was highlighted as an important issue for companies, where proofs of concept or minimum viable products have not been realised, making venture capital (VC) funding more difficult to attract.

165. Grant funding support from organisations such as Innovate UK was highlighted as a key opportunity for early-stage businesses. However, awareness of and access to these support opportunities or high-level funding was raised as an area for improvement.

166. Attraction and retention of talent for UK science and technology companies was considered to be reasonably viable, but requires competitive compensation packages from companies to compete with other countries like the US.

167. Collaboration between businesses and universities was considered beneficial, with businesses able to use local facilities for laboratory space belonging to universities. However, the cost to businesses of using such spaces was often higher than industrial lab space because universities receive grants from research councils or charities for specific areas of research. Therefore, businesses must be charged an overhead to use their facilities. It was recommended that funding should be made available to universities to continue facilitating use of their laboratories to businesses and making them more accessible, which encourages collaboration.

222 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Commercialising Research](#), (HC 791; 22 May 2024).

168. The access to VC funding for ‘black-owned’ and women-owned,²²³ businesses was highlighted as an issue in the UK, which showed as inferior to the experience in the US of these groups. Greater diversity in VC firms could help to improve delivery of funding to diverse business owners.

169. The Committee heard from research and technology organisations and Innovate UK about the support available for UK science and technology companies. Catapult and Fraunhofer UK outlined their role in facilitating interactions between businesses and research, connecting businesses to financial services, and realising the commercial viability of research, particularly in their early stages. Fraunhofer also offered doctoral training for employees in key areas.

170. The interaction between research and industry, and further bridging this gap, was highlighted as critical and witnesses acknowledged the need to improve visibility of organisations such as Innovate UK that can provide support to businesses.

171. The financing of research and technology organisations was a key area. Whilst the public investment of £1.6 billion funding for five years (April 2023–March 2028)²²⁴ from catapults was recognised as a significant amount, the need for certainty of funding is critical to their work. The Committee heard that five-year spending reviews makes long-term commercialisation programmes, in the order of decades, difficult to ensure. The need to avoid diluting the impact of funding was highlighted by witnesses, and retaining the value of science and technology companies in the UK through British investment was seen as important.

172. The impact of core government funding for the Catapults since their creation in 2011 was highlighted. The Committee heard oral evidence that small and medium enterprises that have worked with Catapult grew 50% faster than one that has not, with a five-times return on investment.

173. In terms of attracting funding, industry funding was considered the most difficult to achieve, and mechanisms of support for encouraging that, were welcomed by witnesses. It was noted that securing public funding often led to private investment.

174. The need to increase investment in research and development (R&D), particularly on the development side, was emphasised. In the UK, research usually attracts greater funding (approximately 80% of R&D investment), however, development is critical for innovation.²²⁵ In comparison, in South Korea, 15% of the budget is allocated to basic research, 19.9% to applied research, and 65% to development.²²⁶

175. The operation of research and technology organisations across the UK is a key aspect of the levelling up agenda, to spread opportunities more equally across the UK. The Committee heard that the spread of Catapult centres across the UK were placed in clusters of local excellence and have been successful in building on the local ecosystem. Fraunhofer UK noted the value of local delivery and emphasised that organisations such

223 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Commercialising Research](#), (HC 791; 22 May 2024), [Q31](#) [Byron Dixon OBE].

224 Department for Science, Innovation and Technology, [2023 Update to the ‘Catapult Network Review’: An update on developments since the Catapult Network Review April 2021](#), (September 2023).

225 Association of Innovation, Research and Technology Organisations, [A more DEVELOPMENT-focused strategy for paving the way to IMPACT: Innovation that is Market Pulled, Applied, Commercially Translated!](#), (March 2020).

226 Invest Korea, [Private sector accounts for 80% of Korean R&D investment in 2022](#), (accessed 27 May 2024).

as their Centre for Applied Photonics (CAP) enable early-stage companies to access large infrastructure they would not otherwise have been able to afford. However, the visibility of assets was raised as a key issue in the accessibility of resources.

Recommendations for future work

176. *Should our successor Committee wish to further explore the commercialisation of research, we recommend it considers:*

- *Recommending the establishment of a coherent system to facilitate interactions between businesses and research and technology organisations to make support for business more visible and accessible;*
- *Recommending increased public investment in the development side of research and development to drive innovation and lead the way for further private investment;*
- *Recommending an increase in the spending review period for Catapults to greater than five years to enable longer term projects and decisions to be made based on certainty of core funding; and*
- *Recommending the provision of financial support for universities to enable local businesses to collaborate and use their laboratory facilities at a more competitive price.*

8 Space

177. Towards the end of the 2019–2024 Parliament, the Committee focused on two aspects of space policy. The first was development of a UK launch capability, support for commercial satellite production and delivery of crucial national communication, and observational and navigation services. The second was UK astronomy, in terms of science and instrumentation, its ability to draw on amateur and professional input, its inclusivity and diversity and role in inspiring wider interest in STEM.

178. There are some clear connections between the two areas, with some analogous technologies being used across commercial and scientific programmes and the advantages that a launch capability could offer UK astronomy in the future in developing and testing instrumentation. In addition, both of these strands offer opportunities for the UK to pursue its ambition to be a science superpower, while showcasing the technological and scientific skills for commercial exploitation and leadership in international scientific collaborations. We examined whether the UK Government’s approach provided the necessary support and infrastructure to build on existing UK strengths and deliver on future potential.

UK space strategy and UK satellite infrastructure

179. We launched our inquiry into UK space strategy and UK satellite infrastructure in April 2021.²²⁷ The Inquiry examined:

- the prospects for the UK’s global position as a space nation;
- the breadth of the UK space sector and what support it needed to grow;
- how the Government should ensure that the UK had resilient and future-proofed access to Position, Navigation and Timing (PNT), Earth Observation (EO), and Communication capabilities;
- and what the aims and focus of the National Space Strategy should be.

We published our Report on Friday 4 November 2022,²²⁸ and Government response was received on 8 March 2023.²²⁹ Due to significant events in the UK’s launch sector in January 2023, we subsequently followed up with correspondence, and evidence sessions on 1 March 2023 and 17 May 2023. A follow-up report was published on Friday 14 July.²³⁰ The Government response was received on 12 September 2023.²³¹

227 House of Commons Science and Technology Committee, [UK Space Strategy and UK Satellite Infrastructure inquiry launched](#), (27 April 2021).

228 House of Commons Science and Technology Committee, Second Report of Session 2022–23, [UK space strategy and UK satellite infrastructure](#), (HC 100; 4 November 2022).

229 House of Commons Science and Technology Committee, Second Special Report of Session 2022–23, [UK space strategy and UK satellite infrastructure: Government Response to the Committee’s Second Report](#), (HC 1258; 30 March 2023).

230 House of Commons Science, Innovation and Technology Committee, Seventh Report of Session 2022–23, [UK space strategy and UK satellite infrastructure: reviewing the licencing regime for launch](#), (HC 1717; 14 July 2023).

231 House of Commons Science, Innovation and Technology Committee, Fifth Special Report of Session 2022–23, [UK space strategy and UK satellite infrastructure: reviewing the licencing regime for launch: Government response to the Committees Seventh Report](#), (HC 1900; 27 October 2023).

Key themes from our work and Government progress on implementing recommendations

UK launch sector and licencing

180. Our Inquiry explored the progress being made towards establishing small satellite spaceports in the UK. Concerns were raised in our evidence sessions that the licencing process, which was being carried out by the Civil Aviation Authority (CAA) for the first time, was delaying the first launch attempt.²³² We recommended that the Government should provide further support for the CAA and aim to streamline the licencing process.

181. Our interest in the UK's launch sector continued after the first launch attempt took place from Spaceport Cornwall in January 2023. In the run up to the launch and in the aftermath, it was clear that there were lessons to be learned about the UK's approach to the launch industry, which was our motivation for holding follow-up evidence sessions and making further recommendations. During this work we found that whilst there had been some difficulties with engagement with the CAA, improvements were being made and the sector's experience of the regulators was improving.²³³ We did, however, recommend that the implementation of the regulation be reviewed and streamlined where possible.²³⁴ Our follow-up report recommended that:

As the spaceflight regulations were put in place before any implementation could take place, there is now a need for the regulations and their implementation to date to be reviewed. We are encouraged to hear that the Government does intend to conduct this review, but recommend that it does so at pace, publishing the outcomes of the review and the planned improvements to the regulatory process by September 2023. Focus should be placed on streamlining the process and improving the experience for both licence applicants and the CAA, whilst maintaining the best safety standards.²³⁵

182. Despite us asking for this to be completed by September 2023, the Government response to our Report stated that this work had only commenced in September 2023:

The Government is committed to undertaking a full Post Implementation Review (PIR) of the Space Industry Act 2018. The PIR began on 1 September 2023 and will conclude by 31 March 2024. The Review will follow three distinct phases of activity, including consultation with the space sector. The

232 House of Commons Science and Technology Committee, Second Report of Session 2022–23, [UK space strategy and UK satellite infrastructure](#), (HC 100; 4 November 2022), paras 86–88.

233 House of Commons Science, Innovation and Technology Committee, Seventh Report of Session 2022–23, [UK space strategy and UK satellite infrastructure: reviewing the licencing regime for launch](#), (HC 1717; 14 July 2023), paras 12–21.

234 House of Commons Science, Innovation and Technology Committee, Seventh Report of Session 2022–23, [UK space strategy and UK satellite infrastructure: reviewing the licencing regime for launch](#), (HC 1717; 14 July 2023), para 21.

235 House of Commons Science, Innovation and Technology Committee, Seventh Report of Session 2022–23, [UK space strategy and UK satellite infrastructure: reviewing the licencing regime for launch](#), (HC 1717; 14 July 2023), para 21.

outcome of the Review will form part of a broader review of the space sector regulatory environment being undertaken by the Department for Science, Innovation and Technology (DSIT).²³⁶

183. In addition to the delays in carrying out this review, the UK Space Agency did not publish its report on the lessons learnt after the first launch attempt until December 2023.²³⁷ The report made recommendations on how the Government and the Civil Aviation Authority could improve the regulatory approach. Many of these recommendations were similar to those set out in our follow-up report, published in July 2023, including improvements needed in communication between regulatory bodies and between international partners.

Position, Navigation and Timing capabilities

184. Our Inquiry highlighted the importance of the UK’s Position, Navigation and Timing (PNT) capabilities and found that significant Government funds had been used for the UK to establish its own PNT services, after it the UK had been barred from the European Union’s Galileo programme.²³⁸ We recommended that the Government publish the long-awaited UK PNT strategy.²³⁹ We reiterated this recommendation in our follow-up Report, as the PNT strategy still had not been published over eight months later.²⁴⁰

185. The Government eventually published a PNT framework in October 2023, which included ten measures that aimed to increase the resilience of the UK’s PNT capabilities.²⁴¹ The measures included creating a National PNT Office within DSIT to hold responsibility for PNT policy, coordination and delivery and creating a PNT Crisis Plan that could be activated if PNT services are lost. Alongside the Framework, the Government also published the outcomes of the Space Based PNT Programme,²⁴² which we had called from them to do in our initial report.²⁴³

OneWeb

186. We also scrutinised the Government’s investment in the satellite firm OneWeb.²⁴⁴ We raised concerns about the Government’s rationale for the purchase and asked the

236 House of Commons Science, Innovation and Technology Committee, Fifth Special Report of Session 2022–23, [UK space strategy and UK satellite infrastructure: reviewing the licencing regime for launch: Government response to the Committees Seventh Report](#), (HC 1900; 27 October 2023).

237 UK Space Agency, [UK Pathfinder Launch: Lessons Learned report](#), (14 December 2023).

238 House of Commons Science and Technology Committee, Second Report of Session 2022–23, [UK space strategy and UK satellite infrastructure](#), (HC 100; 4 November 2022), paras 31–43.

239 House of Commons Science and Technology Committee, Second Report of Session 2022–23, [UK space strategy and UK satellite infrastructure](#), (HC 100; 4 November 2022), para 42.

240 House of Commons Science, Innovation and Technology Committee, Seventh Report of Session 2022–23, [UK space strategy and UK satellite infrastructure: reviewing the licencing regime for launch](#), (HC 1717; 14 July 2023), para 42.

241 Department for Science, Innovation and Technology, [Critical services to be better protected from satellite data disruptions through new Position, Navigation and Timing framework](#), 18 October 2023

242 UK Space Agency and Department for Science, Innovation and Technology, [Space-based PNT Technical Concepts](#), (18 October 2023).

243 House of Commons Science and Technology Committee, Second Report of Session 2022–23, [UK space strategy and UK satellite infrastructure](#), (HC 100; 4 November 2022), para 42.

244 House of Commons Science and Technology Committee, Second Report of Session 2022–23, [UK space strategy and UK satellite infrastructure](#), (HC 100; 4 November 2022), paras 12–28.

Government to report to Parliament on state of the Government’s investment.²⁴⁵ We heard conflicting evidence on where OneWeb’s second generation (Gen2) of satellites would be manufactured and called for the Government to gain assurances that Gen2 would be manufactured in the UK.²⁴⁶

187. In its response the Government said that its investment in OneWeb was:

... a significant strategic investment, demonstrating our commitment to the UK’s space sector and ambition to put the UK at the forefront of a new commercial space age. The Government notes the Committee’s interest in the need for transparency and scrutiny of the investment but does not agree that it is necessary to provide a separate yearly report on the investment as the value of the Government’s interest in OneWeb is published in the Department’s Annual Report and Accounts, and significant updates on OneWeb’s business and activities are made public through the Government’s and OneWeb’s press releases.²⁴⁷

On Gen2 manufacturing, the Government did not guarantee that manufacturing would take place in the UK:

Decisions on the design and development of Gen2 are ultimately matters for OneWeb. The Government’s special share rights of first preference for UK procurement only apply on a commercially competitive basis. This means we could not compel OneWeb to locate all elements of the manufacturing process for its Gen2 constellation in the UK where it does not make commercial sense.²⁴⁸

188. Since the conclusion of our inquiry the Government has announced plans to invest £160 million in a Connectivity in Low Earth Orbit (C-LEO) programme, which aims to “ensure the UK becomes a global leader in next generation satellite communication technologies”.²⁴⁹

Cross-Government coordination

189. A key theme of our work on space was the need for an improved approach to cross-Government coordination on space, including establishing clearer leadership structures.²⁵⁰ During the course of our work the newly established National Space Council was abolished. After we called for the Government to provide clarity on its governance structures for the space sector, the Council was established as an ‘Inter-Ministerial

245 House of Commons Science and Technology Committee, Second Report of Session 2022–23, [UK space strategy and UK satellite infrastructure](#), (HC 100; 4 November 2022), para 26.

246 House of Commons Science and Technology Committee, Second Report of Session 2022–23, [UK space strategy and UK satellite infrastructure](#), (HC 100; 4 November 2022), para 28.

247 House of Commons Science and Technology Committee, Second Special Report of Session 2022–23, [UK space strategy and UK satellite infrastructure: Government Response to the Committee’s Second Report](#), (HC 1258; 30 March 2023), para 3.

248 House of Commons Science and Technology Committee, Second Special Report of Session 2022–23, [UK space strategy and UK satellite infrastructure: Government Response to the Committee’s Second Report](#), (HC 1258; 30 March 2023), para 3.

249 Department for Science, Innovation and Technology, [Spring Budget puts UK on fast-track to becoming science and technology superpower](#), (7 March 2024).

250 House of Commons Science and Technology Committee, Second Report of Session 2022–23, [UK space strategy and UK satellite infrastructure](#), (HC 100; 4 November 2022), para 172

Group’.²⁵¹ The Government also established a ‘Space Sector Industry Forum’ to provide “a regular and enduring opportunity for industry leaders to meet with Ministers to help inform the Government’s long-term strategy for space”.²⁵² We welcomed this move, but recommended that the Government appoint a strong leader to drive the success of the Forum.²⁵³ The Government did not commit to this in its response to our report, but told us that the Science Minister and Chair of UKSpace would co-chair the meetings.²⁵⁴

190. In March 2024, the Government published a Space Industrial Plan,²⁵⁵ a joint civil-defence publication, which set out how the Government plans to work with the commercial space sector to “cultivate a vibrant ecosystem of space companies of all sizes, driving innovation and ensuring operational independence in a contested space environment”.²⁵⁶

Recommendations for future work

191. *Should our successor Committee wish to examine UK space policy, it should consider:*

- *Scrutinising the ongoing implementation of the spaceflight regulations and their impact on the success of the UK’s small satellite launch sector;*
- *Exploring the progress made on the ten points set out in the Position, Navigation and Timing Framework, to determine if improvements to the UK’s resilience against loss of PNT services has been achieved;*
- *Analysing whether the UK is benefiting from its investment in OneWeb, including investigating whether manufacturing is taking place in the UK; and*
- *Scrutinising the governance structure put in place for the space sector, including looking at how the National Space Council and Space Sector Industry Forum are functioning, as well as progress being made toward the goals set out in the 2021 National Space Strategy and Space Industrial Plan.*

UK Astronomy

192. We launched our inquiry into UK Astronomy in September 2023.²⁵⁷ The inquiry, which had not reported by the time of Parliament’s dissolution in May 2024, sought to explore:

251 House of Commons Science and Technology Committee, Second Report of Session 2022–23, [UK space strategy and UK satellite infrastructure](#), (HC 100; 4 November 2022), para 171; House of Commons Science, Innovation and Technology Committee, Seventh Report of Session 2022–23, [UK space strategy and UK satellite infrastructure: reviewing the licencing regime for launch](#), (HC 1717; 14 July 2023), paras 34–38.

252 [Correspondence from Minister for the Department for Science, Innovation and Technology in relation to Position, Navigation and Timing, the Space Council and the Space Sector Industry Forum](#), (30 May 2023).

253 House of Commons Science, Innovation and Technology Committee, Seventh Report of Session 2022–23, [UK space strategy and UK satellite infrastructure: reviewing the licencing regime for launch](#), (HC 1717; 14 July 2023), para 40.

254 House of Commons Science, Innovation and Technology Committee, Fifth Special Report of Session 2022–23, [UK space strategy and UK satellite infrastructure: reviewing the licencing regime for launch: Government response to the Committees Seventh Report](#), (HC 1900; 27 October 2023), para 4.

255 Department for Science, Innovation and Technology, [Space Industrial Plan](#), (7 March 2024).

256 Department for Science, Innovation and Technology, [Space Industrial Plan](#), (7 March 2024).

257 House of Commons Science, Innovation and Technology Committee, [Inquiry into the potential of UK Astronomy launched](#), (13 September 2023).

- The strengths and weaknesses of UK astronomy and how these compare to other nations;
- The opportunities and challenges facing UK astronomy and whether it is receiving sufficient support;
- What the aims and focus of UK astronomy should be;
- The extent to which UK astronomy contributes to the UK’s status as a science superpower;
- Whether the UK is maximising the contribution that astronomy can make to the wider UK economy; and
- What role astronomy is playing in encouraging greater diversity and inclusion in STEM and public interest in science.

193. By 23 May 2024 we had received 46 pieces of written evidence,²⁵⁸ and held four oral evidence sessions. The latter included:

- An opening session with the Astronomer Royal (Lord Rees of Ludlow), the Astronomer Royal for Scotland (Professor Catherine Heymans), and the President of the Royal Astronomical Society (Professor Mike Edmunds) and witnesses who covered topics such as the wonder of astronomy, astronomy technology, the use of AI in astronomy and diversity and inclusion across the sector.²⁵⁹
- A second session, which covered the UK’s position as a leader in developing and deploying astronomy technology and its commercial translation into non-astronomy uses. It also covered the strength of the UK’s laboratory and analytical capabilities, in terms of processing astronomy data and samples from the moon, asteroids and planets.²⁶⁰
- A third session, which focused on the role of amateur astronomers and citizen science in the UK, including hearing from the President of the British Astronomical Association, Dr David Arditti. It also looked at the role of broadcasters and institutions such as the Space Centre in Leicester and the network of other Science Discovery Centres in promoting astronomy in itself, and using it as a gateway to STEM more generally. The session also examined how diversity and inclusion in the sector can be improved.²⁶¹
- The fourth session, took a comparative approach and heard from witnesses across Europe, including from Germany, the Netherlands, Italy and Switzerland.

258 House of Commons Science, Innovation and Technology Committee, [written evidence](#).

259 House of Commons Science, Innovation and Technology Committee, [Oral evidence: UK Astronomy](#), (HC 329; 10 January 2024).

260 House of Commons Science, Innovation and Technology Committee, [Oral evidence: UK Astronomy](#), (HC 329; 13 March 2024).

261 House of Commons Science, Innovation and Technology Committee, [Oral evidence: UK Astronomy](#), (HC 329; 17 April 2024).

It covered funding and infrastructure, the development and deployment of astronomy technology, the position of post-doctoral researchers and approaches to improving diversity and inclusion.²⁶²

Key themes from our work

194. The evidence we took suggested that:

- The UK is well-respected as a producer of high-quality astronomy research outputs—ranked third in the world for high impact astronomy papers and for papers published in 2000–2020²⁶³—and occupies leadership roles in international space-based missions (e.g. missions to Mars and Mercury)²⁶⁴ and earth-based observation programmes (e.g. Square Kilometre Array radio telescope and the Very Large Telescope);²⁶⁵
- Despite its historic and current leadership, the UK’s position is challenged by existing and new competitors, such as India and China,²⁶⁶ which will require the UK to have the research, technological and analytical base to maintain its own astronomy outputs and to compete for positions on international programmes;²⁶⁷
- The need for longer funding timeframes of at least ten years, to cover the development and deployment of instrumentation, whether space-based (e.g. probes) or earth-based (e.g. radio or electronic telescopes) and subsequent analysis of data or samples;²⁶⁸

262 House of Commons Science, Innovation and Technology Committee, [Oral evidence: UK Astronomy](#), (HC 329; 8 May 2024).

263 Astronomy Unit, Queen Mary University London ([AST0011](#)), noted that the UK was ranked third in the world for high impact astronomy papers and for papers published in 2000–2020, while those with UK co-authors received 2.7 million citations. While for comparison, those co-authored from the USA community, which is 4.2 times larger, received only 2.6 times as many citations. See also: UK Research and Innovation ([AST0014](#)); STFC Solar System Advisory Panel ([AST0025](#)); UK Space Agency ([AST0042](#)).

264 [BepiColombo](#) is a European Space Agency mission to Mercury that will help our understanding of the formation of the Solar System and its inner rocky planets. It was launched in 2019 and will arrive in late 2025 and has a [key UK involvement](#). The UK has a history of missions to Mars, including development of the [Beagle 2 rover](#), and is involved in developing the [Rosalind Franklin Mars Rover](#), which will be part of [ESA’s ExoMars](#) programme that will explore the surface of Mars.

265 The [Square Kilometre Array radio telescope](#) is an intergovernmental international radio telescope project being built in Australia and South Africa. The combining infrastructure, the Square Kilometre Array Observatory, and headquarters, are located at the Jodrell Bank Observatory in the United Kingdom. The [Very Large Telescope](#) is an astronomical facility operated since 1998 by the European Southern Observatory, located on Cerro Paranal in the Atacama Desert of northern Chile. It consists of four individual telescopes, each equipped with a primary mirror that measures 8.2 meters in diameter.

266 Prof Katherine Joy (Professor of Lunar and Planetary Science at The University of Manchester UK) ([AST0007](#)) The University of Manchester ([AST0027](#)); Aprajita Verma (Senior Researcher at University of Oxford); James Bolton (Associate Professor at University of Nottingham); Poshak Gandhi (Professor of Astrophysics at University of Southampton); Paolo Mazzali (Professor of Astrophysics at Liverpool John Moores University); Noelia Noel (Senior Lecturer at University of Surrey); Stephen Serjeant (Professor of Astrophysics at Open University); Benjamin Stappers (Professor of Astrophysics at University of Manchester) ([AST0039](#))

267 House of Commons Science, Innovation and Technology Committee, [Oral evidence: UK Astronomy](#), (HC 329; 13 March 2024), [Q153](#) [Professor Mahesh Anand].

268 House of Commons Science, Innovation and Technology Committee, [Oral evidence: UK Astronomy](#), (HC 329; 8 May 2024), [Qq211 to 212](#) [Professor Dr Michael Kramer] and [Q251](#) [Professor Nicolas Thomas]; Professor Mahesh Anand (Professor of Planetary Science and Exploration at The Open University) ([AST0035](#)); Institute of Astronomy, University of Cambridge ([AST0030](#)); UK Space Agency ([AST0042](#)); Professor Mark Sims (Space Projects and Instrumentation Lead and Co-chair Space Academic Network (SPAN) at University of Leicester and SPAN) ([AST0010](#)).

- The advantages of a central voice in astronomy to bring together the community to liaise with government and international partners and organisations, as is the case in the Netherlands and Germany;²⁶⁹
- The benefits of utilising AI to analyse the vast amount of astronomy data being produced on a daily basis,²⁷⁰ aligned with concerns that AI did not stop serendipitous discoveries,²⁷¹ and could address its carbon footprint;²⁷²
- A lack of tenure for post-doctoral researchers in the UK because of a lack of fellowships which is threatening the sustainability of professional astronomy;²⁷³
- The need for international partnerships to develop and deploy earth and space-based programmes/infrastructure which is increasingly beyond the resources of individual nation states;²⁷⁴
- The potential of astronomy to deliver wider societal and economic benefits through the translation of instrumentation into other uses,²⁷⁵ if supported through funding and support in areas such as dual-use exports;²⁷⁶

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- 269 House of Commons Science, Innovation and Technology Committee, [Oral evidence: UK Astronomy](#), (HC 329; 8 May 2024), [Q208](#) [Dr Jessica Dempsey] and [Q211](#) [Professor Dr Michael Kramer].
- 270 Astronomy Unit, Queen Mary University London ([AST0011](#)). See also: UK Research and Innovation ([AST0014](#)); Aprajita Verma (Senior Researcher at University of Oxford); James Bolton (Associate Professor at University of Nottingham); Poshak Gandhi (Professor of Astrophysics at University of Southampton); Paolo Mazzali (Professor of Astrophysics at Liverpool John Moores University); Noelia Noel (Senior Lecturer at University of Surrey); Stephen Serjeant (Professor of Astrophysics at Open University); Benjamin Stappers (Professor of Astrophysics at University of Manchester) ([AST0039](#)).
- 271 House of Commons Science, Innovation and Technology Committee, [Oral evidence: UK Astronomy](#), (HC 329; 8 May 2024), [Q221](#) [Professor Dr Michael Kramer].
- 272 House of Commons Science, Innovation and Technology Committee, [Oral evidence: UK Astronomy](#), (HC 329; 8 May 2024), [Qq223–225](#) [Dr Jessica Dempsey].
- 273 House of Commons Science, Innovation and Technology Committee, [Oral evidence: UK Astronomy](#), (HC 329; 10 January 2024), [Q27](#) [Professor Steve Eales] and [Q68](#) [Professor Martin Barstow]; Professor Wyn Evans (Professor of Astrophysics at University of Cambridge) ([AST0004](#)); Dr N Paul Kuin (Senior Scientist at University College London/Mullard Space Science Laboratory) ([AST0006](#)); Cardiff Hub for Astrophysics Research and Technology, Cardiff University ([AST0009](#)); Astronomy Unit, Queen Mary University London ([AST0011](#)); Dr Judith Helen Croston (Research Area Lead for Astronomy at The Open University); Professor Stephen Lewis (Head of the School of Physical Sciences at The Open University) ([AST0013](#)); UK Research and Innovation ([AST0014](#)); Mullard Space Science Laboratory, University College London ([AST0017](#)); University of St Andrews, University of Glasgow, University of Edinburgh, University of Dundee ([AST0023](#)); Institute of Astronomy, University of Cambridge ([AST0030](#)); Euclid:UK Coordination Group (EUCG) ([AST0034](#)).
- 274 House of Commons Science, Innovation and Technology Committee, [Oral evidence: UK Astronomy](#), (HC 329; 8 May 2024), [Q207](#) [Dr Jessica Dempsey].
- 275 House of Commons Science, Innovation and Technology Committee, [Oral evidence: UK Astronomy](#), (HC 329; 13 March 2024), [Q72](#) and [Qq81–86](#) [Dr Geraint Morgan and Professor Gillian Wright CBE], [Qq118–119](#) [Adam Woodcraft], and [Q109](#) [Justin Byrne]; Dr Judith Helen Croston (Research Area Lead for Astronomy at The Open University); Professor Stephen Lewis (Head of the School of Physical Sciences at The Open University) ([AST0013](#)); UK gravitational-wave community ([AST0018](#)); e-MERLIN/VLBI National Facility ([AST0029](#)).
- 276 House of Commons Science, Innovation and Technology Committee, [Oral evidence: UK Astronomy](#), (HC 329; 13 March 2024), [Qq91–92](#) [Dr Geraint Morgan] and [Qq115–116](#) [Adam Woodcraft].

- The contribution that amateur astronomy can play, both in terms of contributing to research,²⁷⁷ but also in sparking interest in astronomy and related careers;²⁷⁸
- A lack of diversity in astronomy in the UK,²⁷⁹ but elsewhere across Europe,²⁸⁰ and globally²⁸¹ and the need to address this in professional settings through recruitment and retention policies and across the sector as a whole through role models,²⁸² and outreach;²⁸³
- Significant levels of bullying and harassment as reported to the Royal Astronomical Society;²⁸⁴ and
- The central role that astronomy engagement and outreach can play,²⁸⁵ especially with young school children, in increasing interest in both astronomy and STEM more broadly,²⁸⁶ whilst widening diversity.²⁸⁷

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- 277 House of Commons Science, Innovation and Technology Committee, [Oral evidence: UK Astronomy](#), (HC 329; 17 April 2024), [Qq176–178](#) [Dr David Arditti], [Qq180–182](#), [Q184](#) and [Q190](#) [Professor Chris Lintott]; British Astronomical Association ([AST0036](#)); Dundee Astronomical Society ([AST0003](#)); Professor Wyn Evans (Professor of Astrophysics at University of Cambridge) ([AST0004](#)); Dr Judith Helen Croston (Research Area Lead for Astronomy at The Open University); Professor Stephen Lewis (Head of the School of Physical Sciences at The Open University) ([AST0013](#)); The Royal Astronomical Society ([AST0021](#)); Bryn Jones ([AST0041](#)).
- 278 House of Commons Science, Innovation and Technology Committee, [Oral evidence: UK Astronomy](#), (HC 329; 17 April 2024), [Q182](#) [Dr David Arditti] and [Q180](#) [Professor Chris Lintott].
- 279 House of Commons Science, Innovation and Technology Committee, [Oral evidence: UK Astronomy](#), (HC 329; 10 January 2024), [Qq23–25](#) [Professor Catherine Heymans] and [Qq63–64](#) [Professor Anna Scaife].
- 280 House of Commons Science, Innovation and Technology Committee, [Oral evidence: UK Astronomy](#), (HC 329; 8 May 2024), [Q236](#) and [Q238](#) [Dr Jessica Dempsey], [Q237](#) and [Q239](#) [Professor Dr Michael Kramer], [Qq260–262](#) [Professor Nicolas Thomas], and [Qq264–266](#) [Mr Cremonese].
- 281 For example, the International Astronomical Union collates gender statistics which [show](#) that across its entire global membership (12,754 members) only 21.8% of established astronomers (i.e. those who have security of tenure) are female, while of its junior members (i.e. those who have completed PhDs but do not have security of tenure) only 33% are female. Its statistics indicate, of UK members (655 members)—80.3% are male and 18.3% are female.
- 282 House of Commons Science, Innovation and Technology Committee, [Oral evidence: UK Astronomy](#), (HC 329; 17 April 2024), [Q190](#) [Dame Maggie Aderin-Pocock], [Q191](#) and [Q200](#) [Chas Bishop].
- 283 House of Commons Science, Innovation and Technology Committee, [Oral evidence: UK Astronomy](#), (HC 329; 10 January 2024), [Q47](#) [Professor Steve Eales].
- 284 House of Commons Science, Innovation and Technology Committee, [Oral evidence: UK Astronomy](#), (HC 329; 10 January 2024), [Q45](#) [Professor Mike Edmunds]; The Royal Astronomical Society ([AST0021](#)); Professor Wyn Evans (Professor of Astrophysics at University of Cambridge) ([AST0004](#)); Bryn Jones ([AST0041](#)). The Royal Astronomical Society reported that out of the 650 people it surveyed in 2020–2021: 44% of respondents had suffered bullying and harassment in the workplace within the preceding 12 months; (ii) Women and non-binary people in the field are 50% more likely than men to be bullied and harassed; (iii) 50% of lesbian, gay, bisexual, and queer astronomers were bullied in the last 12 months.
- 285 Aprajita Verma (Senior Researcher at University of Oxford); James Bolton (Associate Professor at University of Nottingham); Poshak Gandhi (Professor of Astrophysics at University of Southampton); Paolo Mazzali (Professor of Astrophysics at Liverpool John Moores University); Noelia Noel (Senior Lecturer at University of Surrey); Stephen Serjeant (Professor of Astrophysics at Open University); Benjamin Stappers (Professor of Astrophysics at University of Manchester) ([AST0039](#)); Astronomy Unit, Queen Mary University London ([AST0011](#)); UK Square Kilometre Array Observatory Science Committee ([AST0020](#)); University of Leicester ([AST0016](#)); National Space Centre ([AST0044](#)).
- 286 Professor Wyn Evans (Professor of Astrophysics at University of Cambridge) ([AST0004](#)); European Southern Observatory ([AST0008](#)); Cardiff Hub for Astrophysics Research and Technology, Cardiff University ([AST0009](#)); Dr Judith Helen Croston (Research Area Lead for Astronomy at The Open University); Professor Stephen Lewis (Head of the School of Physical Sciences at The Open University) ([AST0013](#)); UK Research and Innovation ([AST0014](#)); UK gravitational-wave community ([AST0018](#)).
- 287 House of Commons Science, Innovation and Technology Committee, [Oral evidence: UK Astronomy](#), (HC 329; 10 January 2024), [Q65](#) [Professor Martin Barstow]; The Royal Astronomical Society ([AST0021](#)).

Recommendations for future work

195. *Should our successor Committee wish to consider UK astronomy, it could:*

- *Consider whether funding timeframes for astronomy strategies, programmes and infrastructure need to be lengthened and if astronomy needs a single voice rather than a split between the Science and Technology Facilities Council and the UK Space Agency;*
- *Examine whether the UK is fully exploiting its international partnerships so that UK researchers and companies can participate and lead on collaborative programmes and projects;*
- *Assess whether the UK astronomical instrumentation organisations and companies, especially SMEs, have the support they need to contribute to international infrastructure and missions, and to repurpose their technology for other purposes, especially where this might be exported;*
- *Evaluate whether the UK has sufficient laboratory and data facilities to ensure that it can be a significant locus for national and international astronomy analysis and research;*
- *Consider whether current arrangements for post-doctoral astronomy research are sufficient to ensure the sustainability of professional astronomy in the UK;*
- *Examine further reports of bullying and harassment in astronomy and the diversity of those employed or participating as amateurs and how this can be addressed; and*
- *Consider whether astronomy outreach, whether delivered by amateur or professional astronomers, as part of funded programmes or by organisations, such as Science Discovery Centres, is adequate and effective.*

9 Technology

196. During the course of this Parliament, this Committee has explored many issues encompassing technology policy, with the focus on how these technologies can offer beneficial applications to society and promote economic growth. Between 2020–2021 the Committee explored the UK’s telecommunications infrastructure which highlighted the need for increased research and development as well as the impact of the wider geopolitical environment on critical and emerging technologies. In 2022 the Committee undertook a one-off evidence session into current and future applications of blockchain technologies. Finally in 2023–2024 the Committee scrutinised how quantum technologies, one of five critical technologies identified by DSIT, were being commercialised to both future-proof the UK’s critical national infrastructure and create a highly profitable quantum industry.

UK telecommunications infrastructure and the UK’s domestic capability

197. In April 2020 we launched an inquiry to examine the UK’s telecommunications infrastructure and capability,²⁸⁸ following an announcement by the Government that it would allow Huawei and other “high risk vendors” to supply “non-sensitive” elements of the UK’s 5G telecommunications networks, despite security concerns.²⁸⁹ Our report was published on 4 February 2021,²⁹⁰ and the Government’s response was published on 29 April 2021.²⁹¹

Key themes from our work

198. Our inquiry highlighted the extent to which successive Governments had not prioritised developing and implementing a strategy for diversifying the UK’s telecommunications infrastructure; despite the potential risks posed by the supply of telecommunications infrastructure from foreign vendors, and of increasing market concentration.²⁹²

199. We also highlighted the need for greater research and development in this area.²⁹³ We heard widespread support for the establishment of common testing facilities for new 5G infrastructure equipment, with a view to providing services that could encourage diversification. Whilst the Government had identified the National Telecoms Lab as the primary vehicle for delivering on this, we highlighted its focus on security testing and

288 House of Commons Science, Innovation and Technology Committee, [Science and Technology Committee launches three new inquiries](#), (accessed 1 February 2024).

289 GOV.UK, [New plans to safeguard country’s telecoms network and pave way for fast, reliable and secure connectivity](#), (accessed 1 February 2024).

290 House of Commons Science and Technology Committee, Second Report of Session 2019–21, [5G market diversification and wider lessons for critical and emerging technologies](#), (HC 450; 4 February 2021).

291 House of Commons Science and Technology Committee, [Fifth Special Report of Session 2019–21, 5G market diversification and wider lessons for critical and emerging technologies: Government Response to the Committee’s Second Report of 2019–21](#), (HC 1377; 29 April 2021).

292 House of Commons Science and Technology Committee, Second Report of Session 2019–21, [5G market diversification and wider lessons for critical and emerging technologies](#), (HC 450; 4 February 2021), para 14.

293 House of Commons Science and Technology Committee, Second Report of Session 2019–21, [5G market diversification and wider lessons for critical and emerging technologies](#), (HC 450; 4 February 2021), para 43.

validation alone;²⁹⁴ and therefore recommended that facilities established as part of the implementation of the Strategy should also encourage collaboration and the development and commercialisation of new technologies.²⁹⁵

200. Our inquiry found that whilst the then-Government had begun to take steps towards greater diversification, significant barriers remained that would not necessarily be addressed by the 5G Supply Chain Diversification Strategy.²⁹⁶ One barrier specific to new vendors of 5G telecommunications equipment was scaling up production rapidly enough to meet network operator demand and thereby compete with incumbent vendors.²⁹⁷ We recommended that the Government identify opportunities to support new market entrants scale their production by supporting the deployment of novel small-scale 5G deployments.²⁹⁸

201. Our report also highlighted the impact of the wider geopolitical environment on the UK's telecommunications infrastructure. With technological and regulatory divergence between China, countries aligned with China, and other countries on the rise, we found significant potential for differing technical and regulatory standards across different emerging technologies; such as AI and quantum. We concluded that the challenges associated with 5G infrastructure development would likely not be unique, but rather illustrative of wider trends.²⁹⁹

Government progress on implementing recommendations

202. Our report made a series of recommendations intended to promote greater diversification across the UK's telecommunications infrastructure, aimed primarily at the Government's strategy and subsequent implementation. These included:

Implementation

203. Our report recommended that the Government produce within three months "... a more detailed action plan for implementing its diversification strategy. This should include a breakdown of how the initial budget will be spent and a series of milestones with target dates for completion".³⁰⁰

Encouraging existing vendors

204. Our report said that the Government should:

294 House of Commons Science and Technology Committee, Second Report of Session 2019–21, [5G market diversification and wider lessons for critical and emerging technologies](#), (HC 450; 4 February 2021), para 48.

295 House of Commons Science and Technology Committee, Second Report of Session 2019–21, [5G market diversification and wider lessons for critical and emerging technologies](#), (HC 450; 4 February 2021), para 49.

296 House of Commons Science and Technology Committee, Second Report of Session 2019–21, [5G market diversification and wider lessons for critical and emerging technologies](#), (HC 450; 4 February 2021), para 22.

297 House of Commons Science and Technology Committee, Second Report of Session 2019–21, [5G market diversification and wider lessons for critical and emerging technologies](#), (HC 450; 4 February 2021), para 56.

298 House of Commons Science and Technology Committee, Second Report of Session 2019–21, [5G market diversification and wider lessons for critical and emerging technologies](#), (HC 450; 4 February 2021), para 57.

299 House of Commons Science and Technology Committee, Second Report of Session 2019–21, [5G market diversification and wider lessons for critical and emerging technologies](#), (HC 450; 4 February 2021), para 85.

300 House of Commons Science and Technology Committee, Second Report of Session 2019–21, [5G market diversification and wider lessons for critical and emerging technologies](#), (HC 450; 4 February 2021), para 14.

... propose measures within the next six months that could facilitate market entry by existing vendors in the near-term. It should consider options for addressing the barrier of operators' preference for vendors to offer older generation technologies with their 5G equipment, such as incentivising or mandating standalone 5G deployments and/or the use of protocols such as the Open X2 interface.³⁰¹

Alignment of strategy with roll-out support

205. Our report highlighted the importance of combining the diversification strategy with support for the roll-out of 5G network coverage. We recommended that:

Wherever the Government provides funds for expanding 5G coverage, it should look for opportunities to simultaneously support vendor diversification, for example by requiring the use of open standards. The Government should identify opportunities to support new market entrants scale their production by supporting the deployment of novel small-scale 5G deployments.³⁰²

Global standards

206. Our report underlined the value of UK participation in global standards bodies for a range of critical and emerging technologies. We recommended that:

In producing a national strategy for critical and emerging technologies, the Government should review the relevant global standards bodies, the objectivity of their processes and the relative influence of different countries. Similar to those measures outlined in its 5G supply chain diversification strategy, the Government should develop measures to build British capability and influence at standards-setting bodies for all critical technologies.³⁰³

Recommendations for future work

207. *Should our successor Committee wish to examine the UK's telecommunications infrastructure and domestic capability, we recommend it considers:*

- *The implementation of the 5G Supply Chain Diversification Strategy, and relevant policy and technical developments since the then Committee's report;*
- *Examining the Government's participation in international standards bodies for critical and emerging technologies; or*
- *The rollout and uptake of 5G technology in UK infrastructure, and what lessons are being learned for future developments, i.e. the emergence of 6G.*

301 House of Commons Science and Technology Committee, Second Report of Session 2019–21, [5G market diversification and wider lessons for critical and emerging technologies](#), (HC 450; 4 February 2021), para 23.

302 House of Commons Science and Technology Committee, Second Report of Session 2019–21, [5G market diversification and wider lessons for critical and emerging technologies](#), (HC 450; 4 February 2021), para 57.

303 House of Commons Science and Technology Committee, Second Report of Session 2019–21, [5G market diversification and wider lessons for critical and emerging technologies](#), (HC 450; 4 February 2021), para 100.

Blockchain

208. On 29 June 2022 we held a one-off oral evidence session on current and possible future uses of blockchain technology, including in the public sector. We examined its benefits, limitations and key considerations for policymakers, as well as the extent to which the possible deployment of blockchain has been considered in the UK Government’s science and technology policy.³⁰⁴ We also assessed the Government’s plans to make the UK “a global crypto-asset technology hub”.³⁰⁵

Key themes from our work

209. Our session heard contributions from blockchain researchers, journalists and businesses. There were a wide variety of perspectives about the potential benefits and limitations of the technology. Some were sceptical of its practical use, while others insisted it was already playing a valuable role in securitising online transactions and supply chains.³⁰⁶

210. One area of common ground was the potential for unwary consumers to be misled by claims made around cryptocurrencies and non-fungible tokens (NFTs). Sport has been a particular focus of cryptocurrency firms, and many players or other celebrities have endorsed NFTs. We were told that there should be more education about the financial risks associated with such products, more controls on their promotion, and over where such assets are made available to buy and sell.³⁰⁷

Government progress on implementing recommendations

211. Following the one-off session, we wrote to the then-Economic Secretary to the Treasury to ask a series of questions about the Government’s implementation of its plans for the crypto-asset sector, consumer protection and education, and the promotion of cryptocurrency and crypto-assets by sports teams and/or sports players.³⁰⁸ The then-Economic Secretary confirmed that the Government would “... legislate in due course to bring certain crypto-assets into the scope of the financial promotions regulation to ensure that crypto-asset promotions are fair, clear, and not misleading”.³⁰⁹ The Financial Conduct Authority has since focused greater levels of its regulatory activity on the marketing of crypto-assets.³¹⁰

304 House of Commons Science, Innovation and Technology Committee, [Researchers, journalists and businesses questioned on blockchain uses](#), (1 February 2024).

305 GOV.UK, [Government sets out plan to make UK a global crypto asset technology hub](#), (1 February 2024).

306 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Blockchain](#), (HC 467; 22 June), [Qq25–30](#) [Ms. Izabella Kaminska and Mr David Shrier].

307 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Blockchain](#), (HC 467; 22 June), [Qq58–65](#) [Mr David Gerrard and Dr Tom Robinson].

308 House of Commons Science, Innovation and Technology Committee, [Correspondence from the then-Interim Chairs to Richard Fuller MP, then-Economic Secretary to the Treasury, regarding blockchain](#), (19 July 2022).

309 House of Commons Science, Innovation and Technology Committee, [Correspondence from Richard Fuller MP, then-Economic Secretary to the Treasury, to the then-Interim Chairs, on blockchain](#), (15 August 2022).

310 Financial Conduct Authority, [Guidance for crypto firms to help them comply with marketing rules](#), (2 November 2023); Financial Conduct Authority, [FCA warns firms and influencers to keep their social media ads lawful](#), (26 March 2024).

Recommendations for future work

212. *Should our successor Committee wish to examine blockchain technology, we recommend that it examines in greater depth potential use cases in the public and private sectors; including the benefits, risks, potential opportunities, regulatory environment and public understanding about the technology.*

Commercialising quantum technologies

213. In March 2023 we launched an inquiry into Commercialising quantum technologies to explore how the UK is supporting the translation of quantum research into commercial products to benefit the UK's society and economy.³¹¹ This followed the Government's announcement National Quantum Strategy, supported by a £2.5 billion programme over ten-years, during the Spring Budget in March 2023.³¹²

214. The inquiry, which did not report at the time of Parliament dissolution in May 2024, received over forty written submissions and took oral evidence from 19 witnesses, including academics, industry and industrialists, trade bodies, National Laboratories, learned societies, UK Research and Innovation (UKRI), the Head of the Office for Quantum, and the Minister for Science, Research and Innovation, Andrew Griffith MP.

Key themes from our work

215. Our inquiry highlighted that quantum technologies have the potential to create significant benefit to not just the UK economy but society more broadly. We welcomed the Government's commitment to quantum technologies with the announced £2.5 billion commitment over ten years as outlined in the National Quantum Strategy.³¹³ However, we noted that awareness of quantum technologies is low both in industry and more broadly the public, which currently limits the potential commercialisation and uptake of quantum technologies.

216. We heard significant praise for the National Quantum Technologies Programme (NQTP) and the pivotal role it played in establishing the UK as a world leader in quantum technology research. However, there were concerns that as the NQTP enters phase three, a clear roadmap was required which details how the NQTP can aid in the near- and medium-term commercialisation potential of quantum technologies.³¹⁴

217. During the inquiry we heard how the commercialising quantum technologies challenge fund, delivered by Innovate UK (part of URKI), had aided in the establishment of many UK quantum start-up and spinout companies. However, there were concerns that as the fund comes to an end in 2025, between the next spending review, there is the potential that the UK start-ups and spinouts lose a source of vital funding.³¹⁵

311 House of Commons Science, Innovation and Technology Committee, [MPs seek evidence on turning quantum technologies into products](#), (16 March 2023).

312 Department for Science, Innovation and Technology, [National Quantum Strategy](#), (15 March 2023); HM Treasury, [Spring Budget 2023](#), (15 March 2023).

313 Department for Science, Innovation and Technology, [National Quantum Strategy](#), (15 March 2023).

314 UK National Quantum Technologies Programme, [Our Programme](#), (accessed 22 May 2024).

315 UK Research and Innovation, [Commercialising quantum technologies challenge fund](#), (accessed 22 May 2024).

218. We heard concerns from academics about the UK being excluded from Horizon Europe quantum-specific funding. The Head of the UK's Office for Quantum, Tom Newby, confirmed that the Horizon Europe Commission had excluded the UK as quantum technologies were deemed strategically sensitive.³¹⁶

219. This inquiry, as with many of this Committee's inquiries, heard that there is a significant shortage of skilled individuals. Without these individuals, the continued development, deployment, and adoption of quantum technologies in the UK is at risk. Although we welcomed the commitment in the National Quantum Strategy to fund an additional 1000 postgraduate students in quantum relevant disciplines, the Government has yet to set out detailed plans to provide appropriate training for those at other education stages, such as technician or apprenticeship level, who will be vital in delivering the Government's quantum ambitions. The Government committed to publishing a skills report, authored by the Quantum Skills Taskforce. However, as of May 2024 this report had not been published.

220. We additionally heard concerns around the Government's approach to attracting international talent, with the UK's current Global Talent Visa Network route seen unfavourably in comparison to competitor countries due to the upfront visa costs.³¹⁷

221. To ensure that the UK continues to be host to the largest number of quantum start-ups in Europe and attract venture capital for UK quantum companies, the Government needs to focus on incentives for scaling businesses. Concerns were raised during the inquiry over the lack of investment funds for quantum companies for Series B or later in the UK, which if not corrected, may lead to promising quantum companies relocating, selling early to foreign companies, or listing on foreign capital markets. Additionally, we heard the need for the Government to better understand the barriers to quantum technology commercialisation such as the lack of manufacturing capabilities and supply chain vulnerabilities. We welcomed the Government commissioning the Royal Academy of Engineering to conduct an independent review into these issues.³¹⁸ However, this review was due for publication by the end of 2023, and then revised by the Department for Science, Innovation and Technology to April 2024 after receiving an interim report. As of May 2024, this report had not been published.

222. Quantum companies also stressed that the Government needed to act as an early adopter for quantum technologies, supporting and de-risking the market. We welcomed the Quantum Catalyst Fund for government departments and their agencies to explore use cases.³¹⁹ However, most of the Government's procurement initiatives have focused on defence applications or quantum computing, the technology furthest from technological readiness.

316 House of Commons Science, Innovation and Technology Committee, [Oral evidence: Commercialising quantum technologies](#), (HC 270; 20 March 2024), [Qq321–330](#) [Minister Andrew Griffith MP and Tom Newby].

317 Home Office, [Global Talent eligible prize lists](#), (29 August 2023); Department for Science, Innovation and Technology, [National Quantum Strategy](#), (15 March 2023).

318 Department for Science, Innovation and Technology, [National Quantum Strategy](#), (15 March 2023).

319 Department for Science, Innovation and Technology, [£15 million competition to accelerate use of quantum in Government](#), (7 September 2023).

Recommendations for future work

223. *Should our successor Committee wish to examine quantum technologies, we recommend it considers:*

- *Scrutinising how the Government is achieving the aims and objectives set out in the National Quantum Strategy and its associated Missions;*
- *Examining how the Government and UK Research and Innovation are supporting the commercialisation of quantum technologies;*
- *Assessing how the Government is ensuring the UK regains access to future Horizon Europe funding calls for quantum technologies that it is currently shut out of;*
- *Scrutinising the Government’s work on developing and implementing quantum skills and talents to ensure the future workforce;*
- *Examining the UK infrastructure needs for quantum technologies to enable continued research commercialisation;*
- *Assessing the strengths and weaknesses of the UK’s quantum supply chain; and*
- *Evaluating the effectiveness of the Government’s UK quantum procurement initiatives.*

Conclusions and recommendations

Health-related inquiries and Covid-19

Recommendations for future work

1. *Should our successor Committee wish to further explore emerging diseases and learnings from covid-19, we recommend:*
 - *Funding should be made available for diagnostic facilities to uphold contracts, maintain equipment, and run laboratories to allow for fast and accurate diagnoses and aid the surveillance of emerging diseases; and*
 - *Ensure the UK Government focuses on multiple vaccine technologies for future pandemics and maintaining collaboration with academia and industry. (Paragraph 35)*

2. *Should our successor Committee wish to explore the reform of the UK health data strategy, we recommend it considers:*
 - *Investigating the replication of the academic model of open and competitive funding to solve problems and develop Privacy Enhancing technologies (PETs) and other critical pieces of data infrastructure as an alternative to internal or contracted software development work;*
 - *Recommending a trial comprising an over-resourced, centralised SDE covering a smaller number of trusts to build working templates, develop a skilled workforce and prove the security and privacy approaches to the public and industry. This would aid in obtaining widespread public support by swiftly demonstrating the viability and utility of the SDE model, supporting the success of further projects;*
 - *Recommending the implementation of a technical solution for the public to opt back into data sharing, and a targeted campaign to encourage those who have previously opted out to reconsider sharing their health data, now that data protection regulation and technologies have improved and tangible public benefits can be realised;*
 - *Recommending the consolidation of the Clinical Practice Research Datalink (CPRD) into the NHS SDE as soon as the latter meets all reasonable user needs, as the CPRD currently provides access to NHS data circumventing the protections of a TRE with significant overlap in functionality and replication of effort;*
 - *Recommending the simplification of ethical governance structures to avoid duplication and excessive overlap, and publishing an overview of this system so that all actors know where to obtain guidance;*
 - *Investigating the establishment of a single organisation solely responsible for delivering data architecture for public projects. This would assume centralised*

responsibility for the ongoing data projects by NHS England and other government entities, removing the fragmentation of skills across different bodies and facilitating competitive recruitment;

- *Investigating the requirements for facilitating the development of AI models within TREs;*
- *Investigating the potential for implementing a shared data controller framework model similar to that used in Scotland, where the burden of data stewardship is removed from GPs and instead rests with NHS Scotland, simplifying data governance structures and facilitating clear and efficient data sharing mechanisms;*
- *Recommending the implementation of real-time audits for quality and completeness of NHS data;*
- *Investigating the potential establishment of an NHS data trust, which manages data and forges external partnerships for health data research, which would then be fed back into the NHS. This would build upon the principles in NHS England’s Value Sharing Framework for external partnerships, and seek to emulate the success of the BBC’s model of blending public funding with commercial revenue generation to reinvest into the service. Benefits to the NHS of negotiation with research entities could be realised either through direct profit or cost-price access to any treatments developed using NHS data. Advocates argue this would centralise NHS data initiatives, decrease the public funding burden, lengthen funding periods to allow more ambitious planning and confidence, and accelerate the development of novel treatments. However, others argue this would not address the existing challenges facing the healthcare data sector, present more risks to patient autonomy and public acceptance and reduce accountability of organisations using NHS data; and*
- *Investigating the establishment of a research institute focussed on AI medicine. This may be in the form of a new laboratory network across the biological and computational sciences, or as a partnership between relevant existing bodies such as the Francis Crick and Alan Turing Institutes. With a well-established public and private biomedical research sector, the UK is well positioned to take advantage of this burgeoning field and become a world leader in AI medicine. (Paragraph 50)*

Artificial intelligence

Recommendations for future work

3. *Should our successor Committee wish to examine the governance of AI, we recommend it considers:*
 - *The powers, coordination mechanisms and capacity of UK regulators to respond to the growing prevalence of AI in their sectors;*

- *The case for AI-specific legislation in the UK, and what lessons can be learned from other jurisdictions as they implement their own approaches to AI governance;*
- *The commitments outlined at the AI Safety Summit and AI Seoul Summit, and their implementation by Governments and leading developers;*
- *The current and potential future deployment of AI in the public sector, its benefits and any associated risks;*
- *The potential consequences of widespread AI deployment on current and future employment trends, and how to equip workers of the future with the skills to engage critically with the technology; and*
- *How future administrations respond to the Twelve Challenges of AI Governance highlighted in our interim Report. (Paragraph 62)*

Digital

Recommendations for future work

4. *Should our successor Committee wish to examine the cyber security and resilience of the UK's critical national infrastructure, we recommend it considers:*
 - *Following up how the Government is monitoring the emerging threats from nation states, state-sponsored actors, and criminal organisations on the UK's critical national infrastructure. This should include the threat from pre-positioning;*
 - *considering how the Government is protecting and strengthening critical national infrastructure supply chains and interdependencies;*
 - *Scrutinising the Government's ability to meet their targets for the UK's CNI to be significantly hardened to cyber-attacks by 2025, with all government organisations across the whole public sector being resilient to known vulnerabilities and attack methods no later than 2030;*
 - *Exploring how emerging technologies, such as artificial intelligence and quantum computing, may bring both unprecedented opportunities and threats to cyber security and resilience;*
 - *Exploring whether there is a need for a general duty for cyber resilience and it would apply to critical national infrastructure;*
 - *Investigating Whether the payment of ransoms should be made illegal for critical national infrastructure;*
 - *Scrutinising the Government's work around improving cyber literacy across all levels;*
 - *Scrutinising the commercial viability of secure by design technologies; and*

- *Considering the need to update cyber security legislation such as the Network and Information Systems regulation and the Computer Misuse Act 1990. (Paragraph 74)*

Energy

Recommendations for future work

5. *Should our successor Committee wish to examine the role of hydrogen in achieving net zero, we recommend it considers:*
 - *Scrutinising Government decision-making relating to the deployment of hydrogen ahead of 2030;*
 - *Examining findings from trials of hydrogen in different areas of the economy (e.g. energy storage, transport) and considering whether lessons have been learned and implemented by Government;*
 - *Examining what progress has been made in deciding upon the role of hydrogen in domestic heating, and the associated implications for consumers and the UK's Net Zero target;*
 - *Examining what progress has been made in identifying which industrial settings could utilise blue hydrogen ahead of 2050, and the phase-out of grey hydrogen; and*
 - *The development of green hydrogen projects at scale in the UK, to ensure that green hydrogen can be produced and become cost-competitive with blue hydrogen. (Paragraph 88)*
6. *Should our successor Committee wish to examine the Government's approach to delivering new nuclear, we recommend it considers:*
 - *Examining what progress has been made towards the Government reaching FID for two new nuclear plants by the end of the next Parliament, including progress made on Sizewell C and progress made towards supporting a Small Modular Reactor (SMR) developer;*
 - *Scrutinising how the role of Great British Nuclear (GBN) has developed beyond running an SMR competition and if it is bringing value to the nuclear sector;*
 - *Examining the ongoing approach to financing new nuclear projects, including the results of the consultation on "Alternative routes to market for new nuclear projects";*
 - *Assessing the work of the Nuclear Fuels Taskforce and progress made towards bridging the nuclear skills gap; and*
 - *Reviewing the progress made towards selecting a site for a Geological Disposal Facility (GDF) and whether delivery is on time. (Paragraph 110)*

Life sciences

Recommendations for future work

7. *Should our successor Committee wish to consider the antimicrobial potential of bacteriophages, we recommend:*
 - *Seeking updates on whether the MHRA has produced guidance relating to the data that would be required to evaluate applications for clinical trials and licensed phage products promised in the Government’s response;*
 - *Asking for updates on what progress the MHRA is making on producing a future ‘monograph’ - directive guidance for medical clinicians - for the compassionate use of phages;*
 - *Regularly tracking the latest phage developments from Innovate UK’s Phage Knowledge Transfer Network, which is bringing about collaboration between phage researchers, companies, research funders and regulators;*
 - *Scrutinising whether opportunities for phage research funding, phage infrastructure, including Good Manufacturing Practice (GMP) facilities, and access to specialist laboratories, such as those run by UKHSA, have improved; and*
 - *Questioning whether lessons are being learnt from phages that can be applied to similar personalised therapeutics that are not produced to a single formulation. (Paragraph 123)*

8. *Should our successor Committee wish to examine the Government’s approach to fungal research, we recommend it considers:*
 - *How the Government and UK Research and Innovation can support research into the antifungal resistance in the environment, animals, and humans, to increase the evidence base;*
 - *How the Government and its agencies can support fundamental and applied fungi research in the UK. Additionally, the successor Committee could look at the provisions of funding for long-term agricultural field trials;*
 - *How the Government and its agencies should consider ways in which to better communicate the science of fungi and their potential in tackling grand challenges facing society;*
 - *The possibility of widening the scope of the Genetic Technology (Precision Breeding) Act 2023 to include fungi; and*
 - *How the Government and its agencies could support the development of a UK ‘Red List of Threatened Fungal Species’ to aid in the conservation of threatened UK fungal species. (Paragraph 138)*

9. *Should our successor Committee wish to examine the Government’s approach to insect decline and UK food security, we recommend:*

- *Examining the Government and its agencies' strategies for sustaining long-term insect monitoring research and initiating new studies to address systemic knowledge gaps;*
- *Scrutinising the Government's communication methods around the realities of insect decline and the steps that can be taken to tackle the decline;*
- *Exploring whether there is need to develop a National Invertebrate Strategy, building on the successes of the National Pollinator Strategy;*
- *Scrutinising the remit of the National Bee Unit and its work on wild bees;*
- *Monitoring the impact of the new National History GCSE and its role in promoting entomology;*
- *Scrutinising the monitoring and evaluation programme for Environmental Land Management Schemes;*
- *Examining the work of the Initiative in disseminating advice to farmers on implementing Integrated Pest Management strategies; and*
- *Assessing work towards meeting the UK's international commitments to reducing the overall risk caused by pesticides by at least half by 2030. (Paragraph 148)*

Scientific research environments

Recommendations for future work

10. *Should our successor Committee wish to consider levels of diversity and inclusion in STEM, we recommend it considers:*
 - *Examining whether the trends in STEM education, particularly in subject uptake and attainment, as well as the delivery of STEM curriculum content, have changed since the Committee's inquiry, and the potential reasons for this;*
 - *The role that neurodiverse people play in the STEM ecosystem, whether they are over-represented compared to other sectors, the reasons for this and the benefits that their participation can deliver; or*
 - *Scrutinising the implementation of UKRI's first equality, diversity and inclusion strategy, its impact on the wider research sector, and to what extent findings from the Research and Innovation workforce survey have been made meaningfully useful across different departments, non-departmental bodies and the wider STEM sector. (Paragraph 162)*
11. *Should our successor Committee wish to further explore the commercialisation of research, we recommend it considers:*
 - *recommending the establishment of a coherent system to facilitate interactions between businesses and research and technology organisations to make support for business more visible and accessible;*

- *Recommending increased public investment in the development side of research and development to drive innovation and lead the way for further private investment;*
- *Recommending an increase in the spending review period for Catapults to greater than five years to enable longer term projects and decisions to be made based on certainty of core funding;*
- *Recommending the provision of financial support for universities to enable local businesses to collaborate and use their laboratory facilities at a more competitive price. (Paragraph 176)*

Space

Recommendations for future work

12. *Should our successor Committee wish to examine UK space policy, it should consider:*
 - *Scrutinising the ongoing implementation of the spaceflight regulations and their impact on the success of the UK's small satellite launch sector;*
 - *Exploring the progress made on the ten points set out in the Position, Navigation and Timing Framework, to determine if improvements to the UK's resilience against loss of PNT services has been achieved;*
 - *Analysing whether the UK is benefiting from its investment in OneWeb, including investigating whether manufacturing is taking place in the UK; and*
 - *Scrutinising the governance structure put in place for the space sector, including looking at how the National Space Council and Space Sector Industry Forum are functioning, as well as progress being made toward the goals set out in the 2021 National Space Strategy and Space Industrial Plan. (Paragraph 191)*
13. *Should our successor Committee wish to consider UK astronomy, it could:*
 - *Consider whether funding timeframes for astronomy strategies, programmes and infrastructure need to be lengthened and if astronomy needs a single voice rather than a split between the Science and Technology Facilities Council and the UK Space Agency;*
 - *Examine whether the UK is fully exploiting its international partnerships so that UK researchers and companies can participate and lead on collaborative programmes and projects;*
 - *Assess whether the UK astronomical instrumentation organisations and companies, especially SMEs, have the support they need to contribute to international infrastructure and missions, and to repurpose their technology for other purposes, especially where this might be exported;*
 - *Evaluate whether the UK has sufficient laboratory and data facilities to ensure that it can be a significant locus for national and international astronomy analysis and research;*

- *Consider whether current arrangements for post-doctoral astronomy research are sufficient to ensure the sustainability of professional astronomy in the UK;*
- *Examine further reports of bullying and harassment in astronomy and the diversity of those employed or participating as amateurs and how this can be addressed; and*
- *Consider whether astronomy outreach, whether delivered by amateur or professional astronomers, as part of funded programmes or by organisations, such as Science Discovery Centres, is adequate and effective. (Paragraph 195)*

Technology

Recommendations for future work

14. *Should our successor Committee wish to examine the UK's telecommunications infrastructure and domestic capability, we recommend it considers:*
 - *The implementation of the 5G Supply Chain Diversification Strategy, and relevant policy and technical developments since the then Committee's report;*
 - *Examining the Government's participation in international standards bodies for critical and emerging technologies; or*
 - *The rollout and uptake of 5G technology in UK infrastructure, and what lessons are being learned for future developments, i.e. the emergence of 6G. (Paragraph 207)*
15. *Should our successor Committee wish to examine blockchain technology, we recommend that it examines in greater depth potential use cases in the public and private sectors; including the benefits, risks, potential opportunities, regulatory environment and public understanding about the technology. (Paragraph 212)*

Recommendations for future work

16. *Should our successor Committee wish to examine quantum technologies, we recommend it considers:*
 - *Scrutinising how the Government is achieving the aims and objectives set out in the National Quantum Strategy and its associated Missions;*
 - *Examining how the Government and UK Research and Innovation are supporting the commercialisation of quantum technologies;*
 - *Assessing how the Government is ensuring the UK regains access to future Horizon Europe funding calls for quantum technologies that it is currently shut out of;*
 - *Scrutinising the Government's work on developing and implementing quantum skills and talents to ensure the future workforce;*

- *Examining the UK infrastructure needs for quantum technologies to enable continued research commercialisation;*
- *Assessing the strengths and weaknesses of the UK's quantum supply chain; and*
- *Evaluating the effectiveness of the Government's UK quantum procurement initiatives. (Paragraph 223)*

Formal minutes

Thursday 23 May 2024

Stephen Metcalfe, in the Chair

Chris Clarkson

Dame Tracey Crouch

James Davies

Katherine Fletcher

Legacy – Parliament 2019-24

Draft Report (*Legacy – Parliament 2019-24*), proposed by the Chair, brought up and read.

Ordered, That the draft Report be read a second time, paragraph by paragraph.

Paragraphs 1 to 223 read and agreed to.

A foreword agreed to.

Resolved, That the Report be the Fourth Report of the Committee to the House.

Ordered, That the Chair make the Report to the House.

The Committee adjourned.

List of Reports from the Committee during the current Parliament

All publications from the Committee are available on the [publications page](#) of the Committee's website.

Session 2023–24

| Number | Title | Reference |
|-------------|---|-----------|
| 1st | The antimicrobial potential of bacteriophages | HC 328 |
| 2nd | Insect decline and UK food security | HC 326 |
| 3rd | Governance of artificial intelligence (AI) | HC 38 |
| 1st Special | The governance of artificial intelligence: interim report: Government response to the Committee's Ninth report of Session 2022–23 | HC 248 |

Session 2022–23

| Number | Title | Reference |
|--------|--|-----------|
| 1st | Pre-appointment hearing for the Executive Chair of Research England | HC 636 |
| 2nd | UK space strategy and UK satellite infrastructure | HC 100 |
| 3rd | My Science Inquiry | HC 618 |
| 4th | The role of Hydrogen in achieving Net Zero | HC 99 |
| 5th | Diversity and Inclusion in STEM | HC 95 |
| 6th | Reproducibility and Research Integrity | HC 101 |
| 7th | UK space strategy and UK satellite infrastructure: reviewing the licencing regime for launch | HC 1717 |
| 8th | Delivering nuclear power | HC 626 |
| 9th | The governance of artificial intelligence: interim report | HC 1769 |

Session 2021–22

| Number | Title | Reference |
|--------|---|-----------|
| 1st | Direct-to-consumer genomic testing | HC 94 |
| 2nd | Pre-appointment hearing for the Chair of UK Research and Innovation | HC 358 |
| 3rd | Coronavirus: lessons learned to date | HC 92 |

Session 2019–21

| Number | Title | Reference |
|---------------|--|------------------|
| 1st | The UK response to covid-19: use of scientific advice | HC 136 |
| 2nd | 5G market diversification and wider lessons for critical and emerging technologies | HC 450 |
| 3rd | A new UK research funding agency | HC 778 |