

Searching for the Holy Grail of a science and innovation strategy that makes a difference

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Chair:	The Earl of Selborne GBE FRS Chair, The Foundation for Science and Technology
Speakers:	Professor The Lord Hennessy FBA House of Lords The Rt Hon the Lord Heseltine CH House of Lords The Rt Hon the Lord Willetts House of Lords
Panellist:	Rebecca Endean OBE Strategy Director, UK Research and Innovation (UKRI)
Sponsors:	Association for Innovation, Research and Technology Organisations (AIRTO), the Defence and Security Accelerator and The Wellcome Trust
Audio Files:	www.foundation.org.uk
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LORD HENNESSY noted that since 1945 the British government had produced some twenty science and innovation strategies. By comparison over the same period there had been thirteen defence reviews, eight industrial strategies and just one welfare review – the historic Beveridge Report.

The reviews came back to the same key themes of funding, commercialisation and the skills needed to increase productivity. It was hard to increase public and private spending on research; challenging to connect pure science to commercially useable patents; and the problems of low productivity caused by

an education system never fully focussed on teaching scientific and technical skills had remained with us.

Similarly, we had yet to produce a society that was confident in its relationship with science, despite many changes. The modern research council framework began in 1965. In 1972 a customer/contractor approach was implemented, with departmental chief scientists given the customer role. In 1993 there was a focus on cross-cutting research with the Office of Science and Technology and the Technology Foresight programmes. By 2000 Parliament was promoting a two-way dialogue between scientists and the public.

The focus then moved towards innovation

and improving productivity with the establishment in 2006 of the Technology Strategy Board, later renamed Innovate UK, to support innovative companies. Now the seven Research Councils, Innovate UK and Research England are coming together as UK Research and Innovation (UKRI), in line with the Nurse Review recommendations¹.

Against this ever-changing background, getting full value from our research spending and setting the right priorities to help improve productivity remains a challenge which it is vital to meet successfully.

LORD HESELTINE drew on his personal understanding of business, which wanted less regulation and state involvement, as well as his extensive Ministerial experience across government, culminating in his 'No Stone Unturned in Pursuit of Growth'² report. Free trade and competition were good but often had little to do with the real global market place, in which other countries would seek advantage by buying into UK scientific or technological advances, thereby undermining the UK's own industrial base.

He counted some ten successive British industrial strategies. The current Green Paper was a serious and comprehensive piece of work which importantly was under the Prime Minister's direct leadership. There was a recognition that we did not yet have all the answers. Government now needed to make a detailed Strength, Weaknesses, Opportunities and Threats (SWOT) analysis of UK commercial advantages and risks compared with global competitors.

This should lead to a more joined up approach, with a central group able to challenge narrow departmental or regulatory interests. Conclusions should be implemented by all departments – today the Department of Culture, Media and Sport was the third most important industrial strategy department because of its role in the media, digital and communications sectors.

The UK's complex and overlapping structures of governance remained a problem and caused delay and confusion for local initiatives. Moving to around 60 unitary authorities would provide the needed clarity of responsibility and more local autonomy.

Our education standards remained too low. We needed to build the skills and energy of people across the country but were no longer in the top twenty

countries for education quality, and still had some unacceptably poor schools.

Overall we had to be more ready to take a strategic view and follow it through, as our competitors in the USA, Europe or China regularly did; and without crudely picking winners be ready to make a range of choices about our priorities.

LORD WILLETTS reviewed how our Industrial Strategy and Science and Research strategies have developed over the last century. During world war one the UK modernised its research and science structures to keep up with Germany and the US. This set the framework for research autonomy – the Haldane principle – and funding structures for higher education which are still recognisable today. Research over the next fifty years was heavily defence-related. But shortcomings in UK technology including the Comet aircraft crashes led to a wider focus on innovation. The years from 1970 to 1990 were heavily market focussed, with closure of many research institutes.

More strategic industrial strategies from 1990 were partially frustrated by the prior existence of a research strategy which focussed on research excellence and autonomous university led research. This in turn reflected student choices from the age of 14 rather than a strategic approach to science and technology needs.

Three doctrines made reconciling science and industrial strategy difficult. First the dual funding model, with project-based Research Council funding and separate high-trust Hefce funding to universities only through the Research Excellence Framework. This left a gap which has only recently been partly filled with the Catapult innovation partnership model.

Second, the customer contractor model developed by Lord Rothschild required departments to spend equivalent funds on research, which proved not to be the case because wider public spending pressures had taken funds away from research for other purposes. Meanwhile business was not prepared to fund sufficient applied research, leaving the UK with a 'valley of death' gap which other countries were prepared to meet through more applied research funding.

Finally, the lack of a functioning system of public sector research institutes in the UK compared with the US or Germany left no base from which to grow the state-funded intermediate research which could fill the gap between university research and the market place. Universities had come to dominate the research landscape; other bodies could only survive with substantial charitable endowments. The creation

1 www.gov.uk/government/collections/nurse-review-of-research-councils

2 www.gov.uk/government/publications/no-stone-untuned-in-pursuit-of-growth

of the Technology Strategy Board, subsequently Innovate UK, was positive. But its funding and therefore its impact was reduced by budget cuts in 2015.

Successful industrial strategy needed to make strategic choices, covering sectors, places, challenges and technologies. These should encourage inherently disruptive innovation and a new approach to place as seen in the Northern Powerhouse or City deals. Sectors such as automotive or aerospace were an effective focus for industrial strategy, though areas such as education should also be included, despite not being in the Green Paper. Specific challenges such as anti-microbial resistance could be helpful. Overall however the technology focus needed to build on professional input and be coherent, as with the choice of Eight Great technologies covering digital, genome research, energy and advanced materials research.

Lord Willetts was optimistic that with the support of the Prime Minister and the coordinating role of UKRI there would be sustained attention to developing further our industrial strategy.

In discussion it was noted that UKRI should use its new structures to think strategically about how to get best value from the additional £4.7 billion of funding, and also look at encouraging researchers to work more closely with industry to boost growth.

The struggle to ensure Treasury funding for research had meant that overall spending as a percentage of GDP had remained static at 0.7% between 1997 and 2010 due to declining departmental spending. Pressures on applied technology spending meant that restoring the funding of Innovate UK should be a priority.

Disruptive technologies - including machine learning in sectors such as autonomous driving, block chain and smart contracts, and synthetic biology where the costs of gene synthesis was falling rapidly - needed to be identified and supported. This required speed and flexibility from an Industrial Strategy. For example the car industry value model was shifting rapidly towards companies who could provide transport as a service and owned the customer.

In terms of place Cambridge now had a research ecosystem, building connections between research parks, innovative graduates, and entrepreneurs. Academics needed these networks to build good ideas into companies.

UKRI needed to avoid building a better yesterday, and should look overseas at others' experiences of successful strategy. The time taken from scientific discovery to commercial application was continuing

to get shorter.

Smart, flexible regulation had a key role in driving innovation. Research excellence could help the UK set future standards in areas such as embryology, or 5G telecoms if Ofcom prioritised density of coverage over competition. Synthetic biology was another area where UK research could define the language used in the sector.

The UK was short of R and D intensive prime companies able to buy innovative research and scale it up for the market. Patient capital was also in short supply, with no real equivalent of the German KfW government owned development bank. One role of government was to bear risk that no commercial entity could take, and the UK was not strategic in this area. Without a proactive strategy, letting innovative companies be sold abroad with the guarantee of continuing a research focus in the UK could be the best available option to keep value at home.

Polarisation between the political parties was not conducive to maximising the value of our research effort, though there was much underlying consensus on what needed to be done. Even the German system was not a holy grail, but it avoided short-term and confusing changes in the research and innovation landscape by modernising within familiar existing structures.

Better knowledge exchange was needed to connect new ideas to all those who might benefit from them. Simple template structures to set up new research bodies could save a lot of time and money. The Local Enterprise Partnerships were now widely accepted and had an important role to play.

Measurement of university success at innovation should not be measured by start-ups alone as this could be misleading; we needed more focus on scale-ups and the best business models for the future. The neglect of technical education be ended so as to provide people with the skills they would need for the future economy.

There was an important and continuing role for foreign direct investment in developing the UK's research base and supporting the wider economy. It was however important not to be naïve about the interest of some overseas governments in moving advanced technology offshore.

Within government Ministers should avoid being too short-term in their decisions, and civil servants should build more expertise in key issues by remaining in post longer. There was a case for putting a duty on all public bodies to report annually on how they had supported innovation and wealth creation.

Wider efforts were needed to build understand-

ing and consensus among politicians and the media that the long-term challenges we faced in building a successful industrial strategy had been with the UK

for many decades, and required a similarly sustained effort in response.

Sir Martin Donnelly KCB

BRIEFING NOTE

At the end of this report there is a briefing note on the history of science and innovation strategies - scroll down.

USEFUL REPORTS AND URLS

Research Councils:

Arts and Humanities Research Council
www.ahrc.ac.uk

Biotechnology and Biological Sciences Research Council
www.bbsrc.ac.uk

Engineering and Physical Sciences Research Council
www.epsrc.ac.uk

Economic and Social Research Council
www.esrc.ac.uk

Medical Research Council
www.mrc.ac.uk

Natural Environment Research Council
www.nerc.ac.uk

Science and Technology Facilities Council
www.stfc.ac.uk

Companies, Research Organisations and Academies:

Association of Innovation, Research and Technology Organisations (AIRTO)
www.airto.co.uk

Academy of Medical Royal Colleges
www.aomrc.org.uk

Academy of Medical Sciences
www.acmedsci.ac.uk

British Academy
www.britac.ac.uk

Catapult Programme
www.catapult.org.uk

Defence and Security Accelerator, DSTL
www.gov.uk/government/organisations/defence-and-security-accelerator

Department for Business, Energy and Industrial Strategy
www.gov.uk/government/organisations/department-for-business-energy-and-industrial-strategy

Department for Communities and Local Government
www.gov.uk/government/organisations/department-for-communities-and-local-government

Department for Culture, Media and Sport
www.gov.uk/government/organisations/department-for-culture-media-sport

Department for Education
www.gov.uk/government/organisations/department-for-education

Department for Health
www.gov.uk/government/organisations/department-of-health

Government Office for Science
www.gov.uk/government/organisations/government-office-for-science

Higher Education Division, Department for Education, Northern Ireland Government
www.economy-ni.gov.uk/articles/higher-education-division

Higher Education Funding Council for England
www.hefce.ac.uk

Higher Education Funding Council for Wales
www.hefcw.ac.uk

Innovate UK
www.gov.uk/government/organisations/innovate-uk

Knowledge Transfer Network
www.ktn-uk.co.uk

Learned Society of Wales
www.learnedsociety.wales

National Physical Laboratory (NPL)
www.npl.co.uk

Research Councils UK
www.rcuk.ac.uk

Royal Academy of Engineering

www.raeng.org.uk

The Royal Society
www.royalsociety.org

The Royal Society of Edinburgh
www.rse.org.uk

The Royal Society of Medicine
www.rsm.ac.uk

Russell Group
www.russellgroup.ac.uk

Scottish Funding Council
www.sfc.ac.uk

University Alliance
www.unialliance.ac.uk

Wellcome Trust
www.wellcome.ac.uk

Universities:

For a full list of UK universities go to:
www.universitiesuk.ac.uk

SCIENCE AND INNOVATION STRATEGIES SINCE 1946: A CARTOGRAPHY

Handout prepared for a Foundation debate held on 18th November, 2017

SUMMARY

1. Looking back 25 years, there have been a multitude of science and innovation strategies and supporting reviews and guidance. Each was set in the context of the time, e.g. in 2017 the themes are Brexit and continued financial pressures. Financial pressures were a feature of the 2008 - 2014 strategies. In Lord Sainsbury's review in 2007 the theme was globalisation.
2. The strategies since 1993 have contained many notable similarities on the contribution of science and innovation to the UK's prosperity, funding (government and private funds), setting priorities, skills and education.
3. Recent strategies have noted that the UK has ring-fenced and prioritised funding for science in innovation at a time when other public spending has been reduced. However, other nations have been increasing their spending on these areas during the same period. The 10 year anniversary brochure of InnovateUK noted that 'The UK's productivity, and spend on R&D, as a percentage of GDP, has declined, putting jobs, business confidence and inward investment at risk'.
4. In the context of a continuous world-class strength in basic research and world research institutes and universities, the main themes to emerge from the analysis are:
 - a. Funding: a constant theme has been the difficulty in meeting the stated aspirations of consecutive governments to raise government spending as a percentage of GDP and to encourage UK businesses to follow suit.
 - b. Commercialisation: from 1946 onwards there has been at best a mixed picture and at worst a continual struggle to take the world-class ideas created by UK scientists and innovators and convert these into patents and commercial opportunities – compared to traditional competitors and competition from a rising number of new countries.
 - c. Skills and Higher Education: although significant effort has been expended over many decades, these issues will require constant funding, resource and commitment to remain at the current levels in an ever more technically advanced and globalized world, let alone surge ahead as a number of strategies have forecast.

INTRODUCTION

5. In May 2017, the House of Lords Science and Technology Committee wrote to the Secretary of State stating that they were convinced of the potential benefits of a strong Industrial Strategy with “science and innovation as its pervasive themes”. In order to assist with the debate on the Industry Strategy for the UK, the Foundation for Science and Technology has carried out a review of the implementation of past science and innovation strategies. A key observation of the research is that there has never been a Beveridge-style report into the usefulness of science and innovation strategies in the UK. The review focuses on the last two decades, but also stretches back as far as 1946 with the Barlow Report of 1946 on ‘Scientific Man-Power’.

6. The analysis of the strategies focuses on four themes: skills, higher education, science and innovation, and funding. The analysis draws out the evidence of success or otherwise of the implementation of the strategies and observations on the causes of both. The research and analysis prioritises science and innovation strategies, with technology strategies as a secondary priority. Connected strategies are referenced, but have not been analysed. There are a plethora of science and innovation strategies for departments, regions and sectors for example the recently published Life Sciences Industrial Strategy.

CURRENT SITUATION

Green Paper – Building our Industrial Strategy

7. The 2017 Green Paper from the UK Government on building our Industrial Strategy, states “the objective of our modern industrial strategy is to improve living standards and economic growth by increasing productivity and driving growth across the whole country. 10 pillars we believe are important to drive our productivity growth across the entire economy: science; research and innovation; skills; infrastructure; business growth and investment; procurement; trade and investment; affordable energy; sectoral policies; driving growth across the whole country; and creating the right institutions to bring together sectors and places.”

8. On science, research and innovation, the Green Paper draws out the point that “as well as making scientific and innovative breakthroughs, the UK needs to adopt new and more productive ways of working. To become a more innovative economy requires the ability to seize new opportunities and adapt to change.” The paper sets out the challenge that although the UK has a strong scientific base the UK has “not been as successful at commercialization and development as we have been at basic research” and have often been “slower than competitors to take up and deploy existing technologies” for example making less use of robotics and automation than most of countries in Europe.

9. In terms of funding the “UK invests 1.7 per cent of GDP in private and public funds on research and development” which is well below the OECD average of 2.4 per cent and “substantially below” the leading backers of innovation. The UK Government has protected the public science budget in nominal terms since 2010 despite having to make substantial savings to reduce the deficit, but the paper notes other countries have been increasing their investment in research and development in relation to GDP.

10. The UK public funding is relatively concentrated on early stage research. The Industrial Strategy Green Paper also notes the regional disparity in the spend on research and innovation, with a heavy focus on the ‘golden triangle’. The Green paper states the need to build on the excellence in research and innovation that exists in other parts of

the country.

Extant Strategy – 2014 science and innovation strategy

11. The extant UK Government Strategy for Science and Innovation, published in 2014 and set to cover a 10 year period, drew out the point that the “UK has historically invested less in research and development than our competitor nations” and would require both public and private sector commitment. The strategy stated that the UK coalition government was prioritising spending on science and innovation in difficult times. The strategy recognized the need to commercialize science and new technologies and to “provide businesses with the environment and infrastructure necessary to generate large scale innovation in areas where there are higher risks and wider benefits”. Science and innovation are “at the heart of our long term economic plan”.

12. The strategy had six elements: deciding priorities; nurturing scientific talent; investing in our scientific infrastructure; supporting research; catalyzing innovation; participating in global science and innovation. Although the strategy made clear that it was not the job of the strategy to specify specific scientific questions to be answered, there was a desire to back emerging technology. Eight ‘great technologies’ areas were included in the strategy that had been identified in a paper by Lord Willetts¹. The technologies were: big data; robotics and autonomous systems; space; cell therapies; synthetic biology; agritech; advanced materials; and energy storage.

13. The evidence paper for the science and innovation strategy issued in 2014 concluded that UK government leadership would be necessary to remain at the forefront of solving the challenges facing nations globally of expanding the frontiers of knowledge and capability.

14. The 2014 strategy was supported by a collection of documents covering government and industry partnerships, covering 11 sectors and one covering cross cutting areas. A progress report on government and industry partnerships was produced.

KEY OBSERVATIONS

Review of science and innovation strategies

15. The 1946 Barlow Report reviewed the scientific manpower in the UK and the role of universities.

16. Key to the progress of science and innovation strategies was the report by Committee on Higher Education, chaired by Lord Robbins, published as the Robbins Report in 1963. The report argued for a ‘massive expansion of higher education and the “bringing together under one Grants Commission of the universities and the Colleges of Education, together with the Colleges of Advanced Technology and their Scottish counterparts”, ensuring “uniformity in policy and in the principles of allocation over the entire field of autonomous institutions”.

17. The 1965 Science Act made further provision for UK research establishments, including the Research Councils.

18. A Framework for Government Research and Development in 1972 contained both the Lord Rothschild Report and Dainton Reports. Lord Rothschild’s report caused much debate and some criticism from the scientific research councils on the point that budg-

¹ Eight Great Technologies, Policy Exchange, David Willetts, 2013

ets for applied R&D should be allocated directly to Administrative Departments. In addition, the spend of the budget did not have to be via the research councils. The Dainton Report covered a review of the proposal to transfer the Agricultural Research Council to the Ministry of Agriculture, Fisheries and Food. The proposal had not been discussed with the CSP who “felt that no sufficient case had been made for what appeared to them to be a fundamental and ill-advised change”.

19. The recommendations from Lord Rothschild’s report were accepted by the government with only minor amendments, with the transfer of funds related to the customer/contractor model in 1974. Miles Parker (former Deputy CSA at Defra) in an interesting paper reflects on his practitioner’s experience of implementing Rothschild’s principles and their implications, with particular respect to their effect on “evidence based” policy-making ².

20. Realising our Potential for science and engineering and technology in 1993 was the first general review of relevant policy and organization since the reports of Lord Rothschild and Dainton’s in 1971. The aim of the strategy was to improve on the nation’s competitiveness and quality of life by maintaining the excellence of science, engineering and technology. The overall effectiveness of that strategy, and the health of science and technology in the UK, was to be monitored through the Forward Look initiative and the Technology Foresight Steering Group. The Office of Science and Technology was established, bringing together elements of the former Department of Education and Science and the Cabinet Office. Innovation, as a theme, features prominently throughout the paper.

21. The 1996 Green Paper on a ‘prospectus for the electronic delivery of government services’ sets out a strategy for new ways of delivering central government services across the UK. The Paper states ‘a common theme across all sectors of the economy has been the importance of IT and communications’. In 1996 the government also launched the Information Society Initiative.

22. In 2000, the science and innovation policy (Excellence and Opportunity), the white paper sets out the actions needed and lists a total of 55 commitments representing 10 separate agendas.

23. In 2002, the Investing in Innovation strategy set out how the science, engineering and technology research strategy is intimately connected to the government’s economic goals. It builds on the commitments made in the Science and Innovation White Paper of 2000, Excellence and Opportunity. The government said it would take action to ensure science in government departments was of the highest possible standards and was used effectively in the delivery of policy and public services. The UK’s strongest innovative industries are global leaders, but “too many of our sectors are significantly lagging behind international investment levels in R&D”.

24. The science and innovation investment framework, published in 2004 has been subject to a number of reviews. Lord Sainsbury’s review in 2007, “the race to the top: a review of government’s science and innovation policies” noted many of the themes that exist in the 2017 Green Paper a decade on. The review recommended “more effective ways to exploit our investment in research”. In 2007 the review stated that the UK’s performance on quantity of industrial research and volume of patenting was “unim-

² Parker M (2016) The Rothschild report (1971) and the purpose of government-funded R&D—a personal account. Palgrave Communications. 2:16053 doi: 10.1057/palcomms.2016.53.

pressive". In 2017, the Green Paper states that although the UK now produces a similar number of spin-off companies, we register far fewer patents.

25. In 2001, the sixth report of the Select Committee on Science and Technology produced an extensive review of the impact of the 1993 White Paper 'Realising Our Potential: A Strategy for Science, Engineering and Technology'. The review noted that the 2001 paper 'Excellence and Opportunity' was built on 'Realising Our Potential' but made no reference to the latter. The review noted that Forward Look was published in 1994, 1995, 1996 with only the statistical tables published in 1997 and 1998. Forward Look was published in 1999 and two months later the statistics. In 2000 only the statistics were produced. The review recommended that Forward Look be published annually, together with the statistical supplement, as it is widely used by the science, engineering and technology community. The review also recommended that the following issue of Forward Look provide a clear statement of the government's overall strategy for science and technology. The statement should show explicitly how expenditure figures match policy objectives. Finally, the review looked forward to the publication of departmental strategies and observed that they should contain meaningful measures of Departments' science, engineering and technology performance.

26. In 2004 the science and innovation investment framework set out the ambitions over the 2004-2014 period. The strategy sets out how the UK could seize the opportunity of competing 'on high technology and intellectual strength, attracting the highest-skilled people and companies which have the power to innovate and to turn innovation into commercial opportunity'. The 'framework' sets out how the UK 'will continue to make good the past under-investment in our science base – the bedrock of our scientific future'. The strategy stated that the government fully supported the conclusions and recommendations of the Lambert Review and analysis presented. The Strategy contained the Government's response to the Lambert Review. Annual reports and reviews were produced in 2005 and 2006.

27. The 'Next Steps' report on progress in implementing the 2004 Science and Innovation Investment Framework was the inspiration to establish the Technology Strategy Board, which later became Innovate UK.

28. In 2007 Lord Sainsbury's 'Race to the Top' was published, setting out a comprehensive set of recommendations. The report stated that trends in publicly funded R&D showed that there had been a steady increase in the amount of money spent by the Research Councils, but a decline in government department funding of R&D as a percentage of GDP, mainly accounted for by a decline in MOD spending. The report highlighted that this was of concern for the quality of our public policy-making, and the stimulation of innovation in the companies with which government departments interact. The report stated that research outputs from publicly funded R&D 'remained, however, of a very high standard'. In 2004 data, the UK was ranked second in the world to the USA in its share of global publications (9 per cent) and global citations (12 per cent). The UK was a more consistent performer across the range of research disciplines than most other countries, ranking second in the world in seven of the ten disciplines.

29. A response to the Race to the Top was produced in 2008, in which the Prime Minister accepted Lord Sainsbury's recommendations in full and asked the Secretary of State for Innovation, Universities and Skills to take forward its implementation. This report outlined the Government's progress and future plans. Implementation of the Sainsbury

Review formed an integral part of the Department of Innovation, Universities and Skills (DIUS) science and innovation strategy 'Innovation Nation'. The report stated that 'excellent progress has been made in delivering the 72 recommendations'. Of these, over 20 have 'already been implemented and the rest are in the process of implementation'.

30. DIUS reported on progress in 2008. The White Paper drew attention to the way in which the UK "excels at 'hidden innovation'" – in its leading services sectors and "called for better measures of business innovation, especially for forms of innovation that did not involve R&D or the creation and development of new technologies and for non-R&D intensive sectors. This included marketing, business model and managerial innovations." DIUS would drive implementation of the Leitch Review of Skills to raise the nation's skill levels and enhance opportunities for innovation, building implementation of the Sainsbury review recommendations into its wider strategies for Further Education reform.

31. The BIS innovation strategy in 2011 aimed to continue to support blue-skies, curiosity-driven research. The strategy aimed to identify and mobilise resources to support emerging technologies as well as encouraging increased business investment in all forms of innovation. The strategy stated a commitment by Government to maximise its contribution, by making public data available to innovators, removing red tape that blocks innovation, using prizes and challenges to solve problems and acting as a lead customer for innovative products and services.

32. Lord Heseltine was invited by the Chancellor to examine all parts of government policy that impacted on economic growth. He reported in October 2012 with 89 recommendations which included changes to the machinery of government, an emphasis on shifting power to regions and simplifying processes for funding to support growth, strengthening links between government and business, and business and education. The Government responded in March 2013 accepting 81 of the 89 recommendations. These included recommendations to create industrial strategy partnerships in 11 key sectors and promote stronger links between researchers, universities and businesses. There were also proposals for reforming the education system to deliver the skills business needs to increase productivity.

33. The main themes to emerge from the analysis are:

- a. Funding: a constant theme has been the difficulty in meeting the stated aspirations of consecutive governments to raise government spending as a percentage of GDP and to encourage UK businesses to follow suit.
- b. Commercialisation: from 1946 onwards there has been at best a mixed picture and at worst a continual struggle to take the world-class ideas created by UK scientists and innovators and convert these into patents and commercial opportunities – compared to traditional competitors and competition from a rising number of new countries.
- c. Skills and Higher Education: although significant effort has been expended over many decades, these issues will require constant funding, resource and commitment to remain at the current levels in an ever more technically advanced and globalized world, let alone surge ahead as a number of strategies have forecast.

Brief history of the organisation of research and development in the UK³

34. The Science Research Council (SRC) was formed in 1965 to address issues highlighted by the Trend Committee. Prior to this, the Minister of Science had been responsible for defining research activities and the Treasury made decisions about the priority of funding. In 1981 the Science and Engineering Research Council (SERC) was formed to reflect the increased emphasis on engineering research and was responsible for all publicly-funded scientific engineering and research activities, including astronomy, biotechnology and biological sciences, space research and particle physics in the UK. In 1994 the Engineering and Physical Sciences Research Council (EPSRC) was formed. The SERC was split into disciplines-specific areas after the release in 1993 of Realising our Potential: A strategy for science, engineering and technology.

35. The Science and Technology Facilities Council (STFC) was formed in April 2007 by merging the Particle Physics & Astronomy Research Council and the Council for the Central Laboratory of the Research Councils.

36. In 2017 there are seven Research Councils - the Arts and Humanities Research Council (AHRC), Biotechnology and Biological Sciences Research Council (BBSRC), Engineering and Physical Sciences Research Council (EPSRC), Economic and Social Research Council (ESRC), Medical Research Council (MRC), Natural Environment Research Council (NERC) and the Science and Technology Facilities Council (STFC). The Medical Research Council is the oldest; it was established in 1913.

37. The 2017 Green Paper states that the UK will 'strengthen our strategic capability through the creation of UK Research and Innovation (UKRI)⁴ which will bring together the Research Councils and later-stage innovation funding through Innovate UK and support well-founded laboratories through Research England. UKRI will develop a clear strategy from fundamental research through to business innovation'.

Reference Material

38. The expenditure on R&D for the UK is shown at Annex A

39. A time line of the main strategies is at Annex B.

40. A brief summary of some of the key points from each strategy and some of the associated reviews are at Annex C.

40. A full list of the documents identified as part of this analysis are at Annex D.

3 Various sources including: <https://www.epsrc.ac.uk/about/history/ourbeginnings/>

4 www.ukri.org

ANNEX A - ONS Data on Research and Development

ONS have a range of publications on R&D spend in the UK and international comparisons. Two examples are shown below. See for further analysis:

<https://www.ons.gov.uk/economy/governmentpublicsectorandtaxes/researchanddevelopmentexpenditure/bulletins/ukgrossdomesticexpenditureonresearchanddevelopment/2015#international-comparisons-of-gerd-as-a-percentage-of-gdp-rd-intensity>

Figure 1: UK productivity per hour worked lags behind other G7 nations despite strategies to stimulate productivity improvement.

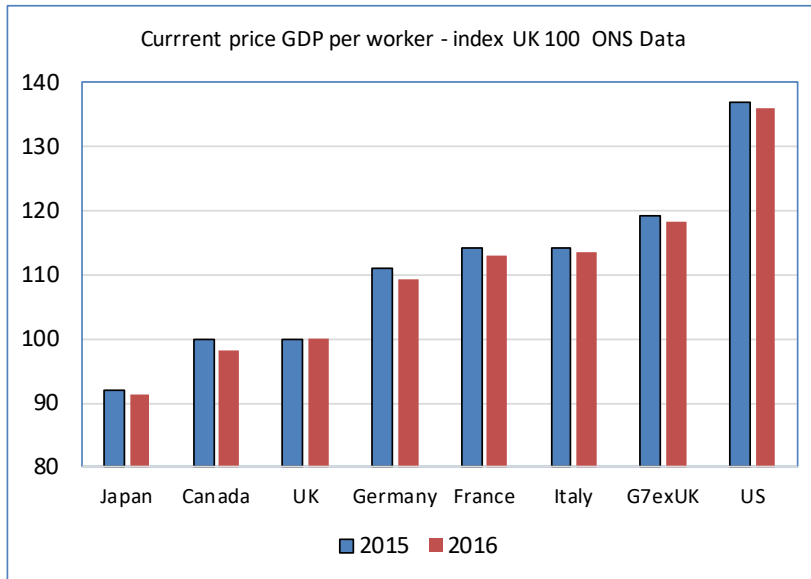
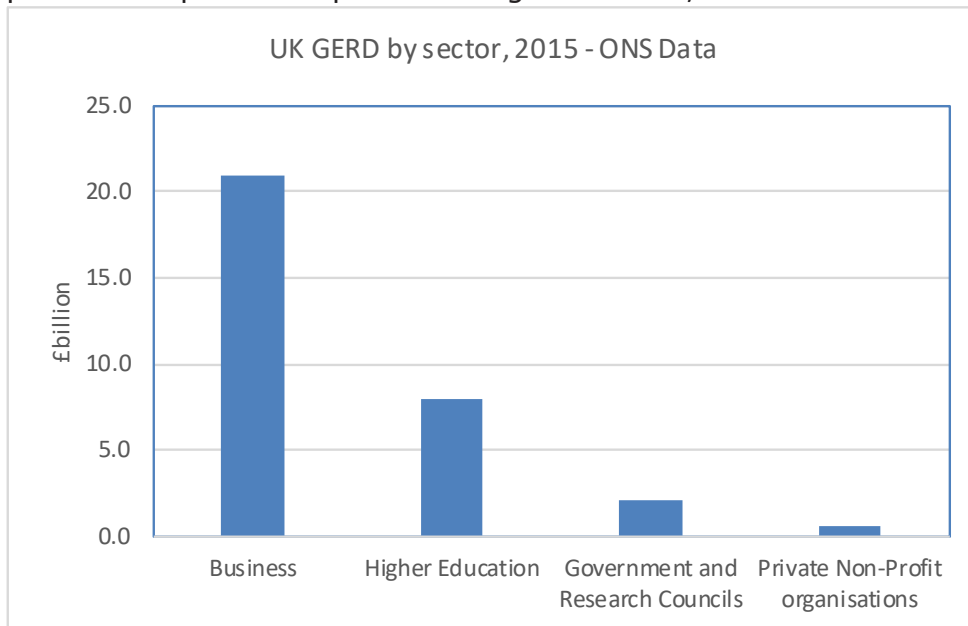


Figure 2: Spend on R&D in the UK is dominated by business spend emphasising the importance of partnerships between government, charities and business



ANNEX B - Time line

- 2017 Building our Industrial Strategy, Green Paper, January 2017
- 2014 Our plan for growth: science and innovation, December 2014 (Cm 8980)
- 2013 Government response to the Heseline Review, March 2013
- 2012 Heseltine Review - No Stone Unturned in pursuit of Growth, October 2012
- 2012 DECC Science and innovation strategy 2012
- 2011 BIS Innovation and Research Strategy for Growth, December 2011
- 2008 Innovation Nation: Department of Innovation, Universities & Skills, 2008 (White Paper)
- 2008 Implementing "The Race to the Top" Lord Sainsbury's Review of Government's Science and Innovation Policies, 13 March 2008
- 2007 Lord Sainsbury Review of the UK Science and Innovation system, 5 October 2007
- 2006 Science and innovation investment framework 2004-2014: next steps, published March 2006
- 2005 The ten-year science & innovation investment framework annual report 2005
- 2004 Science and Innovation investment framework, 2004-2014, published in July 2004
- 2003 21st Century Skills: Realising Our Potential, July 2003
- 2003 Innovation Report – Competing in the global economy: the innovation challenge, December 2003, DTI
- 2002 Investing in Innovation: A strategy for science, engineering and technology, DTI, HMT, DES, July 2002
- 2001 Opportunity for all in a world of change, A White Paper on Enterprise, Skills and Innovation, Cm 5052, February 2001
- 2000 Excellence and Opportunity: a science and innovation policy for the 21st century, July 2000 [implementation plan]
- 1998 Our Competitive Future – Building a Knowledge Driven Economy (1998) White Paper
- 1996 Information Society Initiative (ISI), launched in February 1996
- 1996 UK Government: Green Paper, "Government Direct": A Prospectus for the Electronic Delivery of Government Services (19 November 1996)
- 1993 Realising our Potential: A strategy for science, engineering and technology, April 1993 (White Paper)
- 1972 A Framework for Government Research and Development, Cm 5046, July 1972.
[contains the Rothschild report and Dainton report – see previous two rows]
- 1971 The Organisation and Management of Government Research and Development (The 'Rothschild Report') 1971
- 1971 The future of the Research Council System (the 'Dainton Report'), Cm 4814, May 1971
- 1968 Report by the Committee on Manpower Resources for Science and Technology on the Flow into Employment of Scientists, Engineers, and Technologists, Cm 3760, 1968
- 1965 Science and Technology Act, 1965
- 1963 Committee of Enquiry into the Organisation of Civil Science, Cm 2171, 1963 [The Trend Report]
- 1946 Barlow Report of 1946 on Scientific Man-Power

ANNEX C – Summary of Strategies

Barlow Report of 1946 on Scientific Man-Power

- Review of the quality and number of scientific skills in the UK and the role of demobilization and Universities to bring back qualified scientists to civil life from the Armed Forces. Percy Commission's review on the distinctions between functions of Universities and Technical Colleges.

Trend Committee Report, October 1963 and Science and Technology Act, 1965

- Trend Committee recommended the establishment of a Science Research Council
- Research Councils, including the Science Research Council (SRC), incorporated under Royal Charter, setting out the role and mission of each Council. The Research Councils are autonomous bodies, incorporated under Royal Charter and receive grants-in-aid from the Secretary of State for Education. The SRC provided and operated equipment and other facilities in science and technology by Universities and Colleges or other institutions or persons engaged in research and to make post graduate instruction in science and technology.

A Framework for Government Research and Development, July 1972

Contains the Rothschild and Dainton Reports - see:

Future of the Research Council System, the 'Dainton Report'

- Proposed that the new co-ordination Board for Research Councils should be associated with the Department for Education and Science.
- The terms 'applied' and 'pure' where 'harmful' and Dainton proposed the categories of tactical science, strategic science and basic science.
- Recommendations covered the roles of government departments, principles must be preserved of scientific responsibility and judgement on scientific merit, and an opposition to any 'monolithic' national research council.

Organisation and Management of Government Research and Development, the 'Rothschild Report'

- Budgets for applied R&D should be allocated directly to Administrative Departments and the budgets did not have to be spent via research councils.
- Central theme is to divide R&D in to 'pure' and 'applied'. The report states that 'the council for scientific policy does not accept that the research councils are concerned with applied R&D but with 'strategic and basic science' and that the 'concepts of scientific independence used in the Haldane Report are not relevant to contemporary discussion of Government research'.
- The report highlights the Fulton Committee recommendations on training and development of scientists and other specialists in the Civil Service.

Realising our Potential: A strategy for science, engineering and technology, April 1993

- Strategy builds on the country's existing strengths in science, engineering and technology. Its aim is to improve on the nation's competitiveness and quality of life by maintaining the excellence of science, engineering and technology.
- Overall effectiveness of that strategy, and the health of science and technology in the UK, will be monitored through the Forward Look initiative, the IT and Technology Foresight Programme.
- The strategy announced establishment of Office of Science and Technology bringing together elements of the former Department of Education and Science and the Cabinet Office, and for 'the first time in thirty years that a Cabinet Minister given specific responsibility for the area'.
- Strategy is clear that there will be no general tax incentives for spending on R&D, stating

that the government wants to avoid special tax subsidies which distort commercial investment decisions.

UK Government: Green Paper, "Government Direct": A Prospectus for the Electronic Delivery of Government Services, 19 November 1996

- Strategy for ways of delivering central government services across the United Kingdom, including providing information, collecting taxes, granting licences, administering regulations, paying grants and benefits, collecting and analyzing statistics, and procuring goods and services. The strategy also includes new ways of working and sharing information between government departments and agencies which would improve efficiency.

Our Competitive Future – Building a Knowledge Driven Economy (1998)

- Sets out measures to enhance business support in the regions, including new funds for the RDAs to promote collaborative strategies building on companies' know-how in the English regions, the RDAs will benchmark performance in the English regions and set targets for competitiveness as well as review Government support to businesses in the regions.
- £10 million pounds over three years for RDAs to increase competitiveness, promote innovation and support clusters.

Excellence and Opportunity: a science and innovation policy for the 21st century, July 2000 [implementation plan]

- Aim of the strategy was to produce excellence in science and new opportunities for innovation.
- The people and skills agenda covered three distinct challenges, including 'improving opportunities for women'.
- The strategy was aimed at ensuring that the UK is a society that is confident in its relationship with science.

Opportunity for all in a world of change, A White Paper on Enterprise, Skills and Innovation, February 2001

- Sets out the next steps for Government in helping individuals, communities and businesses to prosper.

Investing in Innovation: A strategy for science, engineering and technology, July 2002

- The UK has a long tradition of scientific excellence and technological invention but has been much less successful in capitalising on earlier waves of scientific and technological breakthroughs. Early innovation gains were not diffused through the economy as rapidly as in other countries, contributing to the UK's relative productivity decline.
- Strategy sets out how the science, engineering and technology research strategy is intimately connected to the Government's economic goals.
- The use of tax incentives for R&D, introduced in 2000 among smaller technology-based firms, was extended to include all UK-based business R&D.

Innovation Report – Competing in the global economy: the innovation challenge, December 2003

- The review notes that some sectors lead the world in innovation, e.g. aerospace, pharmaceuticals, biotechnology. 'However, overall, our performance is not good enough. In business R&D and patenting, the UK's performance is only average compared with our international competitors. In business R&D we are well behind the US and roughly equal to the EU average. The UK has in recent years produced more new science and engineering gradu-

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- ates as a percentage of 25-35 year olds than any other G7 country other than France.’
 - The report sets out a strategy for innovation that will be backed by the DTI and RDAs. Direct measures will be taken in 7 key areas to most effectively act to raise the rate of innovation, including the development of a Technology Strategy and RDAs and DAs to ensure national priorities take full account of regional priorities. The Technology Strategy Board was created as a result of the Innovation Report and the Lambert Review.

21st Century Skills: Realising Our Potential, July 2003

- Strategy commits the government to creating a more demand-led, responsive and flexible training system delivered through the Skills Alliance chaired by the SoSs for Trade and Industry and that Education and Skills, the joint Department for Education and Skills (DfES) and DTI Leadership and Management Unit, the joint DfES and DTI sponsored Skills for Business Network of Sector Skills Agreements, and Regional Skills Partnerships.

Science and Innovation investment framework, 2004-2014, published in July 2004

- Strategy sets out how the UK could seize the opportunity of competing ‘on high technology and intellectual strength, attracting the highest-skilled people and companies which have the power to innovate and to turn innovation into commercial opportunity’. Sets out how the UK ‘will continue to make good the past under-investment in our science base, raising science spending faster than the trend rate of the growth of the economy’.
- The Robert’s Review, “SET for success” in 2002, found that fewer students in the UK were choosing to study many science and engineering disciplines and the number of students gaining first class degrees in physical sciences has fallen by 8% from 1999/2000 to 2001/2002.
- The vision included the UK have state-of-the-art facilities and laboratories and a skilled workforce. These strengths will be recognized by the economic contribution of a growing high technology manufacturing sector and the influence of R&D on the UK’s services industry.

The ten-year science & innovation investment framework annual report 2005

- The review concluded that “overall, the annual report shows that a solid start has been made in implementing the ten-year framework in 2004-2005, though significant challenges clearly remain, particularly in raising business investment in R&D and increasing the supply of science, engineering, technology and mathematics (STEM) skills.”
Note: Annual reports were also produced in 2006 and 2007.

Science and innovation investment framework 2004-2014: next steps, published March 2006

- The discussion paper presents the next steps on 5 key policy areas: Maximizing the impact of public investment in science on the economy through increased innovation; Increasing Research Council’s effectiveness; Supporting excellence in University Research; Supporting world class health research; Increasing the supply of science, technology, engineering and mathematics skills.
- The government expects the Technology Strategy Board to play an increasing role in contributing to the development of the Government’s innovation strategy across all important sectors of the economy. The Technology Strategy will deliver a wider remit to stimulate innovation in those areas which offer the greatest scope for boosting UK growth and productivity, and plans for it to operate at arms-length from central Government are being developed.
- The UK Trade and Investment (UKTI) will have an enhanced role in marketing the UK science base to business, implementing a new £9 million international R&D strategy to attract R&D investment to the UK and to promote Britain’s innovative firms abroad.

"Race to the Top" - Lord Sainsbury Review of the UK Science and Innovation system, 5 October 2007

- Whilst noting that the UK's record of innovation is 'better than is commonly supposed, but we have not yet produced the best possible conditions to stimulate innovation in industry', review made 72 recommendations ranging across all aspects of science and innovation, key of which were those covering the Technology Strategy Board, knowledge transfer, science and engineering education, government departments and the Regional Development Agencies.
- Trends in publicly funded R&D show that there has been a steady increase in the amount of money spent by the Research Councils, but a decline in government department funding of R&D as a percentage of GDP, mainly accounted for by a decline in MOD spending.
- A major campaign was needed to enhance the teaching of science and technology.

Implementing "The Race to the Top" Lord Sainsbury's Review of Government's Science and Innovation Policies, 13 March 2008

- Implementation of 'The Race to the Top' forms an integral part of the Department of Innovation, Universities & Skills (DIUS) 'Innovation Nation' strategy. 'Excellent progress' has been made in delivering the recommendations'. 20 had been implemented with the rest being progressed.
- A new leadership role for the Technology Strategy Board was announced in which it would play a key role to play in addressing the fragmented technology and innovation landscape in the UK.

Innovation Nation: Department of Innovation, Universities & Skills (DIUS), 2008

- Creation of the DIUS as a champion for innovation across the board is 'an important step towards building an Innovation Nation'. The strategy highlighted that the UK "excels at 'hidden innovation' – in its leading services sectors and "called for better measures of business innovation".
- Other countries are also investing in research and becoming attractive to globally mobile R&D investors. As well as China and India, countries in the Middle East are increasingly investing in research. In the face of growing competition, the UK needs to ensure that the 'science-driven, arms-length system which underpins our success nationally and internationally is able to adapt to the challenges of the changing global environment. The DIUS will drive implementation of the Leitch Review of Skills to raise the nation's skill levels and enhance opportunities for innovation, building implementation of the Sainsbury review recommendations into its wider strategies for FE reform. Resources permitting, DIUS will establish at least one National Skills Academy (NSA) in every major sector of the economy.
- Since 1997 the ring-fenced science budget has increased from £1.3 billion to £3.4 billion per annum. It is due to increase over the next few years. Taken all together, the DIUS now invests £6 billion and year through the dual support system to foster a financially sustainable research base.
- The white paper sets out proposals on government use of procurement and regulation to promote innovation in business as well as in the public sector. The Technology Strategy Board should be used to 'bring everyone together'.
- Gowers Report noted that successful translation of creativity, ideas and insights into value 'is one of the critical determinants of our prosperity'.

BIS Innovation and Research Strategy for Growth, December 2011

- The aim of the strategy is a continued support for blue-skies, curiosity-driven research across a broad range of disciplines, identifying and mobilizing resources to exploit emerg-

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- ing technologies, encouraging increased business investment in all forms of innovation, strengthening the ability of the UK to be a participant and beneficiary of the changing geography of innovation, and a commitment by Government to maximize its contribution.
- Fast growing economies like China, Brazil or India are rapidly raising their game. China, for instance, is set to become the second largest recipient of foreign direct investment in the world.
 - The government has protected the science and research budget and committed to investing over £20 billion by 2015, allocated an additional £495 million of capital investment since the Spending Review in 2010, and committed to establishing an elite national network of Catapults, investing over £200 million between 2011-15.

Our plan for growth: science and innovation, December 2014

- The themes of the strategy are achieving excellence, showing agility, fostering higher levels of collaboration, recognizing the importance of place and the modern demand for openness and engagement with the world.
- The strategy continues to prioritise science and innovation spending in difficult times as well as strengthening partnerships between the public and private sector with a focus on commercialization. This is epitomized by the Industrial Strategy, the 8 Great Technologies and the expansion of the network of elite technology and innovation centres, adding two more.
- The strategy sets out investment across the skills pipeline from primary school to university.

No Stone Unturned in Pursuit of Growth, Heseltine Review, 2012

- Report by Lord Heseltine to the Chancellor of the Exchequer and Secretary of State for Business on how the UK might 'more effectively create wealth in the UK' in the context of 'the worst economic crisis of modern times'. The report covers 89 recommendations in the areas of Localism; Whitehall; Government and growth; Private Sector; Education and skills; and making it happen. The report does not single out a few 'headline making initiatives' for the areas that need to be improved.
- Implementation of the report would require 'long term stability which can only be achieved through maximum political consensus' and will be more effective if the process involves, firstly, people from outside government who have experience of the private sector and, secondly, represent the Local Enterprise Partnerships (LEPs) and local government upon which the success of the new partnerships depend.
- Central to the vision for the report are enhanced roles for both LEPs and the chambers of commerce and are 'essential building blocks in our competitiveness agenda'.

Government Response to No Stone Unturned in Pursuit of Growth, 2013

- In welcoming the report, the Government accepted in full or in part 81 out of the 89 original recommendations to 'dramatically advance the process of decentralisation'. In five cases the government took a different view, the reasons for which were explained in the response.
- The government response agreed that, at its heart, Lord Heseltine's report is a 'powerful case for decentralising economic powers from central government to local areas and leaders, as those best placed to understand and to address the opportunities and obstacles to growth in their own communities'.
- In responding to the report, the government acknowledged the important role of the devolved administrations to foster and promote growth across the whole of the UK.

Building our Industrial Strategy, Green Paper, January 2017

- The industrial strategy focuses on 10 pillars aimed at driving the UK's industrial strategy across the entire economy: science; research and innovation; skills; infrastructure; business growth and investment; procurement; trade and investment; affordable energy; sectoral policies; driving growth across the whole country; and creating the right institutions to bring together sectors and places.
- UK government continues to protect the public science budget despite having to make substantial savings to reduce the deficit, noting that other countries have been increasing their investment in R&D in terms of GDP.
- On back of the Industrial Strategy, the government announced the creation of UK Research and Innovation (UKRI) and backing, through Innovate UK, of 125 innovative, disruptive, research and development projects across the UK.

ANNEX D

Reports on science, innovation and industrial strategy included in this review are listed below. This document will be posted on the Foundation website - www.foundation.org.uk - all the links will be accessible by clicking on the URL.

1 Building our Industrial Strategy, Green Paper, January 2017

https://beisgovuk.citizenspace.com/strategy/industrial-strategy/supporting_documents/buildingourindustrialstrategygreenpaper.pdf

2 Our plan for growth: science and innovation, December 2014

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/387780/PU1719_HMT_Science_.pdf

3 Government response to the Heseltine Review, March 2013

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/221902/PU1465_Govt_response_to_Heseltine_review.pdf

4 Heseltine Review - No Stone Unturned in pursuit of Growth, October 2012

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/34648/12-1213-no-stone-untuned-in-pursuit-of-growth.pdf

5 DECC Science and innovation strategy 2012

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48335/5107-decc-science-innovation-strategy-2012.pdf

6 BIS Innovation and Research Strategy for Growth, December 2011

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/229028/8239.pdf

7 Innovation Nation: Department of Innovation, Universities & skills, 2008

<http://webarchive.nationalarchives.gov.uk/tna/+http://www.dius.gov.uk/publications/scienceinnovation.pdf/>

8 Implementing "the race to top" Lord Sainsbury's review of government's science and innovation strategies, 13 March 2008

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/243607/9780108507175.pdf

9 Lord Sainsbury Review of the UK Science and Innovation system, 5 October 2007

http://webarchive.nationalarchives.gov.uk/20071204132931/http://www.hm-treasury.gov.uk/media/5/E/sainsbury_review051007.pdf

10 Science and innovation investment framework 2004-2014: next steps, published March 2006

http://webarchive.nationalarchives.gov.uk/+http://www.hm-treasury.gov.uk/media/7/8/bud06_science_332v1.pdf

11 The ten-year science & innovation investment framework annual reports, 2005, 2006 and 2007

<http://webarchive.nationalarchives.gov.uk/20100407170242/http://www.berr.gov.uk/files/file28546.pdf>
<http://dera.ioe.ac.uk/14223/1/file31810.pdf>

<http://dera.ioe.ac.uk/14224/1/file40538.pdf>

12 Science and Innovation investment framework, 2004-2014, published in 2004

http://webarchive.nationalarchives.gov.uk/+http://www.hm-treasury.gov.uk/spending_sr04_science.htm

http://news.bbc.co.uk/nol/shared/bsp/hi/pdfs/science_innovation_120704.pdf

13 The ten-year science & innovation investment framework annual report 2005

14 Science and innovation investment framework 2004-2014: next steps, published March 2006

http://webarchive.nationalarchives.gov.uk/+http://www.hm-treasury.gov.uk/media/7/8/bud06_science_332v1.pdf

15 21st Century Skills: Realising Our Potential, July 2003

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/336816/21st_Century_Skills_Realising_Our_Potential.pdf

15 Innovation Report – Overview: Competing in the global economy: the innovation challenge, December 2003

<http://webarchive.nationalarchives.gov.uk/+http://www.dti.gov.uk/files/file12093.pdf>

16 Investing in Innovation: A strategy for science, engineering and technology, July 2002

http://webarchive.nationalarchives.gov.uk/+http://www.hm-treasury.gov.uk/spend_sr02_science.htm

17 Opportunity for all in a world of change, A White Paper on Enterprise, Skills and Innovation, Cm 5052, February 2001

<http://webarchive.nationalarchives.gov.uk/+http://www3.dti.gov.uk/opportunityforall/>

18 Excellence and Opportunity: a science and innovation policy for the 21st century, July 2000

<http://webarchive.nationalarchives.gov.uk/20060715232105/http://www.dti.gov.uk/files/file14470.pdf>

19 Our competitive future – building a knowledge drive economy (1998)

http://webarchive.nationalarchives.gov.uk/+http://www.dti.gov.uk/comp/competitive/prs_n2.htm

20 Information Society Initiative (ISI), launched in February 1996

21 UK Government: Green Paper, "Government Direct": A Prospectus for the Electronic Delivery of Government Services (19 November 1996)

<https://ntouk.files.wordpress.com/2015/06/government-direct.pdf>

22 Realising our Potential: A strategy for science, engineering and technology, April 1993 (White Paper)

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/271983/2250.pdf

23 A Framework for Government Research and Development, Cm 5046, July 1972.

24 The Organisation and Management of Government Research and Development (The 'Rothschild Report') 1971

25 The future of the Research Council System (the 'Dainton Report'), Cm 4814, November 1971

26 Report by the Committee on Manpower Resources for Science and Technology on the Flow into Employment of Scientists, Engineers, and Technologists, Cm 3760, 1968

27 Science and Technology Act, 1965

<http://www.legislation.gov.uk/ukpga/1965/4>

28 Committee of Enquiry into the Organisation of Civil Science (The Trend Report), Cm 2171, 1963

29 Barlow Report of 1946 on Scientific Man-Power

Associated Papers

The following papers are related to the analysis of the science and innovation strategies:

AP01 The mystery of TFP, Nicholas Oulton, London School of Economics, ESCoE Discussion Paper 2017-02, October 2017

<https://www.escoe.ac.uk/wp-content/uploads/2017/10/ESCoE-DP-2017-02.pdf>

AP02 UK productivity introduction: April to June 2017, ONS

<https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/labourproductivity/articles/ukproductivityintroduction/aprtojune2017>

AP03 Evidence: Improving the use of evidence in UK government policymaking, A report by the Campaign for Science and Engineering, April 2017

<http://www.sciencecampaign.org.uk/our-work/evidence-in-policy-making.html>

AP04 Lambert Review of Business-University Collaboration, 2003

http://www.eua.be/eua/jsp/en/upload/lambert_review_final_450.1151581102387.pdf

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- AP05 InnovateUK 10th Anniversary Brochure, 21 September 2017
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/645036/10th_Anniversary_Brochure_WEB.pdf
- AP06 Funding for nuclear innovation, June 2017
<https://www.gov.uk/guidance/funding-for-nuclear-innovation>
- AP07 Parker M (2016) The Rothschild report (1971) and the purpose of government-funded R&D—a personal account. Palgrave Communications. 2:16053 doi: 10.1057/palcomms.2016.53.
<https://www.nature.com/articles/palcomms201653#the-reaction-to-rothschild>
- AP08 Forensic science strategy, March 2016
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/506652/54493_Cm_9217_Forensic_Science_Strategy_Accessible.pdf
- AP09 Non-animal technologies in the UK: a roadmap, strategy and vision, November 2015
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/474558/Roadmap_NonAnimalTech_final_09Nov2015.pdf
- AP10 Animal and plant health agency science strategy 2015 to 2020
<https://www.gov.uk/government/publications/apha-science-strategy-2015-to-2020>
- AP11 Technology and innovation futures, Government Office for Science, last updated January 2017
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/584219/technology-innovation-futures-2017.pdf
- AP12 Eight Great Technologies, 2013
<https://www.gov.uk/government/speeches/eight-great-technologies>
- AP13 Technology and innovation futures 2012
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/288562/12-1157-technology-innovation-futures-uk-growth-opportunities-2012-refresh.pdf
- AP14 Technology and innovation futures 2010
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/555911/10-1252-technology-and-innovation-futures.pdf
- AP15 UK Science and Innovation Network Country Snapshots [covering 31 countries], FCO, 2016
https://www.gov.uk/government/publications?keywords=scientific+innovation+network+snapshot&publication_filter_option=all&topics%5B%5D=all&departments%5B%5D=all&official_document_status=all&world_locations%5B%5D=all&from_date=&to_date=
- AP16 Innovate UK Delivery Plan Financial Year 2016/17
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/514838/CO300_Innovate_UK_Delivery_Plan_2016_2017_WEB.pdf
- AP17 Nurse review of research councils: recommendations, November 2015
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/478125/BIS-15-625-ensuring-a-successful-UK-research-endeavour.pdf
- AP18 UK-Japan science and innovation collaboration: sources of funding, October 2015
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/468815/SIN_Japan_Funding_guide_2015_as_of_15_Oct.pdf
- AP19 Dowling review: linking business needs with research capability, January 2015
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/440927/bis_15_352_The_dowling_review_of_business-university_research_collaborations_2.pdf
- AP20 BIS Our plan for growth: science and innovation – evidence, 17 December 2014
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/388015/14-1247-science-innovation-strategy-evidence.pdf

AP21 UK science and innovation: commercial benefits of innovating in the UK, March 2014

<https://www.gov.uk/government/publications/science-and-innovation-in-the-uk-commercial-benefits/uk-science-and-innovation-commercial-benefits-of-innovating-in-the-uk>

AP22 International comparisons in the translation of science into growth, Council for Science and Technology, March 2012

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/225618/12-1045-international-comparisons-letter.pdf

AP23 Science and Innovation annual report 2011-2012

<https://www.gov.uk/government/publications/science-and-innovation-network-annual-report-2011-12>

AP24 The United Kingdom's science and technology strategy for countering international terrorism, Home Office, August 2009

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/97946/science-and-technology-strategy.pdf

AP25 Science and Innovation Network Report, April 2008 to March 2010

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/32494/10-1129-science-innovation-network-report-2010-part-1.pdf

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/32495/10-1130-science-innovation-network-report-2010-part-2.pdf

AP26 Science and innovation annual reports, FCO & BIS, 2004-2011:

<https://www.gov.uk/government/publications/science-and-innovation-annual-reports-2004-2011>

Science and innovation annual report 2010-2011

Science and innovation annual report 2008-2009a

Science and innovation annual report 2008-2009b

Science and innovation annual report 2007-2008

Science and innovation annual report 2006-2007

Science and innovation annual report 2004-2005

AP27 BIS Skills for sustainable growth, 16 November 2010

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/32368/10-1274-skills-for-sustainable-growth-strategy.pdf

AP28 Government-wide Forward Look [Annual report prepared by the OST each April, starting April 1994]

AP29 Innovation 2000, A research and development strategy for Northern Ireland, Department of Economic Development, 1992.

AP30 Science and Technology Issues: A Review by ACOST, September 1991

AP31 Civil Research and Development, government response to the first report of the House of Lords Select Committee on Science and Technology, 1986-87 session, Cm 185, 1987

AP32 Annual Review of Government Funded Research and Development [since 1984-1993]

AP33 Life Sciences Industrial Strategy

www.gov.uk/government/publications/life-sciences-industrial-strategy

AP34 Richer Britain, Richer Lives, Labour's Industrial Strategy

<http://labour.org.uk/wp-content/uploads/2017/10/Richer-Britain-Richer-Lives-Labours-Industrial-Strategy.pdf>

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