

Developing a future: Policies for science and research

**Liberal Democrat
Spokesman's Paper**

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July 2012

Preamble

Liberal Democrats believe that scientific research is critical to the future success of the UK. It is hard to imagine what the UK economy will look like in 2030 or 2050, if it is not based on the fruits of knowledge-based work being carried out now.

We include in the term 'scientific research' not just the natural sciences, but also the humanities, computing, engineering, and mathematics. All play a critical role, independently and together. For brevity, however, we will frequently refer to 'science' as an all-encompassing term. We also discuss specific policies relating to STEM (Science, Technology, Engineering and Mathematics) education.

We also include in the term 'research' everything from the most speculative blue-sky thinking through to the most immediately applied product development. We need the entire spectrum, and they interact strongly, generating significant economic benefits over both long and short timescales. We have seen many examples of blue-sky research leading to spectacular and unforeseeable paybacks.

However, the purpose of research is not just economic growth. Curiosity about the world, and developing understanding of how things operate, is also a valid justification for intellectual activity. From schoolroom to research laboratory, science should be fun.

In order to perform good quality research, a number of factors must be present. Firstly, money. This is available from government, industry, charities and the EU – we need to increase the funds available from each of these sources to amplify the resulting scientific benefits.

Secondly, people, with the skills to do the work. These can be home-grown, and hence we need to ensure that at schools and in Higher and Further Education, these skills are learned. Alternatively, they can be imported – in which case we need an immigration policy that allows skilled people from around the world to come to the UK to contribute their abilities.

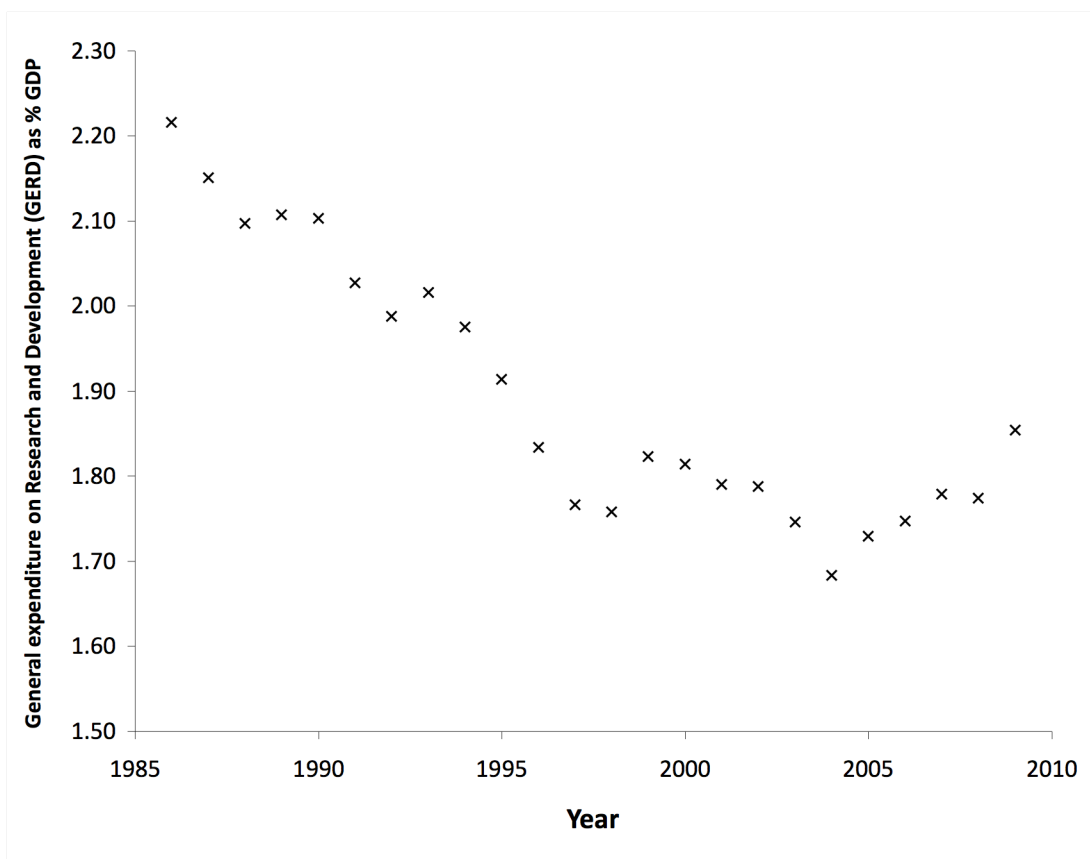
Thirdly, infrastructure. Research must be supported through access to the appropriate experimental facilities and equipment – whether located within the UK or overseas. A long-term vision must be developed to sustain and enhance infrastructure provision in a stable, progressive manner.

Government also has a role in how it uses and thinks about science, and, more generally evidence and the scientific method. Civil servants, Ministers and MPs need to understand how to use evidence to shape policies, rather than picking evidence to suit their policies.

MONEY

Research funding in the UK

1. The UK has traditionally had low levels of funding for R&D, compared with other developed countries. However, it has traditionally managed to outperform this low spending profile, for example publishing 13.8% of the world's most cited research papers, and outperforming other countries on papers and citations per pound spent or per researcher. Despite having less than 1% of the world's population, the UK produces 12% of the world's academic citations
2. The most recent figures (2009) show the UK spending 1.85% of GDP on Research and Development, including both business and government expenditure. This has barely changed since 1997 (1.77%) and is a decline since 1986 (2.22%).
3. In comparison, in 2009 France spent 2.21%, Germany 2.78%, Japan 3.34% and the USA 2.79% (2008). Only Italy among the G7 spent less on R&D. Across the whole OECD, the average is 2.3%.



UK R&D expenditure

(source: SET statistics <http://www.bis.gov.uk/policies/science/science-funding/set-stats> table 3.1, 2011)

4. The Conservative government in the 80s and 90s presided over a significant decline in R&D expenditure, which was stabilised – but not reversed – by the last Labour government. If the UK continues to underfund R&D in this way, we

will continue to fall behind competitors, especially as the expenditure by the new BRIC economies rises. The UK signed up in 2002 to the pan-EU Lisbon Target to spend 3% of GDP on R&D by 2010 – it has singularly failed to do so. Liberal Democrats would seek to ensure that there was a sustained increase in the proportion of GDP spent on R&D, towards the 3% target.

5. A significant factor in the UK's disappointing levels of R&D investment is the lack of industrial investment. In 2007, only 47.2% of total UK R&D spending came from industry. This compares to a G7 average of 65.8%, and an OECD total of 63.8%.
6. An explanation for low levels of UK R&D has been that this country has traditionally had less R&D intensive industry, such as financial services, and it would therefore require a disproportionately high level of Government spending to offset this.
7. Liberal Democrats are not persuaded by this un-ambitious view. The evidence shows clearly that it is possible to incentivise and increase private sector investment in R&D, and we believe that this must happen for the country's prosperity. Low-skilled jobs will increasingly become automated or exported, so it is vital for the country's economic future that we make the most of our academic excellence, and become a more knowledge-intensive economy.
8. OECD analyses suggest that increasing public expenditure on R&D can lift industry investment; there is a crowding-in effect. It is therefore troubling that despite Labour's 'rescue' of the Science Budget post-Thatcher, Government spending on R&D in 2007/8 was almost the same in real terms as it was in 1986/7 (£9,258m and £9,371m, respectively).
9. Liberal Democrats would bring in a range of measures to incentivise private-sector R&D spending, including investing in R&D tax credits, giving an enhanced role for the Technology Strategy Board, introducing a quota for civil procurement from Small and Medium Enterprises (SMEs) and pressing for an increased Science Budget, as resources allow.

Government Funding and Priorities

10. Research is not an instant process, and in order to attract investment and the best people, security of funding is required. Long term security gives investors confidence that the UK is committed to the research base in the long run, and gives similar signals to the world's top researchers. It therefore makes it easier to attract both people and external funding. We therefore support a continuation of the ring-fence for science, to include as it currently does the direct research funding administered through the Research Councils, HEFCE and others.

11. Many projects require significant infrastructure, and this capital work also requires forward planning and funding stability. We therefore support a ring fence for capital allocations, which were removed from the ring fence in the 2010 CSR. Security of capital investment is as important as certainty of research funding for the continued success of the UK's science base.
12. The ring fences will provide certainty of funding levels, but what is also needed is growth, which must be sustained over a long time period. We would seek to build a cross-party consensus to provide an annual increase in the science budgets, both revenue and capital, of 3% over inflation for the next 15 years.
13. Many studies have shown very large returns to the UK economy from investment in research. For example, the Wellcome Trust, MRC and Academy of Medical Sciences found that every pound invested in medical research generates an ongoing return of 30p/year. Jonathan Haskell of Imperial College Business School estimated that a £1 billion cut in research council funding results in a potential GDP loss of £10 billion.
14. Exact calculations are very hard to make for the economic returns from research investment, especially since there is often a very considerable time delay between investment and benefits. Nevertheless, all the evidence suggests that the return is very high, compared to most other areas of government expenditure. These returns are generated both via the innovations delivered, and the training provided to individuals.
15. Government funding for academic science is delivered primarily through the 'dual funding' system. University science departments are supported by HEFCE and HEFCW funds, but in addition, individual research teams receive grants from the Research Councils. We believe this plurality of funding works well, and that the system has broad support. We have no plans to challenge the dual funding stream, and recommend that it is retained.
16. Liberal Democrats believe that decisions about which scientific projects are funded should be based on the excellence of the proposals. We further believe that scientists themselves are the best judge of that excellence. This approach, known as peer review, has been a significant factor in the UK's scientific excellence.
17. We believe strongly in the power of the individual creative imagination, and the vision that researchers can have, without being constrained by management processes.
18. When Government overrides the peer review decisions process and seeks to micro-manage research decisions, they run the risk of choking basic curiosity-driven, or 'blue skies', research. As the name implies, such research is conducted without commercial or industrial applications necessarily in mind, as compared

to 'applied' research. Yet experience has shown us that many of our most innovative and revolutionary technologies started in a blue skies setting. Lasers, which were investigated for 40 years without commercial application in mind, are today used in everything from DVD-players to car manufacturing.

19. Liberal Democrats therefore support what is often known as the Haldane Principle, that political interference in science funding decisions should be kept to a minimum.
20. However, Government does need to provide a strategic lead within the broader research landscape; for instance, by pressing for more research into areas such as climate change adaptation and mitigation, healthcare for an aging population, or clean manufacturing. Liberal Democrats recognise that policy-makers must set over-arching priorities for research, while still allowing ample room for basic research, as we have described. This is different to 'picking winners' – policy-makers would not determine the exact research to be done, and would have no input into the success of any particular technology.
21. Liberal Democrats would therefore, after consultation with scientists, set funding levels within the Science Budget to address the strategic needs of the nation. We would also support the retention of the cross-council funding programmes, whereby interdisciplinary challenges are addressed in a coordinated way by more than one Research Council.
22. We are also committed that such prioritisation decisions should be taken in a transparent manner, so that their rationale can be debated and scrutinised. This is essential in ensuring the long-term credibility and validity of the process.
23. Research Councils play a critical role in ensuring that funding is allocated to the best research. It is therefore essential that those leading research councils, in particular the Chair and Chief Executive, are well respected by both the academic community and by government. We will ensure that they have the freedom to attract the best people into these roles.
24. Staff in Research Councils need to be encouraged to interact closely with the research communities, and understand their concerns. We would investigate the models used by the NSF and NIH in the USA, to facilitate secondments between research councils and academia, and to allow research council staff to remain research active while also acting as science administrators.
25. Interdisciplinary research is becoming increasingly important, but funding streams and journals are still discipline-focused. We would support the existing trend to supporting more interdisciplinary work, and would encourage Research Councils to work together to ensure there are not gaps in funding availability.
26. We strongly support collaborative work between different academic institutions and between academia and industry. We believe that links between researchers

at more research intensive universities and less research intensive universities could be beneficial to both.

27. The Research Excellence Framework (REF) has caused much controversy, especially around the use of 'impact' measures. The Liberal Democrats agree that we should ensure that we get as much value as possible from publicly-funded research, but that it is inappropriate to judge all research by a measure of short-term impact. We accept the need to establish how individuals and departments are performing, and how they use public funding, but are concerned about the time taken by the processes currently in place. We do think, however, that it is beneficial for researchers to consider carefully what practical benefits could be derived from their work.
28. We support 'blue-skies' research, but more or less by definition, it is not possible to predict the outcomes from it. We would therefore not require those conducting such research to predict or demonstrate impact as a sign of success or failure, as even excellent research may not show any impact in a five-year horizon. However, we would require those engaged in blue-skies research to go through a process of considering how their discoveries could be used to try to extract as much value as is possible early on, and would maintain an emphasis on university industry collaborations.
29. Liberal Democrats welcome the fact that the UK Science has a traditionally strong record in R&D funding from the charitable sector. Funding from this source can often fill gaps when neither Government nor industry are in a position to support research, so it is vital that this sector is supported. This is particularly important in the biomedical sector, and medical research charities such as the Wellcome Trust and Cancer Research UK contributed £1.2 billion in 2011/12. We will maintain the Charity Research Support Fund (CRSF), and review the ways in which charitable R&D can be made as effective as practicable.
30. We believe that there could be stronger links between the NHS and bio-medical research, in order to benefit patients as well as researchers. We will investigate appointing appropriately qualified academic clinicians to direct combined research and clinical units, targeted at specific diseases or organs, to maximise the benefits that can be derived. We will make increased use of NHS data for research, subject to appropriate safeguards on patient anonymity and confidentiality.
31. European funding for research and innovation has grown substantially, and the last year of FP7, in 2013, is expected to spend around €10 billion. The next programme, Horizon 2020, is anticipated to continue this growth trajectory. The UK is well placed to attract large amounts of this funding, bringing fresh funding into the country. However, applying for funding from European sources is not currently prioritised, partly because of the bureaucracy involved, and partly because of the lack of full economic costing. We would establish a EU Research

Support Fund, to incentivise applications, and would seek to ensure that the processes involved in both applications for EU funding and the ongoing monitoring and audit processes are simplified, so more of the money goes directly to research. We would also seek to establish funding protocols with the EU to deal with both the full economic cost approach of the UK and the embedded cost procedures of other European countries

32. We note that the MoD spends approximately £2bn a year on Defence R&D. We also note that only a fraction of that total, perhaps £200m or so, is spent on real innovative research, some is spent on providing the MoD with up-to-date scientific information but the majority (about £1.5bn) is spent on weapons system development. We recognise the importance of the UK maintaining a strong military, but believe that the money spent on weapons development is not necessarily spent to the nation's best economic advantage and that it has not been shown to have the same wider economic benefit that civilian R&D does. Liberal Democrats would therefore investigate the redirection of funding from Defence development programs – especially from the Trident nuclear missile programme - directly into the civilian science budget, thereby stimulating academic and private sector research. The defence research budget (known as the Science & Technology budget) has already been much reduced in the last decade and we would not cut it further, although we do believe it could be spent more effectively.

Promoting industrial R&D

33. There is clear evidence that government investment in research and development incentivises and creates the conditions for additional private sector investment. We therefore anticipate that a consequence of the additional science base funding, there will be further growth in private sector R&D funding. However, further steps are required to maximise the amount of useful R&D that will be performed.
34. R&D Tax credits have demonstrated themselves over the years to be an extremely successful and well-regarded way of incentivising private sector investment in R&D, although concerns have been raised that they can on occasion fund some research that would happen anyway. We support them, and would continue to have significant R&D tax credits. However, they can be too bureaucratic for smaller and medium sized firms, and the definitions can be inappropriate for some IT firms. We would therefore simplify the claim system for small firms, and broaden the definitions.
35. The Technology Strategy Board (TSB) plays a very important role in encouraging innovation, generating an estimated £7 of gross value added for every £1 invested. However, it needs to ensure that it is approachable to smaller companies and organisations, as well as catering for larger, established industries. They will also need to significantly streamline their bureaucratic

processes. In particular, they need to process applications from start-ups and smaller companies significantly faster, to assist with their cash flow. This particularly applies to schemes such as the very welcome SMART awards.

36. Bridging academia and industry effectively is an ongoing challenge. We support the proposal by Hermann Hauser for Clark Maxwell centres, to act as lighthouses for such applied research. We also note the success of Fraunhofer centres in Germany and elsewhere, in helping SMEs to harness the latest research. We will monitor whether the recent 'Catapult' Technology and Innovation Centres manage to achieve either of these goals, and will encourage the creation of centres in the Clark Maxwell or Fraunhofer style if these are needed. We would rename Catapult Centres as Alan Turing Centres.
37. We would protect and seek to expand funding for applied research organisations such as the Catapult Centres, TSB and the National Physical Laboratory's Technology Innovation Fund; applied research is key to developing economic returns.
38. We note the success of innovative linkages such as the Bioprocessing Research Industry Club, funded by BBSRC, EPSRC and industry, and would encourage research councils to support such initiatives where demand exists.
39. There is strong evidence to suggest that small innovative companies grow best when they have an initial client, and the government is well placed to ensure that it uses its procurement power to support small R&D-based businesses. We therefore support the Small Business Research Initiative (SBRI). However, the size of contracts available is much smaller than the successful US Small Business Innovation Research programme. We would therefore increase the funding available to the SBRI, focus the funding on firms which can prove that they will spend money on innovation, and set a target for the proportion of government R&D contracts each year going to SMEs.
40. The US has demonstrated that inducement prizes can be a very effective way of stimulating innovation. For example, the Ansari X prize in the US offered a \$10 million prize for the first non government organisation to launch a reusable manned spacecraft. This drew in \$100 million in R&D investment. Liberal Democrats would increase the current prize fund at TSB and NESTA and develop new inducement prizes in key areas.
41. We welcome the 2011 Government Strategy for UK life sciences, and in particular the commitment to funding for stratified medicine and a biomedical catalyst fund. We further propose that the Government coordinate a UK Life Sciences Investment Fund, aiming to collect around £1 billion in investments from sovereign funds and other investors, to support university-based research projects from early stages through to exit, in high-risk high-return projects.

Provision of Infrastructure

42. Education and training is only part of the picture. We note the quality of the UK's scientific output and achievement must also be underpinned by provision of appropriate experimental facilities and infrastructure for researchers to use. We believe that a better understanding of facility provision, recognising not only the initial capital outlay, but the requirement for ongoing operation and maintenance costs and the value of a committed, well-trained, technical support staff, strengthens the UK's scientific position.
43. The UK operates, or contributes to the operation of, world-class science facilities within the British Isles, overseas and off-planet – examples range from the HECToR supercomputing service at Daresbury and the Diamond Synchrotron in Oxfordshire, to the Large Hadron Collider near Geneva, the British Antarctic Survey in Cambridge and the poles, and the Cluster satellites in orbit around the Earth. We welcome the outstanding contributions all these valuable institutions and facilities make to our science base.
44. We value the opportunity to host such facilities in the UK, recognising they support local economies through provision of sustainable, high-tech jobs and the national economy by forming a market and showcase for British science, engineering and manufacturing, as well as underpinning the scientific breakthroughs that benefit UK industry. We welcome the significant contributions from charity and industry that both enable these facilities to be built and speed the uptake of their scientific output.
45. We also acknowledge that the scale of human scientific endeavour is such that the UK cannot drive forward progress alone and must contribute to international partnerships to build advanced facilities in a global context. The UK's reputation is enhanced by such partnerships and the outstanding quality of the research our academics undertake means the UK's fraction of usage, and hence benefit, is often higher than our financial contribution.
46. As well as such large-scale facilities, well-equipped laboratories within an academic environment are also essential for a healthy science base. However, funding for small pieces of equipment has not been consistent, and we recommend that it be protected in the same way as grant expenditure on staff time and consumables.
47. Whether large-scale or small, the value of such facilities and equipment can only be maximised through specialist operations staff. These highly-trained people: engineers; technicians and support, are often employed on short-term contracts; this insecurity means their knowledge is easily lost from the system as they move to other posts, often to the benefit of our international competitors. To maintain continuity of operational expertise we recommend that ongoing support requirements are properly costed into facility provision, for the life-time of the facility.

PEOPLE

Immigration

48. One of the key contributions to the UK's success in the sciences has been our ability to attract researchers and scientists from across the world, allowing free exchange of knowledge and ideas. Science is increasingly global in nature, and we must view science in an international context. With other countries increasing their science capability, if we do not have an immigration system that actively encourages top scientists and academics to come to the UK then they will go elsewhere. It is hard to build up a reputation as the world's best place to come and do research, but easy to lose it. We must demonstrate that the UK is open for business for science, entrepreneurship and overseas investment.
49. The HE sector is one of the most successful sectors in the UK economy, and this is due in part to its ability to attract scholars and students from around the world – to act as teachers, students and researchers. Overseas students are also vital to subsidising STEM provision in many university departments, and this too is highly vulnerable to changes in immigration policies. Loss of income through the recent changes in visa policies may negate any additional funding STEM subject have received through other government mechanisms. The government's changes to tier 4 student visas are estimated in the government's own impact assessment to cost the UK economy £2.4 billion. Liberal Democrats support clamping down on abuse of student visas (Tier 4), but do not support undue restrictions on *bona fide* students, which would be bad for the students, bad for our universities and bad for the economy.
50. We not believe that students should be counted as immigrants in the published statistics, and would seek to revise the UN standard, so that this can be achieved. In the interim, we would publish statistics which would allow a distinction between students and other migrants.
51. We would encourage students who have completed their studies in the UK to remain in the country, where their skills are those from which this country could benefit. We would therefore continue the Post-Study Work Visa for such students.
52. Whether it is a genuine problem, or merely a perception, there are significant risks that unless the UK is seen to be open and inviting for scientists and researchers, they will go elsewhere, which will damage UK's excellence in science. Indeed there are a significant number of reports that this is already happening, and combined with fears over long term UK science investment, this

doesn't make for attractive environment to attract the brightest and best from around the world.

53. Scientists and researchers must be presented with a clear route to work and settle in the UK, so that they know that when they have built up expertise in this country, they will be welcome to stay and work here. Liberal Democrats would ensure that any restrictions on non-EU migrants would ensure that those with a doctorate or chartered status would be exempt from settlement restrictions.
54. Academics frequently come to the UK for short time periods, such as for conferences, lectures or as doctoral thesis examiners. There have been a number of instances where such visitors have been prevented from coming by difficulties in obtaining a visa. We would ensure that there was a rapid and simple process for such academic visitors to be able to enter temporarily, even if they are receiving payment for their activities.
55. We welcome the Tier 1 (Exceptional) scheme to allow a route of entry for particularly talented scientists, academics and artists. However, this system needs to be simpler. We recommend that those appointed to a range of prestigious positions (eg Royal Society University Research Fellowships) be automatically deemed to be eligible under the Tier 1 (Exceptional) scheme, so as to remove the concern among applicants and appointers that there may be visa issues. We would remove the numerical quota on the number of exceptional people allowed to have visas, as these are people we would very much like to attract here, and the presence of a numerical cap may drive people away. We note that there is no numerical constraint on the number of elite sportspeople and ministers of religion entitled to visas.
56. We are concerned that changes to the immigration system are made arbitrarily with a focus on the estimated economic output of an individual migrant. This causes particular concerns within the NHS, with its specialist requirements. The immigration system must remain flexible enough to recruit skilled individuals from outside the EEA should the resident workforce be unable to produce suitable applicants to fill specialist or generalist vacant roles or if an individual has particular skills and knowledge not readily available in the UK.

5-19 education

57. We believe that rebalancing the economy towards a knowledge economy and high-tech industries will not be possible without a highly educated and skilled work-force; young people need improved science education whether they are destined to become professional scientists, or scientifically literate citizens.
58. The United Kingdom must develop an education and training system to produce a highly-skilled workforce that supports research and innovation. In this, natural sciences, technology, and mathematics are highly important. However other

STEM subjects – such as design and technology, computing, ICT, and engineering – should not be overlooked. It is estimated, for example, that we need to produce around 20,000 more engineers per year than we currently do, to cope with the retirement bubble and growth in sectors such as energy, automotive, and aeronautical engineering.

59. We believe that having a pool of scientifically literate young people is the basic prerequisite to any functioning national policy on science. Systematic change will be required to maintain and increase this pool. We note a lack of high quality teaching, and perceptions of careers and opportunities, are key barriers preventing young people from studying science and engineering.
60. Improving the science and mathematics education in schools is a particular priority – to inspire next generation of scientists, and to ensure that all young people obtain the scientific skills and knowledge to live in an increasingly technological age. The seeds of future choice are sown early.
61. The quality of maths and science teacher training at Primary level needs to be reviewed, and more encouragement given for STEM graduates to consider teaching at Primary Schools.
62. The quality of science teaching and the educational progression of pupils in schools are strongly influenced by the qualifications of science teachers. Teaching expertise has been shown to be an excellent independent predictor of attainment at both GCSE and A-level. Teachers with strong education backgrounds in STEM subjects are crucial for developing young peoples skills in science and maths, and enthusing them to pursue further studies
63. It is particularly important to secure the quality of STEM teaching in schools with high level of deprivation and low levels of achievement – where potential gains are greatest.
64. Liberal Democrats will ensure that all primary schools have a science specialist in each school, to support other teachers in their knowledge of and confidence in science. In addition, schemes currently run by some universities should be expanded to ensure that STEM undergraduates have the opportunity to work with primary school children, such as the Stimulus Scheme run by Cambridge University. Evidence from these placements show that primary pupils become much more enthusiastic about STEM subjects, and that more undergraduates then consider teaching as a career.
65. We will seek to ensure that secondary STEM teachers have a degree or other appropriate qualifications for the subject in which they teach, and will provide funding towards this via continuous professional development (CPD) with entitlements of £500 per teacher per year. We would consider whether CPD courses should be made compulsory for STEM teachers.

66. Liberal Democrats note the excellent work done by various science outreach schemes, for instance STEMNET and the Royal Society Partnership Grants Scheme. However, we also note that the coverage of these schemes is far from universal, and that the range of schemes can be confusing for schools and teachers.
67. We would therefore institute a Science Champions Network, a framework which would make information on various schemes easily available to the public, set minimum standards for such schemes, and highlight areas without coverage. We would work to ensure that every primary school has access to a science and maths champion.
68. We support the work done by the Wellcome Trust and others to develop project kits and practical equipment, to encourage real practical experimentation, both inside and outside the classroom, for a wide range of age groups.
69. Liberal Democrats are concerned that only half of those who choose to become STEM teachers are still in the profession five years after graduation. We believe that this figure could be improved by giving such teachers more support, suitable mentors (from other schools, if necessary), creating more appropriate financial rewards, and professional development.
70. We particularly note that science teachers consistently cite the presence of technicians as a major factor in improving workload and job satisfaction, and reducing stress levels. We would therefore encourage and support the role of technicians.
71. Liberal Democrats would therefore bring in a range of measures to improve retention of STEM teachers. We have already proposed replacing the 'golden handshake' starting bonus with an equivalent sum being used to pay off a proportion of student loan debt for a number of years. We would also provide more training opportunities, and provide funding for more support staff.
72. As part of a curriculum review, we would look at the introduction of a course on Mathematics for Citizenship, containing key elements of mathematics and statistics that are used in typical daily life, as a compulsory post-16 element. This would include topics such as financial education.
73. We will ensure that those consulted over curriculum development includes teachers, government, Higher and Further Education and employers, so that the material that is taught is best suited to the demands of the students, later education and the workplace. We would ensure that the full range of Higher Education establishments were consulted.
74. We support the work done by the British Computer Society, the <goto> Foundation, Coding for Kids and others to promote computer science and

coding as part of the curriculum. Too much ICT teaching is about using individual software packages, rather than the principles of how computers work.

75. Liberal Democrats are concerned by reports in recent years of Creationism and Intelligent Design (ID) being presented in school science lessons as an alternative to theories tested by the scientific method. We believe that if such subjects are to be discussed at school, it should be in the context of philosophy or religion, not science, or in the context of specific discussions about the scientific method. Liberal Democrats therefore oppose the presentation of creationism or ID in science lessons as a legitimate alternative to evidence-based theories.
76. We would seek to encourage direct private- and charity-sector involvement in STEM education in schools. We believe that exposure to 'real-world' science will not only improve students' education experience, but will also improve careers advisory services, in turn growing the talent pool which those private- and charity-sector employers employ from. We would create a framework for existing schemes, and create incentives for new ones. We would establish a National Young Science Ambassador scheme, encouraging recent graduates to talk at schools about their STEM experiences.
77. We would also encourage doctoral students, as part of their PhD funding arrangements, to spend time teaching in state schools, which will further expose school pupils to the opportunities (and challenges) of a career in science, as well as encouraging the students to consider teaching as a career.

Universities, Careers, and Diversity

78. Liberal Democrats believe that the security of core science departments at higher education institutions is a necessity for a modern, innovative economy. We also believe that student welfare suffers when the choice of universities they can attend is thinned, exacerbated by the pressure students are already under from tuition fees, which may limit the geographic area they can choose from. We believe it is even worse for existing students to be faced with the closure of the department at which they study.
79. We are concerned by recent examples of STEM departments in universities either closing, or being threatened with closure, as a result of declining student numbers. In Chemistry, for example, we have seen departments at the University of Coventry, University of Exeter, and University of Swansea under threat.
80. Liberal Democrats are therefore committed to defending core science departments in Higher Education against closure, where practicable, and call for funds to be made available to support them in times of financial stress. Such

departments should not simply be closed due to market forces, particularly when it is much more difficult to re-establish them than to close them down. We would also ring-fence a STEM element of the HEFC budgets, preventing money earmarked for science departments being used for other priorities.

81. We are concerned that the ability of academic staff to teach students is not sufficiently prized or rewarded in many universities, when compared to conducting research. We would encourage universities to allow those academics who prefer to focus on teaching to do so, and to recognise this as a valued role within the university. We support, for example, the creation of specific teaching fellowships and prizes for teaching quality. We believe that this would be in the best interests of the students and academics.
82. Currently, postgraduate students, unless they are among the few who obtain funding from Research Councils, are liable to pay their own course fees, which can be very substantial, as well as maintenance. These fees are payable upfront, unlike undergraduate fees. As a result, unless they have their own or family money, postgraduate students are typically required to borrow the money from a bank, at commercial interest rates.
83. We would introduce a scheme, similar to that currently in existence for undergraduate tuition fees, whereby the government would pay fees up to a certain limit and for approved courses, and the student would pay the money back as a capped post-graduate tax, paying a proportion of their income over a defined threshold towards the debt. This would ensure that no-one had to pay a graduate tuition fee up front, and that low earners are not required to pay back a large debt after they complete their post-graduate course.
84. Details of how high a fee limit there would be, which courses would be covered and the exact repayment mechanism, would be developed to fit with the available funding for such courses. We anticipate that graduates would be entitled to up to two years of post-graduate funding under this scheme. This would be a clear improvement on the current scheme for all eligible students, but we would allow students who preferred to pay the fees up front to do so.
85. We recognise that the University experience for those studying science is a key factor in their subsequent potential path into a scientific career. In particular, we feel that the current PhD structure could be serving graduates better. Our Further and Higher Education paper noted that too many doctoral students leave their specialism after their doctorate, due to a shortfall of post-doctoral posts and a relative lack of skills compared to doctoral students arriving from abroad.
86. We would continue the trend towards extension of all PhDs to four years, which is common in other countries, with the extra time – spread throughout study – used for training in new research methods, industry exposure, teaching in state schools, and public engagement activity. These post-docs would be more

competitive for post-doctoral posts, and also more qualified for a competitive skills market.

87. We are concerned about the fragmentation of the academic career structure after the doctoral level. Too many post-doctoral positions are very short term, which does not allow individuals enough time to full engage with a particular problem before they have to seek new grants or a new contract. This is one of the factors that pushes people out of the academic pathway, and we will seek to provide greater certainty for good postdoctoral researchers, such as by supporting the Research Councils UK Academic Fellowship scheme. There is a particular need within the NHS for better career pathways for scientists and for clinician/scientists.
88. While we do not believe that everyone who leaves a direct STEM career is somehow a failure of the system, or necessarily a loss to STEM. Indeed, the country benefits greatly from having STEM-educated workers in other parts of society. However, we would like to better understand the reasons given for leaving direct STEM subjects. We would therefore encourage exit interviews, so that a picture can be built up of why people leave STEM, and what changes might be made to keep them. We would also provide careers advice for people considering leaving academic research.
89. We support the move by Research Councils towards 5-year grants, so that academics are given the certainty of funding, and are able to go ahead with research programs without constant grant applications. However, there needs to be care given that there is also sufficient support to new academics, who may not yet have the track record needed for such large grants. In addition, there needs to be flexibility for smaller grants and pump-priming project funds so that new ideas can be rapidly tested.
90. The need for diversity in the STEM workforce has long been recognised, but it is an issue that is central to the Liberal Democrat STEM agenda. Liberal Democrats acknowledge that being part of an under-represented group is in itself a disadvantage, partly because of the lack of role models at higher levels, and partly because these groups then tend to be under-represented on influential committees. It is very important to target the full range of people – leaving people out because of their background will hinder our ability to keep the best people in the STEM workforce.
91. Liberal Democrats therefore recommend that the National Science Champion database should include a dedicated pool of scientists from under-represented groups to serve as role models for young people. We will also ask a Working Group to undertake specific research into how to promote study of science subjects by members of ethnic, disabled, and other minority groups. This will also include consideration of socioeconomic disadvantage, and the geographic spread of scientists.

92. We note the particular difficulties that disabled students face when studying science, as well as the particular impacts they can have in their careers when allowed to fulfil their potential. We therefore recommend that the Liberal Democrats remove the cap on financial support for disabled students, to allow extra support in specific cases of severe need. We also recommend that a dedicated resource centre is established to support disabled people in STEM.
93. Socio-economic background is often a neglected diversity issue, but there is growing evidence that people from lower socioeconomic backgrounds are less likely to study STEM subjects, particularly medicine. This is especially true for mature students.
94. Liberal Democrats would also implement a 'STEM Diversity Bursary', as proposed by the Campaign for Science and Engineering, and based on the Texan 10% plan. This would provide bursaries to the brightest pupils who study STEM subjects at university, at those schools that send fewest pupils to university. This measure would incentivise students from poorer educational backgrounds, reduce educational inequality, and result in more trained scientists.
95. Liberal Democrats are concerned by evidence showing the continuing under-representation of women in science, at all levels. Women make up only 18.5% of employees in the science sector. As well as pointing to a lack of opportunity for some women to achieve their potential, it also represents a huge loss to the UK economy. This is a particular problem in ICT and engineering subjects. We will not generate the number of scientists and engineers we need until we recognise and tackle the shortage of women working in these fields.
96. We further note that not only do fewer women than men study science in Higher Education, their subsequent career progression is also slower – for instance, there is a 25% difference between the genders in promotion from senior lecturer to professor.
97. Liberal Democrats will therefore bring in a range of measures to support women in science, as well as evaluate and support existing schemes where appropriate. We would ensure that every school has access to a female Science Champion through the National Science Champions Network (recommended in para 65). We would ensure more flexible employment frameworks are implemented across the publicly-funded STEM sector to accommodate the career breaks and part-time working which women scientists benefit disproportionately from, encourage organisations to consider crèche facilities, and ensure that career breaks are correctly accounted for in grant considerations. We would support the expansion of the Athena SWAN charter.

Science Advice

98. Liberal Democrats recognise the importance of policy being informed by the best available evidence. We have been vocal in calling for public policy to be

evidence-based, and defending the independence of scientific advisers. If advisers can be dismissed by ministers because their advice is not in line with government policy, then ultimately the only advice that government will still receive will be biased.

99. Liberal Democrats remain committed to evidence-based policy, and would respect the independence of advisers. We wholeheartedly agree with the Principles for the Treatment of Independent Scientific Advice, proposed by the Royal Society.
100. As well as expert advice, Government requires novel research into policy aims and implementation. Liberal Democrats are therefore concerned that departmental R&D spending has continued to decline. We believe this may be a sign of lack of emphasis of the importance of research in government.
101. Liberal Democrats would ring-fence civil departmental R&D. In particular, a significant proportion of government-wide R&D would be a central protected pot, to which individual departments would submit bids. This would prioritise the most vital research, regardless of which areas of government it happens to fit into. Departmentally-funded research would be expected to be subjected to peer review, to ensure the quality of the work.
102. We believe that civil servants would be better equipped to fulfil their roles if they were trained in the basics of statistical science, evidence-based policy, and the scientific method. Liberal Democrats would commit to provide such training to civil servants without these skills. We would expand the Science and Engineering fast track scheme for civil service appointments. We would support the role of organisations such as the Centre for Science and Policy in linking civil servants with academics.
103. We note that it is not always possible to arrive upon a definitive answer as to whether a particular policy has a strong evidence base before it is implemented. We would therefore make greater use of pilot schemes, whereby promising but untested policies are trialled before universal adoption. In that way, the evidence necessary to endorse or reject a policy can be generated.
104. Impact assessments would be required to specify how the outcomes from a particular policy can be measured and assessed, and what studies will be performed into their success or otherwise. We support the approach described by Haynes, Service, Goldacre, and Torgerson to increase the use of randomised control trials to develop public policy, where appropriate.
105. We accept that for the vast majority of government decisions, there is not a scientifically 'right' and 'wrong answer'; values and policy judgement play a key role, but they should be based on an examination of the evidence. Formal independent advice should be published, as well as the evidence considered, alongside the final governmental decision.

106. Liberal Democrats believe that the Parliamentary Office of Science and Technology (POST) could play a vastly enhanced role in Westminster. Liberal Democrats would review the role of POST so that it provides a more dynamic service for parliamentarians, proactively responding to policy debates and educating parliamentarians and their staff. We would ensure that all newly elected parliamentarians are offered a training course from POST on basic statistics and the scientific method. We would also seek to make this available for candidates for election.
107. We support the role and independence of Chief Scientific Advisors, which should be in all significant Department. They should be full time (save for residual time to continue research), at Permanent Secretary level (4* for MoD), and have a seat on their Departmental Boards, their own budgetary control, their own staff and access to papers and to Ministers. They should be given any necessary security clearances appropriate to their Department.
108. We would appoint a Chief Social Science Advisor, based in the Cabinet Office, and working with Social Scientists across all departments, as well as the Government Chief Science Advisor.
109. All Departments should establish an independent scientific advisory group, including representation from relevant Academies Institutions and Learned Societies as well as other academic experts.
110. We view with great concern litigation against scientific advisors in Italy, and will ensure that it is clear that advice given in good faith to government is protected from prosecution if it turns out not to be correct
111. We would establish an independent Office of Science Responsibility, which would be responsible for oversight of the use of evidence-based policymaking by departments. It would not be expected to disagree on policy decisions, but to comment on the use of misleading or inaccurate evidence, following from the model of the Office of National Statistics.

Science, integrity and the public

112. Liberal Democrats are committed to reforming the libel laws such that, whilst the right of the individual to protect their reputation from reckless and malicious smears is upheld, there is a defence for scientific and medical discourse, unless it is false and malicious.
113. Liberal Democrats note the success of open-access journals, including evidence that papers submitted to such journals are more widely read and cited. We believe they also confer other benefits, including better access to published material not only to scientists, but to society in general – particularly key when

such research is taxpayer-funded. This will also assist companies in accessing the latest published research.

114. Liberal Democrats therefore support a move to Gold Open Access publication, such that the author pays the costs of publication, and the articles are available for free immediately upon publication. We will ensure that money is available as part of research grants and HEFCE funding to pay the costs of publication. We anticipate significant savings from libraries, which will no longer have to pay for journal subscriptions. We will ensure that some funding is provided for those from poorer developing countries to cover their publication costs
115. We also support the principle of Open Data, such that research data is made available in usable formats upon publication, together with meta-data as required. This will help to ensure that maximum value can be obtained from research performed.
116. We are also concerned by the effects of publication bias, whereby those papers showing positive results are more likely to be published in journals than other papers. Given the importance of reliable scientific data, especially in medicine, we feel that measures should be taken to reduce the impact of publication bias.
117. In particular, we would ensure that the results of all registered clinical trials would be made available, whether they are positive or negative.
118. Liberal Democrats believe that all health interventions paid for by the NHS should be as evidence-based as possible, so that patients get the best treatments and taxpayers get value for money. We would ask NICE to examine all Complementary or Alternative Therapies that may be being used on the NHS to see if their use is cost-effective. If NICE's advice was that the treatment did not perform better than placebo, then it should not be funded by the NHS, although it may continue to be commercially available.
119. We need to ensure that regulatory controls applied to UK science are appropriate to achieve their aims, and are not overly bureaucratic. We would implement in full the Academy of Medical Sciences recommendations regarding the regulation of clinical trials. We support harmonisation of regulations across Europe to remove competitive disadvantages, where there are no specific reasons to take a different stance.
120. However, we welcome the additional protections being provided in the UK above the required standard for the protection of animals used for scientific purposes. We are firmly attached to the '3 R's' – seeking to replace, reduce and refine the use of animals for scientific purposes. We strongly support research to find alternatives to animal experimentation where these exist.
121. Liberal Democrats believe that public engagement with science is an important factor in any science policy, and it is a consideration that runs through this

paper. We have also consistently encouraged engagement between scientists and the media in debates such as animal research and hybrid embryos, and would continue to do so. Liberal Democrats also believe that science centres are as important to culture as traditional museums, and would ensure that the funding system is the same for both, doing away with the financial handicap that science centres currently face.

Global Challenges

122. Liberal Democrats see science as a vital tool in both diplomacy and development. It is capable of providing solutions to world-wide problems, employment opportunities, and an evidence base for policies. It is especially vital that we seek to improve science capacity in less economically developed countries, as native scientists will be better placed to identify research avenues important for their own nations than UK scientists would be.
123. Liberal Democrats would therefore call for Research Councils UK to create a new cross-council Grand Challenge of International Development. Such a strand would focus investment into research which encouraged collaboration with scientists in the developing world and/or into technological solutions to challenges facing people in the developing world.
124. Liberal Democrats would also incorporate science capacity-building into our International Development policies. This would be achieved by a range of measures, including training for Government scientists and science advisers, and investing in science infrastructure as a form of aid.
125. As Prof Sir David King, the former Government Chief Scientific Advisor has said, climate change is the greatest threat facing Britain and the world. We believe that British expertise has a key role in climate change mitigation and adaptation. We would therefore encourage research in these areas, and support investment in the cleantech industry.
126. Scarcity of global resources – rare metals, fuels and water – limits development and growth, and acts as a driver for conflict within and between nations. In the coming decades these pressures will worsen as supplies become ever more limited and demand increases. Liberal Democrats welcome research which seeks alternatives to these resources by developing innovative manufacturing technologies, which optimise and minimise use of scarce current materials.
127. To meet and overcome all these global challenges in the coming decades, we must harness the innovation and creativity that has characterised British science in the past. This will benefit the UK as well as the rest of the world.

ACKNOWLEDGEMENTS

I would like to thank all those people and organisations who provided submissions and ideas, assisted with writing the document, and took time to consider and comment on the drafts. In particular, I would like to thank Michelle Brook, Imran Khan, Dr Evan Harris, Dr Jenny Woods, Tom Gault, Susannah Kerr, Steve Coltman, parliamentary colleagues, and the members of ALDES, the Association of Liberal Democrat Engineers and Scientists.