

Trends in research funding and the future of research in acoustics

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Summary

- **Global trends in science, technology and innovation**
- **Recent changes in the UK Research Landscape**
- **Implications for acoustics research**

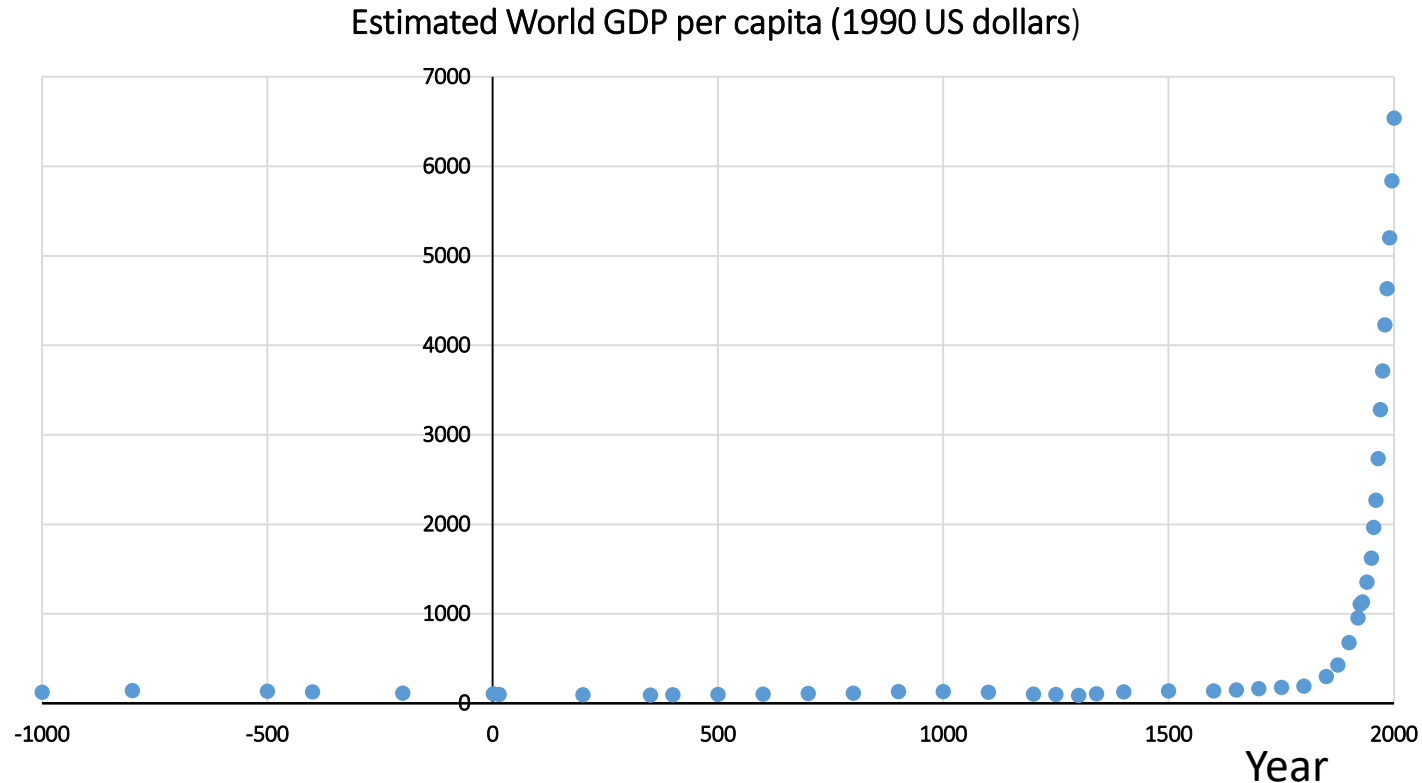
Selected global “mega-trends”

.....influencing Science and Technology Policy according to OECD† Science, Technology and Innovation Outlook 2018:

- **Demography:** Global population ~10Bn by 2050, 10% over 80, increasingly urban, 90% of growth in Asia and Africa
- **Natural Resources and Energy:** Severe water stress in many parts, persistence of food insecurity, sharp rise in energy consumption
- **Climate Change and Environment:** several critical impacts could be avoided by limiting to 1.5deg C, but rapid, far-reaching unprecedented changes required (IPCC 2018)
- **Globalisation:** centre of gravity of world economy shifting eastwards and southwards, but counter currents of geopolitical instability, conflict, increased protectionism.
- **Health, inequality and well-being:** treatment of infectious diseases compromised by growing antibacterial resistance, non-communicable diseases growing due to spread of unhealthy lifestyles

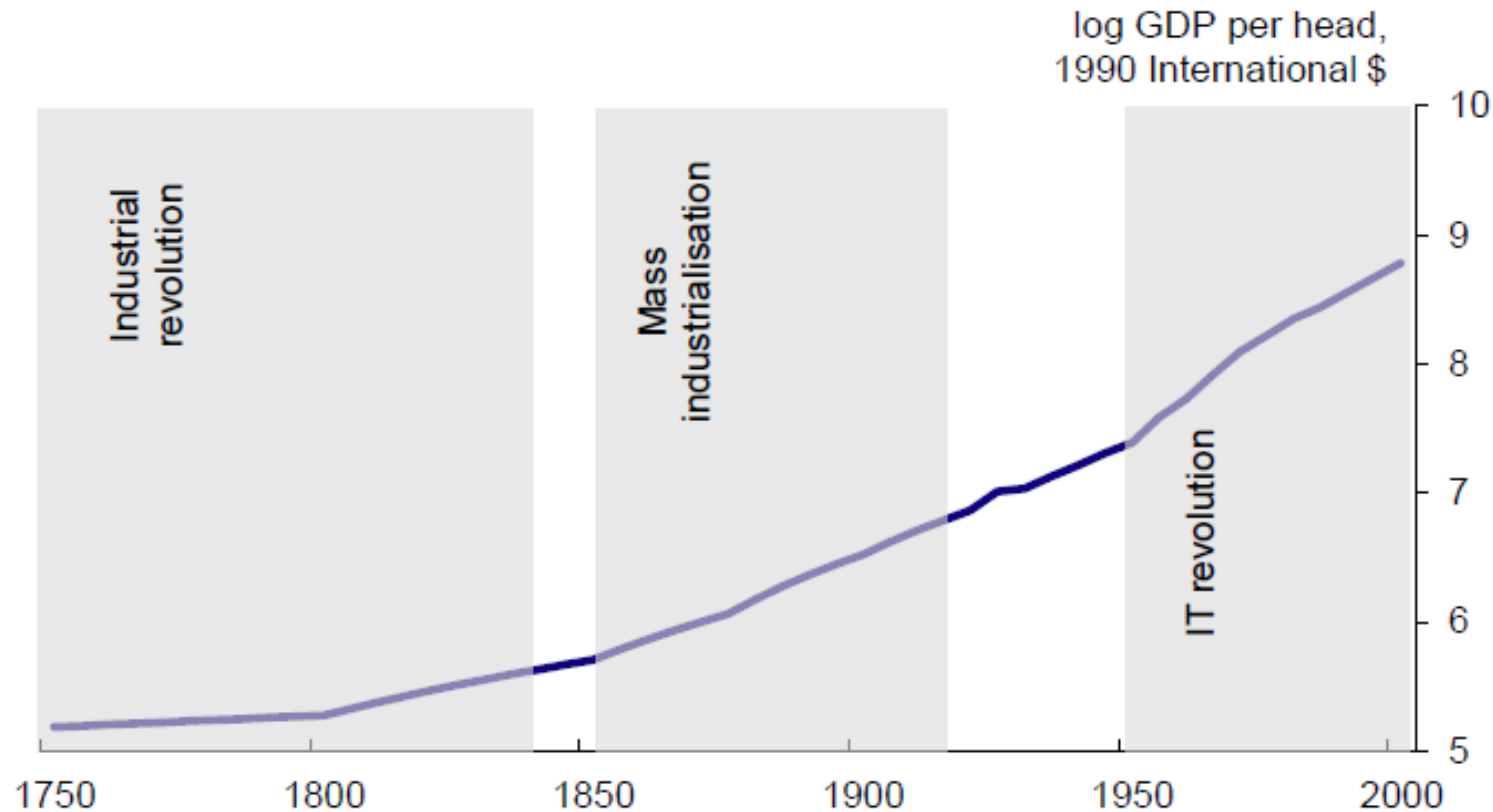
†Organisation for Economic Co-operation and Development (36 member states from the developed world)

Impact of investment in research and innovation; the big picture



Data from DeLong 1998, U.C. Berkeley “Estimates of World GDP, One Million B.C. – Present”.
See: Andrew G. Haldane. Speech: “Growing Fast and Slow”. Bank of England 2015.

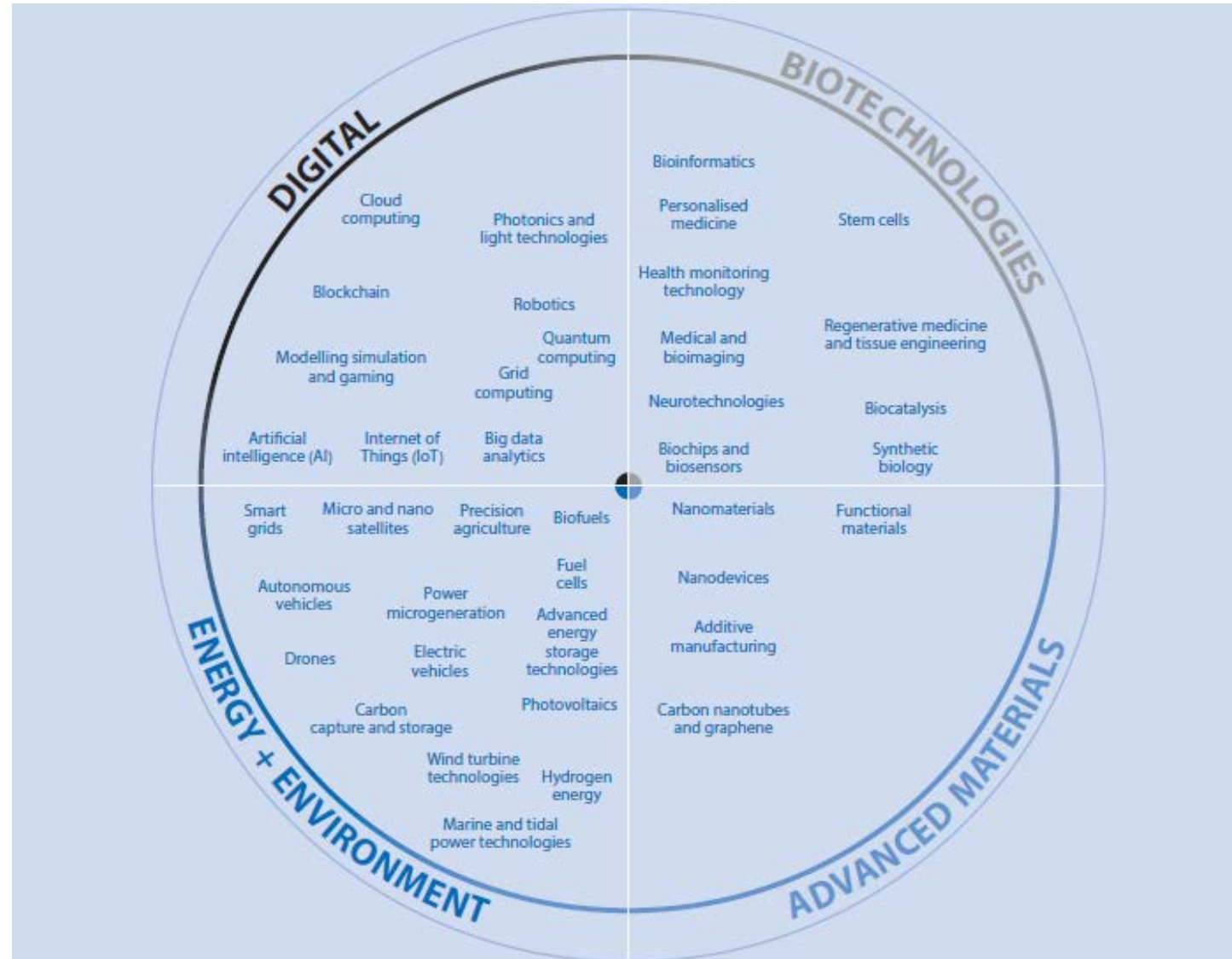
GDP growth since 1750



Source: DeLong (1998).

Data from DeLong 1998, U.C. Berkeley “Estimates of World GDP, One Million B.C. – Present”.
See: Andrew G. Haldane. Speech: “Growing Fast and Slow”. Bank of England 2015.

40 key and emerging technologies for the future (OECD Science, Technology and Innovation Outlook 2016)



Ten terrific technologies

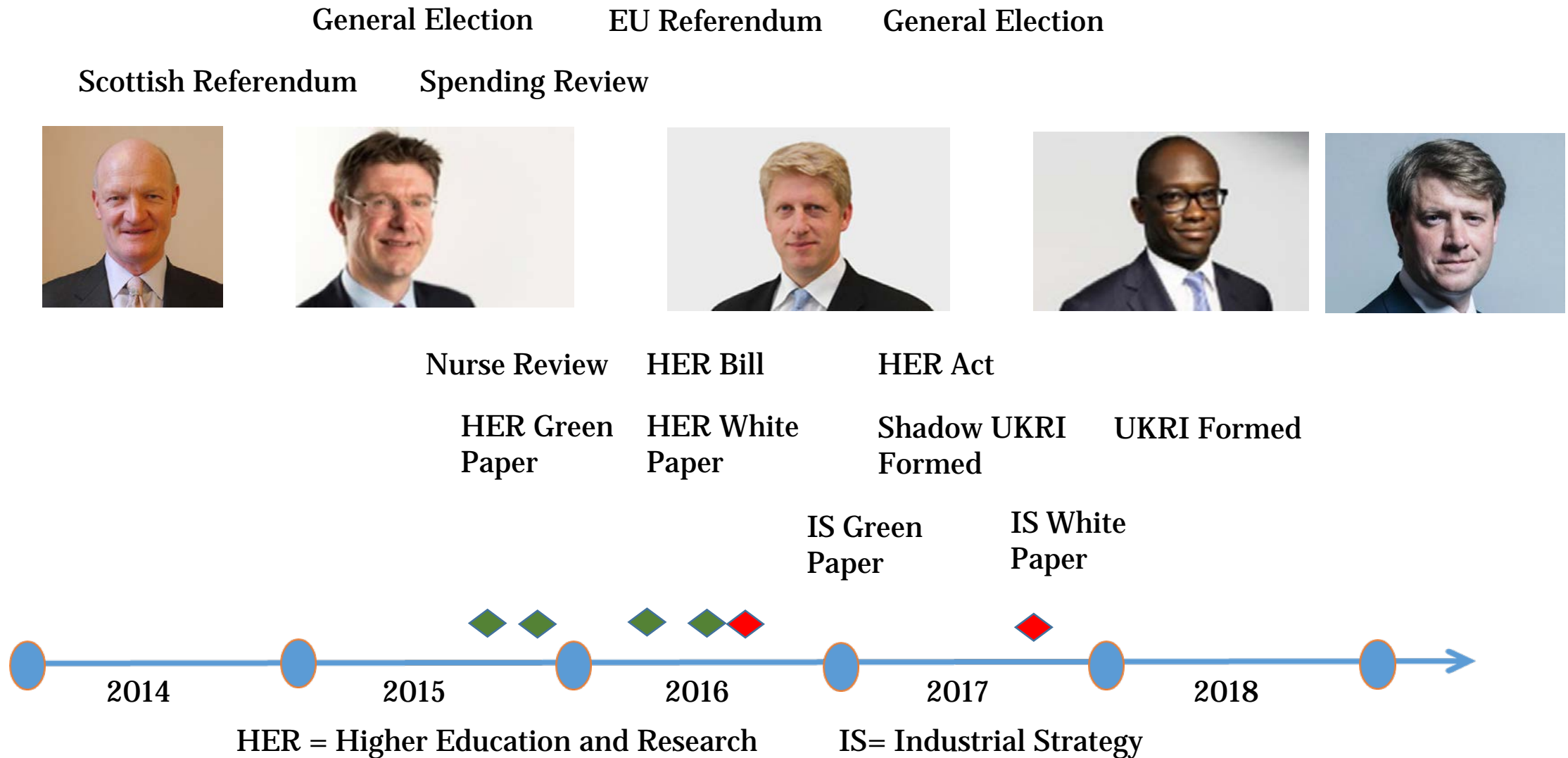
- Identified in the OECD Science, Technology and Innovation Outlook 2016
 - internet of things – big data analytics – artificial intelligence –
 - neuro-technologies – nano/microsatellites – nanomaterials –
 - additive manufacturing – advanced energy storage technologies –
 - synthetic biology – blockchain –

Some global changes in approach to funding policy

.....identified by the OECD Science, Technology and Innovation Outlook 2018:

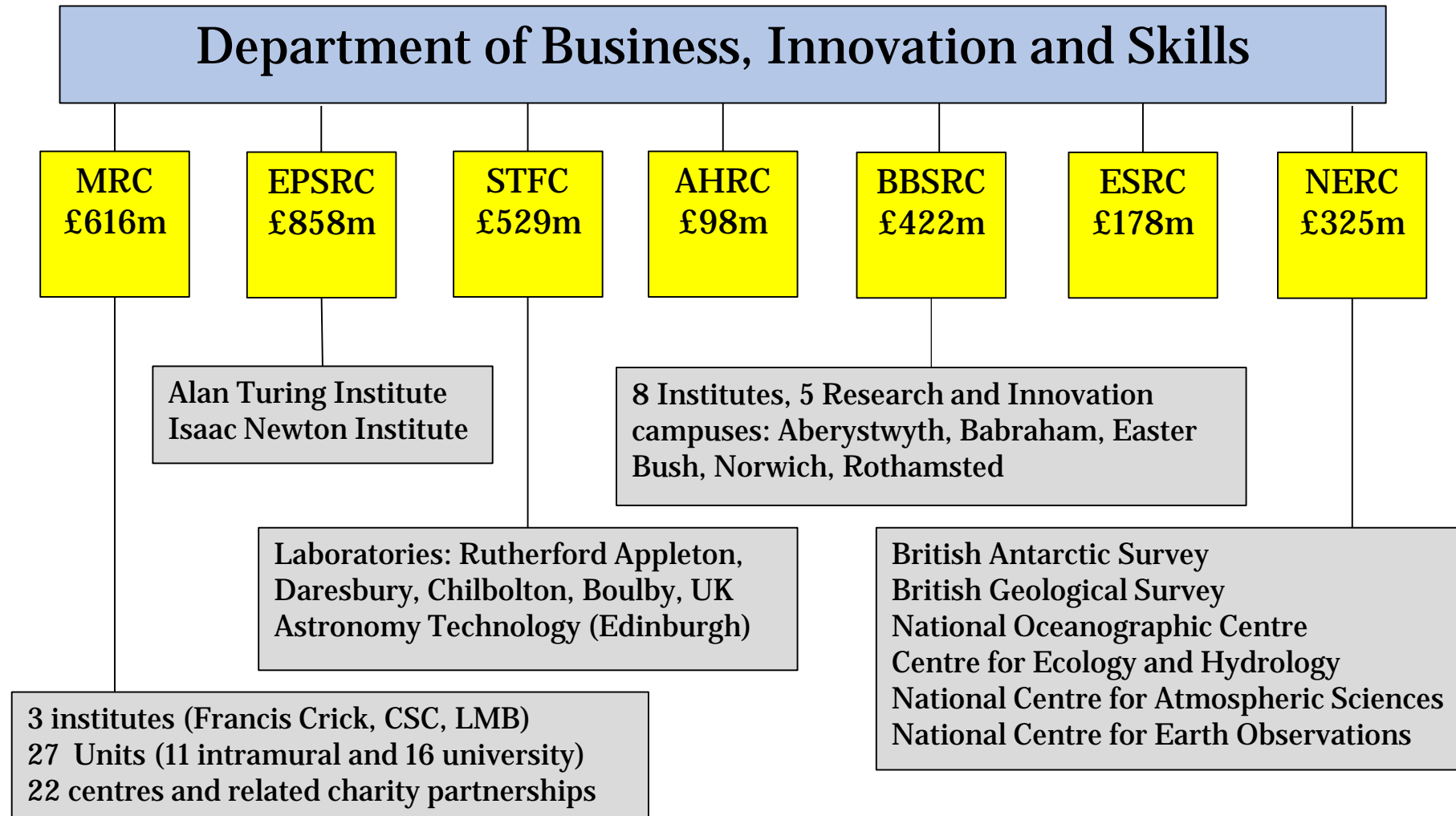
- Fiscal restraint and competing policy demands placing **pressure on government budgets**
- Growing importance, in some state systems, of **non-state funding** (charities, philanthropy)
- Growing share of public research performed by **emerging economies** (e.g. China)
- Reorientation of public science agendas towards **“grand societal challenges”**
- A turn towards more **challenge-driven public research**

Yes Minister!



UK Research Councils 2015

(Figures include resource and capital allocated from Science Budget for FY15/16)



The Nurse Review

Extract from evidence given by Sir Paul Nurse to House of Commons Select Committee on Science and Technology, 15th December 2015:

“What are we trying to achieve? We are trying to achieve independent research councils operating as they are, but with a cover that allows cross-cutting activities to be looked after more effectively. It is cross-cutting in the sense of both interdisciplinary and multidisciplinary work, grand challenges and a place where budgets can be properly discussed overall, in distribution between the different councils.”

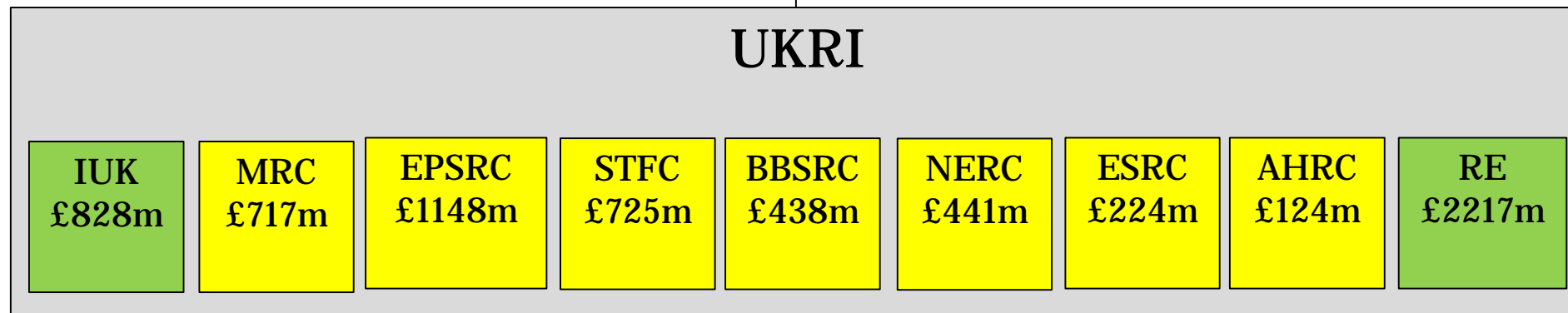
<https://www.gov.uk/government/publications/nurse-review-of-research-councils-terms-of-reference>

<https://www.gov.uk/government/collections/nurse-review-of-research-councils>



UK Research and Innovation

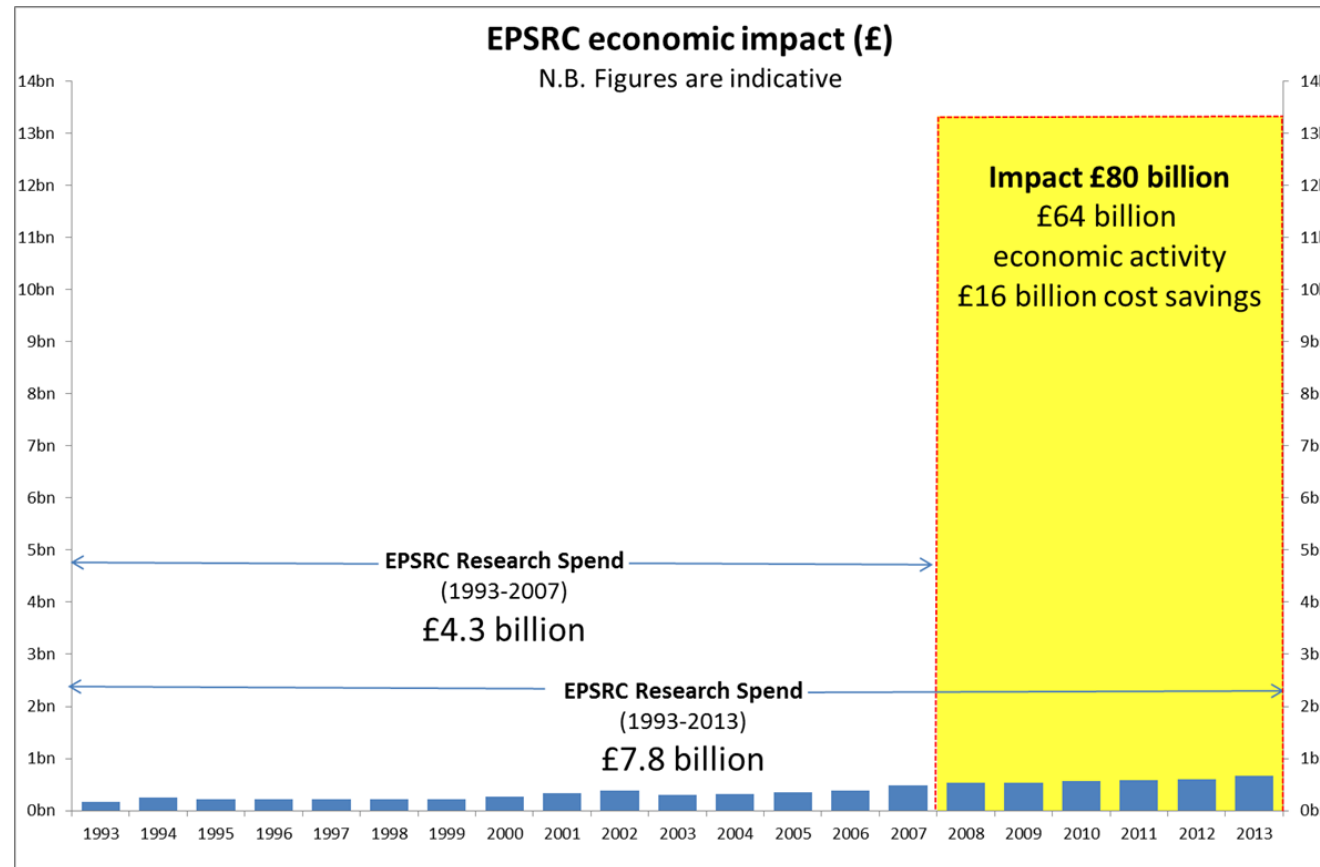
Department of Business, Energy and Industrial Strategy



Figures shown are allocations for FY 2018-19 taken from “The Allocation of Funding for Research and Innovation”, BEIS, July 2018. Note that allocations from new “cross-cutting” funds are included in the allocations to Councils.
<https://www.gov.uk/government/publications/research-and-innovation-funding-allocation-2017-to-2021>

IUK = Innovate UK, RE = Research England

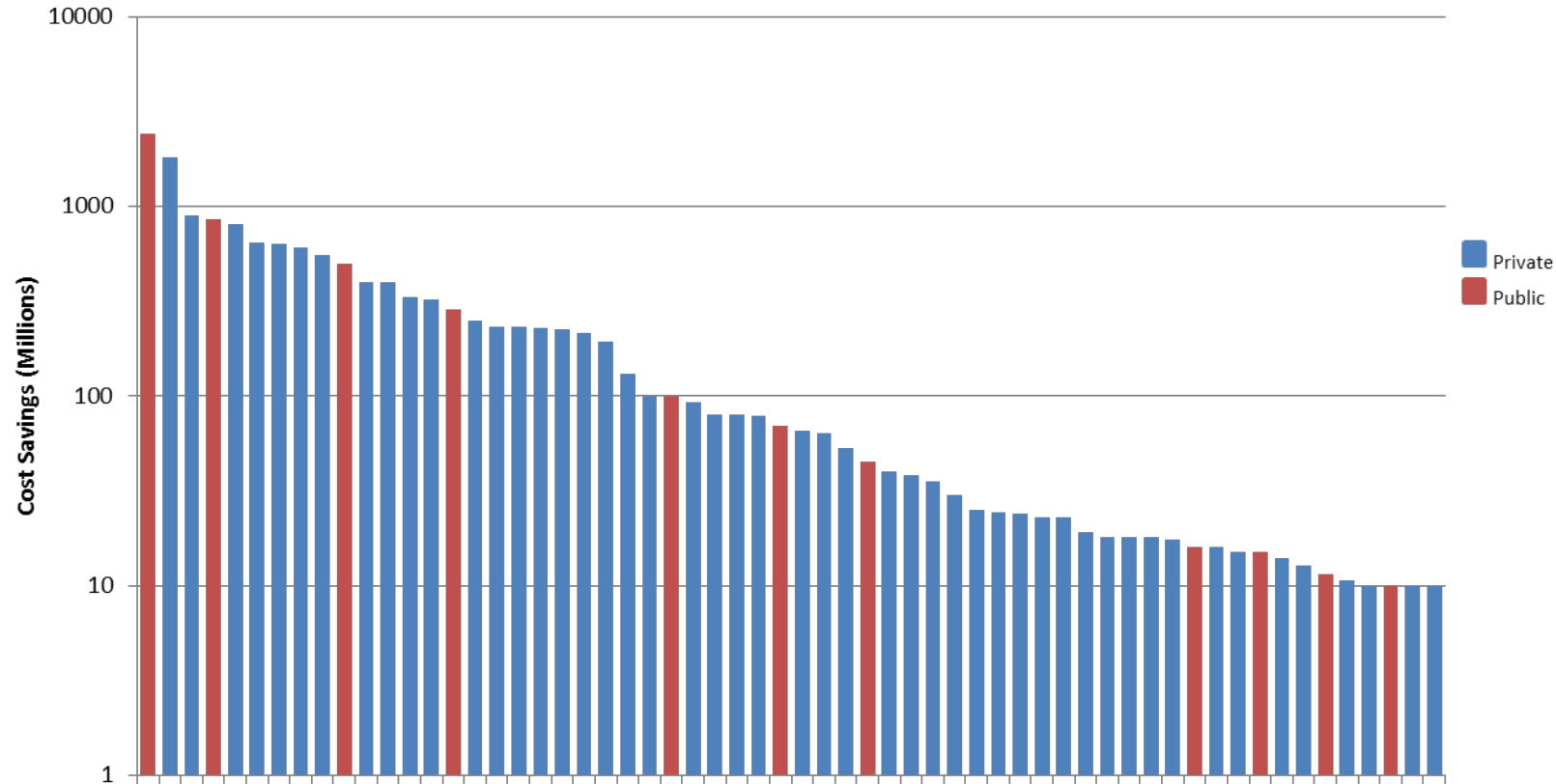
Analysis of REF 2014 impact case studies



Investing in excellence, delivering impact for the UK, EPSRC 2015 (Graphic courtesy of EPSRC)

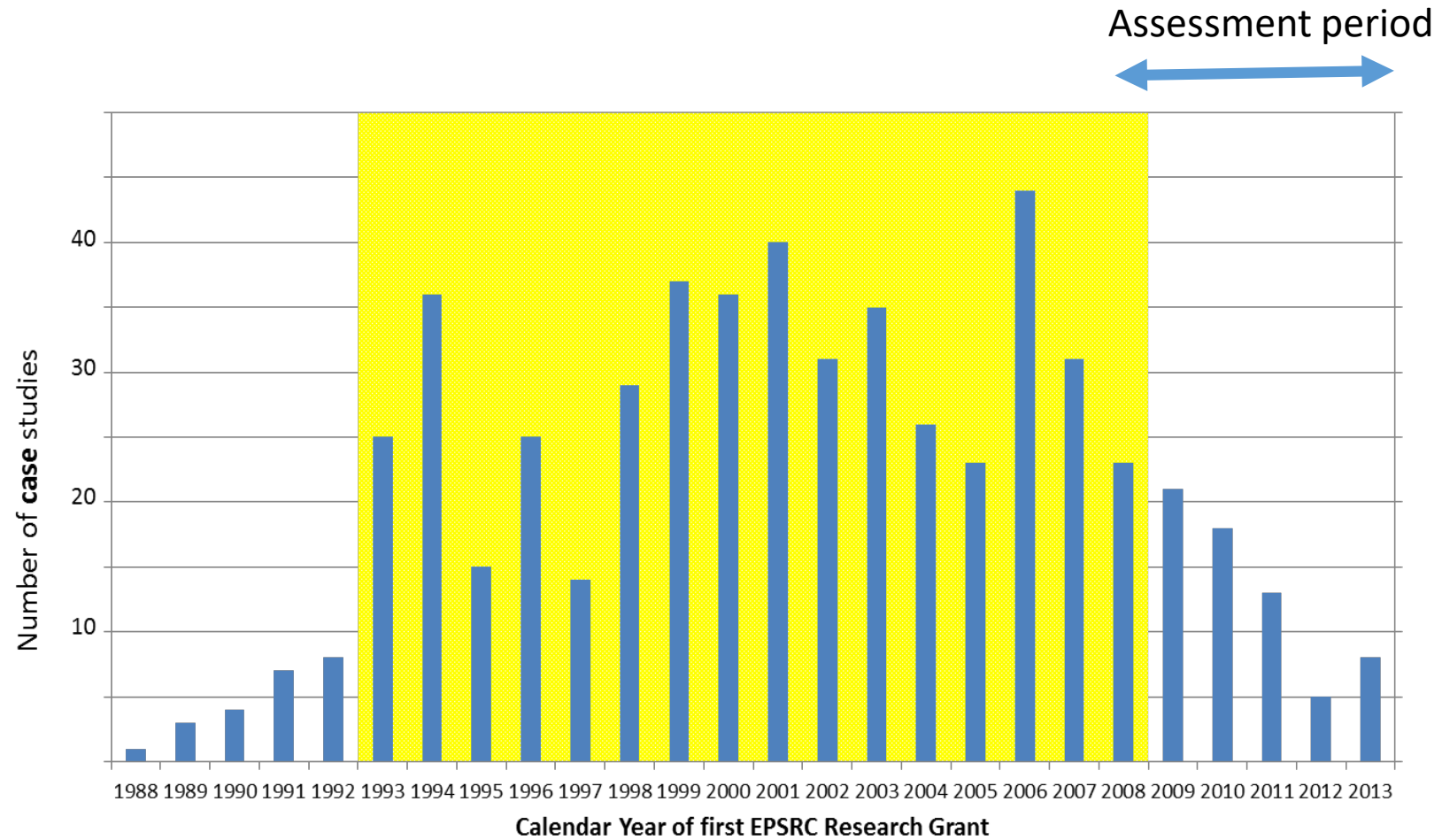
N.B. 1226 case studies examined. Total economic activity includes 394 new businesses (spin-out companies) created, of which 87% were active, collectively representing ~47,000 jobs and a contribution of ~£4 billion to the economy

Cost savings reported by 150 case studies



Investing in excellence, delivering impact for the UK, EPSRC 2015 (Graphic courtesy of EPSRC)

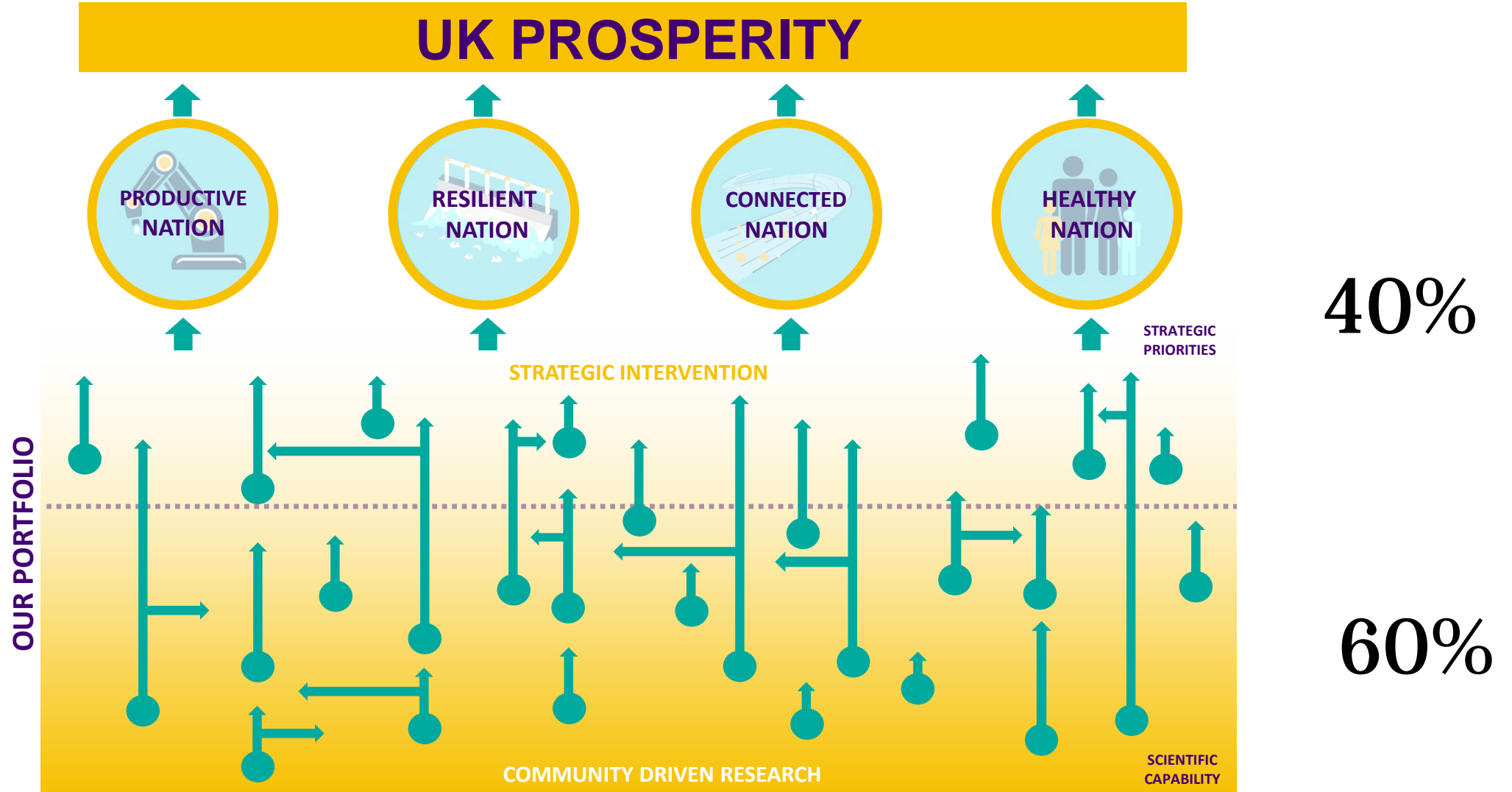
Time to impact



Investing in excellence, delivering impact for the UK, EPSRC 2015. (Graphic courtesy of EPSRC)

EPSRC Delivery Plan

(Currently under revision)



UK Industrial Strategy

White paper published November 2017

We will set Grand Challenges to put the United Kingdom at the forefront of the industries of the future:



AI & Data Economy

We will put the UK at the forefront of the artificial intelligence and data revolution



Clean Growth

We will maximise the advantages for UK industry from the global shift to clean growth



Future of Mobility

We will become a world leader in the way people, goods and services move

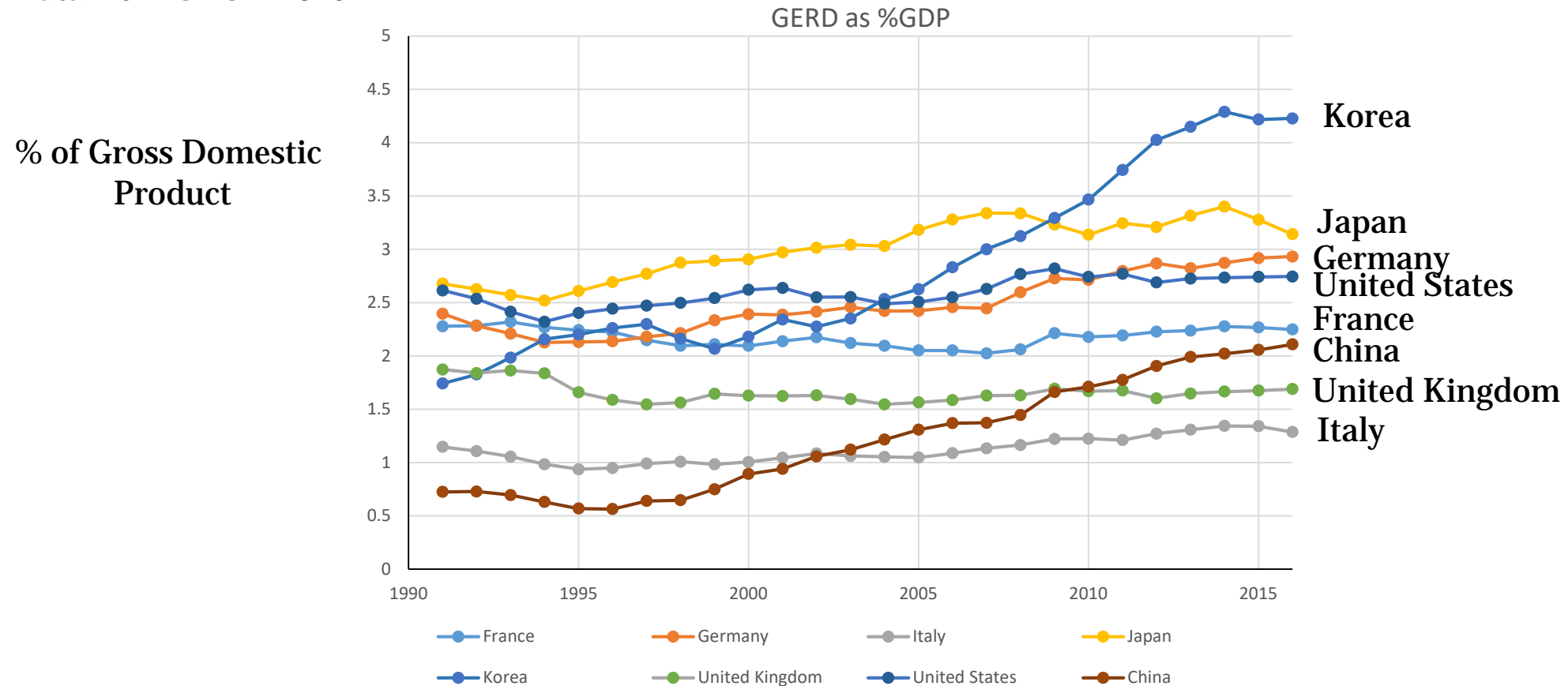


Ageing Society

We will harness the power of innovation to help meet the needs of an ageing society

Gross Expenditure on Research and Development

Data from OECD 2016



20th November 2017: “The government will work with industry to boost spending on R&D to 2.4 per cent of GDP by 2027.”
<https://www.gov.uk/government/news/record-boost-to-rd-and-new-transport-fund-to-help-build-economy-fit-for-the-future>

Funding allocations

Funding allocated to UK Research and Innovation (£m):

	2017-18	2018-19	2019-20	2020-21
Research and Innovation	4,906	4,848	4,818	-
National Productivity Investment Fund	385	650	1,003	952
Official Development Assistance	233	306	291	240
Science Infrastructure	857	1,016	882	931
Total	6,381	6,819	6,994	2,123

Figures shown are taken from “The Allocation of Funding for Research and Innovation”, BEIS, July 1018.
<https://www.gov.uk/government/publications/research-and-innovation-funding-allocation-2017-to-2021>

Funding allocations

New planning allocations from the National Productivity Investment Fund (NPIF) (£m)

	2017-18	2018-19	2019-20	2020-21
Industrial Strategy Challenge Fund	249	386	491	469
Talent	51	126	186	266
Fund for International Collaboration	-	10	45	55
Quality Related Funding	-	20	88	-
Commercialisation	55	93	97	116
Strength in Places	-	2	32	82
Other NPIF Programmes	67	132	226	166
To be allocated	-	70	344	862
Total	423	839	1,509	2,017

Figures shown are taken from “The Allocation of Funding for Research and Innovation”, BEIS, July 1018.

<https://www.gov.uk/government/publications/research-and-innovation-funding-allocation-2017-to-2021>

Industrial Strategy Challenge Fund: Wave 1

Investments announced April 2017



Leading edge healthcare £181m



Faraday battery challenge £246m



Robots for a safer world £93m



Driverless cars £38m



Manufacturing and future materials £26m



National satellite test facility £99m

See <https://www.ukri.org/innovation/industrial-strategy-challenge-fund/> for a full description of each challenge

Industrial Strategy Challenge Fund: Wave 2

Investments announced November 2017



Audience of the future £33m



**From data to early diagnosis
and precision medicine £210m**



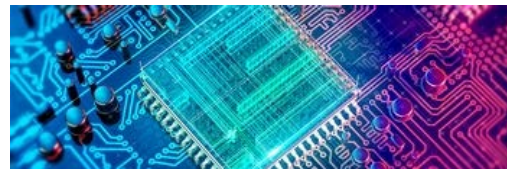
Next generation services £20m



Healthy ageing £98m



**Prospering from the energy
revolution £102m**



Quantum technologies £20m



**Transforming food
production £90m**



Transforming construction £170m

See <https://www.ukri.org/innovation/industrial-strategy-challenge-fund/> for a full description of each challenge

More Recent Announcements

Budget November 2018: £1.6bn increase in support for research and innovation including

- £1.1bn for ISCF including £121m for “Made Smarter” and £78m for the “Stephenson Challenge”
- £235m for Quantum Technologies (including £70m ISCF, £80m for extension of QT Hubs, £35m national centre for quantum computing)
- £150m global AI and future talent fellowships

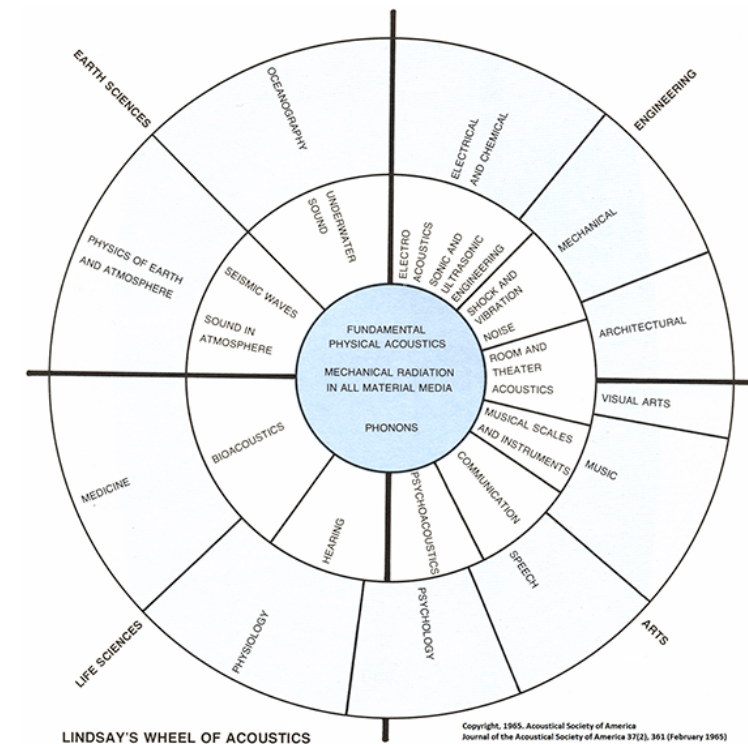
December 2018 announcements:

- £125m for “Future Flight” (ISCF)
- £15m EPSRC/MRC/BBSRC “Physics of Life” (Strategic Priorities Fund)

EPSRC Current Grants in “Acoustics”

At least ~60 current grants having a total value of over £50m (estimated of value of grants across all of UKRI ~£140m as at May 2017) classified under the following EPSRC Research Areas:

- Clinical Technologies (excl. imaging) (8)
- Control Engineering (4)
- Digital Signal Processing (16)
- Fluid Dynamics and Aerodynamics (5)
- Medical Imaging (13)
- Music and Acoustic Technology (11)
- Speech Technology (5)
- Structural Engineering (8)
- Vision, Hearing and other Senses (7)



See “Grants on the Web” <https://gow.epsrc.ukri.org/> (N.B. Grants may be classified in more than one research area)

Clean Growth



Some current EPSRC grants (from “Grants on the Web” <https://gow.epsrc.ukri.org/>)

[Passive vibration control of a floating hydrostatic transmission wind turbine and theoretical extensions](#)

[Dynamic Loadings on Turbines in a Tidal Array \(DyLoTTA\)](#)

[Characterising dynamic performance of fibre reinforced polymer structures for resilience and sustainability](#)

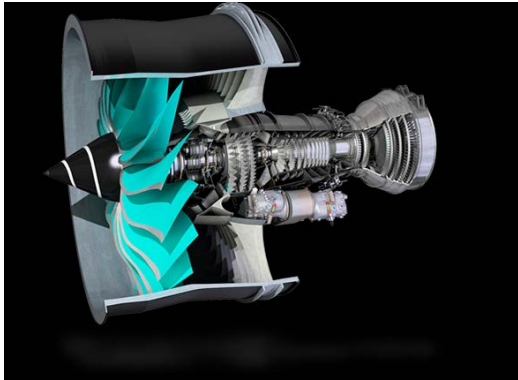
[An integrated physics-based and data-driven approach to structural condition identification](#)

[Structural Health Monitoring of Systems of Systems: Populations, Networks and Communities](#)

[Uncertainty Quantification and Management in Ambient Modal Identification](#)

[Listening to Infrastructure](#)

Future of Mobility



Some current EPSRC grants (from “Grants on the Web” <https://gow.epsrc.ukri.org/>)

[JINA: Jet Installation Noise Abatement](#)

[Quiet aerofoils of the next generation](#)

[Effect of Separation and Stall on Aerofoil Noise](#)

[Understanding and developing new noise reduction mechanisms for aerofoils in unsteady flow through the use of analytical Mathematics](#)

[Trackside Optical Fibre Acoustic Sensing \(TOFAS\)](#)

[The science and analytical tools to design long life, low noise railway track systems](#)

Artificial Intelligence and the Data Economy



Some current EPSRC grants (from “Grants on the Web” <https://gow.epsrc.ukri.org/>)

[Fusing Semantic and Audio Technologies for Intelligent Music Production and Consumption](#)

[Machine Learning for Hearing Aids: Intelligent Processing and Fitting](#)

[Acoustic Signal Processing and Scene Analysis for Socially Assistive Robots](#)

[Structured machine listening for soundscapes with multiple birds](#)

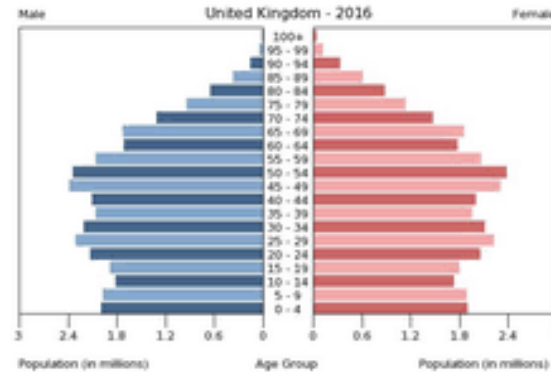
[Making Sense of Sounds](#)

[S3A: Future Spatial Audio for an Immersive Listener Experience at Home](#)

[SpeechWave](#)

[CALOPUS - Computer Assisted LOW-cost Point-of-care UltraSound](#)

Ageing Society



Some current EPSRC grants (from “Grants on the Web” <https://gow.epsrc.ukri.org/>)

[New pathways to hearing: A multisensory noise reducing and palate based sensory substitution device for speech perception](#)

[Towards a multisensory hearing aid: Engineering synthetic audiovisual and audiotactile signals to aid hearing in noisy backgrounds](#)

[Towards visually-driven speech enhancement for cognitively-inspired multi-modal hearing-aid devices \(AV-COGHEAR\)](#)

[Ultrasonic neuromodulation of deep grey matter structures for the non-invasive treatment of neurological disorders](#)

[Therapy Ultrasound Network for Drug Delivery & Ablation Research \(ThUNDDAR\)](#)

[ULTRASPINE: Ultrasound-Enabled Minimally Invasive Disc Replacement](#)

[Maximising cavitation to clean dental implants](#)

Some thoughts on the future (to stimulate discussion!)

- Future systems for mobility will require concerted efforts in acoustics (e.g. future flight) and dynamics (e.g. lightweight structures)
- The ageing population will continue to drive advances in biomedical applications, (and an associated increase in hearing difficulties seems inevitable)
- Speech and hearing provide a vital human interface to AI systems and are thus key to realising the potential of the digital age (including virtual reality etc.)
- There may be some solutions to “old problems” provided by new AI/ML technologies (e.g. retrieving signals from noise, blind signal separation etc.)
- The Internet of Things can provide unprecedented access to acoustical data (e.g. environmental and condition monitoring)

Conclusions

- The UK government has made a welcome commitment to increase gross expenditure on R&D to 2.4% of GDP
- The formation of UKRI should enable more opportunities for interdisciplinary working
- There is a global trend towards “mission led” approaches to “grand challenges”
- UK research in acoustics is in good health and already contributing to the solution of many such challenges

- *It will be important to continue to facilitate “investigator-led” research, (which very often pre-empts “top-down” strategies!), but awareness of the “big picture” is likely to be increasingly important in applications for funding*