

Science Landscape Seminar Reports: Energy

Background to the meeting

This seminar is one of a series convened by the [Council for Science and Technology \(CST\)](#), which is working to provide a map of the UK Knowledge Landscape as a whole. This mapping includes all areas of research carried out by academia, industry, charities and others.

The seminar series has brought together diverse sets of experts to discuss eight parts of the research landscape in depth; these areas are roughly aligned with the [UK government's eight great technologies](#).

The aim of this work is to provide decision makers with a clearer picture of the whole landscape and enable better strategic decisions to be made. We would also like the reports to prompt communities to think more about what they can do to ensure their areas continue to make the best case for themselves and operate in a coherent way. The seminar series is limited in scope, but has revealed the importance of a clear articulation of the strengths and requirements of different parts of the UK research landscape. Specific research communities may wish to hold further sessions of their own.

The discussion took place under the Chatham House rule. This document represents the views of this group at the seminar and is published alongside an infrastructure resource (see below) which reflects the seminar's view of the energy landscape.

This meeting addressed energy research and development, and was asked to consider:

- Strengths and weaknesses of energy research in the UK;
- How the UK compares internationally; and
- What future concerns exist for the discipline.

1. Infrastructure list

To seed discussion, attendees were provided with a draft list of infrastructure relevant to energy. The list is not exhaustive but does provide a summary of some of the key facilities for energy research in the UK. It was updated in the light of discussion at the seminar to include, for instance, some key networks and infrastructure manufacturers. The infrastructure list is available at: www.gov.uk/government/publications/science-landscape-seminar-energy.

2. The energy research landscape

The energy landscape is complex and made up of many disparate parts. Attendees felt that there are a number of structural barriers to collaboration including: the

fragmentation between certain technology areas; a regulatory framework which can inhibit cross-sectoral communication; and differences in public opinion as to the appropriate direction of energy policy.

Research activity in the sector often centres on resolving the 'energy trilemma'. The term was coined by the World Energy Council to refer to the need to have secure energy supplies and cater to rising demand without prices becoming unaffordable, while producing sufficient energy in an environmentally sustainable way. Research takes a number of different directions as it tackles the three dimensions of the trilemma: this can make it difficult for the sector to coalesce around distinct global challenges.

3. Strengths and weaknesses in UK energy research

It was felt that the UK has a good diversity of energy expertise and, as with many other research areas, punches above its weight in academia (including research ranking, number of universities in the top 100 globally, and number of journal and patent citations). Seminar participants identified the following specific areas of strength:

- Global targets for emission levels have driven growth in clean energy research and development and approximately 15% of the UK's electricity now comes from renewable sources compared with a starting point of around 2%.
- The UK has strong nuclear capability and is considered one of the world's top five nuclear nations. We are amongst a few nations who have managed to "close the nuclear fuel cycle", and have the expertise to dispose of spent nuclear fuels. Our strength in nuclear is underpinned by world leading facilities such as National Nuclear Laboratory (NNL) and UK Atomic Energy Authority (UKAEA).
- There are a number of specific energy research areas where the UK is very strong, including: electrochemistry, carbon capture and storage, energy generation, offshore wind technology, offshore oil and gas engineering (which has extended the lifespans of North Sea oil and gas fields) and excellent tidal energy capabilities.
- Testing and development facilities such as Wave Hub off the north coast of Cornwall and the European Marine Energy Centre (EMEC) in Orkney are world leading. This is an area of real opportunity and could make a sizeable contribution to the UK's future energy mix.
- The UK has expertise in a number of STEM disciplines which can be applied right across the energy sector. Expertise in robotics could reduce manufacturing costs in the supply chain; advanced materials that can tolerate high temperatures could transform energy efficiency in power stations; superconductivity may change the energy transmission sector; and digital technologies could be used to increase innovation on the demand side via smart systems.

Despite the strengths, seminar participants mentioned several areas of energy research where there is scope for improvement:

- There needs to be a stronger focus on developing technologies which will help reduce demand. Worthwhile gains could be made by finding ways to

reduce demand through research into improving energy efficiency, the use of behavioural science to nudge consumer behaviour, better understanding of systems complexity, and the development of new storage technologies.

- There is a lack of large scale test facilities for demonstrating and modelling innovative new technologies. The impact of this is that UK researchers cannot easily scale up their research. At the moment the only real option is to use facilities in other countries including Switzerland, Belgium, Sweden and Australia.
- There could be greater collaboration between industry, academia, cities and local authorities to demonstrate and trial local solutions to energy challenges. Systems for fuels for transport, energy efficient housing and smart systems could be installed at a local level.
- The UK needs to improve its ability to ensure that research outputs are able to move up through the technological readiness levels (TRLs) and get new products and innovations to market. This difficulty is often accompanied by an “entrepreneurial gap” where academics are motivated only to chase the areas that have already had some investment and are therefore promising.
- It has sometimes been difficult to attract large investments for innovation in the UK energy sector. Rates of return may not be competitive or generate the income that multinationals want to see. This can entice these firms to conduct their research activities elsewhere.
- Despite a large number of coordinating bodies, industry groups and research collaborations, there is a lack of consensus on the principal energy grand challenges the UK should be tackling. Attendees suggested a number of potential unifying challenges including:
 - a long-term aim of a low carbon economy;
 - solving the engineering challenges that are currently barriers, for example, the cost of off-shore wind; and
 - (low carbon) energy storage, improvements to which were seen as potentially game-changing.

4. Skills

The UK needs to ensure it has sufficient people with the right mix of skills in the energy sector.

A number of points were made in discussion:

- There is a need for ever more people with STEM skills across the energy sector, and it is encouraging that the number of students studying these subjects continues to increase. The sector could be more proactive in attracting highly skilled researchers, especially from engineering, mathematics and chemistry. It is also important to be forward-thinking, consider what future energy users will want from research, and develop the next generation of skills accordingly.
- STEM skills need to flow between sectors, and experts need pathways to move their expertise to other areas of the economy. There is an ageing

workforce in some parts of the sector: there is a risk of losing a body of expertise which needs to be built up over 15-20 years and cannot be replaced easily with new trainees.

- Although some progress has been made, more can be done to encourage a more diverse range of people to take up study and employment in the energy sector.
- There is a specific shortage of electrical engineers, mechanical engineers and power engineers, due to both a lack of take-up of these subjects and demand for them in other disciplines.
- There also needs to be clearer focus of technicians, and those trained to Masters level.

5. Future direction for the sector

The seminar concluded with a short discussion of what future direction might be set for the sector. The following issues were raised:

- The energy landscape is diverse and some areas are very joined-up, collaborate well and understand their reason to be. Other areas are much more disparate and work together in only a limited way. These communities would be well-served by coming together more effectively and developing a set of grand challenges that they could achieve critical mass around. This sort of working has been a success in robotics and autonomous systems, particle physics and aerospace research.
- It would be helpful to find strong incentives for commercial ventures and entities to join up. This is unlikely to happen otherwise.
- It may be useful to look at the priorities that are emerging from the International Panel on Climate Change (IPCC's) work to identify areas where UK research could be world-leading.
- The energy sector could look to aerospace for inspiration. The aerospace sector also competes very strongly but, despite this, has been able to work together to good effect in recent years.
- There needs to be a more sophisticated approach to the levers that might be used to reward people (and companies) for using less energy. At present many incentives work by encouraging individuals to generate more, rather than use less, energy.
- It would be advantageous to think about what choices can be made with respect to energy research. In particular, it would be good to consider what areas the UK could choose to excel most in. Seminar participants were careful to note that making research choices is not the same as "picking winners", a phrase that was generally felt to be unhelpful.



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