Research Councils UK Energy Programme Strategy Fellowship

Energy Strategy Fellowship Report 5

Summary of Synthesis Workshop

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Research Councils Energy Programme

The Research Councils UK (RCUK) Energy Programme aims to position the UK to meet its energy and environmental targets and policy goals through world-class research and training. The Energy Programme is investing more than £625 million in research and skills to pioneer a low carbon future. This builds on an investment of £839 million over the period 2004-11.

Led by the Engineering and Physical Sciences Research Council (EPSRC), the Energy Programme brings together the work of EPSRC and that of the Biotechnology and Biological Sciences Research Council (BBSRC), the Economic and Social Research Council (ESRC), the Natural Environment Research Council (NERC), and the Science and Technology Facilities Council (STFC).

In 2010, the EPSRC organised a Review of Energy on behalf of RCUK in conjunction with the learned societies. The aim of the review, which was carried out by a panel of international experts, was to provide an independent assessment of the quality and impact of the UK programme. The Review Panel concluded that interesting, leading edge and world class research was being conducted in almost all areas while suggesting mechanisms for strengthening impact in terms of economic benefit, industry development and quality of life.

Energy Strategy Fellowship

The RCUK Energy Strategy Fellowship was established by EPSRC on behalf of RCUK in April 2012 in response to the international Review Panel's recommendation that a fully integrated 'roadmap' for UK research targets should be completed and maintained. The position is held by Jim Skea, Professor of Sustainable Energy in the Centre for Environmental Policy at Imperial College London. The main initial task is to synthesise an Energy Research and Training Prospectus to explore research, skills and training needs across the energy landscape. Professor Skea leads a small team at Imperial College London tasked with developing the Prospectus.

The Prospectus will contribute to the evidence base upon which the RCUK Energy Programme can plan forward activities alongside Government, RD&D funding bodies, the private sector and other stakeholders. The tool will highlight links along the innovation chain from basic science through to commercialisation. The tool will be flexible and adaptable and will take explicit account of uncertainties so that it can remain robust against emerging evidence about research achievements and policy priorities.

One of the main inputs to the Prospectus is a series of four high-level strategic workshops and six in-depth expert workshops, which took place between October 2012 and July 2013. Following peer-review, the first version of the Prospectus will be published in November 2013 and will then be reviewed and updated on an annual cycle during the lifetime of the Fellowship, which ends in 2017.

This document reports views expressed at a strategy-level Synthesis Workshop held in July 2013. Views expressed are noted by the Fellowship team but not all will necessarily be endorsed in the final version of the Energy Research and Training Prospectus.

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Executive Summary

This report describes the outcomes of the Synthesis Workshop held at Imperial College London on 15 July 2013. The workshop was the fourth in a series of 'strategic' workshops held under the auspices of the RCUK Energy Strategy Fellowship. The main aim of the Fellowship is to develop an **Energy Research and Training Prospectus**, which will help the Research Councils to plan their portfolio of research and training in the energy field. The Synthesis Workshop picked up on four priority themes identified in previous workshops: the role of the Research Councils in the UK energy innovation system; postgraduate training; public engagement; and how to make best use of the UK's 'networked' energy research structures.

1. The opening session introduced the workshop and the wider process within which it fitted. Emerging findings from the preceding strategic and expert workshops were presented.
    a. **Strategic workshops**. In considering 'desirable' versus 'likely' UK energy futures, people's expectations had fallen well short of their aspirations for the deployment of low-carbon technologies. There existed continuing weaknesses in the support of interdisciplinary energy research activities, although the situation had improved somewhat. A balance between 'use-inspired' and 'science-inspired' research was needed. Additionally, establishing feedback loops from application to basic research was essential.
    b. **Expert workshops**. The six workshops had identified important messages in relation to: the role of the Research Councils; research 'style'; infrastructure and facilities; data collection and curation; policy and wider links; industry links; and training needs.
2. The session on **the role of the Research Councils in the UK energy innovation system** considered how research agendas might be defined, touching on issues such as the utility of the 'Technology Readiness Level' (TRL) concept for the Research Councils, the importance of long-term fundamental research and the value of horizon scanning. Participants rejected the idea of a 'hand-over' from the Research Councils to funding bodies operating further along the innovation chain, emphasising the need for a two-way process. Differences between Research Councils in terms of their support for more applied research were also noted. Benefits for the UK could be maximised through common metrics for measuring success and improved co-ordination mechanisms.
3. Participants emphasised the value of a balance between **PhD training models** in the energy field. Centres for Doctoral Training (CDT) could be combined with project studentships and studentships allocated to university departments. Other recommendations related to the balance between depth and breadth in PhD training, the balance between encouraging teamwork and independent working, the need to build communities of PhD students both within and across institutions, and the role of industry/policy placements in enhancing career prospects.
4. **Public engagement** was seen to have two sets of aims. The first refers to the public 'looking in' towards the scientific research process, whilst the second refers to researchers 'looking out' towards audiences where their work had some potential relevance. Additionally, it was emphasised that public engagement is a two-way process. Further discussion points and recommendations related to: the role of wider stakeholders in setting and developing research agendas; communication of findings; and processes for engagement and working with key intermediaries.
5. The UK no longer has large energy research centres and relies instead on networking between universities and industry. Reflecting on these existing arrangements, participants considered **how the UK might make the best of its energy innovation system**. The topics discussed included: EU and international engagement; infrastructure and field trials; data collection and curation; and interdisciplinarity. A key theme running through the discussions was that good science may need to be underpinned by longer-term perspectives that run beyond conventional budgetary timescales.
6. The degree of **independence of the Research Councils** from the policies of the government of the day (c.f. the Haldane Principle) was also discussed.

Acronyms

BBSRC	Biotechnology and Biological Sciences Research Council
BGS	British Geological Survey
BIS	Department of Business, Innovation and Skills
BSBEC	BBSRC Sustainable Bioenergy Centre
CASE	Collaborative Awards in Science and Engineering
CERN	European Organization for Nuclear Research
CCS	Carbon Capture and Storage
CDT	Centre for Doctoral Training
DECC	Department of Energy and Climate Change
DEFRA	Department for Environment, Food and Rural Affairs
DOE	Department of Energy (US)
EERA	European Energy Research Alliance
EngD	Engineering Doctorate
EPSRC	Engineering and Physical Sciences Research Council
ESRC	Economic and Social Research Council
ETI	Energy Technologies Institute
GDP	Gross Domestic Product
HEFCE	Higher Education Funding Council for England
ICT	Information and Communication Technologies
IP	Intellectual Property
ISIS	Pulsed Neuron and Muon Source
KTN	Knowledge Transfer Network
LCICG	Low Carbon Innovation Co-ordination Group
NERC	Natural Environment Research Council
NGO	Non-governmental Organisation
PI	Principle Investigator
POST	Parliamentary Office of Science and Technology
PV	Photovoltaic
RAL	Rutherford Appleton Laboratory
RCUK	Research Councils UK
RDD&D	Research, Development, Demonstration and Deployment
REF	Research Excellence Framework
SMC	Science Media Centre
SME	Small to Medium Sized Enterprise
STFC	Science and Technology Facilities Council
SUPERGEN	Sustainable Power Generation (EPSRC-supported consortium)
TRL	Technology Readiness Level
TSB	Technology Strategy Board
UKCCSRC	UK Carbon Capture and Storage Research Centre
UKERC	UK Energy Research Centre

1. Introduction

This report describes the outcomes of the Synthesis Workshop held at Imperial College London on 15 July 2013. The workshop was the fourth in a series of 'strategic' workshops held under the auspices of the RCUK Energy Strategy Fellowship. The main aim of the Fellowship is to develop an **Energy Research and Training Prospectus,** which will help the Research Councils to plan their portfolio of research and training in the energy field. The Synthesis Workshop picked up on four priority themes identified in previous workshops: the role of the Research Councils in the UK energy innovation system; postgraduate training; public engagement; and how to make best use of the UK's 'networked' energy research structures.

2. Opening session

2.1 Introduction

During the opening session, the Strategy Fellowship team described the background to the workshop and introduced the day's activities. These covered four topics: the background to the Energy Strategy Fellowship; emerging conclusions from preceding 'strategy' workshops; preliminary conclusions from preceding 'expert' workshops; and the conduct of the synthesis workshop.

2.2 Background to the Fellowship

Jim Skea (Energy Strategy Fellow) made a presentation outlining the background and rationale for the RCUK Energy Strategy Fellowship and the activities being undertaken. He noted the role of the Prospectus in informing the future design of the RCUK's Energy Programme. The presentation covered the following points:

- The recommendations of the International Panel for the 2010 RCUK Review of Energy.
- The conclusions regarding the high quality of the science tempered by concerns about links to policy and follow-through to commercialisation.
- The vision for the Energy Research and Training Prospectus under development by the Fellowship Team.
- The programme of strategic and expert workshops and light-touch reviews being conducted.
- The purpose of the expert workshops and the process which through the workshop outputs would be translated and synthesised for the prospectus document.

2.3 Emerging conclusions from strategy workshops

Aidan Rhodes summarised the outcomes of the preceding 'strategy' workshops.

The first workshop, **Energy Strategies and Energy Research Needs**, had highlighted a gap between participants' aspirations for an ideal energy system in 2050 which met the UK's climate objectives and the system they expected to emerge. The deployment of technologies associated with the low-carbon agenda was anticipated to be lower than aspirations and the deployment of incumbent technologies correspondingly greater. The example of electricity generation technologies was presented, with unabated gas expected to play a larger role than would be desirable, while technologies such as offshore wind would play a lower role. Participants had also assessed the range of energy technologies in terms of their relevance to future UK energy, the UK's industrial capabilities relative to competitors and the UK's scientific capability. In areas such as **oil and gas** and **energy systems analysis** the UK scored very highly.

The second workshop**, The Role of Environmental Science, Social Science and Economics**, was less easy to summarise but participants had believed that the UK academic incentive system did not encourage interdisciplinary working. There was also a belief that energy research was currently focused too much on 'kit' and did not pay enough attention to human behaviour.

The third strategy workshop, **The Research Councils and the Energy Innovation Landscape**, had used two case studies**, marine renewables** and **molecular photovoltaic (PV)**, to exemplify respectively 'use-inspired' and 'science-inspired' research areas. Participants noted the needs for: stronger mechanisms for feeding back findings from later stages in the innovation process to basic research projects; adaptable and flexible testing facilities; ensuring spin-out companies can understand and access their potential markets; and clear policy signals and market regulations.

2.4 Emerging conclusions from expert workshops

Matthew Hannon provided a preliminary assessment of the outcomes of the six preceding 'expert' workshops. The assessment represented a 'work in progress' and the conclusions would be further refined during the process of drafting the prospectus documents. The outcomes were grouped into the following seven cross-cutting themes:

- the role of the Research Councils;
- research 'style';
- infrastructure and facilities;
- data collection and curation;
- policy and wider links;
- industry links; and
- postgraduate training.

2.5 Role of the synthesis workshop

Jim Skea described how the agenda for the current workshop had been developed with input from the Energy Strategy Fellowship's Advisory Group. The Fellowship team had proposed a range of possible workshop topics which the Advisory Group had whittled down to four:

- the role of the Research Councils in the UK energy innovation system;
- research training;
- energy research and public engagement; and
- making the best of the UK energy innovation system.

The choice of the latter subject was prompted by the fact that the UK no longer had large energy research centres and relied instead on networking between universities and industry, which is typically the responsibility of researchers. The key question was how the UK could build on current arrangements to derive the benefits of a more centralised system.

The four topics would be discussed in two successive parallel sessions (see Annex A). Participants were free to choose which sessions they wish to participate in.

2.6 Discussion

The opening session concluded with a short discussion.

There was discussion as to whether certain types of research had been 'left to industry'. This had emerged especially from the **fossil fuels and CCS** expert workshop where participants believed there had been a particularly large knowledge gap between the public and private sectors. It was noted that whilst the Research Councils supported more basic research, parts of the system (e.g. the British Geological Survey (BGS - part of NERC)) were directly engaged with industry. It was noted that academic/industrial collaboration is not just a paper exercise and that there is a critical need for industry and academic to work alongside one another.

Some felt that we needed to move **beyond interdisciplinarity** (e.g. through working in partnership on shared problems). This topic had permeated all the previous expert workshops. Catapult centres may help fulfil this need. Secondments could also help move 'beyond interdisciplinarity'.

The challenge of **data-sharing** was highlighted. It is rarely a two way process since everybody likes to receive data but few are willing to share.

Some participants wanted to address **Masters level training**, as these degrees acted as a pathway into UK energy research.

There was a discussion regarding **'fast-track funding' to support policy needs**. Burning issues require quick answers and political timeframes are much shorter than those in academia. Questions were raised as to whether there was a role for Research Council supported research in this arena. Do we need a structure in place to help facilitate this kind of research within the academic community or are the consultancies that typically undertake this research actually better placed to do this? It was noted that longer grants can provide flexibility for people to respond on shorter timescales, obviating the need for new funding calls.

The idea of the Research Councils conducting **independent horizon scanning** exercises was raised.

3. Session 2a: The role of the Research Councils in the UK energy innovation system

In addressing the role of the Research Councils, participants considered four main points:

- How should research agendas be defined?
- Where is the hand-over to other innovation bodies (Energy Technologies Institute (ETI), Technology Strategy Board (TSB), Department of Energy and Climate Change (DECC) etc.)?
- Should this be the same across all aspects of energy?
- What processes are needed to maximise benefits for the UK?

How should research agendas be defined?

To begin the group considered the use of Technology Readiness Levels (TRLs). They acknowledged that they work well in certain technology-heavy areas (e.g. components) but not so well in all areas of energy research (e.g. energy systems). They explained that TRLs take a particular approach (research to commercialisation) that is inappropriate for some areas. For instance, modelling, simulation and policy cannot be adequately described by TRLs.

There is a danger in defining a research agenda too tightly so that it becomes a process of **picking winners**. However, this process, either conscious or unconscious, was seen as an inevitability of research funding. As discussed in Strategy Workshop 3, energy research can broadly be divided into two motivations, one from industry or policy 'pulling' the research along to meet a perceived need, and one from science 'pushing' research from promising fundamental breakthroughs.

Horizon scanning is a powerful tool and a lot of value can be derived from looking at exciting bits of fundamental research and using them to develop more applied research agendas. Should this be carried out by the Research Councils by themselves, or in collaboration with industry and government? Several members of the group agreed that a combined approach is better, identifying STFC's work in this area as an example. The UK's strength in research needs to be combined with perceived market opportunities to prevent a bias towards 'science push'. However, it was argued that whatever systems of horizon scanning are developed, that they should take into account the variety of stakeholders in different sectors (e.g. nuclear; energy demand etc.). Different stakeholders will have different insights regarding what research could or should deliver. Horizon scanning should be sector specific and sensitive to stakeholder networks in specific sectors.

The speed of deployment varies by technology and sector. For example, Information and Communication Technologies (ICT) develop very quickly, whereas conventional energy technologies have not changed greatly since after the Second World War. In energy research, there is a need therefore to look beyond what the government of the day deems to be a priority, and a more long-term approach. Some level of independence needs to be maintained, though there must be room to be steered somewhat by government.

The single-discipline versus inter-disciplinary approach is also important for energy horizon scanning. Fundamental research from disciplines outside the traditional energy research sectors could feed into significant breakthroughs in energy research, and these more fundamental research topics should be assessed to see how they might inform the energy research agenda. Unexpected synergies and exciting breakthroughs could result.

Long-term fundamental research provides the knowledge base for future research. The work of the BGS was given as an example, highlighting that the fundamental work it has conducted in surveying the UK's geology was crucial when asked by the Government to provide an assessment of shale gas resources. A recent review of NERC centres concluded that this fundamental research was important. However, it was felt that the research councils tended to view long-term research as pedestrian and sufficiently innovative, and that the Research Councils typically looked to fund new projects rather than continue existing ones that could provide valuable insight via longitudinal data collection and analysis. Additionally, industry and government tend to take a shorter-term view and consequently are not interested in funding long-term fundamental research. As such the UK is lacking insight into some fundamental aspects of the energy sector. For example, there had been no long-term national survey of energy use and the key factors that are responsible for impacting upon this, meaning little is known about the level of heat loss through an average solid brick wall or what the average ventilation rate of UK homes is.

Where is the handover to other innovation bodies?

Participants objected to the formulation of this question, highlighting that there was a **two-way link** between basic research and further demonstration and commercialisation and was therefore not a one-way handover. A distinction needs to be made between the handovers of system-level research versus technical research. Systems research tends to stay within the academic sphere. Different research areas have different types of overlap between basic and applied research.

Consultants can only use data that is available to derive their conclusions. Therefore, the Research Councils should make a regularly updated evidence base available to help inform decision making. A 'match-making' funding mechanism is lacking whereby policy-makers can contract academics for shorter-term research projects to inform quick decisions.

The TSB Catapult centres intend to link industry and academic research but do not as yet appear to have established strong links with the Research Councils. The Catapults may do a good job in shaking up the traditional TRL approach to Research, Development, Demonstration and Deployment (RDD&D), so that industry feedback on challenges can feed back to academic research.

How should academics present information to policy-makers? Policy-makers do not typically read academic papers, often due to lack of access or interest. One way of addressing this would be to provide them with subscriptions to access such literature, as well as organisational incentives to read this literature as part of their policy making process.

It is also important to look at the incentive framework for academics to engage with and inform policy makers. Whilst some incentives have been incorporated within the current academic reward system (e.g. changes to the Research Excellence Framework (REF) to take account of impact on policy making), direct incentives for engagement with policymakers are insufficient. Three options were identified, to establish:

1. Approximately ten prestigious five year Senior Academic DECC Fellowships. These would be awarded only to PIs with strong, historic track records of Research Council funded research in centres of excellence and would buy out a significant proportion of their time (e.g. 30%) to engage with government departments (e.g. DECC) and inform their policy making.
2. A network of researchers to examine policy related research topics. These researchers could devote a small percentage of their time to the translation of research outputs to inform policy making. The Avoid Programme, which was co-founded by DECC & Department for Environment, Food and Rural Affairs (DEFRA), is a possible model. However, the success of this model should first be reviewed.
3. A targeted fund that academics could bid for in order to translate research outputs and inform policy making. However, one participant warned that such a scheme might not work because turnaround times of researchers (e.g. six months plus) are unlikely to match the timeframe in which policy-makers need an answer (e.g. one month).

Moving beyond funding, it was argued that the Low Carbon Innovation Coordination Group (LCICG) could provide an important platform for linking research with policy.

The different **Research Councils target their research projects differently** in terms of fundamental versus more applied work. The group believed that this demonstrates inconsistencies across the research landscape. Bioenergy, where Biotechnology and Biological Sciences Research Council (BBSRC) targets more fundamental research and EPSRC more applied, was given as an example. There was discussion as to whether this was really a problem. For instance, if there is no duplication and the reason for the research is well communicated, then these differences may not be an issue. However, there needs to be an overarching strategy and strong communication mechanisms are needed.

Should the approach be the same across all aspects of energy?

The group believed that this question had already been covered. Different processes and interface points need to be considered for different parts of the energy research landscape. Some areas may not require an interface with other innovation bodies at all.

What processes are needed to maximise benefits for the UK?

Is 'maximising benefits' just about growth? Government departments are currently focusing on a growth agenda. The group believed that DECC was acting more as a department for growth and jobs, rather than an energy department. However, this may not be permanent – government is built on 'shifting sands'. CO_2 reduction, energy security and quality of life are important metrics as well as growth.

The group then touched on the Government's **industrial strategy**, especially the '**eight great technologies**' championed by Department of Business, Innovation and Skills (BIS). This initiative is focusing on underpinning technologies (for example automotive batteries) which may not be being addressed fully by the research councils.

Academics and policymakers need to be aware of what is happening outside their immediate research areas. There should be some way to communicate clearly and concisely the outputs of the energy research that is being undertaken in the UK, as well as who the key players are in this area. Transparency and clarity are extremely important when looking from an outside perspective into the energy research arena. The group suggested that having people from the research councils attending a range of meetings across different bodies could help to solve this problem. It was also suggested that UKERC has played an important role in providing such a platform for communication, as part of a third phase.

Do the Research Councils look deeply enough into the **EU Framework Programmes** to see if there is any **duplication of funding?** Representatives from the Research Councils replied that they do look at the Framework Programmes before issuing calls for proposals. It was explained that the Research Councils are getting more actively involved at a European level in order to help to shape the European research agenda, which was an area the UK could improve on.

What are the **metrics** and what are the **wider outcomes** that the Research Councils are looking for? What benefits are they trying to maximise? Each council has its own remit, and within that its own goals and targets. Therefore, are we attempting to define overarching goals for RCUK?

The LCICG is currently working on a framework to measure impact and effectiveness. The group suggested that it is important to look at the longer-term outcomes of research, as well as the short-term outputs of current research programmes. The TSB measures outcomes in added Growth Domestic Product (GDP) but the group was sceptical about this measure.

The group decided that **better coordination** and a **structure familiar to everyone** would help reduce the complexity of the framework by identifying key funding bodies and allowing for more collaborative working. The group queried whether the UK Energy Research Centre (UKERC) could be at the centre of this?

The group had predominantly discussed the coordination of Research Council research but Research Council activities happen in a wider context. The Government Office of Science was a potential coordinator. However this may fall outside its remit. There is currently a project looking into the coordination of Research Councils in general and the results of this may be relevant.

Other points?

It is **difficult to understand and access the research community** if you stand outside it. It would be useful to have a central point of contact to help provide a way in. EPSRC is addressing this, and UKERC, through its Knowledge Exchange and Research Atlas functions, is trying to facilitate. The LCICG was seen as being too opaque and needing to improve its transparency. Resourcing issues may currently be an issue.

The **Knowledge Transfer Networks (KTNs)** were seen as an effective means of getting researchers connected to end-users. The large contact databases of the KTNs are used by DECC and other bodies to organise events. However, energy is a complex area for KTNs. For instance, whilst there is one KTN for Energy Generation and Supply but some aspects of energy research fall under the remit of at least three other KTNs.

UKERC will shortly be bidding for Phase II funding, at about two-thirds of the current Phase II level. Participants questioned whether this reduction in funding might mean UKERC pulls away from its research coordination role to focus on whole-systems research. However, it was pointed out that UKERC has played a critical role in coordinating UK academic energy research over the last ten years. If its coordination role were to be 'watered down' in a third phase, UK energy research could become more disjointed.

4. Session 2b: Research training

The group considered both PhD training needs and, more briefly, masters training. In both areas, the group came up with a number of recommendations. While these recommendations were made in relation to energy research, many of them could provide insight into how to structure training in other areas of research.

PhD Training

The group began by outlining the relative strengths and weaknesses of the three most common PhD training models in the UK: (1) CDTs; (2) distribution through universities; and (3) allocated through research projects. These are outlined in detail below.

Strengths and weaknesses

CDT model. A university department is awarded funds to establish a CDT which specialises in PhD training on a particular subject (e.g. energy technology engineering).

Strengths

- Specific focus on training student cohorts, which can help foster a research community. While this is also the focus of many high quality departments, the size and nature of CDTs means that the cohort community aspect will usually to be more pronounced and better structured than compared to the average department.
- Strong focus on training with courses designed for CDT students. The large cohort aspect of the CDT model also provides the required critical mass of PhDs, who are at the same stage of training, to run these training courses in a cost-effective manner.
- Provides students with a good understanding of the 'bigger energy picture', particularly as part of the first year (i.e. Masters year) of the four year course, which examines a broad range of topics.
- Model flexible enough to enable students to engage with research projects that relate to their own area of interest or to apply for industrial/government placement schemes.
- Enables students to select the focus of their own research project, without having this imposed upon them.
- Wide-ranging skills training (e.g. networking; presentation skills etc.); an appreciation of the wider energy landscape; opportunities to engage with industry/government; and the existence of a

strong internal network provide CDT students with an excellent base from which to build an important network of contacts.

Weaknesses

- Too focused on training people to move into industry. To ensure these skills are retained within academia it is important to ensure that CDT training promotes both career paths equally, i.e. providing the skills to be either a consultant, policymaker or post-doc.
- Cohort nature of CDTs often means that students choose to operate within this 'small community pool' instead of the broader PhD community both within and outside their university. Despite the existence of the Energy CDT Network, which was designed to bring CDT students from one centre into contact with students from another, it was felt that the CDTs typically operate as 'islands' and would benefit from being better connected.
- Despite the advantages of learning about the wider energy landscape, it was argued that the CDT model's focus on 'setting the scene' in the first year may divert valuable time training students into areas that may not necessarily be relevant to their preferred career choice or research focus.
- Whilst valuing industrial experience, CDTs typically require applicants to hold a Masters qualification. It may be that an applicant with a strong research track record from an industrial background but who does not possess a Masters may not be successful. The added time, cost and effort associated with undertaking one poses a barrier to those looking to retrain from industry via a PhD.
- By training PhDs via a handful of CDTs rather than a much larger number of project-based or university allocated training arrangements, you are likely to lose some degree of diversity which accrues from PhDs being supervised by a wide range of academics with valuable skills distributed across the country.

University distribution model. Universities are given money to allocate as PhD studentships. The university has direction over which departments it awards the PhD studentships. The number of placements (i.e. PhD funding) is proportionate to how much money the university has received from RCUK in terms of research funding.

Strengths

- The model enables universities to build centres of research excellence that integrate PhDs into the wider institute.
- In a similar fashion to the project funded PhD model, PhD placements can be linked to research projects being undertaken in the university. This helps to provide project leaders with extra support but also provides the PhD with valuable experience about how research projects work.

Weaknesses

- No/little quality assurance associated with university allocations e.g. have students been located in an office which is conducive to community building, i.e. not on their own, in the middle of nowhere?
- Focus of the PhD is likely to be influenced by university's current strategy, i.e. where it wants to move towards in terms of research.

Project model. Researchers can make funding applications that have PhD placements attached to them. These PhDs are employed to help undertake the research project. This model has been phased out by some Research Councils such as EPSRC.

Strengths

- Working on a project team improves the PhD ability to teamwork typically making you more employable.
- Project PhDs gain valuable experience of how to deliver a large research project.
- Easier for people coming from industry with the relevant experience to do a PhD, because Masters not always needed. Usually at the discretion of the individual who holds the funds.
- If the funding is direct from research council projects then it will not be subject to the politics and strategy of the university in terms of research focus.

Weaknesses

- PhDs working outside of a project can develop the ability to work independently because they are not working as a team.
- Students can find themselves very isolated and not part of a cohort, thus without many peers.
- Quality of PhD training very dependent on the strengths of the project leader as a PhD supervisor and ability to link PhD student into a broader community within their institute.
- Quality of PhD student training can suffer if they are employed instead of a post-doctoral researcher, as opposed to alongside one. Hiring PhDs in place of post-docs can also redirect funds that would have otherwise funded post-doctoral researchers, who are naturally better equipped to undertake this type of research given their experience.

Recommendations

A balance between PhD training models. Given the relative strengths and weaknesses of the different PhD training and funding models (i.e. CDT, university allocated and project based models) the group highlighted the need for a combination of these approaches to provide a balanced PhD training portfolio in the UK.

Research council communication. If there is not already such a system in place, ensure that there is a structure in place to enable communication between the different Research Councils about how they are supporting PhD research training in order to identify lessons learned and whether a more standardised approach could be beneficial in terms of research training quality.

Breadth and depth in training. Ensure that PhD students are provided with a training programme that offers both depth and breadth to help ensure that they become an expert in a particular area but also understand the relevant context of that area, i.e. the bigger picture. This understanding of the wider context was also deemed invaluable from an industrial and governmental (e.g. policymakers) point of view when employing post-graduates.

Whilst it was acknowledged that research training in terms of broader, underlying skills (e.g. engineering) offered a broader range of career opportunities it was also noted that training by energy application (e.g. Carbon Capture Storage (CCS); nuclear engineering etc.) will also improve the likelihood of the student being employed in this area and possibly at all.

Flexible training programme. Ensure that students are part of a flexible training programme that combines mandatory and optional training for all PhD students to ensure that they reach a minimum standard in certain areas but also have the option to specialise in others. This may take the form of a 'menu based' training scheme with a few mandatory integrating training modules.

Avoid molly-coddling PhD students. In the US, PhD students are 'infantilised' and treated as an extra pairs of hands rather than an independent, critical researchers in their own right. At the same time, students require close supervision and training particularly in the first years of their PhD - a balance must be struck.

There was a suggestion that the culture of training PhDs has arisen from the culture of litigation in the UK where people who fail PhDs may sue the university. Extensive training is therefore often there to cover the university's back rather than help the student.

Also a suggestion that PhD training is to some extent required to make up for a lack of training at Bachelors level. Are we coping with lack of training within BSc courses? Could this be addressed by RCUK working alongside Higher Education Funding Council for England (HEFCE)?

Transdisciplinary training. Are there non-linear models for research training, i.e. can we put structures in place that enable people with relevant experience to move into a PhD without BSc/MSc background? These may take a similar shape to the 'Masters equivalence' standards used in Chartership requirements. Could these structures facilitate 're-training' so that people can move into energy research more easily?

Freedom to determine research scope. Provide students with some degree of discretion around determining the scope of their research and be wary of how this can be constrained under joint-funding with an industrial partner (e.g. Engineering Doctorate (EngD); Collaborative Awards in Science and Engineering (CASE) studentships).

Balance training in teamwork and independent working. Most employers, even universities, want PhD graduates to demonstrate an ability to team work and meet assigned objectives. This skill is often best developed within project-specific PhDs, as these have to work closely with other people e.g. Principle Investigator (PI), co-PI etc. However, the ability to work independently is also valued by employers to ensure they will be able to get on with the task at hand without being managed and set their own objectives. PhD training needs to strike a balance between the two.

Industrial and government placements. Placements in government or industry as part of PhD training can radically improve employment prospects (e.g. Parliamentary Office for Science and Technology (POST) fellowships; EngD placements etc). Need to encourage opportunities for students to undertake such placements (e.g. provision of module credits) but also recognise the risk of students being isolated during these placements. Need to ensure that they remain plugged into their research community during this industrial placement.

Awareness raising of PhD content. PhD students often do not have complete awareness of the topics that their research projects will cover. Better communication is needed so that prospective students can make more informed choices.

Build a PhD research community. It is important that PhDs are required to work with part of a team or wider community as part of their research training. The notion of **internal** and **external** research communities was identified. The former relates to research communities within the institute/department, normally as part of a PhD cohort. The formation of these communities can be supported by ensuring that universities are awarded PhD funds only if they can provide evidence that such a community is already in place or that they will make efforts to build PhD community. For instance, BBSRC does this at present.

External research communities exist beyond a department's or university's boundaries, often taking the form of research networks (e.g. UKERC's Sparks network). This is particularly important for PhD students who may be isolated from other like-minded students within their own institute by providing them with an external research network they can engage with to support their learning. Whilst it was thought that strong internal research communities will normally engage with other communities anyway due to the way in which researchers network with one another, internal communities (e.g. CDTs) should still be incentivised to engage and collaborate with others in order to make the most of these opportunities.

Communities are often best formed when there is a single location that many PhD students tend to visit regularly as part of their research and engage with one another whilst there. This may be a communal office, a summer school (e.g. the UKERC summer school) or an external research site, e.g. physicists use European Organization for Nuclear Research (CERN); nuclear engineers use Sellafield. These common research spaces are crucial in community building. The demand-side of energy is a trickier topic for community building as there is not one 'place' to congregate e.g. CERN's Large Hadron Collider.

Build bridges between PhD and post-doc communities. Experience of working with post-docs is extremely valuable for PhDs to improve their research skills and to help them make career choices. However, whilst some participants observed this happening, many had not. Suggested ways of facilitating this interaction included the supervision of mini-projects; outreach programmes; and embedding CDT within an existing large community of post-docs. For example, BBSRC has a policy where PhDs placements are provided only to larger projects that already have post-doc position attached to them, thus providing a balance between the two.

There was a suggestion that Research Councils should perhaps not award for a CDT unless the university can demonstrate a link between PhD and post-doc communities.

Masters Training

Recommendations

- **Stepping stone to inter-disciplinary research.** Masters courses are well suited to providing training across a broad range of energy related disciplines. Building on this structure, Masters could be used more effectively to provide inter-disciplinary research training.
- **Promote non 1+3 Masters as a PhD Feeder.** The majority of Masters students undertake courses that are not tied to PhDs via RCUK's 1+3 model. Often their intention is to become suitably qualified in a single area that they will be employed by relevant companies or government departments. However, whilst many students develop a strong interest in continuing research during this year following their thesis, relatively few post-graduates go on to do PhDs or further university research. It could prove valuable for both RCUK and HEFCE to work together to explore how more promising, research focused post-graduates could be encouraged to apply for PhD positions.

5. Session 3a: Energy research and public engagement

The agreed topics for discussion included those suggested by the organisers plus some that were added by the group:

- What are the aims of public engagement?
- The role of wider stakeholders in agenda setting;
- Engagement in developing research agendas;
- Communication of findings; and
- Processes for engagement and working with key intermediaries.

What are the aims of public engagement?

The group first explored the **broad aims of public engagement efforts.** They defined two sets of aims – one set referring to the public 'looking in' to the scientific research process, covering such themes as public acceptability, and the other referring to researchers 'looking out', where their work had some effect on the public. The latter includes public demonstrations, school lessons and other wider education efforts. Thus, public engagement implies a two-way relationship.

There are **different levels of public engagement**; education and disruption of existing paradigms were mentioned as examples.

The role of the public in research was discussed – is the aim just to educate the public or do they have a more interactive role to play? Public education and understanding and public engagement are separate issues. The nature of public engagement changes depending on the technological maturity of the system. Public engagement with respect to electricity pylons, for example, is very different from public engagement with respect to geo-engineering. There also needs to be a latent public interest – it is difficult to stimulate productive engagement in areas that people have no interest or knowledge of.

It was noted that the Research Councils provide media training, but not as yet public engagement training.

There is a variety of models for public engagement and the process has the potential to be time consuming. It can sometimes take months and consume considerable quantities of resources. There are now experts in public engagement (within industry and academia), although this is a relatively new role.

The role of wider stakeholders in agenda setting/engagement in developing research agendas

How do stakeholders fit into research agendas, and how should the public be involved in setting the wider goals of research agendas?

A balance needs to be struck in terms of the level of engagement and amount of time people are willing to give up in order to be part of the process. Do the public need to be rewarded for their engagement?

Research agendas often develop over long time periods, longer than the life cycle of a topical issue that a member of the public may be interested or involved in. Some non-governmental organisation (NGO) stakeholders may have a longer-term perspective but perhaps are not consulted, or are not able to express their views.

Who are 'stakeholders'? Are they the whole population or groups within the population that hold similar views, e.g. environmental stakeholders, industrial stakeholders.

The public often **actively seek energy information** to educate themselves on the local and wider debates in their communities. There appears to be room to make more linkages between academic institutions and community groups. There are synergies between initiatives that communities want to explore and research topics currently being addressed by academics (for example, community energy projects).

However, many of the subjects researchers wish to engage the public with may have little actual bearing on everyday lives or be of little direct interest (for example, energy efficiency). It may be more effective to **integrate energy issues into a public engagement agenda defined by wider issues** that the public is actually concerned about, rather than focusing strictly on energy.

We should be aware that much of the energy research being conducted is likely to be associated with some **'hard truths'** such as impending threats to energy security and affordability. Furthermore, many of the associated recommendations to address these issues may be difficult for the public to digest given the considerable effort and cost involved. Therefore, it is important to appreciate that the public may initially be unreceptive to many key energy research findings.

The group believed that stakeholders can actively try to set research agendas. This raises questions as to how **stakeholders' agendas should fit with Research Council agendas**, and to what extent they already feed into the RCUK energy programme at a higher-level. This situation puts academics into a difficult position and, raises questions as to whether academics should act purely as analysts or should take advocacy positions. Importantly, the focus of energy research can divide opinion (e.g. fracking; onshore wind etc.). Consequently, one participant argued that researchers should avoid advocating one approach over others in such contexts. For instance, researchers should provide a balanced, critical perspective on a number of potential recommendations to address a specific issue/set of issues with a view to informing decision makers.

What role should **evidence from public engagement play in setting research agendas**? If entirely up to the public, for instance, most energy research would be into renewables. It is hard to define exactly how the stakeholders ought to influence the agenda. One suggestion was for the Research Councils to have a community budget allowing some research agendas to be decided at a more local level.

Public-private initiatives such as the ETI represent a way to involve stakeholders directly in the energy research agenda. However, research is then influenced by private stakeholders as well, and these sponsors can potentially have a big influence on the research agenda. Is it fair for large stakeholders to 'buy' their way into the process, excluding other stakeholders who cannot raise the same money?

Communication of findings

The top criticism of current approaches to public engagement is that it is a **monologue and not a dialogue.**

What about the **role of postgraduates and post-docs?** There are opportunities here for much greater public engagement, e.g. through CDTs. The CDTs do provide training and undertake public engagement projects, but the amount differs from one CDT to another. The CDT network also has public engagement expertise, so this is potentially a very important resource.

What about **engagement with the media?** There is currently a debate about (and there has been a recent House of Lords enquiry into) how the media engages with science and engineering in the UK. The Science Media Centre (SMC) has significant expertise in putting scientists in contact with journalists to facilitate discussions. They also train scientists on how to engage with the media.

A major issue is that media engagement occurs only in relation to **the most controversial issues in energy**.

Electronic media also provides a good way of engaging with the public. Websites, blogs and other forms of social media are important but the Research Councils' websites are fairly impenetrable and confusing for the wider public. There may be a generational gap here – younger researchers interact naturally with these tools, whereas older researchers may not. A shift to these media may occur naturally over time.

TV personalities such as Brian Cox have influenced younger people to get involved with science. It would be interesting to understand how much of an effect they have had. They offer a different means for engaging with the public, and may captivate a wider audience.

How do you stimulate interest in interacting with the public on the part of post-grads? This can be an important skill for a post-grad to have. Should this be covered by PhD funding?

Researchers **generally communicate in academic journal articles**. The public do not read or have access to these. Are there better ways to communicate with them, for example through policy briefings?

Two-page accessible executive summaries can improve the accessibility of articles and reports and provide enough detail for people to understand the issues. Direct contacts with the media and stakeholders are important to ensure that the messages are heard – just launching with a press release is ineffective.

How will the new **measurements of impact on policy** under the new REF affect how academics write and publish? Though difficult, an audit trail to determine the impact of an academic output on government policy could be set up.

Processes for engagement and working with key intermediaries

People and organisations that have a role in enabling public engagement, for example the Science Media Centre, were seen as key intermediaries.

Most projects will have an advisory board that can have a serious influence on the project agenda from an early stage. **It is better to get key intermediaries involved as early as possible**, rather than towards the end of a project. What about actively partnering/participating with local authorities or other similar organisations? These may not have the resources to contribute but are definitely willing to engage. Does government have more flexibility at a local level than at a national level?

Many NGOs **have large memberships that can be mobilised** and used to influence government policy and to build consumer confidence in particular technologies. Is it worth considering partnerships with these organisations?

Broader Points

Participants **generally believed that public engagement is an integral and important part of the research process**. Public engagement can help people prove the value of their research.

There is still **a great deal of work to be done**. What could be done to progress the agenda further and to ensure engagement efforts are sustained and improved?

Researchers **should be sincere** when engaging with the public.

Is there a need for a review of **how public engagement influences Research Council** priorities? Does it and should it?

6. Session 3b: Making the best of the UK energy innovation system

The UK no longer has large energy research centres and relies instead on networking between universities and industry. How can the UK build upon current arrangements to derive the benefits associated with a more centralised system?

EU and international engagement

Difficult to know how to engage with EU. If you do not spend a lot of time in Brussels it can be tricky to get EU funding. It is hard to figure out how to submit good EU funding applications. Knowing the right people is key.

The UK's decentralised research system makes engagement difficult. At the individual level, UK researchers do engage internationally but we have a relatively decentralised energy research system in the UK and lack an overarching, strategic view on research. This can make international engagement difficult. Nobody has an overall picture of what the UK is doing. It was thought that countries that have a central research institute that is responsible for managing the nation's energy research portfolio are likely to find it easier to engage internationally as they can coordinate international engagement. They are likely to possess a clearer picture of the nation's energy research landscape, which they can articulate clearly to potential collaborators.

Value of international engagement. Do we derive net benefits from EU engagement? Is the whole greater than the sum of the parts? We need to examine whether efforts made to engage internationally have been worthwhile, e.g. via the European Energy Research Alliance (EERA). For example, what metrics should we be using to gauge the success of international engagement, such as the amount of money brought in, the value generated by research supported by this money, the amount/type of knowledge generated etc.?

Costs associated with coordinating engagement. There is no real incentive to act as the organiser of a research stream within an international research network (e.g. EERA); neither the individual nor the institution benefit from doing this. Why should an individual academic spend time coordinating? The funding body should be responsible for coordination and not leave it up to researchers. Alternatively, it was noted that there might be value in researchers leading engagement given their detailed knowledge of the research area. As such, support should be made available for academics who spend time as EERA coordinators, along with support for secretariat time for some of the more administrative work.

DECC could become more engaged in the EU to ensure that the UK attracts more EU funding. This would require more people but it is a very time consuming process. People need to know how to play the game, e.g. have knowledge of Brussels. However, institutional knowledge has disappeared from government departments. With no national laboratory it is hard to keep things coherent. There is also a lack of government funding.

Mismatch between UK academia and industrial benefits. Academia does quite well out of EU funding but UK industry does not.

Jointly funded, international research calls. The Research Councils do engage with other countries via funding collaborations, e.g. EPSRC has partnerships with China, India and US. How can they do more of this?

Priority countries. The UK should consider collaborating on specific topics with countries other than those currently defined as priorities by the Research Councils. For example, South Korea is a global leader in smart grids and its approach aligns well with that of the UK. More equal and productive partnerships could result from this more targeted approach.

Using research centres to promote engagement. Should Sustainable Power Generation (SUPERGEN) hubs be required to help out with international engagement by being given a specific remit to do so? Having a centre of research excellence supported by other stakeholders is key to making it easier for people outside to connect with UK academics.

CCS is a good example of a coordinated community that has engaged internationally thanks to the help of UK Carbon Capture and Storage Research Centre (UKCCSRC).

Engagement Champions. Leading individuals in academia, government and industry could act as focal points for international engagement. Reference was made to the previous Focal Point scheme which paid individuals to perform such a role. We need respected people who can build relationships but senior people often do not have the time and would need to be supported by a good secretariat.

'Picking winners'. UK does not identify 'winners' to promote at the international level, e.g. through EERA. This approach has been critical is maintaining the high level of consensus in the UK around the need to undertake a transition to a sustainable, low-carbon energy system. However, the UK currently seeks to promote all options equally but does so with limited resources, limiting the degree of engagement. It was thought that it might be difficult to maintain this approach when the UK enters the 'deployment phase' of its low-carbon transition and has to make some decisions about which technologies to implement. Consequently, focussing resources on a handful of subjects ('picking winners') may work well. If this is a viable approach, how should we pick winners?

Infrastructure facilities and field trials

Maximize use of existing facilities. UK has a number of high-quality research facilities, e.g. STFC's Rutherford Appleton Lab (RAL). However, many of these are currently underutilised, such as ISIS (a pulsed neutron and muon source), which is only used approximately 120 days a year due to lack of money to cover running costs (e.g. electricity). This was a huge capital investment but there are not sufficient funds to operate it fully. Participants believed that funding arrangements should allow fuller use to be made of these facilities. Once participant advocated a mechanism that enabled the cross-council Energy Programme to feed its requirements into the Research Council facility funding model.

We may need to explore innovative ways of funding these facilities. STFC covers 50% of the operating cost of using ISIS if the resulting data is made widely available. It does not contribute if the data remains confidential (e.g. private companies). Whilst one participant explained that this business model has worked for the projects that have run so far on ISIS, many in the group saw value in assessing how the model could be revised or refined.

STFC facilities have been built for the public good but business customers help to cover the costs. However, taxpayers' money should not subsidise industry. Additionally, business use of public facilities may restrict its use by the academic community if it is scheduled at the same time. However, such a situation would hopefully be avoided given that STFC prioritises academic used over industry use over business use.

We may need to market these facilities better. For instance, STFC is setting up cross-disciplinary networks that help to raise awareness of what their facilities can be used for (e.g. batteries) and how these can benefit them, in order to maximize the utilisation of STFC's facilities and the value they provide.

There is an international market for these facilities. Could we draw in international money to help run these? This could be through private or public funding.

Economies of scale are needed to make large research facilities financially viable. We need to see where these scales can be achieved.

Longer-term perspectives/stable teams

Facilities for field trials. The scale-up of energy crops on different types of land is needed. However, individual small plots are difficult to manage and there is a lack of funding for larger scale field-trials. Five to ten years is needed for interesting long term analysis. This requires long-term funding and stable teams.

The US Department of Energy (DOE) has annual funding cycles but they have a 25 year plan at the back of their mind. Such a long term perspective is needed to fund certain types of energy research such as field trial projects.

Maintain long-term testing. The UK is good at providing initial grants to start up experiments/field trials but we struggle to maintain projects, especially under changing political priorities.

Data collection and curation

Need to demonstrate the value of data curation. The case for the value of data sharing needs to be made, given that the sharing and cleaning data has a cost but also a potential value. We need to demonstrate this investment is worthwhile and can generate additional 'public good'.

Managing the risks. People are worried about the risks associated with sharing their data. We need to identify exemplars that show these risks can be managed and the benefits that can be generated from doing so. People need to be able to understand how they can share data while maintaining ownership and IP protection. We need to identify which data types should be shared to provide additional public good and which should not, i.e. data that is sensitive and confidential.

Curation as a condition of granting research funding. We need to be clear that if you are taking research money that your data will need to methodologically rigorous, transparent and openly available. For instance, the Ofgem Low Carbon Network Fund stipulates that any learning must be shared.

Inter-research council collaboration. Some Research Councils have a data policy (e.g. ESRC, NERC), whilst others do not (e.g. EPSRC). It was suggested that the Research Councils should discuss with one another the strengths and weaknesses of their strategies in a bid to develop a standardised approach to data curation across the Research Councils. This would mean that data could be managed centrally, e.g. via centralised national data hubs. However, collating data across different Research Council projects is likely to prove difficult due to the differences in characteristics between the types of data produced by projects rooted in different disciplines.

Cost-benefit analysis of data curation. Data curation is costly. It takes lots of human resources to collect, clean and manage data. We should first undertake an assessment of the associated costs and benefits before 'rolling out' a national data curation strategy. An example highlighted was the obligation on companies leading offshore wind projects to provide associated environmental data.

Who should be responsible for paying for this data infrastructure? How would these costs be recovered? Should it be available at a nominal cost for those who want it? There are analogies with 'open access' publishing. There needs to be evidence as to whether the benefit of funding data curation by existing/past projects exceeds that of funding additional research projects.

Avoid compromising commercialisation of innovation. Certain data (e.g. technology testing and design) has significant Intellectual Property (IP) associated with it. This IP is the 'life-blood' of companies working on commercialisation. If data is made available too early then the value of IP might be compromised, undermining innovation at a critical stage. Data should be shared in such a way that small to medium sized enterprises (SMEs) are still incentivised to commercialise technologies.

Realising interdisciplinarity

Awareness raising. Academia needs to be taught the value of interdisciplinarity. Awareness has been raised but the situation can still be improved.

Learning by doing. Interdisciplinarity cannot merely be taught it must also be learnt by doing, for example through working on an inter-disciplinary energy research project.

Map interdisciplinary career challenges. We should map out the challenges associated with following an interdisciplinary career path and address these.

Joining research initiatives. It was suggested that interdisciplinarity could be realised if centres/consortia linked, e.g. Bioenergy SUPERGEN and BBSRC Sustainable Bioenergy Centre (BSBEC). Cross-fertilisation of different initiatives would be beneficial.

Academic system a barrier. Currently, people need to be able to teach a specific subject and publish in single-discipline journals as these generally have a higher impact and are better recognised under the REF. Taking an interdisciplinary career path is therefore a risky strategy.

REF panels often align with traditional faculty/departmental structures. Academics who undertake research that does not fit neatly into a single discipline are unlikely to be recognised by panels. REF panels should be sufficiently flexible to acknowledge the value of interdisciplinary research.

Whilst this was thought to be the case for some disciplines more than others, early and mid-career researchers are less likely to undertake interdisciplinary research as they are concerned that they will not be recognised as an 'expert' in a specific field and thus be less able to build a successful career. For instance, being an inter-disciplinary researcher can make it difficult to secure a full-time academic position, which constitutes an important step in the typical university researcher's career path, given that these are typically affiliated with a particular faculty (e.g. Engineering; Natural Sciences). In addition, there is more pressure on junior academics to specialise since only a limited number of people can lead big projects and you have to prove yourself as a PI on smaller projects, which peer reviewers normally expert to be more specialised.

In contrast, senior researchers are may be less concerned about working within the confines of a discipline as they have 'already made it' and may be able to afford being interdisciplinary. Furthermore, the breadth of interdisciplinarity seems to be very valuable for leading major projects.

Interdisciplinary studentships are seen as particularly useful for PhDs who want to move into industry. However, they are not so useful for those looking to follow an academic career path due to the barriers described above.

Acknowledge the value of single discipline approaches. We do need single-discipline specialists otherwise research may stay at too high a level. Single-discipline experts provide the 'in-depth' research skills and insights that scientific research projects require to work effectively.

7. Wrap-up Session

There was only a very brief discussion in the wrap-up session. The main topic discussed was the degree of independence of the Research Councils from the policies of the government of the day (c.f. the Haldane Principle). For example, should the Research Councils take account of BIS's 'eight great technologies' in shaping their agendas? It was clarified that the 'eight great technologies' had been chosen following consultations with the Research Councils and others.

Annex A: Workshop Programme

<table>
<tr><th colspan="3">Monday 15th July</th></tr>
<tr><td>10.00</td><td colspan="2">Arrival, Registration and Coffee</td></tr>
<tr><td>10:30</td><td colspan="2">Introductions</td></tr>
<tr><td>10.40</td><td colspan="2">Session 1: Introduction
• Summary of emerging conclusions from three Strategy and six Expert Workshops
• Key themes for discussion</td></tr>
<tr><td>11:30</td><td>Session 2a: The Role of the Research Councils in the UK Energy Innovation System
• How should research agendas be defined?
• Where is the hand-over to other innovation bodies (ETI, TSB, DECC etc)
• Should this be the same across all aspects of energy?
• What processes are needed to maximise benefits for the UK?</td><td>Session 2b: Research Training
• The role of the Research Councils
• PhDs and Masters?
• Centres for Doctoral Training and project studentships
• Structured in terms of energy application or underlying skills?
• Subsequent career development : business/academic needs</td></tr>
<tr><td>12:45</td><td colspan="2">Report back</td></tr>
<tr><td>13:00</td><td colspan="2">Lunch</td></tr>
<tr><td>13.45</td><td>Session 3a: Energy research and public engagement
• The role of wider stakeholders in agenda setting
• Engagement in developing research agendas
• Communication of findings
• Processes for engagement and working with key intermediaries</td><td>Session 3b: Making the best of the UK energy innovation system
The UK no longer has large energy research centres and relies instead on networking between universities and industry. How can the UK build on current arrangements to derive the benefits of a more centralised system?
• EU and international engagement
• Infrastructure facilities and field trials
• Longer-term perspectives/stable teams
• Data collection and curation
• Realising interdisciplinarity</td></tr>
<tr><td>15:00</td><td colspan="2">Tea break</td></tr>
<tr><td>15:15</td><td colspan="2">Report back</td></tr>
<tr><td>15:30</td><td colspan="2">Session 4: Wrap-up and next steps
• Overview of conclusions
• Peer review and publication of findings
• Maintenance of the energy research and training prospectus</td></tr>
<tr><td>16.00</td><td colspan="2">Close</td></tr>
</table>

Annex B: List of Attendees

First name	Surname	Organisation
Roy	Alexander	Ashton Hayes Community Energy CIC
Geoff	Hammond	Bath University
Michael	Booth	BBSRC
Duncan	Eggar	BBSRC
Sue	Armfield	BIS
Catherine	Butler	Cardiff University
Nick	Pidgeon	Cardiff University
David	Howard	CEH
Adam	Cooper	DECC
Sarah	Ulliott	DECC
Hannah	Chalmers	Edinburgh University
Jacqui	Williams	EPSRC
Mike	Colechin	ETI
Richard	Green	Imperial College London
Bill	Gale	Leeds University
Peter	Taylor	Leeds University
Blanche	Coleman	NERC
Alan	Moore	Offshore Catapult Advisory Board
Jeff	Hardy	Ofgem
Philipp	Gruenewald	Oxford University
Eleni	Papathanasopoulou	Plymouth Marine Laboratory (PML)
Richard	Walker	RSC
Benedict	Gove	RSPB
Kevin	Smith	STFC
Matthew	Hannon	Strategy Fellowship Team
Aidan	Rhodes	Strategy Fellowship Team
Jim	Skea	Strategy Fellowship Team
Tadj	Oreszczyn	UCL
Jim	Watson	UKERC

Annex C: List of Energy Strategy Fellowship Reports

Report 1: Summary of Stakeholder Views and Way Forward, September 2012

Strategic Workshop Reports

Report 2: Energy Strategy and Energy Research Needs, November 2012

Report 3: The Role of Environmental Science, Social Science and Economics, December 2012

Report 4: The Research Councils and the Energy Innovation Landscape, March 2013

Report 5: Report of the Synthesis Workshop, October 2013

Expert Workshop Reports

Working Document: Fossil Fuels and CCS, March 2013

Working Document: Energy in the Home and Workplace, August 2013

Working Document: Energy Infrastructure, August 2013

Working Document: Bioenergy, August 2013

Working Document: Transport Energy, August 2013

Working Document: Electrochemical Energy Technologies, August 2013

'Light Touch' Workshop Reports

Working Document: Industrial Energy, August 2013