

RSC Policy Bulletin

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Steering policy with science

The RSC submitted a response to a consultation on how scientific analysis is applied to policy making

The relationship between scientific advisers and government policy has been a controversial topic in recent months, attracting widespread media attention. The RSC welcomed the opportunity to respond to a consultation on best practice in this area.

Last year, the Innovation, Universities, Science and Skills Select Committee conducted an inquiry into *Putting Science and Engineering at the Heart of Government Policy*. Then in October 2009, the Government response to this was published and one of the commitments made was to update the *Guidelines on Scientific Analysis in Policy*

Making. On this basis, the Chief Scientific Adviser recently opened a consultation seeking views on updating these guidelines, which provide a high-level framework for addressing the way in which government departments obtain and use science and engineering advice.

Gathering evidence intelligently

The guidelines recognise the importance of science and engineering as central components of the policy making process, and have been put in place to ensure that advice is sought when needed. The RSC submitted a response highlighting how



important it is that those seeking advice are equipped to interpret it and apply it appropriately. The RSC called for increased scientific literacy amongst civil servants and politicians in order to establish them as “intelligent purchasers” of guidance. Having scientifically literate and discriminating civil servants to process the evidence can help distinguish how the information can be best utilised.

In order to ensure a clear and transparent advisory process and sound policy formation, the RSC impressed the importance of publishing all the evidence and indicating when and how scientific advice has (or has not) been used. The response called for expert advice to be sought as early as possible in the policy making process, with the final decision not being taken until the Government is satisfied that all the relevant viewpoints have been considered.

The RSC agreed with the recommendations that the full range of evidence must be taken into account in policy development, but emphasised the need to consider the evidence from different sources carefully, and to ensure that policy reflects the weight of evidence. By opening up the results of expert advice for comment before completion of the advisory process, a broad spectrum of expertise and advice can be easily gathered and this may lead to the expression of some extreme viewpoints. Such opinions should not be rejected, if supported by robust evidence, and the use of peer review is vital to establish the validity of all evidence considered.

Public awareness

The RSC sees it as the responsibility of both policy-makers and scientists to engage with the public, acknowledging and considering lay opinion as an important component of policy making. The public need to be informed of scientific methods and the questioning nature of science; they must understand that there are not definitive answers in the field of research and accept the level of doubt associated with statements.

Impartial expertise

On the subject of selection of scientific advisers, the RSC agreed that departments should ensure



that their selection of advisers is appropriate to the issue and the breadth of judgment required. Expert advisers should be chosen based on experience and reputation. They may be identified by examining their publishing record, commercial and political interests or involvement with NGOs. In terms of reputation, their standing amongst professional bodies and learned societies could be used as a clear indicator of their eminence. Advisers should be as free as is practically possible of any potential conflict of interest and bias that would sway them in their advice.

The RSC highlighted quality assurance as being necessary at all times and under all circumstances. When it comes to science, the ‘facts’ that policy makers deal with are often subjective opinions based on

data; experts must first assess the quality of data before any inferences can be drawn. Quality assurance provides confidence in the evidence gathering process, making the resultant policy stronger in the face of opposition. Those that use scientific evidence should do so transparently and keep clear records, including a declaration that the original data is archived for reassessment if necessary. Such steps to assure quality of the process are essential.

To read the RSC’s full response to this inquiry, visit the RSC website.

www.rsc.org/scientificadvice

The new guidelines, which have been published since the RSC made its response, can now be found online.

<http://tinyurl.com/scientificadvice>

In summary

The Department of Business, Innovation and Skills, on behalf of the Government Chief Scientific Adviser, undertook a review of the guidelines for use of scientific analysis in policy making.

The RSC responded and highlighted the following points as vital to supporting the formation of sound policy.

- Increased scientific literacy amongst civil servants and politicians is needed so that they are equipped to interpret and apply scientific advice appropriately.
- The advisory process should be clear and transparent. All evidence should be published; how scientific advice has been used (or not) should

also be made available.

- A wide range of evidence and opinion should be gathered prior to policy formation. Peer review should be used to establish the robustness of evidence when conflicting opinions appear.
- Public engagement by policy makers and scientists is key to ensuring public trust.
- Scientific advisers should be chosen based on experience and reputation. It is important that they are free of bias and willing to openly declare any possible conflicts of interest.
- Quality assurance is necessary at all times and under all circumstances.

Driving solar fuels

The RSC held a workshop on solar fuels to determine the current UK position and potential for future developments

Solar fuels are chemical fuels produced by harnessing energy from the sun. As it becomes increasingly necessary to investigate alternative renewable sources of energy, it is important to understand the current position of solar fuels research within the UK.

The RSC policy document, *Chemistry for Tomorrow's World*, is a roadmap that highlights solar fuels research as an important opportunity for the chemical sciences. In order to scope the current position of this research, and determine how to drive the development of solar fuels technology, the RSC held a workshop in December 2009 at the Chemistry Centre in London, which was chaired by Professor James Durrant, Imperial College, London. This article summarises the opinions of the expert group that took part in these discussions.

Key Drivers

The development of solar fuels technologies has several key drivers, including the following societal drivers:

- The supply of energy to the UK has historically been through fossil fuels, which are a finite resource.
- Production of clean fuel is of global importance; there are major concerns regarding the use of fossil fuels as a predominant energy supply, namely pollution and growing CO₂ emissions.
- There is a need to develop a globally scalable strategy for CO₂-neutral synthesis and use of fuels for transport.
- Security of supply – the UK (along with many other countries) currently needs to buy its liquid fuels and so is subject to price fluctuations and dependant on good international relations.
- Renewable energy storage strategies to address the intermittency limitations of current UK renewable energy are currently based almost entirely on producing electricity.
- For the chemical industry to be sustainable, chemical feedstocks will



Solar cells provide one means of producing solar fuels, by the electrolysis of water

need to shift from oil to alternatives.

- The use of CO₂ as a large scale chemical feedstock for fuel synthesis would provide an alternative to CO₂ sequestration.

Alongside these societal and commercial pressures, recent scientific advances are additional drivers for the timeliness of a solar fuel initiative. These include advances in the design, synthesis and characterisation of nanomaterials, in our understanding of biological multielectron catalysis, and in rapid advances in the development of catalysts for electrochemical and photochemical fuel synthesis.

Solar Fuels Research Strategies

Solar energy represents the largest renewable energy resource available globally. Research into solar fuels began during the oil price spike in the 1970s, and has now gained global momentum. The US recently announced a \$250m solar fuels hub initiative, and solar fuels are gradually moving up the European agenda, for example the Dutch €35m Biosolar programme.

At present, a range of strategies can be envisaged for solar fuel synthesis. These strategies range from the use of photovoltaics to drive water electrolysis through to the direct photochemical reduction of CO₂. Common features of all of these strategies are that they rely on solar energy and that they use multielectron catalysis to drive

molecular fuel synthesis, often employing bio-inspired materials design and development.

Solar fuels research within the UK

It is vital that the UK engage in the rapidly developing field of solar fuels, if we are to ensure that we establish a sound base on which to develop a leading research and development programme. This will allow commercial exploitation by UK plc, in an area which has the potential to grow in the medium and long term to be a major component of global energy supply.

The UK already has significant strengths in many relevant areas of research that support solar fuels technologies, including world leading research in materials chemistry, catalysis chemistry, electrochemistry, molecular processes of photosynthesis, and organic and dye sensitized photovoltaics. There are several academic programmes within the UK which are directly focused upon solar fuel strategies, for example the SolarCAP project between the Universities of York, Nottingham, Manchester and UEA, which targets the development of photoelectrochemical nanoscale systems for CO₂ fixation and alkane oxygenation. A collaboration between University College London (UCL) and University of Strathclyde is targeting nanocrystalline photochemical diodes for water splitting or CO₂ fixation and alkane oxygenation, while scientists at Imperial College are investigating solar driven renewable hydrogen generation.

In addition, three new projects targeting CO₂ reduction, based at Imperial College, UCL and University of Bath, are starting in May 2010 and have been funded under the Engineering and Physical Sciences Research Council's (EPSRC) Nanotechnology Grand Challenge programme.

There is significant value in further enhancing the strong research areas associated with solar fuels, as successful products in the solar fuels supply chain will be in high demand throughout the world. It is possible that research in this area will be viewed as being of high risk, due to the long time scales; they are technically highly challenging, and it may take several years to advance technologically enough to create products which are ready to market.

However, the financial and societal gains have potential to be very large when the technology comes to fruition.

Meeting solar fuels research challenges

Basic research and training

Within this relatively recent field of research, there are many significant fundamental questions that must still be answered, and on this basis, the expansion of relevant scientific knowledge will depend on both applied and basic research.

The most important foundation for the future of solar fuels research is the strong chemistry education required to develop a thorough knowledge base. Training the next generation of chemists should exist in a supportive environment; it should be stimulating and informative in order to retain skilled scientists in chemistry. The competent teaching of science and especially of chemistry is essential throughout all stages of schooling, through to undergraduate and postgraduate studies in well-equipped and well-funded universities.

Funding

In order for the UK to benefit from the opportunities offered by the growth of a solar fuels industry, participants of the RSC workshop proposed that the following funding strategies should be presented to the relevant funding bodies:

- A coherent solar fuels programme needs to be established. This requires a strategy that incorporates funding from BBSRC (Biotechnology and Biological Sciences Research Council) and EPSRC in order to cover all areas of solar fuels research. It has been acknowledged by researchers within the field that a specific "centre of excellence" is not required.
- A managed programme will be required to accelerate the research in the most efficient way.
- In order to capitalise on investment in solar fuels research there needs to be a long term research programme.
- The UK should follow the lead of other countries where the funding duration is extended for projects that are long term and offer significant potential societal gain.

Raising Awareness

There is currently very little general knowledge, outside its core research

base, about solar fuels technologies, and it is increasingly important to provide more substantial information for the general public, for industry and for government, in order that the potential of solar fuels can be understood. The RSC is well placed to communicate this potential to relevant stakeholders to ensure that it is fully appreciated.

If the UK energy and chemical industries become more exposed to the idea of producing fuels and chemical feedstocks from solar energy, and to the science behind it, then the UK could be in a very strong position to develop this area.

Key Stakeholders

Industry is cautious about getting involved with solar fuels research due to the associated high risk and long timescales. The industrial partners that could see the most benefit from investing in solar fuels research would be those who are currently involved in the relevant materials and catalysis synthesis as well as in the energy and utilities sectors.

Small and medium enterprises (SMEs) and spin-off companies often play a vital role in bringing new emerging technologies from research into commercial development. In the UK, such companies employ a large proportion of skilled workers and greatly enhance regional economies. It is essential that they are properly supported, and given access to as wide a branch of funding as possible, as they are much more vulnerable to market fluctuations than larger organisations.

Given the increased focus within Europe, it will be hugely beneficial for the UK to position itself strongly alongside European researchers in order to be part of large scale solar

fuels programmes commissioned in Europe. In this regard, it is felt by attendees of the workshop that the lack of engagement of the EPSRC in a recent European Science Foundation (ESF) call was a significant opportunity to have missed.

Encouraging innovation in the solar fuels sector requires the transfer of knowledge and skills across the supply chain and from academia into industry. Initiatives set up by the Technology Strategy Board, such as the Knowledge Transfer Networks (KTNs), are intended to facilitate this transfer and it is essential that this continues to be supported. The RSC works closely with the Chemistry Innovation KTN, which acts as a link to the other KTNs and instigates connections with a wider industry base. Other organisations, for example the Society of Chemical Industry (SCI), the Institution of Chemical Engineers (IChemE) and the Institute of Materials, Minerals and Mining (IOM3) should also be engaged as they represent industrialists and engineers.

In order to increase the awareness of solar fuels technology in the community it is important to engage with the wider bracket of national policy makers and funders. In the first instance this will include the Department of Energy and Climate Change and Department of Business, Innovation and Skills in central government and the relevant lead technologists in the Technology Strategy Board (who could disperse information to the regions through the Regional Development Agencies).

With suitable buy-in from funding bodies, government, and industry, solar fuels has the potential to be a viable solution to a huge global challenge.

In summary

The RSC determined solar fuels to be a clean technology that could potentially be employed to provide sustainable energy and held a workshop to scope the current position and determine how to drive development in the UK.

This opportunity is one that is very heavily routed in fundamental chemistry, where there is currently relatively little focus from the public sector and industry in the UK.

The RSC is well placed to provide a significant impact in driving forward work in this area.

The RSC solar fuels workshop group would like to take steps towards raising awareness of solar fuels as a clean technology to get it on to the national energy/sustainability agendas.

The group recommends promoting early investment, and long term funding, in both fundamental and applied research in areas relevant to solar fuels, enabling a strong UK position.

Building confidence in science

The RSC responded to an inquiry into the unauthorised disclosure of climate data from the University of East Anglia

In January 2010, the House of Commons Science and Technology Committee announced an inquiry into the unauthorised disclosure of climate data from the Climatic Research Unit (CRU) at the University of East Anglia (UEA). Emails were leaked after a UEA server was hacked into, and sceptics claim this show data was being manipulated.

The inquiry focused on the implications of the disclosures for the integrity of scientific research and on the terms of reference and scope of the UEA's Independent Review announced on 3 December 2009 and led by Sir Muir Russell.

The RSC responded to the committee's call for written evidence and RSC views are quoted in the Committee Report highlighting the importance of widespread confidence in science. This is a prominent issue because the data disclosure and subsequent inquiries and reviews have been subject to considerable media coverage and public interest.

The RSC believes that it is essential that the public and all non-specialists remain truly confident in the scientific method to provide sound evidence on which strong decisions can be made. The true nature of science dictates that research must be transparent and robust enough to survive scrutiny.

Access to reliable, up-to-date information is vital to advancing research and enabling the discovery or development of solutions to global issues. Dissemination of scientific information is central to progressing scientific developments, as progress is based on a sound knowledge of preceding research.

The RSC firmly believes that the benefits of scientific information being made available to the wider community, and thus open to scrutiny, outweigh the perceived risks. In fact, advances in science frequently occur when the prevailing view is



The leaked emails from the University of East Anglia put the integrity of scientific data under the spotlight

challenged by informed scepticism; this is fundamental to the scientific method and should be encouraged.

Support from the scientific community is needed to present research in an accurate and relevant manner to provide context and to explain the process by which conclusions are reached. Encouraging scientists to openly engage with the public can only be achieved if they are given the necessary backing in the face of any unfounded arguments against their work. This support must come from the highest levels, delivering a strong message on the importance of scientific methodology and research, and promoting information being shared openly between scientists and the wider community.

The issue of misinformation in the public domain must also be tackled. Just as the scientific community must be open with regard to their evidence base, those in opposition must also provide a clear and verifiable backing for their argument, if they wish their opinions to be given weight. When disagreements occur, the validity of the analysis must be established before credence can be given to any opinion. Increased understanding of the process of scientific research, firstly in the government, but also within the media and general public, is vital in order to foster a more open sharing of information.

With the increased use of electronic media, access to information is widespread. The quality and validity of information available raises complex problems, as valid scientific information and general opinion are presented side by side. The inability to determine which information is legitimate results in confusion, misinterpretation and may lead to mistrust of science. There needs to be a clearer public understanding of what constitutes a reliable source, including an appreciation of the process that is used for disseminating research and the advantages of peer review.

The purpose of peer review is to prevent the dissemination of unwarranted claims and unacceptable interpretations. Formally published scientific research is subject to this authoritative process whereby a community of qualified, impartial experts examine the information and possess the authority to prevent publication. Due to the competitive nature of research, authors generally protect their data until it has been peer-reviewed and published in a formal publication. The peer review system is central to the credibility of science.

In summary

Recently, the Commons Science and Technology Select Committee conducted an inquiry into the implications of the controversial disclosure of climate data from the Climatic Research Unit (CRU) at the University of East Anglia (UEA).

The RSC responded to the inquiry emphasising the following areas:

- The RSC firmly believes that the benefits of scientific data being made available, and thus open to scrutiny, outweigh the perceived risks.

- It is essential that the public and all non-specialists remain truly confident in the scientific method to provide a sound scientific evidence-base on which sound decisions can be made.

- Access to reliable, up-to-date information is vital to advancing research and enabling the discovery or development of solutions to global issues.

- It is in the interest of scientists and the public that society as a whole has a good understanding and an appreciation of science