

Chemical engineering – a vital part  
of the 21st Century jigsaw

SCIENCE IN PARLIAMENT  
**sip**

SPRING 2013



The Journal of the  
Parliamentary and  
Scientific Committee

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## The impact of Mathematical Science Research extends across all aspects of the UK economy



Productivity of individuals in mathematical science occupations (as measured by GVA per worker) is double the UK average

MSR is most embedded in research-led industries but its contribution to employment is also high in absolute terms in other sectors such as construction

Mathematical science occupation jobs as % of total employment in sector

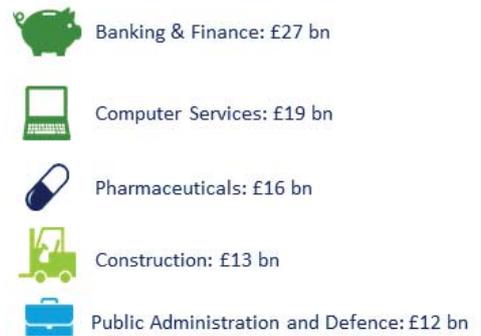


Top 5 sectors for mathematical science occupations (absolute numbers)



MSR's contribution to GVA is largest in sectors in higher productivity sectors that also have a high employment or customer base

Direct MSR GVA contribution ....



Source: Deloitte



The Engineering and Physical Sciences Research Council (EPSRC) is the UK's main agency for funding research in engineering and physical sciences. EPSRC invests around £800 million a year in research and postgraduate training, to help the nation handle the next generation of technological change. The areas covered range from information technology to structural engineering, and mathematics to materials science. This research forms the basis for future economic development in the UK and improvements for everyone's health, lifestyle and culture. EPSRC works alongside other Research Councils, working collectively on issues of common concern via Research Councils UK.



The Council for the Mathematical Sciences (CMS) provides an authoritative and objective body that exists to develop, influence and respond to UK policy issues that affect the mathematical sciences in higher education and research, and therefore the UK economy and society in general. Speaking with one voice for five learned societies, the CMS represents the Institute of Mathematics and its Applications, the London Mathematical Society, the Royal Statistical Society, the Edinburgh Mathematical Society and the Operational Research Society.

The full report is available at  
<http://www.epsrc.ac.uk/SiteCollectionDocuments/Publications/reports/DeloitteMeasuringTheEconomicsBenefitsOfMathematicalScienceResearchUKNov2012.pdf>

Surely nobody can have failed to notice that "Science" is everywhere these days?

We had (Sir) Tim Berners Lee to help open the Olympics. He was closely followed by Stephen Hawking at the Paralympics. It was also clear (at least to the French) that our cyclists had an (unfair) advantage because our science and engineering were superior!

But almost every day on radio or television we can enjoy Dara Ó Briain and Brian Cox as well as Jim Al-Khalili. Melvyn Bragg is not far behind with topics for his programmes. When you were replete with turkey and other comestibles, there were the RI Christmas Lectures. One glimpse of the astonishment in those youthful faces told you what "engagement" really means.

The science Minister, David Willetts, has been able to persuade even the Treasury that graphene may be important. And then we had the astonishing talk at the Oxford Farming Conference by Mark Lynas. He apologised for destroying GM crops, accepted that the position he took was misguided, and admitted that he changed his mind because of science. Allelujah!

And yet there is still much to do. John of Gaunt thought that "sudden storms are short" and that our nation was "a precious stone set in a silver sea", but in the last twelve months we have witnessed a hosepipe ban throughout much of the country coincident with the second wettest year on record. The Ancient Mariner could see "water, water everywhere nor any drop to drink". My Select Committee has recognised both these issues and we are investigating both Marine Science and Water Quality during 2013.

Meanwhile, the P&SC continues to lead the way, whether on High Speed Trains, Gut Health, or Energy. Always worth popping in on a Tuesday at 5.30 to catch up. I hope see you there.



Andrew Miller MP  
Chairman, Parliamentary  
and Scientific  
Committee

# SCIENCE IN PARLIAMENT sip

The Journal of the Parliamentary and Scientific Committee.

*The Committee is an Associate Parliamentary Group of members of both Houses of Parliament and British members of the European Parliament, representatives of scientific and technical institutions, industrial organisations and universities.*



Science in Parliament has two main objectives:

1. to inform the scientific and industrial communities of activities within Parliament of a scientific nature and of the progress of relevant legislation;
2. to keep Members of Parliament abreast of scientific affairs.

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# ROYAL SOCIETY PAIRING SCHEME

The Royal Society runs an annual Pairing Scheme for MPs or civil servants and Royal Society Research scientists. It starts with the 'Week in Westminster' in late October, a programme of activities for the scientists including seminars, workshops, shadowing opportunities and a tour of Westminster. This week aims to give the scientist a taste not only of the approach to science policy but of Parliament and the Civil Service in general.

Gisela Stuart MP and Dr Joanna Parish relate their experiences.



Gisela Stuart MP

I have found the "pairing scheme" of great benefit to me – but not necessarily for the reasons I'd expected. I had hoped, and indeed did, learn more about Birmingham University from the view of someone working there.

But what I had not expected was the mirror that was constantly held up – I had to find answers to the simple questions of "how" and "why".

... Politics isn't a science ...

Politicians like to share their certainties. Voters aren't interested in our doubts. They have enough of their own.

So for us things are black or white, good or bad, right or wrong; but I rarely get quizzed, nor indeed cross examined, on how I arrived at my view.

Politics isn't a science and electoral politics even less so. Local circumstances, history, expectations, behaviour of the opposition – all these things come into play. But there does need to be a factual basis. Our

policies may have unintended consequences, but we need to buckle down and try and forecast how to bring them into line with our social beliefs. This would be fatal to a real scientist. But they too have hunches, and I am sure that they too on occasions come up with good post hoc explanations. Maybe that is the sign of genius.

It was fun to share my world of work with bright young women like Jo Parish, who I am sure will rise to the top of her profession. I will watch her progress with interest.



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As part of the Royal Society MP Pairing Scheme, I spent a week shadowing Gisela Stuart MP. I am a Royal Society University Research Fellow and study the life cycle and molecular biology of the cancer causing human papillomavirus (HPV). Having completed my PhD in 2002, I moved to America to work as a postdoctoral scientist for 5 years before returning to the UK to establish my own research group. Until I gained independence as a scientist in 2007, I was blissfully unaware of how internal and external politics

affected my ability to carry out cutting edge research and deliver high-quality teaching. Now I seem to struggle against a wave of political decisions, particularly in the wake of this year's Research Excellence Framework assessment and therefore wanted to discover how these policies that so greatly affect my ability to be creative and individual in my research are reached within government.

Policies founded within government have a huge impact on my research. For example, government largely influences how my research is funded. It is getting harder and harder simply to follow ideas and hypotheses, a path that many great scientists throughout history have taken. Now we must study questions that fall into priority areas if we are to attract funding from research councils. Likewise, the ability to utilise human tissue is licensed through policies

... blissfully unaware of politics ...

developed with Parliament, policies that seem to have hindered not helped our ability to use tissue samples to study disease processes. For several years I have become interested in how policies which influence research into human health and disease are adopted within Parliament and how these shape the way academic research is conducted within the UK. When I was given the opportunity to take part in the MP Pairing Scheme I realised that this would give me the chance to talk to politicians and learn about decision making processes and how I can influence them. I also hoped that the politicians I met would learn from my experiences as an academic scientist and begin to understand how parliamentary decisions influence academic research.

### ... questions that fall into priority areas ...

I was not disappointed! Through a well-planned series of presentations from key individuals associated with the Parliamentary Office of Science and Technology (POST), the House of Commons and Lords Science and Technology Select Committees, the House of Commons Library, the Parliamentary and Scientific Committee, the UK Foresight Team, the Government Office for Science and BIS, and Professor Sir John Beddington CMG FRS we were talked through the many offices and committees that are involved in making decisions and how the findings of this research are used to influence society. I was

### ... events that have required a rapid response ...

particularly inspired by Sir John Beddington's presentation. He talked us through his role in providing scientific advice to government with several pertinent examples of events that have required a rapid response in order for the government to react swiftly and appropriately.

Following a day and a half of seminars, we were given time to shadow our MP pairs and attend select committee meetings and Prime Minister's Questions. PMQs was without doubt the most surprising element of my time in Westminster! I knew that debates within the House of Commons are hectic, but two

things really shocked me. Firstly the Commons chamber is remarkably small – the opposing sides are much closer to each other than the images on the television would suggest. Secondly, the volume of the heckling and seemingly chaotic speed at which the questions were asked and answered was startling. I am amazed that this is the way our government debates the most important issues. Scientists are far more civilized, but it was great fun to watch!

Shadowing Gisela has also been a very worthwhile experience. She works incredibly hard and seemingly never switches off from parliamentary

issues. She was proactive in the MP Pairing scheme and allowed me to shadow her for the majority of my free time. I attended a briefing dinner with the Fleet Commander and Deputy Chief of Naval Staff, Admiral Sir George Zambellas, which was enjoyable and very interesting. I also sat in on several select committee meetings, observed television

### ... Scientists are far more civilized ...

and radio interviews within the studios at Millbank and worked with Gisela's intern on some research required for a piece Gisela was writing. Above all this, my most valuable experiences stem from sitting and chatting with Gisela for lunch or coffee. We had many insightful conversations and discussed the workings of Parliament and her role as an MP. Sitting in Portcullis House or the House of Commons refectory allowed me to observe life in Westminster from a unique angle. As with science, many of the important interactions that occur between politicians happen in the cafeteria and it was great to be able to see these interactions play out in front of me.

The structured sessions during the week were vital for me to understand the role of the various committees and

offices within government and how these work together to form evidence-based policies and also to prioritise academic research. However, it was the time I spent shadowing my MP that was the most valuable to me. I am very grateful for the amount of time and effort Gisela afforded me. I would encourage all MPs and Civil Servants to consider taking part in the pairing scheme, but only to do so if they are prepared to commit to it. I hope Gisela found it as enjoyable and educational as I did and I am

looking forward to her visiting my research lab and teaching her more about academic research. I have learnt so much about our government and will take this knowledge away with me, fully motivated to engage more with Parliament in the future. Furthermore, I have made a friend and hope the relationship Gisela and I have developed continues in the long term. Perhaps it is friendships like this that will help develop firm links between politicians and scientists, links that are important if we are to make best use of academic research in society.

### ... I have learnt so much ...



# FRONT OF PACK LABELLING: format set to become more consistent



Professor Judith Buttriss  
Director General, British  
Nutrition Foundation

## HISTORY

The UK has been a front runner in establishing access to 'at a glance' front-of-pack nutrition information as the norm when we do our weekly supermarket shop, to supplement the back-of-pack nutrition information commonly found on foods. Over the past few years three distinct approaches have become widespread, each with their supporters and detractors. One is characterised by so-called multiple traffic lights via which the presence in a food of substances of concern in the UK diet – fat, saturated fat, sugars and salt – is flagged using red, amber and green icons. The history of the voluntary scheme dates back to 2006, when the Food Standards Agency (FSA) recommended that businesses adopt additional front-of-pack nutrition labelling, using traffic light colours to interpret levels of these four constituents in seven categories of food (sandwiches and similar products; ready meals (hot and cold); burgers and sausages; pies, pastries and quiches; breaded, coated or formed meat/poultry/fish; pizzas and breakfast cereals)<sup>1</sup>. The scheme or a version of it has been applied more extensively by a number of supermarket chains. Nutritional criteria are used to determine the colour coding. The cut-offs for green/amber have been set at levels consistent with health claims legislation and the amber/red (medium/high) boundaries are based on existing advice for fat, saturated fat, sugars and salt, using 25% of recommended intake levels

per 100g and 30% (40% for salt) per portion<sup>2</sup>. The scheme includes a slightly different set of criteria for non-alcoholic drinks.

The second approach, widely adopted by food manufacturers and some supermarkets, uses comparisons with guideline daily amounts (GDAs); GDAs are derived from UK dietary reference values and similar values have been established by the European Food Safety Authority, known as labelling reference values (EFSA 2009). The original GDA approach did not incorporate red/amber/green colour coding. A third approach amalgamates traffic light coding and GDAs and has been growing in popularity.

No studies examining the various schemes have seriously grappled with their ability to effect change in consumer behaviour. In 2009, the FSA commissioned research that focused on three key content-related signposting elements: traffic light colours, interpretative text (high, medium, low) and percent GDA information. The aim was to establish which front-of pack-labelling format or which combination of elements best facilitated the accurate interpretation of key nutritional information, such that consumers were assisted in making informed choices about the foods they purchase. The research addressed three key questions. First, how well do individual schemes (or elements of schemes) enable consumers to correctly interpret levels of key nutrients? Second, how do consumers use front of pack labels in real-life contexts in the retail environment and at home?

Third, how does the co-existence of a range of front of pack label formats affect accurate interpretation of front of pack labels?<sup>3</sup>.

The research found that levels of comprehension of the different formats tested were generally high (ranging from 58% to 71% when looking at single products), but two formats were particularly favourable. One combined text (the words high, medium, low), traffic light colours and percent GDA. This achieved comprehension of 70% and was one of the top two preferred formats. The other, with a comprehension of 71%, combined text and traffic light colours. The balance of evidence favoured a hybrid approach that combined GDAs, traffic light colours and text, which has been used by several major retail chains for some time. Expressed preference alone for a format was not a reliable indicator of ability to comprehend the information provided.

## GOVERNMENT ANNOUNCEMENT ON FRONT-OF-PACK LABELLING

New European legislation, the Food Information Regulation (FIR), came into force at the end of 2011 and makes mandatory (from 2016) the provision of nutrient composition data 'back-of-pack' and also includes provision for additional voluntary declarations of specified nutrients front-of-pack (either energy alone or a combination of energy, sugars, fat, saturated fat and salt). To

prepare for implementation of aspects of the Regulation in the UK, a consultation was held in 2012 about the approach for front-of-pack declarations, focusing on the lack of consistency of the formats in current use and the impact of this on consumer understanding and usage. The details of the consultation, which concluded on 6 August 2012, have yet to be made public but on 24 October 2012, Health Minister Anna Soubry and other health ministers announced that the UK governments will work towards a consistent (still voluntary) front-of-pack scheme based on a hybrid approach combining GDAs (%GDA) and colour coding. It was stated that the approach already had the support of the 10 leading retailers in the UK and the government wished to agree the details of the scheme by early 2013. The announcement also listed aspects about which there were inconsistent responses in the consultation, such as whether to include high/medium/low text in the scheme, whether to colour code energy, and where the various thresholds for colour coding foods should be set (ie should the existing FSA thresholds be adopted or was there another approach that would be preferable?). Another aspect often highlighted is that as the FSA scheme applies the criteria on a 100g basis, it penalises

foods consumed in small amounts.

Although a number of retailers already base their schemes on the FSA criteria, there are subtle differences in the details and the presentation. Extensive changes to labels will be required if consistency is to be achieved. For example, some schemes have been modified so that they are able to differentiate within categories eg cheese and spreads, and/or to take into account the role of the food within the diet (eg main meal item vs a snack). The new requirements of the FIR will necessitate numerous packaging changes, even in relation to the font size used. The changes to front of pack information, which will affect all retailers' own brand food and beverage products will add to the cost and complexity of the process and also influence the deadlines by which decisions are required.

## NEXT STEPS

The consultation revealed that for some food categories, eg biscuits, cheese, butter and spreads, breakfast cereal, and yogurts (for at least some of the nutrients), the existing FSA thresholds fail to differentiate healthier options within the category. Does this matter? In the cheese category, for example, at least 80% of products carry 3 reds according to new research conducted

recently on behalf of the Department of Health (and the nutrients targeted do not take into account the positive nutritional attributes of cheese, particularly calcium). It is argued that this implies that the approach may be ineffective in nudging consumers to make a number of small steps in a healthier direction. This is important if purchase decisions are undertaken within categories rather than between categories, that is biscuits vs biscuits rather than biscuits vs fruit. Furthermore, it has been argued that the thresholds chosen and the degree of categorisation that is implemented (ie whether there are separate sets of thresholds for particular types of food as has been mooted for the nutrient profiling element of the Nutrition and Health Claims Regulation and has been adopted in schemes used elsewhere) influence the nature of the impact of the labelling scheme: whether it moves consumers towards healthier options within a category or whether it simply highlights levels of nutrients/ingredients of public health concern and requires a separate education programme to effect behaviour change. The choice of thresholds may also influence the extent to which the scheme drives reformulation in a positive direction, ie whether it's feasible to modify a product such that it moves from red to amber or amber to green for a particular nutrient. It is worth noting that the October announcement referred to some adjustments made to the FSA salt criteria in 2009 but never published. This recommended bringing the salt value that triggers 'red' down from 1.5g/100g to 1g/100g. Many products have been reformulated and now show amber using the published (1.5g) criteria. But if the new value of 1g is adopted, many

products are likely to revert to red, hence removing the degree of differentiation that currently exists that can be used to affect consumer choice.

A window of opportunity exists to explore the pros and cons of existing schemes and fine tune them. Using the threshold criteria developed by the Food Standards Agency, officials at the Department of Health have been meeting with interested parties and have commissioned modelling work on the impact of the FSA thresholds on the colour coding of foods and also on approaches to colour coding of energy (not currently included in the FSA scheme). In the run up to Christmas (21 December 2012), the Department of Health circulated a summary of the findings from the modelling work.

Time constraints, linked to the roll out of the FIR, are likely to dictate the scope for extra modelling work and for making changes to the existing FSA criteria that might provide consumers with a tool for decision making within categories as well as between categories of foods. It can still be argued that anything that encourages consumers to make use of the nutritional information provided on foods and as a result improve their food choices and eating habits is a step in the right direction.

## References

EFSA (2009) Scientific opinion of the Panel on Dietetic Products, Nutrition and Allergies on a request from the European Commission on the review of labelling reference values for selected elements. EFSA Journal 1008, 1-14.

- 1 <http://www.food.gov.uk/news/newsarchive/2006/mar/signpostnews/march>
- 2 [www.food.gov.uk/multimedia/pdfs/frontofpackguidance2.pdf](http://www.food.gov.uk/multimedia/pdfs/frontofpackguidance2.pdf)
- 3 <http://www.food.gov.uk/multimedia/pdfs/pmpreport.pdf>



# CHEMICAL ENGINEERING MATTERS



Andrew Furlong

**The Institution of Chemical Engineer's Director of Policy & Communication, Andrew Furlong, talks about a new initiative that will highlight the role of the chemical engineer in delivering better quality of life.**

IChemE issued a poster during the 1980s, extolling the virtues of chemical engineering. The narrative went something like this:  
*"If you don't wash, or use deodorant, shave, or wear cosmetics, eat, feed your pets, work on a farm, wear wellies, drive a car, play music, go on holiday – or stay at home, sleep on a mattress, take medicine, comb your hair, or wear a hat, go to the movies, watch television, listen to the radio, buy books, or read magazines, drink water, or breathe then... chemical engineering doesn't affect your life!"*

The effectiveness of this promotional campaign was limited in an era when the best engineering graduates were all too frequently seduced by the prospect of a brick-sized mobile phone and evenings spent waving fifty pound notes in City of London wine bars. Nonetheless, the central message remains true – chemical engineering matters.

## TALENT PIPELINE IN CRISIS

UK chemical engineering was facing a crisis by the mid-1990s. Applications to study the subject at first degree level were forecast to plummet and many departments were struggling to secure students with the good A-level grades that are a prerequisite for success on a demanding degree course. Urgent intervention was called for and a new campaign, dubbed *whynotchemeng*<sup>i</sup>, was launched in 2001 with

substantial backing from industry and from many UK universities. The campaign highlighted the product and lifestyle outcomes supported by chemical engineering. Based on careful market research, *whynotchemeng* was both focused and targeted; features that are often lacking in many STEM careers campaigns. *whynotchemeng* has triggered substantial growth in the number of young people applying to study chemical engineering in the UK. UCAS reported a record number of applications in 2011, with 2201 chemical engineering students commencing their studies last September. This increase represents growth of 234% since the launch of *whynotchemeng* and an improvement that surpasses other mainstream engineering disciplines. New programmes have been launched, or are under consideration, at Lancaster and Liverpool John Moores, adding to recent additions at Aberdeen, Bradford and Hull, while other departments have expanded intake numbers. Meanwhile, the quality threshold for applicants has soared and three A grades at A level is the entry requirement for many departments. At undergraduate level, the chemical engineering talent pipeline has never been in better shape.

## PUBLIC UNDERSTANDING

Despite this positive backdrop, chemical engineering remains opaque to the wider

public, as well as amongst opinion formers and policy makers. Opinion research carried out for IChemE by IPSOS-MORI consistently reveals that less than a third of the public claim any real understanding of what chemical engineers do. Ignorance is never bliss, however, and IChemE continues to work through its 38,000 members worldwide to improve public understanding of chemical engineering and science and technology more generally. Engagement with others to promote the development and use of chemical engineering and the appreciation of its importance is a key component of the Institution's plan and one that is fully aligned with its Royal Charter obligation to act with integrity and in the public interest.

## WHAT DOES SOCIETY NEED?

IChemE celebrated the 50th anniversary of the granting of its Royal Charter in 2007. This presented an ideal opportunity to take stock and to scope out the role of the discipline in delivering sustainable solutions to the challenges confronting humanity. IChemE published the *Roadmap for 21st Century Chemical Engineering*<sup>ii</sup> and this report, which was widely welcomed, addressed a simple compelling question, "What does society need; what are the desirable outcomes and how can chemical engineers work in partnership with others to make it happen?" The report set out

20 goals, underpinned by a series of action plans that would need IChemE support.

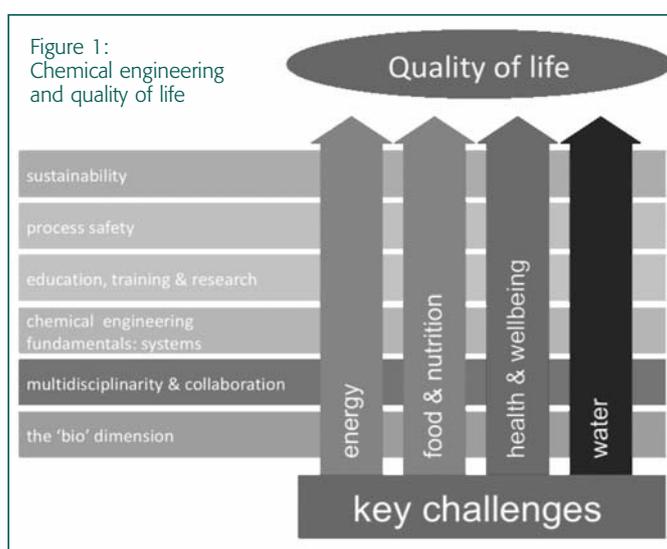
The report was written before the onset of the global financial crisis. Iraq was still under military occupation and the Arab Spring lay around the corner. The events at Fukushima and in the Gulf of Mexico were yet to unfold. The potential of shale gas was still not fully understood and concerns around access to rare earth metals and other strategically important resources had not materialised. Crystal ball gazing is a risky business, but despite the uncertainties of geopolitics and its impact on the world of chemical engineering, IChemE has made progress since 2007 and a good deal of the ambition set out in the report has been realised.

Predictably, some weaknesses were identified in the original report. Insufficient prominence was given to wealth creation. The essential role of the chemical engineer in food production and industrial biotechnology was understated and some stakeholders viewed the action plans as too narrow, or too vague. Further work was needed to build on the *Roadmap for 21st Century Chemical Engineering* and five years on, the time had come to re-evaluate the report, assess its fitness for purpose and outline new ideas for the next period.

## CHEMICAL ENGINEERING AND QUALITY OF LIFE

IChemE's review of its technical strategy was published in January 2013. *Chemical Engineering Matters* <sup>iii</sup> has moved away from the traditional roadmap approach in favour of a more open-ended look at options for progress. The new report, running to a very

digestible 26 pages, is an exploration of possibilities and a vivid illustration of the versatility and wide-ranging application of chemical process solutions to human challenges. It positions the discipline as a vital piece of the jigsaw that is the quest for sustainable living in the 21st Century. The work is organised around delivering solutions in four challenge areas: food & nutrition, health & wellbeing, water and energy (Figure 1). At the same time, attention is drawn to the need to embrace a



series of essential issues and concerns in every aspect of chemical engineering practice including: sustainability, process safety, education & training, fundamental science, collaborative working and the need to accelerate the transformation to a 'bio' economy.

The report contains four 'vista diagrams' – one for each challenge area. The diagrams seek to capture the current status and some specific challenges under each heading and propose some options for action by chemical engineers and others. External factors are also addressed in the context of the four challenges. The vistas represent the beginning of a

process, rather than an end. They are intended to provoke debate and stimulate target setting. *Science in Parliament* readers are invited to download the report, which examines a number of contentious issues, including shale gas, carbon capture, water reuse, food security and bioengineering.

## REACHING A WIDER AUDIENCE

In addition to an analysis of the technical contribution that chemical engineers can make to

based and supported by the strongest possible input from the engineering community. The report commits the Institution to work with its members to develop coherent policy goals that will form the basis of engagement with opinion-formers and policy-makers. IChemE's work with POST and its financial support for the Ashok Kumar Fellowship is an example of its work in this area.

*Chemical Engineering Matters* also challenges IChemE to rethink its public engagement work. The chemical and process industries support many of the technological advances that have improved the lives of millions of people in the UK. However, lifestyle commentary and media reports present 'chemicals' as something that can be avoided or eliminated. The reality is very different. Everything is made of chemicals and people are often anxious without reason. IChemE will encourage its members to engage productively in the public conversation about the impact of chemical processes and products. The Institution will work with science media centres and other NGOs to address the disconnect between lifestyle commentary and chemical realities.

## WHAT HAPPENS NEXT?

The recycling bags in the corridors of the Norman Shaw Building and Portcullis House are frequently the first destination for much of the printed material that is sent to parliamentarians. IChemE is keen to ensure that *Chemical Engineering Matters* does not suffer the same fate. MPs and peers will be heartened to learn that the Institution does not intend to add to already overloaded in-trays. During

secure, maintain and improve quality of life all over the world, the report also examines the relationship between the profession and policymakers and the public at large. The *whynotchemeng* campaign has already done much to raise the visibility of chemical engineering as a career choice, *Chemical Engineering Matters* seeks to continue that work by enhancing the reputation of the profession more widely.

IChemE is politically neutral. However, the Institution recognises that political decisions, including those that impact on funding and the regulatory framework within which chemical engineers must operate, should be evidence-

2014, the Institution's policy team will prepare a series of short briefing papers under each of the action headings highlighted in the report. These will be used to target engagement with Associate Parliamentary Groups, Select Committees and Members of both Houses who have expressed interest in specific issues where chemical engineering can make a difference. Given the international nature of IChemE's membership, this work will not be solely confined to the UK.

*Chemical Engineering Matters* should prove of interest to all those whose work is

connected with government policy-making at local, national or international level. IChemE is an advocate for solutions that will support a safer and more sustainable world. If you think that our members can be a useful addition to your contact book please get in touch. To continue the conversation please email chemengmatters@icheme.org or call Dr. Alana Collis at the Institution of Chemical Engineers on 01788 534484.

#### References

- i [www.whynotchemeng.com](http://www.whynotchemeng.com)
- ii [www.icheme.org/roadmap2007](http://www.icheme.org/roadmap2007)
- iii [www.icheme.org/chemengmatters](http://www.icheme.org/chemengmatters)

### ABOUT IChemE

A member of the Parliamentary & Scientific Committee, the Institution of Chemical Engineers (IChemE) is the global professional membership organisation for people with relevant experience or an interest in chemical engineering. It is the only organisation to award Chartered Chemical Engineer status.

IChemE is also licensed to award the titles of Chartered Engineer (CEng), Chartered Scientist (CSi) and Chartered Environmentalist (CEnv) to suitably qualified members. Founded in 1922 as a professional institution for chemical and process engineers, IChemE has grown to its current status of 38,000 members across 120 countries. IChemE currently has offices in Australia, China, Malaysia, New Zealand and the UK.

# INVESTOR IN INNOVATIONS®: A New Industry Standard



Dr Alison Todman FIKE  
Head of Innovation Services,  
NEF: The Innovation Institute

**Can organisations afford not to invest in innovation? All recent business surveys have identified innovation as an imperative for any business to compete and grow. In recent years, considerable effort has gone into exploring the theory and practice of innovation in an attempt to capture the elusive organisational culture that underlies the ability of some organisations to excel, and to gain a competitive advantage over their peers. Leaders of industry are united in calling for innovation to be prioritised, which in turn requires an appetite for risk, resilience and the ability to adapt to changing landscapes.**



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FIKE CEO, NEF:  
The Innovation Institute

At Innovisions 2012 conference, Jo Lopes, Head of Technical Excellence at Jaguar Land Rover said *"Innovation is a key part of any engineer's toolbox. Innovation is the soul of engineering – it provides an engineering company with a competitive edge"*. The East of England Development Agency claims that *"Innovation plays a critical role in economic development and growth."*<sup>1</sup>

To NEF, innovation is not an abstract concept, but a vital process that develops new products and markets and improves business performance. It is the successful implementation of creative ideas that enables an organisation to survive, adapt, change and maintain its competitive advantage. This definition is very general so that it can be used throughout education and across

all sectors of industry. While our work builds on significant research by leading experts, it also challenges and blurs some of the traditional boundaries between disciplines that are often treated as being outside innovation.

**NEF Investor in Innovations®** is an industry standard that identifies organisations whose culture and

practice feature the defining characteristics shown to lead to effective and sustainable innovation. This evaluates the innovation practice of an organisation against the NEF Innovation Assured framework which is based on a set of criteria derived from research. This approach allows an organisation not only to evaluate its own practice, but to demonstrate its commitment towards innovation to its clients, employees, and the wider public. It recognises the different contexts in which innovation takes place in small and large organisations, and in different sectors of industry. To achieve the award, organisations must demonstrate practice

## ... in-depth understanding of customers ...

developing the capacity to exploit opportunities and respond to the external environment with agility. The strategy and structure must be founded on a comprehensive understanding of core capabilities in the organisation, knowledge of competitors and similar industries, and an in-depth understanding of customers or clients. Metrics of benchmarking are needed to evaluate the effectiveness and impact of innovation and to highlight potential improvements to the innovation process. NEF

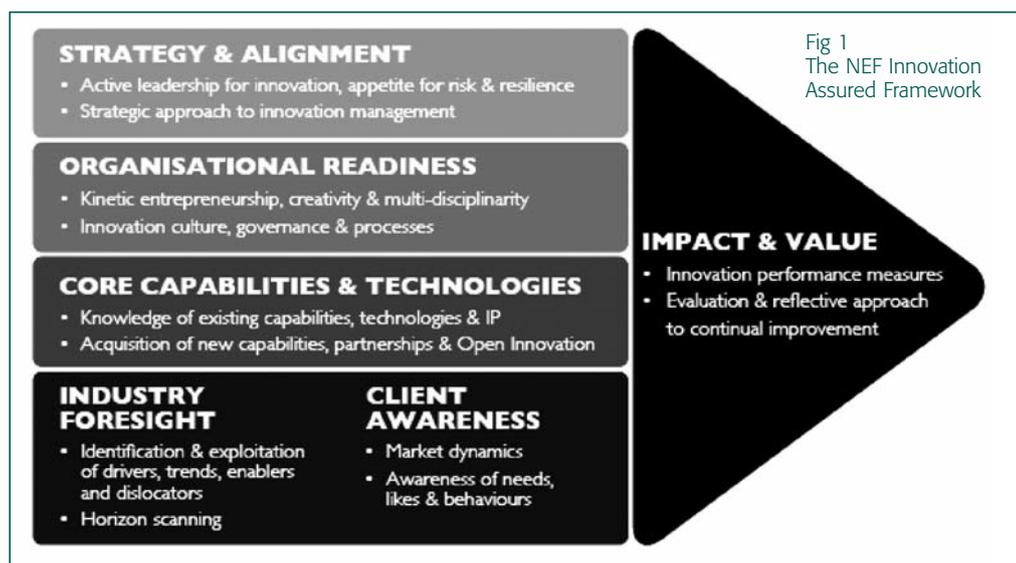
### ORGANISATIONAL CULTURE AND THE "ADJACENT POSSIBLE"

Knowledge of an organisation's own competencies and resources, customers, clients and competitors, and advances in technologies and/or processes with the potential to impact on its business, are fundamental to the management of innovation. This enables an organisation to identify the creative potential for change, and also the limitations and constraints, the so-called

develop their ideas to fruition. As Dave Drury, Chancellor of EDF Energy Campus states, "Innovation is about having a different state of mind and getting the best out of the processes and people within the organisation – allowing people to contribute to the organisation in a novel way".

It is clear that some environments stimulate innovation apparently effortlessly while others inhibit it and, although the precise nature of such an environment will vary from organisation to organisation, there are characteristics that can be identified as supporting innovation. These can be seen in the structures and activities that are part of the working environment<sup>5</sup>. Significant innovation often comes about through borrowing ideas and technology from an entirely different field and putting them to work to solve an unrelated problem (known as exaptation). For an organisation to maximise the possibility of this happening, it needs to promote knowledge sharing and develop broad networks that extend outside the organisation to involve people from diverse fields of expertise.

New ideas also come about through chance meetings and discussions with people from different disciplines or different parts of an organisation. Organisations need to create opportunities for these random collisions to occur, both internally and externally. It has been shown, for example, that proximity and physical environment have a role to play in encouraging innovation<sup>6</sup>. The quickest way to stifle innovation is to isolate people in single offices behind closed doors. Shared spaces where people have the opportunity to meet



appropriate to the context in which they operate.

### A MODEL FOR INNOVATION MANAGEMENT: A STRATEGIC APPROACH

Management studies<sup>2,3</sup> have pointed to the importance of strategy and alignment in ensuring the successful delivery of innovation. An organisational structure that supports formal (governance) and informal (cultural) mechanisms to encourage innovation is vital in

has taken the concepts highlighted in these studies and has expanded them within its Innovation Assured framework. This framework further identifies key characteristics within the categories shown in Figure 1 which allow an organisation to explore the details of its innovation function and to benchmark it in a systematic manner.

"adjacent possible"<sup>4</sup>. Most innovation, both incremental and radical, is brought about by continual exploration and expansion of the boundaries of the adjacent possible. An innovation culture is about establishing an environment in which individual employees and teams across an organisation can best explore this space and

## ... opportunity to challenge assumptions ...

## ... the innovation cycle is about diffusion and adoption ...

informally are essential to provide an innovative environment in which random connections and exchange of ideas can take place. An innovation-driven organisation will build opportunities for its employees to meet with people from other organisations into its normal working practice. Group interaction, group problem-solving, the freedom and opportunity to challenge assumptions are all important in an organisation that takes innovation seriously.

### INNOVATION MANAGEMENT: PROCESS AND IMPACT ASSESSMENT

Innovative systems have a tendency to gravitate towards the “edge of chaos”, existing somewhere between too much order and too much anarchy<sup>7</sup>. This could lead organisations to believe that the management of innovation is a bad idea and that a structured approach will stifle the creative process. Evidence suggests that this is not the case. There is a strong correlation between the existence of formalised mechanisms for managing innovation and reported success rates<sup>2</sup>. Good leadership, appropriate organisational structures and innovation governance, are required to increase the effectiveness of innovation. Dr Elaine McMahon, Chief Executive and Principal of Hull College, affirms that *“It is important to have a clear framework for innovation. A role model of success is key.”*

NEF advocates the use of “kinetic” entrepreneurial techniques to identify and assess enablers for growth, to horizon scan new technologies, applications and markets, and to unleash hidden potential and accelerate entrepreneurial innovation. It should also be remembered that a considerable percentage of the innovation cycle is about diffusion and adoption; not simply about invention of new products or services. This means that the marketing function and good communication with customers and users is needed to raise the potential for acceptability, and improve the speed of adoption<sup>8</sup>. The location of innovation activities within an organisation will vary. The existence of key figures to lead the innovation process and effective mechanisms for alignment with

corporate strategy, management decision-making, communication with internal and external stakeholders, knowledge management, resource allocation, and performance evaluation, are all defining features of an innovative organisation. The danger of progressively eroding and diluting ideas as they pass through a structured set of stages may be mitigated by maintaining a cross-disciplinary environment that continually stimulates and challenges at all stages of the process.

Assessment of impact is essential if organisations are to demonstrate success in innovation to their clients and investors. The KPIs and metrics used to evaluate performance are crucial in terms of their impact on the innovation process as these should be used to drive forward improvements. Again, a diversity of metrics should be applied, examples of which are well defined in the literature<sup>9</sup>. The specific metrics used are not the issue here. What is important is that the metrics evaluate the innovation in relation to wider business objectives while being appropriate to the development itself.

### INVESTOR IN INNOVATIONS®

The Innovation Assured framework specifies criteria that enable an organisation to evaluate the systems it has in place to support all aspects of the innovation function. This can be used to benchmark the innovation process and highlight

culture that encourages and supports creative practice is a key factor in ensuring retention of staff in hi-tech industries<sup>10</sup> where advanced skills and industry experience are very hard to come by. Economic resilience and ultimately growth depend on organisations recognising the importance of innovation and taking formal steps to ensure that the factors shown by research to enable successful innovation are effectively managed

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## ... metrics evaluate the innovation ...

areas for improvement, if necessary. The NEF Investor in Innovations® standard has an important role to play in publicly highlighting organisations that have demonstrated the capacity and culture to deliver innovation consistently and in a sustainable manner. As well as giving confidence to investors and other stakeholders, this standard signals to high performing potential employees that the organisation takes innovation seriously. Research now indicates that excellence in innovation and an organisational

# MATHEMATICAL SCIENCES RESEARCH – Leading the Way to UK Economic Growth



Professor David Delpy  
Chief Executive, Engineering and Physical Sciences Research Council

Working in partnership with the Council for the Mathematical Sciences (CMS), the Engineering and Physical Sciences Research Council (EPSRC) commissioned a study which has shown that 10 per cent of jobs and 16 per cent of Gross Value Added (GVA) to the UK economy stems from mathematical sciences research.

The report, by Deloitte, was the first of its kind, and reflects the excellence of the UK mathematics research base, that has generated a range of impressive and far-reaching impacts.

The fruits of mathematical research affect the daily lives of everyone in the UK, for example:

- Smart-phones which use mathematical techniques to maximise the amount of information that can be transmitted
- Weather forecasting is based on complex mathematical models
- The latest Hollywood blockbusters take advantage of the mathematics behind software for 3D modelling to showcase cutting-edge special effects
- Elite athletes at the 2012 Olympic Games used tools based on sophisticated mathematics to maximise their performance.

It is not just contemporary mathematics research that has an impact. Research from the past century has paved the way



for technology used in a range of activities, goods and services, such as mobile telecommunications and medical devices.

## ECONOMIC IMPACT

The report estimated the contribution of mathematics to the UK economy in 2010 to be 2.8 million in employment terms (around 10 per cent of all jobs in the UK) and £208 billion in terms of GVA contribution (around 16 per cent of total UK GVA).

In addition to these direct impacts, mathematical research activities have influence across the supply chain (indirect effects) and also affect household spending (induced effects). There are also wider impacts and benefits generated by organisations using the research.

Productivity (as measured by GVA per worker) is significantly higher in mathematical science occupations compared to the UK average, and as such the direct GVA impact of mathematics in 2010 is

proportionately higher than the share of employment (16 per cent versus 10 per cent).

The direct contribution of mathematics is highest in research-dependent industries such as computer services, aerospace and pharmaceuticals. Mathematics plays a key role in tackling the modern-day challenge of cybersecurity,

## CONTRIBUTION OF MATHEMATICAL SCIENCES

- 10% of UK jobs, 16% of UK GVA
- Productivity of mathematical science occupations is double the UK average
- UK maths accounts for:
  - 4% of world maths researchers
  - 6% of mathematical articles
  - 11% of mathematical citations
  - 14% of highly-cited articles.



Professor Frank Kelly  
Chair, Council for the Mathematical Sciences

## ... personalised healthcare ...

ensuring that the UK is a safe place to do business and that we all benefit from a secure and resilient cyberspace. It is part of the 'big data revolution' with the development of massive databases and energy-efficient computing – both key areas highlighted by the government for excellence and contribution to economic growth – resulting in the need for new tools from the mathematical sciences.

UK manufacturing sectors such as aerospace, the second largest in the world, benefits from a highly-skilled home-grown workforce, superior manufacturing processes and sophisticated quality management systems – all made possible by research and training in mathematics.

High levels of employment associated with mathematics include sectors such as public administration and defence, architectural activities and technical consulting, construction and education. Mathematical science occupations include not only professional mathematicians and statisticians, but also engineers, physical scientists, IT professionals, social scientists, finance professionals, medical practitioners, administrators and senior managers.



## HOW MATHEMATICS CONTRIBUTES TO THE UK ECONOMY AND SOCIETY

Through its contribution to the development of a skilled workforce, the production of high-end, value products and the development of quality processes, mathematics enables us to:

- Make sense of data and better understand the world by building the 'information infrastructure' upon which myriad businesses and individuals rely, and supply the tools and techniques to analyse and interpret large datasets
- Safeguard society by modelling the impacts of natural disasters, testing drugs and contributing to national security
- Create robust forecasts to address uncertainty and allow for better planning and optimising processes to increase efficiency.

The generation and application of maths drives economic growth and develops prosperity.

## UK LIFE SCIENCES SECTOR

Without mathematics, the UK life sciences sector would not be in as strong a position to contribute to economic growth. It provides the expertise for the development of personalised healthcare and pharmaceuticals, as well as many medical technologies.

In the pharmaceutical industry, statisticians are involved in the design of clinical trials and also work across all areas of R&D, from the initial

## A DEFINITION OF MATHEMATICAL SCIENCES RESEARCH

For the purposes of this study mathematical sciences research was defined as high-end research in mathematics carried out in academic institutions, research centres, the private sector, government and by individuals that adds to the store of accumulated mathematical knowledge.

Mathematical sciences occupations were therefore those which either entail maths or which directly require mathematics-derived tools and techniques.

identification of medicines to product manufacture. In 2010 R&D expenditure amounted to £4.6 billion – 29 per cent of all UK R&D spend and the greatest in Europe.

Britain is a leading location for running the complex and often multinational studies needed to develop new medicines. The industry makes a substantial contribution to the British economy in terms of both income and employment, and has generated a trade surplus for the past 13 years. Exports exceeded imports by over £5 billion in 2011. The Government has identified the pharmaceutical sector as one of the industries to pull the UK out of the current recession.

## WEATHER FORECASTING

Mathematics continues to play a role in weather forecasting and modelling. The cost of not predicting changes in the physical world can be

immense. Natural disasters have cost the global economy over £100 billion in 2011 – the costliest in over 300 years of the insurance industry. With the effects of climate change becoming clearer, through extreme weather events, the demand for robust forecasts is greater than ever.

Around 2,000 mathematicians are employed by the UK Met Office to analyse and evaluate vast amounts of atmospheric information.

The UK is regarded in the meteorological industry as a talent hub with many institutions choosing to locate research facilities in the UK to take advantage of the high-quality workforce.

Mathematical sciences underpin our 21st century technology, economy and society, and as such are vital for the prosperity of the UK and its position in the world economy.

## THE TIMING OF ECONOMIC IMPACT

The study took into account the contribution of both contemporary research and past mathematics research since the full economic impact of a given piece of research may not be felt immediately.

A classic example is the Radon Transformation in topography, first introduced by mathematician Johann Radon in 1917. This research provided the mathematical basis for non-invasive imaging technology used in CAT scans and barcode scanners introduced over 50 years after Radon's breakthrough. Clearly, research performed nearly a century ago continues to benefit the UK economy and society today.

# THE ENERGY BILL – A Missed Opportunity

ROBERT FREER

A previous Energy Minister compared the task of writing an autonomous energy policy with that of Hunting the Snark. It need not be as difficult as that if approached logically.

Over the last ten years we have had a number of policy statements, energy reviews and White Papers from the Government about the national electricity supply, but none of them has been sufficiently realistic, workable or affordable to be successful.

One consistent flaw in these reports has been that Governments have been trying in one policy statement to achieve a number of objectives which although commendable in themselves are sometimes mutually incompatible. This approach is tantamount to asking a pharmacist to produce a drug which will treat everything from ingrowing toenails to dementia. This will not work. A successful policy for the national electricity supply needs to identify priorities and concentrate on solving them in turn

Another flaw has been a failure to recognise that electricity supply needs long term planning. Power stations like all mechanical equipment have a working life after which they become uneconomic and need replacing. We need a policy which encourages developers to invest and which ensures new power stations of adequate capacity are ready to come on line as the older ones

come to the end of their commercial lives.

A realistic policy for a national electricity supply should start by looking at the demand, and select the most appropriate generating equipment to meet that demand. To ensure security of the supply in order to meet the demand should be the overriding priority in building new power stations. Daily demand curves are prepared by the National Grid and Fig 1 shows the maximum and minimum daily demand for 2007, the year before the financial recession.

The maximum demand in winter (for which the system should be designed) starts with a base load of about 40GW. At about 5am the demand starts to increase and in a couple of hours reaches a plateau of about 60GW. After about 7.30pm the demand slowly falls away. In summer, when maintenance can be carried out, the general pattern remains the same but demand varies from a base load of about 25GW to a maximum of 45GW.

The most economical means of generating the base load has been from large power stations centrally located which at present use coal as their main fuel. Although we can no longer rely on being “an island built on coal and surrounded by fish” coal is likely to be our main fuel for the immediate future, especially if we use underground gasification of domestic reserves (an already established technique) or by using carbon capture and storage (yet to be demonstrated on a commercial scale).

With political pressure to reduce the use of coal the alternatives are gas or uranium. Both are imported, unless shale gas is found in substantial quantities, but the uranium is available from a number of stable countries and is needed only in much smaller quantities. Uranium also has the advantage that its cost is only a small part of the cost of generation and fluctuations in its cost of supply do not materially affect the price of electricity. Using present designs we need about 30-40

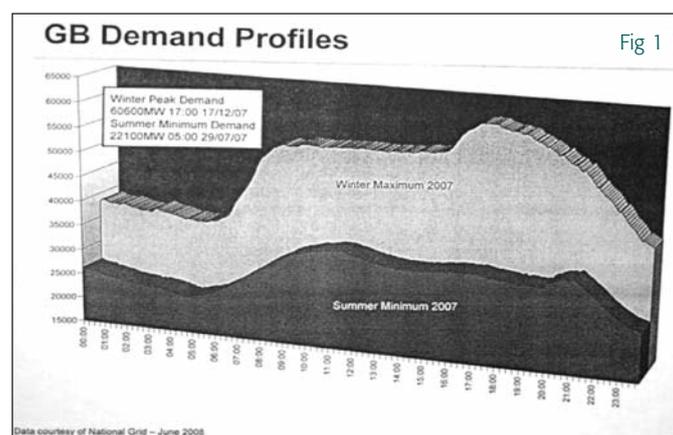
nuclear power stations to take the place of coal. This will also substantially reduce carbon emissions. Whichever fuel is used large centrally located power stations using the existing grid is the most technically efficient choice.

The daytime load can be met using gas turbines (CCGT) which are comparatively inexpensive to build and can be started and stopped quickly to match demand.

Small but useful contributions can be made from the thermal recycling of municipal waste (the council collects the rubbish in the morning and it is returned to householders as electricity in the afternoon) and hydro power which is specially useful in meeting peak demands. Both are well established technologies.

Intermittent supplies of energy from wind turbines are of virtually no use in ensuring security of supply.

Instead of taking the opportunity to use its financial support to promote and encourage the use of established engineering technology, especially the building of major new power stations, the Government's emphasis has been to encourage different ways of generating electricity, often on only a small scale, by using complicated, and sometimes illogical, financial incentives for the benefit of developers. And to do this without considering whether or not the customer



## PUNCH, OR THE LONDON CHARIVARI.



### LOOKING FORWARD.

"PRAY, DON'T PUT TOO MANY COALS ON, MARY! IT MAKES ME SHIVER WHEN I THINK THAT IN THREE HUNDRED YEARS WE SHALL HAVE NONE LEFT!"

[APRIL 25, 1868.

Fig 2

can use the electricity produced or to pay for the incentive.

The lack of new build means we are approaching an

"electricity cliff" as the older power stations are retired and not replaced. This will put our electricity supply in jeopardy for years to come.

To complicate matters further Governments of the past ten years have developed an obsession with wind generation which requires tweaking the National Grid to accommodate the intermittent and unpredictable bursts of small amounts of energy from wind farms. This is the tail wagging the dog. The National Grid is a major technical achievement built in the 1920s and 1930s which allowed the national distribution of electricity to replace the previous inefficient and expensive system of local generation.

Wind energy has the superficial attraction of being "free", which turns out to be an illusion. When fully costed it is more expensive than the alternatives<sup>1</sup>. Wind energy has to be subsidised on a generous scale which is bad engineering and bad economics. This subsidy is consumers' money which could be better spent elsewhere. There is no economic case for wind energy.

Rain is also free but when water is collected, processed and delivered to the home and to industry in a usable form it has to be paid for. And water can be stored whereas electricity cannot be stored and needs to be generated to match the customer's demand.

The Government should change the focus of their electricity policy to encourage the building of a sufficient number of new large power stations with adequate capacity which will ensure security of supply.

There is one part of the Energy Bill which can be fully supported. The Bill does encourage us to reduce demand and use less energy – a solution which Punch proposed in 1868, Fig 2

Robert Freer is a chartered engineer

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# HELIUM

## Why Recent Helium Shortages have Forced us to Temporarily Shut Down our Brain Research Centre



Dr Mark Stokes  
Head of Brain Stimulation, Oxford Centre for Human Brain Activity, Department of Psychiatry, University of Oxford

At the Oxford Centre for Human Brain Activity, we use magnetoencephalography (MEG) to study the human brain in health and disease. MEG is one of the most advanced methods currently available for non-invasive brain imaging, allowing us to listen in on brain function by measuring tiny disturbances in the magnetic field around the outside surface of the head.

MEG is the centrepiece of our brain imaging facility, and provides researchers and clinicians from all over Oxford, and further afield, state-of-the-art technology for safe, painless and accurate measurement of human brain activity. Recently, we have been forced to shut

down our facility on three separate occasions because of critical shortages in liquid helium supplies. We are all hoping for a better year in 2013, but the situation is far from guaranteed.

The superconducting quantum interference devices

... critical shortages in liquid helium supplies ...

(SQUIDS) used to measure subtle variations in magnetic field operate at a temperature of near absolute zero. Only liquid helium can maintain this critical operating temperature, and any disruption in supply causes an immediate shut down of the facility. These shutdowns are obviously disruptive to our research programme, but warming up the cryogenic sensors also incurs significant additional overheads as restarting the system requires a costly and time-consuming re-tune of the entire system from the manufacturer's service engineers.

### ... disruptive to our research programme ...

Although helium is the second most abundant element in the universe, supplies on earth are surprisingly limited. Helium inevitably floats off into space because it is inert and extremely light. Fortunately, the earth produces a very small amount of helium via slow radioactive decay. Most of this helium by-product also floats off into space more or less directly, but a small percentage is trapped underground. Over millions of years, helium has built up in recoverable quantities within a handful of reserves around the world.

The US Government has long appreciated the potential importance of helium for the national interest. Under the Helium Conservation Act of 1925, the US Government essentially seized control of helium supplies for military applications (eg airships). State control was relaxed by the Helium Act of 1937, which permitted helium sales to the private sector for other emerging applications, such as deep-sea

diving. However, by the 1950s the strategic value of helium was reignited by the rocket industry that was to power the space race, as well as the closely related arms race that was fought out in parallel. To safeguard the supply for the national interest, the Helium Acts Amendments of 1960 established an active programme of buying up helium from the private sector to store in the Federal Helium Reserve. Inevitably, all this strategic hoarding came at a huge financial cost. It was thought that the proceeds from future sales would be used to repay the

treasury loans, but the programme was in debt to the tune of \$1.3 billion by the repayment deadline in 1995.

The Helium Privatization Act of 1996 was introduced to sell off the government stockpile and pay off the debt to treasury by 2014, assuming that the market will have established an alternative source by then. But this alternative market source

### ... a handful of reserves ...

has not yet materialised, partly because the 'fire sale' on helium seriously distorted global markets. Moses Chan, Professor of Physics at Penn State University, explains: "the price of federally owned helium, which is set not by current market conditions but by the terms of the 1996 Act, dominates, if not actually controls, the price for crude helium worldwide". The US selloff essentially crippled the market incentive to invest in infrastructure for collecting

### ... crippled the market incentive. ...

helium during natural gas extraction. Cheap helium also drives misuse. A staggering 8% of the world's helium supply is currently used for filling party balloons.

To forestall disaster, Senator Bingaman has put forward a bill to Congress that would extend the Helium Reserve until all the remaining helium can be extracted. Other measures include more realistic pricing to correct the market distortion, and protections for US users. The immediate goal is to protect US medical, commercial and research applications from the serious supply disruptions we have experienced recently due to the rapid privatisation of the Federal Reserve. However, it remains unclear how this bill will affect global markets, and what will be the consequences for UK supplies.

What does the longer-term future hold? Helium demand will inevitably out-strip supply, and although the timescale of effective helium depletion

cryogenics, however, there is no substitute. Without helium, there will be no way to cool to near absolute zero. Our best hope lies in developing superconductors that can operate at higher temperatures. But even if we do manage to perfect higher-temperature super-conductivity in the future, who can predict what further need we may have for the super-cool properties of helium? Helium is a remarkable gas, with many unique properties – we will certainly miss it when it's gone.

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### ... Helium demand will inevitably out-strip supply ...



# ENERGY: A ROLE FOR PROSUMERS?



Frans van den Heuvel  
Chief Executive Officer, Solarcentury

**The energy debate is often full of doom and gloom. With bills going up dramatically, it is easy to feel powerless. Now the time is here for consumers to take control of their energy production.**

Let us remind ourselves that energy powers our society and modernising energy modernises us. How else do we get to the digital lives that we are promised in sci-fi? We leap forward with the next generation of energy, our catalyst for modernity. While there may be anger about bills and fear about climate change, these are the pains of growth in a new direction. We are the fortunate ones to be involved in the third industrial revolution.

The next generation of energy is bringing about a paradigm shift. It is no longer just about financial and social capital but also natural capital. By that, I mean nature is an asset. How dependent are we on its resources? How much do you consume? Whether one runs a country, a company or a family, we must manage our relationships with energy, fuel, water and waste. Our success, our wealth and competitiveness depend upon it. Sustainability is not news, nor is energy getting expensive but it seems to be hitting home only now.

The paradigm shift does not stop with our attitude. In fact, this is where it begins. What greatly alters is our role as energy consumers. We become

both energy producers and consumers, or Prosumers. This is truly modern. Traditionally, our energy producers were utility companies. Traditionally, our energy retailers were utilities too. But now the man on the street is producing and retailing energy as he feeds into the grid. It is happening in the UK; there are solar panels on roofs, both residential and commercial. Energy has begun the process of decentralisation. Next is the transition to smart grids and energy storage in the home and car. We will all be producers, retailers as well as a storage unit for electricity.

This requires local optimisation of production, consumption and storage behind the electricity meters, at customer level. A Distribution Network Operator (DNO) manages the mid- and low-voltage grid, avoiding congestion. Once we produce 15-20% of our electricity locally, the grid in regions like Europe and the US will become unstable due to congestion. IT technology, creating a smarter grid, can prevent this, saving billions in grid extension investments for DNO's. In addition, it will enable the Transmission System Operators (TSO) to balance the

### ... Energy has begun the process of decentralisation ...

This we know already. But what I see for the future is an energy internet, a synergy amongst prosumers. One business has a big roof so installs a large solar system to be the local producer, the neighbouring factory has high-energy use from all its equipment and so has additional consumption requirements. Local electric cars act as a storage unit, a battery for the community.

grid more effectively as consumers will automatically use or store electricity that would otherwise be surplus and sold at a loss. Of course, for this to happen, the right regulatory framework needs to be put in place.

We are bombarded with the idea that the shift to renewables will cripple our economy. So far this has not happened in the UK. The UK has increased its share of renewables in electricity from 5.0% to 9.4% since 2007. According to OFGEM, the Feed-in-Tariff (FiTs) subsidies have added less than £1 per annum per home. The Renewable

... creating over 100,000 jobs ...

Obligations (ROC) has added £21 per annum per home. These figures are for all renewable technologies. Whereas we have seen an average increase of £100 per home in energy bills just this year, mainly due to exposure to volatile energy markets. The price of fossil fuels is moving in only one direction – up.

If we look at the experience in Germany, they have 20% renewable electricity at a cost of £34.50 per annum per home. The impact of local generation of energy through solar PV (photovoltaic) has been overwhelmingly positive. The

impact of decentralised PV and wind, benefiting consumers and businesses. The solar power industry is also credited with creating over 100,000 jobs in Germany.

I envisage a new network of prosumers. How will we, our appliances and our cars interact with each other and the grid? Much has been promised and much confusion surrounds smart grids and what they can deliver and how they change our lives. But really what is being rolled out now is only a fraction of what is needed. It is the difference between an old-fashioned landline telephone

This is what is needed with the grid, not just the dumb ‘smart’ meter that is being offered now. These reveal nothing about the behaviour of the house, the appliances consuming the energy or the people in charge. We need to know what happens behind the meter so we can offer advice on how to act, how to save energy, how to be efficient. Then, we can buy energy off the grid when it is cheapest not just when we use it. We may have lost some of the old ways of doing things with the digital revolution but it has created much growth and many jobs. We must open up the untapped market behind the meter and let business and innovation flourish there.

the light, the more energy is produced and the more money the solar panel generates.

At present the cost of generating solar PV energy is more expensive than gas in the UK, which it competes with for the peak-load market. However the price of a PV installation has plummeted in the last two years, and as the price of the panel drops, it reaches grid parity, starting with areas with highest irradiation and the most expensive conventional energy. According to the McKinsey report, Darkest Before Dawn, solar PV will reach grid parity for the UK around 2014. PV has already reached parity in some developed markets, including parts of California, Spain, Italy, Australia and The Netherlands.

In 2011, global power investments totalled 203 GW of electricity, almost 50% of which is renewable. This percentage is substantially higher if we consider only European investments. This staggering trend confirms that an energy transition is taking place.

A beautiful sunrise after a long dark night.

## ... and the more money the solar panel generates ...

Germans have installed over 32GW of solar PV. This contributes energy during daylight hours when there is greatest demand for electricity (known as the peak-load). Normally, this is when electricity is most expensive. However, the peak-load price of electricity has fallen from 58€/MWh to 44€/MWh, a fall of nearly 25% since 2008 because of the

and an iPhone. The latter is attached to the home and offers no insight into the user. What happens behind the landline, nobody knows? On the other hand, the mobile has become a vital channel for collecting data on users. With those data, companies can offer solutions; offer new products and services, making lives better.

The mood is now set for change. The next frontier is grid parity, which is already hitting parts of Europe. For solar PV, what is important is the intensity of light (irradiation) as opposed to the temperature. It does not need to be hot, it just needs to be light to generate PV power. Different parts of Europe and the UK have different levels of light intensity. The more intense

## ENERGY – THE NEXT GENERATION

# ENERGY – A ROLE FOR SHALE GAS?



Francis Egan  
Chief Executive Officer, Cuadrilla Resources Limited

**The prospects for shale gas in the UK and in parts of continental Europe are very promising, based on assessments of a number of geological formations that are not dissimilar in scale to US and Canadian sites where major deposits of natural gas have been discovered.**

There are upsides to development of an indigenous shale gas industry:

- Reducing our import dependency of liquid natural gas and pipeline gas (we

currently import 50% of our gas)

- A decreased carbon footprint as indigenous natural gas displaces coal and gas imports
- An opportunity to make the

UK a leading centre of shale expertise for Europe and the developing world

- Substantial tax revenues for the Treasury and significant employment opportunities.



However, the journey to realising this opportunity is not purely technical or geological. It is socio-political. And here, all comparisons with the US are essentially irrelevant, because developing shale gas in the UK is a story of two journeys, not one.

## WHO IS CUADRILLA?

Cuadrilla is a UK company, formed in 2008, whose mission is to unlock onshore oil and gas in the UK and Europe.

Cuadrilla's team consists of highly experienced shale gas explorers and engineers. We integrate the technical side with a risk management team who

(OGIP) in the Bowland basin alone. We are analysing a 3D seismic survey completed over the licence area, and analysis of data from the next well, which we are drilling at the Anna's Road site near Blackpool. Based on this we may raise our estimates of OGIP.

However, what of this is recoverable?

The recoverable reserve is a function of shale geology and a function of the number of horizontal wells that can be drilled and fractured. Estimates range from 10% to 40%. Only experience will reveal what we can recover from the Bowland shale.

## ... fully informed about the practice of shale exploration ...

work with regulators and communities to manage health, safety and environmental issues. We are committed to ensuring that all stakeholders across Government and Parliament, along with the general public, are fully informed about the practice of shale exploration, development and production in the UK.

We understand the need for transparency and openness and adopt this ethic at every stage.

We are on two journeys. One is the geological and technical. The other is the socio-political. We strive for excellence on both journeys.

## THE ISSUE IS NOT GAS IN PLACE, BUT ITS RECOVERABILITY

The geological journey has produced some eye-popping opportunity. The economic benefits of shale gas have not yet been fully ascertained. Based on our surveys, core samples and analysis, we believe there are at least 200 trillion cubic feet (TCF) of original gas in place

Our exploration has shown that the Bowland shale in Lancashire is significantly thicker than any comparable US shale. This opens the possibility of developing a very productive horizontal drilling approach, with a much lower-density surface "footprint" than US shale plays.

The most important factors for determining whether shale gas is present and the scale of the resource is dependent on

## ... reality under the ground is much more complex ...

- (1) *Thickness* of the shale
- (2) Natural *fracture intensity* (high fracture intensity allows for increased production rates and recoverable reserves)
- (3) "*Frac-ability*" meaning how brittle and easily the rock will crack
- (4) *Structural setting* (extensional, compressional or strike-slip)
- (5) *Total gas volume*

## ... "surfing" the best layers takes experience. ...

- (6) *Carbon* remaining in the rock or total organic content (TOC)
- (7) *Temperature and depths* of the shale reserve
- (8) *Reservoir pressure* and its stress regime.

Artists usually render shale as a series of coherent horizontal layers. Overall this is a fair picture, but the reality under the ground is much more complex as the layers themselves have been disturbed by sedimentation and the displacements of fault lines in the subsurface. In the UK, Cuadrilla's 3D seismic survey in the Fylde shows there is remarkable subsurface complexity. The Bowland regime shows sequences that reflect disturbance from faults we can see – and faults we cannot see.

What does this do to the chances of successfully fracturing the rock? The analysis is helpful, but no substitute for actual appraisal. We need to fracture some shale, and learn more.

We are hoping the regulators will allow us to fracture and test two wells to start. We are confident that the industry can learn how to work with these formations. Recovery of shale is the product of continuous operating experience coming from both appraisal and production drilling. The process of finding and "surfing" the best layers takes experience.

## WHAT ABOUT THE RISKS?

There are issues about seismicity, migration of hydrocarbons to the aquifer, water use and management. It is important that regulators and operators develop, implement, monitor and improve practices that identify and mitigate these risks.

The UK has a strict regulatory framework governing both offshore and onshore oil and gas exploration and production. Risks with shale exploration are heavily regulated and closely scrutinised by the relevant independent bodies.

Our principal regulator, DECC, and Cuadrilla are guided by best practice. The Royal Society together with the Royal Academy of Engineering have put together a guiding framework for developing shale gas safely.

This is a collaborative process. An example of this is seismicity. Even the best 3D survey cannot see all the faults, and importantly, the pressures. For our first two wells, we developed a plan with DECC to install a micro-seismic array, so that we can see the effects of hydro-fracturing in real time. We can therefore be aware of a perturbation before it is discernible to humans, and reduce our pressures, or move on to another section of the well-bore. It will also help us save water, because a shale can leak away pressure. We will know when we have optimised any given fracture.

Our seismic array is very expensive and is installed in many locations. It cannot be

## ... framework for developing shale gas safely ...

scaled for every well without considerable cost and inconvenience. If experience shows our "traffic-light" system can function with less sensitivity, then we will be able to optimize fracturing at a lower cost and inconvenience.

The water risk is more about our well integrity than fracturing, per se. Above the Bowland shale formation in Lancashire lies the Manchester Marl, a thick impermeable rock forming the 'regional seal', a barrier between the hydrocarbons trapped in the Shale rock below and the aquifer several thousand feet above. We consider it exceedingly unlikely that hydrocarbons or fracturing fluid could leak into shallow aquifer water as a result of the fracturing process. This is very different

from coal bed methane. The fracturing risks from the two are often confused.

### THINK AHEAD TO DEVELOPMENT

If the shale proves out, what will development itself look like? We are treated to pictures of Pennsylvania or Texas – a veritable "pincushion" of locations. Will that be the same here?

We believe development here will be very different and much lower density for several reasons. The thickness of the shale is one of them.

Horizontal wells can radiate from the same well bore like the tines of a fork, and radially in several directions. We have learned that the Bowland shale

is unusually thick, this can be repeated at different vertical levels, so called "vertically stacked" horizontal wells. One pad can manage around 36 such horizontal wells, using current technology, and probably more in the future. Each horizontal well is equivalent to a piece of keyhole surgery.

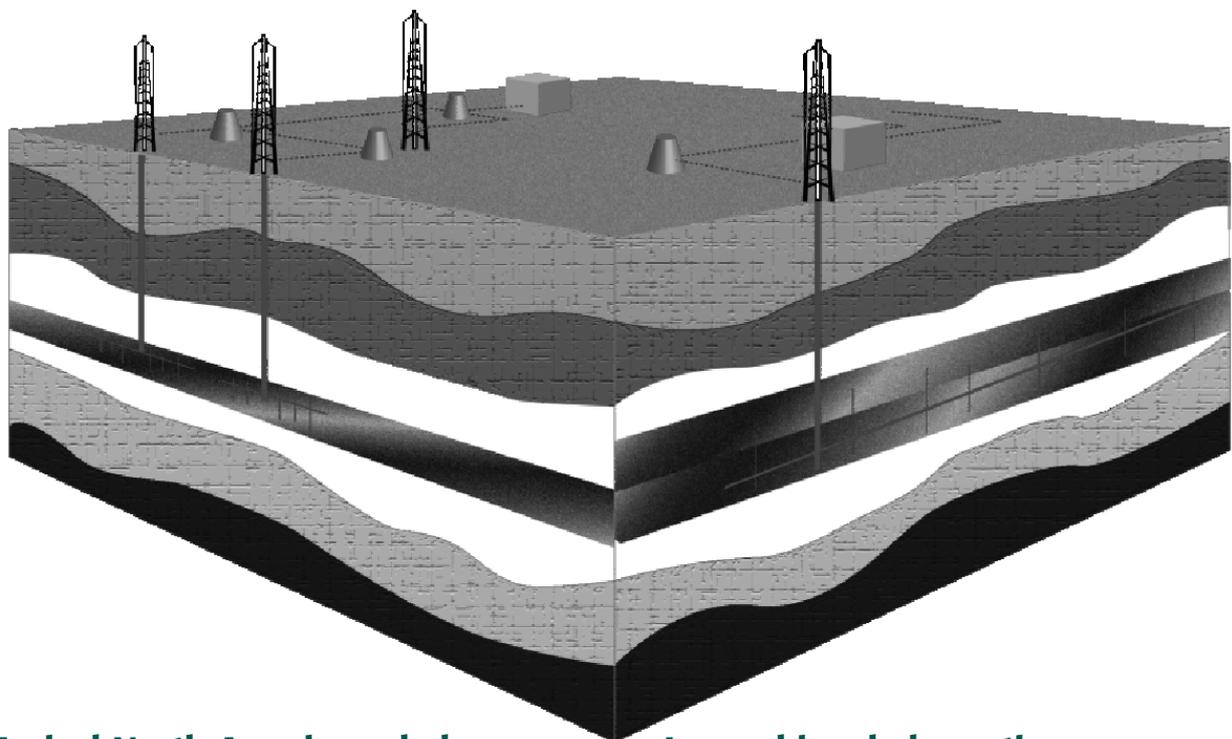
A lot of development can thus take place from a small number of pads – hence our view that the UK offers a low-density development opportunity. Moreover, those pads can also be sites that generate electricity to back up intermittent renewable sources, or provide district heating. In other words, the very concept of "pad" can be re-thought.

### THE SOCIO-POLITICAL CONTEXT

The limitations of UK shale are highly dependent upon the level of public and political acceptance. In the US, exploration firms have traditionally excelled at the technical side of shale development, but less so at understanding and effectively managing the socio-political context. In the UK, we need to tell a different story. Onshore shale development is a relatively new phenomenon across Europe, and because the sector attracted its share of controversy from the outset, Cuadrilla has quickly come to grips with the challenges of the 'social licence to operate'.

This is why we are listening to a wide number of

## ... effectively managing the socio-political context ...



**Typical North American shale section:** Relatively thin shale target (<60m thickness)

**Lancashire shale section:** Much thicker (up to 1'200m thickness) and more structurally complex

stakeholders at every stage. This gives us a unique understanding of the issues.

“Energy” is not a living room topic in the UK, apart from complaints about energy bills. We have learned that all stakeholders have a great deal to learn about natural gas, much less onshore gas. Easy comparisons with US shale gas experience are often misleading. Mis-information is particularly sticky. The image of the flaming tap water has been discredited because hydrocarbons in that part of the US are very close to the surface. But that doesn't matter, because it speaks to a deep fear of the unknown.

A consequence of what we have learned from our stakeholders is the need for a form of ‘industrial education’ so that Government, opposition,

industry bodies, academia, and our supply chain have the opportunity to learn from each other, and can work together to enlist the engagement and understanding of the local and national population.

This education is not pedagogic – it is a “conversation” with different independent voices, including those who are sceptical about shale. This is what we are hoping to catalyse, so that people can make up their own minds.

### IN SUMMARY...

As a socially responsible company, Cuadrilla has made it a goal to demonstrate that shale gas from the UK Bowland licence can be developed safely in an environmentally responsible fashion that is acceptable to all affected

communities. As outlined there are two aspects to this mission, technical and the socio-political.

We await operational clearance to resume our fracturing operations so that we can prove that this gas can be hydro-fractured and will flow successfully. Achieving one or two proven flowing shale gas wells will be a major milestone for Cuadrilla and for the UK.

Maximising the benefit of shale gas for the UK will require a process of long-term investment and technological innovation and improvement by Cuadrilla and others. Shale gas specific expertise can be imported from the US, but the UK has significant oil and gas knowledge and can and must further develop its own shale gas capabilities. These can then be employed not just in the UK but also in European and Global

shale markets.

The UK currently has a first-mover advantage in Europe, while being able to rely and improve upon expertise developed in the United States. However, Cuadrilla recognises that shale gas is a sovereign resource, and ultimately the decision over whether or not to develop it, and at what speed, is a socio-political one. The balancing of local concerns with national priorities is a difficult act.

In this, we err on the side of the communities that we are in the process of becoming part of. Their interests and our interests are closely intertwined. At the same time, clear directives from the centre regarding the national interest, alongside stable and pragmatic policies, will give us the confidence to invest in those communities for the long term.

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## ENERGY – THE NEXT GENERATION

# ENERGY – A ROLE FOR WIND POWER

### The third speaker on 16th October was Dr Gordon Edge, Director of Policy, RenewableUK

He made the following points

RenewableUK is the trade body representing wind power generation.

The UK currently has 5,000MW (5GW) of onshore wind power capacity installed. Together with 2,700 MW (2.7GW) of offshore, this generated 5% of the country's electricity in 2011. This increased by 30% during 2012, and it is anticipated to have 7GW and 4GW respectively available by 2014.

There is also a significant backlog of approved onshore

installations waiting to be built at a cost of around £1bn per GW.

This is all financed by the private sector.

The Department for Energy and Climate Change (DECC) has recently published its targets for 2020. These are 13GW of onshore capacity, and at least 18GW offshore. The industry is totally confident that these are achievable.

Onshore wind generated electricity is the cheapest low carbon source. Offshore wind's present cost is £140 per MWh, but the target is to reduce this to

£100 per MWh.

Wind power is often described as “intermittent”. This is misleading. It suggests that the power is switched on and off at a whim.

The correct description is “variable”. The important point is that too little (and also too much – in excess of 25m/sec) is predictable many hours in advance, and therefore contingency alternatives can be made available. Building a “spare” gas fired plant is not expensive.

However in the longer term, interconnection needs to be increased. The UK already imports power from France and the Netherlands, and future connections to countries such as Norway will allow us to share surpluses and shortfalls to the mutual benefit of all.

Further information is available at <http://www.renewableuk.com/>

Alan Malcolm  
Editor, Science in Parliament

# WHAT NEXT FOR BIOSCIENCE BUSINESS INCUBATORS?



Dr Glenn Crocker  
CEO, BioCity Nottingham and  
BioCity Scotland

*Dr Glenn Crocker is CEO of BioCity Nottingham and BioCity Scotland, and author of the UK Life Science Start-up Reports. Having overseen the foundation and development of two bioscience business incubators, as well as the Mobius Life Science Fund, Dr Crocker shares some of the lessons of the past decade. He describes how a careful balance between partnership, creativity and risk management is crucial for business incubation success. He draws on the findings of the 2012 UK Life Science Start-up Report (pub. Dec 2012<sup>1</sup>) to reflect on the changing pressures in the bioscience market place, and where public and private sector intervention may be required.*

It is ten years since BASF gifted their research facility in Nottingham to Nottingham Trent University to seed a bioscience business incubator, BioCity Nottingham; and one year since MSD handed their 23 acre site at Newhouse in Lanarkshire over to the BioCity team for the creation of BioCity Scotland. What motivated us to take on otherwise redundant buildings and equipment was a vision to build centres of life science excellence, in which new companies can thrive. BioCity is home to over 85 life science companies, by far the largest concentration in the UK, and has established a business model which provides an ecosystem for company formation and growth. We need to know what's going on with life science start-ups in the UK, and so we initiated the UK Life Science Start-up reports, designed to tell us what companies are being formed; where they are located and what the funding climate is like.

## HEADLINE FINDINGS

This is the third comprehensive study of early-stage life science firms across the UK covering the period 2007-2011.

An optimistic picture of the UK life sciences sector emerges with 291 new firms launched in the study period. At the same time, shock waves from the seismic shifts in the way pharmaceutical companies operate have led to a realignment in the industry's business model. The picture is of an industry shaping up to capitalise on the strengthening UK bioscience clusters, the shift

to more specialist pharma service companies, new models for R&D collaboration and the introduction of new funding initiatives.

However, there has been a reduction in the formation of university spin-out companies. Interestingly, this trend is bucked in Scotland where the increase in start-ups is entirely accounted for by increased university spin-outs, up 47% in the study period. Scotland emerges as the leading location for life science start-up companies, assisted in part by strong public sector support and investment as well as an extensive Angel investor network.

This raises the question as to where the new generation of life science companies will come from. Universities are no longer driven by government imposed spin-out metrics, and are more circumspect when it comes to determining whether to spin-out or license a technology. Too many universities jumped onto the spin-out bandwagon without the wherewithal to produce good quality businesses. Many spin-outs failed to take off or deliver any returns. However there is a balance to be struck. The pendulum may have swung too far, and the pool of innovative companies needs to be refreshed.

Reinforcing this decline has been the exhaustion over recent years of the University Challenge Funds, which invested

£250,000-£500,000 in spin-outs. University Challenge Funds were a good idea but limited in what they could achieve. Rather than create a substantial fund to target investment in the best spin-outs, small, regional funds were created which had to get rid of small amounts and many sub-optimally capitalised businesses were created.

Despite the drop in university activity, the demand for physical space and business support provided by the UK network of business incubators is on the increase. Over a quarter of the most recent life science start-ups are located in a bioincubator with another 15% in bio or science parks. BioCity Nottingham, the UK's busiest bioscience start-up incubator, is at 85% capacity and by June 2013 BioCity Scotland is expected to have over 30,000 sq ft of space occupied.

A glance at the membership of UKSPA, the UK Science Parks Association, reveals a wealth of locations, configurations, management styles and service offerings. However, at BioCity we emphasise the quality of services beyond a mere landlord-tenancy agreement. Occupancy is one thing; engagement in a community of like-minded, ambitious companies surrounded by a support infrastructure capable of seeing them over the early-growth hurdles is crucial. BioCity Nottingham was gifted to Nottingham Trent University in

... the pool of innovative companies  
needs to be refreshed. ...



## ... lack of appropriate investment funding ...

2001 for the establishment of a facility dedicated to the creation and nurture of new bioscience companies. The University of Nottingham and the then Regional Development Agency emda joined NTU as Members of BioCity and a unique support 'ecosystem' was built.

Bioscience incubators need to get the tenancy offering right by understanding the often complex needs for labs, access to expensive equipment on a lease agreement, as well as offices and business support. It is possible to develop an ecosystem to nurture new companies which allows access to central services such as book-keeping and PR, catering facilities, meeting rooms, social events and clubs. In other words, building a business community others want to join.

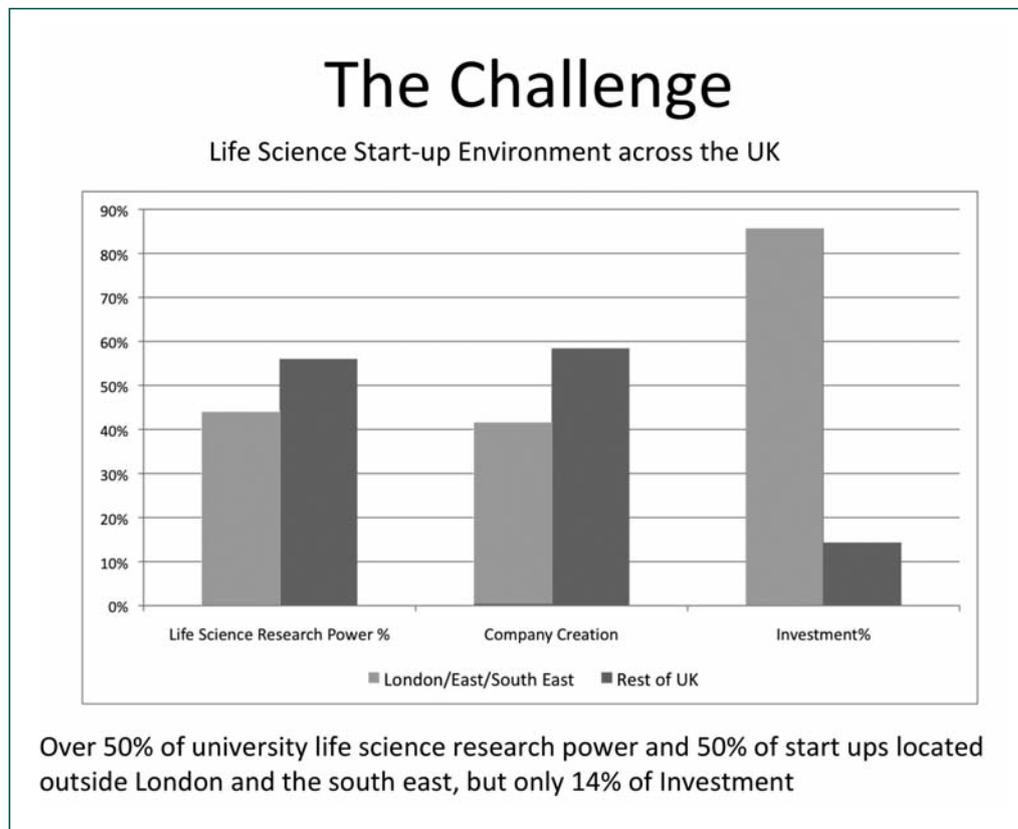
The bioscience incubator looks and feels like the different divisions found in a global pharmaceutical giant, only made up of smaller, independent companies more adaptable and less vulnerable to shifting tides. BioCity is self-financing, including the investments it makes in start-ups; however, public sector funding support is also vital if we are going to leverage medical and life sciences innovation for the benefit of the UK.

The area of most concern to those of us supporting new companies is the continued lack of appropriate investment funding. Despite the introduction of the £180 million Biomedical

Catalyst initiative, there remains a need for early-stage risk funding. According to the 2012 report, 24% of start-ups obtained investment in the period 2007-11, compared to 37% in the period 2005-09. This decline could reflect a greater use of funding from grants, friends and family but the largest fall in investment activity was seen in smaller-scale sub-£500k amounts, down by 23% in number and 17% in value. This is possibly caused by the end of the regional venture capital funds (RVCF) and the University Challenge Funds. Despite opportunities to invest in

companies across the UK, 86% of investment into life science start-ups went to companies in London, the South East and East of England.

brief investors about new opportunities and the potential returns. Despite much hand-wringing in the UK, we have an excellent research base and a strong entrepreneurial



Clearly success relies on companies attracting the right level of funding; building strong management teams, and exploiting the latest technology.

We can expect more focused activity between big

ecosystem. We can be encouraged by renewed government interest in the life sciences as well as the emergence of new funding streams. We have grounds for optimism.

## ... renewed government interest in the life sciences ...

pharmaceutical companies and investors working together on specific projects. This will require the involvement of universities, partnerships with venture capital funds, the provision of sophisticated incubation facilities, sharing of R&D expertise and Open Innovation.

It is our role to help start-ups to spot the opportunities and to

### Reference:

- 1 'Realignment' UK Life Science Start-up report 2012. Published by Mobius Life Sciences Fund 2012. Copies available for download from [www.biocity.co.uk](http://www.biocity.co.uk).

## ... beyond a mere landlord-tenancy agreement ...

# ASH DIEBACK – THE BIOLOGY AND SPREAD OF *Chalara Fraxinea/Hymenoscyphus Pseudoalbidus*



Professor Peter Freer-Smith  
Forestry Commission Chief Scientific  
Adviser, Forest Research

Ash (*Fraxinus excelsior*) is one of only about 30 major tree species native to the British Isles. It is thus a significant component of native woodlands being important in woodland regeneration and succession dynamics. Ash is often a component of mixed broadleaved woodlands and pure ash stands occur naturally in the uplands. Britain has a number of Special Areas of Conservation which are designated because of the tilio-acerion woodlands of ash and other species. Ash is the second most planted broadleaved tree of managed woodlands making up about 5.4% of Great Britain's woodland cover. Its good ability to regenerate naturally means that it is also an important and valued hedgerow and urban tree.

As with other trees, dieback is known to occur in ash and work has been done in the UK over the years to determine its extent, severity and causal mechanisms (Hull & Gibbs, 1991). However from the early 1990s onwards more serious and spreading ash dieback was reported across mainland Europe. Dieback was first noticed in or around Latvia and Poland in c 1990, since then it has spread westwards being reported in Germany in 2002, Denmark in 2003, Belgium in 2010, Northern France in 2012. Symptoms were leaf wilt then necrosis,

defoliation, cankers on branches and stems resulting in crown dieback. Affected trees usually die although the period between early symptoms and tree mortality can be several years. In 2006 the causal agent of this new ash dieback was identified as the fungus *Chalara fraxinea* (Chalara) which was considered to be new to science (Kowalski, 2006). Three years later it was suggested that Chalara was a stage (the asexual form or anamorph) in the life cycle of the cup fungus *Hymenoscyphus albidus*, which had been known since 1851. *H.albidus* is a saprophytic ascomycete which lives on ash leaves without causing harm and indeed being responsible for leaf decay and nutrient release from fallen leaves on the forest floor. It is

anamorph of *H.albidus*, but was the asexual phase of a newly identified fungus *Hymenoscyphus pseudoalbidus* (Queloz et al 2010). *H.pseudoalbidus* is identical to *H.albidus* in appearance and the two can be distinguished only by DNA analysis. However it appears that only *H.pseudoalbidus* has the pathogenic asexual phase now known as Chalara. The lag between arrival of the disease and the identification of the causal agent and the time taken to sort out its taxonomy have been factors in the lack of action over this new ash dieback as it spread across mainland Europe.

We know that Chalara has a life-cycle which is unique but not unlike that of a number of

### ... identified as the fungus

#### *Chalara fraxinea*...

indigenous across Europe. However as a result of the spread and severity of Chalara-related ash dieback across Europe with some 60 to 90% of trees infected in many countries, Chalara was added to the European & Mediterranean Plant Protection Organisation alert list in 2007. In 2009 Forest Research published on its website a description of symptoms and the UK forestry and land management sector were asked to be alert for symptoms.

Molecular studies conducted in 2010 showed that the pathogen responsible for ash dieback (Chalara) was not the

other ascomycetes. The cup fungus or fruiting body (apothecia) of *H.pseudoalbidus* is c 3mm across and grows on the midrib or rachis (central stem of the compound leaf of ash) of fallen leaves. Each midrib may have many fruiting bodies and each produces a large number of ascospores over a period of about two weeks at some time between July and October. Spores are shed from the fruiting body around dusk and are small (17 x 4µ) floating freely in the wind. When sufficient spores are intercepted by ash foliage and twigs, they develop as Chalara infection which grows slowly, the leaves

### ... Ash is the second most planted broadleaved tree ...

## ... a systemic infection which discolours the wood ...

wilt and develop areas of black necrosis. The fungus spreads down the shoots infecting the inner bark and xylem causing lesions and shoot dieback. In branches and eventually the main stem, Chalara spreads as a systemic infection which discolours the wood. It may take several years for the tree to die but the discolouration of infected wood reduces its value. Mortality occurs more quickly on saplings. Chalara persists over winter on fallen leaves on the forest floor until the fruiting bodies of the sexual phase (*H. pseudoalbidus*) are produced in the following summer. Critically, spread of the infection is by two mechanisms – the movement of windblown spores and transportation of young plants with infected foliage. The disease has spread in Europe at rates of c 20 to 30 km per year and this is mainly associated with the first of these two mechanisms; windblown ascospores. These life cycle details have important consequences for the control of the outbreak and the longer-term prospects for adapting ash silviculture to the presence of Chalara in Britain.

In 2009 the Forestry Commission conducted a limited survey of ash in GB to look for Chalara infection and did not identify the disease as being present. Chalara was first found in the UK in February 2012 in a forest nursery which had imported young trees from the Netherlands. Since then it has been found in a number and variety of locations in Britain – initially all these were sites which had received young ash plants from nurseries in the last

five years. A Pest Risk Assessment (PRA) on Chalara was published and a formal consultation on its management was held during September and October 2012. However infection was found in an established woodland in late October 2012 and by the end of October it had been found to be present in over 40 woodland sites in East Anglia and Kent. The UK Government took emergency measures on 29th October banning the import of

ash and imposing movement restrictions in the UK. A rapid survey of ash was conducted by the Forestry Commission in the first week of November 2012 with three sites being inspected in every 10Km grid square of GB. During November as samples from this survey were analysed the presence of Chalara across Great Britain and Northern Ireland has become more clearly understood. By 28th November the disease was known to have been present in 17 nurseries, 105 recently planted sites and 135 sites in the wider environment (woodland, hedgerow and amenity trees). In addition to the rapid survey an important source of information is the observations of the forestry and land management sector and the wider public. At the time of writing the Forest Research Disease Diagnostic and Advisory Service has received a large number of enquiries about ash health. These reports are

investigated and some result in the identification of infected sites.

For nurseries and recently planted sites there are good prospects for elimination of the infection by destroying infected material. The wider environment sites will inevitably prove more difficult to manage. However these sites are clustered on the east side of England (131 sites) and Scotland (only four wider environment sites at November 28 2012), and ascospore production will not occur from the fallen leaf litter of these sites until May 2013 giving a short window during which a control

strategy or plan can be drawn up based on the best available evidence. The Chalara control plan will be published in early December 2012 along with supporting biosecurity and operational guidance.

There remain a number of important gaps in our knowledge of the biology and epidemiology of *Chalara fraxinea* / *Hymenoscyphus pseudoalbidus* which need to be addressed as quickly as possible to inform the control strategy or plan can be drawn up based on the best available evidence. The Chalara control plan will be published in early December 2012 along with supporting biosecurity and operational guidance.

There is some evidence to suggest that ash in GB may survive the arrival of Chalara. There are a number of fungal pathogens present in our woodlands which can be tolerated through good biosecurity and appropriate management (forest operations). For a small number of fungal pathogens biocontrol systems have been developed. Lastly it is known that there is a range of susceptibility of different ash species to Chalara, *Fraxinus excelsior*, *F. angustifolia* (narrow-leaved ash), *F. nigra* (American black ash) are the most susceptible. *F. ornus* (flowering ash from mainland Europe) and *F. pennsylvanica* (Green ash) are of moderate susceptibility while *F. americana* (American ash) and *F. manschurica* (from North

## ... ash in GB may survive the arrival of Chalara ...

eastern Asia) are the least susceptible. In addition, observations in Europe have shown that some 1 to 2% of *F. excelsior* – our native ash – show some level of useful resistance. Useful meaning resistance which could be exploited in a breeding programme. The Future Trees Trust ([www.futuretrees.org/](http://www.futuretrees.org/)) is an organisation with a range of partners in the UK and The Irish

## ... the relationship between it and its host ...

plan and its implementation. Critical questions are: How common are incidences of ascospore arrival from Europe with sufficient inoculum potential to infect trees in the UK? Will such incursions diminish in frequency and intensity of inoculum potential as ash dies in Europe and Scandinavia? Do the conidia (spores) produced by the asexual phase (Chalara) result in

spread of the disease as well as the ascospores produced by *H. pseudoalbidus*? How will the fungus and the relationship between it and its host (ash) now evolve? Can we deal with the recently planted sites which are infected before they become sources of infection in established woodlands? If so can we develop and implement the control strategy so that it is more effective in slowing the spread of Chalara?

## ... banning the import of ash ...

Republic which has made real progress in broadleaved tree breeding and which has a number of ash collections that will make an excellent starting point for the breeding of Chalara resistant or tolerant *F.excelisior*.

of Chalara has proved to be a further reminder of the importance of proactive work to protect trees, woodlands and the natural environment from plant pests and diseases. Good biosecurity measures and an effective plant health regime are

### ... resistance which could be exploited ...

The risk from tree pests and pathogens is growing with the expansion of international trade and the transport of live trees and timber products. The arrival

clearly essential. For woodlands, trees and the natural environment there is an ongoing need to manage established and emerging pests and

### ... new pests are likely to arrive occasionally ...

pathogens. However effective our border controls, new pests and pathogens are likely to arrive occasionally, and we know that pathogenicity can develop through evolutionary change to non pathogenic, indigenous fungi. Fungi and invertebrates will remain as components of forest ecosystems. Tree species selection, regeneration methods, silvicultural systems and woodland management overall need to be undertaken in ways

which optimise resilience to pests and pathogens.

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## ASH TREES – EFFECT OF CHALARA FRAXINEA

# CHALARA ASH DIEBACK IN CONTEXT



Martin Ward  
UK Chief Plant Health Officer, Defra

***Chalara fraxinea* is one of many organisms which threaten our trees, crops, gardens and ecosystems. In 2012 it was found established in woodland in eastern England, probably through aerial spread of spores from the continent. It has also been introduced on infected young plants. It is likely that Chalara originally arrived in Europe on imported plants from the Far East.**

There are standards and legislation to reduce the risk of such organisms spreading. These are currently under review to see how they can be made more effective, while continuing



Symptoms of ash dieback, with some regrowth from new shoots

to facilitate safe trade. Under the Sanitary and Phytosanitary Agreement (SPS) of the World Trade Organisation countries may take measures to protect human, animal or plant health. Standards agreed under the International Plant Protection Convention (IPPC) set out how risks should be assessed, how risk management measures are

selected and applied, and the form of phytosanitary certificate to be used for trade. The “phyto” represents a statement from the plant health service in the exporting country to the importing country that a consignment of plants or produce meets import requirements and is free from quarantine pests.

A quarantine pest is defined by the IPPC as “A pest of potential economic [including environmental] importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled”. “Pest” covers fungal and bacterial pathogens, viruses and nematodes, as well as insects.

Low grade wooden packing material, with bark attached, has proved an effective pathway for



## ... eradication campaigns for pests of arable crops ...

moving pests around the world, and difficult to regulate at a national level. International Standard 15 requires wooden packaging material to be treated (usually by heating) and branded with an internationally recognised mark. The recent outbreak of Asian longhorn beetle in Kent is likely to have been caused by import of infested wooden packaging material before this standard was implemented.

International standards do not set out lists of quarantine pests: a quarantine pest in one region is often unregulated in some other part of the world. This may be because it originates there, and natural enemies limit its impact, or its host plants have evolved resistance over many years. Pests introduced into new areas can be very damaging. However, once they are widespread they no longer meet the definition of a quarantine pest and regulation may no longer be appropriate. Hundreds of years of food imports and plant collection have brought to the UK many pests which are now well established. Farmers, growers, foresters and gardeners manage them routinely, though at a continuing cost.

The European and Mediterranean Plant Protection Organisation (EPPO) has fifty member countries, including all EU Member States. Unlike the IPPC, EPPO does list the pests it recommends for regulation by its members, and maintains an "alert list" of new threats drawing on reports from member countries, from other Regional Plant Protection Organisations, scientific literature and other sources. EPPO has a small secretariat and relies for

much of its work on panels of experts drawn from member countries. Much of the EU plant health regime derives from horizon scanning and risk assessment carried out by EPPO over its sixty year history. More recently the European Food Safety Authority, an EU agency, has established a plant health panel, which considers scientific questions and risk assessments referred to it by the European Commission.



Countries of the European and Mediterranean Plant Protection Organisation

The EU Plant Health Directive (2000/29) sets out lists of regulated pests, and measures applied to imports of plants and plant produce from outside the EU.

For some types of plant which represent a risk of moving specific pests within the EU, it prescribes the use of plant passports. These are issued under official supervision by the nursery where the plants were grown. Amendments to the detailed lists in the Directive are considered each month at a Standing Committee on Plant Health, at which all Member States are represented.

Risks are very different in different parts of the EU, and some regionalisation is permitted. Areas which are free from a pest can apply for

protected zone (PZ) status, and take measures to stay free, even if the pest is present in the rest of the EU. The UK has more PZs than any other Member State, including for Colorado beetle and 11 forestry pests. Some PZs only cover Northern Ireland (with the Republic of Ireland) because the pest is already established in GB.

Within the UK the Plant Health Act 1967 allocates responsibility for forest trees to the Forestry Commissioners and for other plants to the Agriculture Departments: Defra

in the case of England. It does not define "forest trees". Defra's Food and Environment Research Agency (Fera) carries out research, risk assessment, diagnosis, import and export inspections and eradication campaigns for pests of arable crops, nurseries and gardens. Fera's Inspectors operate across England and (under a concordat with the Welsh Government) in Wales.

Many pests affect both forest trees and other plants, and in practice Forestry Commission and Fera work closely together. The five year programme to reduce the level of inoculum of *Phytophthora ramorum*, by removing hosts such as rhododendron from woodland, has been a joint endeavour. When an outbreak of Asian

longhorn beetle was detected in Kent in March 2012 Fera and Forestry Commission collaborated on the basis of the different capabilities of the two organisations, without letting discussion of remit become a distraction. We are cautiously optimistic that the outbreak has been eradicated, but further survey work over several years will be needed to confirm that.

Steps have been taken over the last two years to formalise governance of plant health. A Plant Health Strategy Board has been established, chaired by Defra, and comprising representatives from Fera, Forestry Commission, JNCC, and the Devolved Administrations. Alongside the Plant Health Strategy Board an Advisory Forum has been convened, with stakeholders representing different sectors. The Forum has helped to develop and promote UK lines on review of the EU plant health regime. A Risk Management Workstream commissions and prioritises pest risk assessments, consults on appropriate measures based on the assessment, and prepares UK positions for the Standing Committee.

There are around 250 pests listed in the Plant Health Directive and a further 25 on EPPO's Alert List. New pests are listed after a process of pest risk assessment (PRA) according to international standards. Fera publishes 10-15 PRAs each year as part of an ongoing process of consultation on new risks.

Damage now believed to have been caused by *Chalara fraxinea* was observed in Poland in the early 1990s but it was not until 2006 that the causal agent was isolated, 2010 that its identity was clearly established, and 2012 that a PRA was carried out. The reasons for those delays need to be



Asian Longhorn Beetle – cautiously optimistic that an outbreak in Kent last year has been eradicated

understood in order to learn the right lessons about how the European and UK plant health regimes can be improved. It is also important that experience with other pests is taken into account in learning and applying lessons from Chalara. Successes in preventive work tend to be inconspicuous. Research has been commissioned to quantify the benefits associated with the current plant health regime, as a

baseline against which the impact of necessary improvements can be assessed.

In October 2012 Defra's Chief Scientific Adviser, Professor Ian Boyd, was asked by the Secretary of State to convene an Expert Task Force to advise on Defra's response to recent tree and plant disease outbreaks. Interim recommendations were published at the beginning of December, and the final report will be available this spring.

Two areas where progress should be achievable are early detection of outbreaks and assessment of risks from new trades. The first of these is a technical issue, the second about strengthening the EU and international regime.

Outbreaks detected early can be dealt with at lower cost, and with more chance of successful eradication. Fera and Forest Research are working with partners in other countries to improve detection through



Colorado beetle – continuing exclusion from the UK is a longstanding success of citizen science.

technology: remote sensing, acoustic signals (larvae munching inside trees), and spore trapping. We have found that by going back through old pollen traps we can detect DNA from Chalara spores. In future that approach might give us early warning about a pathogen, even when symptoms have not yet been seen. Citizen science has a lot to contribute. Colorado beetle has been kept out of the

UK for over a hundred years partly by ensuring that enough people know what it looks like, and report findings.

One of the key shortcomings of the current EU plant health regime is that new trades in plants from other continents develop without any form of risk assessment being carried out. It is often only when a problem has been found on such a trade that measures are put in place, and this is too late. A more precautionary approach would require that trades of which there is no significant experience are subject to an assessment before they start. That will be one of the main points for negotiation when the Commission publishes formal proposals very soon.

## ASH TREES – EFFECT OF CHALARA FRAXINEA

# ASH DIEBACK: Resources at Royal Botanic Gardens, Kew available to research the disease



Dr Monique Simmonds, Director, Kew Innovation Unit, Royal Botanic Gardens, Kew

and

Tony Kirkham, Head of the Arboretum, Royal Botanic Gardens, Kew



Images of *Fraxinus excelsior* Copyright RBG, Kew

## BACKGROUND

Chalara dieback of Ash is caused by the fungus *Chalara fraxinea* and was first recorded in the UK in February 2012 and is thought to have entered UK in a consignment of nursery stock imported to an English nursery from the Netherlands. It has since been found in several locations in England, Wales, Scotland and Northern Ireland. It is believed that many sites have had imports from the continent of young ash transplants over the past 5 years. However, there have also been an increasing number of cases of ash dieback in trees which have no links to the nursery trade. Thus it is important that we have a better understanding of how the fungus is being dispersed so that measures to control the spread of the fungus are informed by sound scientific evidence. There is a lot to learn

on the continent indicates that it kills young ash trees very quickly, while older trees tend to resist it for some time until prolonged exposure causes them to succumb as well.

Researchers in Europe have shown that the common ash tree *Fraxinus excelsior* and the narrow-leaved ash *F. angustifolius* are the most susceptible to the fungus, as is the American black ash, *F. nigra*. Other species of *Fraxinus* vary in their susceptibility. Understanding why there is this variation in susceptibility, especially why some individual trees of *F. angustifolius* appear to be resistant, whereas others are very susceptible should provide clues as to how to control the fungus.

species of *Fraxinus* and the damp woodland areas of the Loder Valley Nature Reserve and other outlying woodlands have a high proportion of ash amongst the native vegetation.

These living collections, as well as over 2,700 herbarium accessions (dried plant samples) at Kew, provide a rich resource to further our knowledge about the factors that influence the susceptibility of ash to attack by the fungus. For example, the herbarium collection contains 293 specimens of *Fraxinus* that include samples from "wild" populations from different parts

with *Chalara fraxinea*. Although our knowledge about plant-fungal diseases has increased since Dutch elm disease devastated the elms in Britain, every pathogen usually requires a new solution. It takes time to mobilise resources to tackle a new disease and this is why the collections at Kew are important. The collections are there to be used. Currently, Kew is looking at how the horticultural and scientific staff at Kew can work with others to maximise the use of these important collections. As part of these collaborations the Millennium Seed Bank

## ... dying in large numbers in Poland ...

## ... variation in susceptibility ...

about the life cycle of the fungus, how it is spread and why trees vary in their susceptibility to the fungus.

Ash trees suffering with *C. fraxinea* infection have been found in many parts of Europe since they were reported dying in large numbers in Poland in 1992. These have included forest trees, trees in urban areas such as parks and gardens, and also young trees in nurseries. It is potentially a very serious threat to ash trees in the UK. As it has caused widespread damage to ash populations in parts of Europe, including estimated losses of between 60 and 90 per cent of Denmark's ash trees since 2007; the consequences of it entering the natural environment in Britain could be as serious. Experience

## RESOURCES AT ROYAL BOTANIC GARDENS, KEW

The Royal Botanic Gardens, Kew has a diverse collection of over 500 ash trees at both the Kew Gardens and Wakehurst Place sites that currently show no signs of ash dieback. The ash collection at Kew Gardens comprises 43 different species of *Fraxinus* from Europe, Asia and North America. This includes 18 different cultivars grown for their horticultural merit. For those that know the gardens, the majority of the trees are growing either side of Princess Walk. At Wakehurst Place there are 16 different

of Europe. A key to the importance of these collections is that they are taxonomically verified (that is they are the correct species) and the providence for them is known. So if resistant traits are identified then researchers can go back to the area the plants came from and hopefully collect more material and evaluate whether the plants in these areas are still resistant.

Often the traits associated with resistance to fungal pathogens are present in nature. It is our ability to identify them that can take time! A fungus becomes a pathogen on a plant because it shuts down in some way the plant's natural defence mechanisms or exploits some other weakness in the plant. This seems to have happened

Partnership, which is run through Kew's Seed Conservation Department at Wakehurst Place, will be working with the Forestry Commission and others to collect seeds from different populations of ash so that the seeds can be screened for the presence of any resistance traits. Having seeds available from resistant plants will enable plants to be grown that could decrease the spread of the disease. Currently there are no collections of wild populations of viable ash seeds that represent the diversity of elms in the UK.

Meanwhile staff at the Kew sites will be actively monitoring the collections for any signs of the disease.

## ... these collections are taxonomically verified ...

## ... The collections are there to be used... ..

# ANNUAL LUNCHEON OF THE PARLIAMENTARY AND SCIENTIFIC COMMITTEE

The Annual Lunch of the Parliamentary and Scientific Committee was held on Wednesday 31st October 2012 in the Cholmondeley Room and Terrace, House of Lords.

Lord Jenkin of Roding said he was delighted to see so many friends and supporters and extended a particular welcome to two of his predecessors, Lord Waldegrave of North Hill and Lord Soulsby of Swaffham Prior, and to former Chairman, Ian Taylor.

He said that it was no secret that the Committee had found it more and more difficult to attract MPs and Peers to meetings. One reason was undoubtedly the proliferation of other channels for engaging Parliamentarians with science and engineering: the increasing influence of Select Committees, the development of POST, and the huge expansion of all-party groups – many covering aspects of science and technology.

He continued, "All this has prompted the P&S to decide to take a good look at ourselves in this developing environment. We asked Lord Oxburgh to lead an inquiry, and he agreed his mission – 'how to improve engagement of Parliament in Science and Engineering'. Ron Oxburgh's report contains a lot of wise thoughts and recommendations and Council has been taking this forward."

He introduced Professor John Womersley, Chief Executive Officer of the Science and Technology Facilities Council – "a post he has held for exactly one year today. Prof Womersley is well known to many here as one of the UK's most distinguished scientists in the field of Particle Physics. Many here will have met him in September



Lord Jenkin of Roding

when he spoke at the Parliamentary exhibition which gave MPs and Peers an opportunity to learn about the Large Hadron Collider at CERN, and to hear about the discovery of what he described as 'the Higgs-like particle' on July 4th this year. This event was well reported in *Science in Parliament*. Professor Womersley has been a key figure in the development of this branch of Physics for many years, and we are delighted to have him with us today."

## PROFESSOR JOHN WOMERSLEY:

"Thank you for that warm introduction. Firstly, I would like to say a few words about what the Science and Technology Facilities Council is and what we do. STFC is one of the UK's seven



Professor John Womersley

Research Councils and our particular remit is to support research in Particle and Nuclear Physics, Astronomy and Space Science. In addition we run major national facilities such as the Rutherford Appleton Laboratory – home to the Diamond Light Source – in Oxfordshire, and the Daresbury Laboratory in Cheshire. We are also responsible for managing the UK's involvement in major international collaborations such as the European Southern Observatory, the Institut Laue-Langevin (ILL) and the European Synchrotron Radiation Facility (ESRF) in Grenoble.

Perhaps the most well-known of these collaborations, of course, is CERN, the European Organisation for Nuclear Research, based in Geneva. You will all be aware that this has been a momentous year for CERN's Large Hadron Collider (LHC), from which on 4 July there was the announcement of the discovery of the Higgs Boson – or rather 'a particle consistent with that predicted by Professor Peter Higgs in 1964' – I have to be careful how I phrase this and my colleagues in CERN will be quick to admonish me!

What does this mean? Well, the Higgs boson is a fundamental particle responsible for the origin of mass. It is famously difficult to explain how this works in lay terms. I see Lord Waldegrave in the audience who is rightly acclaimed, when Science Minister in 1993, for setting the challenge to explain the Higgs particle when

scientists were first seeking funding to build this £1bn experiment. The winner of that particular competition was as follows: Imagine a cocktail party of political party workers distributed across a room, all talking to their nearest neighbours. Mrs Thatcher enters and crosses the room. All of the workers in her neighbourhood immediately start to cluster round her. As she moves through the room, she continues to attract a knot of people always clustered around her and this has the effect of slowing her down, giving her essentially a greater mass. Once moving she is harder to stop, and once stopped she is harder to get moving again because the clustering process has to be restarted.

Without going too far into the details, the universe is filled with a field of Higgs particles which act like the party workers in this analogy – they are responsible for the creation of mass, and stop everything from just zipping around at the speed of light. This makes it possible to combine all the fundamental forces of the universe in a single unified mathematical framework which we call the Standard Model – a comprehensive and remarkably successful explanation of the basic building blocks that make up our universe.

It is important to note that the United Kingdom has been at the forefront of this discovery – of course Peter Higgs is an emeritus Professor at Edinburgh, and UK scientists and engineers have also



Lord Jenkin, Dr Stephen Benn, Professor John Womersley, Andrew Miller MP



Philip Wheat



Lord Walton of Detchant and Stephanie Fernandes



Dr Stephen Keevil, Ms Rosemary Cook and Sarah Newton MP



Stephen Metcalfe MP and Lord Broers

been central to designing, building, operating and performing the experiments on the LHC. The UK is one of the leading nations in terms of volume of papers published in Nuclear and Particle Physics and we rank number one in quality as measured by citation rates.

Scientifically, then, this was a major breakthrough. However, it is very important – especially at a time of economic difficulty, and for a political audience like this one, that I also have a good answer to the question ‘why should we care?’ Aside from Mrs Thatcher’s observation on the expense of the LHC ‘isn’t it interesting, though?’ which is difficult to disagree with, the huge resonance of the general public to this year’s Higgs announcements goes some way to answering the question. On the day of the announcement the news in the UK alone reached an audience of 12 million on TV and 14 million on radio. There were more than 1,200 stories in broadcast media within 24 hours and it was mentioned every 1.1 seconds on Twitter, with 8 of the top 10 ‘trending’ topics being Higgs related. Internationally there were more than 4,500 print articles, it made the front page of major newspapers and even The Economist.

We understand that communicating discoveries such as the Higgs effectively is an obligation for scientists who are supported from the public purse – and just one aspect of this in recent months has been a small exhibition including a replica of a section of the LHC tunnel which STFC has been touring around the UK, including Westminster, the devolved administrations, and science festivals. The statistics I set out show that there is a real public hunger for science and this is supported by other trends: 90 per cent of physics graduates cite inspirational fundamental science advances in physics and astronomy as the reasons they decided to study the discipline. In the past year, University applications in physics have increased by eight per cent at a time when overall applications fell by eight per cent, so we may well be seeing an impact.

Attracting young people into STEM careers is hugely important for our future competitiveness in the global knowledge economy. However, the cover of The Economist gives us another hint as to why supporting science is so important. Aside from helping humanity gain a more complete understanding of our place in the universe, the technological innovation and skills that need to be developed to carry out this research feed straight back into the economies and the Governments which support it. The US Census



Past and present Directors of POST:  
Professor David Cope and Dr Chris Tyler



Dr Richard Worswick and Lord May of Oxford



Andrew Miller MP with Dr Tom Price, a Research Fellow at the Institute of Integrative Biology at the University of Liverpool, his pair in the Royal Society Pairing Scheme



Bureau estimated in 2002 that the value of a single science PhD student to the economy over their lifetime was an additional \$2.2M, roughly £1.8M today. This is a tangible measure of what the 'knowledge economy' really means and I would like to expand on this.

George Bernard Shaw famously said that *'The reasonable man adapts himself to the world; the unreasonable one persists to adapt the world to himself. Therefore all progress depends on the unreasonable man.'* Fundamental research, like particle physics and astronomy, plays the role of the unreasonable man – it makes demands on technology and engineering which require new inventions, new technologies, new capabilities to be developed. These advances then feed back into the broader economy to the benefit of everyone.

For example, in order to collide particle beams at very high energies, physicists needed ways of generating very high magnetic fields. This led to a series of technology breakthroughs in superconducting magnets going back several decades. The large hadron collider magnets are based on this technology but so are the magnets used for Magnetic Resonance Imaging (MRI). Two and a half million MRI scans were performed in the UK in 2010, equipment manufacture contributes £100m to the UK's GDP each year and a further £100m is saved every year just through the improved treatment of spinal disc herniation – slipped discs. I am told that MRI scanners helped the TeamGB cycling team achieve golds in the Olympics through its application to their training regime!

The same particle accelerator technology used in the LHC is what drives the Diamond Light Source and ISIS neutron source at the Rutherford Appleton Laboratory. The ISIS machine – still on a vast scale and housed in a hangar sized facility – is used to create neutrons which are uniquely valuable in analysing the internal structure of materials. ISIS has many collaborations with industry. One recent example has been work done with EDF where we looked at the integrity of the welds and materials within nuclear power stations. These studies showed that the materials were sound and gave confidence that the safe working lives of the plants could be extended by five years, leading not only to continued security of energy supply but also deferment of £3bn decommissioning and replacements costs.

I am also pleased to see Richard Worswick in the audience. This gives me the chance to mention Cobalt Light Systems, an extremely promising spin out company from STFC's Central Laser Facility. Cobalt uses a technique known as spatially offset Raman spectroscopy which was developed for scientific analysis; Cobalt has been able to commercialise the application to the stage where prototypes are now being used at airports to scan containers of liquids to identify if they contain illicit or dangerous substances. This technique can lead to a lifting of current restrictions for taking liquids onto flights. Cobalt is just one example where STFC's development of Science and Innovation Campuses at our Harwell and Daresbury locations, and the innovation friendly ethos at the STFC's national facilities has helped enable such a successful development. In fact we are now collaborating with both CERN and with the European Space Agency to operate business incubation centres at Harwell and Daresbury. These centres are specifically

designed to help support small, UK-based businesses to commercialise the technologies coming out of these projects.

## WHAT ARE THE BIG SCIENCE PROJECTS OF THE FUTURE THAT WILL BRING MORE SUCH ADVANCES?

Let me start with what's next for the LHC. During 2013 the experiment will cease operations to undergo a major new upgrade that will see its energy doubled and the rate of data acquisition increased. This will enable us to investigate the properties of the Higgs boson in detail, and also allow us to extend the search for new physics, for example, to address the nature of dark matter, which is thought to constitute 84 per cent of the Universe. Fortunately, this year-long shutdown will allow visitors to enter the tunnel 100 metres beneath Geneva once again and STFC is particularly keen to encourage UK policy makers and general public to do this. If you are interested in taking this opportunity please contact my office.

The next big new fundamental project that we hope will capture everyone's imagination and inspire future generations is the Square Kilometre Array, or SKA. This is a radio telescope consisting of around 3,000 dishes distributed over a huge geographical area across South Africa and Australia. Mapping the sky precisely with this huge array and bringing together the data collected on this enormous scale will allow us a completely new view of the universe. We will be able to look back in history to a time before the first stars formed, investigate the nature of gravity and challenge the theory of general relativity, study magnetic fields in space and even search for extra-terrestrial signals that might be broadcast from other civilisations.

SKA is a global project but we are particularly proud that Jodrell Bank in the UK hosts the SKA's international headquarters which will be inaugurated in 2013. The initial stages of work on this decades-long project demonstrate clearly how the experiment will drive the need to develop new technologies that will bring benefits across the economy. Key to the design of SKA is the acquisition and processing of vast quantities of data from the thousands of distributed telescope dishes – more information than is currently transmitted across the entire global internet today. Supercomputing and e-Science teams from Cambridge, Oxford and Manchester universities and from STFC's Hartree Centre at our Daresbury Laboratory are already working on how to solve these challenges, in collaboration with companies like IBM and Intel who can see how this science is going to drive innovation in their sector.

I hope my talk has demonstrated that there really should be no distinction between 'basic' and 'applied' research – even the most fundamental research about the nature of the universe has a huge impact on everyday life, both in terms of attracting people into STEM careers and in creating new inventions because of the way that it makes 'unreasonable' demands on technology. Organisations such as the Research Councils work hard to maximise these benefits to the economy through encouraging spin out companies and collaboration with industry. Most importantly there is very exciting science and many more challenges ahead with projects such as the Square Kilometre Array, in which the UK is privileged to be playing a leading role."



# ENERGY EFFICIENCY SOLUTIONS FOR BUILDINGS



Gill Kelleher, BASF Sustainable construction advocate

**BASF is the world's leading chemical company. Its chemical products are used in almost all industries, from electronics and agriculture to consumer goods and construction.**

By 2050 it is estimated that the world population will grow to about nine billion and 75 per cent of those will be urban dwellers. This is a challenge that demands new concepts for housing and construction.

As a leading provider of raw materials, systems and solutions to the construction industry, BASF is working with industry to increase the energy efficiency and lifespan of buildings, developing solutions that reduce the amount of resources needed for construction and contribute to greater living comfort. Our insulation materials, concrete admixtures and many other products help significantly to reduce carbon emissions generated by buildings over the course of their lifecycles. According to the Intergovernmental Panel on Climate Change, by 2030 around 6.5 billion metric tones of CO<sub>2</sub> emissions could be saved globally in the area of housing and construction as a result of investment in efficient technologies. As a reliable partner to the construction industry, it is our goal to help increase this contribution to climate protection.

We understand sustainable construction as the process of developing built environments that balance economic viability with preserving resources, reducing environmental impacts

and taking social aspects into account.

As a result, BASF construction experts are actively engaged in Green Building Councils and work closely with architects, planners and urban developers to create housing for all types of climates and diverse architectural traditions. In the UK we have partnered a number of organisations to provide data and evidence for industry to demonstrate the savings which can be achieved from adopting energy efficiency measures.

### UNIVERSITY OF NOTTINGHAM CREATIVE ENERGY HOMES PROJECT: AFFORDABLE, LOW CARBON HOUSING

The objective for the BASF House, Nottingham, was to design an affordable, practical, low Carbon home. At the outset the target was for the house to have an energy consumption of 15kWh/m<sup>2</sup> (meeting Passivhaus standards). The highly insulated fabric of the building (specified U-value for walls of 0.15W/m<sup>2</sup>K) is considerably in advance of current Building Regulations and the structure was designed to demonstrate a cost-effective approach to meeting Level 4 of the Code For Sustainable Homes.

The first principle was to design the fabric of the house to be well insulated to minimise energy loss. A combination of insulation materials demonstrated the range that exist in today's market.

Since its completion in 2008 the house has been occupied by both University staff and students and has been carefully monitored as part of the University's research into building with low carbon solutions and the impact of occupier behaviour. Data from the building's sophisticated monitoring equipment have evaluated energy consumption, and a range of climatic conditions in the house from the temperature and relative humidity to the lighting, solar radiation and ventilation. The occupants were electronically tagged to create a record of their living patterns. An important aspect of the house's evaluation was to test the general comfort and practicalities of the house and how it affects the occupants.

Initial monitoring data indicate that the house is beating the target of 15kWh/m<sup>2</sup> and achieving as little as 10kWh/m<sup>2</sup>.

**. . . savings from adopting energy efficiency measures . . .**



SIPS was chosen because of the high insulation factor, outstanding air tightness, light weight and the ability to prefabricate off-site non-rectangular shapes – ie for the gable walls. The roof was also constructed of SIPS to demonstrate the versatility of BASF heat management solutions used within the steel coatings.

The result is that the walls and roof structures have a U-

value of 0.15W/m<sup>2</sup>K combined with high air tightness. The South facing aspect of the house consists largely of glazing in order to capitalise on passive solar gain.

The structure also considers the important issue of heat management. As new buildings have to be highly insulated to meet the Code for Sustainable Homes, the energy required to cool these houses down is a concern.

## SUMMARY OF MATERIALS USED

The lower floor and foundations were built using the BASF Neopor® insulated concrete formwork (ICF) system to provide high thermal mass. Neopor, a lightweight, expandable polystyrene (EPS) contains graphite, which considerably enhances the insulation capacity. Blocks of Neopor were assembled to create the shape of the building, including window and door openings. The core was then filled with a pumpable concrete.

For the first floor a prefabricated timber insulated sandwich panel system (SIPS) was used, containing BASF rigid polyurethane insulation.



To overcome this issue a modified plasterboard incorporating Micronal® Phase Change Material (PCM) has been used internally within the house. Micronal PCM is made of polymer capsules containing a special wax mixture which stores latent heat. When the temperature rises above 23°C, the wax melts and the phase change material absorbs heat. When the temperature drops, the wax solidifies and heat is emitted.

This innovative material enables a 1.5cm thick plasterboard to contribute a

thermal storage capacity identical to that of 7cm concrete or 9cm brickwork. It allows a lightweight construction to capitalise on the temperature stability benefits of high thermal mass – contributing to more comfortable living conditions and better energy efficiency.

The first floor and roof area required a lightweight, durable, waterproof cladding. Colorcoat Urban® by Corus was selected. Traditional roofing materials absorb solar energy, generating heat that is transported by thermal conduction into the roof and by convection to the surrounding air. The Colorcoat Urban steel cladding system uses BASF's coil coating PLASTICERAM®, this has superb

efficient terraced homes fit for 21st century living. The target was to improve the energy performance rating of the building from band F to band A/B.

## INTERNAL AND EXTERNAL INSULATION SOLUTIONS

Over a third of the energy heating a property escapes through the external walls. Old solid wall, hard-to-treat buildings such as the BRE Victorian Terrace are most affected. Through participation in this project, BASF has demonstrated innovative products and solutions that tackle a number of the issues facing the refurbishment market.

## ... glazing to capitalise on passive solar gain ...

UV durability and corrosion protection while also achieving maximum solar reflectance.

### THE BRE VICTORIAN TERRACE PROJECT

The UK Government has a legally binding commitment to reduce CO<sub>2</sub> emissions by 80% by 2050. To meet this target it has to ensure that existing buildings are made more energy efficient. The UK's housing stock releases 150 million tonnes of carbon dioxide per year, with older buildings contributing disproportionately. The Government has therefore put in place a country-wide energy efficiency programme, recognising that refurbishment of the oldest housing stock is essential.

In collaboration with BRE (Building Research Establishment) at its headquarters in Watford, BASF materials were used to transform a disused Victorian stable block into three energy

The finished development now houses an Information Centre where Visitors are able to learn about best practice refurbishment, including the latest processes, materials and technological advances to treat existing homes.

One of the walls of the presentation room was internally lined with rigid polyurethane insulation. Magnesium oxide boards were adhered to an 80mm Polyisocyanurate (PIR) insulation board consisting of a foam core with two low emissivity facers. This achieved a U-value of 0.22W/m<sup>2</sup>K.

The South wall of the presentation room presented additional challenges. The wall was very unstable so a number of structural repairs had to take place before all the existing plaster was removed. WALLTITE® spray foam insulation was then sprayed directly onto the rough, bare brick substrate to a thickness of

## ... refurbishment of the oldest housing stock is essential ...

100mm without the need for primer or levelling coat. The strength of WALLTITE helped to consolidate this very unsound surface. WALLTITE is a closed cell foam. Its structure helps to control the movement of vapour and moisture throughout the building, reducing the risk of mould and condensation. At a thickness of 100mm, WALLTITE achieved a U-value of 0.25W/m<sup>2</sup>K.

An added performance property of WALLTITE is the air tightness of the system. Air leakage accounts for 25-50% of heat loss. WALLTITE has no joints and has a measured air leakage value of 0.0033 @ 50 pascals m<sup>3</sup>.h-1.m-2 per BSRIA. Further performance was achieved by eliminating thermal bridging via studwork or framing. The whole surface area of the wall was sprayed seamlessly and then finished with gypframe studs before applying plasterboard.

Three of the walls were insulated with an External Thermal Insulation Composite System (ETICS) consisting of 150mm thick insulation boards made of BASF's Neopor expandable polystyrene (EPS) and the Heck® external render system. Neopor insulation boards were fixed to the outside of the building and covered with an alkali resistant reinforcing mesh, scrim adhesive and a final decorative finish. This layered method reduces heat loss and prevents water ingress.

It is not only the walls that need consideration. Uninsulated floors can produce as much as 15% of heat loss from a building, while effective waterproofing is essential for a building of this age.

The floor was therefore made fully waterproof using BASF's Thoroseal® Super which was lapped up the walls to form a damp proof course. Styrodur® C, an insulation board, was chosen to meet the thermal insulation requirements, with the substrate then being finished with PCI Novoment® Z3, a fast track screeding solution with rapid cure capabilities. The result is an overall floor U-value considerably less than the target of 0.22W/m<sup>2</sup>K in the Building Regulations.

BASF's Micronal phase change material (PCM) was incorporated into the ground floor presentation room to contribute to the temperature management of the space. In this installation, the PCM was incorporated into a suspended ceiling tile system.

These projects are designed to demonstrate how energy efficiency can be built into the structure of homes – whether at the construction stage or as part of refurbishment projects. Visitors are welcome to both sites. These are two projects in which BASF has collaborated and research continues to provide evidence of how chemical solutions can contribute to sustainable buildings – whether they are for commercial, industrial or domestic use.

For further information on this and other demonstration projects, go to [www.basf.co.uk/ecp1/Solutions\\_UK\\_Ireland/Construction](http://www.basf.co.uk/ecp1/Solutions_UK_Ireland/Construction)



## ENERGY – HOW TO USE LESS

# ENERGY EFFICIENCY: THE ROLE OF SMART METERS



Ashley Pocock  
Head of Industry Change,  
Regulation and External Affairs,  
Smart Metering Project,  
Transformation, EDF Energy

The Meeting also heard from Ashley Pocock, Head of Regulation for Smart Metering at EDF Energy.

Among the points he made were the following:

The target is for the installation of smart meters in all homes and small commercial businesses to be completed between 2015 and 2019.

This will involve 34m properties, over 50m gas and electricity meters, and 50m other technical devices, including displays and communications equipment.

The Government has pledged to deliver a National Communication Network, combining 3 super-regional networks a central data hub.

The meters will allow for a seamless transition between different energy suppliers, and will support different payment modalities. One immediate

benefit is that it will no longer be necessary to have estimated bills – a great source of customer dissatisfaction.

For most consumers £ is more intelligible than kWh, and so this is how the information will be displayed. There will not be an output revealing the CO<sub>2</sub> footprint of generation.

When the customer signs up to acquire a meter, there will be three phases – a pre-installation consultation, then the installation itself, and a follow-up later to ensure comprehension and satisfaction.

It is clear that tariffs affect demand, but nonetheless an impact assessment suggests that savings overall will be small – less than 3% anticipated from increased sensitivity by consumers to the energy they use.

In order to achieve more, further changes in behaviour will

be needed. Since the largest proportion of domestic energy is used for heating, consumers may have to get used to lowering thermostats, and of course improving insulation.

Even where families are living in identical houses, there can be significant variation in patterns of energy consumption. For example retired people have a comparatively flat pattern throughout the day. A family using, for example, hair dryers will have a noticeable peak early in the day.

Finally, although the benefits should be clear, no one will be compelled to accept such meters if they do not wish.

Additionally, there will be strict regulation to control external access to domestic data and to ensure both privacy and security are maintained by all providers and users of this unique, complex and extensive infrastructure.

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## ENERGY – HOW TO USE LESS

# ENERGY EFFICIENCY



Roger Kemp  
Lancaster University

Energy policy in the UK is faced with three conflicting demands: security of supply, affordability and environmental impact: politically, all are important. Failure to keep the lights on or shortages at petrol stations can be toxic to any government. A sudden rise in electricity, gas or road fuel prices

creates unwelcome headlines and consumer protests. All recent governments have committed to reducing carbon dioxide emissions, as well as the oxides of sulphur and nitrogen, blamed for the acid rain that

had destroyed many North European forests, as well as ground level pollution in cities.

The scale of the challenge faced by policymakers in resolving this trilemma can be

... shortages at petrol stations can be toxic ...

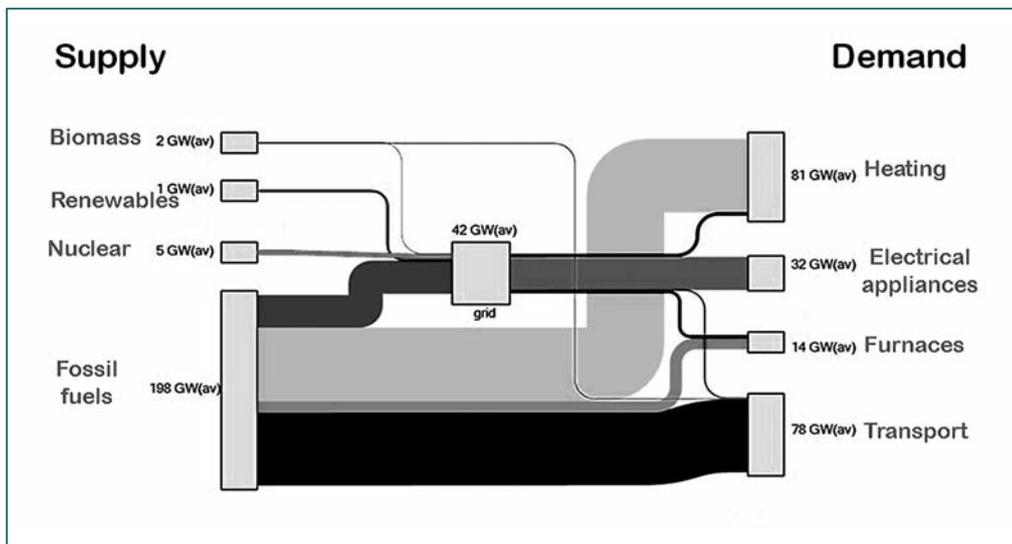


Figure 1: UK energy flow diagram 2008<sup>1</sup>

seen in Figure 1, which shows the supply and demand of energy in the UK when the Climate Change Act 2008 was passed.

On the left are the four main sources of energy – fossil fuels, nuclear power, renewables and biomass. On the right are the uses made of energy – transport, furnaces and other high temperature uses of heat, electrical appliances and low temperature heating. It can be seen that the major energy flows are from fossil fuels to transport and heating.

The diagram shows average values throughout the year; although many uses of energy are reasonably constant, most of the heating load is taken during the winter months and, predominantly during the early morning and early evening, the peak load can be more than three times the average.

From the point of view of the consumer, it would be convenient to be able to keep the utilisation side of the diagram the same but to change the supply side to more secure low-carbon sources. A glance at the numbers shows the

impossibility of this approach. The peak load (heating and electricity) in winter is 250GW which is equivalent to 100 nuclear power stations or 100,000 large wind turbines. As well as changing the source of supply, we have to reduce the

### ... peak load can be more than three times the average ...

amount of energy we use – hence the importance of energy efficiency.

If the UK is to get near the targets in the 2008 Act, we have to tackle the two big sources of CO<sub>2</sub> – transport and heating. Both are hugely challenging but transport is probably the easier of the two. One could envisage widespread adoption of electric vehicles and a major shift to electrically-powered trains and trams, all powered by renewable or nuclear energy. Aircraft and the remaining HGVs, which require more energy than could be stored in batteries, could be fuelled by biofuels derived from agricultural waste and algae or other plant material that do not compete with food crops when food shortages will be

increasingly commonplace.

Although we can envisage a technical solution to decarbonising transport, the politics and economics would not be straightforward. We are accustomed to owning a car that

is used daily for a 20 mile commute but that can also be used for a 200 mile weekend trip to a remote farmhouse or a 2000 mile family holiday. Asking people to reorganise their lives to use short-range EVs for the daily commute and public transport for longer trips might not be a vote-winner. Expanding the rail system to cope with greatly increased peaks of Christmas and holiday travel, while maintaining subsidies at an acceptable level and providing a financial incentive for people to use the low-carbon alternative to a car, would be more challenging.

### ... a major shift to electrically-powered trains and trams ...

If the political challenge of decarbonising the transport sector at an acceptable cost is “difficult”, the problems with domestic heating are even greater. In the last 50 years we have moved from homes in which we switched on heaters only in occupied rooms and it was normal to wear a sweater indoors to the expectation that buildings are centrally heated and our choice of indoor clothes is dictated by fashion, not the weather.

When constructing new buildings it is possible to build in high-performance insulation and heat exchangers to warm incoming fresh air from the air being extracted. With good design it is possible to build homes that require almost no external sources of heat. However, there are no readily-available technical solutions for installing low-carbon heating in existing buildings and most of the houses that will be in use in 2050 have already been built.

Attempting to balance the trilemma of security of supply, affordability and environmental impact has resulted in more than a decade of policy paralysis, punctuated by occasional bursts of political hyperactivity in pursuit of one of the three, while conveniently ignoring the others. In 2008, the Climate Change Act prioritised reductions in CO<sub>2</sub> emissions – Coalition promises to be “the greenest government ever” followed this line. Five years ago, new nuclear power stations were seen as crucial to keeping the lights on; legal challenges,

the repercussions of the tsunami deluging Fukushima, together with private sector reticence to carry financial risk ensured none has been started. Recent campaigns to cut prices by opening up the energy market and encouraging consumers to switch suppliers seem to have forgotten last year's plan, which encouraged suppliers to form long-term relationships with customers, investing in insulation and energy saving measures, recouped by lower energy use over the following years.

Since the Energy white paper 2003: *Our energy future: creating a low-carbon economy* there have been half a dozen major restatements of energy policy but little to show on the ground; we still burn large amounts of coal and run our cars on petrol and diesel, much as in 2003. Energy infrastructure is a long-term business; power stations cost many millions, take several years to build and have a life of 40 years. Companies considering whether to invest

## ... Asking people to reorganise their lives ...

the objectives of the 2008 Climate Change Act and other measures to reduce CO<sub>2</sub> emissions and the Climate Change Committee (CCC) produces carbon budgets for years ahead which represent increasingly incredible extrapolations of current policies. With more than 100 MPs formally opposing wind farms, and growing support for shale gas, it is increasingly difficult to see a consensus supporting the CCC plans.

Recent government initiatives have been to reduce retail energy prices and to improve the efficiency with which it is used. *The Khazzoom-Brookes postulate* (sometimes referred to as the *Rebound Effect*) states that if energy prices do not change, cost effective energy efficiency improvements will inevitably increase energy consumption above what it

manufacturers have been forced to improve the fuel efficiency of cars so there is now a range of vehicles with emissions below 100gCO<sub>2</sub>/km. Engineers in the industry reckon that further improvements to 80 or even 60gCO<sub>2</sub>/km might be possible but, if this is not to lead to long term increased car use, this has to be accompanied by a

importance, government needs to have a coherent vision of what it wants to achieve in terms of security of supply, affordability and emissions and a long-term strategy to implement this vision: how many days demand of gas storage, how many power stations of what types, what proportion of electric vehicles, what penetration of district heating, etc, etc. This is a national strategy, requiring agreement between ministries,

## ... more than 100 MPs opposing wind farms ...

comparable fuel price increase.

If holding down gas use by increasing prices is not politically acceptable, the alternative could include more intrusive regulation, perhaps by individual carbon allowances or the imposition of maximum thermostat settings, or more draconian and retrospective building standards. If neither regulation nor price increases is acceptable, we are running out of options to limit energy use and CO<sub>2</sub> emissions.

For the last decade politicians have talked about taking "tough decisions": in energy policy they have studiously avoided taking any decisions. Partly this policy vacuum is based on a misguided belief that "the market" will make sound strategic decisions in the absence of government policy.

What should an energy policy include and what should be the dividing line between the public and private sectors? Of critical

which cannot be left for the markets to decide. Once the strategy is determined, the private sector can deliver what is needed and would be expected to bear the risk if they fail to deliver. However, what the private sector cannot be asked to do is to carry the risk of the government's strategic vision.

Creating coherent energy policies requires an understanding of how the different components of energy systems interact and how these relate to other policies, including those on land use, transport and taxation. In the absence of coherent policies, we risk missing all three of the objectives of security of supply, affordability and environmental impact and simply increasing energy efficiency will not deliver the policy objectives we seek.

<sup>i</sup> Diagram from: *Generating the Future*, The Royal Academy of Engineering, 2010.

## ... more than a decade of policy paralysis ...

seek a degree of policy continuity. If companies are expected to fund the massive investment needed in new energy infrastructure from their own resources, they need assurance of future profits.

One of the largest areas of contention is the extent to which policy should focus on reducing CO<sub>2</sub> emissions. Most people accept the fact of climate change, although the extent to which this is caused by anthropogenic CO<sub>2</sub> emissions may be open to debate. The government has signed up to

would be without those improvements. The corollary of this is that, to use the market mechanism to reduce CO<sub>2</sub> emissions, inflation-adjusted energy prices (including taxation) have to rise faster than efficiency improves.

If governments oppose energy price rises, what alternatives are there to reduce overall energy use? One mechanism, which has been successful in reducing car emissions, is regulation. Under EU rules, supported by UK taxation policy, car

## ... imposition of maximum thermostat settings ...

# SUPPORTING GOOD PRACTICE IN UNIVERSITY MATHEMATICS DEPARTMENTS

Sean McWhinnie, Oxford Research and Policy

The London Mathematical Society (LMS) is launching a new report on *Good Practice in UK University Mathematics Departments* on 27 February 2013 at an event in the House of Commons. This highlights good working practice found in UK university mathematics departments with an emphasis on improving the recruitment, retention and progression of women.

Around 40% of graduates from UK first degree mathematical sciences courses are female. However, there is a significant drop-off in the proportion of women who become academic mathematicians, and only around 6% of professors of mathematics in the UK are female. Although all Science, Technology, Engineering, Mathematics and Medicine (STEMM) subjects suffer a drop in the proportion of women in senior positions, the fall off is particularly bad in mathematics.

The LMS Women in Mathematics Committee set out to support mathematics departments to improve working practices and the recruitment, retention and progression of women in academic mathematics, for example by working towards an Athena SWAN award.

## THE ACADEMIC MATHEMATICS PIPELINE

Figure 1 presents a snapshot of the mathematics pipeline for

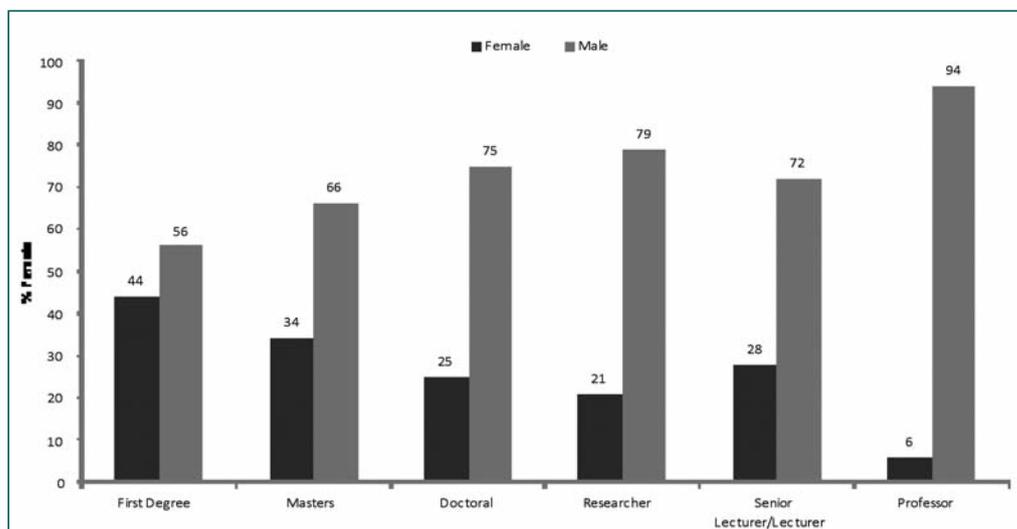


Figure 1 The mathematics pipeline for all nationalities in UK Higher Education Institutes - proportions of the populations at different stages who are male or female in 2011.

people of all nationalities who study mathematics or hold academic posts in mathematics in UK higher education.

The data illustrate that a smaller proportion of female students progress from first degree programmes to masters or doctoral programmes in UK higher education institutions (HEIs). 38% of mathematics staff who have only a teaching function in UK HEIs are female. If staff who have a research function as part of their contract are considered, the proportion of senior lecturers/lecturers that are female is 21%. In other words, women are significantly more likely than men to have teaching-only mathematics roles. The discontinuity illustrated in Fig 1 is explained by the numbers of women in teaching-only roles: if teaching-only roles are excluded then the proportion of researchers and

senior lecturers/lecturers that are female is the same.

It is sometimes suggested that the reason that there are lower proportions of women at more senior academic grades is because there was a lower proportion of women graduating in the past. However, as illustrated in Fig 2, within a particular age range, the proportion of women academic staff in mathematics who are

professors is much smaller than the corresponding proportion of men. For example, considering permanent academic staff in mathematics aged between 51 and 60 years in 2010/11, 58% of the male academics were professors compared with 22% of the female academics. The implication is that a smaller proportion of professorial-calibre women than men achieve their potential.

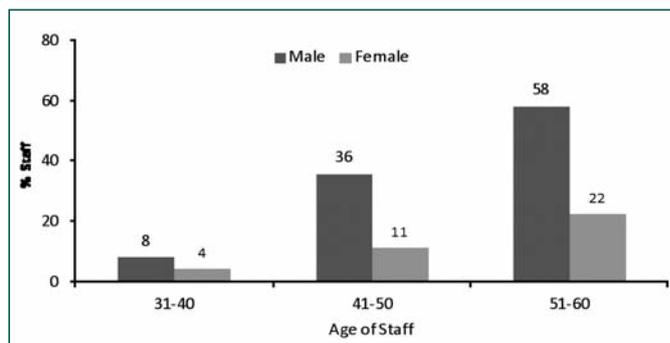


Figure 2 For each gender, the proportion of permanent mathematics staff in a specific age range who are professors (2010/11).

This shows that within mathematics a smaller proportion of women progress from undergraduate study to higher level study and that, among staff who gain academic posts, women are more likely to be in teaching only roles than men, and are less likely to be at more senior grades. This underlines the need for action to encourage a higher proportion of talented female mathematicians to stay in academia and to support those women to stay in research and progress in their careers. Similar patterns in respect of the progression of men and women are evident in other STEM disciplines irrespective of the proportion of undergraduates who are female.

## THE ATHENA SWAN CHARTER AND AWARDS

The Athena SWAN Charter is a scheme that recognises excellence in STEM employment for women. It provides awards and opportunities to share good practice.

The Athena SWAN process ensures that all aspects of academic progress and careers are examined, with a focus on gender equality and opportunity, developing good practice in the recruitment, retention and promotion of women in university STEM departments. Any HEI committed to advancing the careers of women in STEM can become a member of the Charter, accepting and promoting the six Charter principles. The Athena SWAN Charter awards are for both institutions and departments. There are three levels of award Bronze, Silver and Gold.

Currently there are 85 HEIs that are members of the Charter and although almost 80 departments hold Bronze or Silver awards, there are only two

mathematics departments that hold Silver awards: the Universities of Reading and Leeds.

The LMS Women in Mathematics Committee decided to engage with mathematics departments to improve their interaction with Athena SWAN. The LMS also wanted to provide guidance on the Athena SWAN process and to disseminate examples of good working practice already in place.

## GOOD WORKING PRACTICES AND WOMEN IN SCIENCE

Research carried out looking at working practices in science, technology, engineering and technology departments<sup>1</sup> makes it clear that:

1. Good working practices benefit all, staff and students, men and women. However, bad practices adversely affect women's careers more than men's.
2. The best university departments do not target measures specifically at women because improved working conditions benefit all and make for a happy department. Good practice is not about how many women are in the department, it is about processes that are fair, flexible, accessible and transparent to all.
3. Departments with good working practices are able to attract and retain women better than other departments.
4. There is no evidence that the introduction of good practices adversely affects the excellence of the science carried out. Good practice equates with good science. In contrast the detrimental effects of bad practice build

up incrementally over the course of a career resulting in a smaller proportion of women than men reaching their potential.

5. Leadership from the top, with the head of department acting as champion, is critical to changing culture, to making the changes stick and to changing behaviour. Simple changes to processes, which deliver clear benefits to staff, can start to change policy and behaviour, but without a head of department prepared to introduce changes and monitor adherence, little will change.
6. The age profile of the department, and the diversity of its staff, makes a difference. Young men and women with families have different expectations and needs from their older colleagues. Those younger staff's careers cannot thrive unless the culture of the department reflects the reality of dual career partnerships.
7. Successful action is based on good planning, which takes account of the department's academic plan and which is evidence based.

## THE LMS PROJECT

The LMS distributed a questionnaire to all UK university mathematics departments, which requested information and examples of working practices around a number of key processes such as recruitment, induction, promotion, training, flexibility and career breaks, including maternity leave. Thirty departments returned completed questionnaires.

These were analysed to identify examples of good practice. These were used to provide the main content of the report. In addition, the practices

described in the checklists were scored to benchmark each department. These were used to produce individual reports for departments, and to produce an overall summary for the LMS.

The departments that completed the questionnaires are at very different points in their Athena SWAN journeys and had varying working practices.

If we take the example of how a mathematics department 'ensures that the arrangements made for career breaks can enable individuals to maintain a career trajectory, which meets their circumstances, abilities and ambitions'. Departments with the best working practices demonstrate their ability to support staff to cope with the practicalities before, during and after a career break. Before a break, the best departments arrange a meeting to check that individuals are getting the support, advice and information they want and the department helps with support arrangements before, during and after the career break. Departments also recognise returners' needs, including flexibility, personal support, and mentoring. The head of department holds a meeting some weeks after an individual returns to discuss what support is needed.

The questionnaires revealed a division between those departments which had good systems in place and those that had little experience of staff taking career breaks and therefore took less formal approaches. A number had visible role models with experience of career breaks who were available to give advice, although there was also a view that expecting people in this position to support others was unreasonable. A few departments had formal

arrangements in place for cover, while some left it to the individual to make arrangements, and others dealt with it informally, reallocating responsibilities to others in their group. The best practice was where departments received a budget from the university for cover from sessional lecturers either during the maternity leave or for the period just after maternity leave, and where the arrangement was discussed in advance.

There were examples of good practice to support returners. One university had

produced a good practice document on maternity returners. A number of departments work with individuals to ensure that they are given support. In one case staff were encouraged to meet with their line managers, as well as the head of department, before their return to discuss arrangements. In another case individuals taking parental leave were expected to have a staff development review on their return. There were examples of returning staff being given time to readjust to the workplace and to catch up with research

through, for example, being given a term's grace from teaching responsibilities or being granted a period of study leave immediately following a period of maternity or adoption leave. Some departments also had in place arrangements to monitor returners on an ongoing basis. In one example during the phased return period the head of department met the member of staff weekly, to assess progress and identify any problems and to discuss future career progression. A number of departments also encouraged returners to take up flexible

working arrangements.

The LMS hopes that by disseminating and highlighting the best working practices currently in place in mathematics departments, all departments will be encouraged to learn from the best and in doing so improve the position of women in mathematics.

#### References

- 1 Planning for Success - Good Practice in University Science Departments, Royal Society of Chemistry, London, 2008 ([www.rsc.org/diversity](http://www.rsc.org/diversity)); Women in University Physics Departments, Institute of Physics, London, 2006 ([www.iop.org/diversity](http://www.iop.org/diversity)).

## METHANE: THE UNNATURAL GAS



Dr Grant Allen  
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University of Manchester

Methane (commonly known as "natural" gas) is one of the major greenhouse gases (GHGs) recognised by the Intergovernmental Panel on Climate Change (IPCC). Molecule-for-molecule, methane ( $\text{CH}_4$ ) is 23 times more potent than  $\text{CO}_2$  and it accounts for ~7% of all GHG emissions in the UK (in 2009). Luckily, there is much less  $\text{CH}_4$  in the atmosphere (on average) than there is  $\text{CO}_2$  – about 200 times less. However, although the absolute concentration of  $\text{CH}_4$  is currently relatively small, its potency means that even a small change in the total amount of methane in the atmosphere could be comparable to the global-warming impact of its more well-known counterpart. Just as importantly,  $\text{CH}_4$  changes the way in which the atmosphere can naturally cleanse itself of pollutants, which can result in poorer air quality. Such changes could be under way.

One thing is certain – the atmosphere is (and always has

been) changing. This change has historically been the result of natural perturbations, often (but not always) over long timescales. However, in recent history, mankind has been speeding up this pace of change with uncertain consequences. Whilst the general premise that climate-change-equals-global-warming is widely publicised, the more localised and extreme impacts implicit to climate change are often missed. For the UK alone, these impacts are thought to be more frequent extremes in weather of all types, hot and cold, dry and wet, windy and stagnant. This is because we are an island in the middle of the North Atlantic storm track – where energy is often racing fast from the equator to the poles. While no single weather event can ever be directly attributed to climate change (by virtue of the way climate and weather are necessarily treated differently within mathematical models), we rely on statistics

over long timescales. The number of weather records broken in the UK over the past 7 years (and in 2012 alone) should not be forgotten, nor should similar statistics reported around the world. Whilst still the subject of debate, a growing number of meteorologists and climatologists are beginning to talk about climate change as something that has been having a growing impact on our weather (and our lives and economies) for many years.

The principal driver of climate change is an increased greenhouse effect driven by increases in the amount of GHGs in the atmosphere, which trap infrared radiation (heat energy) near the Earth's surface. Various feedback processes, tipping points and buffers are known (or thought) to exist, which may exacerbate or limit changes in surface temperature (eg cloudiness, ice cover), yet the underlying response of the

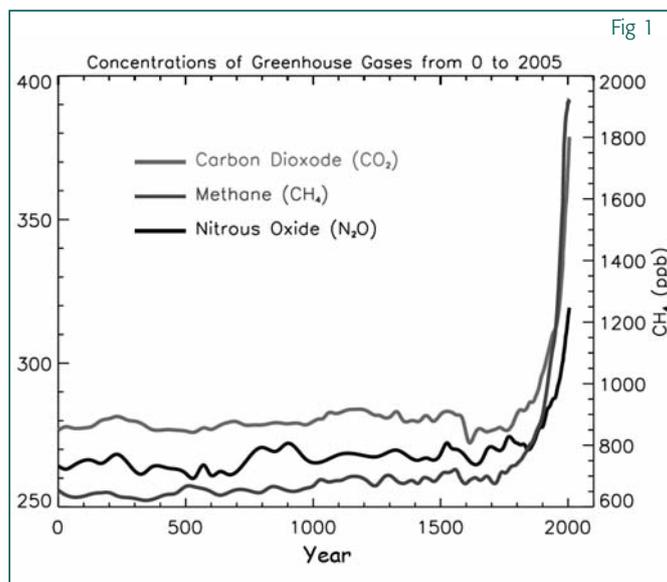
... speeding up this pace of change ...



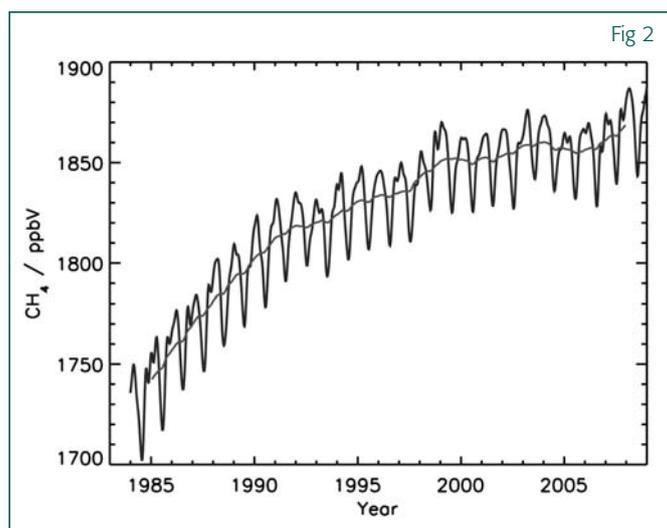
atmosphere can be linked to the concentration of GHGs.

Monitoring (and predicting) the concentration of GHGs in the atmosphere and how they are changing is therefore key to understanding the global (and local) consequences of climate change. While much successful effort has been put into better global monitoring of GHG concentrations in the atmosphere (eg through the WMO-led Global Atmospheric Watch programme and EU-led Integrated Carbon Observing System), the various sources and sinks of these gases remain the subject of study which bridges the many academic disciplines required to understand the Earth system. These include branches of physics, chemistry, biology and geology – all of which are required to assess how GHGs are emitted and/or deposited into the atmosphere from their various reservoirs (land, biosphere, ocean and the deep earth). Once in the atmosphere, we need to know how they evolve chemically as they are transported on the wind all around the planet. Furthermore, to make longer-term forecasts and attempt to mitigate changes in the future, we must also include sociology, economics and engineering. This is because the Earth's atmosphere (and its composition) is a dynamic system driven by different processes on different temporal and spatial scales. To make matters even more complex, local monitoring alone cannot address remote inputs and impacts. This interdisciplinary activity must be coordinated internationally. Much progress has been made but more still needs to be done.

Whilst much press is given to the rise of CO<sub>2</sub> in the atmosphere, the sources and sinks of CH<sub>4</sub> are less well



Atmospheric concentrations of important long-lived greenhouse gases over the last 2,000 years. Concentration units are parts per million (ppm) or parts per billion (ppb), indicating the number of molecules of the greenhouse gas per million or billion air molecules, respectively, in an atmospheric sample. Source: The Fourth Assessment Report of The Intergovernmental Panel on Climate Change, Chapter 2, FAQ 2.1, Figure 1. The source of this image is a PDF file that can be downloaded at <http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter2.pdf>



Atmospheric methane concentration measured at Ocean Station M, Norway, between 1983 and 2009. Figure created using public archive data from the Cooperative Atmospheric Data Integration Project – Methane, NOAA ESRL, Boulder, Colorado; available via FTP to <ftp.cmdl.noaa.gov>

understood. What we know is that CH<sub>4</sub> is on the rise. Figure 1 shows ice core data from Antarctica, which can be used to track globally averaged CH<sub>4</sub> concentration in the atmosphere. What we see is a general pattern of a steep and accelerating rise in concentration since the industrial big bang at around 1800 AD, which

continues to the present. This pattern is typical of many of the gases in the atmosphere that can be traced to manmade (anthropogenic) activity, whether directly or indirectly. With the benefit of plurality and accuracy of modern measurement techniques, we now know that within this upward trend, there are significant and sudden

changes in global average CH<sub>4</sub>, as well as seasonal cycles and other modes of variability (see Figure 2). It is the subtlety within these modes of variability and their potential causes (and uncertainties) that are the source of much important scientific effort. This article highlights this and also the work that remains to be done.

Among the sources of atmospheric CH<sub>4</sub> are many so-called natural ones. These include geological seepage of fossil-CH<sub>4</sub>, anaerobic microbial activity in the near-surface, and animals. However, these are dwarfed by the various “unnatural” sources that can be linked to human activity, which include livestock, agriculture, fossil fuel burning and direct emission from natural gas exploration (and lines of transmission). As we can see from Figure 1, the concentration of methane has more than doubled since pre-industrial times. Furthermore, new additional sources of CH<sub>4</sub>, which are being driven by climate change, are a key cause for concern. Chief among these is the unquantified release of CH<sub>4</sub> trapped in frozen methane hydrates in the permafrosts and ice of the Arctic and sub-Arctic (see “Arctic Methane Emergency” in SiP Spring 2012). Together with rising Arctic temperatures and increasing microbial activity in Arctic tundra, emissions in the area are hypothesized as one of the contributory causes of sudden increases in global methane seen in Figure 2 in recent years. Other contributing sources are thought to be the continued reliance on fossil fuels for energy generation, particularly in rapidly growing nations and the recent growth in natural gas exploration and transmission lines.

## ... increasing microbial activity ...

We should recognise the world-class research by the UK academic community in this important area, enabled by funding through the Natural Environment Research Council (NERC) and DECC. Recently, the NERC Arctic programme has funded a number of projects that will tackle Arctic change and the issue of methane emissions in the region. Chief among these, a consortium of UK universities and international partners led by Prof John Pyle of the University of Cambridge, entitled Methane in the Arctic: Measurement and Modelling (MAMM), is currently investigating local and remote impacts of methane in the Arctic by studying the land surface and atmosphere over an area from Sweden and Finland to Svalbard. I am the coordinator of an aircraft-based study with the UK's Facility for Airborne Atmospheric Measurement (FAAM), which can measure

GHG concentrations with unprecedented sensitivity while mapping wide areas. Early data show that the wetlands of Finland represent an important source of methane locally, whilst methane over the ocean can be dominated by a mix of signals both local and remote (with inputs from forest fires as far away as Canada). Further field campaigns throughout 2013 will help to place these data in both

## ... largest source of CH<sub>4</sub> remains anthropogenic ...

a wider and seasonal context such that regional emissions estimates may be extrapolated and used to improve models of how climate change takes place.

Given the importance of the role of CH<sub>4</sub> in climate change, and in recognition of the fact that the largest source of CH<sub>4</sub> remains anthropogenic and can

therefore be controlled, the UK Government is committed to reducing methane emissions under the Kyoto Protocol as one of a basket of four compounds (the others being CO<sub>2</sub>, N<sub>2</sub>O and SF<sub>6</sub>). To meet these targets, the UK must reduce total carbon emissions by 12.5% (when averaged over the period 2008-2012) versus 1990 emissions. Currently, the UK is performing extremely well in meeting those targets, with total carbon emissions down by 29.6% (excluding emissions trading) by this measure in 2011 (DECC,

2012). This is significantly better than the EU-15 member group, which achieved an average reduction of just over 10% over the same period. However, although significant reductions have been made since 1990, these have been largely fortuitous due in part to a decline in the UK coal industry,

and improved landfilling technologies (Methane UK – Environmental Change Institute, Oxford University).

The method by which these figures are calculated is far from ideal and relies on a bottom-up approach of summing a large number of emissions reports and estimates (often compiled within industries with vested interests), rather than hard measurement and direct attribution. To validate (and improve on) this approach, we must compare these emissions estimates with those derived using a top-down approach, where direct measurement is employed to attribute better emissions sources at high spatial resolution. This is critical to providing accurate emissions data under our regulatory obligations and to the economics of any future emissions trading schemes. To this end, NERC have recently commissioned the Greenhouse Gases: Emissions and Feedbacks programme, which has funded three national academic consortia to investigate this



## ... measurements in flights around the UK ...

problem from both sides, with the ultimate aim of better constraining and predicting UK GHG emissions. One of these consortia, the Greenhouse gAs UK and Global Emissions (GAUGE) project is a four-year measurement and data analysis programme beginning in January 2013, which involves six UK universities led by Prof Paul Palmer at the University of Edinburgh, and includes national agencies such as the Met Office, in collaboration with DECC and other agencies. GAUGE has been designed to measure directly GHG concentrations over the UK in order to characterise and quantify the variety of sources that determine the UK's contribution to the trend and variability of atmospheric concentrations of GHGs globally. I will lead the airborne measurement package of GAUGE by recording measurements in flights around the UK mainland to measure

what comes in and what goes out in the air that passes over the UK. These so-called "boundary conditions" are important in understanding what the relative impacts of emissions within the UK are versus what comes in from further afield. For example, it is currently well known that days of poor London air quality are often exacerbated by polluted Continental air entering the UK. By continuous and direct measurement across the UK, models of atmospheric transport and chemistry can be used to determine not only what the UK emits en masse, but also to disaggregate these emissions between specific areas and industries thus providing the acid test of the current approach.

Once again, it is CH<sub>4</sub> that carries the most uncertainty in the UK's GHG emissions inventory and the GAUGE project will strive to better constrain it. The exploratory hydraulic fracturing ("fracking") licences recently granted to Cuadrilla for shale gas extraction in the North West, warrant close attention. This industry could represent an additional new source of methane through what are known as fugitive emissions, or unintended venting of CH<sub>4</sub> to the atmosphere. The routes of emission are not fully understood or quantified but may include localised emissions at the drill site or diffuse emission through potential geological fractures far away. These hazards are not unrecognised and Cuadrilla has plans to capture any vented methane at drill sites. What is called for is appropriate

monitoring as this industry expands. A safety hazards assessment has been reported by DECC in May 2012, yet that assessment did not seek to assess environmental hazards, which would include the climate impacts of fugitive emissions and implications for regional air quality. It is my hope that DECC will commission such an assessment before any larger scale roll-out of fracking and that the academic community is properly engaged in that assessment.

The UK has risen to the challenge of meeting its Kyoto pledge and fostered a world-class academic community and infrastructure fit for the purpose of understanding and monitoring of GHGs both nationally and internationally. Methane remains a significant source of uncertainty and work must be continued to monitor and understand how the concentration of this important gas is changing in the atmosphere both within the UK and globally if we are to provide the best possible forecasts of climate change in the future.

## ... These hazards are not unrecognised ...



# HOUSE OF LORDS SCIENCE AND TECHNOLOGY SELECT COMMITTEE

The members of the Committee (appointed 16 May 2012) are Lord Broers, Lord Cunningham of Felling, Lord Dixon-Smith, Baroness Hilton of Eggardon, Lord O'Neill of Clackmannan, Lord Krebs (Chairman), Lord Patel, Baroness Perry of Southwark, Lord Rees of Ludlow, the Earl of Selborne, Baroness Sharp of Guildford, Lord Wade of Chorlton, Lord Willis of Knaresborough and Lord Winston. Lord Lucas of Crudwell and Dingwall and Baroness Neuberger were co-opted to Subcommittee 1 for the purposes of the inquiry on higher education in STEM subjects.

### Open access

The Committee has recently launched a short inquiry into the implementation of the Government's open access policy. It has issued a targeted call for evidence to key stakeholders for this short inquiry. The Committee will publish its findings in February 2013.

### Regenerative medicine

The Committee launched an inquiry into regenerative medicine. The deadline for

submissions was 20 September 2012. The inquiry will cover current research in regenerative medicine and potential treatments which could be developed in the next 5-10 years, barriers to translation of this research to applications and commercial products, and compare the UK's efforts with international examples. The Committee expects to report in Spring 2013.

### Higher Education in Science, Technology, Engineering and Maths (STEM) subjects

In September 2011, the Select Committee

appointed a Sub-Committee, chaired by Lord Willis of Knaresborough, to conduct an inquiry into higher education in STEM subjects. The inquiry considered how the UK can ensure that the supply of graduates in STEM subjects meets future needs, looked at 16-18 maths provision, and undergraduate and postgraduate education. Oral evidence sessions began in December and finished in April 2012. The Committee published its report on 24 July 2012. The Government response was received in November 2012. The report will be debated in the House.

### Sports and exercise science and medicine

In May 2012, the Select Committee launched a short inquiry into sports and exercise science and medicine to consider how the legacy of London 2012 could be used to improve understanding of the benefits exercise can provide for the wider public, and in treating chronic conditions. The Committee explored how robust this science is, and how lessons learnt from the study of athletes can be applied to improve the health of the population

generally. The Committee held a seminar on 29th May 2012, and took oral evidence during June from sports and exercise scientists and clinicians, UK Sport, and officials and Ministers from the Department of Health and the Department for Culture, Media and Sport. The Committee published its report on 17 July 2012. The Government response was received in October 2012. The report will be debated in the House.

### FURTHER INFORMATION

The written and oral evidence to the Committee's inquiries mentioned above, as well as the Calls for Evidence and other documents can be found on the Committee's website. Further information about the work of the Committee can be obtained from Chris Atkinson, Committee Clerk, [atkinsoncl@parliament.uk](mailto:atkinsoncl@parliament.uk) or 020 7219 4963. The Committee Office email address is [hlscience@parliament.uk](mailto:hlscience@parliament.uk).



Listed opposite (grouped by subject area) is a selection of debates on matters of scientific interest which took place in the House of Commons, the House of Lords or Westminster Hall between 8th October and 20th December 2012

## SELECTED DEBATES

### Agriculture and Animal Health

Common Agricultural Policy: 1.11.12 HoC 133WH  
 Animal Welfare: 13.12.12 HoC 479  
 Badger Cull: 25.10.12 HoC 1095  
 Zoos: 8.10.12 HoL GC388  
 Animals (Scientific Procedures) Act 1986  
 Amendment Regulations 2012: 13.12.12 HoL GC379

### Education

Education: Development of Excellence: 18.10.12 HoL 1567  
 Education: Further Education Colleges: 9.10.12 HoL GC405  
 Higher Education: EUC Report: 11.10.12 HoL 1203  
 Higher Education: Reform: 12.11.12 HoL 1340

### Energy

Energy and Climate Change Committee Report: 20.12.12 HoC 1015  
 High Carbon Investment: 18.12.12 HoC 821  
 Onshore Gas: 24.10.12 HoC 1037  
 Shale Gas Profits: 19.12.12 HoC 293WH

### Plant Health

Ash Dieback Disease: 12.11.12 HoC 49  
 Trees: British Ash Tree: 5.11.12 HoL 861

### Fisheries

Fisheries: 6.12.12 HoC 323WH

### Health

Cancer: 9.10.12 HoL GC438  
 Health: Active Lifestyles: 17.12.12 HoL 1439  
 Mobile Technology (Health Care): 21.11.12 HoC 207WH

### Industry

Britain's Industrial Base: 9.10.12 HoL 986  
 Industrial Policy and Manufacturing: 22.11.12 HoC 795

### International Development

Access to Sanitation: 26.11.12 HoC 113  
 Millennium Development Goals: 22.11.12 HoL 1938  
 HIV (Developing Countries): 19.12.12 HoC 270WH

### Science Policy

Antarctica: Centenary of Scott Expedition: 18.10.12 HoL 1612  
 Chief Scientific Advisers: S&T Committee Report: 17.10.12 HoL GC513  
 HoC Administration and Savings Programme (POST): 8.11.12 HoC 1057 & 1064

### Water

EUC Report: EU Freshwater Policy: 5.12.12 HoL 721





# HOUSE OF COMMONS SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY

The Science and Technology Committee is established under Standing Order No 152, and charged with the scrutiny of the expenditure, administration and policy of the Government Office for Science, a semi-autonomous organisation based within the Department for Business, Innovation and Skills.

The current members of the Science and Technology Committee are:

Caroline Dinenage (Conservative, Gosport), Jim Dowd (Labour, Lewisham West and Penge), Stephen Metcalfe (Conservative, South Basildon and East Thurrock), Andrew Miller (Labour, Ellesmere Port and Neston), David Morris (Conservative, Morecambe and Lunesdale), Stephen Mosley (Conservative, City of Chester), Pamela Nash (Labour, Airdrie and Shotts), Sarah Newton (Conservative, Truro and Falmouth), Graham Stringer (Labour, Blackley and Broughton), Hywel Williams (Plaid Cymru, Arfon) and Roger Williams (Liberal Democrat, Brecon and Radnorshire).

Andrew Miller was elected by the House of Commons to be the Chair of the Committee on 9 June 2010. The remaining Members were formally appointed to the Committee on 12 July 2010. Caroline Dinenage, Gareth Johnson, Sarah Newton and Hywel Williams were formally appointed to the Committee on 27 February 2012 in the place of Gavin Barwell, Gregg McClymont, Stephen McPartland and David Morris. Jim Dowd was formally appointed to the Committee on 11 June 2012 in the place of Jonathan Reynolds. David Morris was formally re-appointed to the Committee on 3 December 2012 in the place of Gareth Johnson.

## CURRENT INQUIRIES

### Bridging the “valley of death”: improving the commercialisation of research

On 16 December 2011, the Committee announced an inquiry: Bridging the “valley of death”: improving the commercialisation of research. The Committee invited written submissions by 8 February 2012.

On 18 April 2012, the Committee took evidence from: Professor Luke Georghiou, Vice-President (Research and Innovation), University of Manchester; Dr Paul Nightingale, Science and Technology Policy Research, University of Sussex; David Connell, Senior Research Fellow, Centre for Business Research/UK Innovation Research Centre, Judge Business School, University of Cambridge; and Dr Douglas Robertson, Chair, Praxis-Unico. The Committee also heard from: Dr Ted Bianco, Director of Technology Transfer, Wellcome Trust; Dr Ian Tomlinson, Senior Vice President, Head of Worldwide Business Development and Biopharmaceuticals R&D, GlaxoSmithKline; Dr David Tapolczay, Chief Executive Officer, Medical Research Council Technology; Dr Gareth Goodier, Chair, Shelford Group (Chief Executives of ten leading Academic Medical Centres and large teaching hospitals) and Chief Executive, Cambridge University Hospitals NHS Foundation Trust; and Dr Andy Richards, serial biotechnology entrepreneur and business angel.

On 25 April 2012, the Committee took evidence from: Katie Potts, Herald Investment Management; Anne Glover, Amadeus Capital Partners Ltd; Matthew Bullock and Stephen Welton, Business Growth Fund. The Committee also heard from: Dr Richard Worswick, Cobalt Light Systems; Dr Peter Dean, Cambio; and Dr Trevor Francis, Technical Director, Byotrol Technology Ltd.

On 20 June 2012, the Committee took evidence from: Sir David Cooksey and Sir Peter Williams; David Sweeney, Director (Research, Innovation and Skills), Higher Education Funding Council for England (HEFCE); Professor Ian Haines, UK Deans of Science; and Professor Nick Wright, Russell Group.

On 2 July 2012, the Committee took evidence from: Rees Ward CB, Chief Executive Officer of ADS;

Professor Keith Hayward, Head of Research, Royal Aeronautical Society; Henner Wapenhans, Head of Technology Strategy, Rolls Royce; Dr Ruth Mallors, Aerospace, Aviation and Defence KTN; and Sir John Chisholm, Engineering the Future.

On 5 September 2012, the Committee took evidence from: Tim Crocker, SME Innovation Alliance; Dr Tim Bradshaw, Head of Enterprise and Innovation, CBI; Fergus Harradence, Deputy Director, Innovation Policy, Department for Business, Innovation and Skills; Iain Gray, Chief Executive, Technology Strategy Board; and Sir John Savill, Research Councils UK.

On 12 September 2012, the Committee took evidence from: Rt Hon David Willetts MP, Minister of State for Universities and Science.

The written and oral evidence received in this inquiry is on the Committee’s website. A Report is being prepared.

### Engineering Skills

On 30 April 2012, the Committee announced an inquiry: Engineering Skills. The Committee invited written submissions by 18 June 2012.

On 24 October 2012, the Committee took evidence from: Steve Radley, Director of Policy, Engineering Employers Federation (EEF); Lynn Tomkins, UK Operations Director, Sector Skills Council for Science, Engineering and Manufacturing Technologies (SEMTA); Richard Earp, Education and Skills Manager, National Grid; and Andrew Churchill, Managing Director, JJ Churchill Ltd.

On 7 November 2012, the Committee took evidence from: Georgia Turner, Student, JCB Academy; Georgie Luff, Student, Newstead Wood School; and Kirsty Rossington, Substation Apprentice, National Grid. The Committee also heard from: Jim Wade, Principal, JCB Academy; Liz Allen, Headteacher, Newstead Wood School and Maggie Galliers, President, Association of Colleges.

On 21 November 2012, the Committee took evidence from: Dr Bill Mitchell, Director, BCS Academy of Computing; Nigel Fine, Chief Executive, Institution of Engineering and Technology; and Dr Matthew Harrison, Director of Education, The Royal Academy of Engineering.



The Committee also heard from: Carole Willis, Chief Scientific Adviser, Department for Education; Elizabeth Truss MP, Parliamentary Under Secretary of State (Education and Childcare), Department for Education; and Matthew Hancock MP, Parliamentary Under Secretary of State (Skills), Department for Education and the Department for Business, Innovation and Skills

The written and oral evidence received in this inquiry is on the Committee's website. A Report is being prepared.

### Marine Science

On 4 July 2012, the Committee announced an inquiry: Marine Science. The Committee invited written submissions by 19 September 2012.

On 28 November 2012, the Committee took evidence from: Joan Edwards, Head of Living Seas, The Wildlife Trusts; Alec Taylor, Marine Policy Officer, RSPB; and Dr Jean-Luc Solandt, Senior Policy Officer, Marine Conservation Society.

On 5 December 2012, the Committee took evidence from: Phil Durrant, Managing Director, Gardline Environmental Limited (representing the North Sea Marine Cluster); Professor Ralph Rayner, Institute of Marine Engineering, Science and Technology (IMarEST); and Richard Burt, Chair, Association of Marine Scientific Industries (AMSI) Council. The Committee also heard from: Dr Phillip Williamson, Science Coordinator, UK Ocean Acidification Research Programme; Professor Jonathan Sharples, Research Centre for Marine Sciences and Climate Change, Liverpool University; and Stephen Dye, Marine Climate Change Impacts Partnership (MCCIP).

On 12 December 2012, the Committee took evidence from: Professor Alan Rodger, Interim Director, British Antarctic Survey; and Professor Ed Hill, Director, National Oceanography Centre.

On 20 December 2012, the Committee took evidence from: Dr Matthew Frost, Deputy Director, Policy and Knowledge Exchange, Marine Biological Association; and Professor Stephen de Mora, Chief Executive, Plymouth Marine Laboratory.

The Committee held further oral evidence sessions on 9 and 16 January 2013. The written and oral evidence received in this inquiry is on the Committee's website.

### Proposed merger of the British Antarctic Survey and National Oceanography Centre

On 31 October 2012, the Committee took evidence from: Rt Hon David Willetts MP, Minister for Universities and Science; Professor Ed Hill, Interim Director of British Antarctic Survey and Director of National Oceanography Centre; Edmund Wallis, Chairman, and Professor Duncan Wingham, Chief Executive, Natural Environment Research Council.

The written and oral evidence received in this inquiry is on the Committee's website. A Report was published on 31 October 2012.

### Forensic Science Services (FSS) follow-up

On 22 November 2012, the Committee announced an inquiry: FSS Follow-up. The Committee invited written submissions by 10 January 2013. The Committee expects to hold oral evidence sessions in 2013.

### Clinical Trials

On 13 December 2012, the Committee announced an inquiry:

Clinical Trials. The Committee invited written submissions by 22 February 2013. The Committee expects to hold oral evidence sessions in 2013.

### Water Quality

On 19 December 2012, the Committee announced an inquiry: Water Quality. The Committee invited written submissions by 8 February 2013. The Committee expects to hold oral evidence sessions in 2013.

## REPORTS

### Science and International Development

On 26 October 2012, the Committee published its Fourth Report of Session 2012-13, *Building scientific capacity for development*, HC 377

### Proposed merger of the British Antarctic Survey and National Oceanography Centre

On 31 October 2012, the Committee published its Sixth Report of Session 2012-13, *Proposed merger of the British Antarctic Survey and National Oceanography Centre*, HC 699

### Regulation of Medical Implants

On 1 November 2012, the Committee published its Fourth Report of Session 2012-13, *Regulation of medical implants in the EU and UK*, HC 1163

## GOVERNMENT RESPONSES

### Government Response to the Science and Technology Committee report 'Devil's bargain? Energy risks and the public'

On 1 November 2012, the Committee published the Government Response to the Committee's Report on Devil's bargain? Energy risks and the public, HC 677.

### Government Response to the Science and Technology Committee report 'Regulation of medical implants in the EU and UK'

On 18 December 2012, the Department of Health published the Government's Response to the Committee's Report on Regulation of medical implants in the EU and UK, Cm 8496.

## FURTHER INFORMATION

Further information about the work of the Science and Technology Committee or its current inquiries can be obtained from the Clerk of the Committee, Stephen McGinness, or from the Senior Committee Assistant, Darren Hackett, on 020 7219 2792/2793 respectively; or by writing to: The Clerk of the Committee, Science and Technology Committee, House of Commons, 7 Millbank, London SW1P 3JA. Enquiries can also be e-mailed to [scitechcom@parliament.uk](mailto:scitechcom@parliament.uk). Anyone wishing to be included on the Committee's mailing list should contact the staff of the Committee. Anyone wishing to submit evidence to the Committee is strongly recommended to obtain a copy of the guidance note first. Guidance on the submission of evidence can be found at [www.parliament.uk/commons/selcom/witguide.htm](http://www.parliament.uk/commons/selcom/witguide.htm). The Committee has a website, [www.parliament.uk/science](http://www.parliament.uk/science), where all recent publications, terms of reference for all inquiries and press notices are available.





# HOUSE OF COMMONS LIBRARY SCIENCE AND ENVIRONMENT SECTION

Scientists and other staff in the Science and Environment Section provide confidential, bespoke briefing to Members and their offices on a daily basis. They also provide support to Commons Select Committees, and produce longer notes and research papers which can be accessed on line at <http://www.parliament.uk/topics/topical-issues.htm>

Opposite are summaries of some recently updated published briefings.

For further information contact Dr Patsy Richards Head of Section Tel: 020 7219 1665; email: [richardspa@parliament.uk](mailto:richardspa@parliament.uk)

## RECENT PUBLICATIONS

### Energy Bill

*Research Paper 12/79*

The Energy Bill 2012 seeks to implement 'electricity market reform'. The aims of this are for 'secure, clean and affordable' energy supplies. The Bill introduces a new system of support for low-carbon generation, called 'Contracts for Difference' which will encompass nuclear as well as renewable generation. It allows for other measures to reform the electricity market, such as capacity auctions, and measures to support routes to market for independent generators should such powers be needed. However, it does not include all of the recommendations made by the Energy and Climate Change Select Committee following its pre-legislative scrutiny of the draft Bill. The Committee also said that certainty and stability were needed urgently for investors, but several consultations associated with measures in the Bill are on-going.

Other provisions in the Bill include placing the Office for Nuclear Regulation on a statutory footing, allowing for the sale of the Government Pipeline and Storage System, and 'consumer redress' powers, allowing Ofgem to require energy companies to pay compensation to consumers.

### Growth and Infrastructure Bill

*Research Paper 12/61*

#### Growth and Infrastructure Bill: Committee Stage Report *Research Paper 12/78*

The Bill seeks to reduce delays in the planning system through various means, and to make it easier for new developments to be built. To promote development, the Bill would allow for planning obligations (section 106 agreements) relating to affordable housing to be renegotiated to make a development economically viable. To promote economic growth, it makes provision for a planned revaluation of business rates in England to be postponed and to create a new employment status of employee-owner.

Significant areas of debate at Committee Stage included: proposals to allow applications for planning permission to go direct to the Planning Inspectorate; the renegotiation of affordable

housing planning obligations; postponement of a planned revaluation of business rates; and on the proposed new employment status of employee-owner.

Some substantive Government amendments were made to the Bill on clause 5, the modification or discharge of affordable housing requirements. Two new clauses were added by the Government to the Bill: new clause 3 to remove the requirement for Planning Act 2008 consent and certification that currently needs to be acquired alongside development consent; and new clause 14 on prior approvals related to permitted development right change of use. The Government also made a number of technical amendments.

### Scrap Metal Dealers Bill: Committee Stage Report

*Research Paper 12/66*

The Bill, which has Government support, is a Private Member's Bill sponsored by Richard Ottaway. It would introduce additional regulatory controls on scrap metal dealers in order to reduce the opportunities for thieves to sell stolen material.

A number of amendments were made to the Bill in Committee. Government amendments included: changes to the definition of scrap metal to include platinum; the removal of a national cap on scrap metal dealer licence application fees; and provisions for a defence against certain offences where all reasonable steps had been taken. The Opposition amended the Bill to require scrap metal dealers to keep records for three years, rather than two.

### Ash dieback disease: *Chalara fraxinea* SN/SC/6498

*Chalara fraxinea* is a fungus which is causing a serious disease known as ash dieback. The infection causes wilting leaves and crown die back and it usually leads to tree death. The ash tree is one of Britain's few native tree species and has important conservation value. There are approximately 80 million ash trees in the UK representing 5% of Britain's woodland cover.

Ash dieback was confirmed in the UK in February 2012 and a ban on imports introduced



on 29 October 2012 after a voluntary moratorium by the industry. The Horticultural Trades Association had asked for a ban back in 2009, having seen the impact of the disease in Denmark. Much of the immediate debate on the issue therefore focused on how the UK Government reacted to these warnings, and why it did not act sooner to ban imports.

Now that the disease has been confirmed in established trees in the UK, the focus has shifted to informing and developing action plans to deal with the disease. In addition, a Tree Health and Plant Biosecurity Taskforce has been established to review the UK's strategic approach to tree health and biosecurity. Its report is due in Spring 2013. It published an interim report on 6 December 2012 along with Defra's Interim Chalara Control Plan.

The current approach is to slow the spread of the disease and to minimise its impact to gain time to find trees with genetic resistance and to restructure our woodlands to make them more resilient.

### **Underground power lines and health SN/SC/6453**

Power lines give rise to electric and magnetic fields which fall off with distance. Burying power lines underground effectively shields the electric fields but less so the magnetic. It is the latter which have given rise to health concerns. Current exposure restrictions are based on limiting the electrical currents that time-varying magnetic fields induce in the brain.

Epidemiological studies have suggested that exposure to magnetic fields could increase the risk of contracting childhood leukaemia. However, a biological mechanism has not been established. The evidence for a carcinogenic effect is still too weak to influence exposure restrictions recommended by the Health Protection Agency. These in turn follow the advice of the International Commission on Non-Ionizing Radiation Protection.

There are sometimes aesthetic and practical reasons for replacing overhead power lines by underground ones. However, undergrounding power lines in response to health concerns would be a precautionary measure.

### **Export of Live Animals within the European Union SN/SC/6504**

The transport and export of live animals within the European Union is regulated by Council Regulation (EC) 1/2005 on the protection of animals during transport. This sets out a series of measures, including requirements for transporters to be authorised, vehicle and container requirements, limits to time in transit and requirements for authorised rest stops.

In the UK the Regulation is implemented through the Welfare of Animals (Transport) (England) Order 2006. The Animal Health and Veterinary Laboratories Agency is responsible for carrying out inspections of animals at point of loading and at ports. Trading Standards also has powers to inspect animals during transport, and is responsible for carrying out any prosecutions under the regulations.

Within the EU, Ireland received by far the largest number of exported live animals from the UK in 2012, mainly sheep. Cattle are the second largest export, the two main destinations being Spain and Ireland.

### **Food Prices and Affordability SN/SC/6436**

Food commodity prices have hit historic peaks in the last few years. There have been three big price spikes in the last five years suggesting a trend in rising prices. Most commentators are now speculating that it is the end of the cheap food era, although falling prices at the end of 2012 eased food crisis fears.

A number of factors have come together to bring about the recent price spikes but their contribution is variable and the relative impact of each factor is hard to determine. They relate to unfavourable conditions in some major producing countries leading to less than expected harvests, against the background of growth of demand. In addition, export barriers have added uncertainty and driven prices for wheat higher.

In the UK, all foods have risen in price since 2007 with processed foods and fruit showing the biggest increases. Charities reported a 100% increase in the use of food banks in 2012. The UK response is to work at international level, with the G8 and G20, to address price volatility and to discourage inappropriate reactions to market events such as the use of export bans. At domestic level, the Government has said that it is "highly attuned" to the need to increase high-quality food production to ameliorate the impacts of high food prices.

A 2011 Foresight report on food and farming noted the difficulties of formulating a response to food price volatility without distorting markets. It suggested that food affordability issues were best dealt with by creating safety nets for those most impacted.

## **ACTIVITIES**

### **Visit to Rutherford Appleton Laboratory**

In September 2012 two specialists from the section spent a day at the Rutherford Appleton Laboratory in Oxfordshire to learn more about the major scientific research facilities. They met a number of scientists and were given a tour of the facilities. The day culminated with a discussion on science and science policy with Dr Andrew Taylor, Executive Director of STFC National Laboratories.

### **Presentations**

Staff members addressed various groups of visitors to Parliament during Autumn 2012, including scientists undertaking the Royal Society pairing scheme and Industry and Parliament Trust fellows. They also made a Library presentation alongside Department of Energy and Climate Change (DECC) officials on smart meters. This was accompanied by a practical demonstration of smart metering by industry representatives and DECC in the Portcullis House Atrium on 5 December, which the Library organised.





# PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY (POST)

## RECENT POST PUBLICATIONS

### **Mental Health and the Workplace**

November 2012

POSTnote 422

Poor mental health in the workplace is detrimental to individuals and businesses. This note summarises how the workplace affects mental health and vice versa. It describes the barriers to gaining and retaining employment and looks at ways of tackling mental health in the workplace and through healthcare services.

### **Machine-to-Machine Communication**

December 2012

POSTnote 423

Machine to machine (M2M) communication will allow the connection of billions of 'smart' devices and enable new ways of living and working. This note examines the potential of M2M, the common infrastructure that underlies many applications and the technological barriers to implementation.

### **Plant Made Pharmaceuticals**

December 2012

POSTnote 424

The use of genetically modified (GM) plants to produce pharmaceutical drugs and vaccines is an emerging technology that offers a low-cost, large-scale alternative to current methods. This note looks at recent advances in, and the benefits of, the technology, and analyses the associated biosafety and regulatory issues.

### **Maximising the Value of Recycled Materials**

January 2013

POSTnote 425

Recycled materials are increasingly attractive as a source of raw material, due to insecure supplies of primary resources. This note provides an overview of the way materials are recycled in the UK and how their economic value can be exploited. It examines the challenges faced by the sector and the policy initiatives aimed at overcoming them, including the Materials Recovery Facility (MRF) Code of Practice currently in consultation.

### **Residential Heat Pumps**

January 2013

POSTnote 426

Heat pumps capture ambient heat from the air or the ground and transfer it inside a building. They provide an efficient alternative to conventional methods of heating, such as boilers. This note describes heat pumps for residential buildings and the constraints to their uptake in the UK.

### **Biodiversity in UK Overseas Territories**

January 2013

POSTnote 427

The UK Overseas Territories (UKOTs) support a diverse variety of habitats ranging from ice fields and rocky islands to coral reef atolls and tropical forests. This note summarises the challenges to biodiversity conservation in OTs required under international agreements.

## CURRENT WORK

*Biological Sciences* – Review of Stem Cell Research, HIV – Developments in Prevention and Detection, Managing Online Identity, Minimum Age of Criminal Responsibility, Preventing Mitochondrial Disease, Reducing Greenhouse Gas Emissions from Livestock.

*Environment and Energy* – Biodiversity and Planning Decisions, Non-native Invasive Plant Species and Schedule 9, Environmental Impacts of Tidal Barrages, Selection of Marine Conservation Zones, Intermittent Electricity Generation.

*Physical sciences and IT* – Opening Up Public Sector Data, Accessing Public Transport

*Science Policy* – STEM Education for 14-19 years old

*Science, Technology and the Developing World* – Uncertainty in Population Projections.

## CONFERENCES AND SEMINARS

### **Valuing Resources: The Science and Economics of Recycling**

On 15th January, POST and the Associate Parliamentary Sustainable Resource Group hosted an event to discuss the significant challenges remaining in exploiting the economic value of the materials in used products and packaging, particularly where several different materials are mixed together. This event gave parliamentarians and their staff together with other invited guests the opportunity to hear from experts in recycling and product design on the challenges in generating a high quality of product from recycled materials, and the potential value that could be captured from waste. They also had the chance to view exhibits and network with representatives from charities, academia, government and industry. Speakers included Chris Dow, Chief Executive Officer, Closed Loop Recycling; Marcus Gover, Director of Closed Loop Economy, WRAP, Nat Hunter, Co-Director of Design, The RSA; Ian Hetherington, Director General, British Metals Recycling Association.

### **A Seeping Canker? Tree Disease Biosecurity**

On 28th November, POST and the Parliamentary and Scientific Committee organised a seminar to discuss the growing threat to plant biosecurity from the expansion of international trade and travel and transport of live trees and timber products. This event gave parliamentarians and their staff together with other invited guests the opportunity to hear from experts:

- what will be the impacts of tree disease epidemics on urban and rural constituencies
- how an integrated approach to managing tree biosecurity could be developed

- look at developments in the recent science behind the pathology and control of tree disease
- the opportunities for reforming EU and International plant health regulatory frameworks to address future risks.

This meeting, chaired by Lord Clark of Windermere, heard from Dr Joan Webber, Principal Pathologist and Head of Tree Health Research Group; Martin Ward, Chair of European and Mediterranean Plant Protection Organisation, Head of Plant Health Policy, The Food and Environment Research Agency; Hillary Allison, Director of Policy, Woodland Trust and Dr Steve Woodward, Co-ordinator of the EU ISEFOR project (Increasing Sustainability of European Forests: Modelling for Security Against Invasive Pests and Pathogens under Climate Change), Institute of Biological and Environmental Sciences, University of Aberdeen

### **Foresight Project on the Future of Computer Trading in the Financial Markets - an International Perspective**

On 23rd October, POST hosted the Government Office for Science parliamentary launch of the most recent foresight project. There is increasing debate over whether computer trading helps or hinders financial markets, but scientific analysis has been thin on the ground. Drawing on input from 150 academics in over 20 countries, the Foresight report is the most comprehensive study of its kind. The report also assessed the costs and benefits of EU policies related to computer trading, as the EU revises the Markets in Financial Instruments Directive (MiFID) which sets out how financial markets are regulated. This was to provide a more informed platform for understanding policy implications and for developing possible responses. This meeting, chaired by Professor Sir John Beddington, Government Chief Scientific Adviser, was an opportunity for parliamentarians to discuss the project's final conclusions and options for policy in the UK and internationally with key experts from the project. Invited guests heard presentations from Dr Jean Pierre Zigrand, Reader in Finance, London School of Economics; Professor Oliver Linton, Chair of Political Economy, Cambridge University and Professor Dave Cliff, Professor of Computer Science, University of Bristol.

### **Breathe**

On 16th October, POST and the Environmental Audit Committee hosted an event on the effects and artistic depiction of invisible air pollution. Famously, artists, including Monet and Turner, have painted the effects of air pollution over the Thames. In this event, chaired by Joan Walley, MP, Chair of the EAC, internationally acclaimed artist Dryden Goodwin explored his new work entitled Breathe, a large scale video projection on the roof of St Thomas' Hospital, opposite the House of Commons. The Breathe video projection took place at night during 8th to 28th October 2012. Goodwin's scientific collaborator, Professor Frank Kelly, King's College London, who chairs COMEAP, the Government medical advisory committee on air pollutants, discussed the effects of air pollution on children's health. Professor Kelly leads the EXHALE study which is investigating the implications of the Low Emission Zone on the lung health of 8 year olds in East London, funded by the NIHR Biomedical Research Centre at Guy's and St Thomas' NHS Foundation Trust and King's College London. Turner Updated is part of Invisible Breath a project exploring air pollution and breathing by Invisible Dust supported by The Wellcome Trust, Arts

Council England, King's College London and Guy's and St Thomas' Charity.

### **The Third Industrial Revolution: Industrial policy and disruptive technologies**

On 11th September, POST and the Associate Parliamentary Manufacturing Group hosted a seminar to discuss the relationship between Government policy and cutting-edge technologies that are soon to change the face of manufacturing in the UK. Much UK manufacturing is now characterised by innovation: the use of cutting-edge technologies, ultra-modern and efficient processes, and new kinds of business models that give companies competitive advantage and help bring growth to the wider economy. On the immediate horizon are a number of technologies that are set to change the face of UK manufacturing for good and will fundamentally change the kinds of supportive policy landscapes that Government needs to provide for industry. This meeting was an opportunity for parliamentarians to discuss what these technologies are, how they are applicable across sectors, and question whether or not Government policy is keeping up with the pace of change in industry. Guests heard from Fergus Harradence, Deputy Director of Innovation Policy, BIS; Clive Hickman, Chief Executive, Manufacturing Technology Centre; Richard Hague, Director, EPSRC Centre for Innovative Manufacturing in Additive Manufacturing and Phil Goodier, CEO, Plaxica Limited.

## **STAFF, FELLOWS AND INTERNS AT POST**

### *Conventional Fellows*

Ian Passmore, Cambridge University, Biotechnology and Biological Sciences Research Council

Laura Harrison, Leeds University, Natural Environment Research Council

Lisette Sibbons, University of Hertfordshire, Science and Technology Facilities Council

Kathryn Wills, University of Bath, Engineering and Physical Sciences Research Council

James Lawrence, University College London, Institution of Chemical Engineers/Ashok Kumar Fellowship

Tessa De Roo, University of Cambridge, Arts and Humanities Research Council

Victoria Charlton, Imperial College MSc Course on Science Communication

Daniel Amund, London Metropolitan University, Institute of Food Science and Technology

Alexandra Ferguson, Imperial College, Royal Society of Chemistry

### *Staff*

Dr Aaron Goater, previously working at the British Geological Survey, joined POST as Energy Adviser



# SCIENCE DIRECTORY

THE FOLLOWING ORGANISATIONS HAVE ENTRIES IN THE SCIENCE DIRECTORY:

The Academy of Medical Sciences  
 Association of the British Pharmaceutical Industry  
 AIRTO  
 AMPS  
 Biochemical Society  
 The British Ecological Society  
 British In Vitro Diagnostics Association (BIVDA)  
 British Nutrition Foundation  
 British Pharmacological Society  
 British Psychological Society  
 British Science Association  
 British Society for Antimicrobial Chemotherapy  
 British Society for Immunology  
 Cavendish Laboratory  
 Chartered Institute of Patent Attorneys  
 Clifton Scientific Trust  
 The Council for the Mathematical Sciences  
 Eli Lilly and Company Ltd

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 The Food and Environment Research Agency  
 GAMBICA Association Ltd  
 The Geological Society  
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 Institute of Physics and Engineering in Medicine  
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 Society of Biology  
 Society of Cosmetic Scientists  
 Society of Maritime Industries

Universities Federation for Animal Welfare  
 The Welding Institute

Research Councils UK  
 Biotechnology and Biological Sciences Research Council (BBSRC)  
 Economic and Social Research Council (ESRC)  
 Engineering and Physical Sciences Research Council (EPSRC)  
 Medical Research Council (MRC)  
 Natural Environment Research Council (NERC)  
 Science and Technology Facilities Council (STFC)



**The Academy of Medical Sciences**

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The Academy of Medical Sciences is the independent body in the UK representing the diversity of medical science. Our mission is to promote medical science and its translation into benefits for society. The Academy's elected Fellows are the United Kingdom's leading medical scientists from hospitals, academia, industry and the public service.



**Association of the British Pharmaceutical Industry**

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The ABPI is the voice of the innovative pharmaceutical industry, working with Government, regulators and other stakeholders to promote a receptive environment for a strong and progressive industry in the UK, one capable of providing the best medicines to patients.

The ABPI's mission is to represent the pharmaceutical industry operating in the UK in a way that:

- assures patient access to the best available medicine;
- creates a favourable political and economic environment;
- encourages innovative research and development;
- affords fair commercial returns



**AIRTO**

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AIRTO – The Association for Independent Research and Technology Organisations – is the foremost membership body for organisations operating in the UK's intermediate research and technology sector. AIRTO's members deliver vital innovation and knowledge transfer services which include applied and collaborative R&D, frequently in conjunction with universities, consultancy, technology validation and testing, incubation of commercialisation opportunities and early stage financing. AIRTO members have a combined turnover of over £2bn from clients both at home and outside the UK, and employ over 20,000 scientists, technologists and engineers.



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We are a Trades Union for Management and Professional Staff working in the pharmaceutical, chemical and allied industries.

We also have a section for Professional Divers working globally. We represent a broad base of both office and field based staff and use our influence to improve working conditions on behalf of our members.

We are experts in performance based and field related issues and are affiliated to our counterparts in EU Professional Management Unions.



**Biochemical Society**  
 Advancing Molecular Bioscience

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The Biochemical Society exists to promote and support the Molecular and Cellular Biosciences. We have over 6000 members in the UK and abroad, mostly research bioscientists in universities or in industry. The Society is also a major scientific publisher. In addition, we promote science policy debate and provide resources, for teachers and pupils, to support the bioscience curriculum in schools. Our membership supports our mission by organizing scientific meetings, sustaining our publications through authorship and peer review and by supporting our educational and policy initiatives.



**The British Ecological Society**  
 British Ecological Society

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<http://britishecologicalsociety.org/blog/>  
 Twitter: @BESPolicy

The British Ecological Society's mission is to advance ecology and make it count. The Society has 4,000 members worldwide. The BES publishes five internationally renowned scientific journals and organises the largest scientific meeting for ecologists in Europe. Through its grants, the BES also supports ecologists in developing countries and the provision of fieldwork in schools. The BES informs and advises Parliament and Government on ecological issues and welcomes requests for assistance from parliamentarians.

## British In Vitro Diagnostics Association (BIVDA)

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BIVDA is the UK industry association representing companies who manufacture and/or distribute the diagnostics tests and equipment to diagnose, monitor and manage disease largely through the NHS pathology services. Increasingly diagnostics are used outside the laboratory in community settings and also to identify those patients who would benefit from specific drug treatment particularly for cancer.

## British Nutrition Foundation



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The British Nutrition Foundation (BNF) was established over 40 years ago and exists to deliver authoritative, evidence-based information on food and nutrition in the context of health and lifestyle. The Foundation's work is conducted and communicated through a unique blend of nutrition science, education and media activities.

## BRITISH PHARMACOLOGICAL SOCIETY



Today's science, tomorrow's medicines

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The British Pharmacological Society has been supporting pharmacology and pharmacologists for over 80 years. Our 3,000+ members, from academia, industry and clinical practice, are trained to study drug action from the laboratory bench to the patient's bedside. Our aim is to improve quality of life by developing new medicines to treat and prevent the diseases and conditions that affect millions of people and animals. Inquiries about drugs and how they work are welcome.

## The British Psychological Society



The British Psychological Society

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The British Psychological Society is an organisation of over 48,000 members governed by Royal Charter. It maintains the Register of Chartered Psychologists, publishes books, 11 primary science Journals and organises conferences. Requests for information about psychology and psychologists from parliamentarians are very welcome.

## British Science Association



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Imran Khan will be Chief Executive from 2.4.13

Our vision is a society in which people are able to access science, engage with it and feel a sense of ownership about its direction. In such a society science advances with, and because of, the involvement and active support of the public.

Established in 1831, the British Science Association is a registered charity which organises major initiatives across the UK, including National Science and Engineering Week, the British Science Festival, programmes of regional and local events and the CREST programme for young people in schools and colleges. We provide opportunities for all ages to discuss, investigate, explore and challenge science.

## British Society for immunology

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The BSI is one of the oldest, largest and most active immunology societies in the world. We have over 4,000 members who work in all areas of immunology, including research and clinical practice.

The BSI runs major scientific meetings, education programmes and events for all ages. We disseminate top quality scientific research through our journals and meetings and we are committed to bringing the wonders and achievements of immunology to as many audiences as possible.

## British Society for Antimicrobial Chemotherapy

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Founded in 1971, and with 800 members worldwide, the Society exists to facilitate the acquisition and dissemination of knowledge in the field of antimicrobial chemotherapy. The BSAC publishes the *Journal of Antimicrobial Chemotherapy* (JAC), internationally renowned for its scientific excellence, undertakes a range of educational activities, awards grants for research and has active relationships with its peer groups and government.

## Cavendish Laboratory



The Administrative Secretary, The Cavendish Laboratory,  
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The Cavendish Laboratory houses the Department of Physics of the University of Cambridge.

The research programme covers the breadth of contemporary physics

**Extreme Universe:** Astrophysics, cosmology and high energy physics

**Quantum Universe:** Cold atoms, condensed matter theory, scientific computing, quantum matter and semiconductor physics

**Materials Universe:** Optoelectronics, nanophotonics, detector physics, thin film magnetism, surface physics and the Winton programme for the physics of sustainability

**Biological Universe:** Physics of medicine, biological systems and soft matter

The Laboratory has world-wide collaborations with other universities and industry

## Chartered Institute of Patent Attorneys



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CIPA's members practise in intellectual property, especially patents, trade marks, designs, and copyright, either in private partnerships or industrial companies. Through its new regulatory Board, CIPA maintains the statutory Register. It advises government and international circles on policy issues and provides information services, promoting the benefits to UK industry of obtaining IP protection, and to overseas industry of using British attorneys to obtain international protection.



## Clifton Scientific Trust

CLIFTON SCIENTIFIC  
*Trust*

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**Science for Citizenship and Employability,  
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We build grass-roots partnerships between school and the wider world of professional science and its applications

- for young people of all ages and abilities
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Clifton Scientific Trust Ltd is registered charity 1086933

## The Council for the Mathematical Sciences



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The Council for the Mathematical Sciences is an authoritative and objective body that works to develop, influence and respond to UK policy issues affecting mathematical sciences in higher education and research, and therefore the UK economy and society by:

- providing expert advice;
- engaging with government, funding agencies and other decision makers;
- raising public awareness; and
- facilitating communication between the mathematical sciences community and other stakeholders

## Eli Lilly and Company Ltd



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Lilly UK is the UK affiliate of a major American pharmaceutical manufacturer, Eli Lilly and Company of Indianapolis. This affiliate is one of the UK's top pharmaceutical companies with significant investment in science and technology including a neuroscience research and development centre and bulk biotechnology manufacturing operations.

Lilly medicines treat schizophrenia, diabetes, cancer, osteoporosis, attention deficit hyperactivity disorder, erectile dysfunction, depression, bipolar disorder, heart disease and many other diseases.



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EngineeringUK is an independent organisation that promotes the vital role of engineers, engineering and technology in our society. EngineeringUK partners business and industry, Government and the wider science and technology community: producing evidence on the state of engineering; sharing knowledge within engineering, and inspiring young people to choose a career in engineering, matching employers' demand for skills.

## The Food and Environment Research Agency



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The Food and Environment Research Agency's overarching purpose is to support and develop a sustainable food chain, a healthy natural environment, and to protect the global community from biological and chemical risks.

Our role within that is to provide robust evidence, rigorous analysis and professional advice to Government, international organisations and the private sector.

## GAMBICA Association Ltd



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GAMBICA Association is the UK trade association for instrumentation, control, automation and laboratory technology. The association seeks to promote the successful development of the industry and assist its member companies through a broad range of services, including technical policy and standards, commercial issues, market data and export services.

## The Geological Society



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The Geological Society is the national learned and professional body for Earth sciences, with 10,000 Fellows (members) worldwide. The Fellowship encompasses those working in industry, academia and government, with a wide range of perspectives and views on policy-relevant science, and the Society is a leading communicator of this science to government bodies and other non-technical audiences.

## Institute of Food Science & Technology



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IFST is the independent qualifying body for food professionals in Europe. Membership is drawn from all over the world from backgrounds including industry, universities, government, research and development and food law enforcement.

IFST's activities focus on disseminating knowledge relating to food science and technology and promoting its application. Another important element of our work is to promote and uphold standards amongst food professionals.

## Institute of Marine Engineering, Science and Technology (IMarEST)



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Established in London in 1889, the IMarEST is a leading international membership body and learned society for marine professionals, with over 15,000 members worldwide. The IMarEST has an extensive marine network of 50 international branches, affiliations with major marine societies around the world, representation on the key marine technical committees and non-governmental status at the International Maritime Organization (IMO) as well as other intergovernmental organisations.

## The Institute of Measurement and Control



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The Institute of Measurement and Control provides a forum for personal contact amongst practitioners, publishes learned papers and is a professional examining and qualifying organisation able to confer the titles Eurling, CEng, IEng, EngTech; Companies and Universities may apply to become Companions. Headquartered in London, the Institute has a strong regional base with 15 UK, 1 Hong Kong and 1 Malaysia Local Section, a bilateral agreement with the China Instrument Society and other major international links.

## IOP Institute of Physics

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The Institute of Physics is a leading scientific society. We are a charitable organisation with a worldwide membership of more than 45,000, working together to advance physics education, research and application.

We engage with policymakers and the general public to develop awareness and understanding of the value of physics and, through IOP Publishing, we are world leaders in professional scientific communications. Visit us at www.iop.org.



## Institute of Physics and Engineering in Medicine

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IPEM is a registered, incorporated charity for the advancement, in the public interest, of physics and engineering applied to medicine and biology. It accredits medical physicists, clinical engineers and clinical technologists through its membership register, organises training and CPD for them, and provides opportunities for the dissemination of knowledge through publications and scientific meetings. IPEM is licensed by the Science Council to award CSci, RSci and RSciTech, and by the Engineering Council to award CEng, IEng and EngTech.

## IChemE

ADVANCING  
CHEMICAL  
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WORLDWIDE

The Institution of Chemical Engineers

With over 35,000 members in 120 countries, IChemE is the global membership organisation for chemical engineers. A not for profit organisation, we serve the public interest by building and sustaining an active professional community and promoting the development, understanding and application of chemical engineering worldwide.

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## Institution of Civil Engineers

ice

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The Institution of Civil Engineers (ICE) is an independent, charitable body, representing over 80,000 professional civil engineers around the world. Our vision is to place civil engineering at the heart of society, delivering sustainable development through knowledge, skills and professional expertise.

Established in 1818, the ICE is recognised worldwide for its excellence as a centre of learning, as a qualifying body and as a public voice for the profession. Our members design, build and maintain the infrastructure that keeps our country running.

Under our Royal Charter, we have an obligation to provide independent expert advice on infrastructure issues, and we are seen by Government and industry alike as the independent voice of infrastructure.

## Institution of Engineering Designers



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The only professional membership body solely for those working in engineering and technological product design. Engineering Council and Chartered Environmentalist registration for suitably qualified members. Membership includes experts on a wide range of engineering and product design disciplines, all of whom practise, manage or educate in design.

## IET

The Institution of Engineering and Technology

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The IET is a world leading professional organisation, sharing and advancing knowledge to promote science, engineering and technology across the world. Dating back to 1871, the IET has 150,000 members in 127 countries with offices in Europe, North America, and Asia-Pacific.

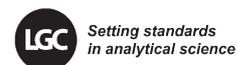
## Institution of Mechanical Engineers

Institution of  
MECHANICAL  
ENGINEERS

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The Institution provides politicians and civil servants with information, expertise and advice on a diverse range of subjects, focusing on manufacturing, energy, environment, transport and education policy. We regularly publish policy statements and host political briefings and policy events to establish a working relationship between the engineering profession and parliament.

## LGC



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LGC is an international science-based company and market leader in the provision of analytical, forensic and diagnostic services and reference standards to customers in the public and private sectors.

Under the Government Chemist function, LGC fulfils specific statutory duties as the referee analyst and provides advice for Government and the wider analytical community on the implications of analytical chemistry for matters of policy, standards and regulation. LGC is also the UK's designated National Measurement Institute for chemical and biochemical analysis.

With headquarters in Teddington, South West London, LGC has 36 laboratories and centres across Europe and at sites in China, Brazil, India and the US.





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Website: [www.linnean.org](http://www.linnean.org)

The Linnean Society of London is a professional learned body which promotes natural history in all its branches, and was founded in 1788. The Society is particularly active in the areas of biodiversity, conservation and sustainability, supporting its mission through organising open scientific meetings and publishing peer-reviewed journals, as well as undertaking educational initiatives. The Society's Fellows have a considerable range of biological expertise that can be harnessed to inform and advise on scientific and public policy issues.

*A Forum for Natural History*

## L'ORÉAL UK AND IRELAND

Contact: Julie McManus  
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Tel: 020 8762 4489  
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Website: [www.loreal.co.uk](http://www.loreal.co.uk)

L'Oréal employs more than 3,500 scientists around the world and dedicates over 500 million euros each year to research and innovation in the field of healthy skin and hair. The company collaborates with a vast number of institutions in the UK and globally.

## Marine Biological Association



Contact: Dr Matthew Frost  
Marine Biological Association, The  
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Website: [mba.ac.uk](http://mba.ac.uk)

For over 125 years the Marine Biological Association has been delivering its mission 'to promote scientific research into all aspects of life in the sea, including the environment on which it depends, and to disseminate to the public the knowledge gained.' The MBA has extensive research and knowledge exchange programmes and a long history of providing evidence to support policy. It represents its members in providing a clear independent voice to government on behalf of the marine biological community.

## Met Office



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Website: [www.metoffice.gov.uk](http://www.metoffice.gov.uk)

The Met Office doesn't just forecast the weather on television. Our forecasts and warnings protect UK communities and infrastructure from severe weather and environmental hazards every day – they save lives and money. Our Climate Programme delivers evidence to underpin Government policy. Our Mobile Meteorological Unit supports the Armed Forces around the world. We build capacity overseas in support of international development. All of this built on world-class environmental science.



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[www.merck.com](http://www.merck.com)

MSD is a tradename of Merck & Co., Inc., with headquarters in Whitehouse Station, N.J., U.S.A.

MSD is an innovative, global health care leader that is committed to improving health and well-being around the world. MSD discovers, develops, manufactures, and markets vaccines, medicines, and consumer and animal health products designed to help save and improve lives.

## National Physical Laboratory



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The National Physical Laboratory (NPL) is the United Kingdom's national measurement institute, an internationally respected and independent centre of excellence in research, development and knowledge transfer in measurement and materials science. For more than a century, NPL has developed and maintained the nation's primary measurement standards - the heart of an infrastructure designed to ensure accuracy, consistency and innovation in physical measurement.

## Natural History Museum



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Website: [www.nhm.ac.uk](http://www.nhm.ac.uk)

We maintain and develop the collections we care for and use them to promote the discovery, understanding, responsible use and enjoyment of the natural world.

We are part of the UK's science base as a major science infrastructure which is used by our scientists and others from across the UK and the globe working together to enhance knowledge on the diversity of the natural world.

Our value to society is vested in our research responses to challenges facing the natural world today, in engaging our visitors in the science of nature, in inspiring and training the next generation of scientists and in being a major cultural tourist destination.

## NEF: The Innovation Institute



Contact: Robyn Burriss  
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Website: [www.thenef.org.uk](http://www.thenef.org.uk)

The Innovation Institute is the leading provider of innovation and growth solutions to business, education and government. Through our strategic programmes we help our clients and stakeholders to:

- Achieve performance excellence
- Drive entrepreneurship
- Diversify products and markets
- Develop innovative cultures
- Influence policy to stimulate innovation

Our charitable arm, the New Engineering Foundation, supports vocational scientific and technical skills development at strategic level. In addition, our Institute of Innovation and Knowledge Exchange is a professional body and "do tank", led by the Innovation Council to support the role of innovation in society.

## Nesta



Contact: Cordia Lewis  
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Fax: 020 7438 2501

Nesta is the UK's innovation foundation with a mission to help people and organisations bring great ideas to life. We do this by providing investments and grants and mobilising research, networks and skills.

Nesta doesn't work alone. We rely on the strength of the partnerships we form with other innovators, community organisations, educators and investors too.

We are an independent charity and our work is enabled by an endowment from the National Lottery.

Nesta Operating Company is a registered charity in England and Wales with a company number 7706036 and charity number 1144091. Registered as a charity in Scotland number SC042833. Registered office: 1 Plough Place, London, EC4A 1DE.

[www.nesta.org.uk](http://www.nesta.org.uk)



## The Nutrition Society



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www.nutritionssociety.org

Founded in 1941, The Nutrition Society is the premier scientific body dedicated to advance the scientific study of nutrition and its application to the maintenance of human and animal health.

Highly regarded by the scientific community, the Society is the largest learned society for nutrition in Europe. Membership is worldwide and is open to those with a genuine interest in the science of human or animal nutrition. Principal activities include:

1. Disseminating scientific information through its programme of scientific meetings and publications
2. Publishing internationally renowned scientific learned journals, and textbooks
3. Promoting the education and training of nutritionists
4. Engaging with external organisations and the public to promote good nutritional science

## PHARMAQ

### PHARMAQ Ltd

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PHARMAQ is the only global pharmaceutical company with a primary focus on aquaculture. We provide environmentally sound, safe and efficacious health products to the global aquaculture industry through targeted research and the commitment of dedicated people. Our product range includes vaccines, anaesthetics, antibiotics, sea lice treatments and biocide disinfectants. We also recently acquired a diagnostics company, PHARMAQ Analytiq, which offers a range of diagnostics services that help to safeguard fish welfare and improve productivity in the global aquaculture industry.



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The Physiological Society brings together over 3000 scientists from over 60 countries. Since its foundation in 1876, our Members have made significant contributions to the understanding of biological systems and the treatment of disease. The Society promotes physiology with the public and Parliament alike, and actively engages with policy makers. It supports physiologists by organising world-class conferences and offering grants for research. It also publishes the latest developments in the field in its two leading scientific journals, The Journal of Physiology and Experimental Physiology.

## Prospect



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Prospect is an independent, thriving and forward-looking trade union with 120,000 members across the private and public sectors and a diverse range of occupations. We represent scientists, technologists and other professions in the civil service, research councils and private sector.

Prospect's collective voice champions the interests of the engineering and scientific community to key opinion-formers and policy makers. With negotiating rights with over 300 employers, we seek to secure a better life at work by putting members' pay, conditions and careers first.



## ROYAL ACADEMY OF ENGINEERING

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Website: www.raeng.org.uk

Founded in 1976, The Royal Academy of Engineering promotes the engineering and technological welfare of the country. Our activities – led by the UK's most eminent engineers – develop the links between engineering, technology, and the quality of life. As a national academy, we provide impartial advice to Government; work to secure the next generation of engineers; and provide a voice for Britain's engineering community.

## Royal Botanic Gardens, Kew



Contact: Director's Office,  
Royal Botanic Gardens, Kew, Richmond,  
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Website: www.kew.org

RBG Kew is a centre of global scientific expertise in plant and fungal diversity, conservation and sustainable use, housed in two world-class gardens. Kew is a non-departmental public body with exempt charitable status and receives approximately half its funding from government through Defra. Kew's Breathing Planet Programme has seven key priorities:

- Accelerating discovery and global access to plant and fungal diversity information
- Mapping and prioritising habitats most at risk
- Conserving what remains
- Sustainable local use of plants and fungi
- Banking seed from 25% of plant species in the Millennium Seed Bank Partnership
- Restoring and repairing habitats
- Inspiring through botanic gardens

*Kew's mission is to inspire and deliver science-based plant conservation worldwide, enhancing the quality of life.*

## The Royal Institution



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Websites: www.rigb.org, www.richannel.org  
Twitter: ri\_science

The core activities of the Royal Institution centre around four main themes: science education, science communication, research and heritage. It is perhaps best known for the Ri Christmas Lectures, but it also has a public events programme and an online science short-film channel, as well as a UK-wide Young People's Programme of science and mathematics enrichment activities. Internationally recognised research programmes in bio- and nanomagnetism take place in the Davy Faraday Research Laboratory.

## The Royal Society



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Website: www.royalsociety.org

The Royal Society is the UK academy of science comprising 1400 outstanding individuals representing the sciences, engineering and medicine. It has had a hand in some of the most innovative and life-changing discoveries in scientific history. Through its Fellowship and permanent staff, it seeks to ensure that its contribution to shaping the future of science in the UK and beyond has a deep and enduring impact.

## RSC | Advancing the Chemical Sciences

### The Royal Society of Chemistry

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Fax: 020 7440 3393  
Email: parliament@rsc.org

Website: <http://www.rsc.org>  
<http://www.chemsoc.org>

The Royal Society of Chemistry is a learned, professional and scientific body of over 48,000 members with a duty under its Royal Charter "to serve the public interest". It is active in the areas of education and qualifications, science policy, publishing, Europe, information and internet services, media relations, public understanding of science, advice and assistance to Parliament and Government.



## Society for Applied Microbiology



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Website: [www.sfam.org.uk](http://www.sfam.org.uk)

SfAM is the oldest UK microbiological society and aims to advance, for the benefit of the public, the science of microbiology in its application to the environment, human and animal health, agriculture and industry.

SfAM is the voice of applied microbiology with members across the globe and works in partnership with sister organisations to exert influence on policy-makers world-wide.

## Society for General Microbiology

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Website: [www.sgm.ac.uk](http://www.sgm.ac.uk)

SGM is the largest microbiological society in Europe. The Society publishes four journals of international standing, and organises regular scientific meetings.

SGM also promotes education and careers in microbiology, and it is committed to represent microbiology to government, the media and the public.

An information service on microbiological issues concerning aspects of medicine, agriculture, food safety, biotechnology and the environment is available on request.

## Society of Biology



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The Society of Biology has a duty under its Royal Charter "to serve the public benefit" by advising Parliament and Government is a single unified voice for biology: advising Government and influencing policy; advancing education and professional development; supporting our members, and engaging and encouraging public interest in the life sciences. The Society represents a diverse membership of over 80,000 - including, students, practising scientists and interested non-professionals - as individuals, or through learned societies and other organisations.

## Society of Cosmetic Scientists

SOCIETY OF  
COSMETIC  
SCIENTISTS



Contact: Gem Bektas,  
Secretary General  
Society of Cosmetic Scientists  
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Website: [www.scs.org.uk](http://www.scs.org.uk)

Advancing the science of cosmetics is the primary objective of the SCS. Cosmetic science covers a wide range of disciplines from organic and physical chemistry to biology and photo-biology, dermatology, microbiology, physical sciences and psychology.

Members are scientists and the SCS helps them progress their careers and the science of cosmetics ethically and responsibly. Services include publications, educational courses and scientific meetings.

## Society of Maritime Industries



Contact: John Murray  
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Website: [www.maritimeindustries.org](http://www.maritimeindustries.org)

The Society of Maritime Industries is the voice of the UK's maritime engineering and business sector promoting and supporting companies which design, build, refit and modernise ships, and supply equipment and services for all types of commercial and naval ships, ports and terminals infrastructure, offshore oil & gas, maritime security & safety, marine science and technology and marine renewable energy.

## Universities Federation for Animal Welfare



Contact: Dr James Kirkwood  
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Website: [www.ufaw.org.uk](http://www.ufaw.org.uk)  
Registered in England Charity No: 207996

UFAW is an international, independent scientific and educational animal welfare charity. It works to improve animal lives by:

- supporting animal welfare research.
- educating and raising awareness of welfare issues in the UK and overseas.
- producing the leading journal Animal Welfare and other high-quality publications on animal care and welfare.
- providing expert advice to government departments and other concerned bodies.



The  
Welding  
Institute

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Website: [www.twi.co.uk](http://www.twi.co.uk)

The Welding Institute is the leading engineering institution with expertise in solving problems in all aspects of manufacturing, fabrication and whole-life integrity management.

Personal membership provides professional development for engineers and technicians, and registration as Chartered or Incorporated Engineer, or Engineering Technician.

Industrial membership provides access to one of the world's foremost independent research and technology organisations.

TWI creates value and enhances quality of life for Members and stakeholders through engineering, materials and joining technologies.

## Research Councils UK

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Each year the Research Councils invest around £3 billion in research covering the full spectrum of academic disciplines from the medical and biological sciences to astronomy, physics, chemistry and engineering, social sciences, economics, environmental sciences and the arts and humanities.

Research Councils UK is the strategic partnerships of the seven Research Councils. It aims to:

- increase the collective visibility, leadership and influence of the Research Councils for the benefit of the UK;
- lead in shaping the overall portfolio of research funded by the Research Councils to maximise the excellence and impact of UK research, and help to ensure that the UK gets the best value for money from its investment;
- ensure joined-up operations between the Research Councils to achieve its goals and improve services to the communities it sponsors and works with.

## Biotechnology and Biological Sciences Research Council (BBSRC)



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BBSRC invests in world-class bioscience research and training on behalf of the UK public. Our aim is to further scientific knowledge to promote economic growth, wealth and job creation and to improve quality of life in the UK and beyond. BBSRC research is helping society to meet major challenges, including food security, green energy and healthier, longer lives and underpins important UK economic sectors, such as farming, food, industrial biotechnology and pharmaceuticals.

## Economic and Social Research Council



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The ESRC is the UK's leading research and training agency addressing economic and social concerns. We pursue excellence in social science research; work to increase the impact of our research on policy and practice; and provide trained social scientists who meet the needs of users and beneficiaries, thereby contributing to the economic competitiveness of the United Kingdom, the effectiveness of public services and policy, and quality of life. The ESRC is independent, established by Royal Charter in 1965, and funded mainly by government.

## EPSRC

Engineering and Physical Sciences  
Research Council

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EPSRC is the UK's main agency for funding research in engineering and physical sciences, investing around £800m a year in research and postgraduate training, to help the nation handle the next generation of technological change.

The areas covered range from information technology to structural engineering, and mathematics to materials science. This research forms the basis for future economic development in the UK and improvements for everyone's health, lifestyle and culture. EPSRC works alongside other Research Councils with responsibility for other areas of research.

## Medical Research Council



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Website: [www.mrc.ac.uk](http://www.mrc.ac.uk)

Over the past century, the MRC has been at the forefront of scientific discovery to improve human health. Founded in 1913 to tackle tuberculosis, the MRC now invests taxpayers' money in the highest quality medical research across every area of health. Twenty-nine MRC-funded researchers have won Nobel prizes in a wide range of disciplines, and MRC scientists have been behind such diverse discoveries as vitamins, the structure of DNA and the link between smoking and cancer, as well as achievements such as pioneering the use of randomised controlled trials, the invention of MRI scanning, and the development of therapeutic antibodies. We also work closely with the UK's Health Departments, the NHS, medical research charities and industry to ensure our research achieves maximum impact as well as being of excellent scientific quality.

## Natural Environment Research Council



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The NERC invests public money in cutting-edge research, training and knowledge transfer in the environmental sciences – through Universities and our own research centres. We work from the poles to the ocean depths and to the edge of space, researching critical issues such as biodiversity loss, climate change and natural hazards. Through collaboration with other science disciplines, with UK business and with policy-makers, we deliver knowledge and skills to support sustainable economic growth and public wellbeing – reducing risks to health, infrastructure and supply chains, and the natural environment on which we all depend.

## Science & Technology Facilities Council



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The Science and Technology Facilities Council is one of Europe's largest multidisciplinary research organisations supporting scientists and engineers world-wide. The Research Council operates world-class, large-scale research facilities and provides strategic advice to the UK Government on their development. The STFC partners in two of the UK's Science and Innovation Campuses. It also manages international research projects in support of a broad cross-section of the UK research community, particularly in the fields of astronomy, nuclear physics and particle physics. The Council directs, co-ordinates and funds research, education and training.



# SCIENCE DIARY

## THE PARLIAMENTARY AND SCIENTIFIC COMMITTEE

Tel: 020 7222 7085  
annabel.lloyd@parliament.uk  
www.scienceinparliament.org.uk

Tuesday 26 February 17.30

**Space Weather:** Extreme Space Weather; impacts on engineered systems and infrastructure

Speakers: Professor Paul Cannon FEng, Senior Fellow, Radio Science and Systems, QinetiQ; David Wade, Space Underwriter, Atrium Space Insurance Consortium; and Chris Train, Network Operations Director, National Grid.

Monday 18 March  
**SET for BRITAIN**

Thursday 21 March 10.00

National Science and Engineering Week Seminar  
The theme is **Speed**

### Dates for future meetings:

Tuesday 23 April 17.30 on Skills

Tuesday 14 May 17.30 on Water Purity

Tuesday 11 June 17.30 on Antibiotics

Tuesday 9 July 17.30 subject to be confirmed

## THE ROYAL SOCIETY

Website: royalsociety.org

The Royal Society hosts a series of free events, including evening lectures and conferences, covering the whole breadth of science, engineering and technology for public, policy and scientific audiences. Highlights in the next few months include the following. Details of how to attend all these, plus information on many more events can be found on our website at [royalsociety.org/events](http://royalsociety.org/events):

Tuesday 19 February 17:30

**Making Britain the best place in the world to do science**

Michael Faraday Prize and Lecture by Professor Brian Cox OBE

Friday 22 February 13:00

Public lecture by Neil Calver on Karl Popper FRS, Peter Medawar FRS and the 'two cultures' debate.

Monday 25 February 18:30

**How can the Arctic help find life on other planets?**

Café Scientifique with Professor Liane Benning

Friday 1 March 13:00

Public lecture by Dr Greg Lynall on Jonathan Swift's satires against scientists.

Friday 8 March 13:00

Public lecture by Professor Felix Driver on 19th century maritime science and the visual culture of exploration.

Friday 8 March

Media training course for scientists

Monday 11 March 18:30

Bakerian Prize lecture given by Professor David Leigh FRS

Monday 11 March and Tuesday 12 March  
**Characterising exoplanets: detection, formation, interiors, atmospheres and habitability**

Scientific discussion meeting organised by Professor Athena Coustenis, Professor Steve Miller, Professor Peter Read and Professor Jonathan Tennyson FRS

Thursday 21 March

Communication skills course for scientists

Friday 22 March

Conference on the life and work of John Lubbock FRS, 1st Baron Avebury – Liberal politician, scientist, banker, and inventor of the bank holiday.

Friday 22 March 13:00

Public lecture by Dr Sachiko Kusakawa on scientific image-making in the 17th century.

Monday 25 March 18:30

**Is growing old an illness?**

Café Scientifique with Dr Matthew Piper

Monday 15 April and Tuesday 16 April  
**Cellular polarity: from mechanisms to disease**

Scientific discussion meeting organised by Dr Rafael Edgardo Carazo Salas, Dr Attila Csikasz-Nagy and Dr Masamitsu Sato

Wednesday 17 April

Kavli Lecture by Professor Neil Greenham

Wednesday 17 April and Thursday 18 April  
**Cell polarity in the Systems Medicine era: the next 10 years**

Satellite meeting organised by Dr Rafael Edgardo Carazo Salas, Dr Attila Csikasz-Nagy and Dr Masamitsu Sato

Friday 19 April 13:00

Public lecture by Dr Diane Johnson on the potential influence of meteorites on ancient Egyptian culture.

Wednesday 1 May - Friday 3 May

**Space in the brain: cells, circuits, codes and cognition**

Theo Murphy international scientific meeting organised by Dr Tom Hartley, Professor John O'Keefe FRS, Professor Neil Burgess and Dr Colin Lever.

Friday 3 May 13:00

Public lecture by Dr Neil Tarrant on 16th century science and the church.

Monday 13 May and Tuesday 14 May  
**eFutures: beyond Moore's Law**

Scientific discussion meeting organised by Professor David Cumming, Professor Steve Furber CBE FEng FRS and Professor Douglas Paul

Wednesday 15 May and Thursday 16 May  
**eFutures: beyond Moore's Law – satellite meeting**

Satellite meeting organised by Professor David Cumming, Professor Steve Furber CBE FEng FRS and Professor Douglas Paul

Wednesday 29 May

Croonian Lecture by Professor Frances Ashcroft FRS

Details of these, and further events in press, will be available on our website at [royalsociety.org/](http://royalsociety.org/)

## THE ROYAL INSTITUTION

21 Albemarle Street  
London W1S 4BS.

All events take place at the Royal Institution. Details of future events can be found at [www.rigb.org](http://www.rigb.org). For more information and to book visit [www.rigb.org](http://www.rigb.org). There is a charge for tickets. Members go free.

### Thursday 21 February 19.00-20.30 **Anatomies: the human body, its parts and the stories they tell**

Hugh Aldersey-Williams.

### Friday 22 February 20.00-21.15 **Strange material**

What materials innovations are on the horizon? Mark Miodownik investigates.

### Wednesday 6 March 19.00-20.30 **Business success: what's luck got to do with it?**

Debate to determine if businesses succeed by being in the right place at the right time or through sheer determination. Hosted by Vivienne Parry, with Richard Wiseman, Matthew Syed, Stephann Makri and Sarah Curran.

### Wednesday 13 March 19.00-20.30 **Project sunshine: how science can use the Sun to fuel and feed the world**

Professor Tony Ryan, University of Sheffield.

### Monday 18 March 19.00-20.30 **The Internet tells us nothing**

The Internet is not just a series of tubes (or physical networks); it's also a series of ideas. Celebrated author Evgeny Morozov discusses.

### Friday 22 March 20.00-21.15 **The race to be the 'cell therapy nation'**

Fierce competition to be the 'cell therapy nation' is under way. Chris Mason explains why.

### Tuesday 16 April 19.00-20.30 **Creation: the origins and future of life**

Adam Rutherford.

### Wednesday 24 April 19.00-20.30 **The quantum Universe**

Join Jeff Forshaw to talk about the real science and the profound theory that allows for concrete, yet astonishing predictions about the world.

### Friday 26 April 20.00-21.15 **Our dynamic Sun**

Helen Mason will explore what causes solar activity and what we are learning about the Sun from space observations.



## SET for BRITAIN

Presentations by Britain's Early-Stage Researchers  
In Science, Engineering, and Technology  
at the House of Commons



### Monday, 18th March 2013

12.30 pm - 2.30 pm

Physical Sciences Exhibition (Chemistry and Physics)

3.30 pm - 5.30 pm

Engineering Exhibition

6.30 pm - 8.30 pm

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# WHAT INNOVATION SHOULD MEAN TO YOU