Editorial
We’ve a bumper crop of event reports for you this time, covering security of supply, energy efficiency, and interesting new work on future fuels. My thanks go to all the contributors. The solar fuels article and event report are complemented by a Royal Society of Chemistry report entitled ‘Solar Fuels and Artificial Photosynthesis: Science and innovation to change our future energy options’ and freely available from the RSC website.

The big news from the UK Energy Research Centre is that Jim Skea is leaving to become the RCUK Energy Programme Strategy Fellow. His post will be held at Imperial College. The aim is to produce a roadmap to act as “a tool which will provide the evidence base upon which the RCUK Energy Programme can plan its forward activities, acting in concert with Government, other RD&D funding bodies, the private sector and other relevant stakeholders”. Furthermore Jim has is taking Aidan Rhodes with him to be part of his new team. Aidan has been very generous with his help for our Newsletter – I hope Aidan will still be able to contribute once in his new post.

Colin Axon

This newsletter is also available on the web and in larger print sizes.

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Solar Fuels and Bio-mimetic Approaches to Artificial Photosynthesis
By Bill Rutherford

Fossil fuels are the product of eons of photosynthesis. The high levels of carbon dioxide in the primitive atmosphere were reduced by this process and trapped as organic material in geological structures. Humans are in the process of returning much of this carbon dioxide to the atmosphere in the course of a human lifetime, a split second by geological standards, and this is having serious consequences on the climate. Solar energy is attractive as an alternative, renewable primary source of energy. However, while it is straightforward (and more and more cost effective) to convert solar energy to electricity, solar energy is not continuously available and the energy collected must be stored. There are several ways of doing this but clearly the most attractive is to do what photosynthesis does: namely to store the energy in the form of chemical bonds, in other words, to make solar fuels.

Photosynthesis provides the energy for life by producing solar fuels. The natural process however is too inefficient to provide a replacement for the huge quantities of fossil fuels that we use. Solar biofuels will play a role in future energy supply but their uses will be constrained given current land and water resources even when they become more viable in energy terms. Clearly we urgently need to develop an artificial version of photosynthesis for solar fuel production that is more efficient than the natural process. Policy makers around the world are beginning to see artificial solar fuel production as a potential long-term solution to the energy crisis. Major projects have been initiated in several countries to achieve this aim and a momentum is beginning to build. Indeed President Obama mentioned solar fuel research in his state of the union address in 2011, likening it to the space race, or ‘Sputnik moment’ for our time.

There are many approaches being tried to make artificial solar fuels a reality. Some of these look to natural photosynthesis for inspiration. Why should this be a sensible approach if biological photosynthesis is so inefficient? The overall energy conversion processes in living photosynthetic species is inefficient because living things have another agenda: to make more plants (or algae or whatever) rather than making fuel for humans. However, in the process of photosynthesis some chemical and physical processes have evolved that are remarkably efficient, specific and rapid. These special features of natural photosynthesis provide key insights that are useful for the development of artificial devices for solar fuel production. A key photosynthetic enzyme that has been the centre of attention in this
context is Photosystem 2 (PS2), which uses light to drive the oxidation of water. This is the focus of much of my research.

The PS2 (the water-plastoquinone photo-oxidoreductase) enzyme is the main solar converter of photosynthesis. PS2 is the only enzyme that can split water (H₂O). The enzyme uses solar energy to drive the removal of electrons from pairs of water molecules and these electrons are provided to the apparatus that fixes CO₂ from the atmosphere, the synthesis of fuel. This splitting of water releases protons (4H⁺) and oxygen gas (O₂) as by-products. PS2 evolved in bacteria on the early Earth, when oxygen was absent from the atmosphere. The release of oxygen opened up to biology the more efficient use of fuels through respiration. The resulting step-change improvement in the biological exploitation of chemical energy enabled the development of complex, multicellular organisms. The oxygen released eventually escaped into the atmosphere and under the influence of UV light, formed the ozone layer that prevented much of the harmful UV light reaching the surface of the Earth: another crucial step for life’s colonisation of the planet.

A simplified scheme of PS2 showing only the main components of the enzyme and the first steps of charge separation is shown in Figure 1. When the chlorophylls (labelled ChlD1/D2 and P₇₀₀/D1/D2) absorb the energy from light, charge separation takes place. Individual electron transfer steps are marked by the red arrows and the order in which they occur is numbered. The first steps take a few picoseconds, getting gradually slower on subsequent steps, with step 5 being around half a millisecond. The active site for water splitting is the Mn₄Ca cluster. Ph stands for pheophytin, which is the same as a chlorophyll but contains two protons instead of a central Mg²⁺ ion. Pheophytin is a better electron acceptor than chlorophyll. QA and QB are quinones which act as electron acceptors. The whole protein cluster (with dozens of smaller subunits) is embedded in a lipid membrane.

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photochemical charge separations fully reduces the QB leading to QH$_2$ exchange with an unreduced quinone from the membrane. Four photochemical charge separations lead to the oxidation of two H$_2$O molecules producing 4H$^+$ and O$_2$.

PS2 is a large and complex enzyme and researchers are trying to understand how it works at a very detailed level. It is the water splitting active site at the heart of the enzyme that is the main focus of attention for the bio-mimetic and bio-inspired studies. The Mn and Ca metal ions, linked together through deprotonated waters, make a Mn$_4$CaO$_5$ geometry that is reminiscent of structures seen in minerals. Recently there has been a burst of activity in the field of artificial photosynthesis using metal oxide, mineral-like catalysts that are able to catalyse water splitting. A proof of principle ‘artificial leaf’ device has been made consisting of a triple junction silicon solar cell, coated with a water splitting metal oxide with similarities to the PSII active site on one side and a mixed metal hydrogen-generating catalyst on the other$^2$. Drop it in water, put it in the light and H$_2$ and O$_2$ bubble off: solar fuel production in action. The water splitting reaction in this device is thousands of times slower than in PS2, but thousands of times more of the artificial catalyst can be used to cover a surface and so the actual amount of water split in the artificial leaf is similar to, or even better than, the natural system. If the special features of the natural enzyme that make it so rapid can be understood and implemented in the artificial system, the scope for improvement is vast. It is clear that the research into solar fuels could greatly benefit from a better understanding of PS2.

The artificial leaf system described above produces a solar fuel, which in this case is H$_2$ and O$_2$ (this happens to be rocket fuel). This process is essentially light-driven electrolysis. It has been possible to do this for decades simply by connecting solar cells to an electrolyser: this is the simplest form of artificial photosynthesis. The new systems however are not only cleverly designed to be simple and wireless devices that catch the imagination but more importantly they replace the noble metals catalysts (typically platinum) with the cheap metal oxides like those used in biology. Other artificial photosynthesis projects aim to go further and produce a carbon-based fuel (e.g. methanol) by using the electrons taken from water to fix CO$_2$: another leaf out of nature’s book.

The overall process of natural photosynthesis is inefficient. Any improvements in efficiency would increase crop yields for food and improve the viability of solar biofuels in energy terms. There is thus a good deal of

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focus on research in this area\(^3\). Again there are many approaches that may be taken to improve the efficiency of biological photosynthesis. I have interests in several of these approaches. These include:

1. understanding the reactions responsible for protection, damage and repair of PS2,
2. elucidating the assembly of the active site in PS2, and
3. the evolution of photosynthesis.

These and other lines of research on biological photosynthesis should not only provide the knowledge on which research towards efficiency improvements can be based but also give us insights into the how this amazing enzyme works and how it came into existence.

Photosynthesis research is contributing to the energy sector in the development of artificial photosynthesis and in the improvement of biological photosynthesis. The latter studies will also have important repercussions in agriculture. Artificial photosynthesis, perhaps under the name of Artificial Solar Fuels, is a concept that will soon be well-known as a generic term for a range of technologies in which solar energy ends up stored as fuel. These technologies have the potential to provide the long-term solution to the energy/climate crisis. At this time, with the launch a new global initiative Sustainable Energy for All by the UN (p24), it is important to spread the word: Artificial Photosynthesis (in one form or another) is coming.

Professor A. William (Bill) Rutherford holds the Chair in the Biochemistry of Solar Energy in the Division of Molecular Biosciences, Imperial College, London. He is President (2011-2013) of the International Society of Photosynthesis Research. In 2011 he received the Royal Society Wolfson Merit Award for his work on ‘Biological and Artificial Water Photolysis’ In 2001 he was awarded the Medaille d’Argent of the Centre National de Recherche Scientifique and became a member of the European Molecular Biology Organisation (EMBO). Previously Bill Rutherford was a Research Director in the CNRS and Head of the Bioenergetics Service at the CEA, France and has worked on photosynthesis and solar energy in the US, Japan and Australia.

www.photosynthesisresearch.org/

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Towards a Global Solar Fuels Project: Governance and Scientific Challenges

Jenny Love reports on a lecture by Professor Thomas Faunce (Australian National University) at Imperial College London, on 30th April 2012.

Faunce introduced the term ‘solar fuels’ as the use of sunlight, CO₂, and a catalyst to split water into hydrogen (a transportable fuel) and oxygen. He is convinced that the future lies in such a ‘photon-hydrogen economy’, and his lecture outlined some of the obstacles which would need to be removed for its widespread adoption.

As for the science, Faunce explained that the idea is to replicate and enhance the photosynthesis process – artificial photosynthesis (AP). Remarkably, there is only one catalyst found in all living green things – a manganese compound known (for short) as Photosystem 2 (PS2). Until recently, biochemists had only been able to produce artificial catalysts with 1/1000th of the efficiency of PS2 in its surroundings (‘efficiency’ here refers to both rate of conversion and lifetime). They have been trying to understand: what is it about this molecule and its environment which is so much better than its manmade equivalents?

Could AP really be the dominant energy generation mechanism of the future? It could provide a cheaper source of hydrogen, or possibly methanol, than other propositions for clean fuels. However, it is still far from being ready. Research into AP is being carried out at a number of institutions worldwide, but is not yet visible in policy circles. Faunce suggested that this was due to the current policy focus on smart-grid rather than off-grid¹. If the closest analogue is to be found in fuel cells, then the pace of development may not encourage high expectation of quick routes to widespread deployment.

Faunce compared AP to other ‘macro-science’ projects with higher-than-average international collaboration, including the human genome project, the superconducting supercollider and the Hubble Space Telescope. AP would seem to have a basis in international convention – for example there is an article in the UN International Covenant on Civil and Political Rights which provides for the right “to enjoy the benefits of scientific progress and its applications”, and the eighth of the Millennium Development Goals is to develop a global partnership for development.

¹ In addition, the authors suggest that perhaps solar fuels are suffering a similar funding fate as fusion – credible carbon savings or commercial applications seem too remote.
Having qualifications in law, Faunce was then entitled to talk about the possible patenting difficulties associated with a global system based on only one process – a patent monopoly. At the moment the patent space in this area is fairly empty, but once people get close to commercialisation there needs to be a mechanism in place such that further research by other parties is not hindered.

Faunce made some rather grand claims: the implication that AP is the ‘silver bullet’ which people in the energy systems field usually acknowledge does not exist, in particular the assumption that UK energy demand could be catered for given that we do not have the best track record for watts per m$^2$ per year, and the assumption that there will be enough catalyst resource for such a global system. We might scale down his vision and suggest that transport fuels on their own would be a worthy target for solar fuels in the developed world.

In conclusion, we might ask whether Faunce is putting the cart before the horse. It is fine to talk about global effort and governance. But, as one questioner put it, “let us see the roadmap”. That should enable public and private funds to work out when they might intercept the development and put onto a faster track to feasibility demonstration and then commercialisation.

Jenny Love BA (Oxon) MSc (Lond) is a PhD student in the Energy Institute at UCL. Her project involves understanding and modelling occupant energy demand in dwellings. She recently completed an MSc in Environmental Design and Engineering having graduated with a physics degree from St. Hugh’s College, University of Oxford in 2008. Jenny has served as Student Representative and as Acting Honorary Secretary to the Institute of Physics Energy Group.

2012 INTERNATIONAL YEAR OF SUSTAINABLE ENERGY FOR ALL
Putting Heat in its Place
By Aidan Rhodes

Things have been heating up on the energy scene with the publication of the Government’s long (long, long) awaited low-carbon heat strategic framework. It’s called a strategic framework instead of a strategy because it claims not to provide any specific policies, instead providing a framework by which you can make policies. This seems like a complex way to wriggle out of any commitments. Currently we are using 46% of our primary energy demand for heating purposes, the vast majority with fossil fuels. The framework is set against the background of the need for an 80% reduction in CO₂ emissions by 2050, which includes a 70% reduction from industry; the majority of these emissions are heat-related.

The document sets out the options for each major heat-producing sector in the UK, focusing on reducing demand for heat, transforming building-level heat with low-carbon options, developing heat networks and reducing industrial emissions from heat. It is interesting to see heat networks featuring so prominently in this report – there’s certainly an increased focus on them in the UK the last couple of years, and I suspect that we will see a great deal more in the future, particularly in high-density urban areas. The issue with many low-carbon heating technologies, such as heat pumps and solar thermal, is that they’re a great deal more efficient and effective with an incorporated heat store, such as a hot-water cylinder. The issue, particularly in small new homes and flats, is that there’s no space to easily install one, and with the rise of condensing boilers new dwellings are being designed without a space for a cylinder. Add to that the space, noise and expense of installing electric air-source heat pumps in high-density areas and the lack of ground space to install ground-source heat pumps, the option of a heat network becomes pretty attractive. You can also run a variety of fuel sources to generate the steam for the network – starting off with gas CHP and converting to biomass of a large-scale heat pump as the technologies mature.

However, there are several huge barriers to installing heat networks. The first being, unsurprisingly, the capital cost. The report estimates the cost of installing a heat network in the UK to be around £1000 a metre, and there are significant planning issues to overcome. Due to the big cost and the fact that heat delivery is a fairly competitive market, the payback time for investors may be over 20 years. For this reason, the

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report states that heat networks tend to start small and connect a few large-scale low risk customers with whom they can form long-term supply contract. Once the network is in place and more mature, only then can it begin to expand to shorter-term higher-risk customers such as the domestic market. Thus, in the short term the report recommends that heat networks should be explored in high-density urban areas, including new-build developments of medium and high densities, and that older heat networks, such as the ones in Nottingham, Sheffield and Pimlico, should be expanded as much as possible. In the longer-term, post 2020, CHP networks should be established and expanded around sources of low-carbon heat such as CCS plants, heat storage should be expanded on the networks to more efficiently use heat, and the older gas CHP plants powering the heat networks should be switched out for lower-carbon options. The report also notes that domestic customer satisfaction in the UK with heat networks has historically been low with customers being unable to control their heat supply or bills. Despite this well-known evidence, the old chestnut ‘greater customer awareness’ has been rolled out again, you’ll be surprised to find! Interestingly, heat is not regulated, unlike gas and electricity, which means that customers may be more reluctant to connect without stronger consumer protections. It would seem that this is an area which needs more work.

Dr Aidan Rhodes is Knowledge Exchange Associate at the UK Energy Research Centre. Aidan can be contacted at aidan.rhodes@ukerc.ac.uk He is author of ‘Smart Grids: Commercial Opportunities and Challenges for the UK’ available at http://tinyurl.com/6a2woxa You can follow UKERC on Twitter, @UKERCHQ
Energy Efficiency – are the Critiques Valid?

Robin Morris reports on this talk by Nick Eyre at the Oxford Institute for Energy Studies on 7 March 2012.

In this talk, Nick Eyre, Head of the Lower Carbon Futures Group in the Environmental Change Institute at the University of Oxford, examined the role for demand side reduction of carbon emissions.

The presentation started with the IPAT equation of Ehrlich and Holdren which considers the pervasive nature of technology (T), growth in affluence (A) and increasing population (P) and their growing environmental impact:

\[ I = P \times A \times T \]

Perhaps more appropriate to the strong contemporary focus on carbon emissions, is the Kaya identity:

\[ C = P \times \frac{GDP}{P} \times \frac{E}{GDP} \times \frac{C}{E} \]

where E is energy use, and C represents carbon dioxide emissions from human sources.

Eyre used IEA data from 1971-2008 to illustrate the global trends for each of these factors. The global population had grown by about 80% over the period. Whilst the energy use per capita had fallen to around 60% of the 1971 value, there had only be a small (<10%) reduction in carbon intensity of energy. GDP per capita had more than doubled. The net result was that (human-related) carbon emissions had also more than doubled over the period. Commenting on the UK picture for the same times, the carbon intensity of energy use had dropped by about 20% [largely owing to the switch from coal to natural gas in electricity production]. By 2008, the UK energy intensity of the GDP had fallen to just over 40% of its 1971 value. Input / output analysis for the UK during 1992-2004 by suggested that the energy intensity only changed by 8% through structural (economic) effects, while technical energy efficiency had delivered a 27% improvement.

Eyre turned attention to the cost of carbon abatement for different sectors of the economy. The IEA ETP 2010 report recognised that a wide range of technologies would be needed to meet goals of reduced carbon emissions associated with energy use. He used the 2007 IPCC analysis to
illustrate that the most significant potential was to be found in the built environment. Savings of 4.8-6.0 Gt CO$_2$ equivalent per year could be accessed for less than $20 per tonne-equivalent of carbon dioxide. This scope for carbon mitigation from buildings at low marginal cost was more than twice the emissions reductions that were foreseen in energy supply. Further, carbon reductions from the built environment were three or more times those that could be expected from the transport, agriculture, forestry or industry sectors.

Improvements in end-use efficiency are generally regarded as offering negative marginal cost for carbon abatement i.e. energy efficiency pays for itself through reduced energy bills. Earlier IEA analysis (2008) had suggested that decarbonising the power sector would have the next lowest marginal abatement cost. Current technologies and approaches put fuel-switching in industry and carbon capture and storage towards the back of the queue as these are currently more expensive to implement. Alternative transport fuels perhaps represented the most expensive challenge at current fossil fuel prices.

The abatement space can be mapped according to technology-optimistic or -pessimistic viewpoint. The IEA Energy Technology Perspectives (ETP) ACT Map \(^1\) (2008) considered trajectories to return carbon emissions back to current levels by 2050. It found that the task would be difficult and costly, requiring investment of around $400bn per annum. The IEA BLUE Map \(^2\) scenario takes a broadly optimistic approach to energy-related carbon dioxide emissions, showing reduction to half their 2005 levels by 2050. In this scenario, the main route for real reduction is from the power generation sector. The BLUE Map projects energy use in the built environment as being held virtually constant against a baseline increase of 60% from 2007 to 2050. Their estimated spend to achieve this flat response from residential and service sector buildings would be around $7.4 trillion (compared with the $2.6 trillion assumed in the ACT Map scenario).

Eyre examined residential energy use in more detail. There are many barriers to energy efficiency: access to capital; attitude to risk; deficient information; split incentives; limited interest and skills; and lack of economic rationality. For domestic energy use, Eyre posed the question whether it was reasonable to expect behaviour to be both rational and cost-minimising. The disconnect between the ‘supply’ and ‘demand’ side of energy efficiency was illustrated using a simplified case study of UK cavity wall insulation. The net present value of cavity wall insulation was said to be

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\(^1\) www.iea.org/techno/etp/ETP_2008_Exec_Sum_English.pdf
\(^2\) /www.iea.org/work/2011/egrd/day1/Remme.pdf
more than £900 (using 6% mortgage rate). Cavity wall insulation is still available with a subsidy in excess of 50% (under CERT). Approximately 800,000 properties are currently being treated each year. There were still around 7 million properties that could benefit from this measure. But the spontaneous and routine decision-making by households was typically poorly informed and was prone to strong cultural influences.

Most significant consumer energy savings were achieved through regulation. According to a study by Rosenow, the energy supplier obligations had been credited with delivering power savings of ~20TWh per year under the EEC1 programme (2002-2005), rising to ~40TWh per year for EEC2 (2005-2008). The current CERT programme and extension (2008-2012) was intended to bring annual savings of at least 100TWh. Looking at regulations of gas boilers, the Energy Saving Trust (2008) had charted the marked shift to class A condensing gas boilers following the introduction of regulations in 2004/05. More than 90% of installations were of Class A or A+ in 2007/08, with almost the whole balance consisting of Class B products.

Eyre then addressed the some of the common problems associated with energy efficiency programmes. Programmes have tended to rely on ex ante models rather than attempt to determine actual benefits. Persistence was seen as less of a challenge for technical measures than for behavioural changes. ‘Free-riding’ had perhaps the least significance where insulation measures had been installed. But appraisal optimism was found to be problematic for many cases, and insulation in particular. Eyre stressed that appraisal optimism was also encountered in other sectors, such as the nuclear industry, carbon capture and storage, and offshore wind. The over-optimistic assumptions for UK household energy efficiency were split into three areas: models that were not applied appropriately, poor installation and well-known behavioural responses. Each of these were ascribed as typically contributing around 20% over-estimate for savings. Eyre suggested that there was no trick to dealing with these optimistic assumptions. It was simply necessary to monitor actual performance and then to revise the estimates accordingly.

This was now happening, based on the Home Energy Efficiency Database (HEED) – developed by EST since 2005 – and the National Energy Efficiency Framework (NEED) – developed from supplier data, by DECC [Secondary analysis.] Work done for DECC in 2011 analysed on the basis of a control group of 910,000 properties and compared the energy use in 2007 with that in 2005 for homes where measures had been installed

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during 2006. The outcomes were found to be variable. For example, homes showed an average 15% reduction of gas consumption following installation of cavity wall insulation. Yet 15% of the homes included in the study criteria ended up using more gas after being insulated. Savings attributed to cavity wall insulation alone (Figure 1) were 2.11MWh mean (2.15MWh median).

Figure 1. Change in annual household gas consumption 2005:2007; control group and cavity wall insulation installed in 2006 [Source: DECC]

Savings for loft insulation were 624kWh mean (594kWh median). From the same analysis, savings were quoted for other measures. Where condensing boilers had been fitted in 2006, the related savings in gas use were 1.66MWh (2.18MWh). Figures for glazing improvements were 386kWh (446kWh) gas saved. For lighting measures installed in 2005 58kWh (55kWh) electricity was saved between 2004 and 2006.

There was still debate on both direct and indirect rebound effects. Rebound was described as any effect that reduces the energy savings to less than the predicted amount. ‘Backfire’ was a rebound effect in excess of 100% – also known as the Jevons Paradox. Major reviews by Greening et al (2000) and Sorrell (2007) described three potential contributions to rebound:

1. Price effect – cheaper energy services
   - Rebound = price elasticity of service demand
2. Income effect – saved energy costs
   - Rebound = ( cost savings % x energy as proportion of spend x income elasticity of demand)

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4 See for example ‘Energy efficiency and energy savings – are we chasing our tail?’ by Steve Sorrell, IOP Energy Group Newsletter, Issue 26, pp.3-6, January 2008.
3. Macroeconomic effect – increased GDP
   • Rebound = (GDP change % x GDP elasticity of demand)

Rebound price effects typically lie in the range 10-30%. This is better understood for some services, such as mobility or thermal comfort. The rebound is usually higher for consumers on lower incomes. Where money saved on energy is spent on something else, there are possible significant rebound effects (for example, being able to afford a holiday involving air travel). The overall effect is significantly less than 10%, but cannot be considered negligible.

Energy efficiency improvements may result in increased economic productivity. There was little quantitative information. Labour productivity appeared a likely larger influence on GDP than energy efficiency investment. However, Eyre suggested that the macroeconomic rebound effects might be very high for major transitions in key, general-purpose technologies. Did information technology now show some parallels with the uptake of steam engines?

Eyre then discussed the policy implications. The assumption that policy has little role to play in rebound and that energy price and costs are set by the market is generally a bad assumption. Arguably, this assumption is further weakening. It was considered self-evident that policy to maintain (or increase) unit energy prices would offer the simplest approach to avoiding price rebound. Forms of carbon pricing would feed into this, though concerns of affordability (fuel poverty) and competition are constraints. Attention to energy efficiency might help to address these concerns. Eyre called for an approach that considered the political economy rather than models of idealised energy markets.

In wrapping up, top-level UK energy demand statistics were considered. There had been drop in household energy use, household electricity demand and total UK energy use over the last few years. Energy efficiency programmes were a major contributor. It was suggested that we have reasonable understanding of scope for improvements in energy efficiency. UK programmes in this area do save energy. There is an improving understanding of under-performance from energy-saving programmes. Rebound remained a controversial topic but Eyre suggested that practical methods were known to deal with this.

Robin Morris is an independent consultant on sustainable technologies. He is currently working with the senior management of SMEs. Robin has particular interests in distributed generation, energy storage and energy efficiency in the built environment. He is a graduate of Imperial College, and is Honorary Secretary of the Energy Group.
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Resilience and Society: Energy Infrastructure

Colin Axon reports on this meeting held at Northumbria University on 26th April 2012.

This meeting was one of a series making-up part of the Energy Security in a Multi-Polar World (ESMPW) research cluster funded as part of the RCUK Energy Programme. The cluster brings together experts in supply chains, energy policy, and international relations. The goal of the research cluster is to stimulate networking; to analyse the three issues; and to stimulate new partnerships and proposals. It aims to achieve in-depth analyses on the core themes proposed but also to explore tangential areas that arise.

This meeting was related to the supply chains theme and was focussed on security of supply rather than energy security per se. Most of the speakers concentrated on networks – operation, effects of user behaviour of networks, or the characteristics of network resilience. The discussion was predominantly, but not solely, about electricity. The gas network was highlighted by several speakers and a couple spoke about interdependencies.

The first speaker was Michael Cousins (DECC), formerly of National Grid; he outlined DECC’s priorities. Cousins briefly outlined Project Avagadro – a desktop study and simulation of a crisis similar to that of the Russian gas dispute in 2009. The aim was to rehearse the capability to respond. The ability of the electricity generation to respond was tested in a ‘road to disconnection’ scenario. The results and observations were fed into new policy. Cousins said that the Cabinet Office carry out a national risk assessment, which manifests as the National Security Strategy. This is not solely about energy, but covers defence, cyber-security, natural disasters (including health incidents), and international events.

Martin De Jong (TU Delft) spends three months per year working in China on ‘eco-cities’. The first half of his talk was about why eco-cities was a nice title, but had little practical outcome (at present) in part due to it meaning different things to different people. He said that most people conceptualise it simply as somewhere with green spaces. De Jong gave some very interesting history of eco-city planning. Most recently Arup were commissioned to design and plan Dongtan in China, though it was never built. Much earlier, people such as David Register designed a low-tech eco-city – that was never built either. There were many other examples, none of
them were even started. He also gave some examples of where cities had been adapted, or considered for adaption. They all had one element that could be identified as a characteristic of an eco-city, but none were able to assemble sufficient elements. Part of the problem, De Jong said, was the obsession of GDP growth as the main driving force for building an eco-city. Many would see these competing factors as irreconcilable. In China, anything ‘green’ can be designed and built, but it will be ditched if GDP goes down. What initially surprised De Jong was the level of internal competition between cities and regions in China. However, he added that health was beginning to be taken seriously, but ecological concerns were not at all – they still want the cheapest possible job.

The next speaker was Jim Skea (UKERC). Skea said that further work was being conducted to the UKERC 2050 scenarios to update them. An interesting point he made was that although the climate change and resilience pathways were travelling in the same direction, they are diverging. Skea’s main discussion was on whether there was a case for a strategic investment in gas storage infrastructure. Currently, the UK has twelve days of gas storage; the average nation from an IEA survey is 30 days. Italy has 50-70 days of gas storage. Skea added that more facilities are at the planning stage. UKERC commission Cardiff University to create a combined gas and electricity network (CGEN) model to undertake various analyses. If pressure is lost in the low pressure network, it can take weeks to get the system back to normal operation. This is the technical reason why domestic consumers are the highest priority protected customers. UKERC conducted an ‘n-1’ (desktop) analysis – where the largest facility is removed from the analysis (assumed to have failed in some way). Becton is the large LNG terminal in the UK and is the landing site for continental gas connections. The analysis showed that a five-day interruption had minimal effect on the UK, but a prolonged outage (40-90 days) at Becton had serious consequences for the nation. The total cost of a 90-day outage was estimated at over £190m. So is storage worth it? Skea’s figures used Treasury rates of return on capital – 10% for commercial and 3.5% for all other sources. At commercial rates, return might be achieved in fourteen years (rising to 43 years). At the lower rate of return, payback came in at 130 years. The last policy position taken in the UK was 2010 when commissioning a strategic storage facility (like the one for oil) was fully rejected. Also fully rejected was a call to mandate for CCGT facilities to hold a store of distillate fuel oil. Skea said that Jonathan Stern’s position was that a strategic storage facility was cheap enough so the UK should just get on with it. Skea concluded that the market will not deliver it, even though the most optimistic estimate for payback time were becoming viable.
Audley Genus (Kingston) considered resilience to mean flexibility. He said that it was inflexibility that was costly, in both fiscal and health terms. He saw inflexibility to be associated with centralised choices. The indicators, Genus suggested, were: capital intensity, reliance on specialised infrastructure, lead time, and unit size. In his view, professionals were not being sufficiently self-reflective in considering their current practices. Genus asked whether or not it was better to just live with the ‘error costs’.

The meeting organiser, Sara Walker (Northumbria), spoke next. She gave an overview of UK and international energy statistics. The most interesting of which was that the top five producers for each of gas, oil and coal account for very substantial proportions of global output. For gas, the top five producer nations account for 60% of the global market, for oil it is 47%, and for coal it is 80%. This underlines the concentration of resources, an issue at the heart of energy security. Walker said that the headroom on UK generating capacity (over peak demand) stood at 16% in 2009. This is predicted to fall to 5% under a ‘business as usual’ case by 2020. The stated aim is to have 20% headroom.

Philip Purnell (Leeds) gave an excellent presentation on the resource limitations which will affect the transition to the low carbon economy. His clear understanding in the scale-up needed for the resource requirements was particularly welcomed. He gave a number of examples including neodymium (for permanent magnets (motors), chromium (for stainless steel rods in concrete), and titanium (cathodic protection, also for low-carbon concrete). A complete transition to low-C concrete for the UK would require importing ten times the current EU total. Purnell pointed out that 50% of global chromium production came from just two countries in Africa. The traditional response, said Purnell, is to stockpile, enter into trade agreements, and to recycle. He suggested that recycling could be thought of as “mining infrastructure”. For example, there is now more Copper above ground than remains to be mined, and that some companies are giving serious consideration to salvaging aluminium from drinks cans in landfill sites. Purnell presented two cases studies, wind turbines and electric vehicles. He said that wind turbines could do without neodymium, but they would have to be of lower capacity and less efficient. EVs, however, need motors of high power density and are unlikely to be able to do without neodymium. The level of demand to make all cars in the UK electric rules this possibility out.

Newcastle University are starting up a new project on the adaption of network structures. Richard Dawson showed their initial work on analysing wind and storm patterns and overlaying this with GiS data of the
high-voltage network topology. Dawson also showed overlays of the electricity and transport networks.

Two speakers from Durham, Harriet Bulkeley and Phil Taylor, did a double-act on the potential socio-technical resilience of smart-grids. Their argument was that resilience is ‘securitised’. They see it as a balance between cost, carbon, and risk. Smart-grids, in their view offer resilience through maximising flexibility and the further sweating of assets. For example, the use of dynamic thermal overhead line ratings might allow more customers to be reconnected more quickly after an outage of some sort. They gave an overview of the massive ‘Customer Led Network Revolution’ project. Half of the £54m budget is being spend on network assets. The project aims to engage 15K customers in trials of load management and direct load control. Taylor also flagged up issues of resource availability for large-scale storage, though lithium batteries, he thought, were only an intermediary technology. Taylor finished by comparing demand-side management (DSR) and technological solutions. Taylor said that DSR was slow in reacting, but cheap, and that technology was fast, but expensive. He suggested that voltage compensation could be achieved through a combination of the two.

Sarah Mander (Manchester) also promoted a new project – Resnet. This is a collaboration between Newcastle and Manchester. Resnet is looking at what will affect the carrying capacity out to 2080. She said that trends in temperature and rainfall were ‘easy’, but that wind speed was ‘hard’. For wind, they are building a stochastic model of UK wind using current data. They will be looking at energy use across all sectors, including transport and shipping. Another part of the project will examine how acceptable decreases in energy system quality of service might be.

In a different, but related vein, John Fitzgerald (Newcastle) showed how resilience was defined and measured in computing systems. He said that software reliability was not a useful concept – it is a system with embedded software. Fitzgerald said that the important characteristic is the level of dependability of the system to deliver a service which can justifiably be trusted. The computer science taxonomy is ‘fault – error – failure’. The question he asked is resilience with respect to what, and recovery to what specification? The big question, as Fitzgerald sees it, is the managing resilience is heterogeneous systems of systems.

The last speaker was Gareth Harrison (Edinburgh). He spoke about resilience in power networks. Network companies have climate adaption plans in place. Harrison described the Adaptation and Resilience in Energy Systems (ARIES) project– a collaboration between Edinburgh and Heriot-Watt. ARIES aims to understand how climate change will affect the
UK gas and electricity systems and in particular its ‘resilience’. Harrison explained that a resilient energy system is one that can ensure secure balance between energy supply and demand despite internal and external developments such as climate change. ARIES aims to deliver a comprehensive risk framework to assess and manage UK energy system resilience to climate change, identify the impacts that these new supply and demand patterns have on energy system resilience and will suggest changes or adaptation that can ‘build-in’ resilience.

This was an interesting event that brought together people with a variety of perspectives of how resilience gives rise to security of supply and a flavour of how this relates to energy security. The question remains for us all to consider – security of what and for whom?

Colin Axon is Senior Research Fellow in the Brunel Institute of Power Systems at Brunel University, London. He works on smart grids, energy and resource use in the built environment, metrics and indicators for energy security, and sustainable mobility. Previously he worked in the Department of Engineering Science at the University of Oxford. He is Founder and Co-Director of the James Martin Institute for Carbon and Energy Reduction in Transport, at the University of Oxford. Colin is the Chair of the Institute of Physics Energy Group.

Next Energy Group One-day Event

Materials Challenges for Nuclear Fission

November, 2012
Institute of Physics
Combined with the Group AGM

The programme will be designed with plenty of time for discussion with the speakers and within the audience.

Charges apply (with the usual concessions), lunch and refreshments are included.

More details on page 35.

Final programme will be available in the summer via the IOP Conference website.
Energy News
We present a round-up of recent energy and energy-related news which may not always have caught the eye of the mainstream media.

Official Energy Efficiency
DECC has created a new Energy Efficiency Deployment Office. The 50-strong team will support the delivery of the Green Deal, the rollout of smart meters and the increase in renewable heat as well as developing a new energy efficiency strategy to identify the potential for further energy efficiency across the economy.

*Department for Energy and Climate Change,*
*8/2/12*

The Winds of Change
The US Department of Energy (DoE) has launched a $180m six-year initiative for offshore wind. DoE will focus investment on technologies that will bring large cost reductions over existing offshore wind technologies. The demonstrations could also help address key challenges associated with installing utility-scale offshore wind turbines, connecting offshore turbines to the power grid, and navigating new permitting and approval processes. DoE’s funds may be used to cover up to 80% of a project’s design costs and 50% of the hardware and installation costs.

*Renewable Energy Focus,*
*9/3/12*

CCS in the Money
The EPSRC and DECC are giving £13m to establish a UK Carbon Capture and Storage (CCS) Research Centre. The five year grant will pay for:

- pilot-scale facilities in Yorkshire, with a 1 tonne CO₂ per day amine capture facility,
- a mobile testing unit for real power station flue gases, and
- oxyfuel fluidised bed and chemical looping pilot facilities.

The consortium, led by University of Edinburgh, includes: Plymouth Marine Laboratory, British Geological Survey, University of Nottingham, University of Leeds, Newcastle University, University of Cambridge, and Imperial College.

*EPSRC,*
*4/4/12*
Bioenergy Beanfeast
Physicist Patricia Thornley is to lead the new EPSRC Supergen Bioenergy Hub. The Hub will bring together industry, academia and other stakeholders to focus on the research and knowledge challenges associated with increasing the contribution of UK bioenergy to meet strategic environmental targets in a coherent, sustainable and cost-effective manner. The consortium consists of Manchester, Leeds, Rothamsted, Bath, Newcastle, and Aston.

_EPSRC_,
_4/4/12_

Tri-gen Downunder
Sydney is to install Australia’s first citywide trigeneration network. It could save AU$1.5bn by 2030 in avoided or delayed spending on grid upgrades and new power stations. The trigeneration network will supply electricity, heating and air-conditioning to council and privately owned buildings in four zones across central Sydney.

_COSPP_,
_5/4/12_

New Niger Uranium Supplies
Toshiba has secured the right to a “significant portion” of the output from the planned Madaouela uranium mine under a convertible debt-financing agreement with exploration and development company GoviEx. Toshiba are paying $40m to support operations through to the start of the extraction and processing. Production is expected to begin in 2017, with peak annual capacity of U₃O₈ at about 1000 tU. Based on current figures, the mine is expected to have a 15-year life.

_World Nuclear News_,
_23/4/12_

Solar Soaring
The global PV market continued to expand with capacity in excess of 29TWₑ connected in 2011, about 12TWₑ more than in 2010. Most installation was in the EU, adding more than 21TWₑ of capacity to the grid last year. A total of 44.8TWh was generated from solar PV in the EU in 2011.

_European Commission_,
_15/5/12_
Book Review.

International Handbook on the Economics of Energy
Edited by Joanne Evans and Lester C. Hunt


This is some handbook at 848 pages and a weighty 1.5 kg! It has 33 chapters covering basic economic theory and modelling, going onto the specifics of each energy form (petroleum, gas, oil, coal, electricity) and distribution systems. I made copious notes having high hopes for some insights. After all, economics is about money, a pretty vital component of the way our economies function and our own interface through our own income, spending and ownership. I bypassed the two chapters on rebound having seen them already in the series by Palgrave Macmillan series ‘Energy, Climate and the Environment’ edited by David Elliott of The Open University, an excellent series I recommend. The chapters I started on were the modelling approaches of MARKAL (market allocation) and CGE (computational general equilibrium). Here was an opportunity to get a feel for what they are about.

The MARKAL energy system model in chapter twelve is described as a data-driven, technologically-rich, bottom-up cost optimisation modelling framework. Bottom-up simulation models are based on technology being selected to minimise total system costs. The ENPEP model (developed at Argonne National Laboratory) has a giddy 70 energy uses and 300 technologies. This detail might be all very well but then a table is shown of ‘exogenous imported fossil fuel prices’ including the price range of oil in 2050 as $35-$82 (at 2000 prices) per barrel. How very convenient that the DTI (now DECC) published such data in 2006, now known to be wildly out, but my point is that this starts to show the weakness of an approach that

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can work only with prices. The phrase “as the model struggles to decarbonise” suggests an obsession with their beloved model rather a tool that should be providing insight into the actual economy. Eagerly I looked out for the validation; I came across:

“the MARKAL outputs are closely matched to the short-term energy forecast from the DTI energy model”

which struck me as simply self-referencing one set of economists with another. Nowhere to be seen was such a test as using the first 75% of historical data to predict the last 25% to check how the prediction compares.

Moving on to CGE, chapter fourteen noted that a significant challenge for top-down modellers is the estimation of statistically significant parameters from real-world experience: “Often there is insufficient variability in the historical record, so elasticities of substitution are set judgementally”. Further on, “determining elasticity of substitution is a thorny issue, with more free parameters than benchmark data”. Eventually the admission that “modellers select values by judgement and assumption”. Ultimately the author points out that usefulness of a model for policy analysis owes less to predictive accuracy but

“should be regarded as computational laboratories within which to analyse the dynamics of the economic interactions from which policies derive their impacts.”

But if there is no validation of the modelling approach, can we believe they predict anything?

Chapter thirteen notes that the Canadian Government has set three different targets since 1988 for GHG emission reductions and launched six different policy initiatives that it claimed would achieve the targets. In every case, the policies have failed and emissions have continued to rise. The writer says the models they describe could test Governments’ ‘future claims’, but I’m minded to ask what was happening when these policies were being developed in the first place. Were energy modelling economists ignored by Government, did the modellers bow to politically acceptable policies, or were those economic modellers just plain wrong? My frustration with coverage of CGE in this book prompted me to come across a paper with the most appealing title of ‘Debunking the Myths of Computable General Equilibrium Models’.

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I dipped into several other chapters, hoping at least to come across a gem I could recommend. I read and reread the section on futures markets, but this was so poorly written I was none the wiser. The book’s blurb notes ‘contributions from a distinguished array of international specialists’, but they didn’t seem too great to my reading. Parts of this book reinforce the notion that economists construct an edifice of abstraction with lots of tricky maths, and then only casually note that the real world they purport to represent differs. The reason why this is significant, rather than mere sneering from one discipline (the physical sciences) to another (the social sciences?) is that economists hold such sway. Not only do they appear to be held in deferential reverence holding the keys to the complexity of the moneyed world, but ‘non-economists’ are rendered impotent to think for themselves.

In 1987, the Santa Fe Institute set up a cross-disciplinary workshop on economics between ten leading economists and ten non-economists: physicists, biologists, and computer scientists. The scientists were impressed by the mathematical virtuosity of the economists. But they were surprised by the way the economists used simplifying assumptions in their models. They reckoned the economists had taken the use of assumptions to an extreme. Economists are using a model so clearly at odds with day-to-day reality. Scientists do make assumptions to simplify reality, but the simplifications don’t actually contradict reality. Also scientists carefully test whether their assumptions matter to the answers given by our theories.

For some final comments on the overall editorial, the selection of contributors was poor – or these economists have a distinctly different style of writing which does not appeal to me. Even simply adding more diagrams and charts would have helped a lot – have they not heard of Excel? Most annoying was a predilection for abbreviations. I jumped to the concluding remarks of one chapter coming across ‘COS’ and ‘PBR’, so I had to hunt back through the preceding 30 pages for their meaning. The editors should have required an abbreviations list for each chapter. Though I must admit to being more the wiser about MARKAL and CGE. Overall, however, this is not a book I would recommend.

Dr. Simon Roberts,
Associate Director,
Arup Foresight Innovation and Incubation
International Year of Sustainable Energy for All
Giving Access to Energy for the People of all Nations
www.sustainableenergyforall.org/

United Nations Secretary-General Ban Ki-moon is calling on Governments, businesses, and civil society to commit to taking concrete actions that will help achieve sustainable energy for all by 2030. These actions will provide significant benefits for all, including strengthened economic growth, expanded social equity, and a cleaner environment. Here is a random selection of Commitments:

**d.light Design**
By 2015, d.light commits to expand the production and distribution of its solar lamps, providing access to clean, safe and affordable renewable light and energy to 30 million people in more than 40 countries.

**ARM Holdings Limited**
ARM Holdings (USA) commits to achieving its vision that all electronic products are based on energy efficient technology, accelerating the move to smart, low-power, right-size, mobile technologies. Commitment Targets, by 2013:
- Business conditions permitting, ARM will expand their engineering personnel by approximately 10% to develop richer roadmaps in the areas of energy efficient microprocessors, graphics processors, platforms and physical IP.
- ARM also pledges to create collaborative initiatives dedicated to improving energy efficiency, accelerating the transition to the new energy economy and reducing global poverty by extending the benefits of technology to the next billion people.

**Infosys**
Infosys Limited commits to reduce its direct footprint: reduce consumption by 50%, source 100% of electricity from renewables, become carbon neutral, and work with public policy makers on regulations. Commitment Targets, by 2018:
- Reduce per capita energy consumption by 50% over FY 2008 levels by the year FY 2018.
• Renewable energy: Source 100% of all its electricity from renewable resources by the end of FY 2018.
• Become carbon neutral across all its emissions by 2018.

**Abu Dhabi Future Energy Company – Masdar**
Implementing a 500 kW PV Power plant feeding around 695 MWh per year into the grid on Vava’u Island of the Kingdom of Tonga. The project will reduce the cost of electricity for consumers in Vava’u and will reduce Tonga’s economic dependency on oil. The aim is to reduce diesel consumption by about 180,000 litres per year. The plant fulfils 13% of the island’s demand.

By 2013, the Masdar electrification programme in Helmand province in Afghanistan will provide power for 600 households in eight villages using an off-grid Solar Home System (SHS). Each house will be provided with a standalone SHS plus appliances.

**Government of Ghana**
Ghana is developing a national action plan to increase its renewable energy capacity and extend reliable energy access to all of its citizens. Their 2020 Commitment Targets are:
• Universal access to electricity.
• Renewable energy constituting 10% of national energy generation.
• Promote the use of Liquefied Petroleum Gas (LPG), which is a cleaner fuel than firewood and charcoal.

To reach the goals, the Parliament passed the Renewable Energy Act, providing the legal and regulatory framework necessary for enhancing and expanding the country’s renewable energy sector.

**The purpose** of the United Nations Sustainable Energy for All Initiative is to bring about concrete action which will lead to the achievement by 2030 of the UN’s three objectives, namely:
• Achieving universal access to modern energy services;
• Doubling the rate of improvement in energy efficiency; and
• Doubling the share of renewable energy in the global mix.

This UN initiative is also supported by:
European Sustainable Energy Week
www.eusew.eu/

The next EU Sustainable Energy Week will take place from 18 to 22 June 2012. Events are taking place all across Europe and we give a selection of those events being held in the UK.

The Bristol BIG Green Week 2012
Where: Bristol – various venues including Colston Hall, Arnolfini, Watershed, Council House, at-Bristol, Bristol Cathedral
Date: 9 – 17 June 2012
Organiser: Forum for the Future, Bristol Green Capital
Web: www.biggreenweek.com/

The UK’s first ever festival of environmental ideas, art and culture, bringing green ideas to life. A packed programme includes inspirational talks by outstanding speakers – Kevin McCloud, Vivienne Westwood, Bill McKibben and Prue Leith are just some of the names on the bill. Plus art exhibitions, the UK’s biggest farmers market, film, poetry and the BIG Green Fringe with a host of events organised across the city. It will culminate in the Festival of Nature, Europe’s largest free natural history festival.

Resource Use and Efficiency Day
Where: Magnox Information Centre Cemaes Bay, North Wales
Date: 22 June 2012
Time: 10:00 – 16:00
Organiser: Isle of Anglesey County Council, Energy Island Programme, Bangor University, Magnox (Wylfa)
Web: www.anglesey.gov.uk/business/energy-island/

The Anglesey Energy Island™ Programme is a collective effort between several stakeholders within the public and private sector working in partnership to put Anglesey at the forefront of energy research and development, production and servicing, bringing with it potentially huge economic rewards. Harnessing a rich mix of energy streams, including
nuclear, wind, tidal, biomass and solar; together with associated servicing projects provides major potential to achieve economic, social and environmental gains for Anglesey and the wider North Wales region. The Energy Island Programme is more than the energy industry and runs through all aspects of life for Anglesey and North Wales communities for example transport links and housing; tourism and leisure facilities to serve local people and visitors.

The Power of Now
Where: SSE, building One, Waterloo Street, Glasgow
Date: 18–23 June 2012
Time: 09:00 – 17:00
Organiser: SSE
Web: www.scottish-hydro-centre.co.uk/

Our exhibition centre aims to educate both young and old about the benefits of renewable energy. We'll explore together the many different means of energy capture along with the process from source to distribution. This is a unique opportunity for schools and the public to get a direct insight into the renewable revolution.

MK Energy Day
Where: Midsummer Place, Central Milton Keynes
Date: 16 – 17 June 2012
Time: 10:00 – 17:00
Organiser: Milton Keynes Council
Web: www.milton-keynes.gov.uk/mklowcarbonliving/

Just drop in to the exhibition.
Wood Fuel Open Week

Where: AD Heating Ltd, Unit 6 Lewes Industrial Estate, Fyvie, Turriff, Scotland
Date: 16 – 23 June 2012
Time: 09:00 – 17:00
Organiser: AD Heating Ltd
Web: www.adheating.co.uk/

As part of the growing visibility and demand for renewable heating solutions there is a need for both a showroom and training facility for wood-fuelled products in the North East of Scotland open to both the general public and trade customers. The VIP opening of the new facility on 15th June marks the start of an open week at the premises on the Fyvie Estate that will showcase various biomass and solar thermal products, as well as those of other local suppliers in the wood fuelled industry (wood pellet manufacturers, wood chip suppliers, and other forestry related). Refreshments, advice and home-bakes will be available for potential customers, architects and installers throughout the week.

The Role of the University in the Transition to a Low Carbon Economy: Research, Partnership and Lifelong Learning.

Where: Ashley Building, Staffordshire University, Leek Road, Stoke Campus, Stoke on Trent
Date: 21 June 2012
Time: 14:00 – 16:30
Organiser: Staffordshire University,
Email: c.dover@staffs.ac.uk Phone: 01782 294 110
Web: www.staffs.ac.uk/

14:00 Introduction
14:05 ‘Developing research, training and a professional framework for a low carbon economy’ by Ruby Hammer (Staffordshire University)
14:30 ‘Partnership working for sustainable cities’ by Phil Dawson (EON)
14:55 ‘Energy efficiency for senior citizens’ by Stephen Hall and Tony Bickley (Staffordshire University)
15:30 ‘Tools and resources from the RETS project to help local policymakers’ by Peter Greene (Staffordshire University)
15:45 Panel discussion
16:30 Finish
Forthcoming Events

Post-Carbon Worlds and Transitions – Physics versus politics: Can we close the gap?

Date: 19–20th July, 2012
Venue: Wales Institute Of Sustainable Education, Centre For Alternative Technology, Machynlleth, Wales
Organisers: Peter Harper, peter.harper@cat.org.uk
Paul Allen, paul.allen@cat.org.uk

We can readily appreciate that both sides are trying to be ‘realistic’ in their own way, yet the ‘yawning chasm’ between them suggests a very serious and under-recognised lacuna in policy. The two-day workshop will attempt to address this question, among others. The detailed programme will include:

- A keynote presentation from Professor John Wiseman, principal author of the Post Carbon Pathways report.
- Presentations of specific decarbonisation plans from both sides of the ‘chasm’.
- Attempts to provide a generic framework in order to compare programmes.
- Proposals for consistent terminology, and metrics, for decarbonisation scenarios. Are ‘carbon budgets’ a necessary standard?
- Are zero, or negative, targets necessary? If not, what is ‘good enough’?
- Attempts to bridge the ‘chasm’ by for example, back-casting, targeted innovation, international carbon trading, geo-engineering.
- Distinction between decarbonisation processes and decarbonised future states.
- Is it better just to set off in what is presumed to be the right direction; or to proceed according a strategic plan towards a defined goal? Which goal?
- Is it simply too late, and mitigation programmes need to give way to adaptation programmes? Are there principles to define the optimum split of resources between the two?

Participants from all corners of the debate will take part and we assume that various publications will follow. However, the style is informal and it is more an occasion for listening and discussion than for presentations.
Measurement Makes Business Sense
Energy and Low Carbon Conference
www.tuvnel.com/tuvnel/energy_and_low_carbon_measurement_conference

Date: Tuesday 18–19th September, 2012.
Venue: Bloomsbury Hotel, 16 Great Russell Street, London.

Call for papers on:

- Innovative measurement in support of the development of sustainable methods of energy generation. Methods for controlling energy generation from intermittent renewable sources such as wind and wave power. Energy storage and grid management.
- The measurement challenges and research involved in exploiting the major reserves of oil and gas that remain unproduced.
- Meeting and measuring the carbon reduction targets through new technologies like carbon capture and storage.
- Nuclear energy: improving measurement technology to enhance safety and control.
- Advances in measurement techniques that improve fundamental accuracy of key process measurement parameters, and create opportunities for innovation in industry.
- Methods of direct energy metering, and measuring and controlling energy usage in industry for effective management. Smart metering.
- The use of sensor-based intelligent diagnostics to enhance measurement systems, optimise process control and reduce intervention and maintenance costs.
- Novel applications of wireless technologies and networked sensors.
- Development of standards relating to the practical application of measurement technology within energy production processes, and associated carbon reduction initiatives.
- Traceability and measurement standards that underpin the practical realisation of instrument calibration in the UK. Papers that address barriers to the introduction of new energy technologies through the lack of appropriate measurement capability are particularly encouraged.
- Policy, regulation, accreditation or certification schemes reliant on measurement techniques and technologies to support their aims. A particular emphasis will be on emerging and novel measurement techniques that will provide a basis for fair trade; consumer protection; low carbon energy production; and carbon trading.
**Advances in Photovoltaics**

Date: Wednesday 19th September, 2012  
Time: 09:30 – 17:15  
Venue: Institute of Physics, 76 Portland Place, London, W1B 1NT  
Organiser: IOP Ion and Plasma Surface Interactions Group  
Registration: [www.iop.org/events/scientific/group/index.html#/?i=2](http://www.iop.org/events/scientific/group/index.html#/?i=2)  
Early registration deadline: 31 August 2012  
Final registration deadline: 12 September 2012  
Contact: Dawn Stewart  
Email: dawn.stewart@iop.org Tel: +44 (0)20 7470 4800  

This one day meeting provides a forum to help assess the current state of the art in solar cells. It brings together a list of distinguished invited speakers whose expertise covers the range of photovoltaic technologies:

- Adam Brunton (M-solv Ltd, UK) ‘Recent Advances in Thin-Film PV Cell Division and Series Interconnection’
- David Lidzey (University of Sheffield, UK) ‘Organic Photovoltaic Devices: Technology and Materials’
- W.S. Sampath (Colorado State University, USA) ‘Mass Production of CdTe Photovoltaic Modules’
- Henry Snaith (University of Oxford, UK) ‘Solid-State Dye-Sensitized Solar Cells: Key Challenges and Recent Advancements’
- Maikel Van Hest (National Renewable Energy Laboratory, USA) ‘Ink Approaches for Photovoltaics’

**Materials Challenges for Nuclear Fission**

Date: November, 2012  
Time: 10:30 – 17:00  
Venue: Institute of Physics, 76 Portland Place, London, W1B 1NT  
Organiser: Dr. Andrew Moffat, a.moffat@fnc.co.uk  

This one-day event will examine the physics of the materials used in the nuclear fission process. It will follow the life-cycle – reactors, fuels, and waste – to unpack the physics challenges facing the life extension question for current reactors, the demands of materials for future reactors, and what characteristics long-term storage materials need to exhibit. The programme will be designed to enable plenty of time for discussion with the speakers and within the audience. Charges apply (with the usual concessions), lunch and refreshments are included. The Energy Group AGM will take place between 10:15 – 10:45.
Energy Group Contacts

We welcome comments and suggestions for events and items for the Newsletter.

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