Durham University

Science and Society

Issue 3: Winter 2013

Durham Energy Institute Review

This issue:

A message from the Executive Director of the DEI

In 1974 Ruth First, then teaching me at Durham, published a book called 'Elusive Revolutions' on the army coup that brought Colonel Gaddafi to power in Libya in 1969. Ruth was a remarkable lady, actively campaigning against apartheid within South Africa and then subsequently in exile until she was blown up by a parcel bomb in Mozambique in 1982. She could lay claim to being Durham's most famous lecturer and campaigner.

When you are 20, being taught sociology of development by Ruth, you don't quite understand the privilege. Elusive Revolutions remains as good a way as any to understand the situation in the Middle East and North Africa after 2011. I used it to argue in my first seminar at Durham in February that, since in Egypt it was the army that had put Nasser, Sadat and Mubarak in power, it was as much the military as the 'Arab Spring' popular up-rising that took Mubarak out of power. The army coup of July 2013 finally confirmed that the 'revolution' in Egypt continues to remain "elusive".

What many have called the 'fracking revolution', the large scale production of oil or gas from shale in the USA (never mind the UK), is equally elusive. The USA, after five years of rising gas output fuelled by shale gas, is still a net importer of gas (largely from Canada). This is partly because gas demand has been rising fast for electricity generation (just short of 40% in the USA) as it has in the UK since the early nineties. This has been further fuelled by how cheap gas has been in the USA. The spot gas price on the Gulf coast has been almost as low as $2 per mBtu (it averaged $2.76 in 2012) but is now trading around $4. This is roughly equivalent to an oil price of $24/barrel. The USA's imports are small: with demand at 700 billion cubic metres (bcm) a year, imports of 30-40 bcm are still almost as much as the UK now imports.

Having imported very little until 2011, China now imports 30 bcm of gas too. Japan faces high costs, paying virtually the oil price for its gas imports of 90-100 bcm. So the very low USA gas price at the moment has not, does not and, very probably will not, set the global gas price. As yet, it does not even set the residential gas price in Boston or New England because due to the pipelines being full, the excess gas on the Gulf cannot get to the North East of America.

Oil from shale or other tight formations is a slightly different story: the increase in USA oil output (from a low of six million barrels a day to nine million in 2012) has made a larger difference. Bernstein (the US broking house) argues, however, that the marginal cost of fracked oil out of the USA is now $114/bbl; almost exactly the global oil price for the last three years. So there is no 'fracking revolution' – not in the technology (which is not in itself new) or in the cost of it - as fracked oil in the USA needs high oil prices to be profitable at the margins. Why else would Cuadrilla be looking for oil, not gas, onshore in Sussex? So Russia, Saudi Arabia (to finance their budgets) and the big oil companies all have an interest in keeping the oil price way above $80. In short, the use of fracking is about as 'revolutionary' for the global oil market as the army coup in Egypt is a revolution.

Extra shale gas output in the USA in the last 18 months has made the short-term problem worse for the UK's old electricity capacity. For cheaper US gas has displaced coal in their power stations. Cheap American coal has gone looking for a home and found one in the UK where coal imports from the USA doubled in 2012. As a consequence, coal-fired power stations in the UK have had a late boost into life. And, as old plants are both run more intensively and use up their carbon permits, shut down dates have been brought forward. In 2012 the 39% of electricity generated from dirty coal in the UK reached levels not seen for nearly 20 years, causing the incentives for cash-strapped European utility companies to invest in more gas-fired generation to collapse. Yet the gas plants of the next generation may also need to be built with carbon capture: increasing both the expense and the uncertainty. For the big six energy suppliers, Ed Miliband's suggested price freeze is in danger of taking away any incentive to invest in gas (or anything else) before 2015. Hence the rush to announce a nuclear deal after years of discussions. The US fracking of gas has made the problems of UK energy worse, not better.

The pan-European, DEI-led ReFINE project launched on November 7th, will bring together new scientific and environmental research on fracking across Europe. Hopefully this will aid a revolution in our scientific thinking. Even so, a fracking revolution is unlikely to resolve the world's fossil fuel problems in the short term.

A fracking revolution in the UK is also too early to call, with any substantial output at least five years away. For all the talk, a fracking revolution in the USA is also elusive; just as the talk of the revolution in Egypt has turned out to be not just elusive, but wrong, at least in 2013.

"A fracking revolution is unlikely to resolve the world's fossil fuel problems in the short term."

Dr. Wilf Wilde
Executive Director,
Durham Energy
Institute

DEI News

Awards News

Ian Marchant recognised nationally and internationally as a leader in the energy industry, begins a Visiting Professorship at Durham Business School. . He is the former Chief Executive of SSE, one of the UK's leading utility companies, and current Chairman of Infinis Energy plc.

Prof. Philip Gaskell joins the Energy Group in Engineering as new Professor in Fluid Mechanics. His research interests include the modelling and prediction of turbulent reacting flows relating to hazards and the efficient use of fossil fuels in a number of contexts: flaring, jet-flames, propulsion, energy generation and pollutant emissions. In addition he addresses thin-film and droplet formation with applications in sensor technology and improved understanding of flow through porous media.

Prof. Nigar Hashimzade joins Durham Business School as Professor of Economics. She has an interest in applied microeconomic theory on the optimal policies for energy markets and energy politics, in particular, in the transition countries of Eastern Europe and the Former Soviet Union.

Dr Behzad Kazemtabrizi joins the School of Engineering and Computing Sciences as Lecturer in Electrical Engineering having already worked here as Research Associate since February 2012. His main research interest is the study of issues involving the integration of large-scale variable renewable power, particularly wind, into the power grid; including developing probabilistic models for accurately assessing the effects of large-scale wind power in system adequacy, cost-benefit analysis of deploying alternative offshore electrical connections, and integration of energy storage for a safer and more robust network integration.

Dr Richard Slack joins the Durham Business School as Reader in Accounting. His research interests include environmental targets that are disclosed by companies – including energy/emission levels – and the level of subsequent disclosure of performance against those targets.

RSC Westminster Fellowship:

DEI PhD student, **Jack Rowbotham** (Chemistry), has been awarded the fellowship to work for three months in the Parliamentary Office of Science and Technology (POST) with the responsibility of keeping members of both houses of parliament informed on matters of current scientific importance.

BP-DEI Internship:

Diana Vonnak (MA Socio-Cultural Anthropology) awarded funding to work on 'Discourses of traditional architecture and renewable energy usage in Ladakh'.

DEI Small Grants Funding:

'Energy Empires? Sustainable Energy Futures in the Post-Ottoman Balkans' **Dr D Knight.**

'Assessing the economics of exploiting low-enthalpy deep geothermal energy resources' **Dr C. Adams.**

'A case study of perceptions and attitudes towards wind power in an island community' **Dr V. Wells.**

Knowledge Transfer Partnership:

Rob Dominy and **Tomasz Koziara** (Engineering and Computer Sciences) have been awarded funding for a KTP to work with Narec on wind turbine blade fatigue over 24 months.

Two NERC Centres for Doctoral Training (CDT):

Durham is part of two successful bids for a new NERC CDTs in Oil and Gas, and in Natural Environment. Durham will be leading the way in creating a highly skilled workforce with expertise that can be used across the wider energy and environment sectors, helping the oil and gas sector put environmental science at the heart of responsible management of our planet.

NERC Oil and Gas Catalyst Funding:

'ReFINE: Researching Fracking in Europe' independent research consortium **Richard Davies** (Earth Sciences).

Commercial development and application of the Re-Os geochronometer and tracer to petroleum systems **Dave Selby and Bob Holdsworth.**

Jurassic shale analogue study: from resource to reserve **Howard Armstrong, Chris Greenwell, Andy Aplin, Jonny Imber, Jon Gluyas, with Tom Wagner** (Newcastle University).

'CO2-EOR ranking and screening tool' **Simon Mathias, Jon Gluyas.**

'Squeezing the Barrel: Knowledge exchange adds value to oilfields in Decline' **Jon Gluyas, Charlotte Adams, and Simon Hogg.**

EPSRC funding:

'Supporting Sub-Saharan Africa's Municipalities with Sustainable. Energy Transitions – SAMSET' **Simon Marvin** (Geography).

'MacroBioCrude: developing an integrated supply' **Phil Dyer** (Centre for Sustainable Chemical Processes), **Chris Greenwell** (Earth Sciences) and **Victoria Wells** (Business School).

'Uncertainty analysis of hierarchical energy systems models' **Chris Dent** (Engineering and Computing Sciences) and **Michael Goldstein** (Mathematical Sciences).

Policy and Impact

The Energy Bill enables a low carbon transformation, but there is still work to be done!

Benj Sykes, UK Country Manager for Wind at DONG Energy UK, talks about the UK Energy Policy landscape and asks whether there is enough clarity for the renewables sector to flourish. DONG Energy, one of the leading offshore wind farm developers in the world, funds the DONG Energy Chairs of Renewable Energy, currently held by Janusz Bialek, and of Carbon Capture and Storage (CCS), held by Jon Gluyas. It also provides scholarships to students on the Masters Programme in New & Renewable Energy and helps fund various research projects.

First and foremost it's down to us and our peers in the sector to run efficient, safe and cost-effective businesses that deliver the energy system that the country needs. However, our businesses don't exist in a policy vacuum and the UK energy industry can often feel confused over UK Government priorities. The confusion is born out of the changing priorities of the policy 'trilemma': 1) decarbonizing the energy system whilst 2) ensuring energy security and 3) keeping energy prices as affordable as possible. Each of these issues is important and whilst deliverable they are not without challenges.

Some may argue that at a time of financial constraint, we cannot afford to invest in the continued innovation and maturing of renewables. However, this fails to recognise that the UK, as with much of Europe, has ageing energy assets that need to be replaced and this gives a major opportunity to shape the investments towards a low-carbon transformation. This opportunity has been recognised by Government and The Energy Bill, aimed at attracting £110 billion in low-carbon investment by 2020, will help. It will create a more stable, predictable and transparent investment framework for investors but a number of specific concerns remain and need to be addressed if the renewables sector is to flourish and deliver the green growth we all want to see.

Firstly, there is a post-2020 policy gap. The UK has ambitious renewable energy targets to meet by 2020 and legally binding carbon reduction commitments to 2050. These commitments are world-firsts and are welcomed. But beyond 2020 there are no near-term targets.

This is of real concern to offshore wind developers and those involved in the industry's supply chain. DONG Energy invests £1.5–2.0bn (15-20 bn. Danish Krone) annually and in most cases with an investment horizon of 25-30 years. As such we, and other energy groups throughout Europe, have a strong need for clarity and visibility beyond 2020. Clearly we cannot undertake this type of large-scale, long-term investment if political and regulatory frameworks are too short-term and leave too much uncertainty on our planning horizon.

In addition, there are huge opportunities for manufacturing and investment in skills and jobs as a result of the offshore wind programme, but these will only materialise if the supply chain for industry is confident of a future market for its goods and services that extends well beyond 2020. Supply chain investment is key to delivering a competitive and robust sector, capturing the full benefits to the UK of building an offshore wind industry.

Secondly, there is the question of cost. We are committed to reducing the cost of offshore wind and have a clear strategy for cutting the cost of offshore wind to 100 EUR/MWh (£85/MWh) for projects we'll be sanctioning in 2020. This represents a cost reduction of up to 40% compared to today, a challenging target which we will meet by building bigger wind farms, using more powerful turbines, and continuing to support the growth of the entire offshore wind value chain. This will be a major step forward in making the renewable technologies competitive with traditional energy sources.

In order to deliver the cost reduction we need to capture economies of scale. That can only be achieved by developing a strong pipeline of projects within a clear and stable policy framework. The Energy Bill is a big step towards this but it is only the start; much will depend on the secondary legislation, which needs to provide the flesh on the bones. A key element will be ensuring open and transparent allocation of contracts under a constrained budget. The Government is to be welcomed in having secured funding for renewables to 2020 in the Levy Control Framework, but it is now important that this funding is allocated efficiently and fairly.

The final part of the trilemma is security of supply. Many commentators have proposed an either/or approach to technology for both cost and climate reasons. But we need a mix of renewable and non-renewable technologies to provide security of supply and a sustainable future. The proposed capacity mechanism within the Bill is there to help ensure we achieve this mix of technologies. Although we should not forget, that energy efficiency and demand reduction are the most efficient ways of reducing CO2 emissions while enabling customers to become more cost competitive.

That leaves one remaining question: will the Energy Bill deliver a strong enough package of solutions to encourage the investment needed to meet the trilemma? The answer must be yes, but there's not much time left and still a lot to do before this is the case.

DONG energy

Is your research having the impact it deserves?

Innovation is seen as one of the most important mechanisms in boosting economic growth and yet, alarmingly, the UK is lagging behind in its ability to transform its research into commercial product. In 2012, only 6,695 new patents were filed in the UK, compared with 34,167 in Germany. In recognition of this low rate of transfer, Research Councils UK (RCUK) have recently introduced a series of incentives to increase the commercial and societal influence of its £3 billion annual budget. The government is seeking far more 'big bang for its buck' and a step change in the translation of concept to practical influence from research projects. Demonstrating impact from research and working with industry partners will become an increasingly important focus for academics applying for funding.

In November last year, the Engineering and Physical Sciences Research Council (EPSRC) announced £60 million Impact Acceleration Account funding across 31 UK Universities with the aim of helping

'our most pioneering scientists and engineers create successful businesses from their research, improve industrial collaboration and foster greater entrepreneurship'.

Durham University received £857,000 of this account to be spent over three years to September 2015. This will be spread across a combination of seed-corn funding, knowledge transfer secondments, technology conditioning programmes and building bridges with industry awards. Within this funding, three research institutes, one of which is the DEI, have been allocated £60,000 each, to focus on developing systems and case studies of impact within their projects.

Durham Energy Institute intends to utilise this funding to develop greater links with industry, deepening our understanding of research that can be swiftly commercialised, as well as longer-term and blue sky technology development. We will also be actively seeking to establish knowledge transfer partnerships and secondments, providing our expertise directly to industry challenges.

Applications are now open for researchers to apply for IAA funding and further details can be found here: **www.durham.ac.uk/bis/projects/iaa**

The Institute would also like to welcome any of our industry partners who are interested in discussing or investing in Durham's research.

We aim to ensure that opportunities for collaboration, knowledge exchange, licensing, technology development and process improvement can be fully explored.

The DEI has utilised some of its funding to employ Jacki Bell to develop an impact support system. She will work with researchers and industry to identify and develop pathways to impact for research and concepts that are recognised as having impact potential.

Here are a few tips for researchers to bear in mind when completing the next grant application.

- Draft the Impact Summary very early in your preparation, so that it informs the design of your research.
- Structure your Pathways to Impact and try to provide information using clear headings and timescales.
- Pathways to Impact should set out what the applicant(s) will do to realise the potential impacts.
- Ask a colleague or an enterprise/knowledge transfer professional to help you prepare your Pathways to Impact.
- Where possible, end users should be involved from the outset of the research design process.
- Include a description of how the collaborators/participants will contribute to achieving the proposed impacts.
- To get the best out of the workshop and to potentially facilitate the application of the research, it is essential to involve beneficiaries and users.
- For more routes to influencing policy, liaise directly with the research council concerned to identify other knowledge exchange mechanisms i.e. policy fellowships, public policy seminars, literature targeted at policy communities.
- For public outreach activities, try to think of your research in the context of two-way engagement not just outreach.

Remember to consider and include project-specific costs relating to proposed impact activities e.g. engagement workshops or marketing materials, publication costs, etc.

Further guidance on Impact can be found on the RCUK website here: **www.rcuk.ac.uk/kei/**

Energy Risk

Future Power Generation Technologies: Durham leads two major EPSRC Consortia.

There is currently a need to develop technologies that will allow conventional steam and gas turbine power plants to operate with more flexibility in the future. This need arises due to the changing power mix, with the steady growth in generation from more variable renewable sources, principally wind. Conventional plants will be required to change generating output much more frequently than at present, in order to balance supply and demand in the future energy system.

Durham is leading a new EPSRC consortium which will be addressing these issues. Launched in September, the consortium will develop new methods and technologies that will help designers to achieve these goals. The project will run for five years and will be led from Durham by Dr Simon Hogg, who is the Principal Investigator. Dr Grant Ingram is a co-investigator as are Prof Janusz Bialek and Dr Chris Dent, who will use their systems modelling expertise to investigate the impact of future energy policy scenarios on the requirements for more variable operation of conventional plant. The other academic partners are the universities of Cambridge, Edinburgh, Leeds and Oxford. The total funding for the project is £2m of EPSRC funding plus an additional £2m of cash and 'in-kind' support from the industry. The principal industry partners are ALSTOM, SSE and Ansys. The DEI provided support during the bidding phase of the project, assisting with the engagement of these partners.

The Future Conventional Power consortium fits nicely alongside the current EPSRC Supergen Wind Phase 2 project, another major power generation technology consortium run by Durham. The focus of the Supergen project is to undertake research to achieve an integrated, cost-effective, reliable and available offshore wind power station. Durham's research work is aimed at developing next-generation condition monitoring techniques and maintenance methodologies, in order to reduce the cost of energy by improving the availability and reliability of wind farm assets. Other academic partners working on the project in different aspects of wind technology are Loughborough, Manchester, Manchester Metropolitan, Surrey, Strathclyde and STFC (Rutherford Appleton Laboratories). The programme is supported by a large number of industry partners including Siemens, Scottish Power & Vestas. Phase 2 of the project stared in April 2010, immediately following Phase 1 which had run for the four previous years. Prof Peter Tavner began as the PI and was replaced on retirement in 2011 by Dr Simon Hogg. Dr Chris Crabtree, Dr Behzad Kazemtabrizi and Dr Peter Matthews are the other Durham academics who are making major contributions to the project. The Phase 2 project receives £4.8m of EPSRC funding over its four year timeline, and is due to finish in March 2014. There had been very little UK funding for wind research for over a decade before the launch of the Phase 1 project. The main objective of the EPSRC in funding Supergen Wind was to rebuild a UK research community in this area. This has clearly been achieved with more papers presented by UK authors at the last two European Wind Energy Conferences than any other European Country, many with direct contributions from Supergen Wind researchers.

In June this year, the EPSRC issued a call for bids for a Supergen Wind Hub with an expectation of academic continuity from the current Supergen projects. Their intention is that the Hub will start in April 2014 after the Phase 2 project has completed, and essentially take on the role of coordinating and representing UK academic wind research in the future. Durham has contributed to a consortium bid which is currently under evaluation by EPSRC. If it is successful it will secure funded research in wind at Durham for a further five years from next year, as well as providing Durham with an opportunity to guide wind research nationally during this period.

For further information on the project contact **simon.hogg@durham.ac.uk**

Framing Fracking: Public responses to potential unconventional oil and gas exploitation in northern England.

Over the past few years the subject of fracking has risen up the political agenda in the UK. It is also increasingly the subject of media attention and public awareness. The issue incorporates diverse themes from fears about a looming energy crisis and dissatisfaction with perceived slow progress on climate change, to concerns about energy security and the power of big business. It also involves ambiguity over 'the facts' from the US case and the difficulties of policy-making and conducting public debate where degrees of uncertainty and ignorance exist. Those expressing concern over fracking and the exploitation of unconventionals in the UK have often been dismissed as NIMBYs, implying that their judgements are shallow, hypocritical and ultimately irrational. Laurence Williams, with funding from the DEI, undertook a project to explore public responses to the controversial technique and the debate that surrounds it. He found something more nuanced and complex thanthe NIMBY tag implies.

The controversy surrounding fracking in the UK continues apace. In June of this year two reports ostensibly brought the debate into sharper focus. Firstly the British Geological Survey released a resource estimate for the amount of shale gas contained within the Bowland Shale which, for some, represents a significant opportunity to increase domestic gas production, and therefore energy security. Secondly, released on the same day, an Ofgem report warned of the increasing risk of blackouts in the short to medium-term future. On the other hand, in late July, a small group of local residents and environmental activists attempted to prevent drilling equipment from reaching a site near Balcombe in West Sussex where the company Caudrilla intends to drill an exploratory well that may be fracked in the future.

This research was an attempt to explore public judgements on fracking, the exploitation of unconventionals and the underlying factors driving them. It started from the assumptions that public responses are based on perfectly legitimate and reasonable social, political, and ethical judgements, hopes, fears, and values; and that much of the public concern that exists is not necessarily about 'the risks' per se but is more accurately based on a complex mix of judgements, broader in scope and social in nature. Focus groups were used due to their interactive nature and their ability to generate rich qualitative material. A variety of groups were recruited, each shared some sort of relationship to the issue without necessarily being committed to any particular side of the debate. Six groups of eight participants were held across three locations, Newcastle, Nottingham, and Lancashire.

Some important themes found to be running through public responses are as follows:

Trust It's well established that public trust in institutions can no longer be taken for granted. There is an anxiety about the ability and willingness of institutions and those in positions of authority to put the public interest, values and genuine social benefits at the heart of energy policy and practice.

Alienation There was a sense of a game weighted in the favour of big business, of unequal power relations and of an unsatisfactory inevitability. The main fear contributing to feelings of alienation was perhaps that of being bypassed, with decisions being made on your behalf without being given the opportunity to voice an opinion.

Exploitation The will to exploit was seen as a dash for cash, informed overwhelmingly by an unfettered economic rationale that was seen as being short-term, unlikely to benefit those who would have to live with its risks, and likely to be dangerously seductive to policy-makers, industry leaders and the public alike.

Uncertainty and ignorance There was a broad consensus over the need for greater knowledge and understanding on fracking. Many were optimistic that this could be achieved and were therefore concerned by the sense that the decision to exploit was being rushed through. For others, fracking just seemed to be asking for trouble. Risk-assessment style assurances expressing minimal danger were likely to exacerbate these concerns rather than defuse them, as they were seen as communicating institutional arrogance and complacency. Overall, though not unequivocally, when making decisions in conditions of uncertainty and ignorance, participants favoured a cautious approach.

A good response for good reasons? Many participants spoke for the relative merits of shale gas, with energy security and the apparently self-evident logics of more general domestic production often highlighted. However, for the majority this resulted from a feeling of alienation generated by abstract and global environmental discourse. On the other hand phrases like 'quick fix', 'scraping the barrel' and 'putting off a decision' were popular to articulate fears that exploiting shale gas may represent a backwards step, an unwanted distraction, a short-sighted, unwise decision, or a dereliction of responsibility.

Concerns over fracking and unconventionals were more complex and ran deeper than simply 'not in my backyard'. They also went beyond risk-assessment style questions of safety. Hopes about potential benefits were often tempered and problematised by senses of mistrust and alienation. At this point in the debate political rhetoric and institutional behaviour have showed signs of a failure to learn from previous instances of technological controversy. Given the technology's potential to transform landscapes, economies, communities, and environments, a broader set of questions need to be addressed than merely: is fracking technically and economically feasible? And does it fall within institutionalised definitions of safety?

Laurence Williams is in the process of publishing his findings from the research. For further information on the project visit **www.durham.ac.uk/dei/projects/framingfracking/**

Smart Energy

Smart Grids: Is this the way of selling low-carbon policy to sceptics?

The party conference season brought energy issues to the forefront of national debate. DEI's Dr Hongjian Sun participated in a panel discussion on Smart Grids at the Liberal Democrat Party Conference fringe hosted by the New Statesman in association with the Energy Networks Association.

The lecturer in smart grids, from the School of Engineering and Computing Sciences, joined Stephen Gilbert MP, (PPS to Rt. Hon Edward Davey, Secretary of State for the Department of Energy and Climate Change) and Jim Sutherland, Engineering Director of Scottish Power Energy Networks to debate whether Smart Grids are just a way of selling low-carbon policy to sceptics. The discussion was chaired by Jon Bernstein, former Deputy Editor and Digital Director of the New Statesman.

Discussion focused on a range of topics including whether smart grids make energy cheaper, how to deal with fluctuations in energy demand and production, and how consumer data can be kept secure.

Mr Stephen Gilbert MP, began by highlighting that as an innovative technology smart grids provide many benefits, such as creating more job opportunities, low-carbon economics, improving energy efficiency and security, and reducing consumer expenses. He argued that smart grids could create 9,000 new jobs by the 2030s and £5bn in exports by the 2050s.

He then briefly discussed smart metering, data privacy, and consumer engagement issues that are closely related to both smart grid and consumers.

Representing the industry viewpoint, Mr Jim Sutherland emphasised that the smart grid is a continuously evolving technology and introduced some low-carbon projects being undertaken by Scottish Power Energy Networks.

Dr Sun emphasised that smart grids move beyond the traditional grid by enabling an interactive link between the utility company and consumer using ICT infrastructure. He also highlighted that smart metering is just a small stride towards achieving a smart grid; demand management is the core purpose of a smart grid. By using smart grids, peaks in energy demand could be smoothed which would mean fewer power plants would be required. Currently peak energy demands create significant financial and logistical difficulties to the energy-supply companies. Since every penny spent on the power system could be delivered to consumers, smart grid will absolutely make energy cheaper due to its improved energy efficiency.

Dr Sun stressed that both the energy storage system and energy management techniques are necessary to mitigating fluctuations resulting from renewable energy use and peak energy demand times. Energy storage systems can store the energy during off-peak hours and supply energy during peak hours. Energy management tools can further improve the power system's robustness. Regarding the peak demand removal, he argued that the combination of renewable energy sources and energy storage units can effectively remove demand peaks. Additionally, he mentioned that day-ahead-pricing and real-time pricing schemes could also mitigate demand peaks.

Significant discussion centred on issues of data security. Dr Sun emphasised that this is a crucial issue that needs to be addressed to avoid a scenario in the future where hackers can easily steal energy consumption information. For example, no energy consumption at a house could indicate that no one is inside, thus convenient for burglar. To avoid this, two areas of research are essential: physical layer protection (such as deploying private cyber networks) and network layer projection (through developing signal processing algorithms and routing protocols).

Finally, Dr Sun concluded that the development of smart grid requires efforts and close collaborations from government, academics and industry. He emphasised that the government needs to develop adequate regulation on how data can be collected, who this data will be shared with, and what the penalty will be in cases of information abuse.

Keeping the lights on

To dim or not to dim? in the face of budget cuts and requirements to reduce energy use, that is the choice local authorities across Englamd and Wales are having to make. While we are used to street lighting being provided throughout the night, over 75% of all local authorities have now started either dimming their lights, or switching them off during part of the night. But how are local authorities choosing what new practices to take up? And can new technologies help cut spending, without compromising on the social benefits of street lighting?

In 2013, DEI's Small Research Grant scheme funded a project called 'Street-Lighting Policy in the North East: Exploring the intersections between Energy policy and local governance'. Carried out by Dr Robert Shaw of the Department of Geography, the research sought to interview council staff from the North East in order to explore how local authorities are responding to the challenge of reducing energy use and spending at the same time. Street lighting offers high potential for energy savings, accounting for around 20% of local authority energy bills. This has driven local authorities to look towards new technologies, which can create more efficient lighting networks.

Issues relating to street lighting extend beyond energy and infrastructure policy though. Street lights can be a key part of community life. They allow people with low mobility, such as the elderly or disabled, greater confidence in leaving their house during the dark, a major advantage at latitudes which see winter darkness for much of the day! Street lighting reduces fear of crime and, if targeted properly, can reduce crime levels as well. Good street lighting has been shown to have economic benefits by encouraging people to travel out to pubs, restaurants and shops in the night. Finally, street lighting significantly reduces road traffic accidents. While cutting energy use is vital, it needs to be done in a way which does not undermine the social benefits of street lighting.

As part of the research project, interviews were carried out with 6 of the 12 local authorities based in the North East of England. In addition, a company involved in a Private Finance Initiative (PFI) lighting scheme, and a local lighting design company both participated. Following the interviews, a report detailing key findings was written, which then formed the basis of a workshop at which the participants gathered to discuss their practices and likely future trajectories. The findings of the research can be summarised into three key points.

First, although new LED lighting technologies can offer the best value for local authorities, infrastructural and institutional obstacles are slowing their introduction. Those local authorities involved in existing PFI deals may be locked into long-term programmes of technology selection and lighting management, which would be expensive to alter. Other local authorities are limited by uncertainty created by the proliferation of new technologies, with particular concern about quality of products at the lower end of the LED market: "There's an awful lot of companies out there making claims as to what their equipment can and can't do" (local authority participant). Finally, local authorities are restricted by the up-front costs of installing new technologies which may only offer savings over their lifespan.

While local authorities are aware of the social benefits of street lighting, they have limited plans for measuring or monitoring the effects of proposed changes. Falling budgets means there is little money for monitoring, and changes based on financial savings will be the primary driver of practice. Some of the staff interviewed felt that as long as they adhered to the British Lighting Standards, social benefits of street lighting would be protected. While the standards are useful, this attitude runs the risk of complacency, missing out on the potential reactions to new practices such as dimming or late-night switching off. This is likely to continue into the future, one participant at the workshop warned that "If there are further financial cutbacks we will have to… start switching off lights without consultation".

The final major finding is that further change is likely. All local authorities interviewed expected to increase street light dimming and switching off in the future. Many believed that Centralised Management Systems (CMS) would help them introduce more intelligent practices, allowing them to dim or switch-off streetlights without effecting service levels. Lighting engineers spoke of being able to regulate times and levels of lighting on different streets over the course of the night. Local authorities could respond to events such as evening football matches by making parts of the city brighter for one evening only. This promise of increased flexibility offers potential for financial and energy savings. However, CMS also has a high upfront cost, and will only work alongside LED lights.

This research from DEI has found that there is significant potential for financial and energy savings in shifting to LED lighting and 'smart' CMS controlled lighting patterns. Take-up of these by local authorities will be slow without any extra support, however, meaning that we could miss out on 20-30 years of energy and money savings. Most importantly, continued attention is required in locations where lights are being switched off, in order to retain the social benefits of street lighting.

For further information about the project please contact Dr Robert Shaw, Department of Geography, on **robert.shaw@durham.ac.uk**

DEI at British Science Festival

Energy Dragons' Den

During the British Science Festival, PhD students from Durham University's Centre for Doctoral Training in Energy (CDT) group ran an interactive energy-based activity for GCSE level students. The session aimed to increase the students' awareness of the growing energy gap within the UK, highlighting the challenges faced by today's government and society.

The task was introduced by setting a scene of impending doom; the UK is importing more fuel from foreign sources than ever before in order to cover the gap caused by the decrease in UK indigenous resources. To reduce this gap, the students were split into groups and given £300m to invest in energy resources. They become the Energy Dragons. Each group visited five energy stalls run by CDT students, each vying for their investment. Nuclear energy, wind energy, geothermal energy, carbon capture and storage (CCS) and biofuels formed the five resources available for investment. The groups' aim was to invest their money such that the annual energy consumption of Newcastle (6,000 GWh) could be covered, whilst trying to keep CO2 emissions as low as possible.

Each stall had the task of demonstrating how the technology worked, some of which involved some hands-on involvement from the students. CCS was a particular favourite as it used chocolate and milk to (very effectively) demonstrate the properties required for a good carbon storage unit. The Energy Dragons were encouraged to question the stallholders about the pros and cons of each energy resource in order to determine if they wanted to invest in it. The ultimate goal of the CDT students was to sell the technology to the Energy Dragons.

After viewing each energy stall, Energy Dragons discussed how they'd like to invest their money. They were encouraged to think not only about making the numbers work to solve Newcastle's energy problem, but to also understand the short and long-term investment of their money. If the lights were turned off tomorrow, could wind energy provide enough energy to switch them all back on? What about in 50 years' time? Are there space issues associated with biofuels? What about CO2 emissions and waste? What about indigenous versus imported energy? All these questions were put to the Energy Dragons to think about.

Nuclear energy proved a popular choice of investment on day one, with both Whitburn Academy and Focus School groups investing 61% of their money into this technology. Geothermal energy took a further 22% of investment, with CCS (11%) and biofuels (6%) taking the final share. Interestingly neither school groups invested any money into wind energy. Schools who attended on day two produced a very different energy mix, with nuclear energy becoming much less popular and wind energy gaining some favour. In total over the two days, nuclear energy gained 38% investment, with geothermal (22%), CCS (20%), biofuels (13%) and wind (7%) making up the remaining investments.

The final results showed the Energy Dragons had understood the need to spread their investment widely across all resources, thus achieving the goal of the CDT group. This key concept had been communicated to the Energy Dragons with only a small amount of chocolate to keep their attention for the duration of the session: an excellent result for Durham CDT!

Making Waves: Energy and Society

Dr Daniel M. Knight, Department of Anthropology, Durham University
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Professor Catherine Alexander, Dr Sandra Bell and Dr Daniel Knight of the Department of Anthropology at Durham University were joined by Dr Jamie Cross (Anthropology, University of Edinburgh) to deliver a panel entitled 'Making Waves: Energy and Society' at the British Science Festival. Hosted by Newcastle University, the public session addressed cultural issues surrounding energy poverty, policy communication and renewable energy generation and was linked to the launch of the new MSc in Energy and Society offered at Durham.

Catherine Alexander provided an introduction to the anthropology of energy, presenting how social and cultural perspectives can help disentangle complex questions of energy politics. She discussed blackouts in Kazakhstan – where she has conducted ethnographic fieldwork – to highlight problems with energy consumption, ownership and maintenance. Blackouts occurred in three separate situations: after the collapse of the Soviet Union when the workforce left and the grid fell into disrepair, when people obtained more disposable income and invested in household appliances, thus overpowering the grid, and when locals could no longer pay utility bills as a result of energy privatisation.

Sandra Bell gave a presentation on the ongoing Customer-Led Network Revolution project to reinstate everyday consumers into the politics of power generation and usage. She explored how working with engineers on new kinds of distributive networks that are more responsive to different kinds of energy allow consumers to play a more active role in determining when, where and how much energy they use.

Daniel Knight discussed the case of photovoltaics and economic sustainability in Greece. The project Solar Energy Transition in Greece found renewable energy export is deemed by the government to be a potential way to decrease soaring national debt and repay deficit. However, on a local level the solar programme is caught up in complex issues of history and land ownership that exasperate notions of neo colonialism. Jamie Cross gave a talk on solar energy in the 'Global South' and how new portable technologies are making a difference to rural Indian communities. However, the introduction of new energy technology is not always smooth, with problems surrounding product maintenance and the prioritisation of power.

The presentations were very well received and the speakers participated in a question and answer session with the audience. The event was considered a resounding success by all involved.

To find out more about the projects presented please visit **www.durham.ac.uk/dei/projects**

The potential for geothermal energy in Britain

DEI's Dr Charlotte Adams launched the BritGeothermal partnership at the British Science Festival. The new collaboration between Durham, Glasgow and Newcastle universities and the British Geological Survey, is being supported by funds from the DEI.

Dr Adams said that the current context of increasing energy prices is driving interest in deep geothermal energy. Geothermal energy has the potential to provide a low-carbon, predictable, secure energy supply for the UK.

She stressed that you do not need to have volcanic activity to produce geothermal energy. The British Geological Survey mapped the UK's geothermal resource during the 1980s, concluding that the UK is sitting on a potential geothermal reserve of 100 gigawatts of thermal energy, which could meet the UK's entire heat demand. However there are still many social, technical and economic challenges when exploiting deep geothermal energy. The BritGeothermal partnership is working to research, understand and promote the use of this resource while addressing these challenges.

Geothermal boreholes access heat which can be used directly for heating or can be used for electricity generation. Dr Adams also highlighted that the Brent oilfield in the North Sea is now producing more hot water than oil and the potential to use the heated water produced during oil extraction to power oil fields and avoid the need for diesel is also being explored by the partnership. Once geothermal wells have been drilled and the amount of heat generated is identified, the well provides a predictable and continuous source of energy. The UK currently has one successful geothermal borehole at Southampton that supplies local industrial and domestic users with 1.8 megawatts of thermal energy and has been operating for the past 25 years.

BritGeothermal has already begun investigating issues such as how to optimise electricity generation from low temperature geothermal sources, and will research economic aspects of deep geothermal energy including how a heat market could work and how people may, in the future, pay for the heat they use rather than gas or oil. This research will then provide a basis for promoting the potential of this exciting energy source to policymakers in the UK.

For further information on the BritGeothermal partnership and its activities please visit **www.britgeothermal.co.uk** or contact Dr Charlotte Adams on **c.a.adams@durham.ac.uk**

BritGeothermal

Carbon capture and storage to be monitored by cosmic rays

Jon Gluyas, Professor of Geoenergy Carbon Capture Storage, spoke at the British Science Festival about Durham's lead in interesting developments in measuring deep-sea CO2. Effectively using dying stars on the other side of the universe to help us deal with climate change on Earth.

Efficient and reliable ways of gathering CO2 from power plants fired by fossil fuel and storing it indefinitely instead of releasing it into the atmosphere could be a key tool in the fight against global warming. However the current cost of monitoring CCS repositories is a major hurdle to adopting the method.

CO2 is captured from power stations and other industrial plants, compressed into liquid form, and injected deep beneath the earth back down into the very rocks that maybe once yielded that fuel. Likely storage sites for CO2 will be depleted gas and oil fields one to two km down, with many candidates in the old oil and gas fields of the North Sea.

Monitoring CO2 once it is buried is crucial to ensure that it stays within the storage site and to chart any changes over time, ensuring that the carbon capture is permanent. However the methods we have for monitoring at the moment, using geophysical seismic imaging techniques, are expensive and provide just a snapshot. It costs around £1m for each one. Durham is working on a much more cost-effective and reliable monitoring method which will mean that carbon capture and storage becomes a more viable option in the future.

Prof Gluyas is working with Dr Lee Thompson at Sheffield University and colleagues at Bath University and Nasa to develop new "passive" methods for cheap monitoring of deep carbon repositories.

The group is using fibre-optic cables in a resin casing that can identify the muons produced by cosmic rays which constantly bombard the Earth's atmosphere. When stars collapse, they emit cosmic rays that shoot across the universe. If they then bump into any atoms of oxygen or nitrogen in the upper atmosphere, the resulting collision produces a muon. The shower of muons in our atmosphere is constant, with one muon every minute passing through an area the size of a thumbnail.

These detection rods can be placed deep underground and deep underwater to detect CO2 storage sites. Depending on where the muons hit the rods the changing density of water above can be mapped, and therefore the location and movement of the CO2 can be identified.

Over the next three years the group will be using the Boulby Mine, which stretches under the North Sea, to test the sensitivity and robustness of the detectors at these depths and refine the equipment. If the technology is successfully developed it could lead to multi-billion pound savings for the carbon storage industry, more accurate data collection, as well as helping to reduce global warming. The muon detection technology could also be potentially deployed in other types of mines to identify tunnels, capacity and overburden.

In conversation with Professor Janusz Bialek, new Chair in Renewable Energy

We caught up with Janusz to ask about his career, research loves and what he hopes to achieve in his new role.

What did you want to be as a child? As a young adult I wanted to be a scientist, I wanted to be Einstein. I don't think I will be Einstein but I am doing my best.

What or who has been your biggest influence on your career to date? It has been chance or luck. I got involved in energy research when it wasn't fashionable and there was no funding available. Since then climate change has been discovered, with energy as a key part, and suddenly my work has attracted interest and funding. You have to be at the right place at the right time, but most importantly, the harder you work the luckier you will get.

What do you think has been the biggest discovery of the last ten years? They say that graphene has, however I am not a physicist. In energy the biggest breakthrough has been the halving of the costs of solar panels, thanks to German taxpayers paying the subsidies. It has changed the game, and now solar panels may become viable on their own without subsidy. That is, for places with more sun than the UK.

If you had £1 million to spend on research what would you do with it? If I had more time so that I could apply for more funds I would look into understanding the technical limit to the penetration of renewables in a power system. This limit is due to the replacement of synchronous generators, which operate in traditional power stations, with induction generators that operate in wind farms and power electronics which connect PV solar panels to the grid. Synchronous generators are fundamental for a stable operation of a power system so replacing them above a certain limit poses a risk to system stability. Ireland is already facing the limit and they shed wind if wind power is more than 50% of demand; this usually happens at windy nights. They fear that if they go above that limit they risk losing system stability. I feel research is needed to understand what the exact limit is and how to overcome it.

What are the real myths around climate change and energy? Myths come from both sides, from both the pro and con lobbies. Those pro-renewables claim it is the best thing since sliced bread, will not cost as much and will solve all the problems. The anti-lobby says renewables are extremely expensive and won't solve the problem. The truth is somewhere in the middle. My research direction is establishing exactly what the truth is.

What are you most proud of? I am most proud of my wife Goshka who is a great artist and sculptor (check **goshka.art.pl**). Although helping her move her very large sculptures around has given me back problems.

What would you say to undergraduates looking for a career in academia? Well it is excellent if you want to be a master of your own fate because you are in charge of your career. In industry you are working for your company and have to do what they want you to do. But if you are looking for big bucks banking is a better option.

What makes Durham University so good? Everything, although I wouldn't say the weather. It is a relatively small and friendly place. It is a good place to live and do research. You can get to know and make contact with people easily, especially important for energy research which is interdisciplinary.

If you didn't do this, what would you be doing? I would still definitely be an academic but would go for economics, which my research touches on but I don't know enough of. Economic assessment of renewable energy is very important, especially investigating the value of renewable energy. The question is linked to what people value and to policy-making. I had some exposure to that during my secondment to DECC last year. Economics and social sciences help you understand the law of unintended consequences which is important for policy-making. The effect of policy is often the opposite of what policy intended. A social science angle and economic insight is needed to answer why this is and to create policies that have the intended outcome.

What is your vision for the DEI over the next five years? I think with the recent change of director DEI is moving toward answering big energy questions and policy issues which need input from scientists, economists and social scientists. Security of supply, energy costs, which directions supply and technology are moving in, and issues of public acceptance. I am very happy with this direction as these are the issues I am interested in exploring.

Events at the DEI

DEI Invited Lecture Series
The series will begin on 6 February 2014 with a lecture by **Ian Marchant**, former chief executive of Scottish and Southern Electric, on 'UK Energy Futures'. See our website for details on this and other exciting lectures by key Energy thinkers from policy, industry and academia.

DEI Early Career Energy Seminars
Showcasing the exciting Energy research being undertaken by lecturers and postgraduates with DEI funding. The series includes seminars on:

- The Syrian War and Energy
- Lessons from a Transition group: the politics of climate change on the ground
- Oil and Gas modeling
- The Complexities of Gas Politics in Lebanon
- Energy Politics in the Sinai peninsula

DEI Research Generators
The DEI hold regular research generator meetings on the first Thursday of every month bringing together researchers from a range of backgrounds to make contact and discuss energy topics in an informal environment.

DONG Energy – DEI public debate series
DEI is working in partnership with DONG Energy to hold public debates in 2014. The aim is to facilitate a sensible, solutions-focused discussion on some key high-profile Energy debates including 'Will the lights really go out?' and 'Energy sources for tomorrow'.

For further information on any of these events, contact dei.admin@durham.ac.uk or visit www.durham.ac.uk/dei/events

Communicate your work!

The Durham Energy Institute provides support to academics and students from all disciplines engaged in energy research at Durham University. Ensuring high quality energy-related research can engage multidisciplinary stakeholders, win funding and attain high visibility.

If you would like your project or event to feature in the Spring 2014 issue of the DEI Review or on our website please **contact dei.admin@durham.ac.uk**