



Durham
University

Science and society

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Durham Energy Institute Review

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A message from the Director of the DEI

On behalf of Durham Energy Institute I am delighted to welcome you to our first newsletter.

Back in 2009 we set out to offer something different in the UK for energy research. It was an ambitious plan to link the social sciences and sciences in energy, because the challenges that humanity faces in this area are inextricably both social and technological. Our tagline 'science and society' was born, the vision agreed and we were launched by the Secretary of State for Energy.

We recognised the potential to carve out a distinctive approach based on interdisciplinary research in the energy domain. The establishment of the DEI placed interdisciplinarity at the heart of the "DEI rose" that became the symbolic representation of its research focus. In this way, DEI sought to build bridges between technical themes such as solar, wind, geo-energy and transmission and the critical social science agendas.

Phase I of Durham Energy Institute is now over. It's been a huge success drawing in 107 researchers across 10 departments in the University, the launch of a CDT in energy, an annual research income of ~ £5m and significant new projects that link the technical and social. We have awarded more than £250,000 to University researchers across 12 different departments working on 51 projects.

As phase I draws to a close I am proud to say that the Institute has achieved its aims to a far greater degree than was initially envisaged. Over the past 3 years it has attracted over

£11 million in research funding including 2 externally funded Chairs (thanks to DONG and Carillion). We have established large scale research projects such as the Customer Led Research Network (CLNR), Rising Powers, InCluESEV, Carbon Capture and Storage, and Energy for Development projects bringing together Engineers and Anthropologists, Mathematicians and Geographers, Physicists and Lawyers, Geologists and Economists in projects that will feature in this and future newsletters.

It's incredibly exciting to start on phase II, challenges and opportunities for Durham University in energy are abundant and we will be striving to become the UK's leading energy institute in this area. We will see our research focus around the central themes of energy, risk and resilience; low carbon transitions and smart energy and networks. We will continue to grow the range of interdisciplinary projects that we support to enable researchers to collaborate, challenge and change existing methodologies. We will continue to work with industry to identify new ways of meeting energy challenges as well as challenging policy communities and practitioners on the basis for decision-making and investment. The past 3 years have seen unprecedented change in the funding and focus of energy research across the globe, this focus will only increase and Durham Energy Institute aims to be at the very heart of it. We'll need your help in getting there and this newsletter is one way we can keep you involved.



Prof. Richard Davies
Director, Durham Energy Institute

The past 3 years have seen unprecedented change in the funding and focus of Energy research across the globe, this focus will only increase and Durham Energy Institute aims to be at the very heart of it.

The DEI advances energy research through a number of services:

- Produces world leading research on the decarbonisation of energy, emphasising the importance of multi-disciplinarity and the social dimensions of energy technology research.
- Provides leadership in framing the energy research questions of tomorrow
- Offers support to researchers, particularly early career researchers, active in every discipline of the energy field through a package of services including enabling connections with industry, academic and government contacts; providing access to key data sets; reviewing and advising on funding proposals; communicating funding opportunities and directly funding projects;
- and generating critical discussions on energy decarbonisation to produce new methodologies, unique international insights and future-proof solutions.
- communicating the knowledge generated through research.
- Supports and encourages undergraduate and post-graduate research in innovative energy areas.
- Supporting industry, government and community groups through innovative partnerships, novel collaborations, awareness raising and providing research insights.



Low carbon transitions

Nations and communities around the world are facing the increasingly pressing challenge of how to respond to climate change.

Over two decades of international efforts to reach a common agreement on climate change appear to have given way to a more fragmented approach. What is increasingly uniting these efforts, however, is the belief in the need for a transition in our energy economies.

At its heart, the climate change challenge relates to how we produce, manage and consume energy. As issues of energy security and energy scarcity join climate change on the list of energy predicaments facing society in the coming century, a range of governments,

people and community groups are calling for a low carbon transition: a fundamental change in the way we provide energy services. How this transition to a lower carbon world is approached, managed and implemented varies dramatically according to the specific context and the people, governments, businesses and organisations involved. Nations around the world have begun using varying tools to achieve change such as introducing incentives for energy producers to increase the energy efficiency of their networks, exploring “greener” energy supplies, encouraging communities to invest in renewable energy technologies and developing a better understanding of the impact of existing infrastructure.

It is becoming more apparent that the way society interacts with varying policy and technology changes will have a huge impact on this transition to a low carbon society. Getting the low-carbon transition right involves addressing questions of what forms of energy are the right sorts to use; variations in the energy needs of different

countries, communities and households; what mechanisms can be used to affect such a fundamental shift in behaviour and energy systems? Researchers within the DEI have been grappling these questions, exploring current behaviour and identifying pathways to achieving our low carbon goals.

The way society interacts with varying policy and technology changes will have a huge impact on this transition to a low carbon society.

Generating hydrogen using novel electrocatalysts

Dr Mark Fox from the Department of Chemistry received a grant of £3400 from One North East to undertake a scoping study into the use of novel electrocatalysts for Hydrogen (H₂) generation.

His research involved looking at different boron-carbon-hydrogen clusters (carboranes) and analysing their ability to catalyse hydrogen

from some acids under electrochemical stimulation. Platinum metal is typically used as an electrocatalyst for H₂ generation from acids. Platinum is an expensive commodity whereas carboranes are relatively inexpensive and easily modified to vary redox potentials. The project required collaboration with experts in measurements of electrocatalyst efficiency at Nottingham University and this co-research will continue if effective electrocatalysts can be obtained here at Durham.

Dr Fox found that the carboranes studied so far had little effect on the generation of

hydrogen from acids. However, new clusters were made during this study that are currently of interest to cluster chemists worldwide. A recent paper (Chem. Commun. 2011, 8632) showed carboranes as successful catalysts for electrochemical reductions of organic compounds. This article indicates that some carboranes should be effective as catalysts for H₂ generation.

For further information visit www.dur.ac.uk/m.a.fox/



Under the Wings of Daedalus

Solar energy transition in Greece

In 2011 the Greek government relaunched an ambitious programme first introduced in 2006 to enhance economic sustainability through the development and export of solar energy. This solar energy investment was heralded as the economic saviour of the Greek state just as the nation headed towards bankruptcy and the country descended into social chaos. Renewable energy was viewed as a long-term solution to fiscal austerity, international dependency and European energy security.

Dr Sandra Bell of the University's Anthropology Department and Dr Daniel Knight of London School of Economics used a DEI small grant to explore the economic and energy futures of southern Europe. Support on photovoltaic technologies was also provided by Dr Douglas Halliday of the Department of Physics. Understanding the opportunities and limitations of the technology continued to be a (sometimes steep) learning curve, but provided new academic challenges.

The project considered the impact of micro- (home), meso- (agricultural land), and macro- (commercial solar parks) scale photovoltaic installations on local employment opportunities, land diversification, socioeconomic relations, bureaucratic and governmental networks, and overall energy and food security.

The productivity of land is currently very low. Farmers cannot sell their produce in local or national markets, making crop production unviable beyond subsistence. As such, farmers are "growing photovoltaics" on their land. The sustainability of this approach has to be questioned due to the long-term nature of the contracts. Due to the rapidly increasing popularity of the current solar programme much agricultural land – Thessaly has long been known as 'the bread basket of Greece' – has been taken out of circulation. This raises questions for local and national self-sufficiency in grain and cereal vital to the Greek socioeconomic recovery. By encouraging energy security through the large-scale solar programme, food security may be threatened and this issue will become even more pertinent should Greece leave the Eurozone.

Dr Daniel Knight conducted investigations into the background of the photovoltaic programme and its impact on the local community. Many people remain sceptical as to the long-term socio-economic benefits of the photovoltaic programme. Concerns raised include the impact of corruption on the flow of finance for the projects, the sustainability of the agricultural livelihood once land is leased on a 25- or 50-year basis to energy companies, the continued benefits to everyday Greeks, the inadequate infrastructure and over-ambitious national plan, the overcomplicated and opaque bureaucracy, and the endemic lack of political and economic trust in all parties involved (especially Greek and German governments).

The research findings have been discussed through paper presentations with human geographers at the University of Birmingham, political scientists, economists, and lawyers at London School of Economics and Political Science, philosophers at the University of St Andrews, theologians and historians at University College London, and ethnobotanists and conservation scientists at the University of Kent. Results of the DEI scoping study were also discussed interdisciplinarily at a workshop hosted by the College of Humanities and Social Sciences (EHES) in Paris, France (December 2012) and among some non-anthropologists at the European Association of Social Anthropologists in Nanterre, France (July 2012). The research will be disseminated at forthcoming interdisciplinary seminars at Oxford University (May 2013), the British School at Athens (May 2013) and London School of Economics and Political Science (March 2013). A workshop is planned in Easter term 2013 to further discuss issues of energy poverty in the Balkans in an interdisciplinary setting.

Daniel has published an article entitled 'Turn of the Screw: narratives of history and economy in the Greek crisis' in the *Journal of Mediterranean Studies*, 2012, 21 (1), incorporating an extended section on the DEI funded photovoltaic research and three further papers are currently under review.

For further information on solar energy transition in Greece please contact Dr. Sandra Bell sandra.bell@durham.ac.uk or Dr. Daniel Knight d.m.knight@lse.ac.uk

Energy recovery from car exhaust pipes

Professor David Wood, Dr Andrew Gallant and Miss Linzi Dodd from the School of Engineering and Computer Sciences used a DEI grant to purchase materials for their research into energy recovery from car exhaust. Their project has focussed on developing the use of platinum as a metal-oxide-metal (MOM) diode. These diodes can then be wrapped around car and other exhaust pipes to capture heat energy and convert this into electricity.

MOM diodes involve the use of two dissimilar metals separated by a native oxide. The thickness and surface area must be strictly controlled to ensure that the diode has a high

enough cut-off frequency in order to rectify the signal through the use of electron tunnelling. In previous work they had successfully demonstrated these diodes at micron-sized areas using non-optimal metallisations.

The researchers worked with the Physics and Chemistry departments as well as those of the School of Pharmacy at Nottingham University in testing these diodes.

These findings have a global impact and are world-leading in demonstrating the usefulness of these diodes using optimal Titanium/Platinum metallisations and validate the need for the use of platinum.

The ultimate application for this research is envisaged to be the automotive industry where interest in this area continues to grow. Presentations have been made to several

suppliers and car manufacturers in the UK and abroad and agreements set up with some companies.

The research has also resulted in four conference publications; one at a specialist event on Automotive Electronics, and three others at international academic conferences with refereed proceedings including:

- L E Dodd, D Wood and A J Gallant,** 'Energy Recovery from Car Exhaust Pipes', *Proc Advanced Automotive Electronics (AAE 2011)*, Gaydon, 27 September, 2011.
- L E Dodd, D Wood and A J Gallant,** 'Optimising MOM Diode Performance via the Oxidation Technique', *Proc IEEE Sensors 2011*, Limerick, Ireland, 28-31 October, 2011, pp 176-179.



Risk and Resilience

In order to be able to “keep the lights on” across the world we need to understand the risks associated with the different forms of energy supply.

These risks span technology, society, politics, meteorology and economics. It is an extremely complex area in which we are only just beginning to understand all of the influences maintaining an energy supply to a world with an ever-increasing population and decreasing resource of carbon based fuel. Our ability to secure supply has to be balanced with the need to ensure that our infrastructure is resilient to changes in the forms of energy being added to it as well as the increasingly severe demands made upon it by our erratic weather, increasing population and energy intense lifestyle. Ensuring we understand energy risk and develop a resilient system will be paramount in the future. Durham’s researchers are leading progress in this field.

Risk informed robust statistical modelling and decision making for planning and managing renewable energy

The performance of all energy systems is affected by meteorological conditions. Energy demand itself can go up and down depending on the weather and the behaviour of the energy distribution network. The network capacity itself also changes depending on the temperature, humidity and wind speed and direction. The introduction of renewable energy to the network adds additional uncertainty and meteorological fluctuation to power supply and intensity.

Whereas wind speed and wind power modelling and forecasting have received a lot of attention over the years, the correlation between renewable energy sources, power demand and network capacity, as a function of meteorological conditions is relatively untouched.

Dr Matthias Troffaes of the Mathematics Department was awarded a DEI small grant to work on this problem with researchers at the Idaho National Laboratory (INL), US.

Both Durham and INL are at the forefront of research in this field and the grant enabled INL researchers to visit Durham in March 2011 to exchange expertise on microgrids, energy storage, dynamic line rating, offshore condition monitoring and a potential offshore US pilot project.

A subsequent visit to the US in 2012 by Dr Troffaes and PhD students David Greenwood and Peter Davison of the School of Engineering and Computer Sciences led to discussions on joint papers comparing current methodologies together with the opportunity for internships and joint PhD agreements.

This initial DEI funding has led to the award of an ESPRC Strategic Partnership Award that was supported by the INL’s Center for Advanced Energy Studies. This will fund a workshop entitled “Uncertainty Quantification and Data Assimilation in Numerical Simulation of Physical Systems for Risk-Informed Decision Making” which is currently planned for March 2013.

Dr Troffaes and Dr. D. Kelly (INL) presented a joint paper “Imprecise Dirichlet Model for Common-Cause Failure” at the ESREL conference (Helsinki) in June 2012.

A Cooperative Research and Development Agreement (CRADA) is also currently being investigated between the two Universities.

For further information on modelling risk in renewable energy projects contact:

Matthias.Troffaes@durham.ac.uk or visit his webpage at www.maths.durham.ac.uk/users/matthias.troffaes/

It is well recognised that long-term planning and management of renewable energy is subject to severe uncertainty.



In the thick of it: The international debate on shale gas

Over the past few years there has been a heated international debate on the benefits and risks of using shale gas as a way to top-up the world's dwindling energy resources. In the UK the issue hit the headlines in December when Secretary of State for Energy and Climate Change, Ed Davey, announced the government's intention to give the go-ahead for the Shale Gas extraction in the UK. Durham Energy Institute's Director, Professor Richard Davies, has been advising some of the key players in this debate.

What is the debate?

Shale Gas is naturally occurring gas trapped within shale formations. It is harder and more expensive to extract than other forms of natural gas as it requires energy to release it, however, it is becoming increasingly viewed by many countries as an important option as other sources of gas start to dwindle. Shale gas is usually extracted using a technique called Hydraulic Fracturing, or Fracking, which involves pumping water, sand and chemicals into shale beds at high pressure in order to fracture the rocks and release the gas. But the technology is controversial as it has been linked to risks such as the contamination of drinking water, small felt earthquakes and there are concerns about how the water that is required will be sourced and cleaned up after use.

What is the DEI's approach?

Firstly in terms of whether shale gas does or does not go ahead – we are agnostic. With claim and counter claim, we've been working on the science, targeting the contentious issues of whether fracking causes the contamination of water and small 'induced' earthquakes. We're looking at the issues that members of the public are less aware of, for example what quantities of naturally occurring radioactive material will be produced as the fracking fluid flows back to the surface through the wellbore. We will only be publishing research through peer reviewed journals. But of course being DEI we are acutely aware that it is not all about the science - there are important issues of trust in oil and gas companies, regulators, governments and we have also launched a project on the social dimensions framing fracking.

Professor Richard Davies, Director of the DEI, gave evidence recently to the UK Parliamentary Select Committee on Energy and Climate Change who are currently investigating the

'Impact of Shale Gas on Energy Markets'.

He said "It is essential that Governments and Industry do not ignore people's fears about the risks of Shale Gas fracking. People need to be listened to and communicated with about the realities of this method of extraction.

The debate must be brought into the scientific realm so that decisions are made based on actual scientific research to enable constructive communication between communities, Governments and Industry".

In response to the government's December announcement giving the go ahead for exploration in the UK, Professor Richard Davies said:

"We have to be cautious about the possible risks presented by shale gas extraction. We now have the technology and know-how to fully explore risks before we undertake a new energy strategy and this should be taken advantage of. Sometimes there is an overestimation of what we know about underground rocks and subsurface. However there is still a lot that we do not know. We have to take risks seriously and fully explore any possible negatives of using a specific energy technology.

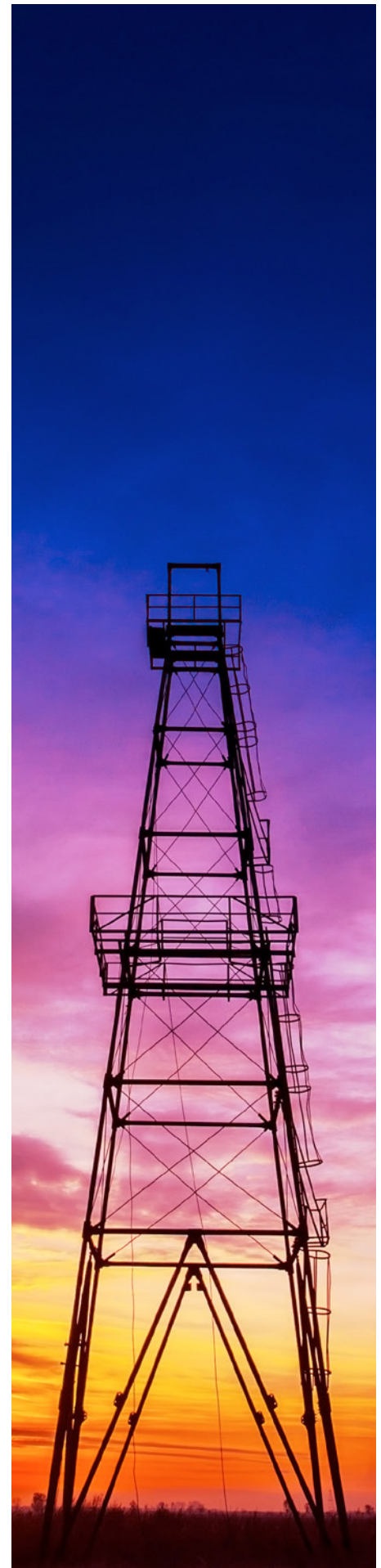
Professor Davies has published a number of reports on the issue. He is on the Expert Advisory Panel for Shale Gas Europe, has met with the Bulgarian government committee looking at shale gas and met with media and local government in Ukraine, Romania and Poland. He is also in process of setting-up a consortium to bring industry and researchers together to research the concerns that are being raised about the risks associated with hydraulic fracking. The consortium is called 'Researching Fracking in Europe' (ReFINE).

For further information on ReFINE please visit <https://www.dur.ac.uk/refine/>

To view or read George Osborne's Autumn Statement 2012 visit http://www.hm-treasury.gov.uk/as2012_statement.htm

Professor Davies recently wrote an article for the New Statesman examining the risks related to fracking:

<http://www.newstatesman.com/energy-and-clean-tech/2012/03/shale-gas-fracturing-fracking>





Smart Energy and Networks

Durham hosts a world leading research Institute for the study of Smart energy and is providing support to energy suppliers and smarter energy projects across the world. The Durham Smartgrid lab provides a unique environment for partner companies and researchers to model and manage energy flows and usage on our electricity supply network. We are currently working with the major suppliers in the UK as they respond to the Government's call to reduce the amount of energy supplied by carbon sourced fuel and switch to a network capable of responding to different supplies and storage opportunities. The DEI is exploring the way Smart can assist in planning, managing and facilitating future energy systems that are flexible, complex, responsive to uncertainty and include emerging technologies as well as societal participation.

Energy Storage and Smart Grids

Dr Neal Wade of Durham's School of Engineering and Computing Sciences is working with distribution network operators UK Power Networks (UKPN), Electricity North West (ENW) and Scottish Power Energy Networks (SPEN) to analyse the effect of placing energy storage facilities on the electricity grid.

The aim of using storage is multifaceted, two key benefits are; reducing peak power flows on the network so that as load grows with time investments in new, higher capacity, equipment can be delayed. This facility, known as peak shaving, would be implemented to save customers money in that this is a lower cost alternative to upgrade investments. This peak shaving capability can also reduce the need for high cost power stations to operate to meet demand at peak times. This means power stations can be scheduled to operate in the most efficient combination throughout the day and thus produce fewer emissions.

The second benefit arises from the increasing need to manage the introduction of renewable energy supplies onto the grid. Energy produced from renewable sources is variable and not necessarily produced at the preferred time of use and so a facility to store this energy and make it available for use at a different time is highly desirable.

Dr Wade is beginning work on the design and evaluation of the control system for a 6 MW/10 MWh Lithium-ion battery storage facility that will be placed in UKPN's network. This system will demonstrate both network upgrade deferral and service offerings to other market participants including NationalGrid and an energy supply company SmartestEnergy.

He is installing a lead acid battery with a configurable three-phase power electronic interface into the Smart Grid lab located in the Engineering dept. This lab can simulate all the current supply and demand.

His research will further understanding of the impact and capability of storage systems on the energy network.

Wade, N.S., Taylor, P.C., Lang, P.D. & Jones, P.R. (2010). Evaluating the benefits of an electrical energy storage system in a future smart grid. Energy Policy 38(11): 7180-7188.

Lang, Peter., Wade, Neal., Taylor, Philip., Jones, Peter. & Larsson, Tomas. (2011). Early findings of an energy storage practical demonstration. 21st International Conference on Electricity Distribution, Frankfurt, Germany, The Institution of Engineering and Technology.

The Durham Smartgrid Lab provides a unique environment for partner companies and researchers to model and manage energy flows and usage on our electricity supply network.

On the long road: testing the electric car for long distances

Two DEI engineering students recently completed a 705-mile round trip driving an electric car from Durham to Cardiff and back to demonstrate the possibilities of Smart Grid power and low carbon electricity. Sergio Roldan and Giannis Sarrigiannis began their journey on Monday 22 October and reached Cardiff on Wednesday 24 October in time to attend the 2012 Low Carbon Networks Fund Annual Conference in Cardiff where they received an enthusiastic welcome.

Durham's electric vehicle is a Mitsubishi i-MiEV, which has a maximum range of 80 miles between charges. The car is an integral part of the Smart Grid laboratory project at DEI with all of the power it uses to charge when based at Durham University coming from our Smart Grid. The trip investigated how well the equipment works in action on a substantial journey, and whether obstacles still remain for using electric vehicles over long distances such as the distribution of charging infrastructure nationally.

Electric vehicles and the national charging infrastructure have already made big advances compared to just a few years ago. Electric cars work well for short trips and with nearly 95 percent of all our car journeys nationally being under 25 miles, they can already

successfully meet the majority of our travel requirements. However this is the first time that the practicality of longer journeys has been fully explored.

The students found some difficulties finding charging points particularly on a Sunday when many places were closed and charging was found to take a significant time. The trip therefore increased from 6 hours to 2 days and more miles had to be covered to find charging points. However even with this increase in distance covered the students found that compared to a similar type of petrol car the journey cost half the amount (£30 versus £62) and the CO2 emissions were a third of the amount (57.68 kg compared to 164.73 kg of CO2).

The benefits of using electric cars is therefore already significant. However these benefits would dramatically increase with improvements to the UK charging infrastructure with more frequently spaced charging points and speedier charging. To read the student's report on the findings from their journey visit the DEI smart grid website www.durham.ac.uk/dei/research/smartgrids/ev

Sergio and Giannis kept a blog of their experiences on the journey which can be found at: experiencedurhamuev.blogspot.co.uk

You can also hear an interview by Mike Parr on BBC Tees with Sergio and Giannis before they set-off on their journey a <http://www.bbc.co.uk/programmes/p00z711g>

Assembling Smart Cities

The concept of a "smart city" is still a somewhat fuzzy one and covers smart economy, smart mobility, smart environment, smart people, smart living and smart governance. This complexity and the potential benefits to be derived by considering smart cities holistically is therefore gaining much more attention from researchers and practitioners across engineering, geography, governance, business studies and the social sciences.

Dr Colin McFarlane of the Department of Geography used a DEI small grant to review current thinking on smart urban energy and to develop a collaborative and cooperative understanding across different countries of their developing smart city structures. His research involved firstly, the compilation of a database of smart city energy processes across different cities and then the identification of the key actors that enable and support smart energy processes. He then organised a workshop with researchers from these countries to help develop collaborative research.

The database has led to a jointly authored paper with Andres Luque (DEI PhD student) and Professor Simon Marvin (who subsequently joined Durham and is working squarely in this area). The paper was presented at the annual conference of the Royal Geographical Society in 2012, as well as in a one-day workshop organised at Durham on smart urbanism.

Dr McFarlane and Mr Luque are currently putting together an application for a much larger grant to thoroughly examine the production of smart cities from an international comparative perspective.

For further information on smart urbanism please contact Dr Colin McFarlane colin.mcfarlane@durham.ac.uk or Professor Simon Marvin on simon.marvin@durham.ac.uk





Energy for Development

The demand for energy in developing countries is increasing at an unprecedented pace. International business and governments are increasing low carbon energy investment to ensure that these energy needs are met. Durham's researchers have been working with communities globally to understand how we can ensure that these new energy systems are optimised and fit-for-purpose, and designed to meet the real needs of communities now and into the future. The DEI aims to internationalise all its research and ask what it means for different economies, climates and cultures across the world.

The Rising Powers, Clean Development and the Low Carbon Transition in Sub-Saharan Africa

From an initial scoping study, funded by DEI, Marcus Power and Harriet Bulkeley have gone on to win a large ESRC fund of £722,000 for an international interdisciplinary research project in collaboration with the University of Sussex, the Chinese Academy of Sciences, the Energy Research Centre at the University of Cape Town, Practical Action UK and the Brazilian Centre for Strategic Studies and Management in Science, Technology and Innovation (CGEE). The project seeks to examine how, why and to what extent China and Brazil are enabling the transition to low carbon energy systems in Southern Africa. What are the implications for the affordability, accessibility and sustainability of energy services in the region?

The involvement of 'Rising Powers' in clean energy systems in sub-Saharan Africa is often obscured by popular images of resource- and land-grabs. However the Rising Powers have increasingly come to incorporate renewable energy projects into

their aid and loan portfolios in Africa seeking to engage more closely with a number of African states, businesses and communities in pursuit of diverse economic and political goals. The depth, drivers, and outcomes of this activity are complex and contested in terms of both development and the implications for international energy and climate governance.

The project will develop new frameworks for analysis to systematically compare the roles that China and Brazil are playing in facilitating the transition to low carbon energy systems in Africa. In particular it will analyse how they are shaping the provision of energy services for productive uses (e.g. for cooking, lighting and mobility). The project also seeks to assess the implications for the wider governance of energy and climate change at the local, national, regional and global scales. The project will look at the range of actors, institutions, partnerships and policy-making processes involved in the Rising Powers engagement with African energy systems and will identify the key interests and beneficiaries being served by this co-operation.

Conceptually this research is shaped by an awareness of low carbon transitions as uneven processes and as differentiated technically, socially and spatially. Across sub-Saharan Africa China and Brazil have each championed different technology sectors and energy services. Their impacts are also socially differentiated in that patterns

of Chinese and Brazilian investment, innovation and infrastructure development benefit particular groups of society and have differential impacts on poverty and livelihoods. Further, the impacts China and Brazil are having on low carbon transitions appear to be spatially differentiated, not just between different countries in sub-Saharan Africa but also between urban and rural spaces within these countries. The project will examine the consequences of these dynamics for key issues of energy access and affordability, and in relation to wider development strategies.

These dynamics will be explored using a combination of semi-structured interviews and community-based participatory research methods. By building collaborations at a community, governmental and academic level in the UK, Brazil, China and Southern Africa the project seeks to build local capacity, to foster knowledge exchange and policy dialogue and to build cross-disciplinary and transnational research networks concerned with the role of the Rising Powers in facilitating low carbon transitions in sub-Saharan Africa.

For further information on the Rising Powers project visit the project webpages on the DEI website at www.durham.ac.uk/dei/research/energyfordevelopment/risingpowers or contact Marcus Power on marcus.power@durham.ac.uk



The problems of off-grid electricity: An interdisciplinary student-led case study in East Africa

Durham Energy Institute funded three Engineering and Anthropology students to visit Rwanda in September 2012 to explore the efficiency of small scale energy storage systems in Solar photovoltaic energy production. The team worked mainly with schools and community hospitals and the local University.

Only one-fifth of the population in sub-Saharan Africa have access to power and there is a major drive in this region for electrification. This is coupled by strong international pressure for green development. Rather than developing a large transmission grid with carbon intensive central generation (such as large coal power stations), it is considered to be more affordable and beneficial in remote areas to develop a de-centralised grid.

In Africa, this is already a reality to some degree. Large distances and difficult terrain often make it prohibitively expensive for rural communities to build a connection to the main

power grid. The traditional alternative for health centres and schools are generators that can be bought at relatively low capital cost but these are expensive to run. International donors are now pushing the use of solar PV systems as an alternative. These cost more to purchase than generators, but have no fuel cost. However, recent projects have found that the batteries in these systems fail prematurely, leaving the owners with no power source and a need to revert to generators.

The student-led DEI project examined the failure mechanisms of these solar systems in context, by looking at both societal and technical factors and worked with a local installer in Rwanda (Great Lakes Energy). By looking at socio-technical factors in combination the project identified the full range of issues experienced by users who rely on this technology and the difficulties faced by the technology within the specific geographical and social context of Rwanda and Uganda. This more holistic real-life assessment will enable a more effective energy storage system to be designed for that particular context.

If you would like the students to present on their findings and experiences please contact andrew.crossland@durham.ac.uk or o.h.anuta@durham.ac.uk

For further information on this project visit www.durham.ac.uk/research/offgridrwanda

“The research is important for the durability and sustainability of PV solar installations in Rwanda. We encourage any such oriented research which will improve the design and practice of solar schemes, the proper use of Solar systems and awareness required by the end users.”

Rwabizi Sylvestre, Engineer in charge of renewable energy at the Energy and Water Sanitation Authority in Rwanda



Methodologies

The DEI has pioneered the application of interdisciplinary research across the energy community with a unique focus on linking societal research to energy technology issues. This interdisciplinarity is being increasingly recognised as valuable to existing and prospective partners as well as other disciplines and has seen the DEI receive over £11m in funding over the past 3 years together with increasing its range of businesses requesting support in understanding energy problems. Our collaborative approach is changing the way that energy projects have traditionally been viewed with people becoming active participants in shaping the energy supply system of tomorrow. Using critical perspectives which challenge preconceived ideas and prejudices in energy research is central to the DEI approach. Questions of equity, justice and how to actively engage all groups affected by energy technology issues are at the core of the DEI methodological approach. Our projects are introducing new methodologies capable of ensuring that solutions are more readily adopted, have fewer unintended consequences and are based on a strong understanding of people's needs and behaviours.

Our collaborative approach is changing the way that energy projects have traditionally been viewed

Engaging Durham to develop a local energy action plan.

Durham Researchers have also been working with local community groups to develop their energy projects. The DEI small grants programme funded work with Transition Durham to develop and implement an 'Energy Descent Action Plan' (EDAP): a plan developed by and for the local community for the low carbon economic regeneration of Durham City and the surrounding area.

This process began in summer 2011 with a weeklong participatory mapping event, 'What? No Oil?', in which Durham-based arts collective Empty Shop helped Transition Durham transform a vacant commercial unit into a temporary project creation space, to which several hundred members of the public

contributed ideas. Subsequently, in spring 2012, a DEI scoping study grant supported a second phase involving a series of stand-alone community engagement events on particular themes, including Community Woodlands, River Management, and Community-owned Renewables, and targeting specific sectors of the community. This combined further participatory mapping with a range of other data production techniques, such as the use of World Café and Open Space technologies. Data from these events has been input into a multi-user blog edap.transitiondurham.org.uk through which ideas can develop through further discussion, and are the basis of a 'Pattern Language' – a set of templates for community-led low carbon development in Durham City – being developed by Transition Durham members.

As a result of this scoping study a Community Woodlands group has been formed and the Durham Community Power Coop was established – a mechanism through which

to initiate and manage community-owned renewable energy projects. Transition Durham is part of the global Transition Network and exists to promote economic resilience through community-led responses to peak oil and climate change. Associated projects of Transition Durham include the development of a local food website www.durhamlocalfood.org.uk, a Housing group which is currently working on a project to develop a brownfield site in Durham City centre into affordable low-impact housing, and the social enterprise Fruitful Durham. Fruitful Durham won the social enterprise category at the Durham Blueprint awards 2012 www.dur.ac.uk/careers/s/employability/skills/enterprise/blueprint/, having (along with the Local Food website) partly arisen as an outcome of Amy Mycock's MA by research.

For further information contact Tom Henfrey at t.w.henfrey@durham.ac.uk or Charlotte Lee at c.e.lee@durham.ac.uk



Engaging the public on Energy through Film

The DEI's Multidisciplinary Centre for Doctoral Training (CDT) in Energy is one of 13 Centres set up in the UK to enable PhD students to develop their research approaches to energy issues and the low carbon economy.

Part of the CDT requirement is that the students engage the public in their research and this was the challenge given to the Durham students at the start of 2012. Their solution was to organise the Durham Energy Futures Film Festival (DEFFF) which took place in September 2012 at the Tyneside Cinema, Newcastle.

This was a free event with prizes for the best two films submitted, and the best photograph. The evening was aimed at engaging the public in a lighthearted way with questions of how our energy use is set to change and what it will mean in the future. Through thought provoking films made by students all over the UK about how energy is made and used, and encouraging the public to ask Durham University researchers questions about what they do and why they think energy so important.

The audience included staff and students from Durham and Newcastle Universities, members of three other Energy CDTs, representatives of energy companies in the North East, groups from nearby schools, and interested members of the public.

The event was a great success and the students are now looking into follow up public engagement events. The evening's submissions have now been captured on Youtube at tinyurl.com/alx7wve

The overall winner was **"Why build a sun on Earth"** closely followed by **"when Alan met Sharon (a U-Value romance)."**

Funded by the Engineering and Physical Sciences Research Council (EPSRC) the CDT network aims to provide skills training in areas such as project management and enterprise to produce a cohort of highly employable, skilled and talented researchers who are equipped to deal with the multi faceted challenges facing the energy sector and wider society in the 21st century. At Durham, the CDT provides a stimulating and interdisciplinary postdoctoral training programme with regular guest lectures and industry visits.

We believe that energy researchers with the ability to understand energy in its broadest context are crucial to their continued success in the energy sector. Energy is a multidisciplinary topic and in order to remain competitive within this sector, the UK will require a critical mass of versatile individuals trained in a wide range of skills. Durham CDT researchers will have a competitive edge when considering the next step in their career.

The Durham CDT was established in 2009 and currently has 38 students across all 4 years. Due to the multidisciplinary nature of the Durham CDT research and publications to date have ranged from Vehicle aerodynamics to saline formations in Carbon capture systems, from Energy strategy in middle income nations to social sciences view on energy transitions.

If you would like any more information about Durham's CDT programme please visit the CCT section of the DEI website www.dur.ac.uk/dei/cdt/ or contact Katie Daniels, CDT Administrator katherine.daniels@durham.ac.uk

Filling gaps in micro-hydro knowledge

Dr Louise Bracken of the Geography Department used a DEI small grant to organise a workshop on the issues of utilising and developing micro-hydro schemes in the UK.

The workshop brought together academics from across Durham University with staff from Durham County Council, the Environment Agency, Northumberland County Council, local community groups developing micro-hydro schemes, and energy consultants. The key research questions that the workshop aimed to address were around the interests of different groups, their gaps in knowledge, and the key research questions that need to be explored around micro-hydro.

Micro hydro is a type of hydroelectric power that typically produces up to 100 kW of electricity using the natural flow of water. These installations can provide power to an isolated home or small community, or are sometimes connected to electric power networks. There are many of these installations around the world, particularly in developing nations as they can provide an economical source of energy without the purchase of fuel. The installation is often just a small, dammed, pool, at the top of a waterfall, with several hundred feet of pipe leading to a small generator housing.

There is a current lack of research around micro-hydro in the UK, and the multiple social, environmental and technical factors at play. However as an important option for reducing the UKs carbon emissions and reliance on external sources of energy it is crucial that the contribution of micro-hydro to electric futures is explored.

The workshop resulted in the setting up of a local network to enable the attendees to continue to discuss and develop ideas emerging from the workshop. A 'go to' document is also being produced containing relevant and useful information and sign-posting around micro-hydro for community groups wishing to explore micro-hydro as an option. Economic feasibility studies and project proposals are also being developed exploring the potential of developing micro-hydro at various locations in Durham.

For further information contact Dr Louise Bracken at l.j.bracken@durham.ac.uk

Equity dimensions of micro-generation: A whole systems approach

Micro-generation is becoming increasingly important. With 17 percent of carbon dioxide emissions produced by the domestic sector in the UK, the role of micro or small scale generation will be essential to meet national carbon reduction strategies (UK Energy White Paper 2003). It is anticipated that domestic micro-generation systems could reduce household carbon emissions by 15 percent per annum by 2050 and micro-generation technology in general could meet 30 to 40 percent of the UKs entire electricity requirements by 2050. A DEI project is developing a new methodology to ensure that micro-generation projects and policy decisions are designed to be as equitable and adaptable to uncertainty as possible.

The Interdisciplinary Cluster on Energy Systems Equity and Vulnerability (InCluESEV), is developing a methodology using a 'whole systems' approach where equity implications are considered across the whole life-cycle of an energy technology. This is being developed for the areas of micro-generation, nuclear energy and carbon capture and storage. Across these three energy technologies three key themes are analysed: a) Technology aspects, b) Policy and Markets, and c) Energy Citizenship. While keeping equity and carbon as the main focus a range of variable and uncertain factors are considered such as energy prices, changing energy policy and socio-economic status of those involved.

A new paper by Charlotte Adams, Phil Taylor and Sandra Bell in the Journal of Renewable Sustainable Energy reviews how InCluESEV has developed this whole systems equity methodology and applied it to micro-generation. The micro-generation work package brought together a wide range of energy and housing stakeholders, with an interdisciplinary team of academics from 13 disciplines, to develop a collaborative tool to support equitable decision making in micro-generation. The paper argues that policy decisions on micro-generation do not currently use a 'whole systems' or equity based approach. Instead assessments often only look at one generation technology at a time or use only one assessment approach or look only at one setting and a specific subset of economic or policy criteria. However these approaches

are often inadequate for addressing issues of equity.

A whole systems approach looks at the various elements of a system and how they interact. It is therefore fundamentally interdisciplinary. The methodology has been designed as a tool which encourages and enables deliberative and collaborative decision-making. By focusing on the dynamic qualities of complex phenomena, the methodology has the potential to identify and address any unintended or unforeseen consequences emerging from micro-generation systems. It aims to ensure micro-generation projects:

- have optimal technical efficiency,
- encourage citizen engagement, and
- equitably distribute costs and benefits.

To read the article 'Equity dimensions of micro-generation: a whole systems approach' visit jrse.aip.org/resource/1/jrsebh/v4/i5/p053122_s1

For further information on the InCluESEV project and whole systems methodology visit the DEI project webpages www.durham.ac.uk/dei/research/societyandenergy/inclusev and the InCluESEV project website <http://inclusev.kcl.ac.uk>

Key facts on InCluESEV

An interdisciplinary research cluster being led by Durham University, Kings College London and Lancaster University, along with academics from Birmingham, Cardiff, Edinburgh and UEA.

Non-academic partners include National Energy Action, Eaga, Warm Zones, the Building and Social Housing Foundation

- Brings together a multidisciplinary membership of over 100 academics and practitioners
- Whole systems approach: a comprehensive analysis technique
- Equity and vulnerability in energy systems
- Impact and policy implications

Applied whole systems methodology to three work packages:

- Micro generation;
- Nuclear energy;
- Carbon capture and storage

In conversation with Harriet Bulkeley, Deputy-Director of the Durham Energy Institute



We caught up with Harriet to ask her about her career, research loves and aspirations for the future.

What was your first memory?

I was born in Sudan, a very hot, dry and poor country. My first memory would be of being on a climbing frame in the midst of a load of circling cyclists. I felt trapped and unable to get out from the midst of the bikes. Thankfully I wasn't traumatised long term and now cycle everywhere.

What did you want to be as a child?

Thankfully I've always wanted to do what I do now. As a child I would have said teacher or working in environment.

What or who has been your biggest influence to date?

My PhD supervisor, Professor Susan Owens at Cambridge University, as she showed me that

you can undertake fantastic research whilst also impacting on national and international policy.

If you had £1million to spend on research what would you do with it?

I would spend it all on Early Career Fellowships on any subject.

What are the real myths around climate change?

That it can be treated as a separate issue, it has to be something that every single person feels that they can take responsibility for.

What are you most proud of?

Apart from my children, and managing a family and career! It would be my PhD and my first book "Cities and Climate Change: Urban Sustainability and Environmental Governance" Routledge, 2003

You seem to spend a lot of time abroad, what are the benefits and disadvantages of this?

My work is internationally relevant so I need to interact and work with people in their different locations. Working with different Universities, politicians and communities benefits our research by providing a broader or different perspective on issues. The disadvantages are obviously missing out on family life and the

inevitable jet lag.

What would you say to undergraduates looking for a career in academia?

Remember that it's just a job, a fantastic job, full of freedom, but you may never be the one to make that final breakthrough or great discovery. A lot of academia is actually quite ordinary.

What makes Durham University so good?

The people, the University and the staff are hugely open minded and supportive to ideas and research themes. It is what attracts world leading researchers

If you didn't do this, what would you be doing?

Probably working for an environmental development organisation somewhere in the world. It is a subject that has held a lifelong fascination for me and I'm very lucky to have been able to work with the world's leading thinkers as interest in this subject continues to grow.

What is your vision for the DEI over the next five years?

I would like the DEI to deliver its promise of representing the importance of the social dimension of energy research. It is its multi-disciplinarity that sets the DEI apart

Events at the DEI

For further information on DEI events visit www.durham.ac.uk/dei/events or email dei.admin@durham.ac.uk

Energy for Development Seminar Series

E4Dev is an interdisciplinary group of lecturers, postgrads and undergrads with a common interest in Energy for Development.

The group holds monthly seminars and is a great way to meet researchers interested in this area. Previously the group has had talks from researchers around the UK, a funded trip to a low-carbon energy conference LCEDN and even a screening of an energy film! For information of the next event, contact andrew.crossland@durham.ac.uk

The Biospheric Project

In July 2013 the Biospheric Foundation, led by Jonathan Silver, a DEI geography postgraduate, will be exhibiting at the Manchester International Festival creating and experimenting with sustainable food systems in a disused mill in the centre of Salford. The derelict industrial site will be transformed into

to a thriving agricultural space, with innovative growing systems all around the building. Events and activities will also be organised to explore how experiments into food, technology and design can become new ways of urban living now and in the future.

More information can be found at www.biosphericfoundation.com

Smart Urbanism debate and workshop

The DEI is funding a new project on Smart Urbanism led by Professor Simon Marvin, DEI Carillion Chair of Low Carbon Cities and Communities, with a multidisciplinary research team. The project will hold a high profile public debate and workshop in June 2013 to kick off an international discussion critically exploring the concept of 'Smart Urbanism' (SU). Looking at whether SU is truly a panacea for the majority of problems currently being faced by cities around the world and unpacking its wider social and political implications.

Research Generators

The DEI holds regular research generator meetings on the first Thursday of every month bringing together researchers from a range of disciplinary backgrounds to make contact and discuss energy topics in an informal environment - without PowerPoint, agendas, chairpersons or minutes.

The Future of the UK Energy Mix

On the 11th February, Prof Richard Davies of the DEI hosted a breakfast roundtable attended by the Rt Hon Ed Davey MP, Secretary of State for Energy and Climate Change to engender debate between energy companies, academic experts and of course DECC regarding all the relevant platforms including oil & gas, solar power, wind, tidal and nuclear. The event was chaired by Bronwen Maddox, Editor of Prospect Magazine and is the first of a series of high level events organised by the DEI and Prospect.

Communicate your work!

The Durham Energy Institute provides support to academics and students from all disciplines engaged in energy research. 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 April 2013 issue of the DEI Review or on our website please contact dei.admin@durham.ac.uk