Durham University

SCIENCE AND SOCIETY

DURHAM ENERGY INSTITUTE REVIEW

ISSUE 7: WINTER 2015/16

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// A MESSAGE FROM THE

DEI EXECUTIVE DIRECTOR

There have been a number of important events and changes since the last edition of the DEI Review magazine with many exciting new opportunities moving forward. The most significant change is that we welcomed our new Vice Chancellor, Professor Stuart Corbridge, to the University in September 2015. He has already released a Vision Statement for the University containing his thoughts on options for the strategic development of the organisation over the next 5 to 10 years. We are taking care to make sure that DEI's vision for the next phase of our development remains fully aligned with the University strategy as it emerges. Several of the University Research Institutes, including DEI, will be taking part in the Science Faculty Meta Review in February as one element of this work. We have put forward our vision for DEI for the next five years.

This contains a plan for strategic growth of DEI focussed on:

- strengthening our international network of partner institutions;
- increasing grant capture from DEI supported projects;
- strengthening our engagement with Alumni and Benefactors;
- further developing our Centre for Doctoral Training in Energy; and
- further developments to our programme of outreach and engagement events, workshops, research generator conversations, all aimed at promoting Durham's research expertise in energy across all of our Faculties and generating impact from our outputs.

We are looking forward to the outcome of the Meta Review and continuing to move forward with our plans.

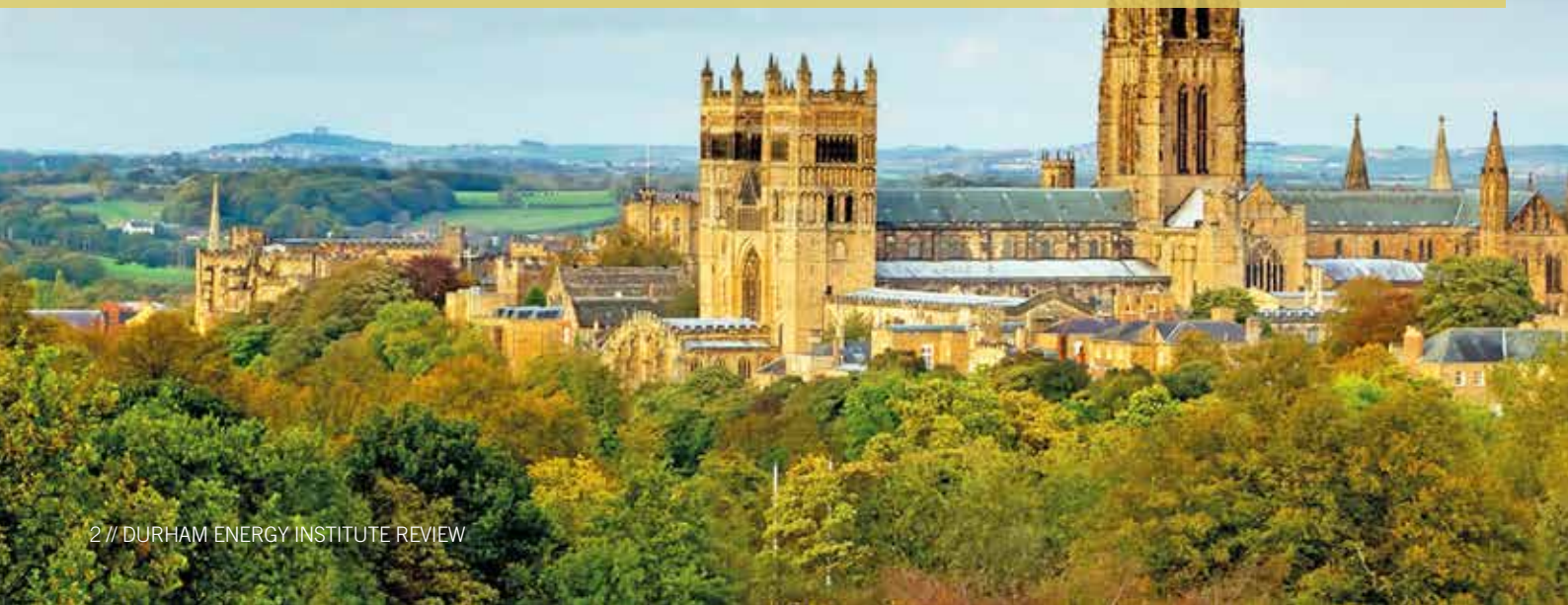
Ian Burdon stepped down from Chair of the DEI Advisory Board in October after several years of dedicated service going back to the formation of DEI in 2009. We thank Ian for all he has done in helping to steer DEI through our development to date. We are delighted that Ian will continue as a member of the board and that Alan Lowdon, another member of the Board since its inception, has taken on the responsibility of Chair.

Our relationship with DONG Energy moved to a new level in November with a celebration event held at the Business School to mark the signing of a Memorandum of Understanding to formally recognise the company as a strategic partner of the University. DEI has played a central role in developing DONG's engagement across the University and we are proud to see the relationship strengthened in this way.

We held the inaugural DEI Research Symposium in September to showcase Durham's research expertise in energy across a wide range of disciplines. Although we arranged the event with science presentations in the morning and social science during the afternoon, it was particularly pleasing to see this differentiation being blurred during the discussions following many of the presentations, with truly interdisciplinary research conversation spontaneously breaking out. We are encouraged by the positive feedback and outcomes from the meeting and we intend for this to now become an annual event.

In other developments we have revised the operation of DEI's Management Committee making the meetings more focussed on communicating and receiving feedback on developing and executing DEI strategic objectives. The Committee will become DEI's Consultative Committee and we will be rolling out the new structure during 2016. We are identifying key points of contact in all Departments and areas of the University that are linked to DEI and support our operations. We are also planning to bring back DEI Research Generator lunchtime events linked to the meetings of the new Consultative Committee.

We are looking forward to an exciting year ahead for the Institute and I am looking forward to playing my part in it.



DEI NEWS

// New Advisory Board Members

DEI works closely with members of the Advisory Board to ensure that we continue to understand and lead thinking within the UK and Global Energy Industry. Members of the Advisory Board have been invited from across the technology and societal energy spectrum to provide us with advice on strategic direction; support into new markets, collaborations and countries; as well as guest lectures on their areas of expertise. Members are happy to provide advice and feedback on project feasibility, funding mechanisms, impact opportunities, as well as opportunities for student internships.

Please contact **dei.admin@durham.ac.uk** if you would like to learn more about how the Advisory Board could support the development of your own ideas.

We are very pleased to welcome the newest members of our Advisory Board:

Andrew Wright was recently appointed Senior Partner in Energy Systems at Ofgem the gas and electricity regulator for Great Britain, where he was previously the Group Finance Director. He has worked at Ofgem since 2008, including a nine-month period as interim Chief Executive and five years leading the Markets Division. He is now responsible in Ofgem for everything from the power station or gas field to the meter, including transmission and distribution policy. Andrew, a Durham graduate, has 30 years of experience of the gas and electricity sector.

Hans Moller is Innovation Director with the North East Local Enterprise Partnership (LEP). He has over 25 years managerial experience including all areas of innovation promotion, sales and marketing. Before starting at the North East LEP in 2015, Hans worked as the CEO of the leading Science Park in Sweden, Ideon Science Park in Lund. He was also Chair of the Swedish Incubators and Science Parks, and is Chair of Karolinska Institutet Science Park in Stockholm.

Barbara Vest has been Director of Generation in the Management Team of Energy UK since 2012. She is a member of the Executive Council of the House of Commons All Party Parliamentary Group for Energy Studies, and serves as an elected Industry Member of the Balancing and Settlement Code Panel, Panel Sponsor of the Imbalance Settlement Group and Chair of the Joint European Stakeholder Group established by National Grid to manage the introduction of the Third Package European Network Codes.

Maggie Bosanquet is Sustainability, Energy and Climate Change Manager for Durham County Council, with responsibility for energy management, renewable energy and energy efficiency installations across the Council's land and buildings as well as for County-wide policy on sustainable development and climate change. Since November 2013, Maggie has also been working with the North East Local Enterprise Partnership to write the European Structural and Investment Funds Strategy for the ring-fenced £70 million allocation for the Low Carbon Economy.

Jenny Cooper specialises in research and development management and has been an Independent Energy Innovation Specialist since September 2014. She was responsible for Transmission research and development within National Grid for over 10 years and has twenty eight years' experience in innovation within the energy industry. Her focus has been on the electricity industry, short and long term strategic planning, environmental issues, new technology and increasingly all aspects of energy technology and innovation.

New Chair for DEI Advisory Board is Prof Alan Lowdon, replacing Ian Burdon who stepped down on 14 October 2015 after chairing the Advisory Board since its inception six years ago. The DEI Executive Director Simon Hogg and the DEI Executive Team would like to thank Ian for his contribution and support and are very happy that Ian is remaining as a board member. Alan Lowdon has been a member of the Advisory Board for some time and is a Visiting Professor in the School of Engineering and Computing Sciences at Durham, a role he dovetails with his Durham Energy Institute Advisory Board position. Alan operates a broad portfolio of interests including holding the CEO position at Invisotech, as well as advisory roles in relation to the Green Port Hull initiative, the University of Strathclyde's Technology & Innovation Centre and water purification technology business, CatalySystems. Alan also advises the UK Government's innovation agency, Innovate UK, and the US Department of Energy and holds non-executive director positions at the Port of Blyth, the Innovation Board of the North East LEP and Innovation North East Ltd.

// OTHER NEWS

DONG Energy and Durham University sign agreement to further develop research and engagement collaborations Durham University consolidated its relationship with DONG Energy to further joint aims in high-quality research, knowledge exchange and teaching by signing a Memorandum of Understanding (MoU) on 5 November 2015. This is one of only two strategic partnerships held by DONG Energy. Find out more about the signing in our events section.

European Platform for Energy Research in the Socio-economic Nexus (PERSON)
Dr Simone Abram, DEI Co-Director, is now a member of PERSON in Brussels and attended a progress meeting in October. The platform is dedicated to promoting and setting the research agenda for social science and humanities research in the EU's energy research programme. The platform connects independent experts from all over Europe who represent the top of their research field. The platform has considerable support from the commission and will present its research agenda during EU Energy Week in Brussels in 2016. Find out more at **person.eu**

AVE ATQUE VALE - HAIL AND FAREWELL!

Ian Burdon - *retiring Chairman of the Advisory Board at Durham Energy Institute.*

Electricity has played a major part, not just in the early development of industry in north-east England, but in my career too. Its ubiquitous value was prophesied by the great Victorian engineer George Stephenson, who was reported to have remarked to a junior partner in RW Swinburne & Co in Newcastle in 1847 that **"I have the credit of being the inventor of the locomotive. It is true that I have done something to improve the action of steam for that purpose, but I tell you young man, I shall not live to see it but you may, when electricity will be the great motive power of the world".**

I have spent the whole of my career in supporting the electricity industry, both at home and abroad. I began as a 17year-old Apprentice with a major manufacturer of power equipment on Tyneside in 1960, and retired in 2010 as a Vice-President of a long-established firm of consulting engineers involved with the world's electricity supply industries.

Over that 50-year period, I saw major changes and phenomenal growth in the extent of energy provision across the globe – and also in the per-capita consumption of energy, not just in the developed world, but in the newly-industrialised countries and the developing nations of Africa and the other continents.

New sources of traditional fossil fuels have been continuously discovered in hitherto unlikely places – under the oceans and beneath the ice caps.

The steady progress of new and renewable energy sources for electricity generation has been observed over the past 30 – 40 years in technologies as diverse as nuclear fusion and wind power. I have seen the introduction of ever-advancing combustion conditions for gas, oil and coal fuels and the application of new technologies and new materials to produce electricity from heat sources more efficiently and economically. Renewable energy resources such as wind and the sun have been deployed in increasingly larger-scale devices and per-unit capital costs have been relentlessly driven down during my lifetime in the industry.

Meanwhile, the earth's population continues to grow inexorably, poverty increases, and the poorer nations demand their fair share of the earth's resources - water, food and energy.

A Past-President of the Institution of Engineering Technology stated more than 65 years ago that "the chief basis of civilisation is the availability of energy in its various forms; mans' future requirements will be so vast that as to make present demands quite insignificant". A prediction proven by the fact that since that date, world energy consumption has risen almost five-fold and is predicted by the IEA to increase by a further 37% between now and 2040. The rapid growth in the demand for electricity, the most convenient of the energy carriers, in the first 75 years or so of the last century was met by technical innovation, economies of scale and a plentiful supply of coal. Great "cathedrals of power" such as that at Drax in Yorkshire were built to provide the nation with secure and reliable supplies of electricity.

That era depended mainly on two technologies: burning coal or nuclear fission to generate heat to raise steam in ever larger and more efficient turbines.

Over the last 30 – 40 years, other technologies have been encouraged by financial subvention or directed by government regulation to play a part in electricity supply. All, bar none, have limited scope for intrinsic enlargement to meet the insatiable demands of a growing global community for an unrestricted supply of electricity – unlike the technologies of yesteryear which benefited so much from economies of scale. I may be mistaken in my belief that long-term global demand for electricity will continue unabated and I am prepared to concede that we may discover a more convenient energy carrier – perhaps one with a smaller environmental impact. To paraphrase George Stephenson, **"I shall (probably) not live to see it but you may, when something other than electricity will be the great motive power of the world".**

One thing I have no doubts about is that Durham Energy Institute, its staff, its students, past, present and future, and its facilities, will be at the forefront of advances to identify and help the exploitation of new technologies to move civilisation forward with new energy carriers and energy conversion technologies.

I wish the Institute a long and successful future.

[1]TGN Haldane, A Partner in Merz and McLellan, Consulting Engineers,1948.

WE WANT TO TALK ENERGY!

// DEI RESEARCH SYMPOSIUM

We held our inaugural Research Symposium on 30 September 2015. This event was the first research symposium organised by the Institute and was aimed at engaging with external stakeholders in showcasing research and researchers at Durham. Funded by the DEI Impact Acceleration Account and designed to demonstrate our multi and interdisciplinary approach to energy research the symposium featured 2 panel discussions on the Science of energy in the morning, followed by a networking lunch and 2 further sessions on the societal aspects of energy. The sessions were chaired by DEI Directors each featured an external speaker invited from our Advisory Board.

// Further details on the subjects covered can be found here: www.durham.ac.uk/dei/events/past.events/?eventno=25758.

The session led to lively discussions which blurred disciplinary boundaries and truly represented the interdisciplinary 'Science and Society' approach to energy of DEI. Discussion brought attention to some of the challenges and opportunities facing the energy system, including whether fossil fuels will continue to be required as part of the UK energy mix, how the world's energy system will look in 20 years' time, problems associated with ageing energy infrastructure, and how important it is to have consistency and clarity from Government if we are to encourage the investment in our energy infrastructure that is urgently needed to meet renewables targets. The Journal newspaper published a double page article on the symposium 'Future of energy in focus as the world's academics gather' Highlighting its role in attracting world-leading academics and speakers to the North East region with over half of the attendees external to Durham University.

A poster competition was held featuring the impressive research being undertaken by our students. This was won by Francis Ridgeon a PhD student in Physics and member of DEI's Centre for Doctoral Training in Energy whose research aims to contribute towards developing a new generation of superconducting magnets for nuclear fusion. A model was also on display of a project being developed by some of our Energy CDT Students to design a Land Art Generator on Durham's disused Belmont viaduct incorporating solar technology.

Following the overwhelmingly positive response to this event DEI plan to run the symposium on an annual basis.

// BRITISH SCIENCE FESTIVAL

DEI took a team of Durham University academics and PhD students (Prof Andy Aplin, Dr Charlotte Adams, Mark Brodie, Matthew Jones and Frank Ridgeon) to the British Science Festival 2015 in Bradford. The team delivered a well-received and well-attended talk entitled 'Can we secure our energy future?'. Professor Andy Aplin explained that since 2003 the UK has been using more energy than it produces. This shortfall means an increasing reliance on fuel imports from other countries which can be unreliable. Despite attempts to increase renewables in the energy mix, more than half of the UK's electricity is still generated using fossil fuels. The event showcased the innovative research being undertaken at Durham by the new generation of energy researchers who are looking for ways to plug the energy gap whilst reducing carbon emissions: Nuclear Fusion, Geothermal, Organic Solar devices, and Enhanced Oil Recovery and Carbon Capture and storage in offshore oil wells.

// You can listen to the audio of the event or download the team's PowerPoint presentation at www.dur.ac.uk/dei/events/past.events/britishsciencefest/

// RUNNING A SUCCESSFUL COMMUNITY ENERGY PROJECT

To celebrate Community Energy Fortnight DEI organised a well-received event on "Running a Successful Community Energy Project" at Chilton Working Men's Club. Featuring Speakers from Oakenshaw Community Association, Chilton Green Energy Foundation, North Star, Absolute Renewables, NAREC as well as Durham County Council, Altogether Greener Durham and DEI. The event was attended by interested parties from across the region.

Feedback at the end of the day was excellent as attendees valued the opportunities to hear from the people who have delivered successful projects, together with those who can help to fund and advise on solutions to fit each community.

Ian Bloomfield from Durham County Council said…

"The community event at Chilton offered many opportunities for local residents to learn from successful energy projects across County Durham. Involving communities and local people in developing solutions to energy efficiency problems can often prove extremely effective, and by putting communities in control of the energy they use, can help maintain energy security and tackle climate change, help people save money on their energy bills, encourage local employment and reduce fuel poverty".

Following this event, the Chilton Green Energy Foundation, who are a community energy group, are working with DEIs MSc Energy & Society students and have provided topics for dissertations this year.

// COMMUNITY ENGAGEMENT WITH ENERGY PROJECTS

On the 9th October, Durham Energy Institute held a research symposium on community engagement with energy projects at the Radisson Hotel in Durham. The event was an outcome from a DEI Impact Acceleration Account funded project that had taken place earlier in the year looking at Community Engagement Practices within the Banks Group. This review had resulted in a number of changes to company's outreach activities. The event aimed to identify the key issues around trying to engage a broad cross-section of the population of communities in planning for future energy provision and discussed a multi-perspective overview of energy development at the national, regional and local level.

Led by Professor Chris Greenwell, the symposium was attended by 30 people from across regional community groups and sought to share best practice and identify the challenges and successes of community engagement activities. We were delighted to welcome academic speakers from Cardiff, Leeds and Sheffield University, as well as Mark Dowdall, Environment and Community Director for Banks Group and Roberta Blackman-Woods MP for Durham City and Shadow Planning Minister. A lively question and answer session involved all of the panellists and acknowledged weaknesses in the current planning system as well as the need for a national energy strategy. The event concluded with an afternoon workshop session looking at the areas of trust and ownership in community engagement.

// ASSET MANAGEMENT AND RISK WORKSHOP

The Asset Management workshop was hosted jointly by DEI and Durham's Institute of Hazard Risk and Resilience in November. The purpose of the workshop was to facilitate learning and research between organisations to support more effective risk management of assets by discussing different approaches used by a range of businesses and organisations. Asset management involves systematic and coordinated activities and practices which enable organisations to optimally and sustainably manage their assets, their associated performance, risks and expenditures over their life cycles for the purpose of achieving their organisational strategic plan. Assets include both tangible assets such as buildings, but also intangible assets such as human capital and intellectual property, which all contribute to the organisational strategic plan. The event explored the key challenges faced in asset management and aimed to identify promising innovations from different sectors for participants to learn from and build on. The event was well attended and included presentations from Northumbria Water, Northern Power Grid, Electricity North West, Arup and DONG Energy.

// MODELLING USE IN UK ENERGY POLICY

In January 2016 a workshop was held to explore the role that quantitative modelling has had in UK energy policy. It explored how modelling has been used to support UK energy policy, how these models are interpreted by policy decision makers and their support teams, and the implications of these processes and structures for energy policy. Ultimately the workshop will explore whether there are opportunities for modelling and science be used more robustly in the policy process.

We were lucky to have an excellent range of expert speakers for the day with experience at each level of the modelling to policy transfer process:

- High level decision making in energy policy - Paddy Teahon (Energy Strategy Implementation Consultant at University College Dublin, previously Department of the Taoiseach, Irish Civil Service and Honorary President of the Irish Wind Energy Association)
- Use of technical modelling in the Electricity Market Reform and UK Energy Scenarios -Duncan Rimmer (Demand & Generation Forecasting Manager, National Grid)
- Interpretation of modelling results for policy and decision-making - Professor Jim Skea (Chair in Sustainable Energy, Centre for Environmental Policy at Imperial College Research and RCUK Energy Strategy Fellow, formerly Research Director UKERC).

Discussion on the day focused on how non-scientists taking decisions based on modelling or scientific insights interpret the modelling results; what models can tell us about the 'real world'; what do policy makers think that modelling or science can and cannot tell them; whether the messages people in one group think they are sending the same as those being received. Finally the workshop aimed to identify the mechanisms and processes which could be put in place to ensure modelling is used more robustly in the policy process.

A final report and key findings from the event will be available shortly.

This workshop kicked off the **Science and modelling in public and commercial policy** series of events, seminars and research discussions which will explore questions related to how modelling and scientific evidence is used in policy making. The programme forms part of the **Institute of Advanced Study theme for 2015/2016 on Evidence.**

The series is organised by Durham Energy Institute in collaboration with **Global Policy Institute (GPI), Centre for Humanities Engaging Science and Society (CHESS), School of Engineering and Computer Sciences, Mathematical Sciences, and Institute of Advanced Study.**

WHAT TO DO WITH CO_2?

A team of staff and students joined the 'GeoBus' from St Andrews University for the launch event of their new educational outreach project "What To Do With CO_2?". The team spent the day at Wolsingham School, working with over one hundred Year 9 learners to investigate the science behind Carbon Capture and Storage (CCS).

With the assistance of staff from St Andrews and Durham University, the students spent the morning training in the various earth science and engineering roles needed to store carbon dioxide. In the afternoon the teams went head-to-head to identify the most appropriate site to store CO_2 and to design and construct the most effective geological trap for storing CO_2. The CO_2 reservoir systems were tested to determine the volume of CO_2 stored and the capacity of their seal. The day ended with an opportunity for students to talk to the staff about the various career opportunities in science and engineering.

The Durham team was led by Dr Paula Martin and included Edward Dempsey, Mark Brodie, Oliver Sanford and Izabela Walczak.

Durham University and DEI engage in a range of outreach activities to schools and community groups.

If you would be interested in arranging an event please contact dei.admin@durham.ac.uk

INTERNATIONAL SUMMER SCHOOL "ENERGY TRANSITIONS IN CONTEMPORARY AND EMERGING SOCIETIES

Report by Mustafa Hasanov a visitor from the University of Groningen on the SELFCITY project blog selfcity-project.com

The summer school was a short, engaging and interesting course, which raised some critical issues addressing the interconnection between energy and society. The two week program provided an in-depth overview of the interconnections between energy and society, focusing on critical social perspectives on issues of energy transition and energy governance in contemporary and emerging societies. The program included seminar and workshop sessions, guest lectures with multi-disciplinary character, film screenings, various fieldtrips and site visits. Some of the main themes of the summer school were:

- Everyday practices (uses, users and understandings of energy)
- Governance and politics (who, how and at what scale?)
- Behaviour change (who, how and at what scale?)
- Materiality/ 'stuff' of energy (e.g., energy and transport infrastructures/systems of provision)
- Development (where, who by and in what way?)
- Low and high carbon lifestyles and transitions

One of the main findings from the summer school was addressing the issues of context, needs and everyday practices of energy transition. Long discussions (sometimes very passionate) and debates took place around the notion of transition. The main dilemma was "transition towards what?" While in the context of the North we talk about achieving targets of low carbon emissions, shift from unsustainable towards more sustainable energy sources and going off-grid the main supply network, in the global South the narrative on energy transition transcends the topic of sustainability. It touches upon discourses such as supplying the population with basic needs and services. In societies where electrification is a luxury, energy transition means providing electricity to households by both grid and off-grid methods. Naturally, this also affects the practice of energy transition.

From a societal perspective, in contemporary societies energy transitions takes the form of societal response in going fossil-free and implementing medium to large scale energy initiates, like solar rooftops and wind parks on almost industrial. Take for example the local energy initiatives gaining popularity in the Anglo-Saxon world within the last years. Currently, only in the Netherlands there are about 200 local energy initiatives or cooperatives, in Germany their number goes dramatically to more than 650 by the end of 2014. Such community projects include PV rooftops, biomass-based heating, small collectively own wind turbines, small scale geothermal energy and heat generators.

In emerging societies, however, the focus is on providing electricity to as many households as possible, for example by means of individual solar panels (and still that energy will be enough to support only an energy-saving lightbulb and a black-and-white TV). Another important aspect of energy transition in the developing world relates to the cultural importance of having access to electricity and light in general. Of course there are exceptional cases, such as the most recent Indian government decision to reach 100GW solar capacity by 2020, which target mass usage application, but those remain as blunt ambitions rather than realistic goals.

The summer school program was closed by a presentation from each participant. I presented some preliminary findings of my fieldwork in combination with insights I gained during the summer school.

The presentation is available online at the following link www.slideshare.net/mufty87/p-owerpoint-duss.

DEI plans another summer school this year, with a new programme of seminars and events. Register your interest at www.durham.ac.uk/international/summerschool/

We also hold intensive teaching weeks twice a year which are open to external participants focused on 'Energy Contexts and Challenges' and 'Energy Society and Practices'.

If you would like to receive details about any of these courses please contact dei.admin@durham.ac.uk or go to www.durham.ac.uk/dei/training

DONG ENERGY AND DURHAM AGREE TO FURTHER DEVELOP RESEARCH AND ENGAGEMENT COLLABORATIONS

One of DEIs key strategic industry partners is DONG Energy, and November 2015 saw the signing of a Memorandum of Understanding (MoU) between DONG Energy and Durham University to further joint aims in high-quality research, knowledge exchange and teaching. This is one of only two strategic partnerships held by DONG Energy.

The signing of a MoU celebrated past successes and demonstrates the desire of both organisations to continue to strengthen their relationship moving forward. This has built up during the last few years through a number of successful collaborative projects, which have already delivered significant benefits. This includes funding for two Professorial Chairs in 'Renewable Energy' and in 'Carbon Capture and Storage and Geo-Energy'; significant research collaborations; DONG Energy studentships and PhD funding within the departments of Anthropology, Engineering and Computing Sciences, and Earth Sciences. DONG Energy has benefited from the close partnership with Durham University and its Durham Energy Institute (DEI) not only through access to its research expertise but also by engagement in DEI's wide network of stakeholders and programme of events. Recently this has included two co-hosted public debates on the Future of Energy: 'Will the Lights Really Go Out?' and 'Which way should the wind blow for our national grid?'.

The MoU recognises the importance of the strategic relationship and will enable ongoing, broad engagement between the University and DONG Energy. Both organisations have a strong commitment to excellence and innovation in all aspects of research, education, technology development and the transfer of knowledge.

Particular areas of mutual research interest include:

- Optimising offshore wind operations and maintenance to reduce the cost of energy and to increase availability;
- Smart Grids development to ensure that renewable energy can be integrated into the power system for the benefit of consumers, society and the environment;
- Enhancing Oil & Gas Recovery through developing new technologies to enhance the rate of recovery in the existing oil and gas fields and to identify new reserves;
- Research into overpressure in sedimentary basins; and
- Research undertaken by the Volcanic Margins
- Research Consortium (VMRC), which provides the petroleum industry with training and research expertise in volcanology, sedimentology and structural geology of volcanic margins.

Headquartered in Denmark, DONG Energy is a leading energy industry group in Northern Europe. The Company is the market leader in offshore wind and has built more offshore wind farms than any other company in the world to date. Exploration and production of oil and gas is another major area of the Company's operations, with a portfolio of fields throughout the UK, Norway and Denmark. DONG Energy is also one of the largest suppliers of gas to industrial and commercial customers in the UK with a growing portfolio of electricity products and services on offer.

DONG Energy has been investing in the UK since 2004 and has committed investments of around £6 billion to date. They are the largest offshore wind developer in UK waters and have been a leader in developing the frontier West of Shetland oil and gas region for over 10 years.

Durham University alumnus Brent Cheshire is UK Country Chairman of DONG Energy, and spearheaded the development DONG Energy's interests in the UK. He has had strong links with Durham Energy Institute and helped shape its development through his role in the DEI Development Board. His links to Durham University were recognised in 2012 when Brent was awarded an honorary Doctor of Science by the University. Benj Sykes, Head of Asset Management in DONG Energy's Wind business has also been an active member of the DEI Advisory Board for several years.

Brent Cheshire said:
"The Durham Energy Institute is one of the UK's leading research institutes and our strategic partnership has already proved its worth as DONG Energy works to develop and deploy cutting edge technologies and techniques in the energy field.

"The signing of the MOU will further strengthen our links with the University and help ensure we remain at the forefront of developing the technologies we need to bring down the costs of low-carbon energy, maintain security of supply and give UK consumers the best value possible."

Durham University's Pro-Vice-Chancellor for Science, Professor Patrick Hussey said:
"At Durham University we take pride in conducting excellent research and research-led teaching. Our relationship with DONG Energy demonstrates that mutually beneficial strategic partnerships kick-start exciting research initiatives with real world applications, facilitate high-profile policy debates on issues of concern to the public and open up a wealth of development opportunities for our students and staff. In DONG Energy we have found a partner who shares our aspiration for excellence, our appetite for engagement at the intersection of science and society and whose knowledge and experience builds on our world-class research strengths to achieve economic and societal impact."

Professor Simon Hogg, DONG Energy Chair in Renewable Energy and Director of Durham Energy Institute, said:
"We are delighted that the strong relationship that has been developed over the years between DONG Energy and the Durham Energy Institute is being further recognised through this agreement with Durham University. DONG Energy has contributed to Durham's teaching excellence by supporting our seminar programmes, giving guest lectures on courses, collaboration with student projects and providing internship opportunities within DONG offices. Our students and staff have also undertaken a number of research projects in collaboration with the Company and have organised several joint events aimed at exploring key energy challenges and engaging the wider public in debates around energy. Durham Energy Institute encourages strong partnerships between our academics and Industry as this is the best way to ensure our research and teaching is innovative, relevant, and effective. I look forward to building on this fruitful relationship and identifying future opportunities for mutual support as we move forward together."

FUEL CELLS GET COOL

www.ill.eu

// SOLID-OXIDE FUEL CELLS ARE CLEAN AND ENERGY EFFICIENT, BUT THE ZIRCONIUM OXIDE CURRENTLY USED REQUIRES HIGH OPERATING TEMPERATURES; NEW VERSIONS OF BISMUTH OXIDE MATERIALS COULD BRING THOSE TEMPERATURES DOWN

The work featured in this highlight article involved a number of Durham Chemistry undergraduates, PhD students and postdoctoral research associates. James Farrell and Jim Madge carried out part of the computational work as summer undergraduate research students. Both went on to do PhDs, James at Cambridge and Jim at Durham. Julia Payne was a PhD student and Xiaojun Kuang a PDRA with Ivana Evans, and their work involved both computational and experimental aspects of research into oxide ion conductors. Julia is now a postdoctoral research associate at St. Andrew's and Xiaojun has moved to an independent academic position at the Guilin University of Technology in China.

Mark Johnson johnson@ill.eu

The key materials component of solid-oxide fuel cells (SOFCs) is the solid-oxide electrolyte membrane. As in other fuel cells, fuel (for example, hydrogen) is supplied at the anode and oxygen at the cathode. In SOFCs, negative oxide ions that form at the cathode flow through the solid electrolyte membrane towards the anode, where they react with hydrogen to form water, generating a current around an external circuit.

SOFCs are one of the most efficient methods of generating energy (up to 85 per cent efficiency, compared with only 30 to 40 per cent for conventional power plants). In addition, they minimise emissions from pollutants such as carbon monoxide, nitrogen and sulfur oxides, and can utilise a wide range of fuels – including natural gas, petroleum, coal, biofuels, and hydrogen generated from renewable sources.

A crucial property of the electrolyte membrane is that it must be impermeable to fuel and oxygen gases under operating conditions, but permeable to oxide ions. Almost all practical SOFCs still use zirconium oxide stabilised by yttrium oxide (Zr1-xYxO2-x /2, or YSZ), first demonstrated to meet these criteria in the 1930s. However, to conduct effectively, YSZ requires temperatures of at least 750 ºC, so SOFCs based on it need a large power input, suffer from mechanical degradation during thermal cycling and require the use of materials that are stable at high temperatures.

STABILITY VERSUS MOBILITY

One way to reconcile the competing requirements of overall chemical (thermal) stability and the necessary chemical flexibility for conduction is to use oxides with much more complex structures than YSZ. Their crystal structures have regions with well-ordered arrangements of ions that act as 'scaffolds' for wide, continuous channels with more irregular arrangements that allow oxide ions to pass through.

An important class of materials in this context is derived from the high-temperature form of bismuth oxide, -Bi203. This is the best solid-oxide ionic conductor known. A quarter of the oxygen sites in the crystal are empty, and these vacancies are randomly spread throughout the structure, so allowing oxide ions to hop across the membrane. Pure -Bi203 has never been seriously considered for practical applications because of its limited thermal stability. However, its useful characteristics can largely be preserved down to room temperature by introducing smaller heavy-metal ions into the structure. The resulting stabilised - Bi2O-type phases have genuine technological potential and have been extensively investigated since the 1970s.

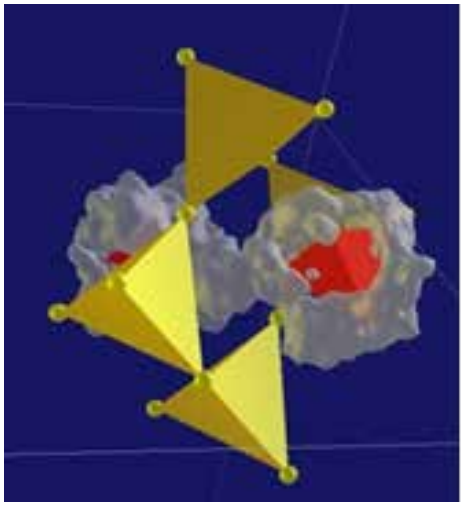
We recently explored the most effective of these phases, known as Type II, which shows the highest conductivities across the widest ranges of chemical and thermal stability. Type-II phases were poorly understood because their structures (p23) had never been fully analysed, due primarily to a lack of adequate data. We overcame this to achieve the most complete determination ever of a '3+3' dimensional incommensurately-modulated structure, by collecting neutron diffraction data from a large crystal of bismuth niobium oxide (Bi203–xNb205) in the Type-II region. The result (right) revealed strings of ordered, niobium-rich regions separating continuous, disordered, oxygen-deficient channels, which are the basis of the very high conductivity.

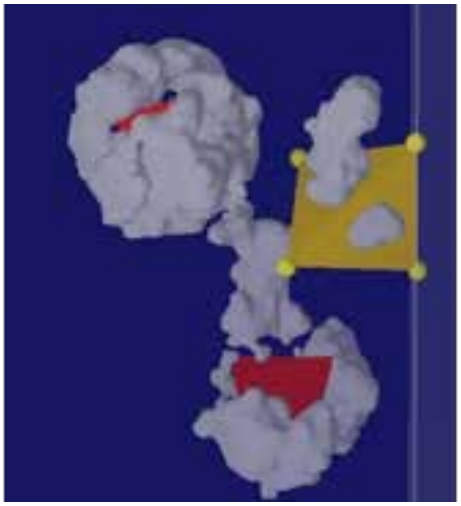
In parallel, we investigated a molybdenum-containing oxide superstructure (Bi26Mo10O69), using a combination of inelastic neutron scattering and molecular dynamics calculations (p23). Our results suggest a new explanation for its high oxide-ionic conduction. They showed that some of the molybdenum ions could bond flexibly with extra oxygen to form different structural building blocks, which allowed the oxygen ions to travel through the crystal lattice. We also observed this behaviour with other metal ions that behave similarly, such as rhenium (Re7+) and vanadium (V5+). We are now carrying out further studies on similar structures and over various length-and time-scales.

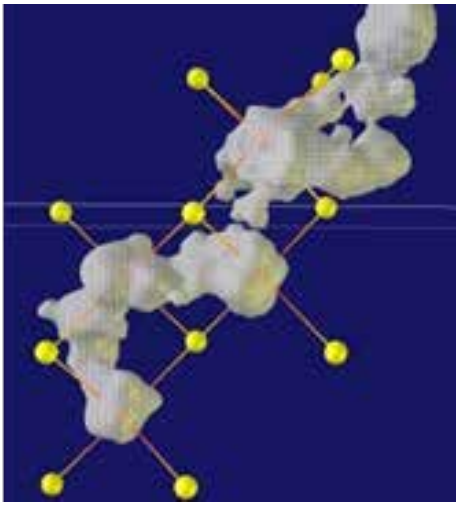
RESEARCH TEAM: Ivana Evans (Durham University, UK), Chris Ling (University of Sydney, Australia) and Mark Johnson (ILL)

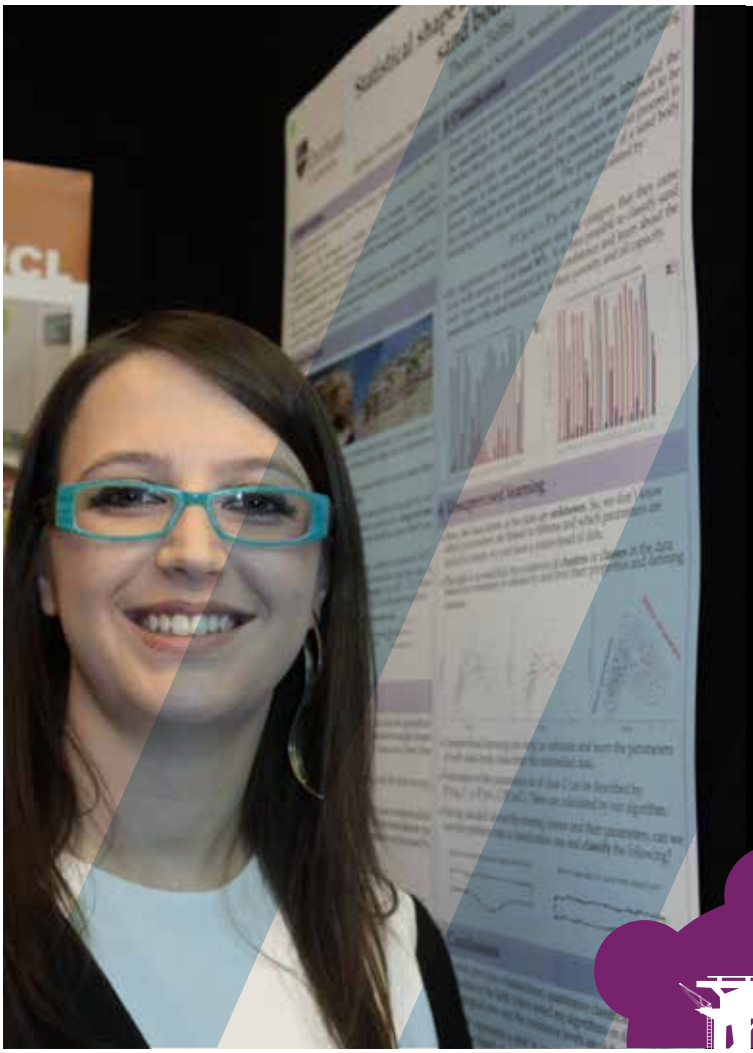
ILL INSTRUMENT USED: Single crystal diffractometer D19, and time-of-flight spectrometers IN4 and IN5

Contact: Dr Ivana Evans, Chemistry Department, Durham University









STATISTICS AND THE HUNT FOR OIL: MATHEMATICAL SHAPE ANALYSIS OF GEOLOGICAL FORMATIONS

THOMAI TSIFTSI

Thomai Tsiftsi has completed her PhD in the Department of Mathematical Sciences at Durham University and graduated in January 2016. She was one of 30 mathematicians across the country to be invited to present their work to both Houses of the Parliament in March 2015. She is now a temporary lecturer in Bath and is building on her PhD research by applying the model she developed in Durham to medical data related to the diagnosis of arthritis.

Searching for energy sources is still a major global preoccupation. Researchers are focusing on ways of finding oil and other substitutes by trying to evolve the methods used in its detection. To date this searching has been done using so-called seismic data which are hard to collect and cumbersome to deal with. For this reason, research has recently turned towards the development of more efficient and economic techniques to advance the hunt for oil. Geologists have suggested that research should be concentrated on particular sand formations called sand bodies which have therefore become of great significance to both geology and the petroleum industry.

My work addresses this area of research by providing an innovative classification technique based on rigorous statistical analysis to determine the likelihood that sand bodies in the field contain oil, or indicate its presence in neighbouring rock formations.

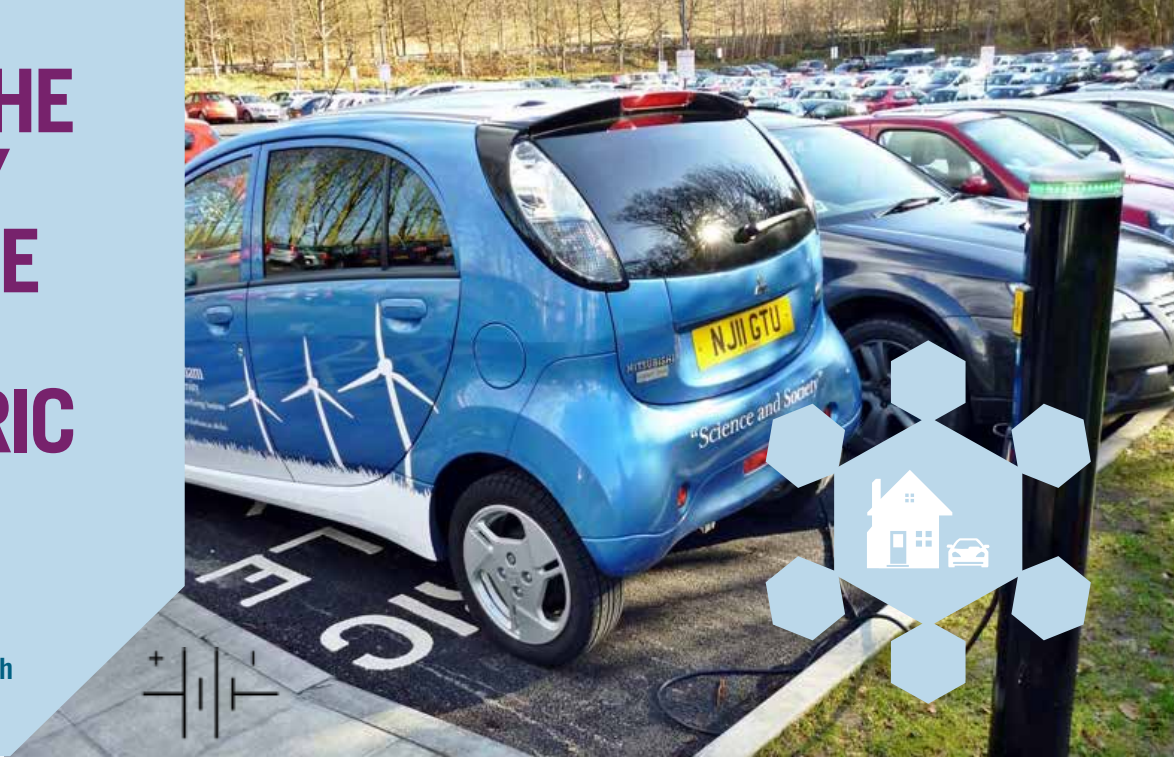
Sand bodies are the geological remnants of rivers that existed in the past; they are the best known sedimentary rocks and as the name implies, they are composed of sand. Sand bodies are important because their sandy nature makes them very porous which in turn makes them the best oil and hydrocarbon reservoirs. The more porous they are the more oil they bear. They may also be the site of heavy minerals such as copper or uranium. Determination of a sand body's type requires knowledge of its shape and its internal characteristics as this will determine their oil–bearing capacity and their porosity. Identifying their nature and class is therefore very important. This is where mathematics comes in and this is where my project has the biggest impact.

Sand bodies are divided into two classes: ribbons and sheets. Geologists use quite simplistic methods to decide on the class of a particular sand body. In particular, they use an ad hoc width-to-thickness ratio to estimate its class. My work replaces this with an algorithm which models the geometrical formation of sand bodies via deformations of idealized example shapes. This represents a shift in paradigm which will determine the sand body class based on physical and geometrical reasoning and hence determine its porosity and its oil content.

Statistical shape analysis and classification is used to analyse the objects of interest in order to understand the variability in their shape. So how can one automate this procedure? How can one decide whether the shapes that one was given came from a particular class? The aim of my project is to tackle the problem of developing appropriate statistical shape modelling tools for sand bodies. For the past three years, I have developed appropriate algorithms that can recognize shapes and the category that they came from with accuracy of at least 80%. With my techniques it is possible to classify sand body types with an associated level of confidence and to learn about the properties of sand bodies such as their porosity and their oil bearing capacity. My techniques provide a standardized, quantitative, classification scheme for application in the field. I have tested the algorithms developed on data sets beyond the geological ones and the confidence levels are of the same scale. This work is promising and can have many applications in sciences beyond identifying oil sources, such as medicine and medical image analysis. My next step will be to extend the work to surfaces and three dimensional data. As my own approach develops I also intend to test its efficiency in an industrial setting which I hope will lead to a closer collaboration between industry and academia.

It was an honour to be invited to the Houses of Parliament, to present my research and have the opportunity to represent the University of Durham, and department of Mathematical Sciences. Presenting my poster and sharing my knowledge helped me to develop my presentation techniques and ability to explain complicated ideas in an accessible way. I think such events are a crucial part of academic research, so that our work can have a long-lasting influence and can be brought to the attention of the government, industry and members of the public.

WHAT'S THE BEST WAY TO CHARGE MILLIONS OF ELECTRIC VEHICLES AT ONCE?



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The continual increase in sales of Electric Vehicles (EV) across the globe raises the question of how millions of EVs may be charged at once on grids that were not originally intended to supply such large amounts of power.

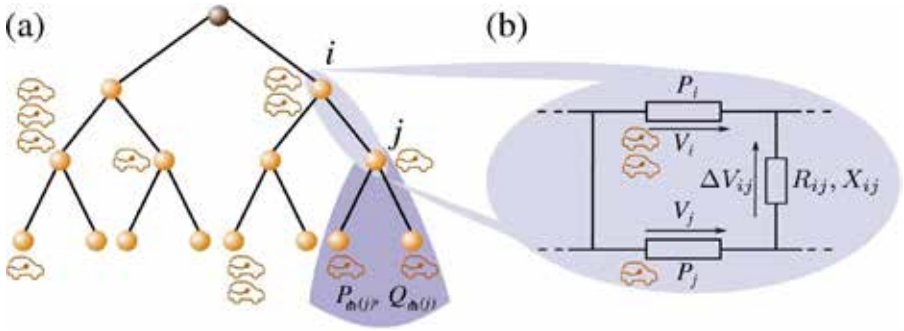
The main problem, as researchers Rui Carvalho and co-authors from the UK and Slovakia explain in a recent paper published in the New Journal of Physics, is congestion—not road traffic congestion, but charging traffic congestion. In their paper, they show that when the number of EVs being plugged into the network reaches a critical point, the system undergoes a phase transition from a "freeflow" state (where all vehicles can be fully charged within the expected time period, say 4 hours) to a congested state. In the congested state, some vehicles have to wait for increasingly long times to fully charge, resulting in queues of vehicles rapidly building up that will then face even longer charging times.

"With high penetration of electric vehicles, charging at home will increase the stress on the 'last mile' of local distribution networks," Carvalho, a researcher at Durham University in the UK, told Phys.org. "The conventional solution would be to lay copper under the road, so as to increase network capacity. The cost of upgrading the last mile of the network, however, would be prohibitive, and we present an alternative, much cheaper approach that could be implemented with minimal hardware requirements: a software layer and controllers at the point of charge."

As the researchers explain, the congestion problem can be avoided, at least to an extent, by managing how the power is allocated throughout the charging network. A good management strategy can increase the critical number of vehicles that pushes the system over the threshold into its congested state, thereby allowing more vehicles to be charged in their normal charge time.

Distributing charge quickly and fairly

In their paper, the researchers compared two charging strategies ("max-flow" and "proportional fairness") with the aim to guide network designers in deciding which algorithms to implement in the real world. Both algorithms investigated here rely on recent advances that combine tools from optimization and critical phenomena. As vehicles randomly plug in to the network, the network must continually solve the congestion control problem and allocate each vehicle an instantaneous power



using the algorithm. The researchers compared the outcomes of both algorithms using simulations that are only possible due to techniques developed since 2012.

As the researchers explained, a good algorithm will have two features: it charges more vehicles at once, and it does so fairly, meaning all vehicles' charging times are roughly equal. As an example of unfairness, the "max-flow" algorithm charges vehicles closer to the main power source faster than those further away, which the researchers expect will not be socially acceptable. Fairness can be quantified by the Gini coefficient, which is traditionally used to measure income inequality. For comparison, the researchers note that Sweden has a Gini of 0.26, the US has a Gini of 0.41, and the Seychelles has the highest Gini of 0.66. The researchers explain that these values might provide a useful benchmark for identifying socially acceptable values for EV charging algorithms.

"The proportional fairness algorithm reaches a maximum Gini of 0.45, which is comparable with the level of inequality in the US society, and thus may be judged sociable acceptable," they write. "The max-flow algorithm, however, reaches a Gini of 0.91, which measures a level of inequality considerably higher than present in any contemporary society."

Fairness beats greed

The proportional fairness algorithm not only scores better on fairness, but it also allows more vehicles to be charged compared to the max-flow algorithm before reaching the critical threshold. The researchers say that they were surprised by the superiority of the proportional fairness algorithm, since the max-flow algorithm maximizes the total instantaneous power, which would seem to lead to a maximization of the number of charged vehicles, but this is not the case. The researchers explain that the downfall of the max-flow algorithm is its "greediness"—its focus on total instantaneous power makes it sub-optimal compared to proportional fairness, which instead focuses on a fair allocation of instantaneous power, and as a result achieves a higher optimum.

"Intuitively, network designers and operators might be led to the conclusion that there will be a price to pay for being fair to users on these local distribution networks, and disregard fair allocations," Carvalho said. "We show that it is possible to 'have your cake and eat it' in the free-flow state: network operators can charge a higher number of vehicles with fair algorithms than with the greedy max-flow, before the system is congested."

Overall, the analysis shows that the most obvious choice isn't always the best, and that careful examination of different algorithms before they're implemented could provide large cost and time savings down the road.

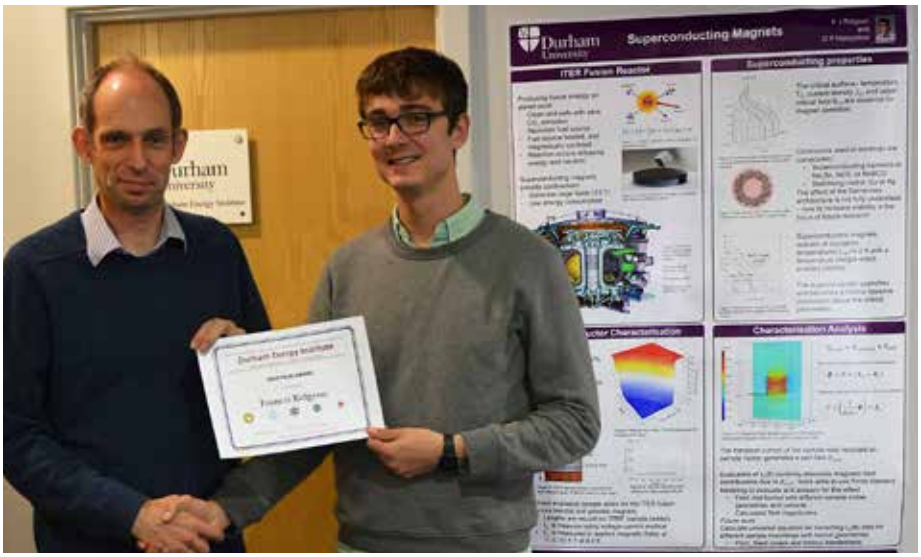
// **More information: Rui Carvalho, et al. "Critical behavior in charging of electric vehicles."**

New Journal of Physics. DOI: 10.1088/13672630/17/9/09500. Rui Carvalho is lecturer in the School of Engineering and Computing Sciences.

SUPERCONDUCTING MAGNETS

By Francis Ridgeon

Francis Ridgeon is a Postgraduate Student in the Department of Physics, a Member of the Centre for Materials Physics and of Durham's Centre for Doctoral Training in Energy. He won the poster prize at DEI's inaugural Research Symposium in September and joined the DEI team at the British Science Festival in Bradford. Here he tells us about his research and its implications.



Francis receives his poster prize from DEI Director

My research involves the visualisation of the magnetic fields around superconductors using finite element analysis (FEA) modelling with the aim of bettering our understanding of superconductor technology for optimising magnet design.

The field of superconductivity technology is well developed with some very specialist applications, from the more everyday (MRI scanners) to the possible future of energy production (Fusion reactors). Superconductors are an integral part of particle accelerators like the Hadron Collider in CERN, Switzerland.

Superconductors carry huge currents in very small wires, which enable large magnetic fields to be generated. Increasing the capacity of the conductor drives the increase in the size of the magnetic field that can be generated. The current densities achieved in superconducting materials are of the order of one thousand times that of normal copper wire. Improving conductor technology further through reducing the volume of superconductor or increasing the capacity required, will reduce costs and overall system inductance whilst maintaining the same magnetic field properties.

Superconducting materials such as Niobium Titanium (NbTi) and Niobium Tin (Nb3Sn) have been used commercially since the late 1960's. These materials operate at very low liquid helium temperatures (-269®C) and their behaviour is known to vary with temperature, current and magnetic field.

A great deal of research work has already been undertaken on reducing the diameter of Superconducting filaments whilst maintaining their current carrying capacity. It has been found that these superconducting properties increase further when the filaments are twisted. However, because these magnets are sensitive to thermal, mechanical or electrical fluctuations they are also inherently unstable which can result in the system operating in a non-superconducting state. If the superconductor becomes 'normal' its resistance causes the dissipation of energy in an undesirable way, producing heat, causing the system to 'quench'. As these systems operate at cryogenic temperatures, the removal of this heat presents many difficulties. Cooling down the system in a factory, or in the lab, involves large volumes of expensive liquid helium and technical knowhow, so stability is a major issue. Combining these twisted filaments with a non-superconducting material, such as copper, has enabled the production of stable superconducting magnets.

Superconductor research to date has resulted in the development of superconducting plasma confinement magnets being used in fusion reactors that have peak fields of 14Tesla. To contextualise this, fridge magnets are 5mT (0.005 T) and the Earth's magnetic field is 25-65 micro T(0.0000025). Researchers are endeavouring to increase these fields yet further, within the confines of maintaining a stable system.

Durham University's superconductivity group houses the European Fusion Energy References Laboratory (ERL). This lab characterise the materials to be used manufacturing the plasma confinement magnets in the International Experimental Fusion Reactor (ITER) currently being built in the south of France.

Working within this Laboratory, Durham's superconductor research group are currently in the process of designing several "barrels", which characterise the materials to be used manufacturing the plasma confinement magnets. The work of the ERL is characterisation of the following aspects: cryogenic; critical current, and the hysteretic losses, and room temperature; twist pitch diameter and the copper to non-copper ratio. The critical current of the sample NbTi or Nb3Sn is measured at cryogenic temperatures in applied fields of 12-13 T. The sample of wire is wound on to a sample holder barrel with a helical groove. The standardised sample holder has fixed diameter, helical pitch. The variance in measured superconducting properties was up to 30% prior to the defining of a standardised sample holder.

The variances in characteristic properties due to the sample holder shows that the winding geometry has a large effect on the measured properties of the same materials. Two effects that could explain this variance in the measured values are the effect due to the heat generated in measurement and the magnetic field generated by the current being applied to test the wire. Two effects that could explain this variance in the measured values are the effect due to the heat generated in measurement and the magnetic field generated by the current being applied to test the wire.

To understand how to quantify the effect of sample measurement geometry it is necessary to computationally model the experimental setup. My approach to this problem has been to develop a FEA model which separates the modelling domain into 'elements' over which partial differential equations are solved. Using this model we are able to understand the field distribution inside a superconducting wire, and evaluate the magnetic field experienced inside the wire during the experiment.

We will continue to explore the impact of these variances and to devise correction factors which may enable the further development of superconducting magnets which require less liquid helium cooling, without any greater vulnerability to quenching or instability.

To see Francis' winning poster go to www.durham.ac.uk/dei/events/past.events

WORK EXPERIENCE – *NEVER BE TOO SHY TO ASK!*

Employability and career opportunities are high on the agenda of most Durham undergraduates. Below we highlight how one of our undergraduates took the initiative to develop his experience, beginning with a simple conversation in a gym in Newcastle.

Chris Elliot is a third year Physical Geography Undergraduate, who was keen to undertake an internship during his summer break to build on his work experience and add valuable skills to his CV.

Chris first met DEI Advisory Board Chairman, Professor Alan Lowdon, through his part-time work at David Lloyd gym in Newcastle. On hearing that Chris was studying at Durham, Alan took a keen interest in supporting his aspiration to gain some useful and interesting intern experience.

Professor Lowdon, himself a Durham graduate, has spent many years working in the north-east and abroad in the water and energy sectors and now provides advice to others on starting up their own companies. He has worked closely with DEI to bring together external organisations and funding to kick-start innovation projects and research investment in the North-East. Alan proved to be the perfect contact when seeking work experience. He was delighted to be able to introduce Chris to his contacts in the Gibraltar Water Distribution Company, AquaGiB (http://www.aquagib.gi/), with whom he had previously worked in a role with Northumbria Water. Chris was soon on a flight to Gibraltar for a 10 week internship.

Chris's initial role was to review the capacity of the existing water supply network and to model the system using replacement pipework, ensuring that the pressure at the joints did not exceed the recommended design specification. Chris used the software package, EPANet, with which he was initially unfamiliar, however, his experience of modelling packages used during his studies and extensive reading of the software manual as well as asking questions of staff soon resulted in his becoming very competent in its use.

Within weeks he had constructed the required model and was able to validate this against observed flows, demonstrating 95% accuracy. This was sufficient to provide confidence that the proposed new network would be able to supply the needs of its customers. The Client was delighted with his progress and asked him to undertake a further analysis of an extension to the network – which Chris was also able to deliver within his intern period.

Chris was able to hand over the new model at the end of his internship to AquaGiB, who were so pleased with his work that they offered to pay all of his accommodation and expenses and have subsequently offered him a graduate position. A great result from a chance conversation in the gym!

Chris said *" Alan has become a great mentor, and has provided me with invaluable insights into the industries I'm interested in, and really helped me narrow down choices of companies to apply to. I certainly wouldn't be in the position I am now with applications etc without his support. A solid connection / network is invaluable in career progression and undergraduate level is a great time to pursue and foster this."*

Alan said: *"It shows the advantage of networking in more ways than one! Chris is a very determined and able person and, as I said to him at the start, I'll help anyone who is prepared to help themself. In this case, I knew that Chris's knowledge of spatially distributed assets, GIS systems and fluvial systems would hold him in great stead and bring something different to the AquaGib team. I was able to convince the MD (and friend), Derek Cano, of Chris's suitability as a key pair of hands to deliver this project. Without Chris, the project wouldn't have gone ahead, not yet, anyway. It was a huge win-win for both parties; for me too as I had a couple of trips to Gibraltar myself! I am very proud of Chris's achievements and it was a pleasure being able to give a fellow Dunelmian a career boost. However, it was Chris who grasped the opportunity with two hands! The moral in all of this is: Don't be shy to ask!"*

This article has been included within the DEI Review as an example of what can be achieved through initiative and the use of contacts that exist within the University network. Adding valuable work experience to your CV will catch the eye of graduate employers and an internship is an ideal way of finding out what career path you may or may not wish to pursue following graduation.

Durham University also have a Careers and Employability Service providing support for students, graduates and employers www.durham.ac.uk/careers/ to achieve excellence in employability.

NEW STUDENT ENERGY SOCIETY @ DURHAM!

In June 2015, eight Durham University students, sponsored by the DEI, travelled across the globe to attend the International Student Energy Summit (ISES). Student Energy is a non-profit organisation whose goal is to educate, unite and inspire students to transition the world to a sustainable future. The summit was attended by eight hundred students from over one hundred countries. It was a life changing experience for all of us. Speakers at the summit included Ms. Sri Mulyani, Managing Director and Chief Operating Officer of the World Bank, Mr. Suleiman Jasir Al-Herbish, Director-General and Chief Executive Officer of the OPEC Fund for International Development and Ms. Noeleen Heyzer, Former Under-Secretary-General of the United Nations. This impressive list continued for another two pages.

The summit was held on the spectacular island of Bali, Indonesia, and was organised, almost entirely, by a cohort of students from Bandung Institute of Technology, West Java. The collaboration of students at the summit from such a diverse set of backgrounds led to an exceptionally engaging and interesting four days. The summit provided us all with an immense sense of hope for the future. As a generation, we are going to be trying to solve one of the toughest challenges ever attempted by mankind. Climate change is having a devastating impact on the lives of many, yet no elegant solution is on the near horizon. In fact, it is likely that there is not going to be one solution to this giant problem. As a generation we are going to have to inspect climate change in its entirety and, as a species, we are going to have to adapt in order to survive. But in order to adapt, we are going to have to develop our understanding of the problem. Education is, and always will be, the key.

Our experiences at ISES inspired us to setup a new society at Durham. Durham Student Energy (DSE) is a student-led society striving to raise awareness and educate students in the complex world that is energy. We provide an environment for enthusiastic students to develop their knowledge, question their understanding and learn about a whole host of topics. The society aims to spark debate amongst students, whilst providing professional and informed personnel to contribute. We provide students with talks, debates and innovation sessions as platforms to develop understanding in different areas of the industry. DSE is the first 'Chapter' of Student Energy in the UK, a pilot program looking to expand their influence around the world. DSE also works in conjunction with the DEI in order to promote its events, talks and bursaries to undergraduate students.

The society gained over two-hundred followers from the university's Freshers' Fair and has an active Facebook page. The committee are organised by their own areas of interest, making their roles informative and more enjoyable. This also ensures that a balance is maintained between the events and posts that go up on our page, in order to appeal to a wide variety of students, and not just those from a STEM background.

Our first event, "Fracking and its Future in the UK", taking place on the 16th February, has had an overwhelming response. The panelists for the talk include Nick Grealy of No Hot Air, John Dewar, Director of Third-Energy UK Gas LTD, and Andy Aplin, Professor of Unconventional Petroleum at Durham University. At ISES we were fortunate enough to build some strong relationships with other universities, including NUI Galway, the University of Nigeria and TU Delft, and industry professionals who we hope to incorporate into our future events.

If you would like to find out more about DSE or are interested in engaging with students who are interested in energy, please don't hesitate to get in touch at durham@studentenergy.org

// DEI PUBLICATIONS

THE RISING POWERS AND THE LOW CARBON TRANSITION IN SUB-SAHARAN AFRICA

This DEI briefing summarises the key findings of from a major project exploring the roles that these 'rising powers' are playing in the transition to low carbon energy systems in Southern Africa. The project explored the power relationships at play in decision-making, policy structures and investment patterns in renewable energy development in Mozambique and South Africa.

The interdisciplinary research project, is funded by the Economic and Social Research Council (ESRC), and led by Professor Marcus Power of Durham University.

Fieldwork for the project was undertaken in Mozambique, South Africa, China, India and Brazil between 2012 and 2014 and involved a combination of 200 semi-structured interviews and community-based research methods. A database of information on 150 renewable energy projects was also collected. Relationships and patterns of associations between variables were explored such as the roles of rising power countries in projects, types of project and technology.

Findings from the project include:

- China, India and Brazil have a growing involvement in the provision of renewable energy technologies in Africa.
- However these 'Rising Powers' are driven by 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.
- Renewable Energy 'progress' has been inconsistent and socially/spatially variable.
- There are concerns in both countries as to who will benefit from the new investment.

The research project involves a team of academics from the universities of Durham (Department of Geography), Sussex (School of Global Studies and Science Policy Research Unit) and the University of Cape Town's Energy Research Unit. These institutions are working together with the UK-based NGO Practical Action and the Brazilian Centre for Strategic Studies and Management.

The project team have written a number of academic publications and social media articles exploring different findings and implications from the project.

// You can find these publications and learn more about the research by visiting http://community.durham.ac.uk/the.rising.powers/

// RESPONSES TO GOVERNMENT INQUIRIES

The DEI was invited to submit three responses to Energy and Climate Change Select committee inquiries over the past few months.

// These are available from www.durham.ac.uk/dei/partnerships/government/

- **Home energy efficiency and demand reduction inquiry (20 October)**
  DEI submitted two responses. Response from Prof Sandra Bell, Dr Janice Astbury, Dr Rebecca Ince, Prof Harriet Bulkeley, Prof Simon Marvin. Response from Tom Yarrow.
- **Investor confidence in the UK energy sector inquiry (26 October)**
  Response by Mahmud Imam, Professor Chris Greenwell, Dr Felicity Greenwell and Professor Tooraj Jamasb.
- **Low carbon network infrastructure inquiry (2 November 2015)**
  Response by Adwoa Asantewaa, Professor Tooraj Jamasb, Dr Hongjian Sun and Professor Simon Hogg.
- **DECC Consultation on ensuring regulation encourages innovation.**
  In February DEI responded to this consultation with contributions from Profs Tooraj Jamasb, Andy Aplin, Sandra Bell, and Jon Gluyas and Drs Charlotte Adams, Douglas Halliday, Hongjian Sun, Budhika Mendis and Manuel Llorca.

// IMECHE JOURNAL OF POWER AND ENERGY: SPECIAL ISSUE ON RENEWABLE ENERGY TECHNOLOGIES: NOVEMBER 2015; 229 (7)

This special issue highlights the excellent standing of Durham University Renewable Energy research in the UK with the Editorial and two papers written by Durham University Energy researchers.

Wind energy: UK experiences and offshore operational challenges: Crabtree, Zappala and Hogg. This paper discusses the development of wind energy in the UK, and explores some of the challenges faced in reliability, performance and condition monitoring. A particular focus is on offshore wind, where the UK now has the world's largest share of installed capacity. The offshore environment presents additional issues beyond those experienced in earlier onshore development. Learning from early experiences has been applied however the cost of energy from wind still remains too high for it to be commercially viable without subsidies. Operation and maintenance costs represent 30% of these costs but research at Durham is focusing on reducing these. However research into reliability and performance is hampered by the lack of availability of data for researchers outside wind developers and manufacturers.

Geothermal energy: The global opportunity: Adams, Auld, Gluyas and Hogg.
This paper reviews the history and present status of geothermal deployment and discusses the various types, temperatures and geological settings of available resources which can be used to provide heat, power or both. It then discusses improvements in deep drilling and energy conversion Technologies which mean that many countries could now develop geothermal energy systems. However there are economic and technical risks and challenges associated. The article summarises these advantages and disadvantages and compares them to other renewable sources.

IN CONVERSATION WITH...

// ALAN LOWDON, NEW CHAIR OF THE DEI ADVISORY BOARD AND VISITING PROFESSOR IN THE SCHOOL OF ENGINEERING AND COMPUTING SCIENCES AT DURHAM

We caught up with Alan to ask about his work, research loves and aspirations for the future.

What was your first memory?

It was sitting in the Cottage Hospital, Whickham, Gateshead getting my hands stitched having fallen onto milk bottles at the age of 5.

What did you want to be as a child?

Always fancied myself as a footballer but knew maths and science was more likely to be kind to me!

What or who has been your biggest influence to date?

My family has been huge for me - my mother and her brother-in-law, my (train-driving) Uncle Alan. My mother provided me with the domestic environment within which to flourish and my academic inspiration came from him. I now spend a lot of time on trains! More recently, my wife, Kathryn, has been a key influence as I have moved from corporate life to the world of start-ups and a blossoming portfolio career. Our kids, Charlotte (21) and James (18), have also been a huge motivational force!

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

I'd split it on rheumatoid arthritis research - the condition which badly affected my mother - and research into why teenagers these days have no concept of switching lights off around the house!!

What are the real myths around energy and climate change?

- That it doesn't exist.
- That it affects someone else.
- That we can't do anything about it.
- That Ant & Dec can make a material impact on it.

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

I'd love to work for the RSPB or be a California-based venture capitalist! Either or both could still happen!

What is your biggest regret?

It's not so much a regret but a 'I wonder what if' moment, as I was offered the chance to do my PhD at MIT but didn't want to pull out of my NEI/Rolls Royce BSc-PhD sponsorship, so I stayed loyal to the company that had supported and invested in me. I have absolutely no regrets but do enjoy going to Boston/Cambridge as often as I can, and have wandered around the MIT campus on a number of occasions wondering what it would have been like to be a postgraduate there! Who knows what the future might bring though?!

What would you say to undergraduates looking for a career in academia? What advice would you give to our energy researchers?

Your value to the students rests in the anecdotes you can relay and the rich pictures you can paint. As such, outside experience is invaluable. Get some!

For energy researchers: Don't just stick within your technical domain. In order to differentiate yourselves, ensure you can understand and converse in all aspects of the sector, and speak its often complex language of technical, policy and finance. Those who do will make a huge impact!

What are you hoping to achieve as Chair of Durham Energy Institute's Advisory Board? Or what is your vision for the DEI?

I have already started to lead by example and do my bit to be a market-facing resource for DEI, presenting and chairing at conferences and symposia and stimulating thought leadership. I also want to both assist in building and reinforcing DEI's networks in the UK and overseas.

In terms of vision, under my watch, I want DEI to be recognised as one of the top 10 global energy centres of excellence but only as long as it remains a grounded, inclusive, pan-energy sector, 'go-to' unit.

// Alan has over 25 years' experience of the international energy and water sectors having worked in major corporations such as NEI/Rolls Royce Industrial Power, PB Power, British Gas, Suez Lyonnaise des Eaux, Shell, Mott MacDonald and Sinclair Knight Merz. In addition, Alan has also held the position of Managing Director for two university spin-out companies, and also spent 4 years as Director of R&D Programmes for ITI Energy, Aberdeen where he was responsible for the identification, development and commercialisation of a £35M portfolio of energy technology investments. Alan was also previously Director of Technology & Innovation at Narec (now the Offshore Renewable Energy Catapult) where he was principally involved in research and technology development and IP commercialisation within the wind and marine renewables sectors, offshore wind in particular.

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