Director’s introduction

Professor Neil Strachan reflects the current state of energy research in the UK, and indeed has specific challenges.

In this implementation challenge the interdependencies between technologies and policies, together with the essential role of demand-led systems perspective – understanding the energy transition. Recognising this, we have been working very closely with the UCL Energy Institute, bringing to bear multiple disciplinary perspectives to observe, analyse, and advise the energy transition, and what market arrangements will be the hardest of all.

However, we are delighted to report that we have still to go. We will therefore continue to prioritise the development of new roles, responsibilities and potential students.

Please do read our 2018 Annual Report, and please do get in touch with us as we continue to build a globally successful energy transition. Recognising this, we have been working very closely with the UCL Energy Institute, bringing to bear multiple disciplinary perspectives to observe, analyse, and advise the energy transition, and what market arrangements will be the hardest of all.

However, we are delighted to report that we have still to go. We will therefore continue to prioritise the development of new roles, responsibilities and potential students.

Please do read our 2018 Annual Report, and please do get in touch with us as we continue to build a globally successful energy transition. Recognising this, we have been working very closely with the UCL Energy Institute, bringing to bear multiple disciplinary perspectives to observe, analyse, and advise the energy transition, and what market arrangements will be the hardest of all.

Professor Neil Strachan reflects the current state of energy research in the UK, and indeed has specific challenges.

In this implementation challenge the interdependencies between technologies and policies, together with the essential role of demand-led systems perspective – understanding the energy transition. Recognising this, we have been working very closely with the UCL Energy Institute, bringing to bear multiple disciplinary perspectives to observe, analyse, and advise the energy transition, and what market arrangements will be the hardest of all.

However, we are delighted to report that we have still to go. We will therefore continue to prioritise the development of new roles, responsibilities and potential students.

Please do read our 2018 Annual Report, and please do get in touch with us as we continue to build a globally successful energy transition. Recognising this, we have been working very closely with the UCL Energy Institute, bringing to bear multiple disciplinary perspectives to observe, analyse, and advise the energy transition, and what market arrangements will be the hardest of all.

However, we are delighted to report that we have still to go. We will therefore continue to prioritise the development of new roles, responsibilities and potential students.

Please do read our 2018 Annual Report, and please do get in touch with us as we continue to build a globally successful energy transition. Recognising this, we have been working very closely with the UCL Energy Institute, bringing to bear multiple disciplinary perspectives to observe, analyse, and advise the energy transition, and what market arrangements will be the hardest of all.

However, we are delighted to report that we have still to go. We will therefore continue to prioritise the development of new roles, responsibilities and potential students.

Please do read our 2018 Annual Report, and please do get in touch with us as we continue to build a globally successful energy transition. Recognising this, we have been working very closely with the UCL Energy Institute, bringing to bear multiple disciplinary perspectives to observe, analyse, and advise the energy transition, and what market arrangements will be the hardest of all.

However, we are delighted to report that we have still to go. We will therefore continue to prioritise the development of new roles, responsibilities and potential students.

Please do read our 2018 Annual Report, and please do get in touch with us as we continue to build a globally successful energy transition. Recognising this, we have been working very closely with the UCL Energy Institute, bringing to bear multiple disciplinary perspectives to observe, analyse, and advise the energy transition, and what market arrangements will be the hardest of all.

However, we are delighted to report that we have still to go. We will therefore continue to prioritise the development of new roles, responsibilities and potential students.
To address these challenges, the also reducing energy use and carbon built environments by 2030, while comfortable, healthy and productive. The theme’s research focus is on number of UCL-Energy researchers Energy theme, with the support of a Institute is leading the Buildings & CREDS’s research themes. have taken on leading roles across the members of the UCL Energy Institute Led overall by Professor Tadj Oreszczyn from the Professor Robert Lowe, again with the is being headed up by UCL-Energy’s Their work is focussed on what solutions are available to decarbonise the UK’s heat and how they could be integrated. They will be reviewing existing proposals on how heat can be decarbonised, analysing and further developing two existing whole energy system models, and evaluating potential social, regulatory and governance implications of findings. Professor David Shipworth and Dr Mike Fell from the Institute are also members of the Policy & Governance theme. As part of this Professor Shipworth is leading a project on distributed ledgers. CREDS was officially launched in London in September 2018. The six End Use Energy Demand (EUED) Centres that were the precursor to CREDS, Professor Oreszczyn spoke to the delegation about the work of UCL-Energy’s EUED Centre, the RCUK Centre for Energy Epidemiology (find out more about the centre on page 5). A new brochure on the projects and on-going impact of the centre, as well as a new animation ‘Energy Epidemiology Explained’ were premiered at the event.

September 2018: The Centre for Research in Energy Demand Solutions (CREDS) was established in 2018 with a vision to make the UK a leader in understanding the changes in energy demand needed to transition to a secure, affordable, low-carbon energy system. Led overall by Professor Nick Eyre at the University of Oxford, members of the UCL Energy Institute have taken on leading roles across the CREDS’s research themes.

Professor Tadj Oreszczyn from the Institute is leading the Buildings & Energy theme, with the support of a number of UCL Energy researchers previously involved in RCUK GEE. The theme’s research focus is on how we can produce affordable, comfortable, healthy and productive built environments by 2030, while also reducing energy use and carbon emissions. To address these challenges, the team will be analysing the co-benefits of energy efficiency in terms of health, comfort and energy systems resilience, exploring the impact of energy efficiency measures can have on the flexibility and resilience of the energy system, and assessing the current energy demand in UK buildings and how this is likely to change over time. Their work will tie in to that of other current projects, such as the Active Buildings Centre, based in Swansea.

The Decarbonisation of Heat theme is being headed up by UCL-Energy’s Professor Robert Lowe, again with the assistance of UCL-Energy colleagues. Their work is focussed on what solutions are available to decarbonise the UK’s heat and how they could be integrated. They will be reviewing existing proposals on how heat can be decarbonised, analysing and further developing two existing whole energy system models, and evaluating potential social, regulatory and governance implications of findings. Professor David Shipworth and Dr Mike Fell from the Institute are also members of the Policy & Governance theme. As part of this Professor Shipworth is leading a project on distributed ledgers.

CREDS was officially launched in London in September 2018. The six End Use Energy Demand (EUED) Centres that were the precursor to CREDS, Professor Oreszczyn spoke to the delegation about the work of UCL-Energy’s EUED Centre, the RCUK Centre for Energy Epidemiology (find out more about the centre on page 5). A new brochure on the projects and on-going impact of the centre, as well as a new animation ‘Energy Epidemiology Explained’ were premiered at the event.

Energy & Development

Equality, peace and prosperity all depend on affordable and clean energy

February 2018: Achieving equality, securing global peace and ending extreme poverty all depend on ensuring people have access to clean, affordable energy found new research from the cross-UCL Energy & Development group.

By analysing the United Nations’ Sustainable Development Goals (SDGs) and their related targets, researchers found that access to clean and affordable energy is at the heart of around two-thirds of these targets – ranging from ending discrimination against women to ending poverty. As UN member nations have committed to implement the goals by 2030, the research suggests that far greater emphasis should be placed on considering these cross-sectoral dynamics (e.g. among energy, water, food, gender and education) when considering wider public policy goals.

The group launched the paper by hosting a high-level panel discussion on ‘Energy and SDGs: what are the synergies and trade-offs?’ in February 2018. After a summary of the paper panelists debated the role of energy in delivering sustainable development.

The event is available to watch online on the UCL Energy Institute YouTube Channel. ‘Mapping synergies and trade-offs between energy and the Sustainable Development Goals’ is available on Nature Energy.

London Building Stock Model

The Greater London Authority commissions UCL to develop London Building Stock Model

May 2018: Researchers from The Bartlett will create a model containing data on every domestic and non-domestic building within the M25.

The work will be carried out by groups at the UCL Energy Institute and the Centre for Advanced Spatial Analysis, both in the Bartlett Faculty of the Built Environment.

The model is to be used by the GLA and London Boroughs to tackle fuel poverty and improve the energy efficiency of the capital’s housing stock. It will support Boroughs in their enforcement of the Minimum Energy Efficiency Standard (MEES), which has just come into force. It will allow poorly performing non-domestic buildings to be identified, and will help small and medium sized enterprises make energy improvements to their premises and reduce their energy bills.

The model will contain data on every separate domestic and non-domestic building in London out to the M25 motorway. Information will be included on the sizes of buildings, the premises and activities that they house, the materials from which they are constructed and their servicing systems. Data on energy use will be attached to premises and buildings, either actual consumption where known or an estimated construction according to Energy Performance Certificates.

The data will be presented in 2D map form via a web interface, and will provide three-dimensional information about buildings including their heights, volumes, wall areas and the distribution of activities between different floors. These data will be drawn from the UCL Energy Institute’s existing 3D stock model of London.

IPCC’s Special Report on Global Warming of 1.5°C

UCL Energy Institute welcomed the publication of the IPCC’s Special Report on Global Warming of 1.5 °C

October 2018: The UCL Energy Institute welcomed the publication of the IPCC’s Special Report on Global Warming of 1.5 °C. We note how the report discusses the lowered planetary risks of a 1.5°C temperature limit, but also that to achieve this requires “rapid and far-reaching transitions in energy, land and urban development, and industrial systems (that are) are unprecedented in terms of scale.” Professor Neil Strachan, Director of the UCL Energy Institute said:

“To meet the very stringent emission reduction pathways in the IPCC 1.5°C report requires a systematic approach to the energy transition. This includes addressing emissions reduction in the most intractable sectors such as heat and aviation, as well as understanding and harnessing the wider innovation, societal change and sustainable development interactions. These are all issues that researchers at UCL-Energy are working on in the implementation of such challenging pathways.”
Teaching

The UCL Energy Institute is a sought-after destination for aspiring Master's and PhD students looking to study and research energy demand and energy economics and policy. Our MSc and PhD programmes equip graduates with the tools needed for a career as a leader in energy-related industry, academia, or policy making. We welcome students from a wide spectrum of professional, academic and cultural backgrounds to develop new skills in a dynamic, multidisciplinary environment.

We are currently home to three Master’s programmes. This academic year we have launched a landmark Masters in Energy Systems and Data Analytics. Students will gain a multi-vector, multi-sector understand of Energy systems, while developing advanced statistical and machine learning skills and getting practical experience of data analysis. Find out more and read an interview with Programme Lead Aidan O’Sullivan on pages 10 and 11.

The Institute is home to the established Economics and Policy of Energy and the Environment MSc (page 12). Through joint teaching with our sister institute, Institute for Sustainable Resources, students learn from experts across topics that are vital to the understanding and analysis of environment-energy-economy interactions.

We also offer a Master of Research programme in Energy Demand Studies (page 13). This programme equips students with the skills and knowledge to become researchers in energy demand reduction in the built environment whilst working with respected researchers in the field.

The Institute is currently home to 43 PhD candidates working across a broad spectrum of research interests. Our candidates these span our core research themes as candidates work alongside UCL-Energy staff to produce an original piece of research. Find out more about the programme and read about our PhD candidates’ experience on page 14.

Student testimonials

What our students think of studying at UCL-Energy

“I had a great time studying as a research student at UCL Energy Institute. Many of my academic research and writing skills have been cultivated here and as it was a relatively small group, I always had many opportunities to discuss my thoughts and issues with people. The particular world-leading ideas of in-situ experiment design will absolutely benefit my future energy related research activities even in my home country.”

Weili Sheng, EDS MRes Alumni

“I have found that my studies at UCL have been tremendously beneficial. Since graduation, I have been working in my home country of Iceland as an energy and environmental consultant. My clients have been power companies, the Icelandic TSO, aluminium smelters and other smaller users and producers of electricity. I have advised on investment in wind-farms, done efficiency analyses of distribution firms, submarine interconnectors, and helped to develop sustainability indicators. Most recently, I have been involved in transmission system planning for 2017-2018. I am currently assisting data centre investors, by developing business plans and analysing scaling and cooling methods.”

Jón Skafti Gestsson, EPEE MSc Alumni

“It is a privilege to be taught by the very best in the field and this combined with the nature of the taught element in small groups, supported with regular seminars and tutorials, has allowed me to engage at an advanced intellectual level.”

Sofie Pelsmakers, PhD alumni

Photos: UCL Energy Institute
Energy Systems and Data Analytics MSc

We talk to Dr. Aidan O’Sullivan, Programme Lead for the new Energy Systems and Data Analytics Master’s degree.

What is your background?
My background is a bit of a mix of disciplines covering; electrical engineering, bio-engineering, transportation, data science and machine learning. This has contributed to my role as Programme Lead where I aim to bring together the different strands of research in the Energy Institute into a coherent and engaging MSc programme that gives a holistic view of the energy system and the role data analytics can play in assisting the transition to a more sustainable system.

“In order to change something, you need to be able to measure it.”

How do you think data analytics can help us solve energy-related problems?
In order to change something, you need to be able to measure it. We are now getting access to energy data at a scale and resolution never before seen so the possibilities for insights and new technologies driven by this data are huge. It’s hard to foresee what form these transformations may take. For example, who could have known that GPS and mobile phone technology would have enabled a platform like Uber to emerge to shake up the transport sector. There are already start-ups and new energy companies beginning to emerge, like Igloo, Verv and Demand Logic who will all be involved in the programme, that are using data to support business models focused on reducing energy consumption.

Looking to the future, how do you think the increasing amount of data we have will transform the way we use energy?
To begin with it may make people more conscious of their energy consumption, how much, when and what they are using energy for and how their energy use compares to their neighbours for example. Energy bills are currently rather opaque in their calculation so this information could encourage people to be more active in reducing their energy bills and switching provider and adjusting their consumption.

Why launch an Energy Systems and Data Analytics Master’s programme?
We feel that there is a need in the industry for graduates with an understanding of the many complex interactions within the energy system and the ability to manipulate data and use advanced statistical methodology. This has been borne out by our industrial partners who have all shown great enthusiasm and a desire to engage with the students from the course.

“Understanding interactions between systems is vitally important to offering effective solutions to fight climate change.”

What will EDSA MSc students study?
In order to get a full understanding of how societies use energy students will take topics in the 3 key areas of research in the energy institute, the built environment, transport, and energy systems. This will be combined with courses in statistics and programming and the students will then have a choice of optional modules from the breadth of MSc programmes available at the Bartlett School of Environment, Energy and Resources. Understanding the interactions between systems is vitally important to offering effective solutions to fight climate change. Research has shown for example that electrifying transport in certain EU member states, such as Poland and Latvia, would produce worse environmental outcomes as a result of the carbon intensity of the electricity generation sector there.

What kind of skills will ESDA MSc students gain from the course?
Students will gain a holistic understanding of energy systems and skills in machine learning and data analysis.

What excites you most about the new programme?
I am greatly looking forward to welcoming our first cohort and seeing them combine the skills learned from the course in their dissertation projects which is a great opportunity for them to express their creativity and ingenuity.
Economics and Policy of Energy and the Environment MSc

Our Economics and Policy of Energy and the Environment (EPEE) Master's equips graduates to become sustainability leaders and entrepreneurs in business, policy-making and research.

EPEE MSc students are equipped with the skills and knowledge to become a leader and innovator of business, policy-making and research.

This advanced degree programme is designed to provide a broad understanding of research concepts and methods, environmental and resource economics, modelling, methods and scenarios, environmental measurement, assessment and law, global economics and the political economy of energy and climate change.

EPEE MSc students, gain a firm grounding across all areas that are vital to the understanding and analysis of environment-energy-economy interactions.

Annual alumni networking event

Each year we host a networking event for alumni, current students and future students to mix with industry experts and our academics.

At last year's event Professor Paul Ekin's addressed the 100 attendees with his lecture on "The State of UK Environmental Policy 2018: The government's 25-year environment plan.

Following the lecture, a panel discussion of alumni was held, discussing the issues covered in the lecture and the importance of long-term planning in environmental policy.

Panellists included EPEE alumni Jesse Glicker from the International Energy Agency, Oliver Kier from Aurora Energy Research and Jie Zhou from the Ellen McArthur foundation. Each delivered informative segments on the work they have been doing since graduating from UCL, responding to questions from the crowd.

Programme Director Wil McDowell said of the event:

"The annual alumni event is a highlight of our year – it’s great to catch up with our former students and see what they’re all doing. It’s really nice to see alumni making connections with each other, and building a network across the years.

Energy Demand Studies MRes

Our MRes offers outstanding preparation for a career as a leader in energy-related industry or academia.

The only programme of its kind in the UK, the Energy Demand Studies MRes (EDS MRes) equips students grounding in the skills and knowledge needed to carry out research into energy demand reduction in the built environment.

The programme has 3 strands:
- technical modules (topics include thermodynamics, building physics, behaviour, energy systems, modelling, policy and economics)
- transferable skills (e.g. writing, presenting, communicating with the public)
- research

Students are introduced to a research-style form of study, reading key texts that provide a focus for research-oriented teaching sessions in small, highly interactive groups, led by experienced researchers.

Studying at the UCL Energy Institute gives EDS MRes students the opportunity to work in a leading centre for research into energy demand and the built environment. Students have the opportunity to learn from experience and respected researchers in the field with the opportunity to undertake original research.

UCL-Energy's multi-disciplinary approach helps students develop into well-rounded researchers and effectively integrate into established research teams in a variety of related disciplines.

The Bartlett MRes Conference

This year UCL-Energy organised the Annual Bartlett MRes Conference. Hosted by EDS MRes programme lead Dr Catalina Spataru, the event showcased the diversity of Master’s in Research programmes across The Bartlett. Students from across the faculty were given the opportunity to share their work to their peers just starting their MRes through presentations and poster displays.

Students heard about the programmes from the Bartlett MRes programme leads. Also addressing the students were Dean of the Faculty, Professor Alan Penn, and Professor Raimund Bleischwitz, Director of The Bartlett School of Environment Energy and Resources, home to UCL Energy Institute. In all, the event highlighted the multidisciplinary nature of the faculty, displaying the different interactions our students have with the built environment, and welcomed a new generation of researchers.
**PhD in focus**

**PhD candidate Dayang Abu Bakar shares her thesis, modelling Malaysia’s pathways for 2050**

Malaysia has set a national voluntary emission intensity reduction by up to 45% (per GDP) by 2030 in relative to 2005 levels through its Nationaly Determined Contribution (NDC). To assess Malaysia’s energy system decarbonisation pathways to 2050 and the specific challenges posed to attain the resultant pathways that can best achieve Malaysia’s climate goal, an energy model is developed using TIMES (The Integrated MARKAL EFOM System) model generator.

The model identifies the sustainable technology pathways and assess the impacts of alternative energy futures in the energy transition by focusing on the role of the power sector and bioenergy. The representation of the bioenergy system in the model takes into account the two important factors that can influence climate change from the production and use of bioenergy i.e. (i) emissions from the bioenergy chain; and (ii) emissions related to changes in biospheric carbon stocks often caused by associated land use change.

The analysis also illustrates how such approach can avoid GHG accounting error when representing bioenergy (against carbon-neutral treatment).

---

**London-Loughborough Centre for Doctoral Training**

The London-Loughborough EPSRC Centre for Doctoral Training in Energy Demand (LoLo CDT) is the premier centre for energy demand research in the built environment in the UK. A partnership between UCL and Loughborough University, LoLo CDT is the UK centre for energy demand research.

The world needs new, clean ways to generate energy. A new focus has been brought to the energy challenges, not to use less, rather than how to make more.

That is why energy demand research is emerging as a vital area of study in the development of policy and business strategy. It connects science and engineering with economics, policy-making, psychology, sociology and design, to develop knowledge and ideas that will lead to rest, long-lasting, large-scale solutions.

LoLo CDT offer researchers a novel learning structure in which to make those connections with other disciplines. Before embarking on their three-year PhD, students undertake a one-year MRes course that allows them time to absorb the context of energy demand studies and to pick up the rules, tools and methods that can support powerful, influential research.

The centre partners with key industry organisations in the creation of high-impact research projects. This year the centre has advertised PhD fully-funded PhD studentships on “Ventilation and Moisture in Residential Buildings” in partnership with Arreco, and “Blockchain enabled peer-to-peer energy flexibility trading” with GreenRunning, among other.

---

**Women in LoLo**

This year, LoLo cast the spotlight on the excellent women who have been a part of the Centre for Doctoral Training. 11 current students, graduates and supervisors shared their experiences of being a woman at LoLo, and in the industry in general, through blogs and video interviews. Women in LoLo was launched online this year, coinciding with International Day of Women and Girls in Science.

On the site they recognise that the Energy and Buildings field is, for historic reasons, largely male dominated. In the blog and interviews the women shared their positive and negative experiences working and studying energy and buildings, reflecting on how things have changed and also how there is a long way to go for achieve diversity.

In her interview alumna Sofie Petersmakers said “Women make up 50% of building users, yet their voice is often absent in the creation and studying of them – let us change that.”

Presently, LoLo recruits a large number of women to undertake PhDs. This is not down to “positive discrimination” or because they must fill a quota but because they come to the CDT as highly skilled, bright individuals. Women in LoLo celebrates and appreciates these individuals’ backgrounds and experiences, opening the conversation about how we can make energy and buildings professional more diverse.

Discover more at: lolo.ac.uk/women-in-lolo
Research is the bedrock of the UCL Energy Institute’s activity

Most energy problems are multidisciplinary in nature, spanning science, engineering and the social sciences. Thus, different approaches are needed to understand and tackle these issues. UCL-Energy’s research works with a range of tools, models and methods to address the energy challenges facing the world in the next few decades.

To tackle the diversity of energy problems, our researchers work across five interacting themes; Energy and Artificial Intelligence (page 17), Transport (page 18), Systems (page 20), Energy Space Time (page 21) and Buildings (page 22).

The UCL Energy Institute is home to 52 members of staff and 48 PhD students, all contributing to our research activity. In the 2017/18 academic year, across the five research themes, members of the UCL Energy Institute worked on 32 active research projects with a value of just over £22.5 million. Across these projects, 85 papers were published, many of the highlights featured in this report. Staff also took on 12 consultancy projects, valuing nearly £500,000. Find out more about our consultancy and partnerships work on page 24.

Across our research themes, we use models to produce results. We design our models to answer specific research questions, although some of our more complex models can also contribute to research in a number of different research areas. Through our research section you will see examples of our models in action - to find out more visit ucl.ac.uk/research-models.

Seasonal shifts

Renewable power systems must overcome yearly weather changes, new research suggests

Renewable energy-based power systems must include energy storage and flexible forms of supply to contend with weather conditions changing from year-to-year, research published in April suggests. Researchers analysed ten years of weather and assessed how to best configure a renewables-focused power system to meet domestic needs. Such systems must be designed to overcome situations of suboptimal weather conditions in order to meet demand, because relying on renewable sources like wind and solar depends on the weather.

The report, ‘Designing low-carbon power systems for Great Britain in 2050 that are robust to the spatiotemporal and inter-annual variability of weather’, published in Nature Energy, found that unless systems are planned as to mitigate the variability of Great Britain’s weather over many years the system will fail to meet demand all of the time (meaning black-outs) or will fail to meet carbon reduction targets (because they have to run fossil fuel plants to fill the gaps). Such mitigation efforts could include utilising energy storage, interconnection to other countries, demand side management and, where necessary, flexible generation like natural gas.

For the first time, this research explores the effect of inter-annual weather variability on systems with high levels of renewable sources. Previous studies have used averages of multiple years or single weather years – but this research is the first to demonstrate the importance of factoring in the changes in weather between years when planning a power system.

Research: Energy & AI

UCL-Energy launches new research theme focussed on the use of artificial intelligence in energy

Artificial Intelligence promises to be one of the most revolutionary technologies of the 21st century. The Energy and Artificial Intelligence (AI) group’s mission is to deploy the most cutting edge and state of the art algorithms and AI methods to solve problems of sustainability, from reducing energy consumption to increasing the stability of the grid to support increased penetration of renewables and the intelligent use of resources.

Launched in early 2018, the Energy and Artificial Intelligence theme is led by Dr Aidan O’Sullivan.

Members of the theme also recently participated in round table discussions between DeepMind for Google and UCL on the societal and ethical implications of using AI in the energy sector.

Having only recently launched, the AI theme has already attracted media attention, being featured in Times’ Raconteur special report article on artificial intelligence in the Energy sector.

Looking to the next year, the team are starting a project in collaboration with Igloo Energy, a new energy services provider, which is focused on reducing the energy consumption of their customers.

Machine learning in energy

Grant won to gain insights into UK energy consumer patterns using machine learning

In partnership with Igloo Energy, the UCL Energy Institute won a £120,000 grant from the government's Industrial Strategy Fund.

There already exist vast amount of energy, property and socio-economic data freely available in the UK alongside energy and contextual data. The grant will enable the creation of an inventory of the data sets and an investigation into their quality. Once created, machine learning techniques will then be used to process the data and derive insights into consumer behaviour that will describe how a customer’s energy consumption pattern relates to their lifestyle and property, and the relationship between consumption and energy spend and expenditure on energy efficient home improvements.

“The UCL Energy Institute is committed to undertaking industrially relevant research to support the decarbonisation of the UK energy system and we are excited to be partnering with Igloo on this project. We hope to demonstrate the ability of machine learning to develop customer insights that can benefit UK energy users, saving them money, and support innovative new business models that reduce carbon emissions.”

Dr Aidan O’Sullivan
Leading the way to monumental maritime agreements

With approximately 1 gigaton of Green House Gas (GHG) emissions, the shipping sector currently represents around 2% of global GHG emissions. While on land the challenges are faced with firm international climate targets, the shipping industry has thus far continued without such obligations. Continuing on this trajectory could see shipping responsible for up to 25% of global emissions by 2050, more than any single nation.

The shipping sector however made a world-first move, taking a sectoral agreement to at least halve GHG emissions by 2050. With its data-centric approach and continuous engagement with industry and policy makers, UCL-Energy’s shipping team played a pivotal role to the agreement being made by the International Maritime Organisation in April 2018.

Most observations and academic papers, UCL-Energy led the 3rd International Maritime Organisation GHG study. Researchers pioneered a new approach to estimate emissions, using satellite and terrestrial satellite data (Automatic Identification System, Ais).

Findings suggested that in 2012, total shipping emissions were approximately 972 million tonnes CO2e for GHGs. For 2007–2012, on average, shipping accounted for approximately 2.8% of annual GHGs on a CO2e basis. This work will remain a key reference for until the next GHG study is commissioned in 2019.

The group’s innovative use of AIS data has led to surprise findings. In a report alongside Ricardo Energy & Environment researchers found a 250% increase in the UK’s domestic shipping GHG estimate, based on a revised modeling methodology to estimate the emissions of shipping for the UK’s National Atmospheric Emissions Inventory (NAEI). The findings are an important first step in making shipping a more authoritative evidence base to be used for official international reporting.

Future transport: Mobility as a Service

The landscape of the mobility sector is constantly evolving. With tightening global CO2 regulations industry has been adopting an innovation paradigm at a quickening rate. Emergence of disruptive innovations, such as peer-to-peer mobility and vehicle sharing, have the power to redefine industries’ and users’ behaviour.

Mobility as a Service (MaaS) is a user-centric, intelligent mobility management and distribution system. An integrator (MaaS Operator) brings together offerings of multiple mobility service providers, including aforementioned disruptive technologies, and provides end-users with access to them through a digital interface, allowing them to seamlessly plan and pay for mobility.

MaaS at UCL-Energy is an enthusiastic multidisciplinary research team, looking to keep at the forefront of the ever-changing transport sector. Currently the team is working on several large-scale national and international research projects studying at innovative mobility solutions and ensuring they are utilised.

One such project is MaaS4EU, providing an end-to-end approach for Mobility-as-a-Service tools, business models, enabling frameworks and evidence for seamless European mobility. MaaS4EU is the first Mobility-as-a-Service project funded by the European Commission through the H2020 framework, designing and demonstrating MaaS services in three EU cities. MasLab is heavily engaged in MaaS4EU with Dr Maria Kamargianni, Head of MasLab, as the Scientific and Technical Manager of MaaS4EU.

MasLab has also recently had the opportunity to study the impact of allowing women driving on the sustainable development and traffic safety in the Kingdom of Saudi Arabia as they hosted Dr. Naif Al-Qurawi as a visitor Research Fellow. The project was completed in collaboration with the Imam Abdulrahman bin Faisal find out more about the findings at l.ae.ac.uk/en/She-Drives-KSA.

Closer to home the team recently produced a report for Transport for London on ‘Londoners’ attitudes towards transport and Mobility-as-a-Service’. The report highlighted that attitudes towards transport is shifting between generation, with millennials more likely to opt for car-sharing over car-ownership than previous generations. Find out more about the findings of the report, see our feature on page 24.

With the way we travel and attitudes towards modes of transportation MasLab’s research stays ahead of the curve, providing in-depth insights and guidance about how MasLab to industry and public sector.
The Energy Systems theme is the largest academic centre of energy systems modelling knowledge in the UK, with a global reputation. The interdisciplinary team conducts research focusing on the interactions of different energy system elements, across a wide range of geographical scales. They use different tools to focus on different elements of the system, such as technology, economy, environment and climate change. The theme, led by Dr Ilkka Keppo, includes four academics and 12 research staff.

The Systems team has been successful in disseminating its work in the high-profile Nature journals. Systems has traditionally been prolific in providing energy system analysis in the UK context. Pye et al., 2017, in Nature Energy focussed on assessing how post-2050 climate targets may affect the necessary ambition for pre-2050 goals and actions. Zeyniger et al., 2018, highlighted how the design of a variable renewable focused power system for the UK can be highly sensitive to inter-annual variability of weather and suggested measures to mitigate this (see page 16).

The team’s global integrated assessment modelling work, in collaboration with others, has also led to several high-profile publications. Marangoni et al., 2017 in Nature Climate Change, used six integrated assessment models in a global sensitivity analysis framework to assess the most important determinants of future CO2 emissions in the models. Jewell et al., 2018, assessed in Nature what the impact of removing fossil fuel subsidies could be on the effort needed to reach climate targets. And most recently, McCollum et al., 2018, showed how the inclusion of heterogeneous consumer preferences for vehicles affects how integrated assessment models project the demand for low carbon alternatives.

Finally, energy and development is a rising area of interest also for the Systems Theme, with cross-UCL collaboration. As a result Ruso Neini et al., 2018 published in Nature Energy mapping the synergies and trade-offs between energy and other sustainable development goals (see page 6).

The Energy Space Time group researches the design of sustainable energy systems accounting for whole system integration in space and time, under the influence of social, economic and meteorological factors.

Activities range from theoretical investigations to implementation research. The group’s major research interests include the design and application of sustainable energy systems and system integration in space and time, working to support the development of secure, environmentally friendly energy systems. It works with research communities, industry, NGOs and the public to promote wider understanding of energy resources in space and time.

The Energy Space Time theme has a number of projects start and conclude this year. The multi-disciplinary project SICEDEs came to an end at the end of 2017. This flagship project aimed to create a strong collaboration with cities stakeholders and create a step change in modelling capability, while engaging stakeholders in industry, government and cities. The Stakeholder City Energy Demand Simulator platform and model simulates energy and environment scenarios for cities and calculates energy flow, costs, emissions, air pollution, health and fuel poverty.

Three major themes are currently research by the team:

- Whole energy systems dynamics
- Interconnections and RES impact
- Integrated systems

The Energy Systems theme has traditionally been prolific in providing energy system analysis in the UK context. Pye et al., 2017, in Nature Energy focussed on assessing how post-2050 climate targets may affect the necessary ambition for pre-2050 goals and actions. Zeyniger et al., 2018, highlighted how the design of a variable renewable focused power system for the UK can be highly sensitive to inter-annual variability of weather and suggested measures to mitigate this (see page 16).

The team’s global integrated assessment modelling work, in collaboration with others, has also led to several high-profile publications. Marangoni et al., 2017 in Nature Climate Change, used six integrated assessment models in a global sensitivity analysis framework to assess the most important determinants of future CO2 emissions in the models. Jewell et al., 2018, assessed in Nature what the impact of removing fossil fuel subsidies could be on the effort needed to reach climate targets. And most recently, McCollum et al., 2018, showed how the inclusion of heterogeneous consumer preferences for vehicles affects how integrated assessment models project the demand for low carbon alternatives.

Finally, energy and development is a rising area of interest also for the Systems Theme, with cross-UCL collaboration. As a result Ruso Neini et al., 2018 published in Nature Energy mapping the synergies and trade-offs between energy and other sustainable development goals (see page 6).
The Buildings theme studies domestic, non-domestic, smart energy and heat through the lenses of energy epidemiology, building physics and socio-technical systems.

The theme, with around 50 staff and doctoral researchers, is the largest theme in the Energy Institute and the leading centre for buildings research in the UK. The highly interdisciplinary theme has staff with background from physics to neuroscience – and from social science to data science applying methods from across these disciplines. Research within the theme ranges spatially from highly detailed physical characterisation of individual buildings to global scale analysis of building stocks. Much of the work is rooted in the collection and analysis of empirical data and its analysis – and the building and evaluation of models against such data.

The last year has seen major projects finishing and new ones starting. The EPSRC funded ‘Centre for Energy Epidemiology’ has been replaced by work on the Centre for Research into Energy Demand Solutions (CREDS) to maintain work core work focused on buildings – and to introduce a new focus on decarbonisation of heat.

Work on analysis of smart meter data continues to grow while the LCNF ‘energywise’ project assessing the impact of smart metering and to introduce a new focus on decarbonisation of heat.

SMRP is breaking new ground by being the first non-utility to access smart meter data through use of smart meter data linked to contextual data that will help researchers and government understand how patterns of energy demand are evolving at a National scale.

CMPRT is increasing the speed and scope of its activity by providing a more detailed picture of energy use across England and Wales in the next two years. SimStock will be developed in parallel with 3DStock with initial plans to develop a detailed set of methodology for the whole of London (inside the M25) in the same time frame.

New methods have also been created by CEE researchers for the estimation of thermophysical performance of building elements using statistical techniques and failed measurements to assess the energy performance of real building elements. The method provided robust estimates of thermophysical properties at all times of year. This rapid and robust method has potential for a wide range of applications as a tool for diagnosis and performance evaluation of real buildings, and opening new regulatory and business opportunities towards closing the performance gap.

Another CEE project found that boiler regulation will save 370 million tons of CO₂ by 2050, equivalent to 5.6 times average UK demand, when investigating the effect of requiring new boilers in the UK to be condensing. The team analysed large publicly available datasets using Bayesian statistics and incorporating insights into the physical behaviour of buildings to investigate the impact of regulatory changes on factors related to energy use. This research also found evidence that dwellings are leakier than their regulated design targets due to secondary or temporary sealing in conjunction with air tightness testing.

Beyond buildings, CEE researchers have also worked in the transportation field, leading to monumental maritime and the investigation of mobility as a service (see page 19).

Looking to the future, UCL will be continuing work through the CEE with their involvement in CREDS (see page 6), the development of 3DStock nice for the Greater London Authority, IEA Annex 70, Smart Meter Research Portal amongst other projects. To find out more about CEE's projects and future activity visit ucl.ac.uk/cee
Partnerships are fundamental to UCL-Energy’s work.

Most of our work is completed in partnership with industry, government and other academic bodies to ensure it has real-world impact.

In our consultancy projects, experts at UCL-Energy work with national and international organisations, seeking to resolve specific problems or gain critical advantage in the client’s market. The Institute has considerable experience in consultancy services, completing 12 consultancy projects in the past year. We work with all organisations from government bodies and global corporations, to public bodies and small and medium enterprises.

We frequently work with external partners on externally-funded research projects for shared skills, facilities, access to data, field studies or help to steer projects. The Vulnerable Customers and Energy Efficiency (VCEE) project is being researched in collaboration with UK Power Networks Ltd. Funded by Ofgem’s Low Carbon Network Fund, VCEE aims to understand the specific needs of fuel poor customers and realise the potential operational and environmental value from their participation in energy efficiency and Demand Side Response; while exploring and attempting to overcome the potential barriers to their involvement in the transition to a low carbon economy and ability to access the potential benefits.

We also collaborate with industrial partners to provide training for future energy pioneers. Through the London-Loughborough EPSRC Centre for Doctoral Training we partner with key organisations to create high-impact PhD studentships. Last year, in partnership with GreenRunning, the Institute advertised a studentship in Blockchain enabled peer-to-peer energy trading flexibility. The partnership gave a student the opportunity to work with a leading technology start-up on the fundamental problem of evidencing and authenticating demand-side response using energy disaggregation and distributed ledger technologies.

National Grid adopts UK TIMES

UK TIMES is a bottom-up, technology-rich, cost optimisation model of the UK energy system. Covering a multitude of areas, from households and social habits to electricity generation and transmission, UK TIMES helps identify energy system transitions that meet energy demands across the UK economy with the lowest discounted cost, subject to constraints such as greenhouse gas (GHG) emission targets.

The UK TIMES model (UKTM) was developed by UCL Energy Institute’s wholeSEM and UK Energy Research Centre teams, in partnership with the Department for Business, Energy and Industrial Strategy (BEIS). In early 2018, the National Grid announced that it will be using the UKTM model to assist with decarbonisation analysis and set out 2050 pathways.

UKTM has become a widely recognised model, with a user group including BEIS, the Scottish Government, the Committee on Climate Change and the National Infrastructure Commission.

Neil Rowley, Gas Modelling Manager in the National Grid’s Energy Insights Team said “Using UKTM allows National Grid to be part of a wider UK energy community all using the same platform.”

Teaming up with TfL

Londoners open to move away from car-ownership to Mobility as a Service schemes, research for TfL shows


Recent years have seen a rise in new mobility services such as vehicle sharing and ride-hailing. Investigating both car-owners and non-car-owners attitudes towards car sharing, the report found the majority of participants agreeing that car sharing is a great way to have access to cars. Among respondents there was a definite preference for car-sharing schemes over peer-to-peer rental. While respondents were not overall in favour of the idea of renting out their own vehicle when they were not using it, there was a significant shift in opinion between millennials and older generation, with more people under the age of 39 willing to rent out their car, especially if there were financial benefits.

While car-ownership has been a possibility for over a century now, and manufacturers have invested vast sums to promote the idea, the option of car sharing has been quickly accepted with the decade it has been around. Looking to the future there is a positive towards alternatives to car owning.

Enter Mobility as a Service (MaaS). MaaS is the virtual integration and bundling of public transport modes and mobility-sharing schemes in London, giving access to all these modes through a single interface payment and fare-matching multilateral. Overall, Londoners seemed willing to use MaaS, with the belief that the service would give them flexibility with their travel and remove several of their travel related pain-points. Again, financial benefits are a serious driver for adoption of Mobility as a Service, with 43% saying this would motivate them to subscribe, moving up to 55% in the under 30 age bracket, removing the pain-point of car ownership.

Regarding MaaS products, the results show that an effective MaaS scheme has to include public transport, with the vast majority of participants preferring MaaS plans which include such modes. The most popular version of MaaS plans chosen includes public transport, car sharing and taxi, with 26% of the respondents choosing this plan. This also shows the importance of integrating the public transport system with other modes available in the city.

Shifting to MaaS could also shift people away from car dependence, with a third of car owners agreeing that MaaS would help them depend less on their cars, while a quarter of respondents would be more willing to try modes of transport they previously did not use before including public transport and borrowing bikes.

Just as telecommunications was transformed by the introduction of mobile phones with new features and the benefits of bespoke payment plans, MaaS could transform the way Londoners travel. A thought experiment was also conducted on what participants attitudes might mean in terms of wider impact to London’s transport system. While this is not based on detailed analytical, operational and commercial modeling of the transport network, it provides some indications as to the ways that a MaaS system, if structured and priced appropriately, could make a significant impact in the city.
UCL-Energy continues to expand its external outreach and engagement.

Our research staff generate impact by presenting their findings on the global stage. Researchers at UCL-Energy have given keynote speeches, hosted workshops and presented papers at conferences, and as part of funded projects in a number of locations this year.

One highlight in the past year was a joint UK/Brazil energy epidemiology workshop organised by UCL-Energy’s CEE researchers in Sao Paolo. Closer to home, the UCL Energy and Development group held a Community Day in July. Several researchers from the Institute are integral to this cross-UCL group, who recently published a pivotal paper on Energy and SDGs in Nature. Visit our website to keep up to date with the latest external engagements.

As always, we hosted our flagship seminar series, welcoming energy experts to share their insights with our students and staff alongside industry members and the public. See page 27 to find out more about the topics covered last year, all available on the UCL Energy Institute mailing list on our UCL Energy10 website.

Our 10th Anniversary coincides with the centenary of our Faculty, The Bartlett Faculty of the Built Environment. Throughout 2019 Institute’s across the Faculty will be hosting outreach events and publishing fresh material in celebration. Keep up to date by visiting UCL.ac.uk/energy

In 2019 we will be celebrating 10 years of UCL Energy Institute.

Officially launched in June 2009, the Institute began as UCL’s response to the global challenges of mitigating climate change and providing energy security in the 21st century. For the first time at UCL, an energy research centre was established with a critical mass to undertake world leading research.

In the last 10 years we have gathered a multidisciplinary team of over 100 staff and postgraduate students working on an extensive research portfolio.

In 2019 we will be hosting a celebration of our achievements over the last 10 years. At the event we will be looking back at our cornerstone achievements that have defined the Institute and created real-world impact, and looking forward, inviting our academics to present what they believe the future landscape of the energy sector will be.

To hear about our 10 year event, as well as other events at the Institute sign up to the UCL Energy Institute mailing list on our UCL Energy10 website.

Each month we host speakers at the forefront of energy research at our seminars. The diverse range of topics in our energy seminar series is manifest of the diversity of our research interests.

Monthly, staff and students together with public and industry gather to hear from experts from across the globe at the forefront of energy research. The UCL Energy seminar series is a pillar of our public engagement, opening the floor for anyone to ask questions.

From hydrogen cells to behavioural insights, this past year speakers have sparked debate across a broad range of topics.

Donning our hard hats and stepping into the building sector we hosted Christoph Reinhardt, building scientist from MIT, to discuss with us ‘Cities for Millennials – Design Tools in Support of Sustainable Urban Architecture’. His seminar discussed the recent work of MIT’s urban design lab on environmental urban performance analysis regarding building energy use, daylighting, outdoor thermal comfort and building integrated agriculture.

Alas in the building sector our Deputy Director, Professor Paul Ruyseveld, took to the stage to discuss whether disclosure helps, with reducing energy use within buildings, looking globally at the effectiveness of building disclosure programmes, such as NABERs in Australia, and examining the case for disclosure to reduce energy use in the UK.

We also heard about Australia’s energy management from Alan Pears of RMIT university. He discussed Australia’s stagnating national energy efficiency policy and the potential of disruptive transformation for our energy future through energy productivity, systems and services thinking and digitalisation.

Marianne Zeyneger and James Price of UCL-Energy presented with systems thinking for Great Britain. They introduced the high spatial and temporal resolution electricity system model highRES, which they have developed application in a UK context for how the yearly variance in weather impact power systems with high renewable shares and also taking a nexus perspective to designing low carbon power systems for GB in 2050.

2050 is the date set in all policy makers calendars as the target to deliver on agreements from the Paris Agreement. We were lucky to have Professor Kevin Anderson share with us his views on the Paris agreement, quoting Alex Steffen that “winning slowly is basically the same thing as losing outright!” but giving hope that cogency, tenacity and courage could yet deliver.

Professor Nigel Brandon, Dean of the Faculty of Engineering at Imperial College, gave a presentation on the role of hydrogen and fuel cell technologies in the UK Energy System. He reviewed the opportunities for decarbonisation across the power, heat and transport sectors, including the role of hydrogen in supporting the de-carbonisation of heat, the positioning of hydrogen fuel cell electric vehicles and battery electric vehicles, the opportunities for high efficiency fuel cell heat and power, and the potential of hydrogen to support significant renewables penetration.

Transport being a major research theme of the Institute, Maria Kamargianni shared the concept of Mobility as a Service, and the work of MaaSLab in the Institute. With the projected growth in transport demand, the current modus operandi in transport supply is deemed unsustainable, generating the need for innovative services that could better manage the existing fleet and deliver the vision of green, sustainable and seamless mobility. Find out more about her research on page 18.

Continuing on theme she welcomed Dr Chandra Bhat from the University of Texas to discuss multi-dimensional dependences among shared mobility service users.

Thinking outside the box, we hosted Michael Sanders from the Behavioural Insights Team to discuss the design of randomised controlled trials, considering whether they are the ‘golden standard’. With more innovative ideas, we also welcomed Professor David Walom from Oxford e-Research to discuss technological advances and the changes these can make to energy, discussing the limitations and capabilities of big data analytics and how we can improve their effectiveness.
Staff list

Management
Neil Strachan
Director
Paul Ruyssevelt
Deputy Director

Academic and Research Staff
Gabriel Anandarajah
Mark Barrett
George Bennett
Phil Buddulph
Lai Fong Chiu
Olivier Dessens
Khan Doyme
Lynette Dray
Simon Elam
Cliff Elwell
Steve Evans
Mike Fell
Pamela Fennel
Toziano Gallo Cassarino
Daniel Godoy Shimizu
Virginia Gori
Ian Hamilton
Gesche Huebner
Kathryn Janda
Charlotte Johnson
Maria Kamargianni
Ilkka Keppo
Francis Li
Peihao Li
Rob Liddiard
Jenny Love
Bob Lowe
Peter Mallabourn
Despina Manousel
Melinda Matyas
Elisheva Melkonyan
Aidan O’Sullivan
Eleni Oikonomou
Tadj Oreszczyn
James Price
Steve Pye

Management
Maja Powell
Institute Administrator
Terese Dawkins
PhD Administrator
Dele Anthony
Programme Administrator
Marta Polancec
Programme Administrator
James O'Toole
SMRP Consortium Manager
Mae Oroszlany
Centre Manager, LoLo CDT

Academic and Research Staff
Nish Rehmatulla
Paul Ruyssevelt
Andreas Schafer
Alexandra Schneider
David Shipworth
Michaele Shipworth
Andrew Smith
Balazs Solako Rodriguez
Catalina Spotaru
Philip Steadman
Neil Strachan
Alex Summerfield
Eleni Webborn
Jez Wingfield
Marianne Zeyringer