Annual Review 2018

UCL Energy Institute
The Bartlett

About the UCL Energy Institute

About

UCL-Energy delivers world-leading learning, research and policy support on the challenges of climate change and energy security.

Our aim is to help to build a globally sustainable energy system, by bringing to bear multiple disciplinary perspectives to observe, analyse, interpret and influence energy use and energy systems.

UCL-Energy is part of the Bartlett School of Environment, Energy and Resources (BSEER), home to three other UCL institutes, giving students the unique opportunity to work across disciplinary boundaries.

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Cover image: DrAfter123, iStockPhoto

Director's introduction

Professor Neil Strachan reflects the current state of energy research

Energy transition is at a critical juncture. There is consensus here in the UK – and a great majority of support globally – for deep decarbonisation targets that cover electricity, transport and heat. Consistent with the core research insights from the UCL Energy Institute, to meet such targets needs a systems perspective – understanding the interdependencies between technologies and policies, together with the essential role of demand-led change.

However, the really difficult process starts now as we move from target setting to the implementation of the energy transition. This will require hard choices; including on which energy technologies will not play a major role, and what market arrangements will enable decarbonisation whilst also meeting security, equity and cost effectiveness goals. Ultimately the energy transition will create winners but also losers and this challenge may be the hardest of all.

There is a window of opportunity, based on rapidly falling technology costs (e.g., offshore wind and solar photovoltaics), an emerging consensus on the use of (and infrastructure needs of) electric vehicles, the analytical frontier being pushed out through the availability of big data in the energy sphere, and the innovative offering of new market entrants (both large and small).

But these opportunities will only be realised if we have bold and sustained policy making – recognising that near-term pressures such as Brexit take up so much political time and energy. We also need societal buy-in and the active participation of consumers, which requires good answers to the really knotty problems – such as how to replace the incumbent option of 28 million gas boilers in UK residential homes.

In this implementation challenge the vision of the UCL Energy Institute remains even more relevant: Our aim is to help to build a globally sustainable energy system, by bringing to bear multiple disciplinary perspectives to observe, analyse, interpret and influence energy use and energy systems.

Our cutting edge research continues to provide underpinning insights for the energy transition. Recognising this a multi-decade challenge our vibrant teaching programmes become ever more important and I am especially delighted by the very successful launch of our new MSc in Energy Systems and Data Analytics led by Aidan O'Sullivan. And our staff's outreach efforts to communicate our work in the real world is hugely important. This spans advising on detailed policies (e.g., for access to the huge flow of smart meter data), though engaging with media (television, print, specialist, and social), to advising international stakeholders (e.g., the global shipping industry).

Lastly, we have been working very hard this year on how to manage the UK's leading energy systems and energy demand centre of excellence. With over 100 staff and PhD students this not only involves raising large amounts of money, but crucially ensuring that we remain a stimulating place to work, while treating all our staff and students with dignity and respect. One vital element of this is in the support of women in science, especially in light of the #MeToo and the gender pay gap debates. Academia is not immune to intended and unintended biases against women and indeed has specific challenges. While we are delighted that Catalina Spataru has been promoted to Associate Professor, that she is the first female professor in the UCL Energy Institute shows how far we have still to go. We will therefore continue to prioritise the development of all our early career researchers and PhD students.

Please do read our 2018 Annual Review, find out about the research, teaching and outreach that we do, and please do get in touch with us as funders, collaborators, colleagues and potential students.

Professor Neil Strachan
Director

Professor Paul Ruyssevelt
Deputy Director

CREDS

UCL plays leading role in new landmark energy research centre

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 CEE. 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 event celebrated the work of 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 23). 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 availble 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 estimated consumption 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 3DStock 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, urban and infrastructure (including transport and buildings), 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 1.5C 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

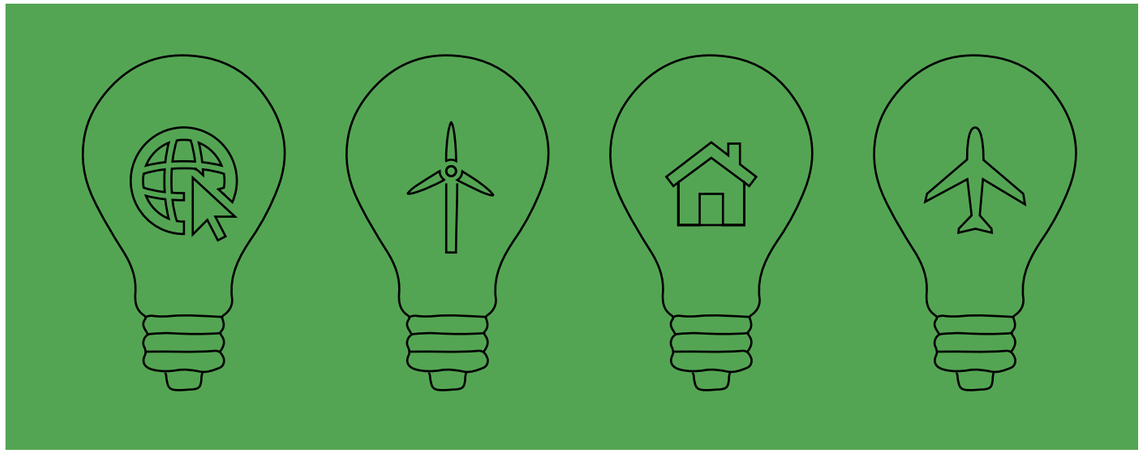
"I have found that my studies at UCL have been tremendously beneficial. Since graduation, I have been working in my home country of Iceland as an energy and environmental consultant. My clients have been power companies, the Icelandic TSO, aluminium smelters and other smaller users and producers of electricity. 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

Postgraduate study

Energy Systems and Data Analytics MSc



UCL launches an innovative MSc combining data science and energy systems

Energy systems are a fundamental component of society that have evolved and changed with new developments and advances in science and technology. The modern phenomenon of advanced analytics, fuelled by big data and massive computational power, has brought about significant changes in a number of industries. The influence of this data science revolution is beginning to be felt in the energy sector and has the potential to transform how energy systems are designed, operated and maintained at a fundamental level.

The MSc in Energy Systems and Data Analytics will provide an academically leading and industrially relevant study of energy systems through the lens of data analytics. The programme encapsulates the whole-energy inter-disciplinary approach of the UCL Energy Institute. Students will gain the skills and knowledge to unlock the transformative potential of big energy data, learn about the role it is playing in reshaping these sectors and the exciting commercial opportunities this presents.

The programme is the first of its kind in the UK and Europe and demonstrates the Bartlett's commitment to developing innovative new programmes to meet the skills needs of industry. The programme has been developed with support from a range of industry partners from large scale utilities like EDF to innovative new startups entering the space like Voltaware and Verv.

London,
Bloomsbury

Full time - one year
Part time - two years
Flexible - two to five years

Programme Lead
Dr Aidan O'Sullivan

ucl.ac.uk/energy/esda

"The MSc ESDA addresses a key skills gap in the Energy Industry for graduates with expertise in energy systems and also cutting edge data analytics skills."

Xavier Mamo
Director of the EDF Energy R&D UK Centre

ESDA scholarship

A new 'ESDA Potential Energy Scholarship' is students specifically for the Energy Systems and Data Analytics MSc programme.

The scholarship, open to UK, EU and overseas students, will be awarded on merit, with applicants being scored on their academic and professional excellence in related fields.

For full details of the scholarship, and other funding opportunities, visit our website ucl.ac.uk/energy/esda

Talking data

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.

Postgraduate study

Economics and Policy of Energy and the Environment MSc

Image: Si-Gal, iStockphoto

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.

London,
Bloomsbury

ucl.ac.uk/energy/epee

Full time - one year
Flexible - two to five years

Programme lead
Dr Lorenzo Lotti

"I credit the EPEE programme with giving me skills I use daily in my work: modelling and scenario analysis, econometrics and statistical thinking, a broad understanding of climate and power sector policies, and environmental and energy economics which are the foundations for my work."

Hiren Mulchandani,
Senior Analyst, Commissioned Projects, Aurora Energy Research
EPEE MSc Alumni

Staying connnected

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 Kerr 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 Will McDowall 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.

Photo: UCL Energy Institute

Postgraduate study

Energy Demand Studies MRes

Photo: UCL Energy Institute

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) offers 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 repescted 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

London,
Bloomsbury

Full time - one year
Flexible - two to five years

Programme lead
Dr Catalina Spataru

ucl.ac.uk/energy/eds

"This course helped me a great deal in not only learning about the pertinent topics in Energy Demand such as the performance gap in non-domestic buildings and behavioural economics but also how to properly research a topic and establish the scope and parameters of a research project."

Duncan Grassie
EDS MRes Alumni

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.

Doctoral research

MPhil/PhD in Energy


Image: UCL Energy Institute

We select the best students for first-class training and prepare them to launch careers as the energy pioneers of tomorrow.

Our PhD candidates work alongside experienced researchers in a dynamic, multi-disciplinary environment. They are core to the Institute's research activities, contributing to a wide range of ongoing research and consultancy projects, including being named authors on a number of national and international papers.

Our core research themes are independent but also interact, resulting in innovative approaches to energy-related problems. At the end of their PhD candidates will produce a thesis on an energy topic of their choice, demonstrating capacity to pursue original research based upon a good understanding of the research techniques and concepts appropriate to the discipline.

London, Bloomsbury

ucl.ac.uk/energy/phd

Full time - Three years
Part time - Five years

> *"Having completed a MSc in Public Policy, I decided I wanted to apply the knowledge I'd gained of behavioural public policy at PhD level. I applied and was fortunately accepted on the LoLo CDT and completed a PhD in how behavioural science could be applied to boost domestic consumer uptake of demand-side response tariffs and products.*
>
> *About a year before I finished, I saw that the British Energy regulator, Ofgem, was advertising for someone with the same experience and skill set I'd been developing over my Masters and then PhD. This is the role that I now work in. I feel very confident that my PhD played a major role in making sure I was qualified for the role and hope that it will help me progress with my career in future too."*
>
> *Dr Moira Nicholson,*
> *Senior Behavioral Insights Practitioner, Ofgem*
> *UCL Energy Institute Alumna '18*

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 Nationally 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).


Photo: Dayang Abu Bakar

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 challeneges: hot 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 real, 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 Aereco, and 'Blockchain enabled peer-to-peer energy flexibility trading' with GreenRunning, among other.

LoLo

Visit lolo.ac.uk for more information on joining as a student or partner.

Women in LoLo


Anna Mavorgianni, Supervisor LoLo CDT


Sofie Pelsmaker, Alumni, LoLo CDT

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 Pelsmakers 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 overview


Photo: UCL Energy Institute

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 reserahcers 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 17/18 academic year, across the five research themes, members of the UCL Energy Institute worked on 32 active research project with a value of just over £22.5 million. Across these projects, 95 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/energy-models

Seasonal shifts


Photo: Shutterstock

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


Photo: metamorworks, iStockphoto

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


Image: liuzishan, iStockphoto

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 exists 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

Research: Transport

The Transport research theme works across modes of transport, with groups focussing on Aviation, Shipping, and Mobility as a Service.

The **Shipping** group has 15 researchers and PhD students involved in a number of on-going projects, funded through research grants and consultancy through University Maritime Advisory Services (UMA. Led by Dr. Tristan Smith, the group researches using models of the shipping system, shipping big data and qualitative and social science analysis of the policy and commercial structure of the shipping system. Its research activity focusses on understanding patterns of energy demand in shipping and how this knowledge can be applied to transition to a low carbon future. The shipping group is world-leading on two key areas: using big data to understand trends and drivers of shipping energy demand or emissions and using models to explore 'what-ifs' for future markets and policies.

Air transportation is a vital enabler of economic growth and quality of life through empowering trade and tourism. However, its large and growing scale generates undesirable effects, such as air traffic delays and environmental impacts at the local, regional, and global level. The Air Transportation Systems Laboratory explores interactions between air transportation, the economy and the environment. Its data-driven work uses physical science, econometric, and operations research-based methods. Its unique Aviation Integrated Model (AIM) consists of interlinked modules simulating current and future levels of global airport-to-airport demand, flight schedules, arrival delay, technology uptake, aircraft performance, local and global emissions, aircraft noise, and related environmental costs and economic benefits under a range of policy conditions. Most recently, work has focused on the local and global implications of airport capacity expansions.

MaaSLab's research focuses on urban and regional transport, exploring new mobility concepts, such as Mobility as a Service, and new mobility technologies, such as autonomous vehicles and drones for passengers and freight. MaaSLab's expertise lies in transport and behavioral models, discrete choice models, survey design and innovative data collection techniques, big data handling and new mobility service design and pricing. MaaSLab has several large-scale national and international research projects on these topics and its activities, approaches and aims synergise with the low carbon and smart cities vision. MaaSLab works closely with the industry and public authorities to make sure that our cutting edge solutions and methods are utilised in real-life and have an impact on society.

Aviation Integrated Modelling +

Airport capacity expansions are among the most contentious policy decisions. Proponents for adding runway capacity point to economic benefits occurring at local, regional, and national levels. In contrast, opponents to capacity expansions argue unrestricted capacity growth would impact those living around airports via increased noise and reduced air quality, and the wider population via its contribution to climate change.

Currently, the world's air transportation system encompasses airport capacity expansion projects with a combined value in excess of $500 billion. However, no tool exists that would rigorously evaluate the associated local, regional, and global-scale trade-offs. Building upon the Aviation Integrated Modelling (AIM) tool, the aim of the ACCLAIM project is to enhance the AIM tool to assess implications from capacity expansion projects at any airport in the world. The resulting AIM+ model captures complex relationships between airport capacity, technology, operational and fleet change and passenger demand in the short-, medium- and long-term, while dealing with the complex interplay of uncertainties.

The key features of the AIM+ model were tested for the Australian air transportation market, as a geographically isolated region with significant levels of demand and complexity. The enhanced model simulates the behaviour of each airline, which maximises profits within its network by adjusting the decision variables of airfare, flight frequency and choice of aircraft on particular routes. The simulated airline specific airfares, flight frequencies on segments, passenger flows and airline market shares strongly correlate with observed values. The AIM+ model is now being tested for the domestic US market, before it is scaled up to global air traffic and applied to evaluate the local and global consequences of airport capacity expansions. Two papers describing the model validation and its application to the planned capacity expansion of Melbourne Tullamarine airport were submitted to the 2019 Transportation Research Board Conference.

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 countries 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 25% of global emissions by 2050, more than any single nation.

The shipping sector however made a world-first move, making 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 cited in policy discussions 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 modelling methodology to estimate the emissions of shipping for the UK's National Atmospheric Emissions Inventory (NAEI). The findings are intended to inform a more authoritative evidence base to be used for official international reporting obligations.

Looking forward, the team utilised UCL's model GloTraM to develop possible emissions scenarios and a method for quantifying an emissions pathway for shipping for the Danish Shipowners Association. The model considers sector changes by simulating growth over time in response to changes in transport demand, macroeconomics, technology, and regulation. This work created maximum impact when used by member state coalition Shipping High Ambition Coalition to argue and use scientific evidence for a high ambition in GHG emissions reductions just prior to shipping's climate deal being reached.

The next battle for our shipping group will be net zero shipping emissions, with better financing for Zero-Emission Vehicles necessary to meet and exceed targets.

Future transport: Mobility as a Service

The landscape of the mobility sector is constantly evolving. With tightening global CO2 regulations industry has been adopting disruptive technologies 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.

MaaSLab 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 framework 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. MaaSlab is heavily engaged in MaaS4EU with Dr Maria Kamargianni, Head of MaaSlab, as the Scientific and Technical Manager of MaaS4EU.

MaaSlab 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. Najah Al-Qarawi as a visitor Research Fellow. The project was completed in collaboration with the Imam Abdulrahman bin Faisal find out more about the findings at iau.edu.sa/en/She-Drives-KSA

Closer to home the team recently produced a report for Transport for London on 'Londoners' attitudes towards car-ownership 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 MaaSlab's research stays ahead of the curve, providing in-depth insights and guidance about MaaS to industry and public sector.

Research: Energy Systems


Photo: yangphoto, iStockphoto

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 theme had a number of EPSRC projects start and conclude this year. The multi-year, project **wholeSEM** finished at the end of 2017. This flagship project aimed to create a step change in energy system modelling capability in the UK, while engaging stakeholders in academia, government and industry. **Bio-value Energy Chains**, focussing on whole system analysis to understand potentials and risks of biomass technologies and supply chains, also concluded this year. A scoping study on how to better **model critical societal and political drivers** of energy transition ended, leading to a successful proposal for a larger project starting soon. Work continues on other EPSRC projects, such **Restless**, aiming to understand how storage technologies could be best integrated in low carbon UK energy system.

Systems has continued to contribute to **UKERC Phase III**, focussing on the roles different vectors may have in the future energy system. UKERC has also funded BECCS project, assessing the potential, feasibility, and impacts of bioenergy with CCS (BECCS) in the UK.

The team was commissioned by Mexico's Ministry of Energy (SENER) to develop **TIMES MX-Regional**, a multi-regional energy systems model for Mexico that will be used for policy-making decisions from 2019. The team is also working on a number of EU-funded projects; **REEEM** focuses on modelling an EU-wide energy system transition and its impacts. **INNOPATHS** investigates how EU's decarbonisation ambitions could be achieved and potential impacts on the EU economy and society. **DEEDS** aims to delivers state of the art knowledge on decarbonisation pathways for EU and facilitate interactions between policy, business representatives, scientists, NGOs and other stakeholders. **RIPPLES** studies the implications of availability of finance on climate targets.

Nature journal papers

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. Zeyringer 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 Fuso Nerini et al., 2018 published in Nature Energy mapping the synergies and trade-offs between energy and other sustainable development goals was (see page 6)

Image: UCL Energy Institute

Research: Energy Space Time

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 SiCEDS 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


Image: imaginima, iStockphoto

Featured projects

In the past year the EST team have worked on a variety of projects across space and time. The Stakeholder City Energy Demand Simulator model was trialled in Exeter and Birmingham and it is now being commercialised. The team is working to extend the model to other cities.

A dynamic model and database is being developed, investigating feasibility of high shares of renewable energy and increasing use of interconnections and storage between countries and islands. This would allow balanced demand and supply across region, achieve sustainable goals, and meet 2030 agendas.

Group members engaged the international community. Mark Barrett and Claire Holman presented to the European Task Force on Integrated Assessment Modelling on modelling air pollution in cities and 'A 100% renewable scenario for the UK'.

Catalina Spataru was spoke on 'Rethinking the future of sustainability: The power of Global Super Grid' at IEEE WIE ILC. She also took part in a discussion on transitioning towards more technology and sustainable, healthier cities at the European Business Summit with a Member of European Parliament.

The EST team disseminated work in high impact journals and books. 'Comparison of CST with different hours of storage on the Australian National Electricity Market' was published in Renewable Energy. The paper on 'Sustainable development of West African Power Pool', in Energy for Sustainable Development, assessed the impact of increasing solar energy integration and regional electricity trade. Various case studies on scenario analysis for sustainable island power systems under energy trilemma index were published. In a cross-UCL collaboration, members contributed to joint publications such the paper on Energy and SDGs (page 6).

Two books of Catalina Spataru' were published. One discusses the Whole Energy System Dynamics while the other one focusses on possibilities of transitioning island nations into sustainable energy hubs.

Research: Buildings

Photo: ivansmuk, iStockphoto

The Buildings theme studies domestic, non-domestic, smart energy and heat through the lenses of energy epidemiology, building physics and socio-techinal 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 replace 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 on fuel poor customers concludes, work on the larger Smart Meter Research Portal begins

The ongoing work on the 3DStock and SimStock models has also received further funding through the iNumber, LUSTER, and GLA London Building Stock models. On top of this work, doctoral research in the theme, supported by the LoLo Doctoral Training Centre (see page 15), continues to push the boundaries of the field across all areas of the Theme's activities.

One of the theme's favourite findings shows how statistical analysis of the variation in EPC values for air permeability in new buildings catches companies 'hitting the target but missing the point' - through a combination of temporary sealing and repeated testing until targets are reached. This illustrates the power of data and analytics to flush out bad practice and drive up standards in the industry.

Smart Meter Research Portal

Building national energy-research infrastructure.

The Smart Meter Research Portal (SMRP) was funded by UKRI in mid-2017 to provide a single point of access to a nationally representative sample of smart meter data to the UK research community.

The project, at the start of its second year, is on track to recruit over 10,000 participants in 2019. In conjunction with the UK Data Archive at the University of Essex, the portal is creating best practice mechanisms for secure, public interest research into energy demand 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.

SMRP is breaking new ground by being the first non-utility to access smart meter data through the DCC Gateway and is reshaping how participant consent is obtained and managed in this sector.

The Portal will move from its development phase into its operational phase in September 2019 by opening up initial data sets to consortium members and the UK academic research community. Once open, the portal will substantially increase access (at lower cost) to high resolution energy data and contextual data, and simultaneously increase the value of that data by providing historical baseline data against which to measure change. This will both accelerate and substantiate work in this field.

Photo: MartinPrescott, iStockphoto

RCUK **Centre for Energy Epidemiology**

The RCUK Centre for Energy Epidemiology (CEE) is the UK's first dedicated energy epidemiology research centre, seeking to transform the way research into reducing energy demand is undertaken. Using an epidemiological approach, CEE provides data-driven insights into the drivers of end-use energy demand, and the impacts of measures to reduce it.

Since launching in 2013, CEE has pioneered research in energy epidemiology, developing and applying new methods and generating impact through collaborations with industry and government to produce novel findings.

CEE researchers have been working to develop a method for modelling all buildings in a given locality, representing the complex relationships of premises to buildings, and recording activities on each floor level. 3DStock was developed, using a combination of Ordnance Survey maps giving building footprints and addresses, data from the Valuation Office Agency giving floor areas and activities in non-domestic premises, and LiDAR data (laser measurements from aircraft) giving building heights and external geometry, a method unprecedented in its detail and sophistication. The team's ambition is to extend the coverage of 3DStock to 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 simulation models 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 CO_2 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 agreements 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

Photo: rawpixel, Pixabay

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 in the creation of 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."

Image: UCL Energy Institute

Teaming up with TfL

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

UCL-Energy's MaaSlab completed a report for Transport for London on Londoners' attitudes towards car-ownership and Mobility-as-a-Service in February 2018.

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 scheme 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 is 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 ideal, the option of car sharing has been quickly accepted with the decade it has been around. Looking to the future there is a positivity towards alternatives to car owning.

Enter Mobility as a Service (MaaS). MaaS is the virtual integration and bundling of public transport modes and mode-sharing schemes in London, giving access to all these modes through a single interface payment and ticketing method. 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 them would even be willing to sell their cars for unlimited access to car sharing for the next couple of years. Further, 40% of non-car-owning participants stated they would not purchase a car at all if MaaS were available. Beyond car sharing, respondents agreed they would be more willing to try modes of transport they previous 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 modelling 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.

Photo: johnkellerman, iStockphoto

External engagement

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 for partners, 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 flag-ship 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 YouTube channel. Keep an eye out on our website for announcements of our next year's speakers, announced monthly.

Our staff also engage regularly with the media, regularly featuring in major news outlets with research findings or commenting on major global energy and environment issues. Professor Neil Strachan, UCL Energy Institute Director, featured on BBC News to discuss on Jeremy Corbyn's announcement at the 2018 Labour Party Conference that he would create 400,000 new green jobs. The shipping team have also made a splash, being featured in a number national and industry publications, with lead Tristan Smith regularly giving comment to news outlets such as the Independent.

We continue to engage with our community online. Our twitter feed @UCL_Energy keeps followers up to date with the latest research news and events coming from the Institute and has gained over 1000 followers on Twitter in the past year. The Institute also continues to expand its LinkedIn presence, with alumni groups connecting past students and opportunities at the Institute regularly posted.

Energy10

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

Officially launched in June 2009, the Institute began as 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 website at ucl.ac.uk/energy

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/bartlett

Photo credit

UCL-Energy seminar series

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 respond to the cutting-edge research of our speakers. All seminars are recorded and rewatched hundreds of times on YouTube, widening their impact.

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 Reinhart, building scientist from MIT, to discuss with us 'Cities for Millenials – 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. Also, in the building sector our Deputy Director, Professor Paul Ruyssevelt, 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 Zeyringer 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 de-carbonisation 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 dependencies 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 Wallom 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.

Image: Kubkoo, iStockphoto

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