Since our last report, the energy supply-side transition has made huge strides. In July 2016, a bid price for offshore wind of €72.70/MWh (€87/MWh with transmission) was recorded at Borssele. Weeks after the last Directors’ Report, €49.50/MWh (without transmission) was recorded, followed by a strike price of £57.5/MWh for offshore wind in the UK CFD Round Two auction in July 2017.

Elsewhere, 2016 and 2017 saw bid prices for utility scale low-latitude photovoltaics (PV) fall steadily, with under 2 US$/kWh recorded in Mexico at time of writing. There are obvious reasons why UK PV prices are likely to be around a factor of two higher, and why Gigawatt scale installations are unlikely here. But that does not undermine the strategic significance of PV at these prices. Costs for renewable electricity routinely below the levelised cost of fossil-fired plant will halt the construction of new fossil-fired plants. Meanwhile, renewables at less than the fuel cost of fossil-fired plant is likely to lead to mothballing or decommissioning of existing plants. Both will cause a sharp reduction in consumption of fossil fuel for electricity production, directly impacting prices that the UK pays for fossil fuels. Meanwhile, the soaring cumulative deployment of wind and PV will boost R&D, reducing global costs.

At least three feedback loops are at work with respect to price trajectories of wind and PV:

- learning effects, driving down production costs by through size, materials innovation and engineering
- de-risking driving progressively lower internal rates of return
- scope for big earnings pulling in large firms, reducing financing and technology costs.

Falling prices are a fine example of the socio-technical nature of innovation. For wind, Denmark, the Netherlands and the UK have optimised bidding and financing systems, with industry in turn optimising turbines, and installation, operation and maintenance processes. Each requires the actuality and the promise of the other. Other factors include modularity, installation speed and, for PV, systems that can be easily installed. At the same time, the pace of electrification in downstream markets such as transport suggest an epochal, and profoundly hopeful, transformation.

Significant challenges remain, such as decarbonising energy intensive industries, aviation, and shipping. Policy uncertainty continues, with the UK Industrial Strategy coinciding with Brexit, and uneven responses to the Paris Agreement globally. Combining demand, supply, transmission and storage technologies, with emerging business models, contractual systems and governance structures, may take decades. The research community should support developments across the whole economy, building resilient, cost-effective whole energy systems as new supply-side technologies emerge. As the rest of this Review demonstrates, the UCL Energy Institute is working at the forefront of this challenge.
UCL-Energy finds that efficient ships save millions but market fails to reward owners
A report released in August 2016 from UCL-Energy and Carbon War Room confirmed that vessels with high design efficiency leave millions in the pockets of fuel payers. However, the market often fails to reward owners of efficient vessels by way of premiums or preferential hiring. This does not help the industry's efforts to meet the challenges of a low-carbon future, and could challenge regulations designed to reduce total industry emissions.

Hinkley Point to be obsolete within a decade, UCL analysis suggests
Analysis published by Andrew ZP Smith and Professor Michael Grubb in September 2016 suggested the planned Hinkley Point C nuclear plant will be outpaced by cheaper, lower-carbon energy sources that will render it largely obsolete within a decade of opening. The analysis, based on National Grid's own energy scenarios, shows that by 2030 wind and solar energy sources, will, for increasing periods of the year, be meeting all the UK's electricity needs.

UCL-Energy examines energy and climate collaboration in Europe
On 21 September 2016 UCL-Energy held the final event in a series organised jointly with the French Embassy under the auspices of the long-established relationship between the French Embassy’s Science and Technology Department and UCL’s Grand Challenges programme. The workshop, entitled “Energy and Climate Collaboration in Europe: Ways Forward” was supported by the UCL Institute of Sustainable Resources, Climate Strategies and the Institute for Climate Economics (I4CE).

UCL-Energy at the UN’s 70th Marine Environment Protection Committee
In October 2016 the International Maritime Organization (IMO) met for the 70th session of the Marine Environment Protection Committee (MEPC). On the first day of the committee meeting Dr Tristan Smith and Carlo Raucci along with the lead authors presented the findings of the IMO fuel availability study as a side event presentation.

UCL-Energy creates animations explaining UKTM and BLUE models
The UK Times (UKTM) Model, maps the complex UK Energy System, helping us plan how to meet government targets and achieve a secure, affordable and low carbon energy system by the year 2050. The Behaviour, Lifestyles and Uncertainty Energy (BLUE) model is a system dynamic model of the UK energy system that simulates future energy transitions and the associated changes to technologies, energy use and emissions. Animations explaining the model can be found on the UCL-Energy YouTube channel.

UCL-Energy report highlights potential for smart meter data to support healthcare
The report entitled ‘Energising health: a review of the health and care applications of smart meter data’ is the most comprehensive review of potential uses of energy data in healthcare to date. Written with Smart Energy GB, the report was published in May 2017, more on page 25.

Electric car revolution would be fuelled by ‘nudging’ drivers to smart tariffs, UCL research finds
Electric vehicle owners can be successfully ‘nudged’ into choosing smarter, lower-carbon tariffs for charging their cars via simple email campaigns, new UCL research published in Nature Energy, led by PhD student Moira Nicholson, suggests.

Reflections on President Trump withdrawing the US from the Paris Agreement
Director Professor Bob Lowe reflected on President Trump withdrawing the United States from the Paris Agreement in June 2017 stating “Perhaps the most lasting effect of the US withdrawal from Paris, and Donald Trump’s greatest gift to humanity, will be to have rendered climate denialism politically untenable.”

New research finds potential for greater retrofit energy savings in homes
New research in paper titled ‘Suspended Timber Ground Floors: Measured Heat Losses Compared with Models’ reveals the actual heat loss from suspended timber ground floors might be nearly twice that of previous estimates. The potential for thermally upgrading such floors is much greater than formerly expected.

Report on time of use tariffs released by Citizens Advice
The report, ‘The Value of Time of Use Tariffs in Great Britain’, commissioned by Citizens Advice was published in May 2017. UCL-Energy researchers Mike Fell, Moira Nicolson, and Gesche Huebner, worked alongside The Brattle Group, to assess the value of time of use tariffs to the UK energy system and to domestic energy consumers.

UCL-Energy lead project on peer-to-peer energy trading through blockchains funded by the PETRAS Hub
Professor David Shipworth will be leading one of 15 new projects funded by PETRAS, the UK’s Internet of Things Research hub, and the Lloyd’s Register Foundation. The project is entitled ‘The Internet of Things: supporting peer-to-peer energy trading and demand side management through blockchains. (P2P-IoET)’.

Discover more at ucl.ac.uk/energy
@UCL_Energy
RESEARCH CASE STUDY

MaaS4EU: End-to-end Approach for Mobility-as-a-Service tools, business models, enabling framework and evidence for European seamless mobility

As transport demand is projected to grow, the current methods of transport supply are deemed unsustainable, generating a need for innovative services to support seamless mobility and a shift from car-ownership to usership. An emerging trend in this direction is the integration of on-demand modes in conjunction with public transport, leading to the Mobility-as-a-Service (MaaS) concept, a user-centric, intelligent mobility distribution model, in which users’ needs are met via a single platform by a service provider.

Launched in June 2017, MaaS4EU over the next three years will address new concepts of MaaS by providing quantifiable evidence, frameworks and tools, to remove barriers and enable a cooperative and interconnected EU single transport market for the MaaS concept.

By addressing challenges at business, end-users, technology and policy levels, MaaS4EU will provide quantifiable evidence about MaaS costs and benefits in three real-life, complementary pilot cases, demonstrating the concept in urban, intercity and cross-border environments at three different European locations (i.e. Manchester, Budapest and Luxembourg-Aachen).

“UCL MaaSlab, as a worldwide leader on the MaaS research, is the Scientific and Technical co-ordinator of MaaS4EU. UCL MaaSlab also leads the working package on the impact of MaaS on short- and mid-term travel decisions, congestion and energy consumption, while it is also responsible for the demonstrations in the three pilot areas.” Maria Kamargianni, MaaSlab, UCL- Energy Institute, MaaS4EU Scientific and Technical Co-ordinator

Discover more at @MaaS4EU maas4eu.eu

RESEARCH OVERVIEW

Research is the bedrock of UCL-Energy. Most energy problems are multidisciplinary in nature, spanning science, engineering and the social sciences. Therefore, different approaches are needed to understand and tackle these issues. UCL-Energy’s research works to develop a range of tools, model and methods to address the energy challenges facing the world over the next two decades.

During the 2016/17 academic year there have been 16 active research projects over the Institute’s four interacting themes: Energy Systems (page 8–9), Buildings (page 10–11), Transport (page 12–13), and Energy Systems (page 14–15).

The Institute also hosts two research centres: The Whole Systems Energy Modelling Consortium (wholeSEM, page 20) and the Research Councils UK Centre for Energy Epidemiology (RCUK CEE, page 22).

Beyond the Institute’s core activity, UCL-Energy also acts as an umbrella for energy-related research at UCL, bringing together leading researchers on a multitude of energy challenges. This academic year saw the launch of the UCL Energy Network. Directed by Professor Bob Lowe, the UCL Energy Network has been set up to promote collaboration between energy-related researchers across UCL, uniting the work of dozens of schools, departments, centres and Institutes under one banner.

Most energy problems are complex, and addressing them requires a range of disciplinary perspectives and methods. UCL-Energy aims to develop a working environment in which colleagues can work across boundaries to address such problems.

Discover more at ucl.ac.uk/energy/research

Credit: Ivan Smuk

Credit: MaaS4EU

“UCL MaaSlab, as a worldwide leader on the MaaS research, is the Scientific and Technical co-ordinator of MaaS4EU. UCL MaaSlab also leads the working package on the impact of MaaS on short- and mid-term travel decisions, congestion and energy consumption, while it is also responsible for the demonstrations in the three pilot areas.” Maria Kamargianni, MaaSlab, UCL- Energy Institute, MaaS4EU Scientific and Technical Co-ordinator

Discover more at @MaaS4EU maas4eu.eu

Credit: MaaS4EU
The Energy Space Time group carries out research into 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. Set up by Professor Mark Barratt and Dr Catalina Spataru in 2015, the group carries out research into the design and application of sustainable energy systems, system integration in space and time, working to support the development of secure, environmentally-sound city and national energy systems. It works with research communities, industry, NGOs and the public to promote a wider understanding of energy resources and environment in space and time.

The group has deep expertise in the following major themes:

- Whole Energy System dynamics
- Interconnections and RES impact
- Integrated systems

Highlights 2016/17

The global islanding cross-border electricity interconnection model Developed by Dr Catalina Spataru, the model aims to assess interconnections between countries and between islands capturing the energy system dynamics. It is currently being trialled in Africa and Greek Islands, investigating the feasibility of very high shares of renewable energy in the energy systems, increasing use of interconnections and energy storage, allowing the balancing of demand and supply across global regions.

City energy and environment model
A team lead by Professor Mark Barrett (technical director) developed SiCEDS (The Stakeholder City Energy Demand Simulator), which simulates energy and environment scenarios for cities, calculating energy flow, costs, emissions, air pollution health and fuel poverty. The model aims to assess energy use in cities and study scenarios. The model is currently trialled in Exeter and Birmingham and is being commercialised. The team is now working on extending the model to other cities.

Dr Catalina Spataru’s books published
‘Whole Energy System Dynamics: Theory, modelling and policy’, authored by Dr Spataru was published in February 2017. Together with colleagues from other universities, Catalina also edited ‘Smart Energy Control Systems for Sustainable Buildings (Smart Innovation, Systems and Technologies)’, published in June 2017.

International presentations
Group members engaged with the international community with presentations, as well as collaborative meetings in the USA and Germany, including:


Selected projects

Stakeholder Interactive City Energy Demand Simulator (SiCEDS)
Funded by Innovative UK, this project, being carried out in conjunction with the Energy Saving Trust, Aecom, and Fraser Nash, aims to aid the development of energy and environment policy in cities and nationally using data and models. It also aims to engage with stakeholders and create scenario plans for energy projects, so that approved schemes best meet each city’s unique visions and objectives.

RESTLESS storage project
As part of this project, the Energy Space Time group will contribute in using the high temporal resolution DynEMo model to examine how active and passive storage can operate, particular in future with electrification and variable renewable supplies. Hourly data and meteorologically driven models of demand and renewables in 30 European countries to assess storage and long distance transmission will also be developed.

Air pollution project
Funded by ClientEarth, this project produced analysis showing an interactive GIS map showing the proximity of UK schools to the most polluting roads and their background pollution levels.

The vulnerability of refrigerated food to unstable power supplies for UK, Brazil, Thailand and India
This project investigates how the proliferation of refrigeration might affect the vulnerability of refrigerated food, as countries develop chilled food chains and electricity grids.

Selected publications


doi:10.1016/B978-0-12-803440-8.00022-1

RESEARCH: BUILDINGS

Buildings is the largest theme of research at UCL-Energy, coordinated by Professor David Shipworth and Dr Clift Ewells. A world leader in buildings and energy research, UCL-Energy’s buildings research work is predominantly applied, with particular emphasis on supporting policy and regulatory work on energy demand in buildings and communities. The research undertaken is distinguished by spanning scales from data driven modelling of national building stocks, to modelling the heat flow through individual building components and systems. While largely funded by research council grants, substantial funding also comes from technology translation bodies, government and industry.

Highlights 2016/17

Building stock modelling
The non-domestic buildings team has progressively consolidated its’ 3DStock and SimStock models. This year it expanded geographic coverage, as well as including domestic buildings within mixed use urban areas. By generating geometrical descriptions of self-contained units (SCUs) and their material properties, the model provides a powerful tool to assess urban morphology. Combined with SimStock, the energy demand of the stock can be modelled. The models have applications in supporting a detailed assessment of the costs of building retrofit, and potential for distributed generation within urban areas. Additional funding has been secured through the iNUMBER project to extend this work in a collaboration with partners in the UK and India.

Peer-to-peer energy trading
The People, Adaptability, Comfort and smart Energy (PACE) group developed a new area of research on peer-to-peer energy trading in buildings and communities. Supported by EPSRC and CDT funding, and with considerable interest from business and the regulator Ofgem, this is a rapidly emerging area of work supporting new business models in the energy transition.

Smart meter research
There has been considerable research using smart meter data, helping to understand both the physical performance of buildings and demand side response. Researchers within RCUK CEE (page 22) have used smart meter data to continue development of the Power Temperature Gradient work with potential application in the development of empirical Energy Performance Certificates. Within the LCNF Energywise project, the impact of smart metering on fuel poor and vulnerable consumers has shown their capacity to save energy and benefit from the national rollout. Funding has also been secured to establish a Smart Meter Research Portal (page 22).

Building physics research
The Physical Characterisation of Buildings group has further developed its fundamental work on methods to assess the thermophysical and hygrothermal performance of buildings. Through the use of Bayesian analysis combined with physically informed models, the group has have contined to drive down the time required to estimate U-values of components, characterise whole house heat loss, and investigate moisture transfer through walls.

Selected projects

iNUMBER (Intelligent Urban Model for Built environment Energy Research)
Led by Katy Janda and Paul Ruysewelt this joint India/UK, four-year, –£1M grant, with Professor Rajan Rawal of CEPT University, will provide the tools and analysis to enable key stakeholders to plan and manage the development of cities to provide high quality built environments while limiting energy demand, carbon emissions and environmental impact. This will build on the work of the 3DStock and SimStock modelling team and apply this in the Indian context.

BEAMS Doctoral Prize Fellowship
Virginia Gori of the Physical Characterisation of Buildings research group was awarded the BEAMS Doctoral Prize Fellowship with a project entitled Bayesian Building Physics: The Rapid Characterisation of Dynamic Building Heat Loss. This two-year project will allow her to continue this potentially transformative building physics work.

Peer-to-peer community energy trading
The PACE research group has had two projects funded, one through the PETRAS Hub (–£107K) and one through the LoLo CDT with Green Running (–£110K). The group has two further grant applications under development and invitations to participate in a further three field trials.

ENDURE
Michelle Shipworth and Paolo Agnolucci submitted an H2020 second stage proposal as part of a consortium. Aligned with the Mission Innovation low carbon heating and cooling challenge, the ENDURE project seeks to identify the factors triggering social acceptance of energy policies by bridging the gap between policy making and both citizen/consumers and a broad range of middle actors relevant to heating and cooling.

EUED II Buildings and Comfort Theme
Professor Nick Eyre of Oxford University has confirmed that Professor Tadj Oreszczyn will lead the “Buildings and Comfort” theme in the preparation of the proposal for the new –£15M EUED Research Centre.

Selected publications
RESEARCH: TRANSPORT

Led by Professor Andreas Schäfer, Dr Tristan Smith and Dr Maria Kamargianni, UCL-Energy’s Transport research theme covers all major modes of transport, spanning all geographic scales, from local scale urban transport to global networks of shipping and aviation. This interdisciplinary team consists of three academic staff and seven research staff.

Highlights 2016/17

Shaping in Changing Climates
One of the shipping research group’s RCUK Energy programme projects Shipping in Changing Climates successfully concluded this year with a UCL-hosted international conference and ‘key findings’ event as part of London International Shipping Week 2017. Along with a series of publications, the research consortium also launched “Low Carbon Pathways 2050 study”, a new report with Lloyd’s Register. The Shipping in Changing Climates brand will continue through an annual industry/academic international conference hosted in Gothenburg in 2018, and the underpinning research continues through a network of diverse arising funding and collaboration.

Hybrid-electric and Electric Aircraft Symposium
The Air Transportation Systems Lab of UCL Energy hosted a symposium on ‘Hybrid-electric and Electric Aircraft—researching the challenges to introduction’ at Woburn House in May. The event, which was jointly organized with the EPSRC and the Aerospace Technology Institute (ATI), had 170 attendees from academia, industry, and the UK Government.

Urban Transport and Energy Group
The Urban Transport and Energy Group focuses its research on new mobility services and technologies quantifying their impact on travel behaviour, congestion, energy consumption and emissions. Earlier this year, the group initiated MaaSLab, the leading research lab on Mobility-as-a-Service. It closely collaborates with public sector and industry to transfer research findings to the real world.

Selected projects

Airport Capacity Consequences
Leveraging Aviation Integrated Modelling (ACCLAIM)
This project explores simulating local and global impacts of airport capacity expansion policies. While the tool to be developed is applicable to any airport worldwide, it will be applied initially to the London airport system, where the UK Government plans to add capacity in the near future.

CO2 emission from international shipping: possible reduction targets and their associated pathways
This project was commissioned by the Danish Shipowners Association and deployed UCL-Energy’s system modelling expertise to inform this industry association’s international policy, and was used in several debates at COP22 in Marrakech.

Supporting the IMO debates
Working with a number of governments and NGOs, the shipping group has deployed research and evidence to support the UN agency IMO debates as it develops its GHG Roadmap in preparation for the launch of its Initial Strategy in 2018.

World Bank Carbon Pricing Leadership Coalition
Selected as co-chair of CPLC’s new maritime thread, UCL-Energy will lead this effort to explore the potential and specifics of carbon pricing as a policy and tool for reducing shipping’s GHG emissions.

MaasS4EU
MaasS4EU is an end-to-end approach for Mobility-as-a-Service tools, business models, enabling framework and evidence for European seamless mobility. It is a H2020 funded project focusing on providing quantifiable evidence, frameworks and tools to remove the barriers and enable a co-operative and interconnected EU single transport market for the MaaS concept by addressing challenges at four levels: Business, End-Users, Technology, and Policy. UCL is the Scientific and Technical co-ordinator of the project.

Londoners’ attitudes towards car-ownership and MaaS
This project investigates the changing attitudes and perceptions of Londoners towards car-ownership and MaaS. The impacts of these on the transport system, economy, environment and society are assessed. Insights are provided for the transition to the MaaS and automated vehicles era.

Redefining Urban Transport Mobility
This project investigates the demand for shared mobility in developed and developing countries, while several set of policies are analysed to identify their effectiveness.

Selected publications


The Energy Systems theme at UCL-Energy is the largest academic centre of energy systems modelling knowledge in the UK, with a reputation in the field that has a global reach. The highly interdisciplinary team conducts research focusing on the interactions of different energy system elements, across a wide range of geographical scales (UK, EU, the world), using different tools to focus on different elements of the system, such as technology, economy, environment and climate change. The theme, lead by Dr Ilkka Keppo, includes four academics and 14 research staff.

Highlights 2016/17
ADVANCE and INSIGHT_E, two FP7 funded projects completed
ADVANCE, a four-year project aiming to produce the next generation of integrated assessment models, was completed, hosting its final conference in October 2016. Systems theme researchers authored and co-authored several papers documenting ADVANCE work. INSIGHT_E was a European, scientific and multidisciplinary think-tank for energy that informed the European Commission. Finally, in June MPSRI Transitions held ‘Modelling the Unmodellable’, a workshop which gathered a group of leading experts from academia, government and industry to advise and steer this exploratory modelling project.

Selected projects
wholeSEM
The UK Research Council’s flagship research initiative to develop, integrate and apply state-of-the-art energy models. Read more about wholeSEM on page 20.

Restless
This project aims to understand how novel energy storage technologies might best be integrated into an evolving, lower-carbon UK energy system in the future.

REEEEM
A Horizon 2020 project focusing on modelling an EU wide transition of the energy system, with a special focus on assessing also the impacts of such a transition.

UKERC Phase III
The UK’s largest energy policy and research consortium. The UCL team focuses on the current and future roles of different resources and energy vectors in the UK energy system.

Helix
The EU-funded project aims to provide a set of credible, coherent, global and regional views of different worlds at 2°C, 4°C and 6°C, and 1.5°C.

INNOPATHS
A four-year EU-funded research project that aims to work with key economic and societal actors to generate new, state-of-the-art low-carbon pathways for the European Union.

Bio-value Energy Chains
Whole systems analysis and optimisation to understand the potential and risks of different biomass technologies and supply chains.

HYVE
The HYVE (Hydrogen’s Value in the Energy System) project aims to find out how hydrogen might contribute to a transition to a low carbon economy.

Modelling the Political, Societal and Regulatory Implementation of the UK Energy System Decarbonisation Transition (MPSRI Transitions)
A scoping study to better model and assess the critical societal and political drivers and feedbacks of the low carbon energy transition.

Selected publications

Research published in Nature Energy
This paper discusses the necessity to consider post-2050 climate targets now, in order not to be blindsided by the challenge and avoid unwanted infrastructure lock ins. The paper received significant attention and a public lecture, hosted by wholeSEM, was organised in June to build on, and further disseminate, the research.

Organising events
Systems theme has also been active in organising events. The most prominent UK energy modelling event of its kind (see page 21), wholeSEM’s final annual conference was hosted in London in July 2017. The Energy Modelling Platform for Europe was established, a new EU initiative with the vision to provide a forum for ongoing exchange on energy modelling issues. The systems theme was represented on the scientific steering group of this event co-organised by the REEEEM project and Joint Research Centre of the European Commission. Finally, in June MPSRI Transitions held ‘Modelling the Unmodellable’, a workshop which gathered a group of leading experts from academia, government and industry to advise and steer this exploratory modelling project.

Credit: ADVANCE
MRes in Energy Demand Studies

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

The MRes in Energy Demand Studies is designed to equip students for careers in a range of sectors such as academia, government, consultancies, engineering companies and NGOs. The programme focuses on the multidisciplinary nature of research in energy demand.

Students learn relevant topics from science, social science and economics, and engage with a vibrant mix of researchers and peers. There are 10 students enrolled on the programme in 2016/17.

“MRes Energy Demand Studies provides a superb grounding with the necessary skills and knowledge to pursue a career in industry, government or academia; a beautiful mix of technical, research and transferable skills”

Dr Catalina Spataru, Course Director

“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, Student

Programme highlights

**Bartlett MRes Conference**
In September 2016, MRes EDS students presented at the Bartlett MRes conference. This conference is an annual event held to welcome new students of Bartlett Masters in Research postgraduate programmes of study. Presentations included:

- ‘What shapes daily patterns of domestic space heating demand in the UK?’ - Clare Hamner, MRes Student
- ‘The assessment of Ice Thermal Energy Storage (iTES) for commercial buildings in Brazil.’ - Bruno Figueira Arcuri, MRes Student

**Loughborough block week**
MRes EDS students spent a week at Loughborough University in September as part of their Energy Demand in Context module. UCL and Loughborough Uni lecturers provided an introduction to the many issues of energy demand in the built environment, setting them in the wider context of climate change policy, the history of energy use.

MSc in Economics and Policy of Energy and the Environment

The **MSc in Economics and Policy of Energy and Environment** (MSc EPEE) equips its graduates to grasp issues such as climate change, resource exhaustion, energy poverty and energy security, and become sustainability leaders and entrepreneurs in business, policy-making and research.

In an interdisciplinary, collaborative learning environment, students are introduced to environmental law, the economics of the environment and natural resources, the issues and challenges of global energy use and the field of energy modelling.

“The programme is now coming to the end of its fourth year, and it continues to grow. It is a real pleasure to see our alumni from previous years establish themselves in such a wide range of careers—in governments, in NGOs, in specialist energy consultancies and in large energy and financial corporations. We clearly provide skills and knowledge that help our graduates into fascinating careers in the energy and environmental policy field, and that evidence of the value of the programme is hugely rewarding for the teaching team.”

Will McDowall, Course Director

“I am very satisfied with the MSc in Economics and Policy of Energy and the Environment as it provides me with my own research and practical experience. Thanks to the outstanding teaching of Professor Paul Ekins, I have been able to pursue my research at the beginning of this year.”

Shimon Hassid, MSc EPEE Alumni

Programme highlights

**Professor Ekins nominated for Outstanding Teaching Award**
Professor Paul Ekins, teacher on the MSc EPEE course, was nominated for Students’ Union UCL ‘Outstanding Teaching Award’ as part of their Student Choice Teaching Awards Roll of Honour 2017.

**Annual Alumni Event**
The Annual Alumni event was held at the UCL Energy Institute in June. The event included a lecture from Professor Paul Ekins and panel discussion with alumni. Discussed were hot-topics of the year; Brexit, Trump, and EURATOM, as well as alumni reflecting on their experiences working in the energy sector. The event was a great opportunity for current students and alumni to commingle and share experiences.

**Field trip to South East London Combined Heat and Power**
The trip gave students a real-world insight into the challenges of combining energy generation with waste disposal, in a densely populated part of London.
DOCTORAL RESEARCH

MPhil/PhD in Energy

The MPhil/PhD in Energy is UCL’s response to the global challenges of mitigating climate change and providing energy security in the 21st century. Students work alongside experienced researchers, in a dynamic, multi-disciplinary environment and 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.

The 2016/17 academic year saw eight students start their PhDs at UCL-Energy. Out of this, five were progressing on to complete their PhD as part of the London-Loughborough EPSRC Centre for Doctoral Training. They joined the 44 students enrolled in UCL’s Energy MPhil/PhD in Energy during the 2016/17 academic year. Within this year, the Institute also saw four students successfully passed their vivas.

MPhil/PhD Alumni

The Institute now has an ever growing community of alumni from the MPhil/PhD programme with over 40 students graduating since 2009. UCL-Energy Alumni have gone on to obtain competitive positions in both academia and industry, continuing to network over the UCL Energy Alumni Group on LinkedIn. In 2017 three UCL-Energy LoLoCDT alumnae were selected as Bartlett Alumni Role Models.

London-Loughborough EPSRC CDT

LoLo CDT highlights

LoLo Annual Colloquium 2016

In November 2016 LoLo CDT held its seventh annual colloquium in London. More than an academic conference, the event invited professionals from the private sector to attend and exchange ideas with students, alumni, and academics on a range of different topics, from purely technical engineering to energy policy. The majority of students presented posters on their work, with UCL-Energy’s Moira Nicholson winning a prize, alongside Loughborough’s Francesco Babich.

LoLo Student Conference 2017

LoLo students held their fourth annual conference at Loughborough University on the theme ‘Energy in an age of uncertainty’. Around 60 delegates came from across the UK, as well as one from Germany. 12 institutions were represented by the speakers, and many more by delegates who attended.

Discover more at @LoLoCDT lolo.ac.uk

“The PhD programme gave us an exceptional amount of contact with non-academic stakeholders and many opportunities to develop our presentation skills—more so than in typical PhD programmes.”

Dr Jenny Love, Bartlett Alumni Role Model
selected project

TopDip

The Top Down Integration Project (TopDip) is a model alignment and iteration process seeking to ‘expose the wiring’ of whole systems energy models in order to understand the implications of the many assumptions implicitly or explicitly embedded within them.

The aims of the project are two-fold; through the align process, to provide a common scenario and set of assumptions to increase transparency by ‘exposing the wiring’ of models and scenarios, revealing the many assumptions implicitly or explicitly embedded within them; through the iteration process, to exploit the strengths of individual aligned models and link them to generate robust new insights that are fed back into the modelling process.

The linked models are focused on providing insights into three case studies; flexibility in the UK’s electricity system; social practices in how we use energy in our homes; nexus between energy, land and water.

wholeSEM highlights

wholeSEM fourth Annual Conference

In July 2017 wholeSEM hosted it’s fourth and final annual conference in London — ‘The Past, Present and Future of Energy Modelling’. The conference keynote was given by Professor John Loughhead, Chief Scientific Adviser at the Department for Business, Energy & Industrial Strategy (BEIS). Feedback from the 120 attendees — from academia, industry, and government and coming from over 120 different countries — highlighted how the wholeSEM annual conference has become the preeminent UK energy modelling event of its kind.

The conference theme was the past, present and future of energy modelling. The past, retrospective analysis, looked back at over a decade of UK energy decarbonisation modelling, and its impact in successive UK policy positions. The present, current analysis was a set of presentations on state-of-the-art implementation of the energy trilemma (decarbonisation, security, equity). The future, new approaches saw innovative sessions including focus groups and discussion sessions on developing and communicating the new insights in terms of technology, society, infrastructures and resources needed by decision-makers to achieve the energy systems transition challenge over the next few decades.

What should the UK’s climate targets be in the post-Paris Agreement era?

The paper ‘Achieving net-zero emissions through the reframing of UK national targets in the post-Paris Agreement era’, was published in Nature Energy in March 2017. The authors highlighted the scale of the challenge giving their insights into some of the complex political, social, technological and economic issues while urging government to make climate policy more ambitious and consider a net-zero greenhouse emissions target soon after 2050. The authors followed the paper with an event in June, hosted at the UCL-Energy Institute, based on the research published.

Experts gather at the IEA to give strategic direction on energy and development

Francesco Fusco Nerini, UCL-Energy Research Associate and wholeSEM Fellow at the International Energy Agency (IEA), participated and helped organise a special event in April 2017 at the IEA, bringing together over 100 experts from 30 countries. Participants from governments, business, academia and the finance sector shared best practices, policy actions and provided strategic direction for a special report entitled ‘Energy Access Outlook: from Poverty to Prosperity’.

Energy System Optimisation Models (ESOMs) used to inform climate policy

Lead by wholeSEM fellow Joe DeCarolis, researchers have drawn on their collective modelling experience to produce a guide for bottom-up energy systems modelling. ESOMs are widely used to generate insight that informs energy and environmental policy. Using ESOMs to produce policy-relevant insights requires significant modeller judgement, yet little formal guidance exists on how to conduct analysis with ESOMs. The paper ‘Formalizing best practice for energy system optimization modelling’ was published in Applied Energy in 2017.

Discover more at
wholesem.ac.uk
@wholeSEM

The whole systems energy modelling consortium (wholeSEM) is a ground breaking multi-institution initiative to develop, integrate and apply state of the art energy models. Energy models provide essential quantitative insights into the 21st century challenges of decarbonisation, energy security, energy equity, and cost-effectiveness. The consortium employs extensive integration mechanisms to link and apply interdisciplinary models to key energy policy problems, with substantive bilateral engagement with stakeholders in academia, government and industry. Led by UCL, the consortium consists of Imperial College London, the University of Cambridge and the University of Surrey, and is funded by the EPSRC.
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 to reduce energy demand is undertaken through the development of brand new tools, methods and resources. CEE provides a step change in the provision of evidence to help innovation in policy, markets, products, services meet carbon targets over the critical coming half-century. 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.

Launched in 2013, CEE aims to respond to the myriad challenges currently facing energy research. Through the use of Research Council funding it has been able to establish an expert, multidisciplinary and multisectoral team of researchers to apply the energy epidemiology approach to develop new and exciting research opportunities.

CEE is one of six Centres of Excellence in End-Use Energy Demand, funded by the Research Councils UK Energy Programme.

**CEE highlights**

**UCL-Energy academics publish data analysis from heat pumps installed via RHPP Scheme**

A paper was published in April, from the analysis of data from 700 heat pumps that shows that significant uptake of heat pumps is not likely to cause a major strain on the energy supply system. It is found that peak grid demand increases by 7.5 GW (14%) with 20% of households using heat pumps. The effect of the same heat pump uptake on grid ramp rate is also discussed; this effect is found to be minor. Finally, a comparison of heat pump and gas boiler operation is given, discussing day and night time operation and mean and peak power at different external temperatures.

**3D model being constructed for all English buildings**

In order to help understand energy use in the built stock, a 3D model of all buildings and the main use of each floor of the building is being created. This information is useful not only for energy research but to help understand how the stock is being used. This work has shown that the simple assumption that most buildings are either domestic or non-domestic is not true, with some areas of London having some 60% of buildings with a mixture of both domestic and non-domestic in the same building.

**CEE staff engaged with the international community on energy epidemiology**

A joint UK/India proposal (iNUMBER) has been funded to develop a building stock and a municipal service energy model (page 11). Also, detailed discussions with Mexico’s Department of Energy (SENER) have resulted in a proposal submitted to the Mexican Research Council for a joint Research Centre with UCL Energy Institute (CIELO). Also, presentations were given at Australia and New Zealand universities.

**Smart Meter Research Portal (SMRP)**

A £6m RCUK funded project that will provide a secure, consistent and trusted channel for researchers to access high-resolution energy data. Run under a strict governance framework overseen by government and the UK Data Archive, the Portal will facilitate innovative energy research for years to come. Smart meter data will only be collected with the explicit consent of households who have agreed to provide their smart meter data to SMRP for research purposes. The portal will transform UK energy research through the long-term provision of high quality, high-resolution energy data that will provide a reliable evidence base for intervention, observational and longitudinal studies across the socio-technical spectrum.

**Digital Innovation with Smart Meters**

Supported by EDF Energy, Jonathan Chamber was awarded his PhD titled ‘Developing a rapid, scalable method of thermal characterisation for UK dwellings using smart meter data’ examining the potential to replace Domestic Energy Performance Certificates (EPCs), which need to be displayed at the point of sale or rent of a property, with a cheaper digital EPC, calculated from Smart Meter and weather data. This method has the potential to be orders of magnitude cheaper and more accurate.

**Hitting the target and missing the point— new research in airtightness testing practice**

Compliance with regulations impacts not only the safety of properties, but also their energy performance and ability to provide healthy comfortable spaces in which to live. Researchers from UCL Energy Institute published an article ‘Hitting the target and missing the point’: Analysis of air permeability data for new UK dwellings and what it reveals about the testing procedure’, raising concerns that building regulations compliance issues may exist in the airtightness of new housing.

**High-rise buildings are much more energy-intensive than low-rise**

A new study, led by Professor Phil Steadman, has shown that office and residential buildings use more energy in operation, per square metre of floor area, the taller they are. Office buildings of 20 stores and above (high-rise buildings), were compared with offices on six stores and below (low-rise buildings). Research found, electricity use in high-rise per square metre of floor area to be nearly 2.5 times that in low-rise buildings. Gas use also increases with height by around 40%, going from low-rise to high-rise. As a result, total carbon emissions from the two fuels together are twice as great in the high-rise buildings. These results were obtained from a sample of 610 office buildings in the UK, for which actual energy consumption data were analysed.

Discover more at @RCUK_CEE cee.ac.uk
Energising Health: A review of the health and care applications of smart meter data

In May 2017, UCL-Energy researchers published a report for Smart Energy GB highlighting the potential for smart meter data to support health and care. The report, entitled ‘Energising health: a review of the health and care applications of smart meter data’, is the first major review of the potential uses of energy data in healthcare to date.

It explores the emerging trends in digital healthcare, that could be transformed by smart meter data. The report gives examples of projects that are using energy use patterns to improve the care of people with conditions including dementia and Alzheimer's.

These include a partnership between Liverpool John Moores University and Mersey Care NHS Foundation Trust, which is using smart meters as a non-intrusive way to monitor the daily habits of people with dementia, Parkinson’s and depression. Irregularities in those patterns of behaviour, such as failing to turn the stove on for an evening meal, or turning the kettle on in the middle of the night, can alert healthcare workers that their patient may need additional support. These trials are designed to allow patients to remain independent at home for as long as possible, and help carers or healthcare workers to provide early intervention when there are any signs of deterioration or distress.

“Digital innovation has the potential to help relieve the enormous pressure our ageing population is putting on our health and care systems - and energy data has an exciting role to play in these emerging technologies. The smart meter rollout provides an exciting opportunity for diverse fields with an interest in this area—from engineering and computing to social care and public health—to come together and create projects that could make large scale improvements to our population’s health and quality of life.”

Professor David Shipworth, UCL Energy Institute

“The rollout of smart meters means, for the first time, we will have regular and consistent energy data from almost every home in Britain. This provides endless opportunities for innovation in all areas of our lives, not least in the way we support people with health conditions.

Innovators are increasingly recognising the central role energy data could play in improving health and care and are developing ground-breaking technologies that are reshaping the way we think about care in the home. The smart meter rollout could bring these innovations to the masses and truly transform the way we care for the most vulnerable in our society.”

Sacha Deshmukh, Chief Executive, Smart Energy GB
Data analysis from heat pumps installed via the Renewable Heat Premium Payment Scheme (RHPP)

UCL-Energy researchers, as part of the RAPID-HPC consortium, published data analysis from heat pumps installed via the Renewable Heat Premium Payment (RHPP), under contract to the Department of Business, Energy & Industrial Strategy. The series of reports documented one of the largest and most exhaustive studies of the performance of heat pumps in dwellings to have been undertaken to date.

Beyond a purely statistical approach, multiple research methodologies were employed to empirically determine the performance of domestic heat pumps. As well as determining the median performance and variations of the pumps defined by seasonal performance factors, the reports also aimed to understand the effects of the Microgeneration Certification Scheme, explore householder satisfaction across a number of metrics with sociotechnical case studies, and finally, make recommendations for future heat pump trial design.

For full findings and reports visit ucl.ac.uk/bartlettenergy/RHPP
UCL-Energy has continued to expand its communication and outreach activities engaging UCL staff and students, as well as members of the public and external stakeholders.

The Institute’s online presence has continued to grow in the last academic year. The UCL-Energy website, the Institute’s outward facing information hub, was viewed over 140,000 from across the world by thousands of people looking to learn more about the Institute’s programmes, news, and events.

The UCL-Energy seminar series, remains a staple for the Institute’s ongoing outreach activity. In the 2016/17 academic year the Institute welcomed speakers from both industry and academia, partnering on occasion with its sister Institute, UCL Institute for Sustainable Resources, to provide a series of seminars on a range of topics at the forefront of energy research. (See page 31 for a full list of seminars hosted in 2016/17)

The UCL-Energy YouTube channel plays host to recordings of UCL-Energy seminar series, as well as informative videos describing the Institute’s work. In the 2016/17 academic year UCL-Energy’s YouTube following grew with a 78% rise in followers with the most viewed this year being an animation entitled ‘UCL model of the UK energy system explained—UKTM (UK Times Model)’.

Looking to social media, the Institute’s Twitter @UCL_Energy saw its following grow by 20% to over 6,600 followers engaging with the Institute’s latest research, news, and events. UCL-Energy continues to expand its LinkedIn presence as networks and groups emerge for past and present students to connect.

The Institute and its staff are frequently featured in the media, disseminating new research carried out by the Institute and, giving expert opinions on current energy related events. See page 27 for our top media mentions in the 2016/17 academic year.

Discover more at ucl.ac.uk/bartlett/energy @UCL_Energy

In the media

30 August 2016
Is the shipping market hindering efficiency?
British Utilities, Dr Tristan Smith

15 September 2016
Hinkley Point nuclear plant will go ahead after all
The Week, Dr Paul Dorfman

09 November 2016
What will Trump mean for climate change?
BBC News, Professor Bob Lowe

28 November 2016
Shipping maps win at the Information Is Beautiful Awards
Geographical, UCL-Energy Shipping Group

02 December 2016
In the heat of the community
New Statesman, Dr Charlotte Johnson

26 January 2017
UK confirms it will leave European atomic energy community
Financial Times, Dr Paul Dorfman

09 March 2017
Fuel cells will be ‘far cheaper than diesel within next decade’
TradeWinds, Dr Tristan Smith

26 April 2017
This Map Tracks Thousands of Cargo Ships to Highlight Their Carbon Emissions
Vice, Shipping Group

04 July 2017
Academics: ‘Don’t use Grenfell Tower tragedy to justify high-rise demolitions’
Architecture Journal, UCL Energy Institute

14 July 2017
Carbon emissions rise with height of building
CIBSE Journal, Professor Phillip Steadman

18 July 2017
Let buyers borrow more on greener homes, urges report
The Guardian, Dr Ian Hamilton

24 July 2017
Get flexible with batteries and smart grids to save energy
WIRED, Professor David Shipworth

Credit: The Guardian via @UCL_Energy twitter feed

Credit: The Guardian via @UCL_Energy twitter feed
Throughout the 2016/17 academic year, UCL-Energy has hosted a number of events, engaging members of the public and industry alongside UCL students, staff, and alumni.

This year saw the launch event for the UCL Energy Network. Following UCL’s radical interdisciplinary spirit, the new initiative was launched to promote collaboration with energy-related researchers across UCL, aiming to avoid catastrophic climate change and transition towards a low-carbon economy. The launch was attended by over 150 academics, students, members of industry and policy-makers, hearing from experts in collaborative energy research.

The Institute also proudly held Professor Mark Barrett’s and Professor David Shipworth’s inaugural lectures, following their promotions to Professorships at the end of the last academic year. Over 100 people attended each lecture to hear Professor Barrett and Professor Shipworth talk on their work and share in their achievements to date.

Notable events
3 April 2017
UCL Energy Network Launch: ‘the future of collaborative energy research’
With Professor Bob Lowe, Director of the UCL Energy Institute; Professor Yacob Mulugetta, Professor of Energy and Development Policy, UCL STEaPP; Dominique Bertin, Smart Energy Applications Manager, EDF Energy Research and Development; Dr Simon Werrett, Senior Lecturer in History and Philosophy of Science, UCL Department of Science and Technology Studies.

6 June 2017
Professor Bark Barrett’s Inaugural Lecture: Swimming in the Energy and Environment River
20 June 2017
Professor David Shipworth’s Inaugural Lecture ‘Transactive energy: Turning the energy system outside-in’

UCL-Energy seminar series
The UCL-Energy seminar series is a trademark of the Institute. This year the Institute welcomed speakers from industry, academia, and beyond, sharing the latest research and activity in the energy field. The series also featured seminars held in collaboration with sister Institute, the UCL Institute for Sustainable Resources.

4 October 2016
Rethinking national and global energy security
With Dr Benjamin Sovacool, University of Sussex

1 November 2016
Energising Faith Communities: the Spirit project’
with Hannah Baker and Rebekah Phillips, Groundwork London

6 December 2016
A breath of fresh air - Air pollution: causes, impacts and policies
With Professor Mark Barrett, Dr Claire Holman, Paul Drummond, UCL Energy Institute

7 February 2017
with Dr. Christophe McGlade

4 April 2017
Meeting UK carbon budgets—what’s needed to get on track
With Adrian Gault, Chief Economist, Committee on Climate Change

2 May 2017
Rethinking the future of sustainability - the power of ‘super grids’
With Dr Catalina Spataru, UCL Energy

All UCL-Energy seminars are recorded and made publically available on the UCL-Energy YouTube channel.

Discover more at ucl.ac.uk/energy @UCL_Energy

Credit: Steve Pye

Credit: UCL Energy Network
SELECTED PUBLICATIONS

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Title</th>
<th>Journal/Conference</th>
<th>Year</th>
<th>DOI/URL</th>
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<tbody>
<tr>
<td>Larkin, A, Smith, T &amp; P. W 2017, ‘Shipping in changing climates’, Marine Policy; vol 75,</td>
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