

Workshop on Modelling of Integrated Multi-Energy Networks - Current Practices and Innovation Gap

12th April 2019 | London

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Background:

Energy networks are vitally essential enablers for the UK energy sector and therefore UK industry and society. Energy networks have a key role to play in achieving the goals set out in the UK government's Industrial Strategy, most notably in terms of the clean growth aspects. Energy networks exist primarily to exploit and facilitate temporal and spatial diversity in energy production and use and to exploit economies of scale where they exist.

The energy trilemma (energy security, environmental impact and social cost) presents many complex interconnected challenges which reach beyond the UK and have huge relevance internationally. These challenges vary considerably from region to region due to historical, geographic, political, economic and cultural reasons. As technology and society changes so do these challenges, and therefore the planning, design and operation of energy networks need to be revisited and optimised. Current energy networks research and practices do not fully embrace a whole systems approach and are therefore not developing a deep enough understanding of the interconnected and interdependent nature of energy network infrastructure. The recent development of local energy systems and global energy internet bring further uncertainties and challenges to the development of our energy systems.

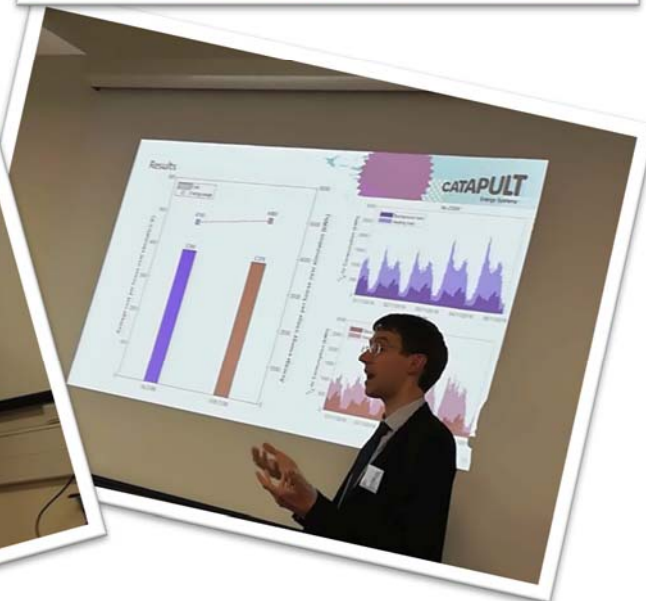
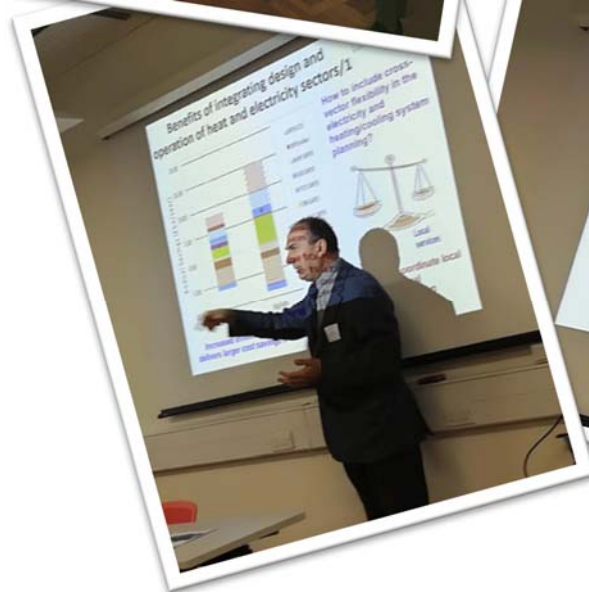
There is a lack of modelling experience and skills in this area, a lack of replicable models, a shortage of commercial software and a lack of awareness of the value of integrated multi-energy networks in the UK, in order to understand better the linkages among different energy vector networks, ICT, policy, markets, and risk; shape the future energy development; and understand how external factors which may lead to significant change in the way we expect energy networks to be planned and operated.

With an excellent line-up of invited participants from government, industry and academia, this one-day workshop was aimed at sharing current best practices in multi-energy system modelling and discussing how to address the barriers and identifying the innovation gaps.

This invitation-only workshop was jointly organised by INCOSE UK Energy Systems Interest Group and the EPSRC Supergen Energy Networks Hub (<https://www.ncl.ac.uk/supergenenergyhub/>), with support from Energy Systems Catapult (<https://es.catapult.org.uk/>) and the UK Energy Research Centre (<http://www.ukerc.ac.uk/>).

The workshop was divided into two parts. The morning session, chaired by Prof. Jianzhong Wu from Cardiff University, was devoted to sharing experiences and practices of modelling among the speakers representing:

- BEIS (Dr. Noramalina Mansor, top left photo),
- Energy Systems Catapult (Dr David Wyatt, bottom right),
- West and Wales Utilities (Mr Chris Clark, top right photo), and
- academia (Prof Mark Barret, UCL; Prof. Goran Strbac, bottom left photo, Imperial College London; Dr Sara Walker, Newcastle University and Dr. Meysam Qadrdan, Cardiff University).



The session gave an insight into the challenges of modelling complex systems, but at the same time examples of new tools, models and projects were given (for more details, please see the attached presentations, whose authors have agreed to share them with the community).

The morning session also provided input to the second session devoted to tackling some pressing challenges, difficulties and uncertainties faced by energy systems modellers as well as the wider community. The second session thus aimed at identifying the gaps in research, questions and potential research topics.



After brief discussions after each of the six presentations about modelling tools and approaches, the floor was open to discussions on how to move forward in terms of research and practice. The “open discussion” session was led by Professor Phil Taylor from Newcastle University and was well attended (as pictured below) by participants from industry (e.g. WWU, TATA, Sembcorp, ENA), Government (e.g. BEIS and NIRO), consultancy (e.g. WSP) and academia (e.g. Bath, Cardiff, UCL, ICL, Edinburgh, Cranfield).

Firstly, a few thematic comments and questions were raised. These are briefed below:

- 1) What are the opportunities and risks of the various network architectures mentioned in the workshop (local energy systems, interconnected bulk networks, and blended architectures)? We need to look at tensions and synergies between national and regional network needs and capabilities.
- 2) How to develop control techniques for integrated cross vector networks?
 - a. How does an automated control system work in the “real” world?
 - b. How to balance control between local and national systems’ needs?

- 3) Don't just think about the destination by 2050 and we need to think about network transitions. Do policymakers lack the vision for decarbonised pathways? If so, how can we address that? Would and could modelling tools provide information to policymakers about pathways to decarbonisation?
- 4) Researchers are encouraged to consider and engage with manufacturing clusters in the UK. Need to study regional clusters based around heavy industrial energy users from a multi-vector network perspective, with workshops.
- 5) Should we consider (and if so, how) an emerging and likely trend of hydrocarbon economies (e.g. Kingdom of Saudi Arabia and Australia) entering the renewable market thus lowering the price of for example, solar?
- 6) Researchers are encouraged to consider a "boundary-less and blurred" approach to energy networks, whereby the boundaries between residential, local, national, and so forth are blurred. In other words, such an approach encourages to design not in silos, but collaboration with other networks.

Secondly, the discussions moved on to areas of future work for researchers. These are as follows:

- 7) Creating tools for policymakers to provide inputs to decision-making processes.
- 8) Creating tools for manufacturing clusters.

Thirdly, gaps in the research were identified as follows:

- 9) Demonstration projects.
- 10) Understanding of data science and security.
- 11) Change in patterns of demand as a result of changing demographics (globally, nationally and locally).
- 12) Interactions between energy, water and food systems – nexus approach and complex problem-solving.
- 13) Integration of real data into models.
- 14) Understanding how system managers of power plants, buildings, industrial plants and so forth operate/decide/think.

Fourthly, the discussion moved to project ideas. These potential projects were:

- 15) Control algorithms on all scales from homes to nations.
- 16) Modelling with extreme events and resilience considering consequences of climate changes (including stranded assets and asset decommissioning).
- 17) (Technical) Modelling of transitions toward sustainability
 - a. for advanced power systems, and
 - b. for emerging or non-existing power systems in developing countries.
- 18) Simple/smaller models but for interconnected systems.
- 19) Open source/Open Data modelling platform.
- 20) Modelling with manufacturing clusters.
- 21) Integration of markets into the models.

There were several actions agreed during the session:

- 1) Share Supergen FLEXI Fund call - <https://www.ncl.ac.uk/supergenhub/senhubflex/>
- 2) Re point 1b: organise an event about balancing between local and national system need Re point 20: organise an event about manufacturing clusters.
- 3) Re point 9: Evie Trolove to share info on Network Innovation calls
- 4) Re point 17: Bruce Mcnaughton to provide more information regarding the literature about the architecture of system transitioning; All: look into the literature discussing technical transitions.
- 5) Re point 19: Meysam Qadrdan to share info on NISMOD model.

The organisers would like to thank all speakers and participants for sharing their views and making an active contribution to the workshop.