Transforming Birmingham –
a city system approach

Modelling city-region energy systems for the 21st century

Thursday 25th January, 10am to 4pm

Sir David MacKay theatre, 7th Floor, Cannon House, Birmingham

Workshop Summary

From our workshops the stakeholders identified a number of issues to be addressed as well as potential scenarios that would not only help them in their particular sector but would contribute to a greater understanding of the interconnections and impacts of changes in the whole energy system:

- Model output variables need to include: energy and carbon outputs, metrics associated with the energy trilemma (security, social impact & environmental sensitivity), and an energy "exchange" balance sheet.
- Model scenarios need to encompass a broad range of behaviours and to be flexible and sensitive enough to cover a broad spectrum of the city's population, including those embracing change as well as those resistant.
- Human behaviour is deemed critical to understanding what needs to be done to accommodate transformative change in the whole-energy system – this includes aspects such as transport mode choice, e.g. walking and cycling uptake, as well as health effects because of air pollution, fuel poverty and obesity which feedback into wider impacts, policies and choices.
- Model sensitivity to data quality and availability need to be paramount concerns to enable other cities and city-regions to build on the experiences of Birmingham and the West Midlands.
- The new West Midland Combined Authority and its mayor, Andrew Street, have a focus on economic planning, integrated approaches beyond siloes and policy that reflects the complexity of local needs and the local context.
- Dissemination of knowledge should focus on children and young people to ensure that crucial messages of the study get spread to the wider public to facilitate behavioural change.

Emerging themes from both workshops

- Energy is often considered in isolation, when in practice interconnections and interdependencies are a major constraint to a step-change or disruptive approaches.
- There is an absence of integrated modelling across different sectors considering embedded energy as well as direct energy such as electricity.
- Spatial issues mean that energy system models don't have the level of detail required at the local level and there are no city-region integrated energy models.
- Temporal issues need to be resolved e.g. renewable energy sources that fluctuate over short time scales and similarly both direct and indirect energy demands.
- Specific sectorial models (transport, waste etc.) are siloed and do not consider the whole infrastructure system or make explicit the direct & indirect energy interactions

Outcomes *from Transforming Birmingham-a city system approach*

- Workshop (26th June 2017) summary distributed to participants and interested parties
- ISNGI 2017 Conference Paper
- Position paper on electric vehicles
- Web page: http://tinyurl.com/yaxvzkam
- Final workshops 25th Jan 2018 to discuss new approaches and modelling scenarios and outcomes

Literature Review Findings

- Gaps in knowledge of interconnections between sectors
- Recognition of systems of systems approach
- Many models are modular but don't have the flexibility to deal with rapidly changing technologies
- Social and environmental considerations need to be accounted for not just economic
- There are challenges in linking models across scales
- Assumption that economic growth and GDP leads to rising transport use may no longer be valid

Introduction

On Thursday 25th January 2018, the Transforming Birmingham group convened its second and final workshop, hosted by the Energy Systems Catapult in Birmingham. The workshop aim was to discuss energy system modelling approaches across the UK and to focus on the next steps for developing an integrated, whole energy systems model to deal with future challenges of a changing climate, a growing and ageing population, new technologies and renewable energy sources to decarbonise at a city-scale.
Approximately 20 people from academia, energy agencies, transport, waste, business and non-governmental organizations participated. This event was motivated by widespread recognition that further research is required to better inform the whole systems perspective of future energy systems modelling.
Drawing from the energy modelling, agent-based modelling and business modelling expertise, as well as knowledge from the other communities, the workshop sought to glean insights on and evaluate the implications of bringing together energy system models with waste, air quality, legacy housing stock, new build and transport issues. In addition, social, economic and environmental aspects were also considered.

Presentations

1) ***Whole Energy Systems Modelling*** (Dr. Susan Lee (Civil Engineering, University of Birmingham)) introduced the workshop and highlighted the outcomes of the EPSRC/ESC-funded scoping study which included findings from a review of the literature. In addition, she set out the objectives of the present workshop to identify priorities for whole energy system modelling at the city and city-region scale. The outcomes of this workshop would inform the priorities for Modelling Innovative City-Region whole-Energy Systems for the 21st century (MICRES21) and provide a framework for new approaches to help improve policy decision making in the future.
2) ***Energy Path Networks in Bury*** (David Lee, ESC, Birmingham) provided details about the Energy Path Networks (EPN) modelling work being carried out in Bury by ESC. The Energy Technologies Institute (ETI) Smart Systems and Heat Programme team have transferred to ESC. ESC will be responsible for Phase 2 of this programme from now onwards. EPN's purpose is to provide "strategic, spatial planning to meet future carbon targets in a local area – focusing on decarbonising building energy demands, specifically heat". A multi- vector approach is taken with an understanding of the spatial relationships between buildings and the networks that serve them. An optimisation approach is adopted whereby many different combinations of options are compared for multiple analysis areas within the study area. The model works on a cost to society basis, so without current subsidies and taxes. This work has identified future priorities and has tested the modelling approach in three different places: Newcastle, Bridgend & Bury.
3) ***Infrastructure Interdependency at Operation Level*** (Samane Faramehr & Taku Fujiyama, University College London). Two examples of infrastructure interdependencies were shown: i) track flooding caused by water main burst in London and ii) power supply and railways in Hull and Yorkshire.

Workshop Themes

The attendees were divided into four groups (6/7 people per group) with a mix of backgrounds. There was a whole group discussion at the end of each session. The group discussions included presentations by a member from each group and summarised on flip charts as well as individual comments noted on post-it notes. All the points raised were drawn together and summarised.
Discussions at the workshop were divided into two thematic sessions:

Session 1: *What model inputs are required?*

Consider user needs and challenges; transformative change and current approaches used to model human behaviour.

Session 2: *What model outputs are required?*

What model outputs would be required from a whole energy-systems model at the city and city-region-scale to address deployment challenges e.g. business models, policy barriers, technological limitations?
Who will use the model?

Further details about session discussions are as follows:

Session 1: *Model inputs*

The following **model inputs** are required:

- Location of transport hubs
- The timeline that is being considered
- Energy inputs
- Monetary inputs
- Different households and their agents' (occupants) behaviour e.g. rational; semi-rational; "standard" etc.
- Data on households and their composition
- Social housing data at specific data points which are available across the city
- Energy use in new build housing compared with retrofit housing
- Current population of the city
- Current land use of city.
- Fuel types (existing and potential new ones: electricity, renewable energy, biofuels, natural gas, oil, hydrogen, methane, new sources)
- Housing types
- Educational attainment of different household residents

User needs and challenges?

Issues that were discussed across the groups included:

- The importance of strong leadership as a catalyst for future change (e.g. Manchester),
- Congestion charges for city centres need to be considered along with the use of an oyster card equivalent for Birmingham and the West Midlands.
- Legislative backing is vital for policy alignment
- Business needs to consider its energy costs as well as the amount it spends on transport fuel
- Austerity cuts to local authorities limit their ability to implement initiatives
- Transport is seen as a way to change behaviour and this information can then be shared with other cities
- Data availability and quality is important
- Public health is important for productivity and jobs
- Housing that is being built is a potential opportunity for radical alterations
- The policy framework needs to be altered to stop current energy consumer behaviour
- Clear air zones need to address congestion charging and parking costs.
- Who are the city investors?
- Multiple sectors are not versed in the energy system

Considerations for modelling:

- End points or pathways as is the current approach?
- Short-term pathways?
- Influences
- Vision of the future
- Not predefining outcomes
- Scenarios and policies that will be used
- How many different agents are to be included?
- Decision-making options
- Selling a lifestyle idea e.g. Apple consumer model
- Timeframes that will be used: 2035 or 2050 or longer?
- What are the city's needs?
- How is energy currently used and by whom?
- What is the current land use?
- How will population change over time?
- Where are the houses, leisure facilities, manufacturing/service jobs etc. located as this drives energy use?
- An understanding of the mechanisms involved is important.
- What are the assumptions made by the model?
- What is the model sensitivity?
- There are many different groups of people and motivations

End users include:

- WMCA
- Local Authorities
- Landscape architects
- Department for Local Communities and Government
- Businesses
- Parents and families (consider Mumsnet)
- Directors of transport
- Healthcare Trusts
- Resilience Managers
- Energy Managers
- Waste Managers

Session 2: *Model Outputs*

What model outputs would be required from a whole energy-systems model at the city and city-region-scale to address deployment challenges e.g. business models, policy barriers, technological limitations?
The following **model outputs** are required:

- Examples of good practice
- Energy use
- Monetary value
- Health impacts
- Air quality
- CO_2 emissions
- Impacts of long-term projects
- The timescales of change
- Transport use
- Locations of where people are living and new industries
- The best achievable scenarios

General Discussion

A range of outputs were suggested with the requirement that system boundaries should to be defined for a particular model metric. Different temporal and geophysical scales need to be studied. Location and the radicalness of the transformation would also impact model outputs. Different users have different output needs which should be considered too. The energy system consists of additional players to solely energy generators and consumers who also need to be taken into account. This could lead to energy being supplied from a range of "everyday" sources.
It is also important to consider the dynamics of the system and how behaviour will change over time. Transport influences and impacts on where people live, work and play. Tipping points for behaviour change need to be identified. Cycling and walking need to be actively encourage through the NHS and the health agenda to address issues of air pollution, by reducing car usage and the improving the provision of green spaces, as well as promoting a healthier lifestyle to reduce obesity. Children and young people are important they are the future users of infrastructure and can influence current behaviours through their parents. Comparison with other areas e.g. Birmingham compared with Manchester, Barcelona or different parts of the city. How Birmingham compares with the Top 10 cities of the world.

Project Outcomes

There are a number of potential outcomes:

1) Outputs from the model itself
2) Vignettes about the barriers encountered and the impacts of technology and behavioural change
3) Households – vulnerable households in particular and how they interact with the transport system. Social housing should be a focus.
4) Model tool that could explore private sector options and plans leading to energy and transport outcomes
5) Testing policy initiatives – what is planned or about to happen
6) Change behaviour through practice e.g. Stimulate and encourage behaviour through taxation
7) Produce best practice exemplars for vulnerable households for use by social landlords. This in turn should impact on transport connectivities, health and mobilities.

Future plans:

Building on the workshop discussions, a research proposal will be completed to submit to the Engineering and Physical Sciences Research Council by 1st February 2018. The participants were encouraged to supply letter of support if they wished to engage further or become project partners. A website about the Transforming Birmingham group has been established on the University of Birmingham website and will be developed further. An email list of interested parties has been being set up. In April we should hear whether the proposal has been accepted. If so the new project, *Modelling Innovative City-Region whole-Energy Systems for the 21st century (MICRES21)* will start on 1st June 2018 and continue until August 2020. Three further workshops are planned within this new project.

Appendices

A: List of participants
B: Contact details

Appendix A: List of Participants

Surname	First Name	Company
Argent	Steve	Arup
Bryson	John	University of Birmingham
Chown	Kevin	Kew Technology Ltd.
Crean	Chris	Friends of the Earth
Faramehr	Samane	UCL
Fujiyama	Taku	UCL
Grayson	Nick	BCC/UOB
Lee	David	Energy Systems Catapult
Lee	Susan	University of Birmingham
Horsfall	David	Webster & Horsfall
McNally	Tony	Climate Change Solutions
Mullan	Martin	Big Changes Company
O'Neill	Alexa	BCC
Page	Andrew	TfWM
Powell	Lesley-Jane	Chase Community Solar Ltd.
Powell	Robin	Chase Community Solar Ltd.
Quinn	Andrew	University of Birmingham
Radcliffe	Jonathan	University of Birmingham
Rhodes	Matthew	Energy Capital/GBSLEP
Terry	David	University of Birmingham
van Soest	Dennis	University of Birmingham

Appendix B: Contact Details

Dr. Susan E. Lee
Research Fellow
University of Birmingham
Civil Engineering, Edgbaston, Birmingham, B15 2TT
s.e.lee@bham.ac.uk

Dr. Andrew Quinn
Senior Lecturer in Atmospheric Science and Engineering
School of Civil Engineering
University of Birmingham
Edgbaston
Birmingham B15 2TT
a.d.quinn@bham.ac.uk

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Other links:
City Region Economic and Development Institute
Birmingham Centre for Railway Research and Education
Birmingham Energy Institute
Liveable Cities