Learning through scenarios: Exploring the future of decentralised energy in the UK

Why use scenarios?

During the past decade, scenarios have been increasingly used as a tool to explore the future of UK energy systems. Since the Royal Commission on Environmental Pollution published its landmark report Energy: The Changing Climate in 2000, policy makers and researchers have used scenarios to understand how the UK could make a transition to a low carbon society.

This briefing shares experience from one of many scenario exercises conducted by the UK energy research community. The analysis was carried out for the research project: Challenging Lock-in Through Urban Energy Systems (CLUES). In our case, scenarios were used to understand the potential contribution of decentralised energy systems in the UK. The aim of the briefing is to discuss some of the lessons learned from the adaptation and further development of scenarios. In particular, it focuses on the challenges of quantifying existing scenarios – and of providing detailed data on the role of decentralised energy in meeting demand and reducing emissions.

Key messages

• To fully explore the potential role of decentralised energy, there is a strong rationale for energy scenarios that include both qualitative explanations of possible futures and detailed quantitative data. The CLUES project has shown that these two approaches can be combined successfully.

• Quantifying existing scenario narratives can be challenging and resource intensive. Through this process, the original scenarios will inevitably be questioned and adjusted. Ideally, both features of scenarios should be developed in parallel.

• Gaps in scenario narratives mean that judgements are often required by researchers to ensure that quantitative analysis is comprehensive and consistent. Stakeholder engagement can help to test assumptions, and to strengthen the validity of the results.

• Models and tools that are used to quantify scenarios need to be fit for purpose. Experience from the CLUES project suggests that the exploration of decentralised energy may require improvements in the way energy system scale is represented in national energy models.

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1 This briefing was edited by Jim Watson, Director, Sussex Energy Group on behalf of the CLUES research project team.
**Scenarios of the UK energy system to 2050**

Our scenarios were developed within the UK government Foresight project on Sustainable Energy Management and the Built Environment. Their aim was to explore future changes in the UK built environment and energy systems over the period to 2050. Four scenarios were distinguished using two major dimensions of uncertainty (see figure). The first, vertical dimension concerns the extent to which innovation focuses on existing energy systems (for example to decarbonise the existing centralised power plant stock) or the development of new systems (for example, to reduce emissions using large scale power plant technologies). The second, horizontal dimension explores whether the UK has open, interdependent relationships with the rest of the world or a more bounded, inward-looking focus.

**From narratives to numbers**

The original narratives included almost no quantitative indicators, except for figures on average GDP growth and the energy mix in 2050. To quantify them further, the CLUES team used a carbon accounting tool that had previously been applied by the Tyndall Centre for Climate Change Research to the UK and Chinese energy systems.

The tool allows a disaggregated analysis of an energy system and its associated carbon emissions. It allows users to change the level of demand in each sector (e.g., households or road transport) over time to create an overall pathway for energy demand. Users can also change the level and composition of energy supply to meet this demand, and to ensure that supply and demand are in balance. The tool was used to calculate energy supply,

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demand and emissions for a baseline year (2008). Using the Foresight scenario narratives, projections were made for each decade between 2010 and 2050.

This analysis was carried out in two stages. First, all four scenarios were quantified by the project team. The results were tested through a stakeholder workshop, and were subsequently revised. Second, new versions of the Green Growth and Sunshine State scenarios were developed. They were re-named Greening Centralised Energy and Exploring the Energy Spectrum. The latter includes a mixture of centralised and decentralised energy systems. Both achieve a 65% reduction in UK emissions, including aviation and shipping.

Challenges of quantification

The quantification of the Foresight scenarios was a challenging process for a number of reasons. Five are particularly important.

First, it proved difficult to identify and justify plausible assumptions for future changes in energy demand in each of the 16 sectors in the tool. Even for sectors (such as households) where the Foresight narratives were relatively rich, it was not possible to determine from the narratives what the detailed contribution of technological change and behavioural change should be. Therefore, judgements had to be made to come up with a ‘headline’ figure for the annual rate of energy efficiency improvement. Given resource constraints, the team drew on existing studies of the potential for energy efficiency to help with this process.

Second, the scrutiny of the Foresight scenarios through the quantification process meant a questioning of some of their original assumptions. This illustrates one of the benefits of quantification: that it provides an additional opportunity to test the original scenario narratives. In particular, some of the assumptions about the overall UK energy mix were challenged at the stakeholder workshop – for example, whether nuclear power would be a feature of the highly decentralised ‘sunshine state’ scenario. As a result of this scrutiny, the results of our analysis differed from the figures in the original scenarios.

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Third, there were several areas in which the original Foresight narratives were found to be weak or lacked detail. This is particularly the case for transport because the Foresight project was not designed to look at this part of the energy system in detail. A key issue of debate for future energy systems is the extent to which space heating and transport will be ‘electrified’ as part of efforts to achieve deep cuts in emissions. Due to the lack of attention to this issue in the scenarios, it proved to be hard to distinguish between them with respect to the extent of electrification, and when this might happen – if at all.

Fourth, many of the difficulties experienced were due to the use of an existing carbon accounting tool that was developed outside this project. A generic issue with the adoption of any model or tool is that it takes time and resources to understand exactly how it works, and all the assumptions that have been made by the original developers. Whilst many developers document their models and tools in great detail, much of the knowledge of how it works – and why particular data and assumptions have been used – are tacit. It is therefore inevitable that some ‘reverse engineering’ will be required by a new team, as well as some interaction (where possible) with original developers. Even if this is successful, some gaps in understanding will remain.

Fifth, the carbon accounting tool was not designed to analyse the role of decentralised urban energy systems. Representing energy system scales in the tool proved to be particularly challenging. The tool distinguished between ‘on site’ electricity generation (e.g. at an industrial site) and grid electricity. But this does not do justice to the multiple scales at which urban energy systems could be deployed: from household scale, via neighbourhood and city scale, to more traditional centralised scales – or their implications for associated infrastructure such as electricity and heat networks. If the scale of energy systems is to be analysed further in future, new models may need to be developed specifically for this purpose.