Abstract submission to:

International UCL-CIRED workshop, 26-27 March 2014, London, "Innovative techniques for Quantitative SCenarios in ENergy and Environmental research (IQ SCENE)"

Exploring low carbon scenarios with the ETI's Energy Systems Modelling Environment (ESME)

Scott Milne and Chris Heaton

Energy Technologies Institute, Holywell Building, Holywell Park, Loughborough, UK, LE11 3UZ

The Energy Technologies Institute (ETI) is a public-private partnership between the UK government and several global companies: BP, Caterpillar, EDF, E.ON, Rolls-Royce and Shell. The ETI makes targeted investments in R&D projects to accelerate the development of affordable, clean, secure technologies needed to help the UK meet its emissions targets.

In 2014 the ETI will publish a set of UK energy system scenarios. This paper summarises the methodology followed, and provides some historical context to the strategic thinking and energy modelling work of the ETI.

ETI energy modelling

In 2009 the ETI developed the Energy Systems Modelling Environment (ESME), a least-cost optimisation model designed to explore technology options for a carbon constrained UK energy system, subject to additional constraints around energy security, peak energy demand and more. ESME covers power, transport, residential, commercial and industry sectors, in 5 year time steps with seasonal and diurnal timeslices, for 23 regions of the UK. The model adopts a Monte Carlo simulation process, enabling a range of uncertainties to be taken into account including the cost and availability of energy resources, and the cost and performance of technologies.

Since its development, ESME has been internationally peer-reviewed and is now used within the ETI and by member organisations to support strategic thinking and decision making. Notable citations of ESME include: The Renewable Energy Review (CCC, May 2011), The Carbon Plan: Delivering our low carbon future (HMG, Dec 2011), UK Bioenergy Strategy (DfT, DECC, DEFRA, April 2012), The Future of Heating: A strategic framework for low carbon heat in the UK (DECC, Mar 2012), The Future of Heating: Meeting the challenge (DECC, Mar 2013). ESME has also been made available on licence to support a number of academic research projects.

To show how ESME will be used within the ETI scenario process, this paper will provide a short history of ESME modelling work carried out to date, which has involved quantitative analysis of a large number of different cases and sensitivities. This begins with an examination of the core ESME demand cases – alternative sets of assumptions around end-use energy demand across the different sectors, each in relation to a particular socio-economic pathway for the UK.

The Monte Carlo simulation feature will then be discussed, showing how this probabilistic approach has been used to support strategic decision-making by identifying both 'no-regret' options that consistently occur across simulations, and more high risk options that form an important part of an optimal energy system but only in a narrow range of simulations.

The opportunity cost (or option value) of the low carbon technologies is another important focus of ETI analysis, and the paper will describe how ESME has been used to explore the system-wide cost of ruling out certain technologies, such as nuclear, CCS or biofuel importing.

Finally, a summary will also be given of some preliminary scenario analysis which involved modifying cost and performance assumptions for certain technologies in accordance with the successful outcome of R&D projects supported by the ETI.

ETI scenarios

The above features of ESME will be used to support the quantification of the new ETI scenarios which will feature narratives outlining major developments over the period to 2050 in each case. The scenario narratives and quantification will be developed iteratively to ensure robustness and internal consistency. This will involve a series of engagement activities to ensure the scenarios speak to the key uncertainties and matters of interest to UK energy sector stakeholders.

ESME is a technology rich model, so the participative process will be crucial in ensuring that these scenarios address the co-evolutionary nature of the energy transition, where technological change occurs in relation to a range of other factors including social acceptance and behaviour change, policy and regulatory frameworks, market structures and the environmental impacts of climate change.

References

CCC (2011) "The Renewable Energy Review", http://www.theccc.org.uk/publication/the-renewable-energy-review/ accessed 12/12/2013.

DECC (2012) "The Future of Heating: A strategic framework for low carbon heat in the UK", https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48574/4805-future-heating-strategic-framework.pdf accessed 12/12/2013.

DECC (2013) "The Future of Heating: Meeting the challenge", https://www.gov.uk/government/publications/the-future-of-heating-meeting-the-challenge accessed 12/12/2013.

HMG (2011) "The Carbon Plan: Delivering our low carbon future", https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/47613/3702-the-carbon-plan-delivering-our-low-carbon-future.pdf accessed 12/12/2013.

DfT, DECC, DEFRA (2012) "UK Bioenergy Strategy", https://www.gov.uk/government/publications/uk-bioenergy-strategy accessed 12/12/2013.