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Research Councils UK Energy For a Low Carbon Future

Supergen Networks Hub

Energy Networks

Planning under uncertainty of smart distribution networks with demand side response

- Innovative, practical framework for planning under uncertainty of smart distribution networks, explicitly considering uncertainty and flexibility
- Methodology to assess the value of flexible, smart grid technologies (with specific application to demand side response)
- Potential pivotal role in national and international development of network planning regulation that considers smart grid technologies, uncertainty and flexibility
- Development of relatively simple tools for real-world applications by network operators
- Modelling and studies assessing risk of using demand side response as a substitute for network asset

Classical deterministic models for investment valuation in networks may not be adequate for real-world decision-making as they completely ignore key uncertain variables (e.g., in load growth). As uncertainty rises with growing distributed energy resources in distribution networks, there is increasing risk of over- or under-investing in network capacity, causing stranded or inefficient use of assets, whose costs are then passed on to end-users. An alternative emerging solution is to release untapped network capacity through Demand-Side Response (DSR). However, there was no approach able to quantify the value of 'smart grid' solutions (and specifically DSR) against 'conventional' asset-heavy investments.

The work carried out has developed a general framework and a novel, practical probabilistic tool for the economic assessment of DSR for smart distribution network planning under uncertainty, allowing, first of its kind, valuation of smart grid technologies and explicitly consideration of uncertainty, with potentially huge benefits for end-users. Risk analysis modelling specifically developed also shows that the use of DSR may also increase overall network reliability.

Case Study: Valuation of Smart Network Planning

A Real Options-based model has been developed to provide an explicit quantification of the economic value of DSR (and potentially other smart grid technologies) against alternative investment strategies. The model can be presented as a practical tool for network operators to gain insights on pricing DSR contracts. The model is also capable of highlighting instances where a particular investment strategy is favourable to the DNO but not to its customers, or vice-versa, and thus identifies aspects of the regulatory framework which can be brought to the attention of policy makers and the regulator, Ofgem.

Electricity North West (ENW) provided case study examples using real network and investment data. Results from the case studies indicate that in many cases DSR is a good economic option for delaying or even avoiding large-scale investment in traditional network reinforcement and thus reduces the overall costs for networks and therefore for end-users. This is achieved with no degradation in reliability and possibly even an improvement. ENW have gone on to make use of the tool to assess the commercial value DSR.

In order for the full value and benefits of DSR to be realised, a change in the regulatory framework (currently based on deterministic analysis) that could take explicit account of uncertainty and flexibility in planning is required, as has been put forward by HubNet researchers. The research thus also provides regulators with a clear model and practical implementation examples for development of future approaches to smart network planning valuation.

> We have already used the model to support signing of one DSR contract, and we'll use it further to support our investment decisions during the RIIO-ED1 regulatory period. It can help us to address multiple objectives: improvement of customer satisfaction, stimulation of the market for future commercial solutions to manage the network, improvement of network performance, avoidance of costs, and managing financial and physical risks due to uncertainty of demand and connection of low carbon technologies
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> Dr R. Shaw, Electricity North West

Achievements:

- Analysis tool produced for use in pricing DSR contracts on basis of cost-benefit approach required by Ofgem. Tool in use by ENW
- Tool can also inform real-world decisions in planning considering uncertainty in key variables (e.g., load growth) and smart grid options (in particular, DSR).

EPSRC Outcomes Focus:

This case study delivers impact with industry and academia and contribute to the following outcomes: R1 and P2

- Resilient
- Connected
- Productive
- Healthy

Academic partners:
The University of Manchester

Industrial partners:
Electricity North West

The Supergen Programme, part of the Research Councils UK Energy Programme, led by the Engineering and Physical Sciences Research Council (EPSRC), aims to contribute to the UK's environmental emissions targets through a radical improvement in the sustainability of the UK's power generation and supply.

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