Low Voltage Network Solutions
Summary Report
Background
Low voltage distribution networks in Great Britain were created on a fit-and-forget basis, assuming that customer demands and diversity would not significantly change. There is no routine real-time monitoring of the low voltage networks. However, as we look forward to future scenarios where customers increasingly adopt low carbon technologies (LCTs), those assumptions about customer behaviour may not hold true. So distribution network operators (DNOs) like Electricity North West now need to better understand the performance of their low voltage networks, how that could change in the future as customer behaviour changes and to explore potential responses.

Monitoring the network
Following a tender process, we worked with GridKey and NorTech as suppliers of monitoring equipment, developing both their products and our installation procedures.

The project developed our approach to how to monitor our low voltage (LV) networks at substations and along feeders, without customer interruptions. We applied this across 200 distribution substations to increase our understanding of how our LV networks perform. Across the network, the project has validated and improved our existing estimates of network loading, and provided us with a tool to assess future capacity headroom in different scenarios.

The University of Manchester built LV network models from our GIS records, with the network configurations validated by the monitoring data. For a sample of underground networks, they assessed voltage and thermal constraints to identify the capacity of the LV feeders to accept low carbon technologies (LCTs) such as solar PV, electric vehicles and heat pumps, and made recommendations about what to monitor in future. This project has validated our approach to connect and monitor/manage PV, this avoids delaying customers wishing to connect clusters of PV systems to our electricity network. The project also developed a ‘Smart Joint’ used in a programme of LV cable midpoint/endpoint monitoring.

LV Network Solutions has contributed to a variety of Electricity North West innovation projects, such as our Second Tier Low Carbon Networks Fund projects Smart Street and CLASS, and other smaller projects such as Customer Voltage and Power Quality, Voltage Management on LV Busbars and Low Voltage Integrated Automation. Further details on LV Network Solutions and all of these projects are available at electricitynorthwest.co.uk/ourfuture.
Understanding customer behaviour and low carbon technologies

The analysis method developed by The University of Manchester included three-phase four-wire models in open DSS, and time-series analysis with a minimum of 10 minute resolution. In a Monte Carlo approach, many simulations were carried out to cater for the diversity and uncertainties of customer behaviour, as well as the location, size and behaviour of low carbon technologies. A simpler analysis approach would underestimate the impacts of new low carbon technologies. Their method represents a major step forward compared to what has been done previously, both by DNOs and in other analysis by industry and academics. Although more time-consuming than could be employed business-as-usual by DNOs, it has a valuable role to inform policy decisions.

Example – findings from analysis of a sample of LV suburban underground networks

- As uptake of PV increases, the first problem is always a voltage issue, not thermal. For heat pumps and electric vehicles respectively, the first problem is voltage in 55% and 65% of cases. This is one reason why Electricity North West is working on voltage management techniques at LV eg in the Smart Street project.

- Many feeders can accept very high levels of PV uptake before there is a voltage problem. For example, all of the feeders studied with less than 25 customers and 1/3 of feeders with more than 25 customers would have no voltage problems even if every customer had PV. Many other feeders have no voltage problems until around 40 customers have PV. So we should not assume that current PV uptake will necessarily cause a problem, and it’s appropriate to let our customers quickly connect PV.

- However, the PV hosting capacity of our LV feeders is actually quite variable. Factors such as customer numbers, feeder length and utilisation give some indication of hosting capacity, but it is difficult to quickly and accurately predict. So if there is a PV cluster, we should monitor to identify if there is a voltage problem, and be ready to manage voltage if there is. This is the ‘connect and monitor/ manage’ approach now being adopted by Electricity North West.

Analysis of solutions

The University modelled the increases in LCT hosting capacity for specific examples of interventions on the LV networks eg on-load tap changers and network meshing. Alongside capacitors and automation, these methods are being investigated further practically in the projects Voltage Management on LV busbars, Low Voltage Integrated Automation and Smart Street. The ‘Smart Joint’ approach to monitor current and voltage on LV feeders, developed under LV Network Solutions is also being used in these projects and in CLASS. The University also identified representative types of underground LV feeders for further analysis.

Find out more

The project closedown report and appendices are available at electricitynorthwest.co.uk/lvns. These include further detailed information on the project, including comparisons with Western Power Distribution’s LV Network Templates project and with the Transform model produced by EA Technology for Work Stream 3 of the Smart Grid Forum.

Find out more about our other low carbon projects at electricitynorthwest.co.uk/thefuture