Capacity to Customers

Selecting circuits for a wide-scale post fault demand side response trial

Introduction

Electricity North West's Capacity to Customers (C_2C) project is supported by Ofgem's Low Carbon Networks Fund (LCNF) and aims to use existing technology and innovative commercial contracts to increase the amount of energy that can be transmitted through the infrastructure that is already in place throughout the region. The project takes advantage of the latent capacity that exists within the current network and could reduce the amount of new infrastructure that would normally be needed to meet the growing demand for electricity. Widespread post trial role out of C_2C could lead to reduced costs for existing and new customers by avoiding large scale network reinforcement and would also offer incentive payments to participating businesses.

The C_2C project will involve industrial and commercial users in the region signing up to a trial which will offer incentives to delay their energy restoration for an agreed period of time following a power outage. This 18 month trial will assess the willingness of new and existing customers to adopt new forms of commercial arrangements and also test the associated technical requirements.

The existing network will be enhanced to provide the active management functionality required to operate the system within the proposed commercial arrangements. Proven low cost remote control will be installed at the Normal Open Point (NOP) between two adjacent radial high voltage (HV) circuits which will be closed to form a closed ring and so increase available latent capacity. At intermediate points on both circuits additional remote control will be installed to enable flexible rapid re-supply of customers subsequent to an outage. This will decrease the amount of time that non-managed customers are off supply due to a fault and minimise the need to utilise the demand management permitted by the C_2C contract.

Introduction to the trial and circuit selection methodology

The C_2C project trial will provide the commercial and technical learning essential to develop the concept for future application, including the following:

- Model commercial contracts
- New connection process
- Development of the technology, including necessary software
- Detailed understanding of system performance through monitoring results
- Data for extended network simulation.

A statistically significant 360 HV circuits, creating 180 closed rings corresponding to 10% of the Electricity North West network and customers, are to be included in the trial. Circuits included in the trial have been selected to ensure that the trial is representative of the whole Electricity North West network and the results will be transferable to other Distribution Network Operators (DNOs).

The selection of circuits for the C_2C trial was undertaken in three main stages – initial circuit screening, preliminary circuit selection and circuit simulation for refined circuit selection – and considered the following factors:

- Network voltage and type
- Customer density and types
- Practicalities
- Suitability for short term trial.

Initial circuit screening
Electricity North West's region covers a range of areas from rural Cumbria to heavy industry and urbanised regions, supplied by a varied cable and overhead line distribution network. To maximise the learning outcomes of the trial, initial screening ensured that the selected circuits were representative of the whole system by classifying circuit types from urban to rural. It was judged that a representative mix of circuit types would provide an appropriate distribution of cable and overhead line circuits across the geographic area, and also a representative mix of customer types.

Full benefits of C_2C contracts and system operation will be realised when reinforcement is avoided, for example when new connections are accommodated on a system which is traditionally considered fully loaded due to power flows under outage conditions. Existing loading was considered to select the circuits on which a new connection during the trial period could require reinforcement.

It was important to select circuits with the greatest chance of new connections during the trial period in order to maximise the number of customers who would have the opportunity to be involved in the trial. Therefore, the initial circuit screening identified circuits in areas with the greatest historic connection application rate and in development areas identified through a survey of planning authorities.

Preliminary circuit selection
Details of the circuits identified for further consideration by the initial circuit screening were then examined to ensure that they were technically and practically suitable for inclusion in the trial. Checks were made that the existing circuits were operating in a radial configuration and that both ends of the closed HV ring would be connected to the same HV source.

It was confirmed that the necessary remote control required for the function of C_2C could be installed at the NOPs, as it is not possible to fit remote control to all types of HV switchgear which exist within the network.

Some circuits were excluded from the circuit selection because planned work on the network would require circuit outages during the trial period, resulting in uncertainties regarding the system topology. Also, circuits with existing operational restrictions or existing automated load reduction schemes were excluded because these could not function with the automation required by C_2C.

Circuit breakers with hand-charge springs only have the ability to reclose once before requiring recharging by hand again, and are unsuitable for the automated switching required for C_2C operation. However, there are a considerable number of hand-charged spring circuit

breakers within the network and therefore a number of circuits with these were included in the circuit selection, with the intention that these circuits will remain operating in a radial configuration during the trial, to obtain learning relevant to future application to a wider population.

Most of the circuits chosen to run as rings for the trial had low historic fault rates, typical of over 80% of Electricity North West's circuit population, to minimise the effect of faults on customers. However, a number of higher fault rate radial circuits were included to gather results for circuits with a lower reliability.

Circuit simulation
The circuits remaining in the preliminary list were simulated using the power system analysis package DINIS to identify any thermal, voltage or fault level issues that may arise as a result of operating the two radial feeders as a closed loop with a typical new load connection. The majority of the cases showed satisfactory behaviour and only 10 circuits, corresponding to five rings, were excluded from the selection because of the simulation results.

Circuit selection results
The final circuit selection was spread across the geographic region, as shown in Figure 1, and included the following:

- 153 closed rings
- 27 open rings with hand charged springs, and
- 20 radial circuits with higher than average fault rates.

The split of the selected circuits compared to the total Electricity North West circuit population based on voltage and circuit type are shown in Figures 2 and 3. These indicate that the circuits selected are representative of the Electricity North West circuit population.

Figure 1: Map showing selected circuit locations within Electricity North West region

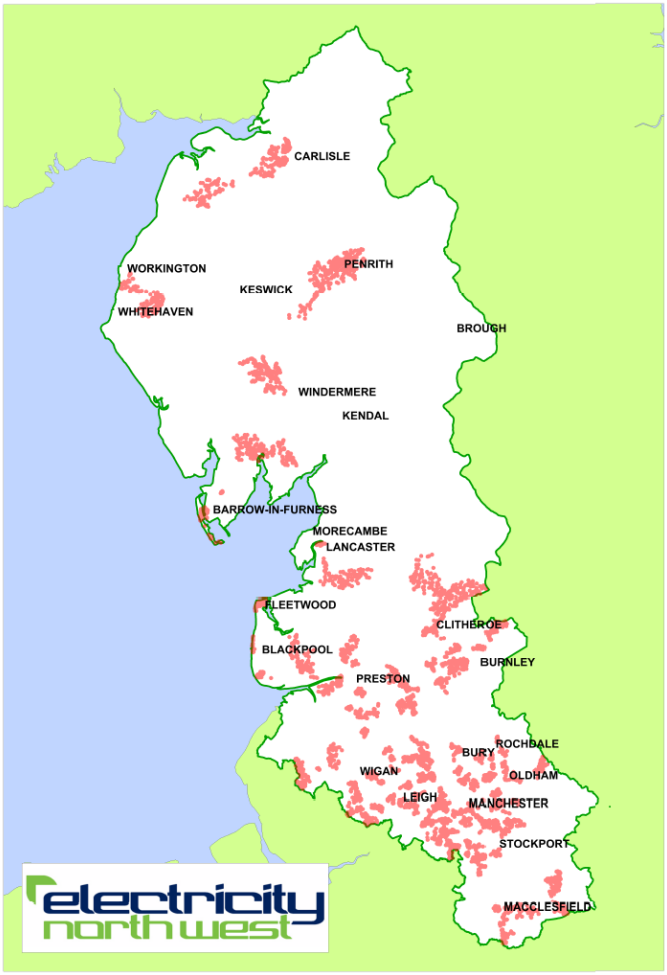
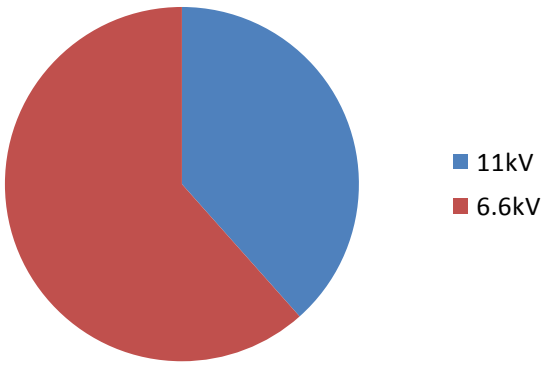


Figure 2: Split of circuits in the total Electricity North West population and the list of circuits selected for the C_2C trial based on voltage

Voltage mix of all circuits in the Electricity North West network



Voltage mix of all circuits in the C_2C trial

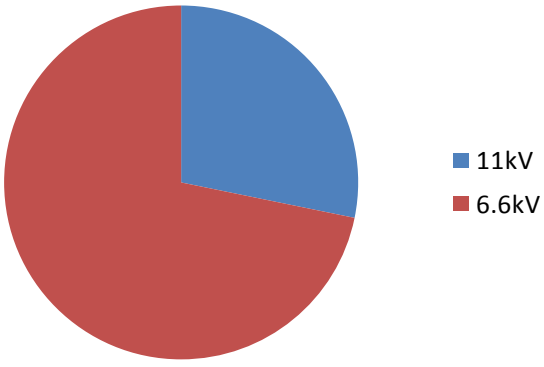
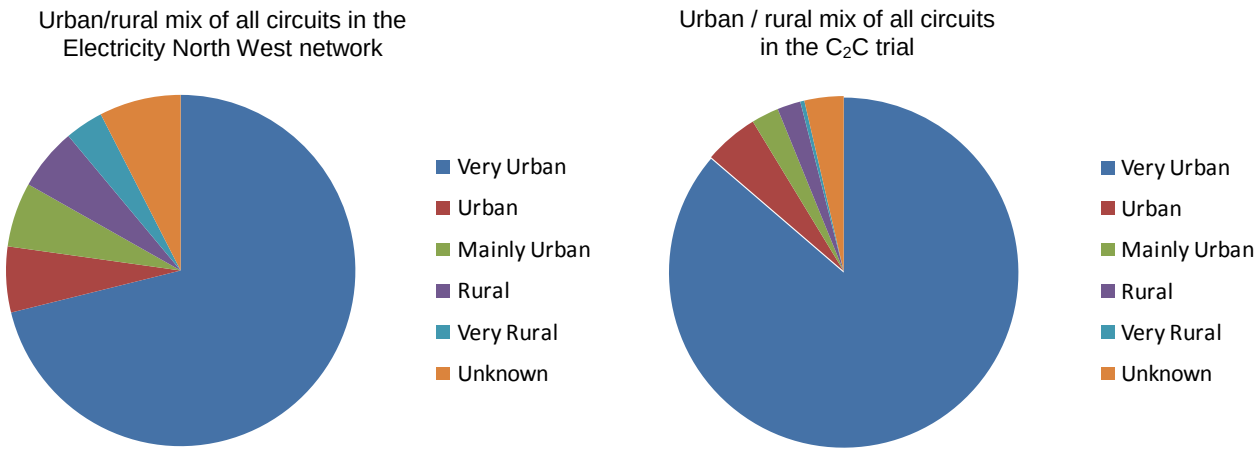


Figure 3: Split of circuits in the total Electricity North West population and the list of circuits selected for the C_2C trial based on circuit type



Derogation from Engineering Recommendation P2/6

Electricity North West's Distribution Network Operator's licence conditions requires that it plans the network to a level of security not less than that defined in Engineering Recommendation P2/6 (ER P2/6) of the Energy Networks Association. The C_2C trial could lead to the circuits involved becoming non-compliant since the unconstrained demand on a system could increase beyond the level of demand that can be supplied with a circuit outage. However, in practice customers contracted under C_2C to reduce demand under outage conditions would be constrained to bring down the demand to a level that can be supplied by the depleted network and other customers would be unaffected.

Electricity North West has applied to Ofgem for a derogation from its Standard Licence Condition 24.1(a) to plan and develop its distribution system in accordance with a standard not less than that set out in ER P2/6 of the Energy Networks Association so far as that standard is applicable to it. Electricity North West has committed to ensure that the appropriate reinforcement to restore compliance of the network will be undertaken at the end of the trial if necessary.

Conclusions

Through a circuit selection methodology considering the range of circuit and customer types within the region, the 180 closed rings chosen for the trial should provide learning applicable to the whole Electricity North West network. This learning should be transferable to the wider GB distribution system. Active participation in the trial will be available to industrial and commercial customers who are currently connected to a trial circuit or who require a new connection to a trial circuit. The circuits chosen for the trial have been included in an Ofgem derogation request for non-compliance with ER P2/6.

Further Information

For the full report on this engagement work please see www.enwl.co.uk/c2c/keydocs.