Project update

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Background

Historic networks have no active voltage regulation.

LCTs create network issues. Customer demand could cause voltage to dip below statutory limits.

Customer generation could cause voltage to exceed statutory voltage limits.

Smart Street stabilises voltage across the load range and optimises power flows.

Conservation voltage reduction. Stabilised voltage can be lowered making our network and customers’ appliances more efficient.
£11.5m, four-year innovation project

Started in Jan 2014 and finished in Apr 2018

Quicker connection of LCTs
Lower energy bills
Improved supply reliability

Trials period Jan 2016 – Dec 2017

Extensive customer engagement programme throughout project
Trial overview

- Six primary substations
- 67,000 customers
- 11 HV circuits – five closable HV rings
- Five substation capacitors
- 79 LV circuit capacitors
- Three pole-mounted HV capacitors
- Three ground-mounted HV capacitors
- 38 distribution substations
- Five OLTC transformers
- Five substation capacitors
### Overview of research workstream

- **Quantified the voltage optimisation and loss reduction techniques used in Smart Street**
- **Proved the benefits of meshed networks and the effects on power quality**
- **Quantified the cost benefits and carbon impact related to the Smart Street solution**
- **TNEI provided research support and consultation for the duration of the trials**
High level conclusions

Network benefits

- Alleviate network issues
- Facilitate energy savings
- Reduce network losses

Benefits from reduced losses and deferred reinforcement if ...

Customer benefits

- Smart Street investment costs low
- Demand growth and LCT uptake uncertain

Economic benefits per customer independent on network type
## High level conclusions

<table>
<thead>
<tr>
<th>Optimisation benefits (energy)</th>
<th>Optimisation benefits (losses)</th>
<th>Trade off between loss and energy consumption reduction</th>
<th>Carbon benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-8% voltage reduction</td>
<td>Up to 15% loss reduction</td>
<td>Does exist but depends on load composition</td>
<td>Electricity system emissions reductions of 7% to 10% may be possible with a full application of Smart Street</td>
</tr>
<tr>
<td>5.5 – 8.5% energy reduction</td>
<td>Rural network has highest loss reduction</td>
<td>Energy consumption dominates</td>
<td></td>
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<tr>
<td>All networks similar energy reduction</td>
<td>Total energy reduction independent of weightings applied</td>
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</tbody>
</table>
### Overall impact of Smart Street trials

<table>
<thead>
<tr>
<th>Perception of power quality</th>
<th>Experience of SDIs</th>
<th>Fault data</th>
<th>Smart Street benefits</th>
<th>The hypothesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceptions driven by exposure to power cuts</td>
<td>Not spontaneously associated with a reduction in power quality</td>
<td>SDIs were generally linked to network faults unassociated with the trials or with equipment installation</td>
<td>Generally customers perceived the Smart Street project to have positive or at least neutral implications</td>
<td>Customers in the trial area have not perceived any changes in their electricity supply when the Smart Street method is applied</td>
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<tr>
<td>Minimal differences re frequency and/or duration</td>
<td>Do not negatively impact customers’ power quality perceptions</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>On balance positive changes</td>
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</table>
## Outcomes

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>CO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitored and</td>
<td>Proven that</td>
<td>Potential deferment of reinforcment</td>
<td>Associated carbon equivalent savings</td>
<td></td>
</tr>
<tr>
<td>actively</td>
<td>techniques</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>optimised</td>
<td>save energy</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>LV network</td>
<td></td>
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</tbody>
</table>
Losses vs energy savings

Contour tangential to Pareto front

Contours corresponding to $\text{HVL} + \text{LVE} = \text{constant}$

Feasible solutions
Pareto front
ODCD Pareto estimate
Min cost solution
Meshing

- Reduces voltage issues
- Improves asset utilisation
- Reduces losses
- Increases fault levels
- No benefit to permanent connection – only mesh at beneficial times
Learning points – system

System architecture

Integration with existing SCADA system

Use of single line diagram
Learning points

Communications  Water ingress  Cabinet design and location  Enclosure size
Carbon impact

Reduction of approx 5% at HV level

Reduction of 7 – 10% at LV level (network dependent)

Significant merit in reducing UK carbon emissions, particularly through reducing network losses and customer energy use
Lessons learned

- Comms reliability
- OLTC ‘safe’ setpoint
- Capacitor banks too large
- Capacitor banks better suited to rural networks
- BAU solution would need a four wire model
- Consider OLTC option in ENA technical specifications
- LV volt drop not as expected
<table>
<thead>
<tr>
<th><strong>Policy changes</strong></th>
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<tr>
<td><strong>LV Design</strong></td>
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<tr>
<td>Voltage drop not as severe as expected</td>
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<tr>
<td><strong>OLTC</strong></td>
</tr>
<tr>
<td>Electricity North West specification modified to allow for use of OLTCs</td>
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<tr>
<td><strong>Connections</strong></td>
</tr>
<tr>
<td>Update connection process for LCTs</td>
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<tr>
<td><strong>Monitoring</strong></td>
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<tr>
<td>Fit monitoring to identify clusters</td>
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</tbody>
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Lynx housing to be redesigned

Monitored network being retained

Integration with new NMS
Further developments

- Capacitors potentially useful if loads increase
- Full network optimisation
For more information

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