Transition to a Low Carbon Future

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Innovative voltage control

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Background

Historic networks have no active voltage regulation

Increased demand

Increased generation

Smart Street stabilises voltage and optimises power flows

Conservation voltage reduction
Project overview

£11.5m, four-year innovation project

Started in January 2014 and finished in April 2018

Quicker connection of LCTs
Lower energy bills
Improved supply reliability

Trials period January 2016 – December 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
Research overview

- 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
- Quantified the voltage optimisation and loss reduction techniques used in Smart Street
Universities created models of network – used measured data to validate

### Modelled 54 scenarios

<table>
<thead>
<tr>
<th>Three networks</th>
<th>Three optimisation modes</th>
<th>Two day types</th>
<th>Three years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dense urban</td>
<td></td>
<td>Winter weekday</td>
<td>2017</td>
</tr>
<tr>
<td>Urban</td>
<td>1. OLTCs</td>
<td>Summer weekday</td>
<td>2035</td>
</tr>
<tr>
<td>Rural</td>
<td>2. OLTCs and capacitors</td>
<td></td>
<td>2050</td>
</tr>
<tr>
<td></td>
<td>3. OLTCs, capacitors and meshing</td>
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</table>
## Consumption and loss reduction

<table>
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<tr>
<th></th>
<th>Energy Consumption Reduction (%)</th>
<th>Losses Reduction (%)</th>
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<td></td>
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<td><strong>Dense Urban</strong></td>
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<tr>
<td>Summer</td>
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<td>6.9</td>
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<tr>
<td>Summer</td>
<td>7.2</td>
<td>7.8</td>
</tr>
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<td>6.7</td>
<td>7.3</td>
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High level conclusions

Optimisation benefits (energy)

- 6-8% voltage reduction
- 5.5 – 8.5% energy reduction
- All networks similar energy reduction

Optimisation benefits (losses)

- Up to 15% loss reduction
- Rural network has highest loss reduction

Trade off between loss and energy consumption reduction

- Does exist but depends on load composition
- Energy consumption dominates

Carbon benefits

- Reductions of 7% to 10% with a full application of Smart Street

Energy consumption dominates
### 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>
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<td>Perceptions driven by exposure to power cuts</td>
<td>Not 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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**Overall impact:**

- **Perception of power quality**
  - Perceptions driven by exposure to power cuts
  - Minimal differences re frequency and/or duration
  - On balance positive changes

- **Experience of SDIs**
  - Not associated with a reduction in power quality
  - Do not negatively impact customers’ power quality perceptions

- **Fault data**
  - SDIs were generally linked to network faults unassociated with the trials or with equipment installation

- **Smart Street benefits**
  - Generally customers perceived the Smart Street project to have positive or at least neutral implications

- **The hypothesis**
  - Customers in the trial area have not perceived any changes in their electricity supply when the Smart Street method is applied
Outcomes

- Monitored and actively optimised LV network
- Proven that techniques save energy
- Potential deferment of reinforcement
- Associated carbon equivalent savings
Learning points – system

- System architecture
- Integration with existing SCADA system
- Use of single line diagram
Learning points – equipment

- Communications
- Water ingress
- Cabinet design and location
- Enclosure size
Learning points – voltage control

- Communications reliability
- OLTC ‘safe’ setpoint
- LV volt drop not as expected
- Capacitor banks better suited to rural networks
### Learning points - meshing

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<th>Reduces voltage issues</th>
<th>Improves asset utilisation</th>
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<th>Increases fault levels</th>
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## Policy changes

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<th>OLTC</th>
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<td>Modify specification</td>
<td>Update connection process for LCTs</td>
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- **LV design**: Is planning tool correct?
- **OLTC**: Prepare specification
- **Connections**: Update connection process for LCTs
- **Training**: New procedures and equipment
Network – today

Substation

[Diagram of network with substations and connections to houses and electric cars]

Substation
Future network – 1

On-load tapchanger

Substation

Substation

On-load tapchanger
Future network – 2

Meshed networks

On-load tapchanger

Substation

On-load tapchanger
Summary

• Energy savings up to 8.5%
• Loss reduction up to 15%
• Active interconnection benefits quantified

Customer Benefits
• Lower energy bills
• More reliable supply
• Reinforcement savings
• No impact on supply

Carbon Footprint
• Faster LCT adoption
• Carbon emissions reduced by up to 10%
• Re-usable technology

OLTCs provide benefits
• Operation of devices proven
• Software needs refinement

Trials
• Energy savings up to 8.5%
• Loss reduction up to 15%
• Active interconnection benefits quantified

Technology
QUESTIONS & ANSWERS
Please contact us if you have any questions or would like to arrange a one-to-one briefing about our innovation projects.