Learning dissemination event
13 October 2015
Steve Cox
Head of Engineering
<table>
<thead>
<tr>
<th>Mobile phones</th>
<th>Breaks</th>
<th>Fire alarms</th>
<th>Main Q&amp;A at end of day</th>
</tr>
</thead>
</table>

Housekeeping
Agenda

- Introduction and overview
- Technical update
- Trial design
- Customer engagement
Introducing Electricity North West

- 4.9 million
- 2.4 million
- 25 terawatt hours
- £12 billion of network assets

56 000 km of network • 96 bulk supply substations
363 primary substations • 33 000 transformers
Our innovation strategy

- Delivering value to customers
- Maximise use of existing assets
- Innovative solutions to real problems
- Proven technology deployable today
- Generate value for customers now
- Offer new services and choice for the future

‘Fit and forget’
Our smart grid development

Leading work on developing smart solutions

Deliver value from existing assets

Customer choice

Four flagship products (second tier) £36 million

LCN Fund Low Carbon Networks

C2C Capacity to Customers

CLASS

SMART STREET

RESPOND
### Smart Street project overview

<table>
<thead>
<tr>
<th><strong>£</strong></th>
<th><strong>£11.5m, 4 year innovation project</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>List</strong></td>
<td><strong>Started in Jan 2014 and finishes in Apr 2018</strong></td>
</tr>
<tr>
<td><strong>House &amp; Car</strong></td>
<td><strong>Facilitates quicker cheaper connection of domestic LCTs</strong></td>
</tr>
<tr>
<td><strong>Calendar</strong></td>
<td><strong>Trials period Jan 2016 – Dec 2017</strong></td>
</tr>
<tr>
<td><strong>People</strong></td>
<td><strong>Extensive customer engagement programme throughout project</strong></td>
</tr>
</tbody>
</table>
Voltage profile

Historic networks have no active voltage regulation
Problem - LCTs create network issues

LCTs rapidly surpass voltage and thermal network capacity

Drift range
Smart Street – the first intervention

- Low cost
- Quick fit
- Minimal disruption
- Low carbon
- Low loss
- Invisible to customers

Voltage stabilised across the load range
- Power flows optimised
Smart Street benefits

Now we can stabilise voltage
We can set the voltage level lower
This will lead to:

- Reduced demand
- Reduced customer energy consumption
- Maximised DG output

How much could customers save?

<table>
<thead>
<tr>
<th></th>
<th>How much could customers save?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reinforcement savings via DUoS</strong></td>
<td>£330 over 25 years</td>
</tr>
<tr>
<td><strong>Reduced energy consumption, 2013 (from CVR ≈ 3 - 7%)</strong></td>
<td>£15 - £30 pa</td>
</tr>
<tr>
<td><strong>Maximise DG output (from maximising Feed In Tariff income)</strong></td>
<td>£70 pa</td>
</tr>
</tbody>
</table>

Efficient network solutions ● Energy savings ● Carbon benefits
Smart Street trial areas

- 6 primary substations
- 11 HV circuits
- 38 distribution substations
- 163 LV circuits
- Around 62,000 customers
- 3 selected primary substations in CLASS

Selected primary substations in CLASS:
- Wigtown & Egremont
- Wigan & Leigh
- Manchester
Project partners

KELVATEK

Tyndall Manchester
Climate Change Research

MANCHESTER 1824
The University of Manchester

SIEMENS

tnei
tnenei
enterprise with energy

Queen’s University Belfast

Impact Research
Damien Coyle
Smart Street Technology Engineer
Existing radial network

<table>
<thead>
<tr>
<th>Network limitations</th>
<th>Customer impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diversity between feeders is untapped</td>
<td>Customers’ needs invisible to the network</td>
</tr>
<tr>
<td>Fuses unable to cope with cold load pick up</td>
<td>Demand and generation levels limited by passive voltage control systems</td>
</tr>
<tr>
<td></td>
<td>Reliability driven by fix on fail</td>
</tr>
</tbody>
</table>
Network reliability improvement

Builds on C₂C and CLASS  ●  Storage compatible  ●  Transferable solutions
System architecture
Distribution voltage regulated transformer

5 OLTCs

9 taps

Local or remote
HV capacitors

<table>
<thead>
<tr>
<th>3 ground mounted HV capacitors</th>
<th>3 pole mounted HV capacitors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secured within GRP housings in urban areas</td>
<td>Installed similar to pole mounted transformers</td>
</tr>
</tbody>
</table>
What customers will see – LV capacitors in street furniture

84 LV capacitors

One on each closed ring

Multi staged
WEEZAP

World leading LV vacuum circuit breaker

Advanced measurement and protection capability

Safe LV interconnection, live monitoring and control

Improves supply reliability and restoration through fault management and detection
**LYNX**

<table>
<thead>
<tr>
<th>LV switch</th>
<th>Allows active network meshing and un-meshing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Advanced monitoring capabilities</td>
</tr>
<tr>
<td></td>
<td>Ability to control the circuit locally or remotely</td>
</tr>
<tr>
<td>Spectrum</td>
<td>Measures, optimises and responds</td>
</tr>
<tr>
<td>----------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td></td>
<td>CVR and losses benefits unlocked</td>
</tr>
<tr>
<td></td>
<td>Oversees network and customer needs</td>
</tr>
<tr>
<td></td>
<td>Builds on CLASS smart voltage control</td>
</tr>
</tbody>
</table>
Technology – monitoring

Gridkey monitoring device

Measures voltage at LV cable end

Data storage one minute intervals
Technology overview

- 84 LV capacitors installed
- 43 Lynx systems installed
- 498 Weezaps installed
- 50 end-point controllers installed
- Spectrum 5 installed on network

Next steps
Commission system
Briefing and training
Go live!
Dan Harber
Trials & Research Engineer
Agenda

- Proposed test schedule
- Research overview
- Trial network overview
- Test regimes
### Smart Street site selection

<table>
<thead>
<tr>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial circuit screening</td>
<td>Circuit classification</td>
<td>Circuit simulation and refined circuit selection</td>
</tr>
<tr>
<td>Use of existing CLASS and C₂C assets</td>
<td>Circuit types &amp; customer types</td>
<td>HV network modelling in IPSA / DINIS</td>
</tr>
<tr>
<td>Avoided areas scheduled for asset replacement works</td>
<td>Physical &amp; electrical constraints</td>
<td>Identification of any thermal, voltage or fault level issues</td>
</tr>
<tr>
<td></td>
<td>Low carbon technology uptake</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LV inter-connection</td>
<td></td>
</tr>
</tbody>
</table>
### Stage 4

**Network design methodology**

- Detailed combined HV & LV network modelling
- Applied a range of meshing scenarios
- Varied capacitor sizes and locations
- Altered transformer tap settings

### Stage 5

**Final site selection**

- Final circuits selected
- Rules based design methodology applied
- Modified the demand profile
- Developed rules based methodology based on results
Trial overview

- 6 primary substations
- 62,000 customers
- 11 HV circuits – 5 closable HV rings
- 3 pole mounted HV capacitors
- 3 ground mounted HV capacitors
- 38 distribution substations
- 5 OLTC transformers
- 5 substation capacitors
- 79 LV circuit capacitors
## Trial design

**Five trial techniques**

| Two years | LV voltage control |
| Two weeks on, two weeks off | LV network management and interconnection |
| One year’s worth of Smart Street data | HV voltage control |
| To be designed to avoid placebo affect | HV network management and interconnection |
| Five trial regimes to test full effects | Network configuration and voltage optimisation |
## Test regimes

<table>
<thead>
<tr>
<th>Smart Street trial</th>
<th>Test regime</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LV voltage control</strong></td>
<td>1. On-load tap changing distribution transformer only</td>
</tr>
<tr>
<td></td>
<td>2. On-load tap changing distribution transformer and capacitor(s) on LV circuits</td>
</tr>
<tr>
<td></td>
<td>3. Capacitors at distribution substation only</td>
</tr>
<tr>
<td></td>
<td>4. Capacitors at distribution substation and on LV circuits</td>
</tr>
<tr>
<td></td>
<td>5. Capacitor(s) on LV circuits only</td>
</tr>
<tr>
<td><strong>LV network management &amp; interconnection</strong></td>
<td>1. LV radial circuits</td>
</tr>
<tr>
<td></td>
<td>2. LV interconnected circuits</td>
</tr>
<tr>
<td><strong>HV voltage control</strong></td>
<td>1. Voltage controllers at primary substation only</td>
</tr>
<tr>
<td></td>
<td>2. Voltage controllers at primary substation and capacitor(s) on HV circuits</td>
</tr>
<tr>
<td><strong>HV network management &amp; interconnection</strong></td>
<td>1. HV radial circuits</td>
</tr>
<tr>
<td></td>
<td>2. HV interconnected circuits</td>
</tr>
<tr>
<td><strong>Network configuration &amp; voltage optimisation</strong></td>
<td>1. Losses reduction</td>
</tr>
<tr>
<td></td>
<td>2. Energy consumption reduction</td>
</tr>
</tbody>
</table>
## Proposed test schedule

<table>
<thead>
<tr>
<th>WEEK 1</th>
<th>TRIAL 1 - LV VOLTAGE CONTROL</th>
<th>TRIAL 2 – LV INTERCONNECTION</th>
<th>TRIAL 3 - HV VOLTAGE CONTROL</th>
<th>TRIAL 4 - HV INTERCONNECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WEEK 2</td>
<td></td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WEEK 3</td>
<td></td>
<td>EQUIPMENT TESTED IN ISOLATION</td>
<td></td>
<td>EQUIPMENT TESTED IN ISOLATION</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>WEEK 4</td>
<td></td>
<td>COMBINED TESTING</td>
<td>COMBINED TESTING</td>
<td>COMBINED TESTING</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>WEEK 5</td>
<td></td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WEEK 6</td>
<td></td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WEEK 7</td>
<td></td>
<td>EQUIPMENT TESTED IN ISOLATION</td>
<td></td>
<td>COMBINED TESTING</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ON</td>
<td>COMBINED TESTING</td>
<td>ON</td>
</tr>
<tr>
<td>WEEK 8</td>
<td></td>
<td>COMBINED TESTING</td>
<td>EQUIPMENT TESTED IN ISOLATION</td>
<td>ON</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ON</td>
<td>EQUIPMENT TESTED IN ISOLATION</td>
<td>ON</td>
</tr>
</tbody>
</table>

**Trial 5:** The optimisation will be applied during the trial on periods where week 4 allows for full optimisation.
Overview of research workstream

WP1 will look to quantify the voltage optimisation and loss reduction techniques used in Smart Street.

WP2 will look to produce the design and operation policies required to convert UK networks into optimal meshed configurations.

WP3 will research the cost benefits and carbon impact related to the Smart Street solution.

TNEI will provide research support and consultation for the duration of the trials.
Customer engagement
Kate Quigley
Susie Smyth
# Customer impact and objectives

<table>
<thead>
<tr>
<th>Pre-trial</th>
<th>During/post-trial</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Warning] Customers have seen increased activity while equipment is installed</td>
<td>![Warning] Possible change in voltage</td>
</tr>
<tr>
<td>Occasional planned supply interruptions due to equipment installation</td>
<td>![Warning] Higher number of faults of shorter duration during trial period</td>
</tr>
</tbody>
</table>

| Objective: To engage with customers and explain impact of Smart Street trial | Objective: To prove that customers will not perceive a change to their electricity supply |
“Customers in the trial area will not perceive any changes in their electricity supply when the Smart Street method is applied”

Customer research methodology

- **Qualitative**
  - Formulate comms materials
- **Customer enquiries**
- **Qualitative**
  - Qualify customer experience

**Potential customer impacts**
- Installation of street cabinets
- A relatively higher number of faults of a shorter duration
- Planned supply interruptions due to equipment installation
- Possible change in voltage
Engaged customer panel methodology

Cross section of customers
Two meetings x three areas = 6 focus groups (to date)

30 customers recruited across 3 groups
### ECP recommendations

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Should we communicate with customers on trial circuits?</td>
<td>Yes</td>
</tr>
<tr>
<td>Why should we do so?</td>
<td>Important public information about our customers’ electricity supply</td>
</tr>
<tr>
<td>What format should the leaflet take?</td>
<td>A simply worded leaflet</td>
</tr>
<tr>
<td>What should it say?</td>
<td>Our role as DNO, benefits of Smart Street, priority service register, contact details</td>
</tr>
<tr>
<td>When should it be delivered?</td>
<td>Delivered before start of equipment installation in September 2014</td>
</tr>
<tr>
<td>To whom should it be delivered?</td>
<td>All customers on trial circuits</td>
</tr>
</tbody>
</table>
ECP recommendations

Important information from your electricity network operator

We are improving the electricity network that supplies your home

Who is Electricity North West?
We operate the local electricity network and distribute electricity to about 1.4 million homes and businesses in the North West.

What are we doing?
We are finding smarter ways of using the electricity network by installing new technology to supply electricity to your home or business more efficiently. This will help reduce our future electricity costs and save you money.

What are we doing this?
To help protect the environment and reduce energy usage, we have installed smart meters at customer sites in your area. This means that we will measure electricity use correctly in running your electric appliances and heating systems.

How will I benefit?
If there is a network outage, we will be able to restore power to your property more quickly than before. You may see a small reduction in your electricity usage.

Will I need a smart meter or other equipment installed in my house?
Some streets have already been selected for smart meter installation. In some areas, we may also install other equipment as we do this.

To find out more about the project process and the equipment being installed, please visit electricitynorthwest.co.uk/smartstreet
ECP lessons learned

- Leaflet must look official to differentiate from junk mail
- Focus on customer benefits not company’s or regulatory
- Most appealing benefit to customers is cost-saving on bill
- Customers sceptical of cost-saving promises unless they are quantified
- Info should be simple, positive & informative with summary at the start
- “What to do in a power cut” info considered negative and irrelevant
- Don’t have pre-conceived ideas about customer information preferences
## Progress and next steps

<table>
<thead>
<tr>
<th>Customer engagement plan submitted to Ofgem and approved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Go live of the Smart Street website and social media forums</td>
</tr>
<tr>
<td>Engaged customer panels held and lessons learned published</td>
</tr>
<tr>
<td>Customer leaflet designed and distributed to customers on trial circuits</td>
</tr>
<tr>
<td>Customers affected by new street furniture installations notified</td>
</tr>
<tr>
<td>Technology installation enquiries / complaints resolved</td>
</tr>
<tr>
<td>Customer Contact Centre briefed before trial go live</td>
</tr>
<tr>
<td>Successful technical installation as a result of well planned customer engagement activities</td>
</tr>
</tbody>
</table>
Next steps

- Engagement with vulnerable customers
- Further ECPs to gauge customer perception & acceptability of trials
- Produce report of customer research findings
- Ongoing engagement with customers during trial
Steve Cox
Head of Engineering
Smart Street overview

New controllable switching devices stabilise voltage

Allows us to lower voltage levels

Enables networks and appliances to work in harmony

Low cost ● Quick fit ● Minimal disruption ● Low carbon ● Low loss ● Invisible to customers ● Faster connection of low carbon technologies
Smart Street summary

**Benefit**
- Lower energy bills
- More reliable supply
- Reinforcement savings

**Challenge**
- Combine into one end-to-end system
- Network optimisation

**Carbon Footprint**
- Faster LCT adoption
- Less embedded carbon
- Re-usable technology
- Optimise energy and losses

**Low Risk**
- First example of CVR
- First example of centrally controlled LV network
- Range of intervention solutions
Next steps

**Dec 2015**
- System commission
  - Integrate and optimise Smart Street system on network

**Jan 2016**
- Start of trials
  - Trials will run for 2 years in conjunction with research deliverables

**Jan 2018**
- ECP and customer research
  - Qualitative research with customers on trial circuits

**Apr 2018**
- Project closedown
  - Project findings and final dissemination event for all stakeholders

Knowledge sharing and dissemination
QUESTIONS & ANSWERS