Innovation
Responding to the needs of customers
Dan Randles
Network Performance & Innovation Manager

3 October 2014
Connecting the North West

- 5 million
- 2.4 million
- 23.5 terawatt hours
- £12.3 billion assets
UK energy challenges

Uncertainty in future demand and generation ● Difficult to predict demand ● More pressure to meet customers’ needs at minimum cost

2014
1/3 gas
1/3 electricity
1/3 oil

2020
34% CO₂ reduction
40% from wind / PV
and new nuclear
5% transport 120,000 electric vehicles
26 million smart meters fitted

2050
80% CO₂ reduction
Significant increase in electricity demand

RIIO-ED1
Traditional reinforcement unaffordable
DG represents the most immediate challenge
Our innovation strategy

‘Fit and forget’

Maximise use of existing assets

Offer new services and choice for the future

Generate value for customers now

Proven technology deployable today

Innovative solutions to real problems

Delivering value to customers

www.enwl.co.uk/thefuture
Built around stakeholder priorities

<table>
<thead>
<tr>
<th>Affordable reliability</th>
<th>Continued unpredictability in economic growth in the region</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High levels of DG necessitating optimisation of output or alternative methods for the storage of excess energy and greater flexibility in network loading and capacity</td>
</tr>
<tr>
<td>Customers</td>
<td>Customers demanding greater transparency over the way in which they are charged for electricity and more control over their own electricity consumption</td>
</tr>
<tr>
<td></td>
<td>Demands for improved quality of service</td>
</tr>
<tr>
<td></td>
<td>Extensive smart meter roll-out</td>
</tr>
<tr>
<td>Sustainability</td>
<td>Greater demands for electricity as more customers switch from gas</td>
</tr>
<tr>
<td></td>
<td>Domestic use increasing by up to 20% through the connection of Low Carbon Technology (LCT) to the network</td>
</tr>
<tr>
<td></td>
<td>Continued upward pressure on energy prices</td>
</tr>
</tbody>
</table>
Our smart grid programme

Leading work on developing smart solutions

- Deliver value from existing assets
- Customer choice

Three flagship products: £30 million
- LVNS
- SMART FUSE
- LV VOLTAGE

Seven smaller scale demonstrators: £6 million
- FCAM
- COLM
- LV PAC

Capacity to Customers: LoVIA
- CLASS: Customer Load Active System Services
- SMART STREET
Capacity to Customers

**Capacity to Customers**

- **Utilised capacity**
  - Combines proven technology and new commercial contracts
  - Releases significant network capacity
  - Facilitates connection of new demand and generation without reinforcement

- **Technical innovation**
  - Remote control equipment on HV circuit and close the NOP
  - Enhanced network management software
  - Effectively doubles the available capacity of the circuit

- **New commercial contracts**
  - Innovative demand side response contracts
  - Allow us to control customer’s consumption on a circuit at the time of fault

**Innovative demand side response contracts**
Capacity to Customers and beyond

When is $C_2C$ cost effective ...? ... or when should we reinforce?

Working with University of Manchester to develop economic methodology
CLASS is seeking to demonstrate that electricity demand can be managed by controlling voltage…without any discernible impacts on customers.
### Smart Street

#### New controllable switching devices stabilise voltage
- Allows us to lower voltage levels
- Enables networks and appliances to work in harmony

#### Benefits
- Low cost
- Quick fit
- Minimal disruption
- Low carbon
- Low loss
- Invisible to customers
- Faster connection of low carbon technologies
FLARE is the first UK demonstration of an active fault level management solution that avoids traditional network reinforcement.

Faster LCT adoption ● Less disruption ● Lower bills
Want to know more?

<table>
<thead>
<tr>
<th></th>
<th><a href="mailto:futurenetworks@enwl.co.uk">futurenetworks@enwl.co.uk</a></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><a href="http://www.enwl.co.uk/thefuture">www.enwl.co.uk/thefuture</a></td>
</tr>
<tr>
<td></td>
<td>0800 195 4141</td>
</tr>
<tr>
<td></td>
<td>@ElecNW_News</td>
</tr>
<tr>
<td></td>
<td>linkedin.com/company/electricity-north-west</td>
</tr>
<tr>
<td></td>
<td>facebook.com/ElectricityNorthWest</td>
</tr>
<tr>
<td></td>
<td>youtube.com/ElectricityNorthWest</td>
</tr>
<tr>
<td></td>
<td><a href="mailto:dan.randles@enwl.co.uk">dan.randles@enwl.co.uk</a></td>
</tr>
</tbody>
</table>

Thank you for your time and attention
Low Voltage Network Solutions

Overview of project (non-academic focus)
Dr Rita Shaw

3 October 2014
LV Network Solutions

Our largest Tier 1 LCNF Fund

2011 - 2014

£1.5 million

www.enwl.co.uk/lvns
and your USBs

Modelling and analysis

But there was more to the project....
Aim of the project

To understand our LV networks now and in future scenarios
LV monitoring – identify technique and deploy

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Develop installation procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine monitoring requirements</td>
<td>Site selection / surveys</td>
</tr>
<tr>
<td>Prepare functional specifications</td>
<td>Train installation crews</td>
</tr>
<tr>
<td>Tender and procure equipment</td>
<td>Prepare for data capture</td>
</tr>
<tr>
<td>£</td>
<td>Roll out to site - 28 pole mounted and 172 ground</td>
</tr>
</tbody>
</table>
Monitoring equipment

GridKey monitoring equipment at 100 substations

2012 UK Energy Innovation award for the ‘Best Smart Grid Technology’
Nortech monitoring equipment at 100 substations
Communications approach

Monitoring unit fitted with SIM card
Assigned private, static IP address
Time stamped data logs created every 1 – 10 minutes

DPN3 Protocol between iHost and monitor

Unsolicited event reporting transfers data logs in near real time

iHost server at Electricity North West consists of communication modules, databases and web user interface

Export produces CSV files to be used by the University of Manchester

1 set of Rogowski coils fitted per LV way 3 phases and neutral measured
LV monitoring – outcomes

10,000 days of good 10-minute data

At transformer and head of each feeder, per phase + neutral

Value of monitoring within LVNS

Performance evaluation of monitored LV networks’

Review / improve load estimates for whole network

Validation of network models

Monitoring used in other innovation projects and BAU

Challenging but achieved!
Apart from the monitoring…

- Extract and transfer monitoring, network and customer data to UoM
- Engage with UoM analysis and outputs
- Leverage learning to support business
What we have learnt

Products + procedures
What parameters and when/where to monitor in future

How to monitor at LV

How our LV network performs now
In detail for monitored networks
Improving our ‘Load Allocation’ estimates for whole secondary network

How our LV network will perform with LCTs
Hosting capacity of underground LV networks for LCTs
Potential network solutions, with implications for future DNO policy
A (rough) future capacity headroom model for whole secondary network
Also ... LV feeder midpoint monitoring

100 midpoints and 100 endpoints outside LVNS project

Smart joint technique developed by us
Why are we doing this?

Drive value for our customers
Want to know more?

<table>
<thead>
<tr>
<th>Email</th>
<th><a href="mailto:futurenetworks@enwl.co.uk">futurenetworks@enwl.co.uk</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Website</td>
<td><a href="http://www.enwl.co.uk/thefuture">www.enwl.co.uk/thefuture</a></td>
</tr>
<tr>
<td>Phone</td>
<td>0800 195 4141</td>
</tr>
<tr>
<td>Twitter</td>
<td>@ElecNW_News</td>
</tr>
<tr>
<td>LinkedIn</td>
<td>linkedin.com/company/electricity-north-west</td>
</tr>
<tr>
<td>Facebook</td>
<td>facebook.com/ElectricityNorthWest</td>
</tr>
<tr>
<td>YouTube</td>
<td>youtube.com/ElectricityNorthWest</td>
</tr>
<tr>
<td>Email</td>
<td><a href="mailto:rita.shaw@enwl.co.uk">rita.shaw@enwl.co.uk</a></td>
</tr>
</tbody>
</table>

Thank you for your time and attention
Voltage Management on Low Voltage Busbars

Dr Geraldine Bryson
Future Networks Technical Manager
Aims and objectives

- Trial solutions to help manage LV networks and cope with changing demand.
- Assess ability to manage voltages in real time.
- Assess effectiveness of devices to correct power factor.
- Assess phase imbalance and power quality.

30 month project started in April 2011 costing £0.5 million.
Four techniques explored through field trials

- Voltage regulation using a distribution transformer with OLTC
- Voltage regulation using a Power Perfector on an individual LV feeder
- Voltage regulation using a shunt capacitor installed part way along an LV feeder
- Harmonic filtering, power factor correction and phase balancing via active filter
Distribution transformer with OLTC

Commissioned June 2013 with Fundamentals and set to existing LV busbar voltage

Training for TapCon230 relay

Operational procedures designed to reduce impact on customers and reduce training needs

Site trials use LV monitoring for results
Power Perfector

Commissioned August 2012

Training for changing settings

Operational procedures designed to reduce impact on customers and reduce training needs

Site trials use LV monitoring for results and change voltage settings
LV capacitors

Commissioned October 2013

Set to control volts NOT VAr

Operational procedures designed to reduce impact on customers and reduce training needs

Site trials use LV monitoring for results and change voltage settings
Active harmonic filters

Commissioned August 2012

Operational procedures designed to reduce impact on customers and reduce training needs

Site trials switch filter ON/OFF

Installed full PQ monitors for results
University of Manchester - Modelling

Modelling complete

Monitoring data used to verify

Alternative solutions modelled

Recommendations for Future Networks
Capacity release with OLTC
Capacity release with capacitor installation
Capacity release for different solutions
Lessons learnt

- Site surveys to get right location
- Elimination of modifications on site
- Attention to security
- Impact on customers

Approvals
- Produced in a timely manner
- Impact on customers

Academic support
- Make sense of results
- Provide guidance on future networks

Approach
- True partnering approach with all project stakeholders

Network monitoring key to understanding the outcomes
QUESTIONS & ANSWERS
Want to know more?

<table>
<thead>
<tr>
<th></th>
<th><a href="mailto:futurenetworks@enwl.co.uk">futurenetworks@enwl.co.uk</a></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><a href="http://www.enwl.co.uk/thefuture">www.enwl.co.uk/thefuture</a></td>
</tr>
<tr>
<td></td>
<td>0800 195 4141</td>
</tr>
<tr>
<td></td>
<td>@ElecNW_News</td>
</tr>
<tr>
<td></td>
<td>linkedin.com/company/electricity-north-west</td>
</tr>
<tr>
<td></td>
<td>facebook.com/ElectricityNorthWest</td>
</tr>
<tr>
<td></td>
<td>youtube.com/ElectricityNorthWest</td>
</tr>
<tr>
<td></td>
<td><a href="mailto:geraldine.bryson@enwl.co.uk">geraldine.bryson@enwl.co.uk</a></td>
</tr>
</tbody>
</table>

Thank you for your time and attention