Session 5.1
Thermal Monitoring and Dynamic Ratings

Dan Randles
Network Performance & Innovation Manager

LCNI Conference
Thursday 13 October 2016
Agenda

Celsius
Enhanced Real-Time Cable Temperature Monitoring

electricity north west
Bringing energy to your door

SP ENERGY NETWORKS

Damien Coyle
Innovation Project Manager

David Ruthven
Ali Kazerooni
Senior Project Consultants
Agenda

- Introduction
- Project overview
- Progress and next steps
- Questions & answers
Our smart grid development

Leading work on developing smart solutions

Deliver value from existing assets

Customer choice

Five flagship products (second tier/NIC) £42 million

C2C

SMART STREET

CLASS

RESPOND

Celsius

LCN Fund
Low Carbon Networks
Investment: £5.5 million

Awarded: 9th December 2015

- Go live: Monitoring installation Mar 2017
- Monitoring trial Mar 2018
- Thermal ratings tool stage 1 Oct 2018
- Retrofit cooling installation Jun 2018
- Cooling trial Jun 2019
- Thermal ratings tool stage 2 Jan 2020
- Closedown Mar 2020

Financial benefits: Up to £583m across GB by 2050
### Partners and roles on project

<table>
<thead>
<tr>
<th><strong>ASH</strong></th>
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<tbody>
<tr>
<td>Supply complete retrofit monitoring solution</td>
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<tr>
<td>Provide ongoing support throughout installation, commissioning and operation of the retrofit thermal monitoring workstream</td>
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<table>
<thead>
<tr>
<th><strong>RICARDO-AEA</strong></th>
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<tr>
<td>Analyse trial data</td>
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<tr>
<td>Develop methodologies to understand relationship between asset temperature, load characteristics and surrounding environment</td>
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<td>Determine impact of cooling technologies</td>
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<td>Develop tool and spec for low cost temperature sensor</td>
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<td>Recommendations for BAU rollout</td>
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<th><strong>Impact Research</strong></th>
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<tr>
<td>Work with ASH, Ricardo-AEA and Electricity North West to develop retrofit thermal monitoring solution</td>
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<tr>
<td>Participate in evaluation and selection of retrofit cooling techniques</td>
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<td>Facilitate customer focus groups</td>
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<td>Develop customer communication materials</td>
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<td>Lead the customer survey engagement</td>
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<th><strong>University of Southampton</strong></th>
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<td>Peer review of the analysis methodology of the retrofit temperature sensor part of the project</td>
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<td>An investigative study on the impact of Celsius on the lifetime health of network assets</td>
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The problem

Objective is to maximise power through transformer

Assets have nominal thermal rating
Ratings $= ^\circ$C
Ratings $K$ amps

Diverse range of environments
Small changes in environmental factors can result in very different actual ratings

Assumed thermal ratings can lead to capacity being under-utilised or unnecessary risk
Celsius as part of the smart future

Smart meter data

Thermal Ratings Tool

- Celsius monitoring
- Retrofit cooling
- Reinforce

Extra capacity

Lower bills for customers
Step 1: Fit thermal monitoring

- **Asset**
  - Internal temperature
  - External temperature
  - Environmental factors

- **Thermal coefficient**
- **Thermal Ratings Tool**
- **More capacity**
Step 2: Retrofit cooling

- **Asset**
  - Internal temperature
  - External temperature
  - Environmental factors
  - Retrofit cooling

**Learning**
- Retrofit cooling specifications, installation methodologies and buy order

**Deliverable**
- Enhanced Thermal Ratings Tool

**Benefit**
- Full capacity
Celsius studies

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<tr>
<th>Thermal analysis (step 1)</th>
<th>Internal asset temperature</th>
<th>$q_{\text{core}}$</th>
<th>$=\times$</th>
<th>Thermal coefficient</th>
<th>External asset temperature</th>
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<tr>
<td>Thermal flow study (steps 1 &amp; 2)</td>
<td>Research into heat and air flows for optimal substation design</td>
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<tr>
<td>Asset health study (steps 1 &amp; 2)</td>
<td>Examines effects of increased load and cooling techniques on assets</td>
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## Monitoring site selection and timescales

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<tr>
<th>520 substations</th>
<th>100 cooling technique sites</th>
<th>Four year project</th>
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<tr>
<td>Enough substations to represent 80% of GB substation population</td>
<td>Subset of 520 substations – enough sites to adequately trial all techniques</td>
<td>To enable trials to take place during all seasons and to trial all cooling techniques</td>
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</table>
Site selection map
Site selection – rural and urban
Celsius technology

Hub

Wireless sensor
Celsius technology – trial fit

LV board with three sensors
Celsius technology – trial fit

Transformer singles

[Images of thermal images showing transformer singles and temperature readings]
Celsius technology – trial fit

Ventilation

![FLIR Image](image1)

25.2°C

![FLIR Image](image2)
Celsius technology – trial fit

Transformer
Magda Rd 750kVA Transformer Load and Temperatures

- P1 kW
- P2 kW
- P3 kW
- Top Oil oC
- Inlet oC
- Outlet oC
- Bottom Oil oC

Temperature Degrees C

Trial site data
<table>
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<tr>
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<th>Traditional</th>
<th>Celsius</th>
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<tr>
<td><strong>Currency</strong></td>
<td>Traditional replacement of ground-mounted transformer is expensive</td>
<td>Low cost options to release capacity as and when required</td>
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<tr>
<td><strong>Clock</strong></td>
<td>Complex and time-consuming</td>
<td>Simple and quick to deploy</td>
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<tr>
<td><strong>Shovel</strong></td>
<td>Highly disruptive</td>
<td>Minimal or no disruption to customers</td>
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Customers in the Celsius trial areas will find the implementation of innovative retrofit cooling techniques as acceptable as traditional reinforcement.

Customers who are educated as to the need for and benefits of Celsius are significantly more likely to find it acceptable.
Progress and next steps

January – June 2016
- Project mobilised
- Partner contracts awarded
- Customer engagement plan
- Data privacy statement

July - December 2016
- Monitoring site selection
- Commissioning tool
- Monitoring installation
- ENA ER P15 & P17 workshop

January – June 2017
- Data capture
- Thermal flow study
- ENA cooling workshop
- Customer focus groups

July – December 2017
- Monitoring installation report
- Cooling installation plan
- Thermal flow study report

Knowledge sharing and dissemination
Installation of temperature and power monitoring equipment at 520 LV substations

Monitoring can be installed quickly, safely, and easily, without outages and commissioned with the help of a mobile phone app.
# Celsius: Site list

**LONG LANE**
- ID: 888888
- Location: Manchester
- Monitoring: Type 2

**LEICESTER ROAD**
- ID: 888888
- Location: Manchester
- Monitoring: Type 1

**NORTH STREET**
- ID: 888888
- Location: Manchester
- Monitoring: Type 1

**BROAD STREET**
- ID: 888888
- Location: Manchester
- Monitoring: Type 1a

Sites are selected on the app to begin commissioning.

Sites are listed by installation progress.

To be done

Search for the right site.
Site information is entered and checked.

Map of site location to help navigation.

Site photographs and thermal images are taken.

Installation of monitoring equipment... mobile phone app.
Installation of monitoring equipment...

mobile phone app

Monitoring equipment can be installed and commissioned

List of required Equipment and sensor positions

Each position is selected to install the equipment
Sensors are added by entering details, and scanning the barcode.
Installation of monitoring equipment…

mobile phone app

Working sensors are indicated in the list

Initial sensor readings can be checked

Sign off the installation
For more information

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<th>Information</th>
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<tr>
<td>✉️</td>
<td><a href="mailto:futurenetworks@enwl.co.uk">futurenetworks@enwl.co.uk</a></td>
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<td>📞</td>
<td>0800 195 4141</td>
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<td>🎥</td>
<td>@ElecNW_News</td>
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<td>🎥</td>
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Please contact us if you have any questions or would like to arrange a one-to-one briefing about our innovation projects