A new approach to managing thermal capacity

LCNI conference, Tuesday 16 October 2018

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Innovation Project Manager
Awarded: 9th December 2015

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

Investment: £5.5 million

Up to £583m across GB by 2050

Financial benefits
The problem

Distribution substation

Customers’ LCTs
Step 1: Fit thermal monitoring

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

**Learning**

**Deliverable**

**Benefit**

- 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 as part of the smart future

Smart meter data → Thermal Ratings Tool

- Celsius monitoring
- Retrofit cooling
- Reinforce

→ Extra capacity
→ Lower bills for customers
Case studies

Thermal analysis

- Internal asset temperature
- Thermal coefficient
- External asset temperature

\[ q_{\text{core}} = q_{\text{external}} \]

Thermal flow study

Research into heat and air flows for optimal substation design

Asset health study

Examines effects of increased load and cooling techniques on assets
System health dashboard

Allows tracking of installation progress and data quality across all sites, including overview, site summaries, and issue tracking.

<table>
<thead>
<tr>
<th>Site</th>
<th>Code</th>
<th>Type</th>
<th>Status</th>
<th>Hubs</th>
<th>Sensor Positions</th>
<th>Measurements</th>
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Data dashboard

Allow visualisation and download of retrofit monitoring data across any site, sensor position and timescale.

Celsius

LATEST DATA
SNAPSHOTS

Over 750,000 inbound requests handled

Nearly 130 million measurements taken

Celsius data management system consists of over 86,000 lines of code

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Celsius data management system consists of over 86,000 lines of code
Transformer hotspot assessment

Goal: To know the hotspot temperature from one external sensor

1. **Use ‘Smart’ transformer data** to understand link between hotspot and internal oil
2. **Use oil measurements** to link between internal oil and surface measurements
3. **Develop a method to use surface measurements to estimate hotspot**

Taking into account ambient conditions and characteristics of the transformer
Transformer hotspot calculation

Analysis supports the case for single sensor hotspot calculation that could be rapidly deployed to BAU and at low-cost.
Thermal flow study

Six trial substations modelled

Validated with monitoring data

Changes to ENW Substation Policy

Application of cooling models underway
Cooling site selection

- Subset of monitored sites
- Appropriate mix of outdoor, GRP, brick building, etc
- Operating temperatures at the site from monitoring data
- Physical requirements of the cooling technology
Active cooling

Powered technologies which can be used to push or pull the hot air from the building

Ekkosense

Uses a fan to pull air over the transformer, and expel it through the top vent

Air is directed by using screens to create negative pressure inside the building

Warm air is directed through trunking to an exit vent
Ekkosense - Audley Hall

Installed June 6th

- Top Oil - Ambient Low
- Power Lead Current
- 100 per. Mov. Avg. [Top Oil - Ambient Low]
Active cooling

Powered technologies which can be used to push or pull the hot air from the building

Passcomm

Uses equipment to force air from outside through the lower vent, which creates positive pressure inside which expels through a high exit vent
Passive cooling

- **Improving ventilation**: Supported by the Thermal Flow Study results, which will provide guidance about the best ventilation arrangements.

- **Painting outdoor transformers**: White paint will be used to reflect solar heating of the asset.

- **Shading outdoor transformers**: To protect from solar radiation.

- **Cable backfill**: Backfilling cable ducts with a material with beneficial thermal properties, to allow heat to escape from cables more effectively.
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.
Perception and acceptability of cooling techniques

600 baseline surveys
Prior to installation of cooling techniques
April 2018

300 uneducated about Celsius

300 educated

600 test surveys
Following installation of cooling techniques
Winter 2018

Test

• Awareness of Electricity North West
• Satisfaction with Electricity North West
• General perception of substations
• Awareness of existing asset location, appearance, size, noise level etc

150 previously educated

150 previously educated

450 new no prior education about Celsius

Test

• Changes in overall satisfaction
• Notice of any changes
• Attitude/acceptance of any change in asset location, appearance, size, noise level
• Design features/barriers
Assessing customer impact

- Surveys of those nearest substation and most likely to be impacted
- Survey carried out on doorstep
- Repeat visits to interview customers neighbouring substations
- Cash incentive for completing baseline
- Dissatisfaction from customers not surveyed because no payment
Progress so far

Engaged customer panel to develop comms materials

Project leaflet for all educated survey participants

Survey developed

Baseline survey complete

Embedded process to capture complaints/enquiries

Feedback via customer contact centre, website and SMS

Materials and findings published on project website

Customers educated about the need and benefits of Celsius are more likely to find it acceptable

Good news. We are improving the electricity network that supplies your street as part of our Celsius project.

Who is Electricity North West?
We operate the local electricity network and distribute electricity to all 2.4 million homes and businesses in the North West.

What are we doing?
We are looking at smarter ways of managing high temperatures at substations, by trialing a range of cooling techniques. These could be modifications to equipment fitted inside our substations, or small changes to a substation’s structure which will cool it down. This will help to reduce costs for all electricity customers. The project is called Celsius.

Why are we doing this?
To help protect the environment we need to use fewer fossil fuels like gas and oil and use cleaner sources of power. This means that in the future we will need more electricity for running electric cars and heating systems. The more electricity that flows through our network, the hotter the equipment in our substations becomes.

How will I benefit?
By cooling our existing substations equipment we can make it last longer which helps us operate the network more efficiently. This will help us to meet the increased demand for electricity, without increasing customers’ bills.
Assessing customer impact

Embedded complaints process to capture/manage customer issues arising from installation

- 3 noise complaints from 19 sites
- High density urban substations close to domestic dwellings
- Settings reduced to lower noise emissions
- Reduction on cooling potential
- Technical solution may be viable but need to consider customer impact in some environments
Progress and next steps

January – June 2018
- Baseline customer survey
- Thermal flow study part 2
- Cooling technology installation

July – December 2018
- Asset temperature behaviour report
- Asset health study report
- Trial customer survey

January – June 2019
- Cooling trial
- Thermal Ratings Tool step 1
- Trial customer survey

July – December 2019
- Thermal Ratings Tool step 2
- Monitoring specification
- Customer survey report

Knowledge sharing and dissemination
QUESTIONS & ANSWERS
For more information

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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