Innovation Learning Event

Wednesday 4 July 2018
Project update

Geraldine Paterson
Innovation Engineer
Awarded: 9th December 2015

- Go live
  - 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

£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

- **Thermal coefficient**
- **Thermal Ratings Tool**
- **More capacity**

**Learning**

**Deliverable**
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

Thermal flow study

Asset health study

Research into heat and air flows for optimal substation design

Examines effects of increased load and cooling techniques on assets

Internal asset temperature = Thermal coefficient × External asset temperature
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

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

Celsius

Over 750,000 inbound requests handled

Nearly 130 million measurements taken

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

Data

Graphs

Chart Legends

- ANDERTON ST::Transformer::Top Oil Temperature - Face 1::Temperature
- ANDERTON ST::Transformer::Bottom Oil Temperature - Face 1::Temperature
- ANDERTON ST::Ambient Air::Ambient Air: High Level::Temperature

Over 130 million measurements taken

Nearly 130 million measurements taken

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

Celsius data management system consists of over 86,000 lines of code
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
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 to models underway
Cooling site selection

- Subset of monitored sites (100 out of 520)
- 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
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

<table>
<thead>
<tr>
<th>Improving ventilation</th>
<th>Painting outdoor transformers</th>
<th>Shading outdoor transformers</th>
<th>Cable backfill</th>
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<td><img src="image" alt="Painting outdoor transformers" /></td>
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<td><img src="image" alt="Cable backfill" /></td>
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**Supported by the Thermal Flow Study results, which will provide guidance about the best ventilation arrangements.**

**White paint will be used to reflect solar heating of the asset.**

**To protect from solar radiation.**

**Backfilling cable ducts with a material with beneficial thermal properties, to allow heat to escape from cables more effectively.**
Customer engagement

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

Test

600 test surveys
Following installation of cooling techniques
Winter 2018

- 150 previously educated
- 450 new no prior education about Celsius

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

- Changes in overall satisfaction
- Notice of any changes
- Attitude/acceptance of any change in asset location, appearance, size, noise level etc
- 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
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
- Thermal Ratings Tool step 1

January – June 2019
- Cooling trial
- Trial customer survey

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

Knowledge sharing and dissemination
For more information

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Thank you for your time and attention