electricity north west

Bringing energy to your door

Celsius

A new approach to managing thermal capacity

The first solution of its kind in Great Britain, Celsius delivered a co-ordinated approach to managing the temperature of electrical assets in distribution substations. The £5.5 million project trialled the release of additional capacity, which will reduce long-term costs for customers and avoid early asset replacement.

Why do we need Celsius?

To meet the decarbonisation challenge laid down by the Government, our customers are being encouraged to adopt new low carbon technologies such as electric vehicles and heat pumps. Government forecasts suggest that there may be up to a 60% increase in total electricity demand in Great Britain by 2050.

On an estate of domestic properties, changing gas central heating to an electric alternative such as a heat pump and adding a new electric vehicle per property, could result in a total load over six times the peak demand that the network was originally designed for.

This increase in load means an increase in the current flowing on the network. The greater the amount of current flowing, the greater the heat generated and the hotter an asset becomes.

The expected increase in electrical load from low carbon technologies will lead to thermal ‘pinch points’ at distribution substations, where load is causing equipment to operate close to its maximum operating temperature.

Thermal constraints

To make sure that networks are operated safely, electricity assets have a manufacturer assigned capacity rating to indicate the maximum amount of energy they can carry. But these ratings do not take into account seasonal and environmental factors such as substation construction type, wind cooling, shade and sun glare, which means that equipment may not be used to its full thermal capacity. These restrictions on an electrical asset’s capacity are known as ‘thermal constraints’.

If demand for electricity at a substation exceeds this static rating, the traditional approach is to replace the affected assets with new, higher capacity equipment. This entails significant capital investment, which customers pay for through their electricity bills.

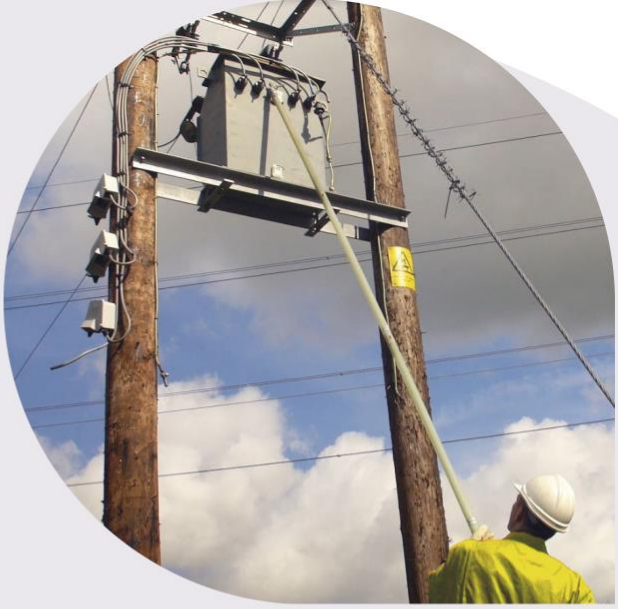
> “Government forecasts suggest up to a 60% increase in total electricity demand in Great Britain by 2050”

What is Celsius?

Celsius is the first application of a co-ordinated approach to managing the temperature of electrical assets in distribution substations in Great Britain. As part of the project's two-step structured approach we gathered data to increase understanding of thermal behaviour and release capacity to customers.

With greater knowledge of the behaviour of these assets, we can support the connection of increasing numbers of low carbon technologies more quickly and at lower cost than deploying traditional solutions.

Celsius will enable electricity distribution network operators to release capacity at a fraction of the cost of traditional reinforcement, reducing costs for customers across Great Britain by around £0.6 billion by 2050 and releasing 13GW of thermal capacity. The project ran from January 2016 until March 2020.



Stage 1 – Thermal monitoring

Celsius developed an understanding of the operating temperatures of distribution substation assets, including transformers and cables, within a range of substation environments. The project also delivered alternative, innovative ways to optimise thermal capacity leading to faster, cheaper connection of low carbon technologies.

The first stage of the project was to record temperature and load measurements from 520 distribution substations (51 pole-mounted and 469 ground-mounted) to evaluate the available capacity margins at each site. As part of this work we delivered mounted and 469 ground-mounted) to evaluate the available a functional specification for a low cost monitoring solution which can be deployed at scale.

To evaluate the capacity margins, we measured the maximum operating temperature (or hotspot) which is at the core of the asset, but it is impractical and cost prohibitive to measure directly, at scale, using retrofit means. To obtain these hot spot temperatures, we have developed a methodology which allows the internal hot spot temperatures to be calculated from the measured external temperature and other known information.

The output of this work was the 'Thermal Ratings Tool', which needs minimal inputs such as temperature and environment to quantify available capacity. This tool in in a Microsoft Excel format, which is easily transferable and could be made available for use by other distribution network operators.

Stage 2 – Retrofit cooling techniques

To release further capacity, retrofit techniques for cables and transformers were trialled at 100 of the 520 Celsius sites.

Working with other network operators, we identified and evaluated a range of techniques which may be used to cool or thermally manage assets. We deployed passive techniques such as additional vents to improve airflow, painting transformers with reflective paint, new backfill material for cables; and active techniques such as positive and negative pressure fan units in substations.

These techniques were installed and we quantified the benefits over an extended period of monitoring (minimum period of 12 months). This allowed thermal behaviour to be compared against the measurements taken in the initial monitoring trial.

The learning from this work was captured as an enhancement to the Thermal Ratings Tool. The tool estimates the potential gain in capacity of each technique for different applications and environment based on the findings of the trial

As the cooling techniques were deployed at substations close to where our customers live and work, we carried out a programme of customer engagement to understand if our customers find the cooling techniques as acceptable as traditional solutions, which in the vast majority of cases they did.

> **Celsius could release 13GW of thermal capacity**

Who was involved

The Celsius project we worked with a number of partners and key suppliers who are leading experts in their respective fields of research, technology and customer engagement. Our project partners are listed below and you can find out about how they supported the Celsius project on our website.

Ricardo-AEA
Ash Wireless Electronics
Impact Research
UK Power Networks
University of Southampton

TO SEE OUR COMPLETE CLOSEDOWN REPORT AND ASSOCIATED DOCUMENTS, VISIT: www.enwl.co.uk/celsius/