



Celsius



A new approach to managing thermal capacity

The first solution of its kind in Great Britain, Celsius will deliver a co-ordinated approach to managing the temperature of electrical assets in distribution substations. The £5.5 million project will release additional capacity, 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 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.



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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 are gathering 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 runs from January 2016 until March 2020.



Stage 1 - Thermal monitoring

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

The first stage of the project is 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 will deliver a functional specification for a low cost monitoring solution which can be deployed at scale.

To evaluate the capacity margins, we need to measure the maximum operating temperature (or hot spot) 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 will be a 'Thermal Ratings Tool', which needs minimal inputs such as temperature and environment to quantify available capacity. This tool is likely to be a Microsoft Excel look-up table or similar, which is easily transferable and will be made available for use by other distribution network operators.

Stage 2 - Retrofit cooling techniques

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

Working with other network operators, we have identified and evaluated a range of techniques which may be used to cool or thermally manage assets. For example, passive techniques such as additional vents to improve air flow, painting transformers with reflective paint, new backfill material for cables; and active techniques such as fans on transformers and heat exchange systems.

Now that these techniques are installed, we will quantify the benefits over an extended period of monitoring for a minimum period of 12 months. This will allow thermal behaviour to be contrasted against the measurements taken in the initial monitoring trial.

The learning from this work will be captured as an enhancement to the Thermal Ratings Tool. The tool will automate the evaluation of the potential gain in capacity of each technique for different applications and environments.

As the cooling techniques are deployed at substations close to where our customers live and work, it is possible that they could notice audible or visual changes. We are therefore carrying out a programme of customer engagement to understand if our customers find the cooling techniques as acceptable as traditional solutions.

“ Celsius could release 13GW of thermal capacity ”

Who's involved

During the Celsius project we are working 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 more about how they are supporting the Celsius project on our website.

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

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CELSIUS PROJECT, VISIT:
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