Electricity Network Innovation Competition Screening Submission Pro-forma

Notes on completion

Before completing this form, please refer to the Electricity Network Innovation Competition (NIC) Governance Document, which details all of the information that you are required to provide.

Please use Verdana size 10 font in your submission. The text entry areas are suggestions and the size of each text area can be altered if you need to provide more information in one section and less in another. In all cases the full-completed submission should not exceed **11 pages** in total.

Ofgem will publish all the information contained within the Screening submission.

Funding Licensee

Electricity North West

Network Licence Project Partners

Funding Licensee area *(or where the licensee does not operate in a specific area the geographic location(s) of the Project)*

North West of England

Project title

Celsius

Project Summary

The Licensee must provide an approximate Project start and end date.

As demand for electricity increases either through natural growth or the adoption of low carbon technologies (LCTs), the current flowing through the network and the temperature of network components will increase. New LCT loads will also increase harmonic currents which can significantly increase temperatures. The operating temperature limit of assets can be the most significant barrier to the efficient connection of new loads.

Question

How can a DNO assess and manage the operating temperature of network components to maximise the capacity of its distribution assets to facilitate the efficient and timely connection of demand and generation while minimising reinforcement costs?

Method

This four-year Project, starting January 2016 and finishing December 2019, will:

- Assess the thermal behaviour of a representative sample of secondary network transformers, switchgear and cables, correlating their performance with a range of environmental factors
- Develop fit-for-purpose monitors which allow economic management of capacity
- Deploy low cost, innovative, retrofit capacity enhancement technologies.

This will show that a DNO can efficiently increase the capacity available for connection of LCTs through the smart utilisation of existing assets.

Estimated Project funding

The Licensee must provide an approximate figure of the total cost of the Project and the NIC funding it is applying for.

Total cost of Project	£5.5m	**NIC funding requested**	£4.9m
Cross Sector Projects only: requested funding from Gas NIC or NIA?	*If yes, please specify*		

Problem(s)

The Licensee must provide a narrative which explains the Problem(s) which the Project is seeking to address.

The Carbon Plan, sets out carbon reduction targets for the UK. Some of the technologies expected to help achieve these targets, such as electrification of heating and transport, means greater demand for electricity is probable. This will have an impact on electricity distribution networks. New low carbon loads and increasing numbers of low carbon and renewable distributed generation are expected as a result of both the Carbon Plan and DECC's Community Energy Strategy which promotes local energy production. This means distribution networks will face higher, multi-directional power flows. This will particularly affect the large population of secondary network assets closest to distribution customers.

Demand/distributed generation growth, including the adoption of LCTs described above, will lead to an increase in current flowing on the network. As current has a direct relationship with temperature, the operating temperature of the assets will increase.

Asset operating temperature is also affected by the surrounding environment and the proximity of other assets. As currents increase, "thermal pinch points" emerge at locations such as distribution substations where load currents are at their highest. As DNOs overcome feeder constraints through techniques such as meshing, they will need to efficiently manage these thermal pinch points to increase capacity.

Traditional techniques for addressing pinch points require reinforcement of the network with larger transformers, higher rated switchgear or cables which have a higher capacity and therefore a higher thermal rating. The cost of reinforcement, driven by general load growth related to the uptake of domestic LCTs, is wholly funded by distribution customers and can involve lengthy installation programmes. It may also mean removing assets before the end of their useful life. This, along with the embodied carbon in new transformers or cables, means that the carbon impact of the electricity distribution network is increased.

Method(s)

The Licensee must describe the Method(s) which are being demonstrated or developed. It must also outline how the Method(s) could solve the Problem. The type of Method should be identified where possible eg technical, commercial etc.

The Method will develop and demonstrate:

- Reliable, low cost monitoring sensors (for HV/LV transformers and other LV assets)
- A thermal indicator tool that will enable a network operator to better understand the actual operating temperature of assets and when to effect an intervention
- A range of retrofit cooling solutions to apply when the thermal model indicates an intervention is required.

By using improved technology to measure temperatures relative to a range of environmental, load and seasonal factors, Celsius will enable understanding of real ratings rather than theoretical. This will allow DNOs to understand the amount of thermal capacity which could be accessed. In addition to existing latent capacity, the Celsius Method will also drive additional capacity release through a range of retrofit cooling technologies across different asset types. When deployed, these low cost retrofit solutions will maximise the thermal headroom.

The Project scope has taken into account other thermal related projects and aims to build on the findings of these and provide enhancements in the form of alternative solutions to thermal issues.

Method(s) continued

The Trials to demonstrate this Method will occur on a representative sample of substations and will explore thermal management of existing network assets in the following ways:

- Identification of potential thermal issues: how different LV distribution assets in differing environments behave thermally under a variety of load and environmental conditions
- How thermal coefficients can be derived to better understand and manage existing LV assets to unlock unused capacity
- Implementing interventions: how retrofit technology can be harnessed to provide low cost alternatives to reinforcement
- Engaging with our customers to understand the acceptability of innovative solutions applied at local distribution substations.

Funding commentary

The Licensee must provide a commentary on the accuracy of its funding estimate. If the Project has phases, the Licensee must identify the approximate cost of each phase. OFTOs should indicate potential bid costs expenses.

The Project will run for four years with a total cost of £5.5 million (including project management and contingency). These costs have been captured using a standardised costing methodology and include learning from creating and costing previous demonstration projects. We anticipate the accuracy of this estimate to be in the region of ± 15%.

Phase 1	*Thermal behaviour and thermal indicator model (£2 300k)*
1A	Selection of representative sample and installation of sensors
1B	Data gathering
1C	Derive coefficients
1D	Development of a functional specification to procure a low cost sensor pack
Phase 2	*Trials and analysis (£990k)*
2A	Investigate and install retrofit solutions
2B	Evaluate performance of retrofit solutions
2C	Test acceptability of retrofit solutions with customers
2D	Undertake business case and carbon benefit analysis
Phase 3	*Learning and dissemination and BAU adoption (£265k)*
3A	Establish dissemination channels
3B	Deliver learning through multiple and varied dissemination activities
3C	Update specifications and codes of practice

Specific Requirements (please tick which of the specific requirements this Project fulfils)

A specific piece of new (ie unproven in GB) equipment (including control and/or communications systems and/or software)	Y
A specific novel arrangement or application of existing electricity transmission and/or distribution equipment (including control and communications systems software)	N
A specific novel operational practice directly related to the operation of the electricity transmission and/or distribution system	Y
A specific novel commercial arrangement	N

Accelerates the development of a low carbon energy sector & has the potential to deliver net financial benefits to existing and/or future Customers

The Licensee must demonstrate that the Solution has the potential to accelerate the development of the low carbon energy sector in GB and/or deliver wider environmental benefits to GB Customers. The Licensee must demonstrate the potential to deliver net financial benefits to existing and/or future Customers.

As stated in the Electricity NIC Governance Document, the Network Licensee must provide the following to demonstrate compliance with this criterion:

i. How the proposed Project will make a contribution to the Carbon Plan. In particular the Network Licensee should outline:
- *What aspects of the Carbon Plan the Solution facilitates*
- *The contribution of the rollout of the Method across GB can have in facilitating these aspects of the Carbon Plan*
- *How the rollout of the proposed Method across GB will deliver the Solution more quickly than the current most efficient method in GB; and/or*

ii. How the proposed Project could deliver environmental benefits to Customers; and

iii. The expected financial benefits the Project could deliver to Customers.

Encouraged by government policy and incentives, the rapid development of a low carbon energy sector is gathering pace. Over the course of RIIO-ED1 and RIIO-ED2, greater numbers of domestic customers will look to access the benefits that can be obtained through electrification of their heat and transport requirements. In the main these LCTs will be connected directly to the LV network. In order to facilitate uptake of this technology, additional network capacity is required. A range of lower cost, retrofit solutions are needed to increase network capacity more quickly. Our previous project, Smart Street, proposed solutions to quickly release capacity through interconnection and voltage management. Celsius proposes quickly releasing capacity through thermal management, specifically at pinch points on the network.

Contributing to the Carbon Plan

The Carbon Plan recognises that when LCTs are deployed at scale or in clusters there will be an increase in demand across the load curve and particularly in peak demand. Network operators will need to adapt the electricity system quickly to accommodate this need. By understanding and unlocking the capacity of existing assets a DNO can meet customers' needs efficiently, facilitating future load growth and allowing the adoption of LCTs at an affordable price.

Reform of the electricity grid

Understanding the behaviour of network assets under a variety of load and environmental conditions will allow network operators to take timely and targeted intervention measures. This approach delivers customer benefits in the form of additional capacity headroom for LCT connections, facilitation of lower cost, faster LCT connections, and lower distribution network operating costs. This means lower future bills for customers and faster connection of LCTs.

Transformation of power sector – secure, sustainable and low carbon energy

Low cost, retrofit approaches will become the first and, in many cases, the enduring intervention technique for network operators to address challenges relating to operating temperature. These techniques will create network capacity and enable network operators to facilitate the connection of more distributed low carbon and renewable generation onto existing LV networks quickly and efficiently.

Delivering financial benefits

The most efficient method currently in use to address the issue of thermal pinch points on LV substations could include replacement of a distribution transformer and overlay of outgoing LV mains cables. The table below demonstrates the potential benefit of the Project (in both cost and time to implement) at the scale of a single installation.

Current most efficient method cost	£27 500	**Method cost**	£3 500	**Benefit**	£24 000
Current most efficient planning and installation time	12 weeks	**Time to install**	< 4 weeks	**Benefit**	8 weeks

Conservative estimates suggest that Celsius will resolve issues on around 2.5% of relevant assets in RIIO ED2. Scaled to GB, this shows Celsius has the potential to deliver > £100m direct financial savings for customers between 2023 and 2031.

Delivers value for money for electricity customers

The Licensee must demonstrate that the Method(s) being trialled can derive benefits and resulting learning that can be attributed to or are applicable to the electricity transmission system/ to the electricity Distribution System.

As stated in the Electricity NIC Governance Document, the Network Licensee must provide the following to demonstrate compliance with this criterion:

i. What is the potential Direct Impact of the Project on a Network Licensee's electricity network or on the operations of the GB System Operator;
ii. Justification that the scale/ cost of the Project is appropriate in relation to the learning that is expected to be captured;
iii. The processes that will be employed to ensure that the Project is delivered at a competitive cost; and
iv. The expected proportion of the benefits which will accrue to the electricity Transmission System/to the electricity Distribution System as opposed to other parts of the energy supply chain.

Sub-criterion v (the internal systems, procedures and processes used by the Network Licensee to identify Project Participants and Project ideas) should be covered in the 'Project Partners and external resourcing/funding' section below.

Celsius will allow better utilisation of existing distribution assets by increasing thermal headroom which can permit faster connection of LCTs and other new loads, hence deferring or avoiding the necessity for further load related investment.

Previous LCN Fund projects such as SP Energy Networks' First Tier Implementation of Real Time Thermal Ratings have looked at the thermal rating of overhead lines. These studies have shown that assessment of real thermal behaviour and the influence of environmental factors on the asset rather than theoretical ratings can increase capacity between 10 - 44%. Additional studies to evaluate whether equivalent levels of capacity can be achieved on other distribution assets at lower voltage levels are necessary.

There is a wide range of asset types, sizes and ages deployed at distribution substations across GB. To understand the thermal behaviour of substation assets, Celsius will gather data on a large enough population of the Electricity North West asset base to establish reliable and transferable thermal models. Accompanied by the low cost sensor pack, developed as part of this Project, and supported by smart meter data, the models will allow a DNO to understand the likely point at which existing thermal capacity (based on actual asset temperature) will be exceeded. In addition to accessing existing latent capacity, Celsius will also demonstrate a range of retrofit interventions to unlock further capacity. Site selection will ensure that a correct representation is realised to allow the learning to be applied to the entire GB asset base.

To ensure that Celsius is delivered at a competitive cost, we will apply best practice project management, refined through experience delivering previous Second Tier LCN Fund projects. Quarterly Celsius Project Steering Group meetings will ensure the Project progresses to plan through review of work stream updates and regular risk and mitigation reviews. In addition to members of the Project team and Project Partners, this group will include oversight by a Project director and a management accountant from the finance directorate responsible for ensuring delivery to budget.

All benefits of this Method will accrue to the customers of electricity distribution network operators. These benefits flow to all distribution customers through lower DUoS charges, lowered carbon impact of electricity distribution and generation and wider environmental benefits including reduced reinforcement-related disruption. As Celsius aims to deliver a business as usual solution by 2021, the benefits achieved can be included in RIIO-ED2 as the most efficient method. GB customers will receive 100% of the benefits.

Demonstrates the Project generates knowledge that can be shared amongst all Network Licensees

The Licensee must explain the learning which it expects the Method(s) it is trialling to deliver. The Licensee must demonstrate that it has a robust methodology in place to capture the learning from the Trial(s).

As stated in the Electricity NIC Governance Document, the Network Licensee must provide the following to demonstrate compliance with this criterion:

i. What new knowledge is intended to be generated from completing the Project;
ii. What methodology will be used to capture results from the Project and how the Project's results will be disseminated to other Network Licensees; and
iii. Whether the Network Licensee wishes to conform to the default IPR arrangements as set out in Section B: Chapter 9. If the Network Licensee wishes to deviate from the default IPR arrangements it must outline the proposed arrangements, justify why the arrangements are more suitable than the default arrangements and justify how the new arrangements will deliver value for money for Customers.

The Project will gather data on the operating temperatures of LV assets relative to load and ambient conditions. This activity will deliver a set of temperature coefficients to cover the wide range of distribution assets. Celsius will provide a methodology to conduct this thermal assessment enabling other DNOs to assess the operating temperatures of their asset base.

Celsius will also demonstrate a range of retrofit technologies, intervention points for deployment, and the cost and environmental benefit assessments for each technique.

Project deliverables

- *Models or tools for assessing asset thermal performance* – including models or tools for assessing unmonitored assets to determine if they should be monitored, and also interpreting the data from monitored assets. This will determine where there is existing capacity to be released, where innovative techniques may be implemented to create additional capacity or where assets require replacement due to excessive thermal loads
- *Specification of BAU temperature monitors* – this may be a very different specification from the devices used within the Trial, for example, the accuracy and sample frequency may not need to be as high but price would be critical
- *Recommendations for retrofit thermal management* – including the suitable applications, costs, potential benefits and limitations of the selected mitigation techniques
- *Recommendations for design and installation of future network assets* – bringing the learning from the other deliverables together and recommending design and installation for improved thermal performance of new build network assets.

Results capture and learning dissemination

A designated knowledge and dissemination work stream will work in collaboration with Project Partners to capture all experiential learning and promote simple, targeted and pragmatic dissemination activities. This approach allows access to a broad range of skilled personnel and other resources to deliver learning cost effectively and document any additional learning experienced around the periphery of Project delivery.

We will use communication channels which support direct feedback from our audiences including one-to-one sessions with other network licensees to enable Project responsiveness and further incremental learning.

Please tick if the Project conforms to the default IPR arrangements set out in the NIC Governance Document?	Y

If the Licensee wishes to deviate from the default requirement for IPR then it must demonstrate how the learning will be disseminated to other Licensees and how value for money will be ensured. The Licensee must also outline the proposed alternative arrangements and justify why the arrangements are more suitable than the default arrangements.

How is the Project innovative and with an unproven business case where the innovation risk warrants a limited Development or Demonstration Project to demonstrate its effectiveness?

Demonstrate why the Licensee has not previously used this Solution (including where the Solution involves commercial arrangements) and why NIC funding is required to undertake it. This must include why the Licensee would not run the Trial as part of its normal course of business and why the Solution is not Research.

As stated in the Electricity NIC Governance Document, the Network Licensee must provide the following to demonstrate compliance with this criterion:

i. Why the Project is innovative and has not been tried before;
ii. Why the Network Licensee will not fund such a Project as part of their business as usual activities;
iii. Why the Project can only be undertaken with the support of the NIC, including reference to the specific risks (e.g. commercial, technical, operational or regulatory) associated with the Project.

Technical innovation to determine the relationship between load and temperature is well developed: however, previous thermal constraint projects have concentrated mainly on higher voltages and involved software implementation in a central control room. At distribution voltages, thermal ratings have only been considered for either emergency load transfer or monitoring when meshing networks. Celsius is focussed on how to enable demand growth and manage thermal issues proactively.

Extensive monitoring of low voltage assets is required to develop the coefficients which will be used across the fleet of electrical equipment to assess thermal capacity.

Innovative retrofit technologies need to be assessed in different environments to give DNOs a range of fit-for-purpose solutions and guidance on their application.

The business case for Celsius's development and demonstration could not be funded from our allowed revenue as the relevant load related reinforcement programme for RIIO-ED1 is £16m with the anticipated cost of undertaking Celsius around 1/3 of this budget. To prove the Method, a large scale demonstration project is required to allow testing of the thermal headroom limits and effect on asset health and losses under different, controlled operating regimes. To do this, analysis of the behaviour of a wide range of assets must be conducted and any uncertain outcomes related to the cost and effectiveness of retrofit techniques tested. Celsius includes: extensive asset monitoring and analysis to establish a reliable and deployable thermal capacity tool; development of a functional specification for a low cost sensor pack; and the proving of a suite of cost-effective retrofit solutions on a live distribution network.

Project Partners and external resourcing / funding

The Funding Licensee should provide a description of the internal systems, procedures and processes used by the Funding Licensee to identify Project Participants and Project ideas.

The Licensee should provide details of any Project Partners, External Funders or Non-Network Licensees who will be actively involved in the Project and are prepared to devote time, resources and/or funding to the Project. If the Licensee has not identified any specific Project Partners, it should provide details of the type of Project Partners it wishes to attract to the Project.

We encourage stakeholders to participate in our innovation work and we make it as simple as possible for them to interact with the Future Networks team and/or suggest innovation ideas. Our Future Networks team and senior managers are active and accessible across the industry and internally within the business to facilitate discussions.

The idea for Celsius was generated following debate and concept testing with technical consultants and academia in response to evidence that rising asset operating temperature, driven by general load growth on our secondary networks, will become a major constraint. These reviews have demonstrated that there is keen interest and support across these stakeholder groups and forerunner projects have validated the issue. The Future Networks Steering Group (FNSG) selected and approved this innovation idea as the basis for the 2015/16 Network Innovation Competition.

There are numerous ways for our stakeholders to discuss their idea(s) with the Future Networks team and we have multiple channels through which our stakeholders can engage, for example:

- Partnership with the Energy Innovation Centre
- Electricity North West contact centre including interactive voice response (IVR) option for innovation, Electricity North West's innovation website and specific e-mail address, plus social media activity
- Industry engagement through presenting at conferences and seminars eg IET and WEET events and chairing forums eg Distributed Generation Forum, Distribution Code Review Panel etc
- Stakeholder engagement plus engaged customer panels for our RIIO ED1 business plan and for the development of customer materials for sharing information on our innovation projects
- Close collaboration with connections activities to ensure developers have opportunity to discuss alternative approaches with our Future Networks engineers
- Innovation engineers seeking new developments in technical and commercial approaches by discussing concepts with other DNOs, industry colleagues, product developers and consultants.

Accessing specialist skills is necessary to achieve the highest degree of learning and deliverables from the Project.

We will maintain a neutral and accessible approach when searching for new partners and suppliers to work with throughout the life of the Project. We will also use transparent, competitive processes using scoring criteria balancing cost, contribution, quality, risk and performance to select Project Partners and suppliers.

Derogations or exemptions

The Licensee should outline if it considers that the Project will require any derogations, exemptions or changes to the regulatory arrangements.

No derogations or exemptions are anticipated at this stage.

Customer impact

The Licensee should outline any planned interaction with Customers or Customers' premises as part of the Project, and any other impacts (such as amended contractual or charging arrangements, or supply interruptions).

It is envisaged that the innovative intervention techniques used to enhance thermal capacity will in some instances change the appearance or sound associated with secondary network assets such as transformers. These assets can be in close proximity to our customers being in the vicinity of their homes and businesses.

If the appearance and audible signature of assets is changed we must demonstrate that these changes are acceptable to customers and do not result in complaints. To this end we will conduct an appropriately sized customer engagement exercise to test and compare the acceptability of the interventions.

All proposed interactions with Customers will be outlined in a customer engagement plan to be approved by Ofgem.

We will work to avoid planned supply interruptions by considering the deployment of generators or back feeding from an adjacent substation for any installation that cannot be performed on a live circuit. If a shutdown is unavoidable we will notify affected customers in accordance with standard procedures. Electricity North West has a dedicated vulnerable customer manager who has been working to increase the numbers of vulnerable customers on our priority services register. In addition to standard written notification, these vulnerable customers will also be notified by telephone or other preferred communication stated by them.

Details of cross sector aspects

The Licensee should complete this box only if this Project forms part of a larger cross sector Project that is seeking funding from multiple competitions (Electricity NIC and Gas NIC). The Licensee must explain about the Project it will be collaborating with, how it all fits together, and must also add a justification for the funding split.

No cross sector funding is expected.

Any further detail the Licensee feels may support its submission
This Project complements earlier work undertaken under Second Tier LCN Fund projects to address feeder capacity limitations and network voltage limits. As these barriers are overcome, network pinch points such as distribution substations emerge as the next most significant challenge to facilitate LCT connections. This Project also builds on earlier work by Electricity North West and other DNOs such as Northern Powergrid and UK Power Networks to better understand the ratings of assets. Uniquely this Project seeks to develop very low cost sensors which, when used in conjunction with smart meter data, can be deployed at very large scale and will enable DNOs to better manage their assets and unlock capacity. Finally, this Project will develop economically efficient retro fit technologies to further increase asset capacity. In combination, these techniques will provide a suite of first and second stage interventions that can be deployed at a fraction of the time and cost of traditional solutions to benefit customers.
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