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Network Innovation Competition Screening Submission Pro forma

Notes on completion

Before completing this form, please refer to the relevant Network Innovation Competition (NIC) Governance Document(s).[1]
Please use default font (Verdana size 10) in your submission and retain 1.5 line spacing.
We will only accept the text visible in the text entry areas.
The text entry areas are predetermined and should not be changed.
The full-completed submission should not exceed 19 pages in total.

Ofgem will publish all the information contained within this Screening Submission.

Is the application for the Gas or Electricity NIC? If a Cross-Industry Project, please state 'Cross-Industry'.
Electricity
Funding Licensee
South Eastern Power Networks
Project Partners including other Licensees
Power Networks Demonstration Centre
Project Title
Constellation

[1] https://www.ofgem.gov.uk/publications-and-updates/version-30-network-innovation-competition-governance-documents All capitalised terms used in this document have the meaning given to them in the respective NIC Governance Document.

Project Summary
By 2030 we expect 90GW of Distributed Generation (DG), 2.5 million heat pumps (HPs), 11 million electric vehicles (EVs) and 11.5GW of storage to connect to the GB distribution network (Future Energy Scenarios: NG ESO, 2019). To facilitate this at minimum cost, smart solutions and network flexibility services are being deployed, increasing reliance on communication and control infrastructure. The existing substation systems are limited in their ability to continue optimised active network operation when communication is unavailable, update safety critical settings following changes in network state and communicate the increased volumes of asset data available. Constellation develops an interoperable local intelligence platform in substations to perform network optimisation, control and protection functions in software. This can manage the future smart and flexible network safely, improve network resilience and resolve constraints unlocking network capacity (estimated as up to 2000MVA across GB). Through this (platform) two methods will address future network protection and optimisation challenges which if unresolved could limit the network capacity or require significant additional costs for our customers. Constellation is about local intelligence: the hardware to enable it, the software to manage it, the rules to govern it and the methodology to deploy it consistently across multiple vendors at lowest cost.

Estimated Start Date		**Estimated End Date**	
01 April 2021		30 November 2025	
Total Project Cost	£14.5 million	**NIC Funding requested**	£12.5 million
Technology Readiness Level (TRL) at start and end of project			6 and 8

What is the Problem that the Project seeks to address?

The UK's ambitious 2050 net zero emissions target drives a significant acceleration in the pace of decarbonisation and is now enshrined in law. This brings changes to the energy industry through the increased penetration of DERs and the high uptake of low carbon solutions technologies such as EVs and HPs[2].

As a result, the complexity in electricity distribution HV and LV networks, where the new low carbon generation and load is connecting, will greatly increase. UK Power Networks (UKPN) has developed industry leading central capabilities for active network management and control[3] however, these systems could have limitations with their ability to:

- Continue to operate the network optimally, when the communication link fails;
- Quickly carry out network actions (e.g. in timescales of under 10 seconds) for safety critical functions, such as protection; and
- Cope with increased data volumes from hundreds of thousands more assets without significant communication link reinforcement.

Our local substations have not evolved at the same pace as our central systems. Substations are mainly equipped with bespoke hardware solutions for each function, with limited digital interfaces, integration issues and little processing capabilities. With the increasing reliance on central communication systems to dynamically maximise the use of assets and enable higher penetration of DERs across the distribution network there is significant risk of unplanned constraints, outages and/or asset damage when the communication links are unavailable with the network operating at its limits. Today losing communication to central systems can constrain actively managed renewable generation, causing up to additional 1.5 tCO2 emissions annually in SPN. This needs to be managed in a sustainable and futureproof manner.

Protection within local substations uses bespoke hardware solutions for each basic function. More sophisticated protection methods that overcome the challenges arising from dynamic load profiles and proactively managed distributed generation are uneconomic to install. Ultimately, we need to operate a full top-to-bottom smart, scalable, flexible and future proof network to enable net zero at the lowest cost to our customers.

[2]The Clean Growth Strategy: Leading the way to a low carbon future, BEIS 2017

[3]Future Smart: Consultation Report, UK Power Networks 2017

What Method(s) will be used and why? Ie, what is being demonstrated or developed? Please describe in terms of the NIC eligibility criteria. (page 1/3)

In order to overcome the limitations of our existing capabilities and facilitate net zero we need to enhance our local substations by making them more intelligent, digital and interoperable. Constellation achieves this through a scalable, flexible, future proofed platform for local intelligence, which in turn, enables **two distinct Methods**. These methods are designed to address the spectrum of requirements associated with the volume, resilience and time criticality of distribution network data as well as to address the specific challenges across resilience and network capacity.

Method 1: Local intelligent control

We currently have a simple logic within a local substation RTU, which "gracefully" turns down generation whenever there is a loss of communications with our ANM system. This method will build on this existing simple capability and demonstrate the ability to maintain the optimal operation of the network when communication with central systems is unavailable by relying on the pre-set limits and locally available parameters.

This requires handling data in near-real-time from a large number of sources and processing to forecast optimum future network states, within known safety and capacity limits. Constellation leverages **the local intelligence platform** to fulfil those requirements and enable the network to operate optimally and reliably during loss of communication with central systems, without the need to turn-off DERs and flexibility services.

Method 2: New and adaptive protection

Protection is an essential part of the operation of the network and requires processing of time critical, high-quality data and consolidation of multiple data sources to deliver optimal protection actions. Constellation leverages **the local intelligence platform** to adjust and deploy new protection functions within software modules. This will include protection techniques which are not widely used in distribution networks due to relay cost or restricted communication between sites and limited ability to process complex power quality waveforms.

This could address the challenges with more DERs, variable fault levels and detection of intermittent faults, which all contribute to constraining the network. When resolved, the available thermal capacity can be fully utilised (rather than constrained due to protection or stability issues) and existing and connecting DERs would not likely need curtailment or expensive reinforcement.

What Method(s) will be used and why? (page 2/3)

To demonstrate the benefit of these methods, an interoperable software platform will be designed, implemented and validated. It will aggregate the data from different sources and provide data to new substation functions securely and in real time. The design of the platform, communication and data architectures will be based on open standards for interoperability and common data formats. The platform will be able to:

- Deploy upgradable and interoperable software for substation functions, instead of the traditional proprietary hardware solutions;
- Operate across hardware solutions developed by any vendor that conforms to our substation computer specification; and
- Run software applications providing substation functionality developed by any third party which meets standard requirements for compatibility with the platform.

We will also be running an open Innovation Competition and demonstrating added value from the platform to inspection and monitoring. As sensor equipment becomes more commercially viable and asset utilisation increases there is a growing opportunity to dynamically inspect and monitor network components. Several use cases will be presented for third parties to solve using the platform. This will demonstrate local data driven insights from scalable sensors and third party software without constraining the communication network or compromising cyber security. It requires handling high data volumes, which are not time critical, and processing them to report by exception and drive management actions. Constellation leverages the local intelligence platform to operate assets optimally across a highly utilised asset base. The network can continue to operate reliably by dynamically inspecting assets, without the need to overwhelm the existing communication network with data.

Part of the project will be dedicated to developing the governance needed to ensure the future world of intelligent substations is safe, enduring and has clear lines of responsibility. This would include the rules for managing the software and firmware needs (upgrades, issue resolution, version control, status verification) for the local intelligence platform and all other software apps developed for the Methods. Another key aspect will be the management of the cyber integrity when local substations have enhanced capabilities. We will develop a detailed procedure on how to ensure overall resilience to various cyber security scenarios.

What Method(s) will be used and why? (3/3)
Academic input within the project will ensure we remain at the forefront of a rapidly changing technology area and prepare the ground for future innovation in local intelligence that could be deployed on the Constellation platform. We will specifically carry out an academic study on the barriers to becoming "fully autonomous" and "fully interoperable" across network operation, and how to overcome these barriers. We also intend to use academia to challenge and validate our new protection methods during the specification and development stages, to ensure scalable outputs across the industry.
Funding Commentary (page 1/2) *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. If the NIC is being used as match funding, please state the other sources of funding.*
The project costs are based on estimated work volumes (and unit costs for tasks where they exist) required for the development, design and validation of the local intelligence platform and the two methods as well as the costs for the trial areas which are to be determined as part of the project. These costs are validated based on experience gained from previous projects and quotations from potential suppliers, where available. Where a partner looks to gain competitive advantage from their involvement in the project, an in-kind contribution to project costs has been be sought (and will be – for future partnerships). The estimated total cost of £14.5 million is based on delivering the identified core activities: • Specification, design and validation of the local intelligence platform (£4.3m); • Function design, procurement of hardware (including sensors), software implementation for each Method (£3.8m); • Innovation Competition – Selection of participants, engagement & incubation, implementation (£0.5m); • Trial design, site selection, equipment installation and commissioning (£2.3m);

Funding Commentary (page 2/2)

- Development of the governance and rules for managing intelligent substations (£0.7m);
- System integration (£0.6m); and
- Project Management (£2.3m).

In preparation for the FSP, a more detailed cost break-down will be developed. The project partners plan to make a contribution of 10% of their respective costs, resulting in a NIC funding request of £12.5m. This in-kind contribution will contribute time, resources and data, and will ensure the project can be delivered at a lower cost than if it were delivered commercially. The details of each partner contribution will be included as part of the FSP submission.

Which specific requirements does the Project fulfill?		
Mark YES in the appropriate box(es)	**Electricity**	**Gas**
A specific piece of new (ie unproven in GB) equipment (including control and/or communications systems and/or software)	**YES**	
A specific novel arrangement or application of existing electricity/gas transmission and/or distribution equipment (including control and communications systems software)	**YES**	
A specific novel operational practice directly related to the operation of the electricity/gas transmission and/or distribution systems	**YES**	
A specific novel commercial arrangement		

How does the Project accelerate the development of a low carbon energy sector and have the potential to deliver net financial benefits to existing and/or future customers in the relevant sector? (page 1/2)

Clean sources of electricity will play a key role in facilitating the UK Government's environmental commitment, as dictated by the UK legislative targets to achieve net zero by 2050. In order to achieve a high penetration of DERs, potential barriers such as reinforcement cost and time need to be overcome. As respected and trusted corporate citizens, DNOs need to ensure their networks are capable of integrating more DERs through leveraging smart services and optimisation minimising the need for reinforcement.

In order to meet the climate change commitments, it is predicted that we need to connect between 50 to 60 TWh more low carbon generation by 2030[4]. We estimate, based on a high level study, that the capacity that could be released through both Constellation Methods across GB could save up to 1MtCO2 emissions annually. Method 1 enables the network to remain in optimal running arrangement in the event of loss of communication with central systems. Ultimately, this manages the risk of communication failure, ensures we can keep running our network optimally and reduces generation curtailment. This could result in more operation hours for generators each year in SPN. Compared with building fully dual-redundant communications Constellation could save up to £6m across SPN.

Accelerates the low carbon energy sector (page 2/2)

Method 2 can enable up to 186MVA more distributed generation (DG) to connect to otherwise restricted parts of SPN, achieved through:

- Dynamically verified protection settings as the network is actively managed. In this way, accurate protection detects faults only and does not operate for non-fault conditions (e.g. high inverse power flow due to DG). In this way the network capacity is not restricted beyond its thermal limits; and
- Increasing visibility of stability issues to enable solutions, such as reactive power management from DG, to resolve them.

This could save £10.3m in SPN alone addressing sites with known challenges and is deployable more quickly than traditional solutions.

The local asset insights provided by the outputs of the Open Innovation Competition will enable improved inspection and monitoring, extending asset lives with fewer visits to substation sites thereby reducing operational carbon emissions.

Commercially, Methods 1 and 2 facilitate cheaper and quicker connections for DER compared to traditional reinforcement, as potential network constraints are alleviated. It also removes constraints on existing DG connections which will unlock greater revenues for those customers. Method 1 also enables greater revenues for connected DG, in events where the communication system has become unavailable, as local DER will not need curtailment.

Through the two Methods and the Innovation Competition, Constellation reduces the need for significant reinforcement of the communication network:

- Reinforcement against loss of central communication requires doubling up on communication gateways in substations; and
- Facilitating the communication requirements for high volume asset data – e.g. 96Mbps per site for utilising thermal images to assess oil levels. If that were to be processed centrally, it would require upgrading the existing bandwidth capacity significantly (between 2 times and 10 times existing capacity).

The Methods, facilitated through the local intelligence platform, were chosen because they can unlock network capacity at a lower cost to our customers.

[4]Net Zero – The UK`s Contribution to Stopping Global Warming: The CCC, 2019

How will the Project deliver value for money for electricity and/or gas customers?
Our trial site selection will be based on proving the Methods and ensuring the solutions are replicable across GB DNOs, while minimising the cost of demonstration. Exact sites and equipment are yet to be finalised but we anticipate one group of sites per method demonstrated. The project partners will employ robust governance and procurement process to ensure that the cost of the project remains competitive. To ensure value for money, the network installations and site work will be assessed and where appropriate competitively tendered. The project will look to build on existing and established relevant innovation projects such as: Unified Protection, FITNESS, OpenLV, Active Response and research outputs from PNDC's digital substation work programme. Constellation will not only build on Ofgem funded innovation projects, but also consider the wider energy innovation landscape and global advancements in open edge computing. Constellation will conduct the development and trials collectively and collaboratively in one project that demonstrates system interoperability for substation functions relevant to all GB network operators. Furthermore, the Innovation Competition aspect will truly test the interoperability aspect of the project and add value to networks by expanding the market opportunity to any third party wishing to participate. We intend to demonstrate a number of "value-add" use cases which run on the local intelligence platform and use the available monitoring. Examples, can include condition monitoring across specific asset groups, post fault location and local carbon tracking. As the project is multi-disciplinary spanning the IT, energy and engineering sectors, learning will be gained and costs lowered through sharing of best practice and knowledge between key enabling sectors to ensure the most cost effective approach. Combining both methods, if successful Constellation could save £16.5m across SPN sites today, estimated at over £253.3m across GB.

How will the Project generate knowledge that can be shared amongst all relevant Network Licensees?
The outcomes from the project will provide insight into resolving future challenges for the entire industry in regards to facilitating renewable energy while keeping costs down, which aims to accelerate the nation's net zero transition. Specifically, the project will generate the following learning of importance to licensees: • A robust and scalable design and architecture of distributed intelligence that coordinates with existing centralised control systems and is resilient to failure of central communications; • A developed software framework for distributed intelligence supporting interoperability of different functions across different vendors; • A means of removing vendor "lock-in" constraints to lower the barriers of entry for SMEs into the market and also stimulate the energy data market resulting in UK economic growth; • Evidence for reliable and scalable application of adaptive protection settings across the distribution network; • A detailed understanding of the suitability of new protection methods to address challenges with variable fault levels, connection of DER and intermittent faults; • A smart, dynamic maintenance model which will enable greater visibility and control of local systems; and • Operational models for DNOs centred around managing the shift towards resilient, whole systems operation in the most efficient and economic manner via utilisation of existing infrastructure. The learning will be disseminated to other licensees through robust existing channels and through PNDC to their members (SPEN and SSEN) and the academic world as well as industry events such as the Low Carbon Networks & Innovation conference. A detailed dissemination plan will be included as part of the FSP, and will be a key work package for the project to ensure learning is shared.

Answering Yes or No, does the Project conform to the default Intellectual Property Rights (IPR) arrangements set out in the NIC Governance Document? *If answer is NO, the Licensee must demonstrate how learning will be disseminated to other relevant 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 IPR arrangements.*
Yes, project partners have confirmed that they are able to work within the default IPR arrangements. However, not all partners have been finalised at this stage of the bid. We will strive to ensure the default IPR arrangements are agreed by any partners who join after ISP stage. In the event this is not possible, we will notify Ofgem prior to FSP submission to inform them of any proposed alternative IPR requirements.

How does the project demonstrate it is innovative (ie not business as usual) and has an unproven business case, that the innovation risk warrants a limited Development or Demonstration Project to demonstrate its effectiveness?
This project is innovative in three main aspects: • Innovative functionality, which has been studied in academia but not demonstrated in practice; • Enhanced substation functions deployed innovatively using an interoperable platform; and • Leveraging software applications, which are compatible with any vendor, which will benefit the entire industry through unlocking greater access to the market and reduced costs for customers. This decoupling of applications from the computation hardware and network assets is the first demonstration of interoperable distributed edge computing for performing monitoring, control and protection applications in a GB DNO. The novelty and associated risk with the methods is listed below: • Method 1 will enable local DERs to continue to operate safely when connection to central ANM is lost for a period. This is not proven and carries significant network/commercial risk if unsuccessful; and • Method 2 will demonstrate protection techniques and settings verification relying on high speed processing of high frequency data samples, not previously feasible due to limitations in local processing and site-to-site communication. While some of the concepts tested through the innovation competition have been demonstrated previously as hardware solutions, the deployment of the resulting software (with any associated additional sensing) within a HV substation IT estate carries significant risk. The outcomes of the project could not be achieved through business as usual as open, interoperable platforms for substation applications are un-proven within DNOs. This presents too high a risk for business as usual investment for a solution/architecture that is complex and unproven.

How were Project Partners, external resources/funding identified, and what are their respective roles in the Project? Please evidence how Partners were identified and selected, including the process and rationale that has been followed. *The Licensee should provide details of any Project Partners 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.*
The Constellation concept was selected based on its vision to solve and address key network challenges in an open manner and its relevance to challenges with the 2050 net zero target. The only external funding identified for Constellation is the in-kind contribution from each project partner. The partners are (and will be) chosen following a review of the future development of digital substations at PNDC. We believe the following aspects of the project benefit from partnerships: The validation and assurance role for the project – the PNDC has a significant track record of de-risking and validating smart grid, industry scale solutions at their unique 11kV test facility. They also have industry leading expertise in existing and state-of-the-art protection methodologies and deliver a leading Digital Substation work programme. We are seeking partner(s) with expertise in software development, operational IT for the development of an interoperable platform. We are currently in discussions with potential provider(s) who may be able to provide that expertise. Any partner or supplier will be asked to provide a suitable financial contribution or will be engaged following a competitive tender process. In either case ensuring cost effective project delivery. We are also seeking another network operator partner to bring their experience to the project and verify the solutions are deployable across GB. Additionally, we will be carrying out a selection process for the innovation competition which will be governed in line with our existing supplier selection procedures for ensuring competitive costs and confidence of quality.

Would the Project require any derogations or exemptions to current regulatory arrangements? *If YES, please provide details of the required changes.*
At this stage, we have not identified any derogations or exemptions that will be required.

How will the Project activities impact customers? *The Licensee should outline any planned interaction with customers or customers' premises as part of the Project, and any other direct customer impact (eg amended charging arrangements, supply interruptions).*
The focus of this project will be on more intelligent operation of the network substations and we do not envisage that there will be any regular interaction with end customers. Since the detail design and trial locations for the equipment to be installed as part of this project are not finalised, there is a possibility that a method statement will require planned outages during the installation of some of the equipment. This will be delivered via normal operational procedures and in such a way as to minimise any disruption to affected customers.

This question is for Cross-Industry Projects only. What funding is being requested from each NIC? Please include justification for the funding split.
N/A

Are there any further details the Licensee considers would support its submission?
As discussed in the value for money section, this project will build on existing relevant innovation projects in the industry. In preparation for the ISP we have summarised how Constellation fits with previous and on-going projects. Unified Protection (UKPN) – This NIA project seeks to implement a substation computer dedicated to our traditional protection functions, based on IEC 61850. As such, it is a necessary stepping-stone for Constellation to build on to develop adaptive and new protection. OpenLV (WPD) – This NIC project is focused solely on the LV network control capabilities. We aim to build on the learning and develop protection and optimisation capabilities across the voltage levels. FITNESS (SPEN) – NIC project focused on the efficient implementation of the IEC 61850 standard. Constellation will use the learning to help defining the interoperable vendor-agnostic architecture. Active Response (UKPN) – This NIC project aims to control intelligent power electronic devices, namely Soft Power Bridges for HV networks and Soft Open Points for LV networks centrally. Constellation will enhance these meshing capabilities, through new and adaptive protection leveraging local intelligence and monitoring. Active Network Management (UKPN) – Focused on developing central capabilities to manage a dynamic network and facilitate flexibility services. Constellation is the next step towards smart network operation, by complementing central capabilities with local intelligence to ensure resilience and optimisation at the lowest cost for customers. A Holistic Intelligent Control System for flexible technologies (SPEN) – this NIA project is focused on centralised control approaches for controllable network devices at all voltage levels. As such, this project will provide valuable learning for Constellation to leverage throughout the functionality and application design stages. Open Distribution System Platform (Open Energy Solutions) – This US concept is focused on the development of standards and protocols for an open source platform that can support any standards. We believe this initiative will add significant value to Constellation and have formed a working relationship with the partner organisations.

Contact Information (Cross-Industry Projects can provide two contacts)

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