NIA Project Registration and PEA Document

Date of Submission

Apr 2022

Project Reference Number

NIA_UKPN0080

Project Registration

Project Title

Stratus

Project Reference Number

NIA_UKPN0080

Project Licensee(s)

UK Power Networks

Project Start

April 2022

Project Duration

1 year and 6 months

Nominated Project Contact(s)

Dean Mason

Project Budget

£1,356,000.00

Summary

This project will aim to demonstrate the capabilities of the solution in a stand-alone mode and as part of a fleet. Initially the device will be installed and commissioned in a live network environment to test the stand-alone capability and functionality. Following that, additional units will be installed for the demonstration of fleet functionality in a live environment.

Nominated Contact Email Address(es)

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Problem Being Solved

With the changing energy landscape, the way electricity distribution networks are managed and operated continues to evolve. The volume and variety of Distributed Energy Resources (DERs) and Low Carbon Technology (LCT) load connected to the network has significantly increased over the last decade. Therefore, the subsequent changes in demand and generation patterns, compounded by more inductive nature of the loads (as opposed to being traditionally resistive), has driven a need for change in the way electricity networks are designed and operated. For instance, the new load types can affect voltage and power factor, and therefore a more active network management approach is required.

Currently the distribution transformers (11kV/LV & 6.6kV/LV) used on most GB distribution networks perform basic voltage step-down, with no additional capabilities. As such networks can only actively manage the voltage at primary substation level, but in the future, we expect variable profiles of generation and load through the day and seasons and therefore we need to be able to intervene at secondary level to tackle power quality challenges.

This problem is expected to aggravate as the forecasted volumes of EVs and electric heat uptake materialise within the upcoming years.

Method(s)

A smart transformer that has the capability to regulate voltage and correct the power factor, and potentially resolve harmonic issues that arise from customers' equipment.

The novel transformer utilises power electronics to provide the smart capabilities. This solution can support the network from the secondary level, with the ability to provide dynamic voltage regulation and power factor optimisation. These transformers can help maximise the penetration of DER, while improving network stability, resilience, and visibility within the secondary network. When operating as part of a fleet, the solution can contribute to network stability by providing frequency control through dynamic modulation of consumer load.

The power electronics enable changing the LV voltage dynamically without the use of a tap changer, as well as:

Bus voltage stabilisation;

Consumer voltage stabilisation;

Consumer voltage modulation;

Power factor and harmonics compensation;

Secondary network optimisation;

and Increased visibility of the LV network.

This project will aim to demonstrate the capabilities of the solution in a stand-alone mode and as part of a fleet. Initially the device will be installed and commissioned in a live network environment to test the stand-alone capability and functionality. Following that, additional units will be installed for the demonstration of fleet functionality in a live environment.

Scope

The scope of the overall project is to trial up to seven smart transformers on the distribution network in order to learn about their installation and operation as well as measure the benefits they provide. Device development cost will not be funded by the project, as they are funded by the manufacturer. The NIA funding will be used to purchase the smart transformers, design the network trial and test them on the network. Specifically the project will:

- Identify a number of trial sites that can host prototypes of the smart transformer;
- Install the smart transformer in up to seven secondary substations;
- Monitor performance over the trial period;
- Share lessons learned; and
- Identify roadmap to BAU (e.g. infrastructure requirements, process changes).

Objective(s)

The objectives of the project are to:

- Monitor the performance of the solution in real network conditions;
- Identify the costs and practical requirements of installation;
- Identify the changes to existing processes and standards which are needed to transition to BAU; and
- Identify and record the benefits from the usage of the smart transformers

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

Not applicable

Success Criteria

The project will be deemed successful when we have:

- Successfully installed and commissioned the devices;
- Collated learnings from trials to understand smart transformer impact on the distribution network;
- Detailed performance data for all smart transformers installed
- Measurable visibility of the load and wider LV network

Project Partners and External Funding

Project will be delivered in partnership with AmpX, who have developed the smart solution. AmpX will also provide at its cost two smart transformers (second generation units).

Potential for New Learning

There is limited data on the performance of low carbon services in dense social housing situations, primarily due to the unsuitability of heat pump solutions in this type of housing stock. Compact hybrids have the potential to resolve some of the issues of heat pumps and traditional hybrids by removing the need for an external unit.

The project will deliver practical learning to help DNOs to understand the benefits of smart transformers. These will include:

- The requirements and specifications for adopting smart transformers on the distribution network;
- The impact smart transformers have in the distribution network; and
- The installation and commissioning requirements for adopting smart transformers.

Project learnings will be published in accordance with the annual NIA reporting requirements and environmental reports (if relevant), as well as:

- Included in UK Power Networks' innovation website; and
- Publication in internal and external articles, where the project materials are relevant.

Scale of Project

The scale of this project is limited to the trial of up to eight smart transformers. This was selected to minimise the project cost while ensuring sufficient learning can be obtained to inform our future network operation. We believe that a smaller trial will not provide sufficient evidence of the benefits of smart transformers, and it will eliminate the learning from the fleet operation.

Technology Readiness at Start

TRL5 Pilot Scale

Technology Readiness at End

TRL8 Active Commissioning

Geographical Area

The project will take place across the licence areas of Eastern Power Networks plc, London Power Networks plc and South Eastern Power Networks plc.

Revenue Allowed for the RIIO Settlement

No allowed expenditure for this work in RIIO-ED1.

Indicative Total NIA Project Expenditure

£1,356,000 of which 90% will be recovered from NIA.

Project Eligibility Assessment Part 1

There are slightly differing requirements for RIIO-1 and RIIO-2 NIA projects. This is noted in each case, with the requirement numbers listed for both where they differ (shown as RIIO-2 / RIIO-1).

Requirement 1

Facilitate the energy system transition and/or benefit consumers in vulnerable situations (Please complete sections 3.1.1 and 3.1.2 for RIIO-2 projects only)

Please answer **at least one** of the following:

How the Project has the potential to facilitate the energy system transition:

N/A

How the Project has potential to benefit consumer in vulnerable situations:

N/A

Requirement 2 / 2b

Has the potential to deliver net benefits to consumers

Project must have the potential to deliver a Solution that delivers a net benefit to consumers of the Gas Transporter and/or Electricity Transmission or Electricity Distribution licensee, as the context requires. This could include delivering a Solution at a lower cost than the most efficient Method currently in use on the GB Gas Transportation System, the Gas Transporter's and/or Electricity Transmission or Electricity Distribution licensee's network, or wider benefits, such as social or environmental.

Please provide an estimate of the saving if the Problem is solved (RIIO-1 projects only)

The gross annual savings if the Problem (losses due to power factor issues) is solved is £3.8m.

We have conservatively estimated the total magnitude of the Problem by using the results from our Losses Strategy. Please note the business case below does not cover resolving the Problem completely, instead it focuses on the benefits of deploying 50 smart transformers (which we believe is a conservative estimate).

Please provide a calculation of the expected benefits the Solution

Key assumptions:

- Traditional method of resolving voltage issues includes cost of monitoring and SCADA communications
- The cost of deployment is conservatively estimated as £55,000 per secondary transformer, which includes installation and commissioning
- Smart transformer is expected to reduce up to 5% of network losses
- Ten smart transformers are installed each year after the project completion in ED2 (conservative estimate)

Base cost:

Number of transformers x (average cost of resolving voltage issues + cost of monitoring + cost of SCADA comms) = £2.2m

Method cost – Benefits:

(Number of transformers x cost of smart transformer) – (Number of transformers x losses benefit) = £2.07m

The project will conclude towards the end of ED1, as such the benefits are forecasted for the ED2 to be: £0.128m

This does not include the expected customer benefits of dynamic voltage correction which we believe will be modest in scale. This is because previous studies indicate that a household electricity bill is only marginally affected by voltage variation.

Please provide an estimate of how replicable the Method is across GB

Based on estimated opportunities for smart secondary transformers evaluated through the bid for the LV Engine NIC project, DNOs

identified approx. 5,000 suitable sites for smart transformers. A conservative estimate is that the solution in this PEA is scalable across 20% of those (1,000 secondary sites in GB).

Please provide an outline of the costs of rolling out the Method across GB.

The estimated cost to deploy smart transformers at scale across GB is £55 million.

Requirement 3 / 1

Involve Research, Development or Demonstration

A RIIO-1 NIA Project must have the potential to have a Direct Impact on a Network Licensee's network or the operations of the System Operator and involve the Research, Development, or Demonstration of at least one of the following (please tick which applies):

☑ A specific piece of new (i.e. unproven in GB, or where a method has been trialled outside GB the Network Licensee must justify repeating it as part of a project) equipment (including control and communications system software).

☐ A specific novel arrangement or application of existing licensee equipment (including control and/or communications systems and/or software)

☐ A specific novel operational practice directly related to the operation of the Network Licensees system

☐ A specific novel commercial arrangement

RIIO-2 Projects

☐ A specific piece of new equipment (including monitoring, control and communications systems and software)

☐ A specific piece of new technology (including analysis and modelling systems or software), in relation to which the Method is unproven

☐ A new methodology (including the identification of specific new procedures or techniques used to identify, select, process, and analyse information)

☐ A specific novel arrangement or application of existing gas transportation, electricity transmission or electricity distribution equipment, technology or methodology

☐ A specific novel operational practice directly related to the operation of the GB Gas Transportation System, electricity transmission or electricity distribution

☐ A specific novel commercial arrangement

Specific Requirements 4 / 2a

Please explain how the learning that will be generated could be used by the relevant Network Licensees

The project will gather, and make available, data that will demonstrate a potential solution that may help overcome the future challenges faced by all network licensees in terms of voltage regulation and network optimisation. A demonstrable solution of the capabilities of a smart transformer such as the one to be trialled by this project will help inform network licensees of the impact of smart transformers on the network and the necessary requirements and specifications in order for DNOs to consider the viability of smart transformer adoption.

Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIIO-1 only)

n/a

Is the default IPR position being applied?

☑ Yes

Project Eligibility Assessment Part 2

Not lead to unnecessary duplication

A Project must not lead to unnecessary duplication of any other Project, including but not limited to IFI, LCNF, NIA, NIC or SIF projects already registered, being carried out or completed.

Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

Network operators are currently in the early stages of investigating the use and benefits of smart transformers. More specifically, Scottish Power Energy Networks launched LV Engine in partnership with UK Power Networks in 2018 with the aim to develop a suitable solution. We have consulted with them and believe there is significant benefit in the demonstration of an alternative technology in project Stratus. As a project partner on LV Engine we will work closely with Scottish Power Energy Networks to ensure no unnecessary duplication will occur as part of this project.

If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

To ensure value for money for GB customers, we intend to evaluate multiple alternative solutions to this specific Problem. We acknowledge LV Engine will provide significant learning in the development of smart transformers. However, it is focused on the development and demonstration of a solution suitable for retrofitting. The project Stratus solution is suitable for new sites without the retrofit needs at a lower cost.

A further benefit in identifying sufficient alternatives to resolving the Problem is avoiding cost inefficiencies with having a single solution in the market.

Additional Governance And Document Upload

Please identify why the project is innovative and has not been tried before

UK Power Networks always looks for solutions that could help to optimise our network operation. However, until now, no suitable technology was available without significant development effort. This project is innovative as the operation of smart transformers is still unproven in GB.

Relevant Foreground IPR

The data created, outputs and deliverables produced as part of the project will conform to the default treatment of IPR.

Data Access Details

For all data access requests, please view the full Innovation Data Sharing Policy available on UK Power Networks' website here: https://innovation.ukpowernetworks.co.uk/wp-content/uploads/2021/11/UK-Power-Networks-Innovation-Data-Sharing-Policy-.pdf

Please identify why the Network Licensees will not fund the project as apart of it's business and usual activities

Due to the risks involved in the project (e.g. the testing and monitoring requirements for smart transformers) and uncertainty in the scale of potential benefits that can be delivered across our licence areas, this initiative would not form part of our business as usual activities. To progress innovation funding which absorbs significant risk in implementation, is required as a stimulus.

Please identify why the project can only be undertaken with the support of the NIA, including reference to the specific risks(e.g. commercial, technical, operational or regulatory) associated with the project

As noted in the NIA guidance, certain projects are speculative in nature and yield uncertain commercial returns. This is the case for with this project. There is a commercial risk that the solution developed as part of the project is not adopted by the stakeholders involved following the trial period. This could be due to the fact that the solution has not generated the amount of benefits suitable for business-as-usual application or there were insufficient network events occurring in the trial area during the trial period.

This risk will be managed through the installation, testing and trial process. If the project is successful, it will result in a technical solution and an equipment standard which will improve our operation. The specific details regarding the benefits are captured under section 2c of this document.

This project has been approved by a senior member of staff

☑ Yes