Notes on Completion: Please refer to the appropriate NIA Governance Document to assist in the completion of this form. The full completed submission should not exceed 6 pages in total.

NIA Project Registration and PEA Document

Date of Submission

Mar 2015

Project Reference Number

NIA_SPT_1502

Project Registration

Project Title

Distributed Photonic Grid Instrumentation

Project Reference Number

NIA_SPT_1502

Project Licensee(s)

SP Energy Networks Transmission

Project Start

May 2015

Project Duration

1 year and 1 month

Nominated Project Contact(s)

James Yu (Future Networks Manager)

Project Budget

£186,210.00

Summary

The project will be conducted over a 9-month period and will focus on the development of photonic sensors that will demonstrate the potential for faster, safer, more accurate and less expensive instrumentation for monitoring, control and protection. An initial 4.5- month phase will focus on the design and simulation of voltage and current sensors using optical fibre. The second 4.5-month phase will focus on construction of the sensors and basic testing to ensure compliance with key elements of the relevant IEC standards.

Following this project consideration will be given to subsequent field trials where the technology would be retrofitted to the secondaries of existing instrument transformers at 132 or 275 kV. By retrofitting to existing CTs/VTs in a follow-on field trial, the distributed measurement capability and resulting minimisation of communications networks, enhanced speed of operation, and improved fault location will be demonstrated with a minimum of disruption.

Third Party Collaborators

Energy Innovation Centre

Parsons Brinckerhodd LTD

Nominated Contact Email Address(es)

innovate@spenergynetworks.co.uk

Problem Being Solved

In the future, increased electricity demand and moves from large-scale centralised generation towards large penetrations of renewables will present challenges to monitoring, protection and control functions. There is an increasing requirement to “observe” the

system more extensively in real-time and for faults to be dealt with more effectively (e.g. minimising further the removal of healthy system elements, requiring more measurement and isolation points) and with minimum delay (e.g. to preserve stability in “weaker” power systems). Protection of future transmission and distribution systems will present challenges, exacerbated by the fact that existing protection is largely based upon single measurement points located sparsely throughout the network.

Method(s)

Synaptec Ltd is developing a unique technology (confirmed 07/2014 by UK IPO audit) which allows any standard telecommunication fibre to be utilised to measure a broad range of electrical and environmental parameters. These include voltage, current, vibration, temperature (ambient or surface), strain, and pressure, with only a single fibre needed to acquire all measurements (potentially 100 discrete sensors per fibre). The type of optical sensing element utilized are well-established in military and structural health monitoring applications due to their small size, light weight, EMI-immunity, and their ability to be multiplexed in high numbers along a single optical fibre.

This innovation provides geographically-distributed measurements of current, voltage, vibration and temperature at a single interrogation point; enabling faster, more selective protection and enhanced monitoring of network conditions. The project will perform development work to progress the technology towards a field trial at 132 kV or above (candidate site identified) demonstrating multi-sensor operation integrated with existing Current Transformer (CT) and Voltage Transformer (VT) secondary circuits.

The technology has a unique potential to drastically reduce network operators’ costs by eliminating conventional infrastructure expenditure associated with instrumentation for monitoring, control and protection. In certain applications, this technology may be able to cut costs by as much as 80% while minimising the ongoing maintenance and management of protection and measurement components. The technology is also capable of underpinning advanced network-wide monitoring and controls by providing a mechanism for the efficient and extensive instrumentation of the network at all voltage levels.

Scope

The project will be conducted over a 9-month period and will focus on the development of photonic sensors that will demonstrate the potential for faster, safer, more accurate and less expensive instrumentation for monitoring, control and protection. An initial 4.5-month phase will focus on the design and simulation of voltage and current sensors using optical fibre. The second 4.5-month phase will focus on construction of the sensors and basic testing to ensure compliance with key elements of the relevant IEC standards.

Following this project consideration will be given to subsequent field trials where the technology would be retrofitted to the secondaries of existing instrument transformers at 132 or 275 kV. By retrofitting to existing CTs/VTs in a follow-on field trial, the distributed measurement capability and resulting minimisation of communications networks, enhanced speed of operation, and improved fault location will be demonstrated with a minimum of disruption.

Objective(s)

Phase 1 – Sensor System Design Programme – 4.5 months:

This phase will involve the design and simulation, and production of a bill of materials, of the prototype optical sensors.
This work will be in accordance with the sensor specifications detailed by IEC standards and in line with the expectations of the project’s stakeholders.

Synaptec will liaise with manufacturers of piezoelectric elements – a crucial component in the design of the sensors – in order to rigorously evaluate which materials exhibit an optimum balance between responsiveness and robustness to fluctuating outdoor environmental conditions.

The design and simulation activity will ensure that assembled transducers shall be packaged and insulated appropriately for conditions in the target environment.

Phase 1 Deliverables

D1.1 Design / packaging specification
D1.2 Bill of materials for transducers

Phase 1 Milestones

M1.1 Functional and physical specification of transducers completed

M1.2 Transducer design and simulation completed

Phase 2 – Sensor Construction and Initial Testing – 4.5 months:

This phase will involve the assembly and testing of prototype sensor elements. This task will be managed by Synaptec, who will work with the University of Strathclyde and the sub-contractor Optocap Ltd to produce packaged sensors based on the designs produced in Phase 1. Assembly will be carried out primarily by Scottish optical packaging company Optocap Ltd, with intermediate testing performed at Synaptec's facilities throughout the assembly procedure.

This phase will ensure transducers are packaged and insulated appropriately for the target environment, and have the potential to progress into commercial manufacturing at the project conclusion.

Phase 2 Deliverables

D2.1 Prototype voltage/current sensors

D2.2 Report on prototype evaluation and testing

Phase 2 Milestones

M2.1 Sensor array assembled

M2.2 Testing of prototype sensor array completed

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The following aspects of the project outputs will be used to assess whether the project has been a success and whether the performance of the innovation is as desired:

1. The project physically demonstrates that standard fibre can be used to measure electrical parameters, i.e. the sensor concept is proven in the laboratory;
2. The project physically demonstrates that this technology is capable of meeting the environmental and safety criteria expected by the target industry, as defined by IEC standards.
3. The project delivers clear recommendations for further demonstration project(s).
4. Produce a business case including validation of expected savings/benefits while complying with ESQCR

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

This project is designed to get maximum output from minimal cost and will take this technology through to TRL 5 at which point it is ready for full-scale field trials on a transmission network. The outcomes will be applicable to the GB transmission network in the first instance but are likely to have impact on transmission technologies more broadly. Any smaller scale project would eliminate the possibility of conducting a follow-on field trial of this technology directly after this project.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL5 Pilot Scale

Geographical Area

Applicable to UK and international transmission and distribution networks.

Revenue Allowed for the RIIO Settlement

Not applicable

Indicative Total NIA Project Expenditure

The total NIA expenditure is expected to be £186,210

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 technology innovation being developed by this project offers potential financial savings in the following areas:

- Reduced spend on "sensor network" and associated telecommunications
- Incorporation of low-cost sensors and interrogator systems in modular/ packaged substations
- Reduced secondary wiring, hence reduced spend on copper
- Reduced energy use due to lack of power supply at sensing locations
- Reduced spend on civil infrastructure at remote sensing locations
- Defer network infrastructure upgrade

Please provide a calculation of the expected benefits the Solution

Not applicable at the present or resultant TRL. This will be applicable in a follow-on development and field trial project.

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

Technology and roll out is applicable to all transmission circuits with fibre installed (>75%) and all transmission substations.

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

Roll out would require a follow-on development and demonstration project to move the TRL up to a level appropriate to roll out. Costs of roll out would be determined during such a follow-on project.

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

Enhanced system monitoring, protection and automation

- Potential to cost-effectively measure at more locations facilitating enhanced reconfiguration and backup protection
- Single-relay/multiple distributed measurements with no dedicated communications – reduced cost and enhanced functionality
- With further integration with monitoring applications potentially reduce risk/damage to cables (and surroundings) through knowledge of fault position on composite circuits
- Faster fault clearance times reducing risk of Distributed Generation (DG) sympathetic/ spurious trips
- Possible development of effective protection of “difficult” applications (e.g. multi-terminal circuits, transformer-feeders, low/variable fault level environments, etc.)
- Potentail development of novel functions – possibility of identifying faults in incipient stages (e.g. high resolution differential current measurements could be used to track and alarm PD activity in cables/ transformers)

Design, installation and commissioning benefits

- Incorporation of sensor and interrogator systems in modular/ packaged substations
- Reduced secondary wiring
- Standard installation – reduction in complexity and time associated with commissioning burden
- Reduced energy use – completely passive sensors – no thermal issues

Facilitation of “smart grid” and required functions through provision of enhanced information on network status and further development of applications by vendors

- Distributed measurement of real/ reactive power flows and voltages to provide accurate information on system status
- Provide information relating to DG status and output – facilitate connection/management of more DG
- Defer network infrastructure upgrades
- Knowledge of major load/energy storage status and demand/ production
- Calculation of capacity headroom/real-time ratings
- Facilitate DSO business model

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

☑ Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees

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.

n/a

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

n/a

Additional Governance And Document Upload

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

n/a

Relevant Foreground IPR

n/a

Data Access Details

n/a

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

n/a

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

n/a

This project has been approved by a senior member of staff

☑ Yes