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

Jun 2019

Project Reference Number

NIA_SHET_0026

Project Registration

Project Title

Refase Circuit Protection

Project Reference Number

NIA_SHET_0026

Project Licensee(s)

Scottish and Southern Electricity Networks Transmission

Project Start

June 2019

Project Duration

2 years and 10 months

Nominated Project Contact(s)

Joe McNeil

Project Budget

£388,361.00

Summary

The scope of this project is to conduct a series of tests, including field trials, to benchmark the performance of the Refase system against existing protection methods. An evaluation will establish if the Refase system is a viable solution to the problem statement detailed within the PEA document.

Nominated Contact Email Address(es)

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Problem Being Solved

The protection of multi-ended Transmission feeders is usually achieved either by distance protection or current differential principles. Distance protection is a non-unit type protection which works by dividing the voltage at the relaying point with the measured current and comparing the calculated impedance value with the impedance of the line up to a predetermined or reach point. The measured impedance under fault conditions is roughly proportional to the distance to the fault. Distance protection can provide instantaneous operation and simplify the grading process among adjacent network segments. It is also capable of providing back-up protection to other circuits using its time-delayed settings for secondary zones. However, the need for both power system voltage and current measurement makes it costly due to instrument transformer, cabling and space costs. In addition, the nature of faults and network complexity can cause inaccurate derivation of the impedance value which may result in reach errors and maloperation. One of the ways to mitigate the impact of distance protection errors is to provide communication links and implement schemes which either accelerate or block operation through exchange of signals between remote ends. However, this increases the cost of implementing this form of protection even further.

Current differential, on the other hand, is a unit type protection which is more stable against maloperation as it operates only for faults inside a clearly defined zone. This is done by comparing information derived from measurement points at the boundaries of the protected zone. However, its main disadvantage is its absolute reliance on a secure and dependable communication link for transfer of information between the measurement points and the relays at all the ends. To also ensure that the comparison of measured

quantities is done for values sampled at the same instant in time, this form of protection requires time synchronisation equipment such as global positioning system (GPS) clocks. These pre-requisites make current differential also very costly to implement.

From the foregoing, implementing feeder protection schemes for complex circuits would be more cost-effective if there is reduction in the infrastructure required at the remote ends. Such schemes would be expected to have reduced numbers of instrument transformers and relaying equipment, the associated cabling between them and footprint. On circuits where fibre-optic communication links exist, technologies are emerging which have potential to make this feasible. However, up to now, all such technologies have been somewhat limited by the length of each circuit which they can cover. This project proposes to assess and trial Synaptec's Refase solution, which has the potential to help address the challenges of conventional protection schemes and improve on the coverage distances of similar emerging technologies.

Method(s)

This is a technical method which will evaluate the viability of Synaptec's Refase solution. This solution is based on the current differential protection principle but avoids duplication of substation equipment as is the case with the conventional.

Refase allows measured values from up to 50 current transformers to be acquired passively using a single optical fibre core over a distance of up to 50 km. These measured values can then be utilised as part of centralised protection and control (PAC) schemes or communicated to traditional PAC devices for analysis via IEC 61850-9-2 / 61869-9, a standard defining communication protocols for intelligent electronic devices (IEDs) in electrical power systems. By centralising current measurements, this method negates the need for multiple protection relays, complex time synchronisation systems at measurement points, and telecommunications equipment among the distributed PAC devices. The measurement system will output sampled value streams locally to protection relays supplied by major vendors which will deploy suitable conventional protection algorithms.
Implementation of the method will involve a Factory Acceptance Test (FAT) of the Refase system in laboratory environment witnessed by SHE Transmission. Upon successful completion, the Refase system will be integrated into a Process Bus Architecture at SHE Transmission's Braco R&D Center and will be subject to Site Acceptance Testing (SAT). Following successful testing at Braco, the Refase system will be installed on a live 132kV circuit for operational testing and will shadow the existing protection scheme. The system will be monitored during the operational testing and the data gathered will be assessed by the relevant teams. An evaluation will be completed at the end of the trials; with recommendations of the system's suitability for transfer to business as usual.

Scope

The scope of this project is to conduct a series of tests, including field trials, to benchmark the performance of the Refase system against existing protection methods. An evaluation will establish if the Refase system is a viable solution to the problem statement.

Objective(s)

The objectives of the project are:

To have fully tested and undertaken a FAT at Synaptec's laboratory.
To have completed a SAT at Braco R&D substation and approved Refase for use in live trials.
To install Refase on a live 132kV circuit and benchmark the performance against existing protection methods.
To have gained an understanding of the system's suitability for business as usual adoption including a comprehensive business case and benefits realisation plan

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The project will be deemed as successful if all items in the scope are met and the TRL level is increased to TRL 8; or if the project clearly shows that this methodology is not suitable for full scale deployment.

Project Partners and External Funding

n/a

Potential for New Learning

The project will provide valuable new learning relating to:

1) current measurement and real-time comparison on a three-ended circuit, without active telecoms;

2) measurement distances greater than 30 km; and

3) passive measurement of 9 phase currents from a single merging unit.

4) integration of IEC61850 9-2 L.E. Process Bus architectures into the SHE Transmission network.

The learning acquired from the project will be disseminated to other Network Licensees through publication on an online portal and via an external dissemination event.

Scale of Project

This project is designed to get maximum learning for minimal cost and is expected to take this technology through to TRL 8 at which point it could be a candidate for full-scale deployment. Any smaller scale project would limit the possibility of conducting a full-scale field deployment of this technology directly after this project. The technology must be assessed in a live environment to determine whether it is fit for purpose.

Technology Readiness at Start

TRL6 Large Scale

Technology Readiness at End

TRL9 Operations

Geographical Area

This project will be undertaken within the Scottish Hydro Electric Transmission licence area in Scotland.

Revenue Allowed for the RIIO Settlement

No allowance has been made for implementing a solution such as Refase. No savings are expected during project implementation; future savings may be possible depending on the outcomes of the project and transfer to BAU.

Indicative Total NIA Project Expenditure

The total expenditure expected from the project is £388,361. 90% of which £349,525 is allowable NIA expenditure.

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)

An estimated cost saving of using the Refase system compared with line differential protection could save around £250k of CAPEX costs per installation. SHE Transmission have identified that Refase could potentially be used on no less than 10 sites within the RIIO-T1 period.
Using Refase in place of distance protection could reduce the likelihood of incorrect tripping at specific locations. The costs associated with incorrect tripping are variable depending on the volume of affected customers and the duration of the outage.

Please provide a calculation of the expected benefits the Solution

The costs identified below calculate the typical cost saving from each Refase installation, on a 3 ended feeder, compared with the current base case cost;

Base case cost per line differential protection installation = £410,000

Method cost per Refase installation = £160,000

Estimated cost saving per installation site (Base case cost - Method cost) = £250,000.

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

SHE Transmission has estimated that Refase, if successful, could be implemented on at least 10 sites within the RIIO-T1 period saving £2.5m. The protection scheme implemented will be site specific and will be designed by protection engineers on a case by case basis. Refase would become another available option to protection engineers, not a standard that would be installed at all sites.

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

As above, Refase installations will be engineered on a case by case basis and the costs will vary with each installation site. Currently, there are no plans to remove existing protection methods at any SHE Transmission sites and replace with Refase.

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

Any other Network Licensees will encounter similar problem utilising the existing protection methods. The learning provided by the project will include the operational and functional experience of using Refase which will be useful to other Network Licensees who have similar assets.

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.

Based on published IFI and NIA information there are no known projects being undertaken by other network licensees to evaluate the Refase system. SSEN previously conducted a low TRL NIA research project on Distributed Photonic Grid Instrumentation (DPGI) in conjunction with SP Energy Networks. Synaptec have continued to develop DPGI and have branded this as Refase. The low TRL project proved the technical capability of DPGI in a laboratory environment whereas Refase will build on that learning by conducting live field trails and benchmarking the results against existing protection methods. Synaptec are involved in the FITNESS NIC project undertaken by SP Energy Networks. FITNESS trials the fitness-for-purpose and interoperability of products and integrated systems designed to the IEC 61850 standards. The work undertaken in FITNESS is significantly different and no duplication of work will take place.

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

Refase is a new innovative technology which has not yet been used by any Transmission network licensee. The project will undertake the installation and testing of this new technology in a laboratory, test station and on a live circuit to allow a full assessment of the technology benefits to be undertaken. The results from Refase will be benchmarked against existing protection methods, and an assessment undertaken to agree its suitability for use in Business as usual (BAU).

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

No allowances have been made in the RIIO-T1 settlement for trialing Refase technology. The results from the project may change procedures and processes on how SHET install circuit protection schemes. SHET needs to fully understand the results from an extended monitoring period, to assess if Refase is a suitable, and a cost-effective method for use in circuit protection schemes in BAU.

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

There is a risk that the Refase technology may not provide SHET with sufficient performance in order to improve our existing protection schemes. Similarly, there is a risk that the Cost Benefit Analysis used during the trials is not sufficient to warrant BAU transfer. The cost of the Refase system and trial period is significant and NIA is deemed the most suitable framework to undertake these trials, capture knowledge and disseminate the learning to other interested parties.

This project has been approved by a senior member of staff

☑ Yes