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

Jan 2017

Project Reference Number

NIA_SPEN0015

Project Registration

Project Title

Real Time Fault Level Monitoring (RTFLM) - Stage 1

Project Reference Number

NIA_SPEN0015

Project Licensee(s)

SP Energy Networks Distribution

Project Start

January 2017

Project Duration

2 years and 9 months

Nominated Project Contact(s)

Geoff Murphy, Ken Lennon

Project Budget

£323,089.00

Summary

This is Stage 1 of a potential two stage NIA project, this initial stage focusses on the development of a prototype solution and proving that it can deliver the required results without any detrimental impact on the network. Stage 1 will also look to analyse the results generated from limited site trials. If necessary, Stage 2 would be a pilot trial of several RTFLM solutions, including their integration into existing DNO systems, followed by a thorough evaluation of the results and benefits they introduce.

Stage 1 has been split into the 5 Work Packages (WP):

1. Prototype Development

Working alongside the project partner to ensure the RTFLM prototype is suitably designed for inclusion within a substation and has a minimal impact on any other assets and systems.

2. Prototype Testing

Factory Acceptance Testing (FAT) and Site Acceptance Testing (SAT) of prototype(s), and assessment of the impact they have on existing assets and systems when introduced to the network.

3. Extended Site Trials

Prolonged site trials enabling SPEN to evaluate the solutions performance, identify the optimum settings and analyse the results returned.

4. Design Review and Recommendations

Analysis of the devices performance and the identification of:

- Improvements / changes required for BaU adoption

- Potential benefits delivered based on limited site trial results
- The business case for BaU adoption

5. Dissemination

External and Internal dissemination.

Nominated Contact Email Address(es)

innovate@spenergynetworks.co.uk

Problem Being Solved

The management of fault levels has always been challenging and problematic for Distribution Network Operators (DNOs). Fault level management is particularly challenging given the safety criticality implications as excursions can result in catastrophic equipment failure and a serious personnel and public safety risk.

While conventional practice has been to establish system fault level design limits in line with accompanying plant specification, novel approaches that enable full utilisation of the existing headroom must be developed to facilitate a timely decarbonisation of the economy.

Renewable energy will play a critical role in meeting the UK legally binding goal of an 80% emissions reduction by 2050. Deployment to date has been strong with renewables meeting 7% of energy demand in 2014, on-track towards the objective of 30% of electricity from renewables in 2020.

Due to unprecedented growth in distributed generation fault level headroom constraints are becoming increasingly challenging often requiring major reinforcement schemes. Fault levels can act as a barrier to the connection of renewable generation and have become a decisive factor in determining the financial viability of many distributed generation connections.

Method(s)

This project aims to develop and trial prototype a novel Real Time Fault Level Monitoring (RTFLM) solution. The solution being developed to:

- Provide reliable and repeatable fault level measurements on-demand
- Be applied to LV → 33kV networks
- Generate results through the application of an artificial LV disturbance to a transformer coupled to the busbar the fault level is required for
- Understand and mitigate the impact the artificial disturbance has on the network
- Identify the optimum solution and potential business case following site trial

The expectation being that the solution will benefit DNOs and customers by providing real time visibility of the network fault level, in doing so:

- Provide a new method for identifying additional capacity on networks currently constrained by high fault levels
- Provide health and safety improvements through the identification of network conditions pushing fault level close / over the design rating of substation equipment

If successful it is expected that this solution will be a key consideration of the Active Fault Level Management (AFLM) Toolbox being developed in a parallel project ‘NIA_SPEN_0014 Active Fault Level Management’.

Scope

This is Stage 1 of a potential two stage NIA project, this initial stage focusses on the development of a prototype solution and proving that it can deliver the required results without any detrimental impact on the network. Stage 1 will also look to analyse the results generated from limited site trials. If necessary, Stage 2 would be a pilot trial of several RTFLM solutions, including their integration into existing DNO systems, followed by a thorough evaluation of the results and benefits they introduce.

Stage 1 has been split into the 5 Work Packages (WP):

1. **Prototype Development**

   Working alongside the project partner to ensure the RTFLM prototype is suitably designed for inclusion within a substation and has a minimal impact on any other assets and systems.

2. **Prototype Testing**

   Factory Acceptance Testing (FAT) and Site Acceptance Testing (SAT) of prototype(s), and assessment of the impact they have on existing assets and systems when introduced to the network.

3. **Extended Site Trials**

   Prolonged site trials enabling SPEN to evaluate the solutions performance, identify the optimum settings and analyse the results returned.

4. **Design Review and Recommendations**

   Analysis of the devices performance and the identification of:

- Improvements / changes required for BaU adoption
- Potential benefits delivered based on limited site trial results
- The business case for BaU adoption

5. **Dissemination**

   External and Internal dissemination.

Objective(s)

Each discrete WP has an objective:

1. **Prototype Development**

   To design and develop a prototype RTFLM solution suitable for trial deployment on the network.

2. **Prototype Testing**

   To prove that the prototype is suitable for network trials without any detrimental impact on the network.

3. **Extended Site Trials**

   To generate consistent and reliable measurements over an extended period of time without any detrimental impact on the network.

4. **Design Review and Recommendations**

   The identification expected benefits based on the limited site trials and the business case for BaU adoption, as well as the further developments required.

5. **Dissemination**

   To ensure that external and internal stakeholders are fully aware of this projects findings and any potential benefits expected through BaU adoption.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

Each discrete WP has Success Criteria:

1. **Prototype Development**

This WP will be successful if a design for a feasible RTFLM solution can be developed and a prototype suitable for deployment is constructed.

2. Prototype Testing

This WP will be successful if the prototype passes FAT and SAT, and is proven to have no detrimental impact to the network when it is introduced.

3. Extended Site Trials

This WP will be a success if the RTFLM can be proven to generate consistent and reliable measurements over an extended period of time without any detrimental impact on the network.

4. Design Review and Recommendations

This WP will be a success if it identifies if this solution is worth pursuing further or not. If it is the WP will identify the potential benefits based on the site trial results and the developments required. If the solution is not worth pursuing the WP will outline the full reasoning and justification.

5. Dissemination

This WP will be a success if the project is disseminated externally and internally on several occasions and generates interest in the solution from the industry.

The continuation of the project will be reviewed at the end of each WP. If it is not feasible to continue to the next WP the project will be drawn to a close at the end of the previous WP, with the exception of WP 5 which required regardless of the success of each of the other WPs.

Project Partners and External Funding

Outram Research Limited (£80,000)

Potential for New Learning

This project intends to provide new learning that will lead to the potential widespread deployment of RTFLMs. The project builds the learning already generated by three SPEN and Western Power Distribution innovation projects:

- Under *'IFI 1007 Outram Fault Level Monitor'* SPEN worked alongside Outram Research Limited (ORL) to develop the first truly portable Fault Level Monitor to the world market. The FLM developed observed naturally occurring disturbances on a radial circuit to generate an overview of the network fault level over a relatively short period of time (1 week).
- {Under *'LCNF T1 Implementation of an Active Fault Level Management Scheme'* and *'WPD T2 FlexDGrid: Advanced Fault Level Management'* WPD have demonstrated that the ORL FLM can be coupled with an 11kV artificial disturbance to provide a RTFLM solution. With the solution deployed proven to generate accurate and repeatable measurements of the network fault level.

This project looks to develop a similar solution to that developed and trialled by WPD, but instead of utilising an 11kV artificial disturbance it utilises one at LV. By doing so it is envisaged it will make the RTFLM solution more accessible to DNOs by making it:

- **Applicable to LV → 33kV networks** - The LV disturbance can be varied for each voltage level to generate results and coupled to the required busbar via existing transformers.
- **Physically smaller** – With the solution compromising solely of LV components the physical size of the solution and the associated connection to the network considerably smaller than the 11kV solution.
- **Relatively low cost** – As above, with the solution compromising solely of LV components the expected solution cost is expected to be in the region of £20k per deployment.
- **Cheaper to operate and maintain** – The LV solution can be designed to be reduce the electrical stresses placed on switches, any component parts easily replaceable.

Scale of Project

Stage 1 of the project only considers a limited development and trial of two prototype RTFLM solutions. Given the timescale of the project it is likely that each prototype will only deployed at one location.

Technology Readiness at Start

Technology Readiness at End

TRL4 Bench Scale Research	TRL7 Inactive Commissioning

Geographical Area

TBC, the exact location(s) will be chosen early in the project, for the initial site trials the location(s) will be chosen to lower the risk of the introduction of the solution and prove that the solution can be applied at 33kV as this requires the largest LV disturbance.

Revenue Allowed for the RIIO Settlement

NA

Indicative Total NIA Project Expenditure

£243,089.38

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 mitigation of network fault level issues varies from location to location and by the network voltage. In general the higher the voltage the fault level is present at the higher the mitigation costs will be. WP 4 of the project will look to deliver analysis of the Net Financial Benefits this solution can deliver be it through deferred investment or through societal benefits of identifying unsafe fault levels on the network.

In the interim, to provide comfort that solution has the potential to deliver a net financial benefit a simple comparison of the BaU equipment costs for the replacing a 33kV RMU vs the expected RTFLM cost. In this scenario the 33kV RMU would be replaced by a 3 Panel Board costing ~£105k, with the facilitating RTFLM costing ~£22k, so on equipment costs alone this solution could deliver a saving of £83k.

Please provide a calculation of the expected benefits the Solution

Using the above example with the RTFLM being deployed at 33kV and identifying additional fault level capacity deferring reinforcement.

Method Cost

Expected RTFLM equipment costs, not including any design, installation, civil costs etc. = £22k

Base Cost

The BaU approach would be to replace a 750MVA 33kV RMU with a 1000MVA 3 Panel Board, with equipment costs, not including any design, installation, civil costs etc. = £105k

Base Cost – Method Cost

£105k - £22k = £83k

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

The RTFLM solution being developed in this project has the potential to be replicable across GB as it is:

- Applicable to LV → 33kV networks
- Physically small
- Relatively low cost

It also tackles an issue that is common to all of the 14 licence areas.

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

The project aspires to deliver a solution with equipment costs of £22k or below, so the rollout costs for the GB will be a multiple of this figure. In the instance that all UK DNOs purchase 3 units, the rollout cost for the equipment alone could be £396k.

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

All UK DNOs have the same challenge with the management of network fault level with the growth of distributed generation. The solution being developed under this project is equally applicable to all UK DNOs, it does not use any network assets or connections bespoke to SPEN.

If this project is a success then UK DNOs can start to utilise RTFLMs widespread to release capacity / reduce any health and safety risks associated with managing networks with high fault level.

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.

SPEN has undertaken due diligence by raising this project with other UK DNOs ahead of registering it to ensure that the project is not leading to unnecessary duplication and that the solution is welcomed. At the time of registering this project we have not received any concerns of duplication.

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

The RTFLM developed under this project is a first of its kind device, it builds upon SPENs IFI project to build the original FLM and WPDs Flexdgrid project that proved the FLM could be utilised to generate real time results through artificial disturbances on the network. The RTFLM developed under this project is the first ever self-contained RTFLM that generates HV results through the introduction of LV artificial disturbances.

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

The TRL of the RTFLM at the start of this project was not sufficient for BAU adoption, innovation funding is required to develop the solution to a suitable level for network trials.

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

The development of the RTFLM carries with it technical risk, there are no guarantees the proposed solution will work to the required extent. Only through developing the solution and undertaking real world testing can this be ascertained. It also carries with it Operational Risk, the impact of the artificial disturbances also needs to be understood through this project.

This project has been approved by a senior member of staff

☑ Yes