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

Feb 2017

Project Reference Number

NIA_SPEN0014

Project Registration

Project Title

Active Fault Level Management (AFLM)

Project Reference Number

NIA_SPEN0014

Project Licensee(s)

SP Energy Networks Distribution

Project Start

February 2017

Project Duration

7 years and 2 months

Nominated Project Contact(s)

Ralph Eyre-Walker

Project Budget

£1,050,000.00

Summary

The project aims to develop and trial an Active Network Management (ANM) FLM solution which improves fault level headroom utilisation in order to avoid or defer network reinforcement works and accelerate the integration of renewable generation. The project will implement and demonstrate the solution to provide alternative technical and commercial connection arrangements.

The project is split into three work packages:

Work Package 1 (WP1): AFLM Toolbox definition and modelling

Desktop-based modelling of 5 selected GSP zones will be undertaken to quantify the fault-level headroom availability across different network operating conditions. GSPs will be selected from both the SP Manweb and SP Distribution licence areas.

Monitoring devices will be installed at the proposed locations to validate the simulation work that informs the analysis. The learning will feed into the drafting of the AFLM Toolbox.

The detailed business case of the AFLM Toolbox will be developed and published. A go / no go decision to proceed with WP2 and WP3 will be made based on outcomes of WP1.

Work Package 2 (WP2): Detailed AFLM Toolbox design and testing

Refinement of AFLM Toolbox components, process and technical specification development.

Model and Manage processes will be developed and application cases will be defined. These will be subject to simulation and testing. A number of Measure and Mitigate Toolbox components will also be fully defined, configured, simulated and tested in a workbench environment prior to network demonstration.

The commercial elements of each proposition will be investigated and a report published.

A go / no go decision to proceed with WP3 will be made based on outcomes of WP2.

Work Package 3 (WP3): Network Demonstration and Learning Capture

Following design and configuration of an autonomous AFLM prototype, the solution will be tested in a live operating environment.

A project learning report will be produced outlining the operational performance during the trial. Further reports capturing the outcomes and learning of the trial will be published.

Nominated Contact Email Address(es)

innovate@spenergynetworks.co.uk

Problem Being Solved

The management of fault levels has always been challenging and problematic for DNOs. Fault level management is particularly challenging given the safety criticality implications as they 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 7.0% 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 distributed generation connections.

Method(s)

There are distinct approaches to Fault Level Management, with variation in the means of management and operational characteristics. Each of the following approaches have a role in the proposed AFLM Toolbox:

- **Model**: where power system modelling is used to support Fault Level Management, either as:
- An operational means of FLM;
- An input to FLM; or
- for FLM.
- **Monitor**: where fault-level measurement methods either:
- Enable the verification of network modelling methods and assumptions; or
- Facilitate the online measurement of fault level for operational management purposes.
- **Mitigate**: where various techniques for fault current limitation are taken in real-time through physical fault current limitation or via protection actions.
- **Manage**: where control systems provide preventative avoidance of fault level infeed exceedance through control of demand and renewable generation to reduce fault level and create network headroom.

The project will aim to develop an AFLM Toolbox based upon the **Manage** approach, using elements of **Model** and **Monitor**, with opportunities to work in co-ordination with **Mitigate** techniques.

Scope

The project aims to develop and trial an Active Network Management (ANM) FLM solution which improves fault level headroom utilisation in order to avoid or defer network reinforcement works and accelerate the integration of renewable generation. The project will implement and demonstrate the solution to provide alternative technical and commercial connection arrangements.

The project is split into three work packages:

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The detailed business case of the AFLM Toolbox will be developed and published. A go / no go decision to proceed with WP2 and WP3 will be made based on outcomes of WP1.

Work Package 2 (WP2): Detailed AFLM Toolbox design and testing

Refinement of AFLM Toolbox components, process and technical specification development.

Model and Manage processes will be developed and application cases will be defined. These will be subject to simulation and testing. A number of Measure and Mitigate Toolbox components will also be fully defined, configured, simulated and tested in a workbench environment prior to network demonstration.

The commercial elements of each proposition will be investigated and a report published.

A go / no go decision to proceed with WP3 will be made based on outcomes of WP2.

Work Package 3 (WP3): Network Demonstration and Learning Capture

Following design and configuration of an autonomous AFLM prototype, the solution will be tested in a live operating environment.

A project learning report will be produced outlining the operational performance during the trial. Further reports capturing the outcomes and learning of the trial will be published.

Objective(s)

The objective of the project is to maximise utilisation of existing fault-level headroom by demonstrating the potential merits of a comprehensive AFLM toolbox combining *model* + *monitor* + *mitigate* + *manage* approaches.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The project will be deemed successful upon delivery of the following:

Work Package 1 (WP1): AFLM Toolbox definition and modelling

Upon completion of WP1 the following deliverables will be produced:

- GSP Fault Level Headroom Analysis Report
- Fault Level Measurement Data Analytics Report
- AFLM Cost-Benefit Analysis Report and Business Case Report

Subject to go/no go decision to proceed with WP2:

Work Package 2 (WP2): Detailed AFLM Toolbox design and testing

Upon completion of WP2 the following deliverables will be produced:

- Model and Manage Process Definition, Simulation and Test Report
- Measurement and Mitigate Solution Requirements, Design, Test Specifications and Test Report
- AFLM Toolbox Simulation Report

Subject to go/no go decision to proceed with WP3:

Work Package 3 (WP3): Network Demonstration and Learning Capture

Upon completion of WP3 the following deliverables will be produced:

- AFLM Toolbox Trial, Requirements and Design Specifications
- AFLM Toolbox Solution Demonstration Report
- AFLM Toolbox Learning Capture Report

Project Partners and External Funding

The project is being developed in partnership with Smarter Grid Solutions.

A partner contribution will be made in the form of in kind support during the development of WP2 and WP3 £50,000.

Potential for New Learning

The project will be a valuable proof of concept for the AFLM Toolbox. The project will provide valuable learning and refinement of the AFLM requirements that are fit-for-purpose and underpin the future roll-out of a mature solution that minimises network reinforcement and allows generators to access fault level constrained networks.

Scale of Project

The scale of this project will include analysis of 5 selected GSP zones within the SP Distribution and SP Manweb license areas for simulation of the proposed *model* + *monitor* + *mitigate* + manage approach (WP1) followed by testing (WP2) and one network deployment (WP3).

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL7 Inactive Commissioning

Geographical Area

Five GSPs will be targeted within the SP Distribution and SP Manweb license areas for the purposes of WP1. The location has not yet been decided. This will be followed by one network deployment within WP3.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£700,000

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)

Based on an analysis of the ED1 spending required to upgrade the UK primary network, circa 85 actions involve Fault Level Management issues at EHV. Such interventions would be similar to those faced by generators aiming to connect into fault level constrained networks. Based on an analysis of the proposed schemes, the savings would be in excess of £600,000 per GSP.

Please provide a calculation of the expected benefits the Solution

Based on a study of EHV faults levels in the SPD license area during the ED1 period, the capex savings associated with the proposed solution are estimated at circa £5m.

A total of 12 EHV fault level driven schemes have been assumed in SPD during ED1 i.e. an average of 1.5 schemes per year. The cost of resolving such constraints by conventional means is estimated at approximately £19.4m.

If the ANM FLM solution becomes ready for business-as-usual deployment by 2018/19, in line with the forecast project timescales, and ANM FLM could be used for 50% of the projects the total ED1 expenditure would be reduced to approximately £14.5m.

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

The solutions proposed in this project are not specific to SPEN, and could feasibly be rolled out to other EHV network areas. Based on a study of EHV faults levels across the UK during the ED1 period, the capex savings associated with the proposed solution could be in the range of £16m - £20m.

It is assumed that 85 fault-level driven schemes will be delivered in the UK during ED1 at a total cost of approximately £77.3m. Assuming the ANM FLM solution is ready for rollout by 2018/19, in line with forecast project timescales, and ANM FLM could be used for 50% of the projects the total ED1 expenditure would be reduced to approximately £61.1m.

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

The cost for a full ANM FLM solution deployment is estimated at circa £300,000. The extension of existing ANM system functionality to incorporate FLM capability is estimated at circa £200,000. Costs include deployment, labour and licensing costs for the solution:

Assuming 50% of the fault-level schemes in the UK from 2018/19 onwards could benefit from the deployment of AFLM techniques, the cost will be in the region of £5 - £10 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 problem addressed in this project is common to every DNO and the proposed solution is not specific to SPEN. It is intended that the AFLM Toolbox generated by this project will be made readily available to other DNOs through project dissemination.

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.

Fault Level Management has been a topic of LCNF funding previously under the following projects:

Project: UK Power Networks - Low Carbon London

Description: The growth in DG has been rapid and is expected to continue across the London network. The diversity of DG has also changed and fault Level has become a major barrier to connections.

Differences with SPEN ANM FLM: The project applied a headroom allocation/management approach based on ANM and captured but did not trial the FLM concept. This SPEN ANM FLM will develop and trial a solution applicable to multiple license areas.

Project: UK Power Networks - Fault Current Limiter

Description: Trial of a Fault Current Limiter (FCL) solution provided by GridOn that would turn itself into a high impedance path during current surges and limit the current for as long as is required to clear the fault.

Differences with SPEN ANM FLM: This FCL is a single tool (based on one technique) that can be applied anywhere on the network to deal with fault currents. The SPEN ANM FLM solution is a suite of tools and techniques to manage fault levels and managed as a toolbox by ANM.

Project: Western Power Distribution – FlexDGrid

Description: Focusing on the 11kV networks in the Birmingham area, a power modelling approach was used in combination with an Outram Fault Level Monitor to measure headroom and other technologies in order to limit fault currents (e.g. saturating core fault current limiter).

Differences with SPEN ANM FLM: SPEN ANM FLM will apply tools and techniques at 33kV, and use a different modelling approach (i.e. model at the planning stage to identify and configure the ANM FLM approach) and monitoring tools (existing switch status and DG status real time measurements). SPEN ANM FLM will directly address the management of headroom for DG operation with the required commercial arrangements.

Project: Electricity North West – Respond

Description: RESPOND uses a Fault Level Assessment Tool and a number of mitigation techniques (protection and explosive fault current limiting) to deal with FLM. This project has a strong focus on the DNO to customer commercial models around FLM services and is being trialed in order to avoid reinforcement.

Differences with SPEN ANM FLM: SPEN ANM FLM will be used to facilitate the connection of generators to the network and avoid network reinforcement. The modelling in SPEN ANM FLM will be performed at planning stage to establish configuration parameters and the required control of DG rather than in real time. The focus in SPEN ANM FLM is on preventive management of fault level through DG management rather on mitigating fault path interruption by protection or explosive limiting devices.

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

Active Network Management based on Fault Level has never been done before

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

Ground breaking work that may not succeed. If the network trial is successful, BaU funds will be used to roll out the technology.

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 this is ground breaking work there are a number of technical and commercial considerations to be overcome. The device for measuring fault level is also new and funded through a separate NIA project. The communications interfaces, network control systems, operational processes and commercial customer arrangements all need to be developed.

This project has been approved by a senior member of staff

☑ Yes