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 2016

Project Reference Number

NIA_NGET0182

Project Registration

Project Title

Feasibility study on suitability of protection policy for future energy scenarios

Project Reference Number

NIA_NGET0182

Project Licensee(s)

National Grid Electricity Transmission

Project Start

March 2015

Project Duration

4 years and 5 months

Nominated Project Contact(s)

Mark Osborne

Project Budget

£295,000.00

Summary

The assessment and feasibility study will consider a small representative section of the network, such that protection performance information can be provided and coupled with contingencies and scenarios identified in the System Operability Framework (SOF) document published by the System Operator. This knowledge will then be applied to evaluating the effectiveness of alternative protection strategies to meet future network requirements.

The associated deliverables include:

1. Develop a Roadmap to evaluate the suitability of existing protection to cater for low system inertia/fault level conditions
2. Protection modelling and validation;
    1. Validate the SOF modelling assumptions
    2. Compare simulations with measured data to validate models
    3. Evaluate the suitability of current and legacy technology to meet these emerging protection requirements
    4. Examine the impact on the transmission protection strategy due more active DNO networks.
3. Establish the limitations of the existing policy to cater for future scenarios
4. Identify alternative protection methodologies and their suitability for transmission systems under the various future scenarios;
    1. Do we still require 2 main protections
    2. What is the role for backup protection
    3. Do we need CBF as switchgear performance reliability improves
    4. Is voltage a better parameter to monitor.
5. Recommendations for optimising the existing protection system to adapt to these challenges
    1. Scope out the role and impact that CIM and IEC 61850 will have in this development

2. Identify any architecture and infrastructure we require to support any migration to new P&C solutions.

3. Long term strategy.

Nominated Contact Email Address(es)

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Problem Being Solved

The protection principles and methodology which have been reliably used on the transmission systems since it was constructed last century have been very effective in providing a reliable and safe network.

The increasing deployment of power electronic converter based technology such as wind turbines, HVDC links and photovoltaic to displace synchronous generation is fundamentally changing the nature of system faults and their detection using the traditional methods.

There is the increasing possibility of new scenarios where the existing methods and policies may not be sufficiently reliable to detect and clear faults, thus increasing the likelihood of wider network stability issues and possible black-outs. As a consequence, the industry has recognised an increasing need to establish the effectiveness of existing protection strategies for the electricity transmission system in order to address the future energy scenarios being considered for the UK.

Method(s)

The approach to this problem will involve researching the capability of National Grid's existing protection solutions to detect and clear power system faults in networks which are dominated by the technology changes envisaged in the future scenarios. The assessment will develop power system models that can identify the technical performance of the existing protection strategy, using measured system data to validate the accuracy of the models.

Scope

The assessment and feasibility study will consider a small representative section of the network, such that protection performance information can be provided and coupled with contingencies and scenarios identified in the System Operability Framework (SOF) document published by the System Operator. This knowledge will then be applied to evaluating the effectiveness of alternative protection strategies to meet future network requirements.

The associated deliverables include:

1. Develop a Roadmap to evaluate the suitability of existing protection to cater for low system inertia/fault level conditions
2. Protection modelling and validation;
    1. Validate the SOF modelling assumptions
    2. Compare simulations with measured data to validate models
    3. Evaluate the suitability of current and legacy technology to meet these emerging protection requirements
    4. Examine the impact on the transmission protection strategy due more active DNO networks.
3. Establish the limitations of the existing policy to cater for future scenarios
4. Identify alternative protection methodologies and their suitability for transmission systems under the various future scenarios;
    1. Do we still require 2 main protections
    2. What is the role for backup protection
    3. Do we need CBF as switchgear performance reliability improves
    4. Is voltage a better parameter to monitor.
5. Recommendations for optimising the existing protection system to adapt to these challenges
    1. Scope out the role and impact that CIM and IEC 61850 will have in this development
    2. Identify any architecture and infrastructure we require to support any migration to new P&C solutions.
    3. Long term strategy.

Objective(s)

The key objectives for this feasibility study are to:

- Develop a Roadmap to evaluate the suitability of existing protection to cater for low system inertia/fault level conditions
- Protection modelling and validation;
- Establish the limitations of the existing policy to cater for future scenarios
- Identify alternative protection methodologies and their suitability for transmission systems under the various future scenarios;
- Develop a list of recommendations for optimising the existing protection system for adaptation to these challenges

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

Production of reports addressing:

- Review of existing protection effectiveness.
- Development of a viable protection strategy suitable for all credible scenarios
- Implementation roadmap to optimise/migrate existing protection to a fit for purpose solution.

Project Partners and External Funding

Project Partner: EPSRC

External funding: EPSRC funding via the CDT program

Potential for New Learning

The outputs from this feasibility study will establish the effectiveness of existing protection technology and the challenges of continuing to provide a fit for purpose protection strategy. As well as identifying the likely time frame and indicators to trigger protection modification or replacement and the identification of likely future design and their benefits and drawbacks.

Scale of Project

The project will consider a section of the network sufficient to be considered representative of a transmission network.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

The initial study will be desk-based. Onsite testing will be undertake on appropriately identified sections of the electricity transmission network, to be selected during the first stage of the study.

Revenue Allowed for the RIIO Settlement

none

Indicative Total NIA Project Expenditure

Indicative NGET NIA investment of £295,000

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)

The primary benefit to this feasibility study is associated to risk avoidance by developing a strategy to understand the need to adjust settings or replace protection to avoid possible large scale voltage collapse and loss of supply.

This study will identify the scope and scale of work required to address the issue. A protection and control settings and coordination review is a resource intensive project and is likely to cost in the order of £1-5m, if this feasibility study can reduce the scope of this by 10-20% the realized cost savings would be in the order of £100 – £1m.

Further benefit will be realised in establishing an independent verification and validation check by using academia, rather than manufacturers. The learnings of which will be disseminated to all network licensees.

Please provide a calculation of the expected benefits the Solution

Not required for Research Projects.

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

The application would be most likely picked up by the Transmission owners and the Distribution Network Operators (DNO) as part of their network modernization and asset replacement programs.

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

The costs to roll out the policy changes are difficult to predict at this stage; the findings from this study will form the basis of new the utility's protection settings policy. Firstly, this will require utilities to review their documentation and secondly the actual resetting or replacement of protection equipment.

The costs of policy review are estimated be in the region of ~£1m per utility at the time of publication. There will be additional costs associated with the identification of assets which may require replacement across the GB T&D system. Assets will be assessed based on its own merits by the utility asset owner, and replacement will be prioritized based on the assessment activity.

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 of the GB transmission licensees have very similar issues and technology challenges. Therefore, the learning from this work will be directly relevant to these utilities.

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

This feasibility study fits with the Managing Assets area of the Transmission Owner Innovation Strategy.

Additionally, the System Operability Framework (SOF) document produced annually by the System Operator (SO) identifies this as an emerging issue which requires addressing. The purpose of the document is to identify issues, existing and emerging, which will impact on the ability of network licensees and the SO to reliably and efficiently transmit electricity.

☑ 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.

The project lead carried out a review of current research programs and identified industry specific issues to build on within this scope of work which have been generically established by current researchers.

This feasibility study was triggered by output from ongoing work in this area and as such is related to, but is looking to address different issues from, another NIA funded project, namely the *Control and Protection Challenges In Future Converter Dominated Power Systems* project (NIA_NGET0106).

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