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 2014

Project Reference Number

NIA_NGET0055

Project Registration

Project Title

Electromagnetic transients (EMT) in future power systems – Phenomena, stresses & modelling

Project Reference Number

NIA_NGET0055

Project Licensee(s)

National Grid Electricity Transmission

Project Start

March 2011

Project Duration

5 years and 4 months

Nominated Project Contact(s)

Forooz Ghassemi

Project Budget

£2,083,333.00

Summary

A collaborative research group is being established, made up of utilities, manufacturers and research bodies, to investigate the electromagnetic transient (EMT) interaction of renewable generation on transmission equipment. The focus of the project will be on the EMT modelling of components (transformers, cables, circuit breakers, instrument transformers etc.) to provide best practice and expert opinion on their interaction with the power system.

System and plant measurements will be carried out to validate the models, which can then be used to simulate and demonstrate the power system interaction phenomena on equipment such as current inrush, harmonic penetration, resonant overvoltages, etc. The work will consider transformer modelling (both in terms of modelling expertise and laboratory facilities), and acquiring cable lengths for the purpose of model validation (complex multi-phase cables with steel armouring). In addition, a number of system studies will be performed in order to highlight special transient phenomena such as how CT/VT saturation may impact on protection performance.

Participants will highlight their interests, for instance, EdF want to compare case studies using PSCAD and EMTP-RV packages, Statkraft would like an activity on modelling oil-filled cables, Vestas is very interested in black-box cable modelling, etc.

Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

Problem Being Solved

The future power system is going to be highly complex, integrating renewable generation, smart grids, voltage upgrades, increasing usage of long cables and HVDC. Successful implementation will require extensive computer simulations during all the planning and engineering phases. Existing simulation tools have limited accuracy for representing some critical components such as transformers and cables. The project will produce models that are sufficiently accurate and compatible with available circuit simulators, and make use of the models in system simulation studies in order to pinpoint bad configurations. There is also limited understanding of these interactions, such that development project and designers do not know what can cause the problems and how to avoid designing potential problems.

Method(s)

Research

The method that has been proposed for this project is as follows;

1. Validated component models in various simulation package formats.
2. Recommendations on component incompatibilities
3. Set of real case studies to validate that the issues are real.

Scope

A collaborative research group is being established, made up of utilities, manufacturers and research bodies, to investigate the electromagnetic transient (EMT) interaction of renewable generation on transmission equipment. The focus of the project will be on the EMT modelling of components (transformers, cables, circuit breakers, instrument transformers etc.) to provide best practice and expert opinion on their interaction with the power system.

System and plant measurements will be carried out to validate the models, which can then be used to simulate and demonstrate the power system interaction phenomena on equipment such as current inrush, harmonic penetration, resonant overvoltages, etc. The work will consider transformer modelling (both in terms of modelling expertise and laboratory facilities), and acquiring cable lengths for the purpose of model validation (complex multi-phase cables with steel armouring). In addition, a number of system studies will be performed in order to highlight special transient phenomena such as how CT/VT saturation may impact on protection performance.

Participants will highlight their interests, for instance, EdF want to compare case studies using PSCAD and EMTP-RV packages, Statkraft would like an activity on modelling oil-filled cables, Vestas is very interested in black-box cable modelling, etc.

.

Objective(s)

A desired result of this project is to help facilitate the connection of £50bn of renewable generation (25GW) onto the network, through understanding the level and impact of transient voltages that will arise from these types of connections to renewable generation and designing solutions to mitigate or neutralise their occurrence. Failure to do this could, in the worst case, lead to substation equipment failure. The ability to provide a better-informed specification could possibly result in an avoided loss of supply through damaged cables or transformer resulting in £1-2m repairs.

The focus of the project will be on the Electro Magnetic Transient (EMT) modeling of components (transformers, cables, circuit breakers, instrument transformers etc.) to provide best practice and expert opinion on their interaction with the power system.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The project will:

- Develop component models to characterise the range of phenomena associated with transient conditions
- Examine the network architecture
- Validate EMT models in different simulation packages
- Disseminate the results and models to the partners

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

This project is of a laboratory based scale.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL5 Pilot Scale

Geographical Area

This project will be undertaken in Scandanavia.

Revenue Allowed for the RIIO Settlement

Zero

Indicative Total NIA Project Expenditure

IFI= £76,000
NIA= £87,000

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)

This work will help to facilitate the connection of £50bn of renewable generation (25GW) onto the network, through understanding the level and impact of transient voltages that will arise from these types of connections to renewable generation and designing solutions to mitigate or neutralise their occurrence. Failure to do this could, in the worst case, lead to substation equipment failure and a consequential reputational loss. The ability to provide a better informed specification could possibly result in an avoided loss of supply through damaged cables or transformer resulting in £1-2m repairs.

Please provide a calculation of the expected benefits the Solution

Research Project - Not required.

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

This modelling will be applicable to the whole of the transmission system.

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

No specifically attributable roll out costs are associated with applying the learning from this 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

☐ 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

n/a

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 project addresses the theme of system operability under the changing profile of renewable generation.

☑ 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