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NIA Project Registration and PEA Document

Date of Submission

May 2022

Project Reference Number

NIA_SHET_0035

Project Registration

Project Title

TOTEM (Transmission Owner Tools for EMT Modelling) Extension

Project Reference Number

NIA_SHET_0035

Project Licensee(s)

Scottish and Southern Electricity Networks Transmission

Project Start

May 2022

Project Duration

1 year and 3 months

Nominated Project Contact(s)

Brant Wilson

Project Budget

£437,000.00

Summary

Continuation of NIA_SHET_0032 TOTEM, to complete the development and associated validation of a full-scale model of the GB Transmission System in electromagnetic transient (EMT) PSCAD simulation software.

Nominated Contact Email Address(es)

transmissioninnovation@sse.com

Problem Being Solved

The GB power system is rapidly evolving as conventional synchronous generation is decommissioned and ever greater levels of renewable sources are connected leading to a much lower level of system inertia and lower short circuit levels. At the same time there are increasing numbers of HVDC links and Flexible AC Transmission Systems (FACTS) devices being connected in close proximity in parts of the system. The potential for adverse control interactions between these devices is rising and needs careful consideration within the context of a potentially weaker GB system.

Conventional phasor-based RMS simulation tools have limitations in studying the behaviour of these new devices due to the level of detail that is represented. A move to developing more detailed electromagnetic transient (EMT) based models which will address these concerns is proposed as a solution and is seen as a key way of de-risking the integration of the technologies described above.

Method(s)

Manitoba Hydro International (MHI) is a world leader in power system simulation and has developed a way to study electromagnetic transient (EMT) behaviour on large systems, like the full GB transmission system, using the PSCAD simulation software. This project proposes to have MHI develop and validate a full-scale model in PSCAD for the GB transmission system.

Scope

The project scope will be to;

- Develop new tools for automatic reduction of the PSCAD model to produce both static and dynamic equivalents of the reduced areas;
- Develop new tools for configuration and quick initialisation of the EMT models to support future work by the Transmission Owners (TOs);
- Perform illustrative studies based on the developed PSCAD network including;
 - sub-synchronous resonance investigations
 - control instability studies
 - switching studies on a selection of substations
- Participate in a knowledge transfer workshop to provide the TOs and ESO with the capability to use the models, extend them as required in the future, and perform a range of studies.

Objective(s)

The objectives of the project are as follows:

1. Validate a PSCAD model of the GB transmission network and from that derive separate models for each of the three TO licence areas;
2. Deliver tools for PSCAD model manipulation and analysis that will support the TOs and the ESO in their use of the GB model;
3. Provide the GB TOs and ESO with the knowledge and understanding required to adopt the models and put them into use; and
4. Install shared computing resources for running the most complex models.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

Not Applicable

Success Criteria

The project will be successful if a working PSCAD model can be created and used to perform illustrative studies.

Project Partners and External Funding

Scottish Hydro Electric Transmission will contribute £101k

SP Transmission will contribute £100K

National Grid Electricity Transmission will contribute £100k

National Grid Electricity System Operator will contribute £136k

Potential for New Learning

This project will provide new tools and resources to model the transmission system which goes beyond current established models:

- enabling much larger sections of the network to be investigated in the EMT domain;
- the ability to perform critical studies on weak grids;
- enhance the support and level of service that the TOs can provide to Users seeking new connections;
- investigation into transient disturbances; and
- will provide the ability to incorporate sensitive vendor models into the network and study the effect, thus enabling development of mitigation plans where necessary.

Scale of Project

The development of the PSCAD model of the whole UK system is applicable to all three Transmission Owners, hence the presentation of a joint project proposal.

Technology Readiness at Start

TRL5 Pilot Scale

Technology Readiness at End

TRL7 Inactive Commissioning

Geographical Area

GB

Revenue Allowed for the RIIO Settlement

Not Applicable

Indicative Total NIA Project Expenditure

The total expenditure for the project is £ 437k.

90% (£393.3k) 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:

To achieve the radical energy transition required to meet net zero targets, the electricity transmission system's behaviour will radically change. In so doing it will challenge many of the assumptions, models and simulation methods used by power system planners to ensure that the system delivers safe, secure and stable operation. Indeed, over the last few years system monitoring has highlighted that the electrical system is indeed evolving at a fast pace as new behaviours have been recorded driven by the generation mix changing with the closure of conventional large scale synchronous plant. It is vital that system modelling remains fit for purpose and is able to accurately represent the new and emerging technologies which will underpin the energy transition and are controlled via power electronics.

During RIIO-T1, the TOTEM project has laid the foundations of an advanced EMT based GB system model. In RIIO-T2 TOTEM will continue the development and testing of the EMT based GB system model. As it is a vital element for the ESO and TOs to plan the long term security and stability of the network.

How the Project has potential to benefit consumer in vulnerable situations:

Not Applicable

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)

Not Applicable

Please provide a calculation of the expected benefits the Solution

This project is focused on the 'Development' of innovative tools and resources for power system modelling and analysis. It will produce a model that can mimic large volume power electronics and enable formulation of mitigation measures to future proof the GB network associated with the energy transition. The end product will be a valuable modelling tool; however it will still need to be validated and improved through studying actual system disturbances.

Given the nature of power system modelling it is not possible to financially quantify the benefit.

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

We are working together to develop and validate a GB solution, which will enable all three Transmission Owners and the System Operator to optimise the knowledge and learning, removing duplication.

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

Not Applicable

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

This is a joint project and will enhance learning, knowledge and ability for all three Transmission Owners and the System Operator.

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

Not Applicable

Is the default IPR position being applied?

- Yes

Please demonstrate how the learning from the project can be successfully disseminated to Network Licensees and other interested parties.

The associated Network Licensees will adhere to industry codes in accordance with their license conditions. This will facilitate the models built under this project to be shared with other interested parties in accordance with the present protocols.

Please describe how many potential constraints or costs caused, or resulting from the imposed IPR arrangements.<

The associated Network Licensees will adhere to industry codes in accordance with their license conditions. This will facilitate the models built under this project to be shared with other interested parties in accordance with the present protocols.

Please justify why the proposed IPR arrangements provide value for money for customers.

The associated Network Licensees will adhere to industry codes in accordance with their license conditions. This will facilitate the models built under this project to be shared with other interested parties in accordance with the present protocols.

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.

Working together to develop and validate a GB solution will enable all three Transmission Owners and the System Operator to optimise on the knowledge and learning, removing duplication.

If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

National Grid ESO is pursuing an innovation project that aims to extend existing models they have developed in PSCAD covering limited parts of the GB transmission system. The emphasis of the NGESO project is on the development of new component models, e.g. how to represent a specific HVDC link. The NGESO project does not include the development of new tools and methods, which will be important in supporting future full GB EMT models. The two projects are therefore complementary.

National Grid Electricity Transmission has a parallel project that focuses on the tools and methods for translation of models from the DIgSILENT PowerFactory format, as currently used for most power systems analysis at NGET, to the PSCAD format. The NGET project complements this joint TOTEM project by focusing on a specific aspect of model manipulation that will be useful as the full GB model is adopted in business as usual.

Additional Governance And Document Upload

Please identify why the project is innovative and has not been tried before

EMT modelling is presently being used on small scale applications to model the electrical connection. This will be the first time in GB that a whole electrical network will be modelled, it will provide each of the TOs and the System Operator with much improved network models of their counterparts. It will be only the second time in the world that large scale EMT modelling of a system is created, following the successful demonstration of the Australian network.

Relevant Foreground IPR

Background IPR – each TO has provided details of their network.

MHI will generate new network models 'foreground IPR' for the Network Licensees, who will adhere to industry codes in accordance with their license conditions to facilitate the models built under this project to be shared with other interested parties in accordance with the present protocols.

Data Access Details

The associated Network Licensees will adhere to industry codes in accordance with their license conditions. This will facilitate the models built under this project to be shared with other interested parties in accordance with the present protocols.

Please identify why the Network Licensees will not fund the project as apart of it's business and usual activities

This new way of modelling the Transmission system, coupled with the different way of interoperating how the electrical system will flex, is in the development stages and still requires validation and testing. There are business risks associated with implementing a solution making it unlikely to secure general funding.

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

Developing the solution under NIA will enable knowledge sharing between the Transmission Owners and the System Operator, to ensure that together this new modelling package is developed and validated for the GB system.

This project has been approved by a senior member of staff

Yes