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 2025

Project Reference Number

NIA_SHET_0055

Project Registration

Project Title

System Short Circuit Tests

Project Reference Number

NIA_SHET_0055

Project Licensee(s)

Scottish and Southern Electricity Networks Transmission

Project Start

February 2025

Project Duration

2 years and 2 months

Nominated Project Contact(s)

Brant Wilson – Innovation Portfolio Manager

Project Budget

£250,000.00

Summary

The electricity system is changing as older thermal plants based on large synchronous machines are displaced by renewables making increasing use of power electronics for connection and interconnectors using high-voltage direct current (HVDC) technologies. The result of this is the fault behaviour of the system is evolving as power electronic sources do not contribute the same high fault current as synchronous machines. These tests will validate the outcomes of the G74 review by recording system behaviour in response to the application of fault disturbances at two locations. By collating data on the network configuration as well as generation and demand during tests, the system can be accurately modelled in accordance with the new G74-2 guidance and the accuracy of the short circuit calculation technique assessed.

Nominated Contact Email Address(es)

transmissioninnovation@sse.com

Problem Being Solved

The accurate calculation of system short circuit currents (or fault levels) is an essential planning task that is required to adequately rate equipment, set protection and, historically, evaluate system strength for assessing the impact of asset energisations. The fault contributions from the electrical machines that historically dominated the system became well understood and robust procedures developed to calculate system short circuit currents (in the UK Engineering Recommendation G74). The strong correlation between fault level and strength has been useful in making initial assessments for certain types of transient or dynamic behaviour.

The electricity system is changing as older thermal plants based on large synchronous machines are displaced by renewable schemes making increasing use of power electronics for connection and interconnectors using HVDC technologies. The result of this change is that the fault behaviour of the system is evolving as, in general, power electronic sources do not contribute the same high fault current as synchronous machines. These sources respond very differently to unbalanced fault conditions and do not exhibit the same offset

decaying characteristic inherent to electrical machines. The overall result is that as time progresses, system fault levels in some regions may be very much lower and present quite radically different waveforms to protection relays and other monitoring equipment.

With these changes in mind, it is essential that high confidence continues in the modelling and calculation methods used to assess the fault behaviour of the system. This will ensure protection systems are able to detect and clear all possible faults thus ensure a safe, reliable and stable transmission system. The new technologies noted above challenge existing methods and have resulted, in the UK, to the publishing of an update to Engineering Recommendation G74 which went into effect from July 2021 (G74-2). One of the main parts of this update is to better represent the current limited contribution from power electronic converters in standard short circuit calculations.

Method(s)

This proposal seeks to provide a means of validating the outcomes of the G74 review by recording system behaviour in response to the application of two separate fault disturbances carried out on the Transmission network. By collating data on the network configuration as well as generation and demand at the time of the tests, it is intended that the system can be accurately modelled in accordance with the new G74-2 guidance and the accuracy of the short circuit calculation technique assessed. The system responses will also be invaluable for validating more complex transient and dynamic simulations in both the root square mean (RMS) and electromagnetic transient (EMT) domains.

Data Quality Statement (DQS):

The project will be delivered under the NIA framework in line with OFGEM, ENA and SSEN Transmission internal policy. Data produced as part of this project will be subject to quality assurance to ensure that the information produced with each deliverable is accurate to the best of our knowledge and sources of information are appropriately documented. All deliverables and project outputs will be stored on our internal SharePoint platform ensuring access control, backup, and version management. Deliverables will be shared with other network licensees through the closedown reports on the Smarter Networks Portal.

Measurement Quality Statement (MQS):

The methodology used in this project will be subject to supplier's own quality assurance regime. Quality assurance processes and the source of data, measurement processes and equipment as well as data processing will be clearly documented and verifiable. The measurements, designs and economic assessments will also be clearly documented in the relevant deliverables and final project report and will be made available for review.

In line with ENA's ENIP document, the cumulative risk score is scored as 6 = **LOW** from the sum of the risk thresholds below:

TRL Steps – 1 TRL Step – Low (Score 1)
Cost – <£500,000 – Low (Score 1)
Number of suppliers – 0 – Low (Score 1)
Data – Assumptions unknown to be explored and validated within project – High (Score 3)

Scope

The project scope will be to:

• Develop a short circuit test scope for two proposed test sites.

• Develop test procedures for executing both short circuit tests.

• Conduct tests at both sites, ensuring suitable system monitoring is available for the recording of data.

• Analysis and validation of recorded results.

Financial benefits can be found in section 3.2.2.

Objective(s)

The objective of this project is to conduct system short-circuit tests on the Transmission network, which will enable the validation of our network models.

Consumer Vulnerability Impact Assessment

An assessment of distributional impacts (technical, financial, and wellbeing related) for this project has been carried out using a

bespoke assessment tool, which assesses the project as having a positive, negative, or neutral effect on consumers in vulnerable situations. To help inform the assessment, this tool considers the categories of consumers identified in the Priority Services Register. This project has been assessed as having a neutral impact, meaning that it does not have any effect on customers in vulnerable situations. This is because it is a Transmission project.

Success Criteria

The project will be deemed as successful if all items in the scope, objectives and learnings are achieved.

Project Partners and External Funding

SSEN Transmission do not anticipate any project partners to deliver System Short Circuit test using NIA funding.

Potential for New Learning

This project will develop learning on the validity and accuracy associated with the calculation of system fault levels and will be a valuable contribution towards validating the outcome of the G74-2 review. Furthermore, the outcomes and learnings from the project can be used by other TO's to conduct further tests and as a basis for supporting future innovation activity in T3 related to system behaviour.

Scale of Project

The project time frame is 26 months and is designed to get maximum learning for minimal cost. Knowledge acquired over the course of the investigation will contribute to advancing industry understanding of our current and future network while providing validation of the new G74-2 guidance. Furthermore, the outcomes of the project will bring benefits to the grid-connected assets by testing and revealing optimisation opportunities in their protection systems.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

The project will take place in the Scottish Hydro Electric Transmission license area in Scotland.

Revenue Allowed for the RIIO Settlement

No allowance has been made for this type of development within the RIIO-T2 settlement. No savings are expected during project implementation; future savings may be possible depending on the outcomes of the project and the future adoption of the learnings.

Indicative Total NIA Project Expenditure

The total NIA Expenditure for the project is £250,000, 90% (£225,000) is allowable NIA expenditure. The project has been extended by 12 months as completion of the early deliverables has been slower than anticipated. This is due to additional technical input being required to complete the test documents than originally expected. Due to the risk factor involved with these tests, it is important to allow time for all relevant experts to review, modify and approve the additional technical test documents. As a result, a change request was submitted to extend the project duration to 26 months to allow completion. There is no change to the scope or budget.

Project Eligibility Assessment Part 1

Requirement 1

Facilitate the energy system transition and/or benefit consumers in vulnerable situations

Please answer **at least one** of the following:

How the Project has the potential to facilitate the energy system transition:

As the energy system transitions, older thermal plants based on large synchronous machines are being displaced by renewable schemes making increasing use of power electronics. The result of this change is that the fault behaviour of the system is evolving as, in general, power electronic sources do not contribute the same high fault current that can inherently be expected from synchronous machines. It is essential that a high level of confidence continues in the calculation methods used to assess the fault behaviour of the system. This will ensure protection systems are able to detect and clear all possible faults thus ensure a safe, reliable, and stable transmission system as it evolves, thus ensure a safe, reliable, and stable transmission system as it evolves which will contribute to facilitating the energy system transition. Consequently, this will bring benefits to the grid-connected assets in terms of reliability and robustness to fault conditions. The project proposed here would enable tests to be conducted that will produce results/data which could be used to validate these calculation methods and identify any improvements that are required.

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

Not applicable.

Please provide a calculation and/or description of the expected benefits of the solution

• Ensure that a high degree of confidence is maintained in the calculation of system fault levels across a range of system conditions incorporating new generation technologies and other sources of fault current. The outputs from these system tests will be a valuable contribution towards validating the outcome of the G74-2 review.

• Provide a library of system responses under controlled disturbance conditions to investigate new measures of system strength and validate RMS and EMT modelling.

Permission to conduct these tests is highly likely to be contingent on an extensive review of protection settings applied to schemes in the area surrounding the test. Such reviews are always helpful in identifying any hidden protection issues thus aiding future system reliability. This will bring benefits to the grid-connected assets in terms of safety and reliability, by optimising their protections systems.

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

The learnings are not limited to Scottish Hydro Electric Transmission, all transmission and distribution network operators across GB could benefit from this research work.

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

This research project is at low TRL level, consequently the costs for rolling out the method across GB network are not fully defined. If this project is proven, then there is the potential to use the outputs of the project for other TO's to conduct further tests. The costs would be dependent on the proven solution and on-site requirements.

Requirement 3 / 1

Involve Research, Development or Demonstration

Projects 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

Involve Research, Development or Demonstration - Please select all that apply

☐ 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 project will develop learning on the validity and accuracy associated with the calculation of system fault levels and will be a valuable contribution towards validating the outcome of the G74-2 review. Furthermore, the outcomes and learnings from the project can be used by other TO's to conduct further tests. The outcomes of this project will bring benefits to the grid-connected assets in terms of reliability and robustness by optimising their protection systems.

Not applicable.

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. Networks must explicitly mention similar projects that they have considered and how these differ.

Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

No project similar to the one being proposed here is currently being conducted, nor are there any currently being planned. This has been established through engagement with various parties including SPT, NGET, and ESO as well performing an initial literature review on the subject.

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

Not applicable.

Additional Governance And Document Upload

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

A test of this nature has not been carried out on the GB system for many decades as the performance of the network was considered well proven. Since then, the network landscape has changed considerably, meaning conducting this type of test now will be the first of its kind.

Relevant Foreground IPR

Any new intellectual property which are completed as part of the NIA project will be made available to other relevant network licensees. No background IPR is required.

Data Access Details

For information on how to request data gathered in the course of this project, see Strategic Innovation Fund (SIF) and Network Innovation Allowance (NIA) Data Sharing Procedure at https://www.ssen-transmission.co.uk/about-us/innovation/.

Additionally, data from this project and all other projects funded under the Network Innovation Allowance (NIA), Network Innovation Competition (NIC) or the Strategic Innovation Fund (SIF) can be found or requested in the ways listed below:

• Via the Smarter Networks Portal at: https://smarter.energynetworks.org. To contact select a project and click 'Contact Lead Network'. SSEN Transmission already publishes much of the data arising from our innovation projects here so you may wish to check this website before making an application.

• Via our Innovation website at: Innovation - SSEN Transmission (ssen-transmission.co.uk)

• Via our managed mailbox: transmissioninnovation@sse.com

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

NIA has been deemed the best method of supporting the delivery of this project. Development projects funded by NIA give suitable financial support to investigate areas for potential development that could not be funded by BAU as no allowance was made in the RIIOT2 settlement.

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 noted in the NIA guidance, certain projects are speculative in nature and yield uncertain commercial returns. This is the case with this project. The scope of this project involves the development of two separate short-circuit tests on the Transmission network. It will need to have an appropriate design such that it allows for the safe and controlled operation of short circuits, as well as have appropriate system monitoring to record the tests results. If the project is successful, the end product will be a set of data which will enable validation of our system models.

This project has been approved by a senior member of staff

☑ Yes