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

Dec 2024

Project Reference Number

NIA_SHET_0050

Project Registration

Project Title

AQUILA LITE

Project Reference Number

NIA_SHET_0050

Project Licensee(s)

Scottish and Southern Electricity Networks Transmission

Project Start

December 2024

Project Duration

1 year and 11 months

Nominated Project Contact(s)

Brant Wilson – Innovation Portfolio Manager

Project Budget

£625,074.00

Summary

HVDC interoperability is the capability of one manufacturer's HVDC System (controls and main circuit) to work seamlessly with HVDC Systems from other manufacturers. This removes the need for AC conversion to transfer power from one manufacturer to another and is an essential step towards HVDC grids, increasing options for greater supply chain efficiency and future system operation. Without interoperability and a single supplier providing large parts of the developing offshore network, future network operation could be disproportionately exposed to outage risks.

This project seeks to develop and understand how such systems could be implemented and commercially established ahead of future demonstration. A technical model development will be performed and the outlines of a commercial framework investigated.

Nominated Contact Email Address(es)

transmissioninnovation@sse.com

Problem Being Solved

AQUILA Lite project aims to prove multi-vendor multi-terminal (MVMT) interoperability in a lab environment. The current lack of multi-vendor interoperability solutions in the industry results in a dependency on a single vendor. This dependency can lead to several challenges, including limited competition, potential monopolistic practices, reduced innovation, and increased vulnerability to service disruptions and lead to a need for more converters and land requirements. The industry needs to develop an interoperable framework that allows seamless integration of services from multiple vendors, enhancing competition, reliability, and reducing the risks associated with single vendor systems.

Method(s)

The project AQUILA Lite seeks to develop and prove multi-vendor interoperability in a lab environment and develop the necessary supporting commercial framework. The National HVDC centre will prove interoperability, i.e modelling of vendor replicas and for commercial readiness, working with academia to review the current situation and how legal landscape will change with the introduction of interoperability with multiple vendors.

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 5 = LOW from the sum of the risk thresholds below:

TRL Steps – 2 TRL Step – Low (Score 1)
Cost – <£500,000 – Low (Score 1)
Number of suppliers – 1 – Low (Score 1)
Data – Assumptions known but will be defined within project – Medium (Score 2)

Scope

Aquila Lite will focus on the Multi-Vendor Interoperability and Commercial Readiness work packages (WP):

WP 1 - Multi-Vendor Multi-Terminal (MVMT) Interoperability Package development
Led by the HVDC Centre, working closely with major HVDC manufacturers to specify and prove interoperable, multi-vendor converter stations. This includes leading the development, patenting and testing of principles allowing network owners to specify multi terminal control functions and running real-time joint-simulations to prove their operation in a multi terminal environment.

This work package includes:
• Generic modelling
• Generic specification
• Control development
• Vendor and TSO engagement, review and critique of approach
• Demonstration and formalisation of interoperability methods to control and monitor performance

WP 2 - Commercial Readiness
This work package is developing the commercial framework for the deployment of multi-vendor interoperability and future connections.

This work package includes:
• Gap analysis
• Liabilities between different parties
• JV Interactions with other TOs connected to the system and legal implications

The implementation of this study of MVMT approach can reduce the need for convertor stations and constraints could be avoided should one of the connections fail, the power can be re-routed to another receiving station. For further information on financial benefits please see section 3.2.2.

Objective(s)

The objective of this project is to develop a fully interoperable, multi-vendor DC switching model to facilitate future demonstrations of connections to offshore HVDC links. This initiative aims to explore the potential for multiple HVDC connections, which could significantly reduce the number of required AC converter stations, thereby offering both economic and environmental benefits.

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. Additionally, success will be measured by demonstration of interoperable control architecture and the extent to which the project enhances the understanding and knowledge in specifying HVDC converter to de-risk control interactions.

Project Partners and External Funding

The project will be undertaken using NIA funding by Scottish Hydro Electric Transmission.

Potential for New Learning

AQUILA LITE aims to advance our understanding of multi-vendor modelling for DC-Hubs and commercial readiness in the early stages of energy distribution network development. Working with multiple vendors, we expect to gather diverse data and insights that will help us evaluate the performance and compatibility of different technologies and solutions. This approach will enable us to identify the most effective strategies for integrating various systems and components, thereby enhancing the overall efficiency and reliability of our network.

One of the key learnings of this project will be the development of a comprehensive multi-vendor modelling framework. This framework will allow us to simulate different scenarios and assess the potential impacts of various technologies on our network. Additionally, the project will include a commercial readiness study to evaluate the feasibility, and risks associated with deploying these technologies at scale.

The learnings from this project will be valuable for all network operators, industry stakeholders, academia. We plan to share the learnings through a series of internal and external dissemination activities. These will include:

• Internal Workshops and Training Sessions - To ensure that our team is fully equipped to implement the new tools and methodologies developed during the project, the primary users are HVDC engineering team in understanding how to issue technical specifications for future tender; the secondary users will be system performance team and system planning team in understanding how to assess HVDC system. Potential internal users extend to system planning team in understanding how to plan HVDC grid.

• Stakeholder Engagement Events - Regular updates and presentations to key stakeholders in monthly working group meeting and bilateral meetings for technical details, including regulatory bodies, industry partners.

• Industry Conferences and Seminars - Presentations and discussions at relevant industry events, such as the IET Conference on AC and DC Transmission Systems, IEEE Power and Energy Society General Meeting, CIGRE, Energy Networks Summit Conference, or equivalent, to share our experiences and insights with a broader audience.

• Academic Publications – Key findings will be published in preprint website, high quality academic journals, e.g. IET Transmission and Distribution, IEEE Transactions on Power Delivery, or equivalent.

• Leadership and monthly update to GB HVDC Interoperability working group, which include GE Vernova, Hitachi Energy, and MECLO, SPEN, ESO, NGET.

• Workshops with European transmission system operator, such as Tennet, and guest lecture/research seminar with academic institution, such as Imperial College London, Delft, Manchester University, or Strathclyde University.

By disseminating the knowledge gained from the AQUILA LITE project, we aim to contribute to the continuous improvement of energy networks and support the transition to a more resilient and sustainable energy system. This project will also provide valuable insights into managing liabilities and ensuring commercial readiness, which are critical for the successful deployment of new technologies.

Scale of Project

This project is designed to get maximum learning for minimal cost. The scale of this project expects to provide sufficient learning to further enable future Transmission project demonstrations. Any smaller scale project would limit the ability to fully assess the suitability

of the proposed solution.

The project timeline has been extended to October 2026 due to contractual negotiations with one of the vendors taking longer than anticipated. The added time taken to complete these negotiations has protected the consumer from potential additional costs.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL4 Bench Scale Research

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 £625,074, 90% (£562,566.6) is allowable NIA expenditure.

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:

Project AQUILA lite has the potential to develop a methodology to enable an interoperable Multi-Vendor DC-Hub demonstration, which will establish the foundations for DC-Grids in Great Britain. A vendor-agnostic, interoperable DC-Hub will reduce the need for onshore converter stations, thereby minimising costs and environmental impacts. Future DC hubs, including those planned offshore, will benefit from the risk mitigation provided by this technology. By integrating various renewable energy sources and enhancing grid stability, the project supports the transition to a more sustainable and resilient energy system.

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

Project AQUILA LITE aims to model interoperable Multi-Vendor DC-Hub, which will establish the foundations for DC-Grids in Great Britain. A multi vendor interoperable DC-Hub will reduce the need for onshore converter stations, thereby minimising costs and environmental impacts. By integrating various renewable energy sources and enhancing grid stability, the project supports the transition to a more sustainable and resilient energy system.

As this project is low TRL (Technology Readiness Level), a cost-benefit analysis is not required at this stage to meet NIA criteria. However, the implementation of the MVMT (Multi-Vendor Multi-Terminal) approach can significantly reduce the need for converter stations. Additionally, constraints can be avoided because if one of the connections fails, the power can be re-routed to another receiving station.

Description of Recipients of the Benefits:

Consumers: Lower energy costs due to more efficient energy distribution and reduced reliance on expensive fossil fuels.
Environment: Reduced environmental impact through minimised need for onshore converter stations and increased integration of renewable energy sources.

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

Not applicable.

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

Not applicable.

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

Project AQUILA LITE aims to model interoperable Multi-Vendor DC-Hub, which will establish the foundations for DC-Grids in Great Britain. The learning generated from this project can be applied in several ways:

Technical Standards and Specifications -

The project will develop and demonstrate interoperable and vendor-agnostic specifications for HVDC converters. These specifications can be adopted by network licensees to ensure compatibility and interoperability across different vendors and systems.

Enhanced Grid Stability and Reliability -

By implementing the MVMT (Multi-Vendor Multi-Terminal) approach, the project will provide insights into managing multiterminal control functions and re-routing power in case of connection failures. This knowledge can help network licensees enhance the stability and reliability of their grids.

Cost Reduction and Efficiency -

The project will demonstrate how to reduce the need for onshore converter stations, leading to cost savings and reduced environmental impact. Network licensees can apply these methods to optimise their infrastructure investments and operational costs.

Integration of Renewable Energy -

The project will provide valuable lessons on integrating various renewable energy sources into the grid. This can help network licensees improve their strategies for incorporating renewable energy, supporting the transition to a more sustainable energy system.

Scalability and Replicability -

The technical groundwork and methodologies developed in this project can be scaled and replicated across multiple sites in Great Britain. Network licensees can use this knowledge to plan and implement similar projects in their regions, addressing specific challenges and opportunities.

By maximising the learning generated from the AQUILA project, relevant network licensees can enhance their technical capabilities, improve grid reliability, reduce costs, and support the integration of renewable energy sources.

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.

SSEN Transmission is leading the way with this development. Currently, the only other organisation in the world with a similar system model is the study conducted by the EU named INTEROPERA. However, SSEN-T's version is more practical with more advanced models being demonstrated . The project expects to produce a method to generate vendor agnostic converter specification to de-risk HVDC control interactions and multi-vendor demonstration with real-time digital simulation. To achieve both, the HVDC centre is the only organization that has developed foreground enabling patents and real-time simulation platform of multi-terminal HVDC grid with vendors' IP fully encrypted.

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

The Aquila Lite project introduces a pioneering methodology that has not been previously tested. This innovative approach aims to address existing challenges in a more effective manner. The development of a novel model system capable of interacting with multiple vendors simultaneously involves inherent risks. This uncertainty necessitates a Research, Development, or Demonstration phase to validate its feasibility and effectiveness.

The project leverages cutting-edge technology to test the developed model, ensuring the system's functionality. This includes the use of innovative equipment and methodologies that could revolutionize the industry if proven successful. By tackling theoretical novel systems, the project embraces risks that might deter more conventional initiatives. This willingness to explore uncharted territories is a hallmark of innovation, aiming for breakthroughs that could lead to significant advancements.

If successful, the Aquila Lite project could pave the way for the widespread deployment of new technologies and methodologies. This potential for large-scale impact underscores its innovative nature.

Relevant Foreground IPR

We do not anticipate in generating foreground IP in this project and we plan to disseminate/publish new findings based on our background IP to all relevant network licensees and general public. Any background IPR generated by HVDC centre will remain property of SSEN-T.

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

The Network Licensee (SSEN-T) is not funding the Aquila Lite project as part of its business-as-usual activities because the project involves a pioneering methodology that has not been previously tested. This innovative approach carries inherent risks and uncertainties, necessitating a Research, Development, or Demonstration phase to validate its feasibility and effectiveness. The project aims to address existing challenges in a more effective manner, leveraging cutting-edge technology and novel systems that require thorough testing before they can be integrated into standard operations.

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

The Aquila Lite project can only be undertaken with the support of the Network Innovation Allowance (NIA) due to several key factors:

Specific Risks Associated with the Project:

1. Commercial Risks:

• **Unproven Market**: The pioneering methodology and novel systems have not been previously tested, making it uncertain whether there will be a commercial viability.

2. Technical Risks:

• **Innovation Challenges**: Developing and integrating cutting-edge technology involves significant technical challenges that require extensive research and development.
• **System Integration**: Ensuring the new model system can interact seamlessly with multiple vendors is complex and untested, posing a risk of technical failures.

3. Operational Risks:

• **Implementation Difficulties**: The innovative approach may face operational hurdles during implementation, requiring specialised skills and knowledge that are not part of the Network Licensee's usual operations.
• **Scalability Issues**: Scaling the project from a testing phase to a demonstration phase could encounter operational inefficiencies and unexpected obstacles.

Why NIA Support is Essential:

• **Risk Mitigation**: NIA funding helps mitigate the financial risks associated with the future demonstration project's high costs and uncertain returns.
• **Innovation Encouragement**: NIA support encourages the exploration of innovative solutions that might be too risky for conventional funding mechanisms.
• **Resource Allocation**: The NIA provides the necessary resources for thorough research, development, and demonstration phases, ensuring the project's feasibility and effectiveness are validated before demonstration.

By supporting the Aquila Lite project, the NIA enables the exploration of groundbreaking technologies and methodologies that have the potential to revolutionise the industry, despite the inherent risks and uncertainties.

This project has been approved by a senior member of staff

☑ Yes