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NIA Project Registration and PEA Document

Date of Submission

Aug 2023

Project Reference Number

NIA2_NGET0034

Project Registration

Project Title

VoltXpanse: Ultra high voltage onshore energy highway

Project Reference Number

NIA2_NGET0034

Project Licensee(s)

National Grid Electricity Transmission

Project Start

October 2023

Project Duration

3 years and 0 months

Nominated Project Contact(s)

Xiaolin Ding

Project Budget

£1,450,000.00

Summary

Electricity transmission networks are the backbone in meeting UK Government's energy transition targets. Ultra high voltage (UHV) transmission technologies such as 765kV AC and 800kV HVDC can play a critical role in increasing bulk power transfer capability in the GB transmission networks. This will also bring an added benefit owing to reduced transmission losses. However, due to the significant increased footprint of UHV technologies, there will be higher risks associated with consenting and increased impacts on local environment and communities. Furthermore, no technical solution is directly available for a section of a UHV circuit which needs to be undergrounded. This project aims to address the key challenges of deploying the UHV transmission technologies for the onshore GB transmission network by investigating economic, efficient, deliverable UHV transmission solutions for network reinforcement.

Third Party Collaborators

Ove Arup & Partners Ltd

The University of Manchester

The National HVDC Centre

Nominated Contact Email Address(es)

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Problem Being Solved

The UK's energy sector is undergoing a fast pace of transition towards net-zero. Electricity transmission networks are the backbone in this transition. Although the existing electricity transmission network has proven to be capable of meeting our energy needs today, without significant infrastructure upgrade it would fail to continue to meet our future needs, particularly facilitating the decarbonisation of our energy systems. Thus, massive reinforcements on the existing transmission network will be required to ensure the network has the

right capability to deliver the UK Government's net zero targets.

The power transfer capability of a transmission line is directly proportional to the square of the voltage. Therefore, UHV transmission technologies, such as 765kV AC and 800kV DC, can play a critical role in increasing bulk power transfer capability in the GB transmission network. Additionally, these ultra high voltage transmission technologies can also bring massive savings to consumers owing to transmission losses reduction. It is essential to ensure that network reinforcement solutions will be economically friendly, efficient, and deliverable, whilst with the consideration of minimising both environmental and community impacts and ensuring deliverability to bring benefits to consumers. Currently, there is no developed UHV transmission technologies applicable to the onshore GB transmission network. This is partly due to the fact that current UHV transmission circuits would likely have twice the footprint and height of the existing 400kV circuits, thus bringing significant consenting risk and impacts on local environment and communities. Furthermore, there may not be cable solutions that are currently available in the market. This means that there is a need to investigate innovative technical solutions and optimal routing solutions in order to address the challenges and mitigate potential consenting and environmental risks.

Method(s)

The project aims to identify strategic UHV solutions (up to 765kV AC and 800kV DC) for future GB network reinforcement requirements; the project will investigate the feasibility of an innovative compact tower design (maximum 50-55m high and wide) to minimise environmental and community impacts, carbon footprint and consenting risks as well as the overall cost; the project will also investigate solutions for cable sections for the UHV circuits and the possible alternative routing solutions required to ensure the deliverability of these ultra high voltage solutions. Furthermore, the project will also develop a delivery strategy for these UHV solutions by assessing operability, carbon footprints, supply chains, resource requirement, whole life cycle cost, environmental impacts and planning challenges, among others. This strategy will provide recommendations with regard to the economic and efficient ways to deliver UHV transmission solutions.

Scope

The scope of this project will include 4 work packages (WPs)

- Work package 1: Identify strategic solutions for onshore UHV transmission network reinforcement (up to 800kV HVDC and 765kV AC) to achieve required transmission capacity for future energy network. Investigate the impacts of UHV solutions on system stability, protection and control, etc.
- Work Package 2: Feasibility study of innovative compact tower design (50m-55m high) for the required UHV transmission circuits (up to 800kV DC and 765kV AC).
- Work package 3: Investigation of technology solutions for cable sections and alternative routing solutions to ensure the deliverability for UHV transmission circuits.
- Work package 4: Develop an optimal strategy for delivery and recommend an economic and efficient way to deliver the solutions.

Objective(s)

This project will address the challenge of required power flow transfer capability to facilitate net zero by developing ultra high voltage (UHV) AC or DC solutions applicable to the onshore GB transmission network. The objective of the project includes the following:

- Investigating the feasibility of an innovative compact tower design (maximum 50-55m high and wide) for UHV transmission solution (up to 800kV DC and 765kV AC) to minimise environmental, community impacts, as well as carbon footprint and overall cost;
- Investigating alternative technologies for cable sections and routing solutions required to enable the deliverability of the UHV circuits;
- Investigating impacts of those UHV solutions on transmission network operations such as system stability, control and protection, etc.;
- Developing a delivery strategy for UHV solutions that considers operability, carbon footprint, supply chains, resource requirements, whole life cycle costs as well as environmental and consenting challenges, etc.

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 an overall positive impact on consumers in vulnerable situations. The assessment has identified that this project will look to significantly increase transmission capability and reduce transmission losses which will reduce the costs for households.

Success Criteria

The delivery of the following items will be used to evaluate the success of this project:

- Identification of strategic options within the onshore GB transmission network for the application of ultra high voltage (UHV) transmission technologies to achieve the required transmission capacity, as well as developing a detailed understanding of the corresponding impacts on system stability, protection and control, among others;
- Clearly identify the feasibility of innovative compact tower design (50m-55m high) for the required UHV transmission circuits (up to 800kV DC and 765kV AC);
- Identify technology solutions for potential cable sections and recommend alternative routing solutions to ensure the deliverability for UHV transmission circuits;
- Recommend an optimal strategy to deliver the UHV solution in an economic, efficient and environmental friendly way.

Project Partners and External Funding

SPEN, SSEN and HVDC centre.

Potential for New Learning

The project will investigate the feasibility of developing innovative compact double-circuit tower design to minimise environmental and community impacts and consenting risks. The project will also address the challenges when a section of higher voltage circuits need to be grounded, and recommend possible alternative routing solutions required to enable the deliverability of the higher voltage transmission solutions. In addition, the project will investigate impacts of those UHV solutions on network operations such as system stability, control and protection, etc. Furthermore, the project will recommend a strategy to deliver the UHV solutions by assessing operability carbon footprint, supply chains, resource requirements, whole life cycle costs as well as environmental and consenting challenges, etc.

The key findings of the projects will be shared with other Transmission Owners and the System Operator via workshops, technical documentation and/or publications.

Scale of Project

This project aims to address the key challenges in applying UHV transmission technologies (specifically, 800kV HVDC and 765kV HVAC) to increase the network power transfer capability. All phases are strategically linked and designed to deliver the defined objectives. Therefore, the scale of the project is as specified, since there would be inadequate potential for new learning with a less ambitious and smaller project.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL5 Pilot Scale

Geographical Area

The project will be a mainly computer-based studies. The project will be carried out at the innovation provider’s facilities. The study will primarily focus on the transmission network, including key transmission boundary areas (ie. B6, B7, B8, B9 etc).

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

£1,305,000

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:

The electricity transmission network is at the forefront of the energy system's transition to net zero, it is the backbone for enabling the required scale of electrification of heat and transport systems, and connections of renewable generation. This means that the requirement of increasing power transfer capability of the transmission network is both significant and critical. Therefore, this project supports the energy transition by addressing the key challenges of applying UHV transmission technologies in the GB transmission network, which will provide solutions to significantly increase the power transfer capability required to accommodate bulk renewable connections, reducing network constraint costs, consenting risk, environmental and social impacts.

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

N/A

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

The project aims to investigate the feasibility of applying UHV transmission solutions in the onshore GB transmission network. As the transmission losses associated with UHV circuits are much lower than that of the existing 400kV circuits, the key benefit results from reduced power losses. The benefits are calculated based on reduced power losses of deploying UHV transmission solutions across B6, B7 and B8 for 20 years' period once the UHV solutions are in place. It is assumed that the costs of building new reinforcements are spread across 10 years. Based on our cost benefit analysis, the estimated benefit in a NPV value is significant and can reach around £1045m if the project is successful, and the UHV technology can be applied in future GB network.

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

The project outcomes are of generic nature and would be applicable to all electricity network Licensees across GB.

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

The project is to focus on the feasibility study of applying UHV transmission solutions in the onshore GB transmission network. The technical solutions for tower design, cable sections, and alternative routing solutions will affect the costs of rolling out the Method across GB, due to location-specific considerations. If the project is successful, the detailed tower design, cable solutions and alternative routing solutions will be further developed to roll out across GB. The estimated cost will be reviewed at the completion of the project.

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

The key findings of the projects will be shared with other Network Licenses (Transmission Owners and Operator) via workshops, technical documentation and/or publications. The key learnings and methods developed in the projects would be equally appliable to relevant network licensees.

N/A

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.

There is the project of NIA NGTO055 ‘Upgrading Transmission Network Capability for Renewable Connection’ which is relevant to this proposed innovation project. However, NIA NGTO055 mainly focused on retrofit solutions to upgrade the existing transmission circuits to slightly higher voltage level (below 550kV) or utilising innovative six-phase technology to rearrange the existing network to increase transfer capacity of the existing circuits. There is no overlapping between the proposed project and the NIA project NGTO055. There is seen to be no duplication or overlapping with any previous projects.

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

The project is innovative because it develops UHV transmission solutions applicable to the onshore GB transmission network, which currently do not exist. This project includes an innovative compact tower design for the UHV circuits aiming to reduce the underlying environmental impacts and consenting risk. This project also investigates the solution for UHV cable sections and alternative routing

solutions to overcome the challenges arising from the need of placing sections of an “U”HV voltage transmission circuit underground.

Relevant Foreground IPR

The expected Foreground IPR from this project will include the innovative design of the compact tower for UHV transmission circuits, recommended alternative technology solutions for cable sections, and the delivery strategy. The Foreground IPR also includes technical reports developed for the projects and any publications associated. The findings will be recorded in written technical reports along with recommendations for further steps to be taken to bring the knowledge into Business as Usual activities.

Data Access Details

Data for this project and all other projects funded under the Network Innovation Allowance (NIA), Network Innovation Competition (NIC) or the new Strategic Innovation Fund (SIF) can be found or requested in a number of ways:

· A request for information via the Smarter Networks Portal at https://smarter.energynetworks.org, to contact select a project and click ‘Contact Lead Network’. National Grid 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 https://www.nationalgrid.com/uk/electricity-transmission/innovation

· Via our managed mailbox box.NG.ETInnovation@nationalgrid.com

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

There is no commercial available technical solutions for deploying the UHV transmission reinforcement solution in the GB network. The development of the project contains high technical and commercial risk in compact town design, maturity of ultra high voltage cables, and suitability of alternative routing solutions. Therefore, the Network Licensee is not funding the project as its BAU activities.

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 project contains high technical and commercial risk in compact town design, maturity of ultra high voltage cables, and suitability of alternative routing solutions. Therefore, it can only be undertaken with the support of NIA.

This project has been approved by a senior member of staff

☑ Yes