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

Mar 2024

Project Reference Number

NIA2_NGET0058

Project Registration

Project Title

HVDC Assets Life Cycle Assessment (HVDC - LCA)

Project Reference Number

NIA2_NGET0058

Project Licensee(s)

National Grid Electricity Transmission

Project Start

April 2024

Project Duration

0 years and 4 months

Nominated Project Contact(s)

Muhammad Shaban

Project Budget

£43,179.00

Summary

High Voltage Direct Current (HVDC) transmission systems are generally considered to have lower emissions compared to traditional AC transmission systems. This is because HVDC systems have lower losses and can transmit power over longer distances with less energy loss. However, HVDC systems do require additional equipment such as converters and transformers, which may produce some emissions during their manufacturing and operation. Accurately quantifying and understanding the carbon footprint of HVDC is important from a project consenting perspective to ensure that the transition to net zero through the increased use of interconnector systems does not result in environmental harm. This project will focus on the asset life cycle assessment of HVDC and intends to identify opportunities to focus on and better understanding of the efforts needed to reduce emissions.

Nominated Contact Email Address(es)

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Problem Being Solved

Recent interest in the HVDC has been primarily motivated by the growth of interconnectors for both offshore and onshore transmission. National Grid Electricity Transmission (NGET) does not have detailed understanding of the carbon footprints of the HVDC activities and projects. NGET currently uses an internal carbon interface tool (CIT) for carbon calculations and currently the NGET and cross transmission operators (TO) carbon database has no carbon values for HVDC assets or marine work. Convertor station buildings used in HVDC are specialised with temperature and humidity control. Current assumptions about GIS halls in NGET process do not fit. National Grid Ventures (NGV) have similar problem and are looking to create better data for the same project type. NGV estimates have been based on large assumptions and do not provide a good level of granularity. Immature supply chain, less detail provided by suppliers, and relying on current CIT tool resulted in limited sustainability returns from Eastern Green Link (EGL)1/2 projects. To reduce the carbon impact of HVDC, we need to understand it first as if we have a good granularity of the schemes carbon footprint, we can focus decarbonisation efforts where the most gains can be made. We need a strong baseline to be able to understand materiality of any submissions for further funds from suppliers because of large pipeline of future HVDC and marine projects in development.

Method(s)

This study is broken down into the following two phases:

Phase 1:
This work stream will involve discussions with National Grid staff to understand the typical design of current HVDC systems (e.g., Western Link and/or the under development Eastern Green Links). The results will be used to determine the environmental impact, in terms of CO2e emissions, associated with a typical HVDC asset in the UK, consisting of 2 HVDC converter stations connected by a cable (part of which will be subsea cable). DNV will undertake an LCA of one representative HVDC asset, covering the construction of the asset (including raw materials, construction activities and transport) and the typical annual emissions during the operation stage of the asset (including maintenance), calculating the carbon dioxide equivalent (CO2e) emissions at each stage in a life cycle inventory. The LCA will include decommissioning of the sites.

In addition to the material provided by NG, DNV will utilize the various ESG (environmental, social and governance) reports provided by OEMs (original equipment manufacturers), either for one specific project or for the whole company to establish the emission baseline of the sample project. DNV will then report the results in terms of CO2e and will add the data outputs from the LCA to the asset carbon data spreadsheet (the template for which is to be provided by National Grid). National Grid will provide the details about a typical, 'average' HVDC asset, which will be used as a representative case for the actual assets being built. To undertake this LCA, DNV will prepare a data request list for National Grid to provide information to support the LCA. Once the data has been received and reviewed, it is proposed that a 1-hour workshop is held between DNV and National Grid to go through the data, highlighting any gaps and to agree any assumptions required.

Phase 2:
This phase will undertake a more focused analysis on this database specifically targeted at assessing the relevance of this extant body of work to HVDC and include life cycle stage analysis to inform consenting methodology. It will also include a discussion on the nature of the typical installation conditions. Following the completion of the LCA, potential options to improve sustainability and reduce carbon emissions associated with HVDC assets will be identified. The LCA results will be used to determine where the greatest scope for carbon emissions is, and DNV will look at how the emissions can be reduced. This process will be based on DNV's knowledge and experience with HVDC assets and research into potential options to improve sustainability. DNV's HVDC and LCA experts will then assess the options identified to select the most suitable ones to take further. Where possible, potential carbon emissions savings from the identified options will be calculated using the same methodology as used in the LCA. Sustainability improvement options will be identified and included within a register summarising detail of the options and the potential benefits if they could be implemented. The number of sustainability improvements in the register will depend on various factors, including the outcome of the LCA, how many potential options are identified and the scale of any potential benefits, with DNV including as many suitable options as the budget allows. DNV will advise NG if more options are identified than can be covered by the initial budget so that a suitable course of action can be agreed.

Scope

This is a research project to understand the carbon footprint of HVDC and seek to find new opportunities for decarbonisation of these projects. Over the 3-month project with DNV, we will perform asset life cycle assessment study of NGET's HVDC work and the associated assets to determine the environmental impact regarding the carbon emissions. This study will be limited to normal cross-country HVDC interconnectors excluding the HVDC interconnectors connecting the offshore wind farms. Such limitation would essentially mean the scope would include two onshore HVDC converter stations, the HVDC cable systems (part of which being submarine cables), but not the offshore platforms which host the offshore HVDC converters.

The scope of the LCA will be aligned with National Grid's requirements, DNV have in-house experience and expertise relating to HVDC assets and the LCA process will involve discussions between the LCA team and those with knowledge of HVDC assets. This will allow the LCA team to discuss specifics relating to the HVDC assets and to determine whether the LCA includes all the relevant components. While data and input for the LCA will be provided by National Grid, this in-house DNV assistance will allow an extra layer of checks to ensure that the LCA covers all necessary parts of the asset and considers its operational phase fully, including any likely replacements and repairs that may be needed during use.

Key findings across all deliverables will be presented in a workshop with NGET staff. A discussion on implications for consenting of the projects, opportunities to focus on will be presented and motivated by the results of the study.

Objective(s)

This project will help us in addressing the optimal whole life cycle criteria with the following objectives:

- Understanding the asset population health/ criticality definitions and diagnosis.

- Understanding of specific assets degradation and risk characteristics
- Life cycle assessment of one representative HVDC asset
- Development of sustainability improvements register to find new decarbonisation opportunities
- Ensure as a business we are adequately addressing environmental impacts of our proposed HVDC projects whilst enabling the transition to Net Zero.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

Financial distributional impact:

This project ensures that NGET and the UK energy industry are at the forefront of global developments in asset management of transmission system research, enabling the industry to make decisions that could reduce the carbon emissions and thus reduce OPEX expenditure and are supported by comprehensive research and experiments. The scale of offshore development planned is unprecedented and there is concern that the understanding around the carbon footprint of HVDC is not mature enough for future decisions. With access to the latest research development on HVDC data related to carbon footprint, NGET will be able to manage the assets more efficiently and effectively which could deliver savings. Furthermore, the leveraged funding mechanism ensures that expensive research can be carried out at subsidised rates, thereby ensuring the best value for consumers' money. The project will not restrict benefits delivered to vulnerable consumers based on any vulnerability class.

Technical and wellbeing impact:

There is uncertainty in the carbon database due to no carbon values present for HVDC or marine assets. Large pipeline of future HVDC and marine projects in development including new technology such as offshore platforms and without the relevant solid data, we are unable to focus in relevant areas to address the carbon footprint. There is obvious environmental benefits only if we are able to understand our carbon hotspots and potential workstreams to decarbonise these. The outcomes from this research will inform and enable the energy industry to take appropriate measures in the best interest of consumers, particularly in the vulnerable category, as the world transitions to a Net Zero future.

Success Criteria

This project will be successful if project provides the insights to the following.

- A better methodology for calculating emissions related to the construction of onsite buildings.
- An updated carbon tools for our supply chain to use that include the detail on HVDC assets and marine work.
- Successful implementation of updated tools/methodology to existing projects and potential inclusion in HVDC framework.
- Delivery of the Asset Life Cycle Assessment (LCA) report.
- Delivery of the sustainability improvements register finding new decarbonisation opportunities
- Short and longer-term recommendations for how to improve and standardise research in this field to allow greater sharing of data and evidence.
- Recommendations for future research in this field.

Our overall objective is to develop an understanding of the impact of HVDC work/assets and then issue group wide/TO wide guidance on HVDC impacts with the data backed up by this study.

Project Partners and External Funding

The following project partners will be supporting the project:

DNV will provide experience and expertise relating to HVDC assets and the LCA process.
NGET is providing all the funding for the project and is the lead project partner. SPEN and SSEN intend to endorse and provide support to the Project with no financial contribution.

Potential for New Learning

Without including additional HVDC carbon footprint assessments within our planning applications, statutory stakeholders are likely to submit objections which can lead to delays in gaining consent. Delays in consent can impact our ability to meet connection dates, have reputational impacts, incur additional costs in late submission of data and could led to additional mitigation being requested which again would introduce additional costs. Any delays or additional mitigation could add significant costs to a project. There is very limited amount of work being done in this area and especially the existing one focus on theoretical research. This work will provide the basis of our understanding of the capabilities of HVDC technology and its associated impact. The work will be valuable resource for National Grid and have immediate application in Sea Link project.

The sustainability opportunities register will be used to seek our new ideas and areas of focus; these will help shape conversations with future suppliers.

Scale of Project

This project will be delivered via desktop only with no site visits required. Any workshops or meetings will be via Microsoft Teams and these meetings are dependent on the availability of DNV and NG staff. As such there is no scope to reduce the scale of the project any further.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL6 Large Scale

Geographical Area

Desktop studies will be performed remotely by DNV at various geographical locations.

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

£ 38,861.10

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:

The project facilitates energy system transition by helping NGET to understand the environmental impact, in terms of CO2e emissions, associated with a typical HVDC asset in the UK. Project will develop the tool and our understanding of the carbon impact of this new type of work. Project will seek out carbon hotspots and identify several clear opportunities for future focus to assist in commitments to reduce scope 3 emissions. We will be able to promote a consistent approach by sharing the data with other TOs (SPEN, SSEN) benefitting the customers with concise carbon calculations and clear reporting on emissions.

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

Developing an understanding regarding carbon footprint is important to reduce the negative impact of carbon dioxide emissions arising from HVDC. Reduction in emissions, material volume, and asset health maintenance has huge societal benefit.

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)

N/A

Please provide a calculation of the expected benefits the Solution

CBA not required as TRL3 research project.

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

Due to HVDC connecting interconnectors to the transmission system, this work will impact all TOs using subsea cable for HVDC transmission. All TOs (NGET, SPEN and SSEN) support this piece of study and are keen to learn the findings. Main outcome of the project will be used for Sea Link project and for other current and future offshore link projects.

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

N/A

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

The learning will be used in the planning and designing of existing and new HVDC projects influencing the delivery of the 5 offshore link projects to reduce the carbon emissions. It is the learning that is directly applied to other networks with similar assets hence other TOs like SPEN and SSEN JV partners are supporting the study. The disseminated results will be shared with all licensees so that the reasons for the conclusions are well understood. It will be the responsibility of others to determine to what extent it applies to other equipment types and different voltages but the underlying work from this project is likely to help.

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

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.

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

There is no overlapping between this work focusing on the HVDC and any other study. There are no other projects in development looking at HVDC carbon footprint or its life cycle assessment. The risk of duplication will be addressed through dissemination of progress with other licensees and being open to co-operate with licensees working in this space.

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

There are currently no NIA/SIF projects looking at the carbon footprint of HVDC projects within the UK. There is significant knowledge gaps around the impact of HVDC due to no carbon values available for HVDC assets or marine work. We need to develop understanding of the whole life cycle assessment of HVDC assets to account for all related emissions. As a responsible business, NG need to cover the knowledge gap to address the issue and manage the expectation to meet the commitments of reducing the scope 3 emissions. The study will help us in addressing the recommendations provided by consenting process and other stakeholders. There

is no overlap between this work focusing on the carbon footprint of HVDC and the work currently under way in different trials and studies. We're also considering opportunities within this project which might require further innovation take advantage of and utilise within BAU.

Relevant Foreground IPR

The technology is a low TRL level and there is currently little information available without carrying out a proper feasibility study. The work has not been undertaken elsewhere before and the results could have significant impact on business planning. The results will benefit other energy networks making NIA the most appropriate route.

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 apart of it's business and usual activities

The nature of a research programme means it inherently carries a risk that the research may be unsuccessful and/or identify unforeseen barriers to implementation and National Grid is unable to consider research of this scale as business-as-usual. The NIA funding offers the most appropriate route for NGET to design experiments, review existing techniques, and perform well designed experiments on certain species. As relatively little is known about the technology and its low TRL level, this justifies the use of NIA.

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 technology is a low TRL level and there is currently little information available without carrying out a proper feasibility study. The work has not been undertaken elsewhere before and the results could have significant impact on business planning. The results will benefit other energy networks making NIA the most appropriate route.

This project has been approved by a senior member of staff

☑ Yes