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

May 2025

Project Reference Number

NGED_NIA_081

Project Registration

Project Title

Step Up - Sub-Transmission Enhanced Performance: Uprating Power to 220kV

Project Reference Number

NGED_NIA_081

Project Licensee(s)

National Grid Electricity Distribution

Project Start

June 2025

Project Duration

0 years and 11 months

Nominated Project Contact(s)

Sarah Thorpe

Project Budget

£257,173.00

Summary

This investigation assesses the viability of operating electricity distribution networks at 220kV.

220kV would establish greater electricity distribution capacity and optimises assets and practices which could move the energy transition forward and reduce the generation connection queue faster than restricting distribution voltage to 132kV. Thinking of electricity networks in road network terms, 220kV voltage is akin to opening 'superhighways' allowing greater traffic flow and faster connections.

Some distribution assets which have the capacity to operate at 220kV are already installed within NGED's 132kV network. Other countries including China, Poland, Spain, Brazil and South Africa utilise 220kV, so procurement options to explore already exist.

Third Party Collaborators

Jacobs

Problem Being Solved

This discovery project will examine whether the use of 220 kV distribution circuits could enable faster generation connections and cost-effective reinforcements compared to conventional operation and reinforcement at 132 kV. Some existing 132 kV routes were installed using towers that are capable of use at 275 kV. These circuits may be better utilised if operated at 220kV.

This project is the discovery phase, with the primary aim of establishing whether it is worthwhile to proceed with further investigations and trials. Electricity distribution at 220 kV would require updates to the Electricity Act. The method below describes how the project is structured to test assumptions and provide guidance for decision making.

Method(s)

This discovery phase project will perform an initial investigation into the viability of 220kV alongside a case study of its use in a location which has existing towers potentially capable of operating at a higher voltage than the existing 132kV. The project will be delivered in the following workstreams:

1. Physical considerations - Examination of the physical requirements and possible solutions to enable operation at 220kV.

2. Regulation and Legislation - Examination of barriers and changes required to licenses and legislation

3. Design, planning and process impact - Review of DNO processes and standards that would be impacted via the introduction of a new system voltage

4. Supply Chain considerations - Assessment of the supply chains' capability to provide 220kV equipment to UK DNOs

5. Business Case - Initial derivation of the 220kV solutions' cost benefit analysis (CBA).

Proposed project deliverables are as follows:

Deliverable 1 ASSESSMENT OF CIRCUIT CONSIDERATIONS AND APPLICATION NUMBERS

To gain understanding of the routes within the NGED license areas that the 220kV solution could be applied to.

The deliverable will be in three parts:

A. Route knowledge:

To review the number, composition and features of the existing and potentially relevant routes in the NGED license area, so that the solution applicability can be determined and an understanding of the requirements for uprating to 220kV obtained.

The first section of the report will detail the salient features of the applicable routes, such as:

Overhead Circuits

- The tower types used and the numbers of each,
- Circuit composition in terms of the numbers of terminal, suspension and angle towers of each tower type.
- Consideration of mid-circuit cable sections.
- The circuits carried on the route and considerations of the associated circuit ends.
- Infrastructure/river crossings and any spans where clearances may require special treatment.
- 132kV customer considerations.

· Consideration of the application of condition assessment data

· Consideration of potential access or land ownership issues.

· Consideration of the existing or anticipated thermal or voltage constraints on the routes between now and 2050 and how operating at 220kV may affect the distribution network.

Underground Circuits

· Cable types available and considerations for underground circuit refurbishment from 132kV to 220kV.

· Requirements for new 220kV underground cable routes.

· Consideration of mid-circuit overhead sections.

· Consideration of the associated circuit joints & cable terminations.

· Infrastructure/river crossings and any spans where 220kV cabling may require special treatment.

· 132kV customer considerations.

· Consideration of the application of condition assessment data

· Consideration of potential access or land ownership issues.

· Consideration of the existing or anticipated thermal or voltage constraints on the routes between now and 2050 and how operating at 220kV may affect the distribution network.

B. Technical requirements for 220kV uprating

The second part of the report will present proof of concept designs for options to accommodate 220kV on the identified

routes.

· An indicative design option for converting each of the 275kV capable tower type families to 220kV operation, with an estimate of costs for conversion and the capacity delivered.

· Identification of any engineering challenges associated with terminal/suspension/angle towers or any route features as identified in Part A.

· If identified as applicable, presentation of design options for converting 132kV capable tower type families and associated cabling requirements to 220kV operation, with an estimate of costs for conversion and the capacity delivered. This would include a literature review to identify available solutions, including innovative solutions such as insulated cross-arms, as well as conventional solutions such as the modification/rebuild of towers.

· Identification of any engineering challenges associated with terminal/suspension/angle towers and cables as identified in Part A.

· If identified as applicable, presentation of options for uprating of mid-circuit cables, including modifications to the cable sealing end compounds, with an estimate of costs for conversion and the capacity delivered.

· Initial estimates of the costs to implement the design solutions.

C. XW Route 220kV uprating research study

Evaluation of global standards implemented for 220kV in other regions with a selection of the preferred standards

· complying to the UK weather and European codes. Following this, the project will:

· Summarize the list of modifications required on 132kV XW OHL for uprating 220kV.

· Summarize the modifications required on Insulator sets, earth wire, tower cross arms and earth wire shielding angles.

· Undertake CAD modelling considering the above changes.

· Check for the clearance infringements with reference to new 220kV guidelines.

· Highlight the clearance infringements and other constraints for existing line using existing conductor.

· Check for the clearance infringements with reference to new proposed conductors and summarize the issues in an OHL report.

· High level assessment on tower modifications and provide recommendations for next stage of detail design.

· High level assessment on foundations and provide recommendations for next stage of detail design.

Deliverables:

· OHL Report, with clearance infringement and recommend.

· Profile Drawings only for spans with clearance issues.

DELIVERABLE 2 ASSESSMENT OF SUBSTATION CONSIDERATIONS AND APPLICATION SPECIFICS

To gain understanding of the requirements to, and viability of, 220kV interface implementation in substations.

This would include two parts:

A. Network interface requirements:

To identify the topology and equipment types required at substations to interface to 220kV circuits.

The first part of the report will present proof of concept connection designs via single line diagrams and representative layouts for connection to 220kV single and double OHL and underground cable circuits. This will include details of the proposed:

· Switchgear types, ratings and configurations,

· Transformer physical size and ratings.

- Cross-site cabling/GIB option requirements.
- Interface equipment to the existing infrastructure
- Initial estimates of the costs to implement the design solutions.

B. Viability assessment of the sites identified in deliverable 1 to accommodate 220kV interface.

The second part of the report will review the substation sites identified in Deliverable 1 to understand which and how many of the sites are suitable to be extended, either within the existing land ownership boundary or onto surrounding land.

DELIVERABLE 3 ROADMAP OF REQUIREMENTS FOR REGULATORY AND LEGISLATIVE CHANGE

Identification of the non-technical documents requiring adjustment to accommodate 220kV use for distribution, and outline of the process, timescales and costs for modification. This will include relevant legislation, network licenses, regulatory documents, safety, training and other workforce considerations e.g.:

- The Electricity Supply Regulations (1988)
- The Electricity Act (1989)
- Ofgem license conditions

DELIVERABLE 4 ROADMAP OF REQUIREMENTS FOR TECHNICAL DOCUMENTATION CHANGES

Identification of the technical documents requiring adjustment to accommodate 220kV use for distribution, and outline of the process, timescales and costs for modification. This would include network design and planning documents, operational procedures, equipment specifications etc.

Example documents include:

- ENA Engineering Recommendation P2, particularly where 220kV operation may cross a class of supply boundary and

necessitate increased network redundancy requirements.

- The Electricity Safety, Quality and Continuity Regulations (2002)
- The Distribution and Grid codes
- NGED Operational procedures
- NGED Network planning standards
- NGED Equipment specifications
- ENA Engineering Recommendations P18, P28, P29 etc.

DELIVERABLE 5 INVESTIGATION INTO THE 220KV SUPPLY CHAIN

Identification of 220kV equipment manufacturers (e.g., transformers, switchgear, OHL conductors and insulators, cables, joints etc) and

assessment of any barriers preventing supply to the UK.

This will include consideration of the cost and timescales for adapting the supply chain to delivery 220kV projects (e.g.

training requirements) against the improvement in capacity delivery.

DELIVERABLE 6 DETERMINATION OF THE SOLUTION COSTS AND BENEFITS VIA THREE CASE STUDIES.

Examination of three representative 220kV projects, to determine implementation requirements (including costs and

timescales) such that a comparison against other solutions providing the same capacity can be made.

The 3 case studies will be selected to explore the sensitivities of the solution, to understand the factors affecting its

effectiveness.

Each of the case studies will include, for both the 220kV solution and a counterfactual conventional solution providing the

same capacity increase:

- a description of the project solutions and the work required to implement each, highlighting the physical and logistical pros and

cons of each (e.g., land requirements).

· Cost of solution,

o For the 220kV solution this would include a proportion of the costs identified in workstreams 2, 3 and 4.

· Timescales for delivery of each solution, highlighting any benefits associated with faster delivery,

· Network studies to confirm that both solutions provide the similar capacity benefits and identification of any adjacent constraints that are introduced or removed.

Deliverable will include assessment of the number of applications in the UK to determine whether the level of effort identified

in workstreams 2, 3 and 4 is justifiable.

FINAL REPORT.

A final report will consolidate the project deliverables into a document which may inform and support investment decisions by providing recommendations for next steps.

Scope

This is a discovery project, performing an initial review of the costs and benefits of the solution, and determining whether follow-on work is warranted. The scale is therefore limited to desktop research and development, with the outputs being recommendations for next steps, including a template for how to implement a trial project if justified.

The CBAs will assess if there is a positive cost benefit in comparison to 132 kV solutions. The key benefit cases that will be considered are:

Enhancing value of reconductoring schemes by stepping up voltage at the same time
Removing the need to build new 132 kV circuits
Strategic value of building new high-capacity networks
Consideration of environmental benefits
Reducing number of existing circuits requiring future reinforcement via efficient capacity uplift to 220kV.

The benefits case for 220 kV uprating must pass a tough business test to be “worth it”. The adoption of 220 kV distribution challenges the definitions of distribution and transmission systems in the Electricity Act 1989, from which all other regulatory instruments such as the Distribution Code derive meaning. Changing this definition requires an amendment to the act via a King’s Speech and consensus for doing so amongst electricity networks.

Consequently, the value proposition of 220 kV distribution cannot be simply be a greater positive return than existing permissible reinforcement options, but of value such that NGED’s senior leadership and Regulation function are willing to accept the scale of work necessary to enable it. The value will need to be tested and accepted by other networks in the ENA and also with Ofgem for their support. Confidence levels in the value will therefore also need to be high.

Key activities to determine if there is a benefits case will include:

Review of the factors affecting the implementation of 220kV.
This will include consideration of circuit types and routes of varying designs, including those overhead circuits with mid circuit cable sections.
Review of the factors affecting the implementation of 220kV in substations, and examination of the circuit ends of the identified routes.

Identification of the non-technical documents requiring adjustment to accommodate 220kV use, and outline of the process, timescales

and costs for modification. This would include legislation, network licenses, regulatory documents, environmental, safety, training and other workforce considerations.
Identification of the technical documents requiring adjustment to accommodate 220kV use, and outline of the process, timescales and costs for modification. This would include network design and planning documents, operational procedures, equipment specifications etc.
Identification of 220kV equipment manufacturers (e.g., transformers, switchgear, cables, OHL conductors and insulators etc) and assessment of any barriers preventing supply to the UK.
Examination of three representative 220kV projects, to determine implementation requirements (including costs and timescales) such that a comparison against other solutions providing the same capacity can be made. Deliverable to include assessment of the number of applications in the UK to determine whether the level of effort identified in workstreams 2 and 3 is justifiable.

Objective(s)

The objective of the discovery phase of the project is to robustly answer the question: “Will an additional 220 kV voltage solution offer system benefits over conventional reinforcement solutions for Distribution Network Operation?”.

Therefore, the project will assess:

The scale of the use cases where 220 kV is technically and commercially feasible
The estimated capacity benefits of the solution in the various applications;
The impact on existing constraints on the network;
Implementation requirements on design and network planning standards, including environmental considerations;
Supply chain capability for implementation;
Safety, training and workforce considerations.
Costs of implementing both the uprated circuit and supporting infrastructure at the terminal substations.

Using this research, the project will determine if there is value in completing further investigations surrounding the 220 kV solution.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

Vulnerable customers will not be directly impacted by the solution. However, a systemic increase to the capacity of the distribution network will proportionally benefit all customers, including vulnerable customers, by ensuring the transition to Net Zero is less disruptive and that the distribution network is not a bottleneck to decarbonisation.

Success Criteria

A successful project will provide clear direction as to whether operating at 220kV is viable for adoption by NGED, or if NGED should cease investment in the development of utilising 220kV.

Project Partners and External Funding

Jacobs will lead on the technical delivery of all project deliverables.

NGED will lead on data provision of its own electricity network and providing NGED related subject matter expertise from key personnel.

The project will be fully funded by the Network Innovation Allowance, minus the mandatory contribution from NGED.

NGED will be providing a contribution to the project of £25,717.34

Potential for New Learning

The project will generate the following learning that can be used by network licensees:

Network design principles for introducing 220 kV circuits into the EHV distribution network
The principal design and specification of the solution for upgrading 132 kV distribution circuits to 220 kV
A metric for assessing the benefit of upgrading a 132 kV circuit to 220 kV in £/MW
An assessment of the accessibility and scale of the supply chain for 220 kV distribution
A roadmap for enabling 220 kV distribution within the distribution network regulatory framework

Learning will be disseminated through NGED’s proven mechanisms. This may include (but is not limited to):

- Reports
- Workshops
- Stands at NGED and other organiser events
- Website updates
- Publications at national and international conferences

Scale of Project

This is a discovery project, performing an initial review of the costs and benefits of the solution, and determining whether follow-on work is warranted. The scale is therefore limited to desktop research and development, with the outputs being recommendations for next steps, including a template for how to implement a trial project if justified.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

The desktop review will initially focus on existing and proposed 132 kV circuit routes within the NGED license areas where assets are capable of being energised at 220 kV.

Revenue Allowed for the RIIO Settlement

257173

Indicative Total NIA Project Expenditure

£231456

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 solution has the potential to facilitate the energy system transition by enabling cheaper and faster connection timescales, by removing thermal constraints from the network on existing circuits. Hence large capacity customers whose connection would benefit from the removal of network constraints in the wider system will benefit via a quicker and/or cheaper connection.

Non-financial benefits of the solution are the potential to remove the need for new build linear infrastructure, thereby reducing construction disruption and the visual impact.

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 (RIIO-1 projects only)

N/A

Please provide a calculation of the expected benefits the Solution

n/a – STEP UP is a research project

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

The discovery phase will estimate the cost and benefit of a variety of cases, the replicability across GB will be determined by the number of these use cases which apply to the other networks, as well as the proportionality of these networks built with the same specification towers. Without detailed network information this cannot be estimated remotely.

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

The discovery phase will quantify the scale of the benefits unlocked by the 220 kV solution in terms of the increased circuit capacity per £ spent on the infrastructure, via production of representative use cases.

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

N/A

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.

The methodology for this project has been reviewed against other projects registered on the Smarter Networks Portal and circulated with other DNOs and TNOs ahead of registration to ensure no unnecessary duplications will occur.

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 will explore the use of a novel system voltage for UK public networks: 220 kV, and the impact of deviating from the established standards to increase circuit capacity. 220 kV is used in other parts of the world, so the innovative element is in exploring whether the potential benefits of increasing circuit capacity outweigh the need for modifications to existing design, planning and implementation processes.

It is assumed that circuits suitable for 220 kV uprating may also include some towers which are specified to 132 kV only and remedial measures will be required. This project will consider innovative techniques for achieving the most cost-effective solution, such as the

use of insulated cross-arms, building upon prior innovation projects such as the Retro-Insulated Cross Arms (RICA) NIA project carried out by National Grid Electricity Transmission.

Relevant Foreground IPR

Foreground IP produced by the project will be the six report deliverables:

D1. Assessment of circuit considerations and application numbers
D2. Assessment of substation considerations and application specifics
D3. Roadmap of requirements for regulatory and legislative change
D4. Roadmap of requirements for technical documentation changes
D5. Investigation into the 220kV supply chain
D6. Determination of the solution costs and benefits via three case studies.

Data Access Details

All project findings will be published on the Smarter Network Portal, and on National Grid's website.

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

220 kV distribution currently has no regulatory standing for use in the distribution network and is low TRL in terms of adequate ENA standards and practices for its use. As such it cannot be funded as part of business as usual without first undertaking discovery research to estimate the costs and benefits of the solution. Due to the significant business case challenge to justify the introduction of new standards and change definitions in the Electricity Act, this expenditure is too high risk for revenue 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

Regulated innovation funding is appropriate for a project for which the outcome is unclear and for which the benefits must be carefully assessed throughout the project. The Network Innovation Allowance provides NGED with the mechanism to assess the value of 220 kV distribution in an appropriately risk managed way.

This project has been approved by a senior member of staff

☑ Yes