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

Jun 2025

Project Reference Number

NIA2_NGET0093

Project Registration

Project Title

Tone Down

Project Reference Number

NIA2_NGET0093

Project Licensee(s)

National Grid Electricity Transmission

Project Start

July 2025

Project Duration

2 years and 1 month

Nominated Project Contact(s)

Neha Moturi

Project Budget

£385,000.00

Summary

The overall aim of this project is to develop an acoustic metamaterial treatment that can be retrofitted to existing power transformer enclosures to enhance the enclosure's tonal noise reduction with consideration for the human perception of sound quality. The treatment should be made from sustainable materials and its acoustic performance should be robust with respect to external environmental influences (weather, UV radiation, animals etc.). The objectives of the project are to review the state-of-the-art in existing power transformer enclosure designs, develop acoustic metamaterial add-on treatment unit cells for enclosure designs and numerically evaluate the acoustic performance evaluation of the metamaterial add-on concepts applied to different enclosures. The project will also endeavour to assess and improve the environmental impact and longevity of the metamaterial treatments.

Third Party Collaborators

Southampton University

Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

Problem Being Solved

Noise emitted by transformers is a well-known problem to the industry. In an electric grid with 50 Hz mains frequency, the noise emitted by high voltage transformers is generally dominated by tonal noise at 100 Hz and higher even harmonics. As a noise control problem, these acoustic characteristics of transformers are challenging due to two reasons. Firstly, the dominant tonal components in the noise spectrum lead to much higher annoyance levels compared to broadband noise sources at the same equivalent A-weighted sound pressure level. Secondly, at low frequencies (typically below 1,000 Hz) most sound-insulating structures are governed by the mass-law which dictates that by doubling the mass of a structure, its sound insulation (measured by the transmission loss TL) is increased by only 6 decibels (dB). Thus, to significantly reduce tonal noise at 100 Hz and achieve acceptable annoyance levels, noise mitigation measures for transformers must be very bulky.

Common current techniques for reducing transformer noise include enclosures, noise barriers, and active noise control. Due to the acoustic challenges posed by low-frequency noise, conventional transformer enclosures and barriers are highly disruptive structures and require large amounts of non-sustainable materials, such as concrete or fibreglass. Active noise control techniques have proven to be very effective to reduce low-frequency tonal noise, but they consume electrical power and therefore reduce the efficiency of the transformer.

Method(s)

R&D has been selected as the approach for this project as it enables the investigation of innovative metamaterials in place of existing transformer barriers/enclosures. This approach enables a holistic assessment of the options available to achieve effective noise reduction from transformers. The method will involve an experimental field test of a proposed metamaterial add-on treatment design on an existing power transformer enclosure. This will either be carried out at university facilities or at a deactivated transformer site.

Data Quality Statement (DQS):

· The project will be delivered under the NIA framework in line with OFGEM, ENA and NGGT / NGET 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. Relevant project documentation and reports will also be made available on the ENA Smarter Networks Portal and dissemination material will be shared with the relevant stakeholders.

Measurement Quality Statement (MQS):

· The methodology used in this project will be subject to our 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 the ENA's ENIP document, the risk rating is scored low.

TRL Steps = 2

Cost = 1

Suppliers = 1

Data Assumption = 1

Scope

WP1: Review of existing enclosure designs for transformers

WP2: Unit cell-based metamaterial retrofit development

WP3: Numerical performance evaluation

WP4: Environmental impact and longevity assessment

WP5: Experimental field test

WP6: Assessment of performance in reducing adverse human responses to noise

WP7: Recommendations to National Grid

Objective(s)

The overall aim of this project is the development of an acoustic metamaterial treatment that can be retrofitted to existing power transformer enclosures to enhance the enclosure's tonal noise reduction while considering the human perception of the sound quality. The treatment should be made from sustainable materials, and its acoustic performance should be robust with respect to external environmental influences (such as weather, UV radiation, animals etc.).

The objectives of the project are as follows:

- To review the state-of-the-art in existing power transformer enclosure designs
- To develop acoustic metamaterial add-on treatment unit cells for these enclosure designs
- To numerically evaluate the acoustic performance evaluation of the metamaterial add-on concepts applied to different enclosures
- To assess the performance in reducing likely adverse reactions to noise using existing models such as BS 4142 and models of sound quality
- To assess and improve the environmental impact and longevity of the metamaterial treatments
- To perform an experimental field test of a proposed metamaterial add-on treatment design on an existing power transformer enclosure

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

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 (please select/delete as appropriate) reduce the costs for households, improve the exchange of information between networks and customers while reducing the amount of disruptions to them in the home. Other considerations including the projects impact on supply, immediate health and safety in the home have been made in carrying out this assessment.

Success Criteria

The project will be deemed successful once the objectives of the project have been achieved. Ultimately, this project should identify and test an innovative acoustic metamaterial solution and be compared against traditional noise barriers.

Project Partners and External Funding

University of Southampton will be the supplier on this project.

Potential for New Learning

Various types of metamaterial designs will be explored and optimized towards retrofitting power transformer enclosures. These will include vibro-acoustic metamaterials, plate-type acoustic metamaterials and Helmholtz-resonance based metamaterials. Literature review and experimental testing will be conducted accordingly to select the most optimal design and will be compared against traditional noise barriers considering social, economic and technical factors.

Scale of Project

This is a 24-month project which involves an experimental field test of a new metamaterial add-on treatment design on an existing power transformer enclosure. This will either be carried out at university facilities or at a deactivated transformer site as supported by the Substations Operations group at National Grid. Experimental testing ensures practicality of the proposed solution and supports a stronger business case for roll-out.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL6 Large Scale

Geographical Area

This will be a desk-based and lab-based project, with experimental tests occurring at either a deactivated transformer site or within University of Southhampton laboratories. The Deeside Centre for Innovation will also be considered as a potential site for testing if an appropriate transformer is available.

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

£346500

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:

N/A

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

This project has direct and meaningful benefits for consumers, especially in terms of quality of life and public acceptance of transformers. Transformers, especially large substation units, generate a low-frequency hum that can be annoying or disturbing to nearby residents. The metamaterials will be designed to provide similar acoustic performance as existing treatments at a reduced cost and designed to significantly enhance the noise reduction through the enclosure. This will reduce the number of people affected by health conditions related to noise (health of >40% of UK population is affected by noise) and also could allow more flexible placement of transformer substations to meet regulations (e.g. closer to residential areas).

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

The main benefits from this project are non-monetary such as wider acceptance of transformer enclosures due to significantly reduced noise as well as use of sustainable materials meaning CO2e savings. Cost savings are anticipated to come from reduction in upfront installation costs, whilst the cost of the metamaterial itself may be more expensive depending on the selected design and its production costs. Operational costs however are anticipated to be cheaper due to reduced intervention/maintenance costs. Given these factors, the cost benefit is anticipated to be 1:1 with greater emphasis to be placed on the non-monetary benefits resulting from the project.

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

The solution is transferrable to other licensees across GB as the area of service does not impact ability of the proposed solution to manage noise levels coming from a transformer enclosure.

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

The costs of rolling out the solution to other licensees across GB will depend on the selected metamaterial design and it's associated production and installation costs.

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

Other Network Licenses can use the learnings from this project in the same capacity as NGET. That is, the acoustic metamaterial treatment can be retrofitted to existing power transformer enclosures to enhance the enclosure's tonal noise reduction. It is worth noting that each network licensee may have additional/different standards governing noise requirements and human perception of noise which should be investigated separately from this project.

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.

No other project explores the use of a metamaterial solution in the design of transformer enclosures.

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 as the acoustic metamaterial solutions to be investigated have not yet been studied, trialled or tested in the context of transformer enclosure design. Currently National Grid Electricity Transmission utilises conventional noise barriers or

enclosures, made of highly unsustainable materials such as concrete and fibre glass, which are highly disruptive in the environment and surrounds. Alternatively active noise control techniques are also in use however this consumes electrical power which in turn reduces transformer efficiency. The proposed solution will bypass these challenges due to its unique material properties.

Relevant Foreground IPR

Background IPR will not be required to use the relevant foreground IPR. New learnings/IP will be generated through the development of an innovative acoustic metamaterial design which can be retrofitted to transformers.

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

External expertise in acoustic metamaterials is required to better understand the practicality of these solutions in a substation setting and will also require considerable effort in research and testing, which will likely involve risk which the business cannot accept.

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

NIA funding facilitates the research, development and testing required in this project. The project meets all NIA requirements, namely benefit to consumers in vulnerable situations, involves research and testing, develops new learnings, is innovative and doesn't duplicate other existing projects.

This project has been approved by a senior member of staff

☑ Yes