

NIA Project Registration and PEA Document

Date of Submission

Oct 2026

Project Reference Number

NIA3_NGET00026

Project Registration

Project Title

Self-Healing Concrete for Substation Assets

Project Reference Number

NIA3_NGET00026

Project Licensee(s)

National Grid Electricity Transmission

Project Start

October 2026

Project Duration

1 year and 7 months

Nominated Project Contact(s)

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Project Budget

£263,250.00

Summary

This 18-month project will review technologies and standards, prioritise substation applications, develop representative mix designs, assess structural, durability, carbon and whole-life cost performance, and test a representative element. It will evaluate healing, permeability, mechanical performance, curing, constructability, supply-chain readiness and exposure conditions, including contact with transformer insulating fluids. The project will define the application envelope, limitations, quality controls and deployment route. It could improve infrastructure durability and resilience while reducing interventions, whole-life cost and carbon. Benefits will be quantified after Stage 1 validates the business-as-usual baseline and addressable asset population.

Preceding Projects

NIA2_NGET0045 - Use of Innovative Materials and Construction Techniques in the Substation Environment to Accelerate Transition to Net-Zero

Nominated Contact Email Address(es)

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Problem Being Solved

Concrete foundations, transformer bunds, plinths and cable trenches are essential to substations. Cracks from shrinkage, temperature, loading and environmental exposure can increase permeability, expose reinforcement to water and contaminants, and require inspection, repair or early replacement, increasing whole-life cost, carbon and operational-site work. Self-healing concrete can seal eligible fine cracks, but NGET lacks evidence that commercial solutions are reliable, repeatable, constructible and cost-effective in substation conditions.

Current design, inspection and repair practices manage concrete cracking, but cracks can accelerate deterioration, particularly in containment, inaccessible or exposed assets. Monitoring, repair and replacement add cost, carbon, disruption and personnel

exposure.

Self-healing concrete could improve durability by sealing fine cracks before significant ingress. However, its business case is unproven due to limited substation-specific evidence on crack-width capability, durability recovery, repeatability, fluid compatibility, structural performance, quality control, standards, supplier maturity and whole-life value. A limited, staged testing programme will determine whether it can safely and efficiently complement or replace conventional concrete and repair methods.

Method(s)

The project will use a staged, decision-gated Method:

Stage 1, feasibility and application screening: review prior art, relevant standards, self-healing mechanisms, candidate applications, commercially available solutions, supply-chain capability and the business-as-usual baseline.

Stage 2, detailed assessment: develop representative mix designs and assess ULS and SLS performance, crack control, healing effectiveness, permeability, strength development, durability, shrinkage, creep, curing, constructability, compatibility with insulating fluids, embodied carbon and whole-life cost.

Stage 3, representative manufacture and testing: manufacture a representative element and evaluate batching, placement, finishing, curing, induced cracking, healing, permeability and repeatability against conventional concrete.

Recommendation: define the application envelope, limitations, specification and quality-assurance requirements, supply-chain route, monitoring needs and whether progression to an operational pilot or BAU adoption is justified.

Measurement Quality Statement: the test plan will define the measurands, acceptance thresholds, reference methods, specimen numbers, controls, equipment calibration, environmental conditions, repeat measurements and treatment of uncertainty before testing. Crack width, crack closure, permeability and mechanical properties will be measured using documented, repeatable procedures. Conventional concrete controls will support like-for-like comparison. Deviations and limitations will be recorded.

Data Quality Statement: project data and metadata will be subject to named ownership, version control, traceable specimen and batch identifiers, quality checks, secure storage and documented processing. Raw and processed data, units, methods, calibration records and assumptions will be retained so that results can be found, understood and reused. Data will be treated as Presumed Open, with only the minimum necessary de-sensitisation for legal, safety or commercial reasons.

Scope

An 18-month Research and Development project covering feasibility, application screening, detailed technical and economic assessment, and representative manufacture and testing. Candidate applications include transformer bunds and containment structures, cable trenches and troughs, below-ground or hard-to-access structures, and foundations in aggressive environments. Network-wide deployment, changes to technical policy and full operational demonstration are outside the project scope; the project will make recommendations for any subsequent pilot or adoption activity.

Objective(s)

The project objectives are to:

Identify priority substation applications and suitable commercially available self-healing technologies;

Determine performance requirements and assess standards, safety, environmental and constructability constraints;

Quantify crack-healing, permeability, durability and relevant mechanical performance against conventional concrete;

Assess insulating-fluid compatibility, supply-chain readiness, whole-life cost and carbon;

Validate practical manufacture and testing on a representative element;

Provide an evidence-based progress, refine or stop recommendation, including an application envelope and implementation controls.

Consumer Vulnerability Impact Assessment

The project is not specifically targeted at consumers in vulnerable situations and no direct differential technical or wellbeing impact has been identified. Potential financial and resilience benefits would arise through more efficient management of shared transmission assets and would therefore be available to consumers generally, including consumers in vulnerable situations. The project will avoid claiming a targeted vulnerability benefit. Any future cost reduction would depend on successful technical validation and deployment and will be assessed through the project cost-benefit analysis. No adverse distributional impact is expected from the research activity itself; any future deployment decision will consider affordability, reliability and environmental outcomes.

Success Criteria

The project will be successful if it delivers:

(1) a documented BAU baseline and priority application assessment;

(2) a technology and supply-chain review;

- (3) agreed test and acceptance criteria;
- (4) comparative evidence on healing, permeability, mechanical and durability performance;
- (5) evidence on constructability and relevant exposure compatibility;
- (6) a whole-life cost and carbon assessment with transparent assumptions;
- (7) a representative manufactured and tested element; and
- (8) a final application envelope and evidence-based recommendation for progression, refinement or cessation.

Project Partners and External Funding

Kelvin Power Structures (Vinci Energies) will lead the feasibility study, detailed technical assessment, trial design, representative manufacture/testing and reporting. NGET will provide project governance, define use cases and assurance requirements, facilitate access to relevant standards and asset information, support the baseline and cost-benefit assessment, and approve stage-gate decisions. Material suppliers and competent testing organisations may provide product information, materials or specialist testing. No external funding is currently identified. Opportunities for peer review and knowledge sharing with other Licensees will remain open.

Potential for New Learning

The project will generate new, transferable learning on the suitability of self-healing concrete for electricity substation assets, including effective application types, crack-width and exposure limitations, durability and permeability recovery, constructability, quality control, insulating-fluid compatibility, supply-chain readiness, standards gaps and whole-life value. It will also establish a repeatable screening and testing approach that other Licensees can use when assessing similar materials. Findings, assumptions, negative results and limitations will be reported so that other Licensees can understand both where the Method may be applicable and where it should not be used.

Dissemination and adoption of learning: In addition to generating new scientific evidence, the project will include a structured dissemination approach to ensure that learning is accessible and capable of being adopted by National Grid, other Network Licensees, regulators and environmental stakeholders. Outputs will also be made publicly available through established NIA dissemination routes. To maximise impact across the sector, project findings will be disseminated through National Grid's innovation channels, NIA annual and completion reports, technical workshops, conference presentations and the ENA Smarter Networks Portal.

Scale of Project

The £263,250 project is limited to the work needed to resolve the principal adoption uncertainties before any operational deployment. Desktop evidence alone would not establish constructability, repeatability or healing performance, while a smaller test programme would provide insufficient comparative evidence to support an application envelope. A network-scale demonstration would be premature before material, standards and cost uncertainties are resolved. The staged approach controls consumer exposure by allowing the project to stop or refine at each gate. The scale is therefore proportionate to the potential for repeated use across substation assets and to the value of avoiding unsuitable deployment.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL5 Pilot Scale

Geographical Area

Desktop activities will be undertaken in the UK. Representative manufacture and laboratory or site testing will be undertaken at a suitable UK facility selected during the detailed assessment. Any site-specific activity will be recorded in Project Progress Information.

Revenue Allowed for the RIIO Settlement

No funding allowed within the RIIO-3 settlement is currently expected to become surplus to requirements as a result of this project. The value is therefore assessed as £0.

Indicative Total NIA Project Expenditure

Indicative Total NIA Expenditure: £263,250 (90% NIA contribution = £236,925), comprising supplier delivery, NGET internal and indirect costs, and the approved contingency. Project expenditure will be managed by stage and reported at Work Package level.

Work package 1: Feasibility Stage	£36,750
Work package 2: Detailed Desktop Analysis	£45,850
Work Package 3: Trial erection drawings	£8,650
Work Package 4: Trial erection cost	£60,000
Work Package 5: Test results analysis	£40,000
National Grid internal cost	£20,000
National Grid indirect cost	£33,000
Contingency cost	£19,000
Total	£263,250

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 project has the potential to facilitate the energy system transition by improving the prospective durability and whole-life performance of concrete assets that support the GB Electricity Transmission System. Substations are required to connect and operate the infrastructure needed for low-carbon generation and future electricity demand. If technically and economically proven, self-healing concrete could reduce deterioration, intervention and replacement, lowering whole-life carbon and supporting resilient, efficient network development. The project will provide the evidence needed to determine whether the Method can be safely adopted, for which applications, and under what controls.

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

The project is not specifically targeted at consumers in vulnerable situations. Potential benefits would arise through shared network cost efficiency and resilience and would therefore be available to consumers generally, including consumers in vulnerable situations. The distributional assessment is provided in the Consumer Vulnerability Impact Assessment above.

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

Benefit assessment at registration

A reliable portfolio-level net present value (NPV) cannot yet be calculated because the addressable asset population, crack incidence and intervention frequency have not been validated. The preliminary assessment will therefore determine the maximum material and quality-assurance premium at which the Method would break even against conventional concrete, including expected inspection and repair costs. Stage 1 will validate these input ranges before expenditure on testing is committed.

Potential scale of benefit

For RIIO-T3, National Grid requested approximately £11.5 million for work related to concrete assets, with the majority associated with concrete repairs. If self-healing concrete is successfully validated and adopted for suitable applications, it could reduce a proportion of these repair costs. The project will quantify the addressable share and potential savings through the staged cost-benefit assessment.

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

The Method could be replicated on concrete assets across GB electricity transmission and, subject to asset-specific requirements, electricity distribution and gas network sites. Potential applications include bunds and containment structures, trenches and troughs, plinths, foundations, and other exposed or hard-to-access concrete assets. The project will not claim a specific site count before Stage 1 validates the addressable population. Replicability will instead be reported by application type, exposure class, crack-width range, construction route, standards constraints and supplier capability. The outputs will include a screening framework and application envelope to enable other Licensees to assess suitability consistently.

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

Roll-out costs would include any self-healing material premium, mix qualification, supplier approval, batching and quality-control changes, design and specification updates, contractor training, assurance testing and monitoring. Costs will vary by technology, asset

type, volume and site conditions and cannot yet be quantified robustly. The project will establish unit-cost assumptions and compare these with avoided inspection, repair and replacement costs. Any subsequent operational pilot or policy implementation would be subject to a separate approval decision and is not included in the £263,250 project budget.

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

Other Network Licensees can use the learning to screen candidate concrete assets, specify relevant performance requirements, select appropriate self-healing technologies, design proportionate tests, assess construction and quality-control implications, and develop their own cost-benefit cases. The application envelope, negative findings and standards assessment will help Licensees avoid unsuitable deployment as well as identify viable use cases. Transferability will be clearly bounded by asset function, exposure, crack width, loading, construction route and assurance requirements.

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.

A review was completed and recorded before registration covering the Dissemination Platform, previous NIA/NIC/SIF projects, relevant UK and international research, and NGET's own portfolio. The most directly related NGET project is NIA2_NGET00045, Use of Innovative Materials and Construction Techniques in the Substation Environment to Accelerate Transition to Net Zero. That project assessed several alternative materials and included graphene-enhanced concrete, which principally investigated modified hydration,

strength, cement reduction and material efficiency. This project is distinct because it evaluates autonomous or enhanced crack-sealing mechanisms, recovery of permeability and durability, substation-specific exposure compatibility, and avoided crack-related intervention.

Published laboratory studies and pilots on self-healing concrete will be used as prior art rather than repeated without purpose. The project adds new learning by defining and testing a GB substation application envelope, comparing with the current Method, and addressing standards, construction, insulating-fluid exposure, supply chain and whole-life value. If the pre-registration review identifies a materially overlapping network project, the scope will be amended to avoid duplication or the rationale for additional learning will be documented.

If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

No materially equivalent Network Licensee project has yet been identified. If a similar project is identified during the final duplication review, NGET will document the different Method, application, conditions, TRL or new learning that justifies this project before registration.

Additional Governance And Document Upload

Please identify why the project is innovative and has not been tried before

Self-healing concrete is not established BAU for NGET substation assets, and its business case remains unproven. The innovation is the novel application and validation of commercially emerging crack-sealing technologies for long-life substation concrete assets under GB-specific design, construction, exposure and assurance requirements. The project will distinguish visible crack closure from permeability, durability and mechanical recovery and will define where the technology should and should not be used. Key uncertainties include repeatability, effective crack width, long-term performance, insulating-fluid compatibility, constructability, quality control, standards alignment, supplier maturity and whole-life value. A limited staged project is therefore required before operational deployment, or specification change can be justified.

Relevant Foreground IPR

Expected Relevant Foreground IPR will comprise the project-specific application screening framework, test plans and protocols, representative design and mix assessment outputs, de-sensitised test datasets and metadata, comparative performance and whole-life assessment methods, application envelope, quality-assurance recommendations and final deployment guidance. Supplier formulations, proprietary healing agents, manufacturing know-how and pre-existing design tools may constitute Background IPR. Contracts will identify the Background IPR required to interpret or use the Relevant Foreground IPR and provide the access rights required by the default RIIO-3 NIA IPR arrangements. The project is not expected to create a new commercial product owned by NGET.

Data Access Details

Data gathered or created will be treated as Presumed Open and shared through the RIIO-3 Dissemination Platform in accordance with NGET's public data policy and Ofgem's Data Best Practice Guidance. Expected data include technology-screening information, mix and specimen metadata, crack-width and closure measurements, permeability and mechanical test results, exposure conditions, carbon and cost assumptions, and trial observations. Interested parties will be able to request data through the project page or NGET innovation contact. Where legal, safety or commercial restrictions apply, NGET will explain the reason and provide a de-sensitised version with the minimum necessary changes. Proprietary formulations and security-sensitive site information will not be disclosed unless appropriate rights and protections are in place.

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

NGET's BAU activities use established concrete design, specification, inspection and repair methods. Self-healing concrete is not an approved standard solution for substation assets, and the evidence needed to specify it, assure performance and demonstrate whole-life value is not available. Funding unproven material development and representative testing through routine delivery would transfer technical and commercial risk to individual capital projects without a validated application envelope or benefit case. The work is therefore Research and Development to create shared learning, not routine procurement or implementation of an established solution.

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 support is appropriate because the Method has an unproven business case and carries risks that would otherwise prevent NGET from progressing it through BAU. Technical risks include variable healing performance, limited effective crack width, incomplete recovery of permeability or mechanical properties, and uncertain long-term durability. Operational risks include constructability, curing and quality-control requirements and suitability for safety- or containment-critical assets. Commercial risks include material premium, supplier maturity, availability and scalability. Regulatory and assurance risks include limited alignment with current standards and insufficient evidence for specification change. There is also a risk that testing demonstrates no viable application or net benefit. The staged NIA project limits exposure permits stop/refine decisions and generates learning that can be shared across Licensees. Without NIA, these cross-cutting uncertainties and the risk of unsuccessful development mean the project would not be undertaken as BAU.

This project has been approved by a senior member of staff

☒ Yes