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

Jul 2025

Project Reference Number

NGED_NIA_082

Project Registration

Project Title

Hi-5

Project Reference Number

NGED_NIA_082

Project Licensee(s)

National Grid Electricity Distribution

Project Start

July 2025

Project Duration

4 years and 4 months

Nominated Project Contact(s)

Scott Ball

Project Budget

£2,731,000.00

Summary

As our existing HV cable assets age over time, and future demand from consumers increases as they transition to low carbon technologies, we need to optimise investment planning balancing asset health interventions and asset reinforcement that minimises the impact to consumers through Customer Interruptions (CI)/Customer Minutes Lost (CML).

The Hi-5 project, is looking to understand the time to failure indicators on our HV cable assets through the installation of low cost monitors. This insight will be used to support changes to our cable health methodologies, and therefore our future asset investment needs.

Preceding Projects

NIA_WPD_060 - Pre-Fix

Third Party Collaborators

EA Technology

Nortech

Problem Being Solved

At present, underground High Voltage (HV) network investment quantification methodologies in Electricity Distribution planning allow for load-related capital expenditure but not non-load (i.e., fault/age related). Unlike other network assets, underground (UG) HV networks are not included within the Common Network Asset Indices Methodologies (CNAIM) (with the exception of fluid filled and submarine cables).

The Energy Networks Association (ENA) industry group have previously explored expansion of CNAIM to include cable types, however, they were unsuccessful due to the lagging nature of available measurable outputs (historical fault data).

Method(s)

Hi-5 will undertake a 4.5year longitudinal study of HV UG networks to provide a methodology that captures all aspects of underground network health. Monitoring equipment and data analysis will identify network indicators that will provide an insight to probability and time scales associated with “time to failure”. This new data driven approach will be the key insight to unlocking an effective sustainable underground network reinforcement methodology improving UG HV network resilience.

The outcomes of HI-5 are vital for all customers, with the uptake of Low Carbon Technologies (LCT)s e.g. increased electrified heating, society will be ever more reliant on electricity and dependent on network reliability. This could be exacerbated in the longer term as UG network asset life related health issues may increase at the time that demand for electricity is at its highest.

Scope

Hi-5 aims to provide a new approach to provide data to expand learning around ‘leading' indicators of emerging underground network health issues rather than historic problematic 'lagging' fault history data. By identifying time to failure of UG networks we aim to provide a data informed approach to cable replacement avoiding unnecessary expenditure, supporting ahead of need network reinforcement to adopt a one touch approach that considers both load/non load UG network replacement and network reliability improvements.

The need to be proactive in the identification of faults will increase as more customers adopt low carbon technologies as part of the road to Net Zero. Net Zero is a strategically important outcome for GB, National Grid, all DNO’s and customers brought into focus through the Clean Power 2030 report by the National Energy System Operator (NESO). The challenge is huge and requires fundamental change in industry approach. As a DNO, NGED is aware that addressing/locating sections of suboptimal network and optimising replacement of HV UG networks will be critical to supporting the road to NetZero.

Analysis undertaken shows that at the time when demand is expected to be at its highest it also coincides with the highest volumes of underground cables reaching the end of their serviceable lives. In reality the service life of a UG HV cable can significantly vary, an aging cable is not necessarily at a greater risk of failure, however, there is currently no method to quantify this. UG networks can fail prior to their suggest cable service life with many networks remaining in service well past their recommended cable service life.

A significant proportion of UG HV network faults are not directly related to cable failure or age, rather being caused by other variable such as deterioration of cable joints / terminations, environmental conditions and historic installation techniques/materials.

There is risk that relacing cables on a purely age-based consideration there may be minimal impact on improving network reliability and overall value for customers. Monitoring the health of underground networks will support areas where condition based replacement would be beneficial to both support load growth and improve network reliability whilst allowing an informed approach to deferring the replacement of aging cables.

At present, current regulations do not allow for the flattening of the future peak volume curve, as investment is only sanctioned and funded for the next price control. To ensure the correct cables are replaced ahead of peak demands and to smooth the cable replacement workload over time, then informed proactive network reinforcement will be require.

The project is seeking to find a solution by altering the forecasted replacement curve to ensure work is undertaken at best value to consumers. Hi-5 will support the one touch approach to cable replacement/reinforcement providing the most timely, cost-effective way of combining network reliability improvements (reduction of faults) with network capacity growth. By investing ahead of need, targeting poor health networks and deferring reinforcement, future work volumes will be sustainable for future years whilst continue to achieve the

road to NetZero. The project aims to gather the evidence needed to improve industry understanding of UG network health to support the flattening of UG load/non-load (currently cable age) replacement curves before the peak demand is reached.

Objective(s)

The project will undertake the following objectives:

- Investigate existing industry health indices & recommend new approaches (if app.) for HV cables.
- Undertake longitudinal studies (c.4 yrs) on HV UG cables with the aim of developing insights & tools to identify when cables are going to fail (Time to Fail)

Consumer Vulnerability Impact Assessment

Not applicable, as no vulnerable consumers would be impacted by this project.

Success Criteria

Success of the project will be measured through the insights on how leading indicators of emerging underground network health issues can be used to direct network investment proactively therefore reducing the Customer Interruptions (CIs) and Customer Minutes Lost (CMLs) associated with events.

Moreover, the output from the understanding of UG network health and indicators could also be used to inform Ofgem about other ways of thinking about investment approaches to underground asset replacement in future price controls.

Project Partners and External Funding

The following project partners will be engaged on this project:

· EA Technology

· Nortech

Due to the value of the expected project expenditure, Laurence Carpanini will likely be engaged to peer review the outputs of the project.

Installation of the monitors external contractors maybe used to support NGED Operational Teams, but this is site specific and team availability.

No external funding will be used to support the project. NGED will contribute 10% of the total project costs as part of the NIA funding arrangements.

Potential for New Learning

The learnings from this project is applicable to all other DNOs. Therefore, Hi-5 will take the learning from prior projects and develop the tools and insights needed to enable the business to be operationally more adept at proactive investment by using longitudinal studies to develop an evidence base.

NGED has been proactive for a few years on developing pre-fault identification methods and has been undertaking research into predictive analytics using monitoring through Network Innovation Allowance (NIA) funded projects ALARM (LV distance to fault), Prefix (HV) and more recently, HV Pinpoint. The results of these projects have been informative and have challenged established thinking within the business to the extent that we intend now to take the challenge of asset health data to the next level by delving into “time to fault”.

To do this, Hi-5 will demonstrate in the field gathering of data and analyse of captured waveforms to determine what they actually mean in terms of UG network health and the probability and time scales of “time to fail”. This will be done at scale in the field covering 5% of HV UG cables. It will also help create a leading position in a debate about where investment is best made to maximise the benefits for consumers for an optimised asset replacement approach.

The outputs will also enable NGED and other DNOs to increase its ability to focus the supply chain on reinforcement work. This is because the requirement to replace UG network on asset life basis in addition to installing new load growth related cables will be reduced.

The benefit case for both NGED and customers is strong but it should be remembered that the key issue the project is attempting to address is the lack of data to validate the hypothesis. This project will open the door to challenging existing industry approaches to UG HV network management.

Scale of Project

As part of existing projects NGED has about 15 circuits under monitoring, the intention would be to extend this number substantially and ensure that we have a variety to differing devices to compare and contrast results. The number of circuits would need to be statistically significant enough and therefore NGED is targeting 300 circuits across 16 sites (5% of the HV UG network), across a range of areas to get as wide a sample.

Technology Readiness at Start

TRL5 Pilot Scale

Technology Readiness at End

TRL6 Large Scale

Geographical Area

The project will expand monitoring from the existing networks in Coventry to all four licence areas, significantly increasing sample size capturing variations in network make up across all of NGED’s regions. Where possible we are also exploring how we repurpose existing monitored locations to further increase sample size.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

Total project budget is £2.731m, NGED will contribute 10% of the budget.

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 HI-5 project is seeking to address something that has not been addressed before. It is essential that industry take a different view of to allow data driven approach to UG networks to utilise existing asset health as well as ensuring networks are futureproofed as we move to net zero carbon operation.

The reliance of electricity is forever increasing, and therefore increasing importance on network reliability, having greater visibility and knowledge of asset health. An intrinsic part of future networks.

This change represents a fundamental shift for Network Operators and as such establishing best practice based on the use of new and innovative monitoring technologies is essential- but it has to be done in a way that ensures that the current service levels are maintained and then these new capabilities embedded as and when they are ready.

This HI -5 Project will provide the analysis (through longitudinal studies) and confidence to be able to do this by scaling up and present solutions that will enable DNO's to be proactive and provide new reporting that will show the need for a more proactive approach to UG faults and network investment. It will build on the lessons learnt on projects during ED2 and aims to provide early insights for ED3 planning with the aim of providing data and rationale for change in ED4.

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

The business case for HI-5 covers a number of business and customer elements. It is therefore split below between those benefits which NGED will see but also those societal benefits that come from resilience of the network to customers and the "contract" that all DNO's have with customers to keep the lights on.

The project will through the use of trials and research propose new standards and an evidence base for change. That change will cover:

1. Identify and validate leading UG network asset health indictors
2. Explore new business practices around asset replacement to reduce fault rates
3. Inform how health indies could be used for UG HV networks in future price controls

It is important to note that in developing this business case we do not have all of the insights needed yet to develop a fully robust case. At this point in time outputs of existing projects such a Prefix are still in the early stages, whilst current learnings are extremely

promising we are not in a position where “time to failure” learnings can be accurate enough to support the case. We have developed a case based on the lack of foresight of when cables will fault and what this means for customers. For customers the outcome of this lack of foresight is the potential for increased faults and associated outages as cables age and demands of future requirement. The project is designed to obtain that foresight to support proactive preventive fault.

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

HV Faults

During 2023- 2024 NGED spent c.£20m on repairing UG HV unplanned cable faults with an additional spend of £18.5m on CML/CI penalties. This was across around 2,103 events giving an average cost per fault of c.£18,000. This cost is a conservative estimate as fault repairs can significantly vary dependent on location and nature of the fault. Recent efficiency drives are aiming to reduce unit fault costs across the business, future costs maybe lower, however at this point we do not have confidence to use values to support forecasts. Additionally, the average CML/CI costs had a annual social cost estimated to be c.£60m. Given that NGED has 44,200km of HV UG cable it suggests an overall annual UG HV fault rate across the business of 5 faults per 100km of HV cable per year across the four NGED license areas.

The relationship between UG network faults and cable age is very complex, for example, circuits with the highest fault count may not necessarily be the circuit containing the greatest length of ageing cables. Distribution of faults are not even across the network, some geographical areas have high concentration of fault rates. Whilst an age-based asset replacement approach may result in greatest volumes of aging asset being replacement it lacks the targeted approach required to reduce fault rates and improve network reliability. Due to underground complexities, we are unaware of leading indicators of the relationship between aging/deteriorating assets and fault rates. HI-5 will identify network characteristics observed of pre-fault activity, it will also identify expected time to failure. By improving our understanding of time to failure we can ensure we balance avoiding the fault and replacing cable too early. With this knowledge an optimised risk-based approach to network replacement targeting circuits most likely to fail can be adopted.

A conservative estimation of reducing UG HV faults by 10% by the end of ED3 could save c.£3.7m per year in overall fault costs, with a further saving of c.£5m per year in societal costs.

Cable replacement

During ED1 NGED replaced around 41km of non-load related UG HV cable, replacing a further 7.5km during the first 2 years of ED2, the total amount of expenditure being c.£8.1m. In the next 25 years 8454 Km of UG cable will be reaching mean life expectancy (87 years) which is c. 19% of the total underground network. If all cable were to be replaced at end of asset life the total spend of this non-load related replacement would be c.£1.5b. This level of replacement increases substantially out to 2059 where an additional 9,000 km will need to be replaced.

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

Hi-5 could be replicable to any DNO licencee area that feature UG HV cable assets.

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

HI-5 will provide an evidence base to seek to change the way that non-load related investment is allocated within ED plans for DNO’s. By having a different approach this would enable DNO’s to plan better for asset failure and reduce Customer Interruptions (CIs) and Customer Minutes Lost (CML).

HI-5 will seek to reduce CI/CMLs because proactive replacement or reinforcement of assets/cables will occur and therefore less opportunity for system failure meaning customers will benefit from a more reliable system.

It will do this by undertaking a longitudinal study, base our recommendations on statistically significant results and propose new methods and processes that will change the way that DNO's and the Regulator approach assets and their replacement.

Requirement 3 / 1

Involve Research, Development or Demonstration

Projects must have the potential to have a Direct Impact on a Network Licensee's network or the operations of the System Operator and involve the Research, Development, or Demonstration of at least one of the following (please tick which applies):

☐ A specific piece of new (i.e. unproven in GB, or where a method has been trialled outside GB the Network Licensee must justify repeating it as part of a project) equipment (including control and communications system software).

☐ A specific novel arrangement or application of existing licensee equipment (including control and/or communications systems and/or software)

☐ A specific novel operational practice directly related to the operation of the Network Licensees system

☐ A specific novel commercial arrangement

Involve Research, Development or Demonstration - Please select all that apply

☐ A specific piece of new equipment (including monitoring, control and communications systems and software)

☐ A specific piece of new technology (including analysis and modelling systems or software), in relation to which the Method is unproven

☑ A new methodology (including the identification of specific new procedures or techniques used to identify, select, process, and analyse information)

☐ A specific novel arrangement or application of existing gas transportation, electricity transmission or electricity distribution equipment, technology or methodology

☑ A specific novel operational practice directly related to the operation of the GB Gas Transportation System, electricity transmission or electricity distribution

☐ A specific novel commercial arrangement

Specific Requirements 4 / 2a

Please explain how the learning that will be generated could be used by the relevant Network Licensees

The learning from this HI-5 project and the previous ones (ALARM and Prefix) are very relevant to all Network Operators. As the system becomes more distributed it will be essential more than ever before to keep the lights on, predictive analytics will be a vital part of the future armoury at the DNO's disposal.

The learning will be shared proactively and it is our intention to involve the other DNO's at the outset from a design perspective and with that in mind Scottish and Southern Electricity Networks (SSEN) form part of the project team. We will engage through workshops and webinars throughout the project. It is important to the outcomes of the project that broad and deep industry engagement is maintained. The ENA will also be involved from a Policy and Regulatory perspective.

Our learning will be shared with the DNOs throughout and it would be our expectation that they can roll out the outputs themselves as any designs would be shared with them. They would also be engaged with the trials to test results and thinking throughout as this is in particular relevant to the production of policies in the future.

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 of the Smarter Networks Portal does not reveal any similar projects, some work has been done at a transmission level but not at a distribution level voltages.

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 Hi-5 project is seeking to address something that has not been addressed before. It is essential that industry take a different view of to allow data driven approach to UG networks to utilise existing asset health as well as ensuring networks are futureproofed.

Relevant Foreground IPR

The following is expected to be delivered as part of the project:

· Recording of learning as to what are reliable time to fail indicators for HV cables

· The production of the Discovery/Define Outcomes Report

· The network Trials Design

· The Project Findings Report

· Recommendation Report (Asset Health Indices and Regulatory Reporting)

· Independent validation of the approach and comment on the direction of the project, this will also include some commentary and input into the BaU planned outcomes

Furthermore, the completion of the project will deliver the following other deliverables that will further demonstrate success:

· Replication of the waveforms seen in the field, in the lab (if this is required) that can then lead to the validation of “Time to Fail” metrics for the business

· The building of a narrative to engage Ofgem on reinforcement investment and in particular around empirical-based non-load-related investment for underground HV cables and how it would be beneficial for consumers

The deliverables will be reviewed internally by experts within the Networks Services and Policy teams and also peer reviewed by SSEN (TBC). The tests undertaken will have full test scripts and as such the results expected will be evidenced against those recorded. We will ensure throughout that the appropriate controls are in place to ensure that the results allow us to proceed to the next stage.

This will ensure that results are in line with expectations and ensure that they can where appropriate transition into business as usual.

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 several 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 Electricity Distribution 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.co.uk/innovation/

Via our managed mailbox nged.innovation@nationalgrid.co.uk

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

This Hi-5 Project will provide the analysis (through longitudinal studies) and confidence to be able to do this by scaling up and present solutions that will enable DNO's to be proactive and provide new reporting that will show the need for a more proactive approach to UG faults and network investment. It will build on the lessons learnt on projects during ED2 and aims to provide early insights for ED3 planning with the aim of providing data and rationale for change in ED4.

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 ability to analyse the data gathered into a set of clear and robust cable asset health indicators has a number of technical and regulatory challenges.

A similar exercise was carried out 20 years ago, but too much noise in the data gathered from the sensors meant the results weren't reliable. New technology advances in the development of sensors, and the analysis via new data science methods has reduced that risk, but there is a possibility that the analysis does not produce a robust enough recommendations for a set of BAU asset health indicator.

This project has been approved by a senior member of staff

☑ Yes