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

Apr 2026

Project Reference Number

NIA_SSEN_0081

Project Registration

Project Title

Pathfinder

Project Reference Number

NIA_SSEN_0081

Project Licensee(s)

Scottish and Southern Electricity Networks Distribution

Project Start

April 2026

Project Duration

2 years and 0 months

Nominated Project Contact(s)

Brian Wann – Innovation Delivery Manager

Project Budget

£2,543,797.00

Summary

Electricity demand is projected to increase by around 50% by 2035. Enabling the construction of the electricity distribution network to support this rapid increase requires new design processes, protection and control equipment and standards to be developed at pace. This project will de-risk the opportunities presented by implementing Low-Power Instrument Transformers (LPITs) and IEC61850 based communication technology that can be deployed in specifications for 132kV Grid and Bulk Supply Point substations. The project will trial the technologies in laboratories, to mitigate the risk of deployment on our network which will unlock benefits to consumers via lower construction costs, more efficient supply chain due to standardisation, reduction in cabling and footprint, and more efficient design and commissioning.

Nominated Contact Email Address(es)

fnp.pmo@sse.com

Problem Being Solved

Background:

The National Infrastructure Commission report projects that electricity demand is expected to increase by around 50 percent by 2035 and double by 2050* SSEN-Distribution currently plan to deploy more than 500 132kV switchboard bays into Grid (GSP) and Bulk (BSP) Supply Points by 2035 to facilitate this demand growth.

The current build process for this infrastructure takes between 30-48 months, and requires a custom design, which is a lengthy process. Adding capacity to existing sites requires procurement of larger areas of land, which impacts not only costs, but also land availability for local communities. The development and deployment of Low-Power Instrument Transformers (LPITs) also known as Non-Conventional Instrument Transformers (NCITs) to replace traditional electromagnetic instrument transformers presents a crucial step for the UK's move towards net zero and for creating a more intelligent, flexible, and resilient energy grid. LPITs reduce the need

for bulky, high-voltage equipment, take up less space, integrate with digital communications, enhance safety by reducing on site time and will be a crucial part of an upgraded network.

*Electricity distribution networks: Creating capacity for the future - NIC.

Problem:

Existing specifications for analogue instrumentation and the associated control and instrumentation wiring can result in lead times of more than two years for equipment supply, require large physical footprints which can be hard to site in the required configurations and lengthen on-site time for installation and complex commissioning tasks. These factors exacerbated by emerging demand outstripping supply will delay construction of these assets and therefore decarbonisation ambitions.

LPIT and digital communications have yet to see widespread adoption in the UK, primarily due to challenges such as high implementation costs, the need for specialised staff training, the complexity of emerging technologies and standards, and stringent cybersecurity requirements.

To address these barriers, it is essential to develop appropriate tools and standards, invest in workforce education, effectively manage cybersecurity threats, and validate system reliability through real-world laboratory pilot projects before scaling up deployment.

Learning from innovation projects such as SPTEN02 FITNESS and UKPNEN05 Constellation, information from the supply chain, and benchmarking from a network operator in the US suggest that Low Power Instrument Transformers (LPIT) and the corresponding IEC61850 compliant digital communications equipment have matured and may now offer cost and delivery benefits in Grid Supply Point (GSP) and Bulk Supply Point (BSP) construction.

Key Benefits:

The use of LPIT will involve replacing point-to-point copper cables in traditional substations with digital technology, using Intelligent Electronic Devices (IEDs) interconnected by communication networks with fibre optic cables using standardized protocols such as IEC 61850. This digitalization enables real-time data acquisition from modern sensors and LPITs, leading to improved monitoring, control, safety, reliability, and efficiency for the electrical grid compared to traditional substations. This enables digitisation at the instrument signal level (process level), and the digital information to be relayed across various levels from process to substation supervisory level (station level) within a substation and even beyond over reliable communication network links.

This project will prove and quantify the benefits available from LPIT and IEC61850 substation communications compared to existing analogue instrument transformers and control and instrumentation wiring. The project will develop standard specifications, ways of working, and training facilities to enable BAU deployments on the SSEN-Distribution network, allowing future replication within other UK DNOs.

The project outcomes will also support and influence other key stakeholders in the industry.

- For Vendors/OEMs - Clear specifications and standards reduce uncertainty, development risk and entry barriers enabling fair competition rather than bespoke tailoring. Also accelerates innovation in this space.
- For partners/other utilities - reduced project delivery times, easier system integration, testing, commissioning, operation and maintenance. Quantified and known risks are easier to manage and performance becomes predictable
- For regulators and standards bodies – Lessons learned will shape future technical approaches, future regulation and compliance frameworks.
- For end users and wider ecosystem - Accelerated availability of mature technology with reduced cumulative life cycle costs. Rapid industry adoption prevents fragmentation into incompatible solutions and builds confidence in emerging technology categories.

Method(s)

Work Package 1. Requirements Specification

Focuses on gathering insights and defining the foundation for substation development.

Key Outcomes:

The project will undertake extensive stakeholder engagement and vendor collaboration. This will be supported by workshops with supply chain partners, Large Capital Delivery, and Procurement teams to validate the project scope, define requirements, capture user stories, and map the current “as is” condition of substations to identify capability gaps. In parallel, the project will conduct comprehensive market research, including a global scan of digital substation technologies and an assessment of relevant UK initiatives—such as NIA and SIF funded work by UKPN and SPEN—to identify best practice approaches and emerging solutions. A deeper technical review of successful LPIT based implementations will further inform the project by extracting lessons learned and

reusable building block designs. These insights will then be consolidated to define clear requirements and develop a suite of implementation solutions.

Key Deliverables:

1. Results from Supply Chain engagement
2. Validated requirements scope and user needs map
3. Gap analysis, Market research and recommendations

Work Package 2. Value Case

Aims to quantify the benefits available from LPIT, IEC61850 communications, and any other technologies identified in WP1 and to define the target architecture and building specifications for substations.

Key Outcomes:

The project will evaluate building block options such as LPIT, IEC 61850 communications, and other WP1 discoveries against criteria including risk, sustainability, deliverability, cost, and efficiency, while developing specifications for key substation components such as asset performance management, communication protocols, and automation systems. These specifications will be validated against previous technical reviews, and a detailed cost benefit analysis will be carried out to identify the most cost effective and efficient digital substation design options.

Key Deliverables:

1. Target Architecture and building block specification report and recommendations
2. Cost Benefit Analysis

Work Package 3. Solution Testing and Analysis

Validates the proposed solution through rigorous testing and analysis.

Key Outcomes:

Laboratory testing will validate substation prototypes under controlled conditions, assessing interoperability, cybersecurity, communications performance, network architecture, and environmental resilience, while also selecting an appropriate Substation Configuration Tool (SCT). The team will identify gaps between current assets and proposed specifications, test multiple scenarios to refine the prototype, resolve non-conformances, and document outcomes through detailed test reports and a white paper. These outputs, together with findings from earlier project phases, will inform the business case by capturing the full range of qualitative and quantitative costs and benefits relative to an agreed baseline.

Key Deliverables:

1. Lab test report and recommendations
2. Business Case

Work Package 4: System Architecture IEC61850 Modelling and Design Standards

Design Standards

1. Define the overall digital substation architecture (process bus, station bus, redundancy model)
2. Specify network topology (PRP/HSR, VLANs, QoS, multicast handling)
3. Develop the IED functional allocation strategy
4. Define time synchronisation architecture (PTP/IEEE 1588, SNTP)
5. Create a standardised architecture drawing set

IEC 61850 Modelling Standards; define modelling rules, create a standardised Substation Configuration Description (SCD) template, modelling guide for protection, control, and monitoring functions.

Cyber Security; defining & creating standards for communication (performance & latency), cyber security.

Asset Management; the project will set standards for managing Substation Configuration Language (SCL) files and firmware, along with consistent procedures for testing, commissioning, engineering, and maintenance of digital substation assets.

Vendor Management; create a standard vendor interface specification, Factory Acceptance Testing (FAT) / Site Acceptance Test checklist

Training and Competency Development; define protection and SCADA competency requirements, create training for engineering, design and Asset Management teams, and establish ongoing programmes to maintain digital substation skills.

Key Deliverables:

1. Design Standards and specifications
2. Modelling Standards - specify SCL engineering tool requirements
3. Cyber Security Standards
4. Testing and commissioning standards
5. Vendor interface specification
6. Training packages

Work Package 5. Project Management, Implementation/Adoption Phase and Dissemination

Focuses on preparing for first digital substation and large-scale rollout, supported by strategic planning and change management.

Key Outcomes:

The project will develop a phased implementation roadmap with clear milestones and BAU design criteria, supported by change management activities including impact assessment workshops, capability building programmes, and updated work instructions, policies, and procedures. A deployment framework will define governance structures, performance metrics, and field trial plans to validate supply point performance under real world conditions. Project setup, delivery, monitoring, reporting, and industry dissemination will ensure effective governance and broad sharing of outcomes.

Key Deliverables:

1. Implementation roadmap
2. Change Impact Assessment and Change Communication Plan
3. Training package, updated work instructions/policy/processes
4. Governance, change management adoption/acceptance
5. Project reporting and dissemination activities (papers, journals and conferences)

Data Quality Statement (DQS):
The project will be delivered under the NIA framework in line with Ofgem, ENA and SSEN internal policies. 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 in our internal systems with appropriate 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 supplier quality assurance regimes, measurement process and equipment as well as data processing will be clearly documented and verifiable. The measurements, designs and assessments will also be clearly documented in the relevant deliverables and final project report made available for review

Scope

This project seeks to enable efficient construction of 132 kV GSP and BSP on the electricity distribution networks by advancing the standardisation of design and engineering practices related to LPIT and IEC 61850 based digital substations, drawing on developments demonstrated by innovation projects and other utilities and OEMs. The benefits to consumers would be financial. The benefits of transitioning to this technology at 132kV, would be in the region of £31m - £54m when compared to delivering our GIS workload using the current conventional approach. There is potential for environmental benefits as well, which will be quantified once explored during the course of the project. Further details on benefits in section 3.2.2.

Objective(s)

1. **Develop Specifications:** Create standard specifications for LPIT and IEC61850 within substations, including architecture,

building blocks and functionality, tailored to SSEN's network requirements.

2. **Validate Capabilities:** Demonstrate the technical feasibility and performance of LPITs through comprehensive lab testing, real world implementation, focusing on critical metrics. Providing engineering artifacts on digital substations (specifications and standards) that can be used to achieve maturity and repeatability at BAU.

3. **Optimise Network Efficiency:** Faster deployment using standards and specifications to reduce re-engineering effort across multiple stages of deployments, demonstrating interoperability to drive vendor diversification, lower CAPEX & OPEX in the long run and smaller footprint.

4. **Support Decarbonisation Goals:** Prepare the distribution network for future growth in renewable energy integration and improve the environmental performance of the distribution network.

5. **Develop a Scalable Roadmap to BaU:** Establish a clear roadmap for the implementation of LPIT based digital substations including a phased approach to BaU deployment, scalability plans and strategies for full network deployment.

6. **Business Adoption and dissemination:** Facilitate the business change to digital solutions by enabling impacted stakeholders to understand, embrace the new processes, ways of working and develop materials for industry adoption.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

The RESOP project is expected to have a positive impact on consumers as shown below. This is mainly due to the collaborative nature of the project designed to improve Net Zero forecasting to create an optimal investment pathway.
See figure 1

Success Criteria

See figure 1

Project Partners and External Funding

The project will be undertaken using NIA funding by Scottish and Southern Electricity Networks – the project will be supported by contractors where appropriate.

Potential for New Learning

Advanced substation technologies such as enhanced monitoring, automation, and modern energy management systems will provide valuable insights into optimising distribution network performance and reducing operational inefficiencies. The project will capture best practices from the Proof of Value phase—including lab testing and field trials—and share these lessons with stakeholders to inform and refine future implementations. Additionally, the experience gained will strengthen change management capabilities, supporting teams as they transition to digital solutions and adopt new ways of working. Findings from the project will be disseminated through published materials such as white papers and through presentations to industry stakeholders, helping to accelerate the wider uptake of LPIT and IEC 61850 technologies across the UK.

Scale of Project

The scale of the project is large and justified by the growing complexity of SSEN's distribution networks and the critical need to address challenges arising from increasing electrification, renewable energy integration, and evolving customer demands. Laboratory testing will create and validate substation standard specifications and templates under controlled conditions, assessing interoperability, cybersecurity, communications performance, network architecture, and environmental resilience, while also selecting an appropriate Substation Configuration Tool (SCT). The project is designed to deliver significant financial, operational, and environmental benefits. This scale of the project expects to provide sufficient learning to fully realise business as usual deployments. Limiting the project's scale would reduce its potential for learning and broader applicability. The project's outputs, including standard specifications, a roadmap for implementation, and detailed lessons learned, will enable adoption by other DNOs.

Technology Readiness at Start

TRL6 Large Scale

Technology Readiness at End

TRL9 Operations

Geographical Area

Testing will be conducted at SSEN laboratories enabling controlled validation of digital substation technologies. This laboratory location will ensure the solution is robust, scalable, and applicable across SSEN's network and other GB electricity networks.

Deployment of the solution on our network will be carried out a 132kV GSP or BSP site to allow for robust dissemination.

Revenue Allowed for the RIIO Settlement

No revenue has been provided in the RIIO-ED2 allowance for this work.

Indicative Total NIA Project Expenditure

The total project expenditure is expected to be £2,543,797

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:

This project supports the transition to a low-carbon energy system by enabling SSEN-D to modernise its substation infrastructure. The digital substation solution enhances network efficiency, enabling better integration of renewable energy sources and reducing energy losses. The project also provides the tools to optimise energy management and promote, directly contributing to a more sustainable and resilient energy system. This aligns with the broader objective of delivering a just and inclusive energy transition and delivering infrastructure needed for decarbonisation.

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

This cost-benefit analysis, together with supporting information from projects such as FITNESS (SPTEN02) and other utilities experience, demonstrates that IEC61850 digital substations technology has financial advantages over the current conventional approach. For SSEN this CBA shows that the CAPEX benefits, of transitioning to this technology at 132kV, would be in the region of £31m - £54m when compared to delivering our GIS workload using the current conventional approach. Similar savings envisaged for other licences if they adopt this solution.

There are a number of uncosted benefits that the project will seek to understand and quantify:

Fully digital substations simplify switchgear procurement by enabling identical bay specifications through low-cost LPITs and merging units, shortening manufacturing lead times and streamlining design. They reduce site-based risks and improve safety by using fibre-optic signalling instead of copper cabling, leading to faster, lower-risk installation and commissioning. Digital technology also enables opportunities for deferred reinforcement through wide-area control, enhanced monitoring, and advanced protection schemes, while IEC 61850 provides greater asset supervision, helping to cut fault investigation and rectification times and potentially enabling remote fault management. Retrofitting and adding bays is quicker and cheaper than with analogue systems, and future technology refreshes—typically required after around 15 years—are expected to be faster and less costly, despite long-term price uncertainty. Overall, LPIT based digital substations offer a more flexible platform for adaptable protection and control schemes, along with the potential for significant maintenance efficiencies, including an estimated three-to-one reduction in maintenance effort.

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

The solution is applicable to electricity licensees across GB.

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

The cost of rolling the method out across GB is dependent on the operation and maintenance arrangements of the rest of the GB network. An estimate of the roll out costs will be provided as part of the project outcomes.

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

This knowledge will enable other Network Licensees to adopt digital substation solutions tailored to their operational needs, contributing to the wider modernisation of the UK's energy infrastructure.

Specifically, the project will provide insights into:

- Cost-effective strategies for scaling LPIT and digital communications across diverse networks due to the ability to simulate different arrangements.
- As many utilities struggle with issues like interoperability between vendors, skill gaps, cyber and assurance uncertainty, a mature BAU framework would support them with proven reference architectures, validated philosophies and tested performance models with known and quantified risks which the utilities can adopt with confidence.
- With standard requirements/specifications/schemes the project enables easier multi-vendor procurement, comparable tendering and interoperable designs which would shift the industry from vendor-defined to utility-defined digital substations. Collaborative efforts can further accelerate targeted innovations from vendors as well. The transferable delivery model created in the BaU framework allows everyone to invest together on optimisation rather than rediscovering the same mistakes.

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.

This project focuses on the development and deployment of digital substations with LPITs tailored to SSEN's specific network needs. A review of existing innovation programmes across IFI, LCNF, NIA, NIC, and SIF demonstrates that no current or historic initiatives have addressed the standardisation, and repeatable deployment of LPIT based digital substations to the extent proposed by this project. Unlike FITNESS (SPTEN02) this project is centred on developing the standards, engineering frameworks, and business processes required to enable the repeatable deployment of LPIT based digital substations across distribution networks. In addition, the project will establish off-site test facilities and training programmes to ensure clear Business-as-usual readiness. The Constellation (UKPNEN05) project was focused on virtualisation, wide area protection and Localised Active Network Management (ANM). These focus areas are outside the scope of this project and importantly the Constellation project did not include any implementation or evaluation of LPITs.

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

This project is innovative as it introduces a clear and robust method for digital substation technology deployment into BaU for the benefit of all DNOs. It will move TRL from 6 to 9 and prove that BaU implementation is possible at scale by delivering the ability to simulate different arrangements. It also leverages new approaches, such as advanced monitoring, automation, and energy management, to optimise network efficiency. These technologies represent a step-change from traditional substation operations and address the growing demands of electrification and renewable integration, which have not been fully explored at this scale.

By developing scalable methodologies and frameworks, the project enables the adoption of novel solutions across all DNOs, ensuring equitable improvements to network performance and supporting the transition to a low-carbon energy system.

Relevant Foreground IPR

The project will generate intellectual property related to digital substation specifications, methodologies, and engineering models. These outputs will be designed to address SSEN's specific network challenges and objectives.

Data Access Details

For information on how to request data gathered in the course of this project, see SSEN Distribution's Network Innovation Competition (NIC) and Network Innovation Allowance (NIA) Data Sharing Procedure at https://ssen-innovation.co.uk/innovation-strategy/

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

This project involves advanced R&D beyond business-as-usual activities and since this is intended for use by all DNOs, it is appropriate that it forms part of the NIA programme. It aligns with NIA objectives by delivering value across the sector while keeping costs low for stakeholders.

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

Commercial The high upfront costs for developing and testing exceed SSEN's business-as-usual funding. NIA support ensures the risk of this innovation can be mitigated, which benefit all DNOs.

Technical Advanced data systems like real-time monitoring and automation, which carry risks in scalability and interoperability. NIA funding enables rigorous testing to mitigate these risks.

Operational Integrating the technology into live networks is complex and risks operational disruptions. NIA funding supports controlled trials to refine and de-risk solutions before deployment.

Regulatory The project aligns with RIIO-ED3 objectives but requires validated, scalable solutions to meet regulatory requirements.

NIA funding ensures these standards are achieved.

This project has been approved by a senior member of staff

☑ Yes