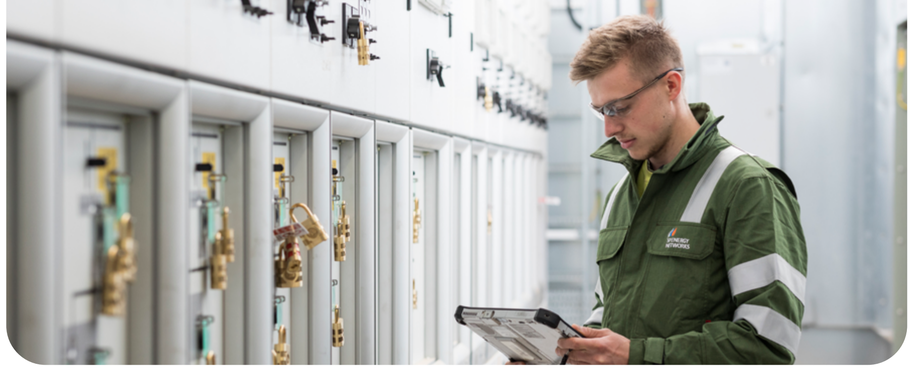
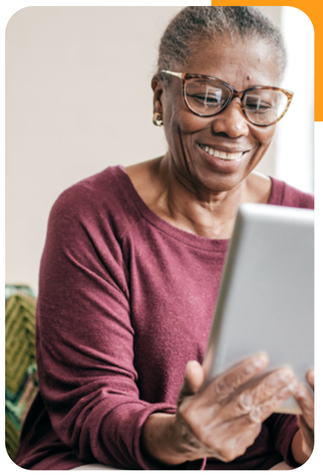
SP Energy Networks Transmission

NIA Annual Summary 2022-23





SP Energy Networks

Contents

SP Transmission plc is committed to delivering an energy network that will mitigate the impacts of climate change, achieve a low-carbon energy system, and facilitate a future that allows society to meet its energy needs sustainably. Our transmission network is crucial to reaching GB-wide Net Zero targets set by the UK, Scottish and Welsh governments.

SP Energy Networks owns and operates three regulated businesses in the UK: SP Transmission plc, SP Distribution plc, and SP Manweb plc.

Graham Campbell
Director, Processes and Technology

If you have an idea you would like to discuss with my innovation team or, if you'd like more information on a particular project, please get in touch via: spinnovation@spenergynetworks.co.uk

This Network Innovation Allowance (NIA) Annual Transmission Report is our second under the RIIO-T2 price control period. It provides an overview of NIA projects in our area that were initiated, progressed and completed during 2022-23.

The electricity transmission system remains the cheapest and most reliable method to transport bulk energy; however, we need to be future fit. The UK Government is seeking to increase offshore wind capacity to 50GW by 2030 – with c.28GW likely coming from Scotland over the next decade as part of 'ScotWind'. Additionally, the Scottish Government has set a low-carbon hydrogen target of 25GW by 2045, whilst National Grid's fastest credible future energy scenario envisions battery storage in GB increasing to 20GW by 2030.

Our network will be instrumental in connecting new renewable generation whilst facilitating the transfer of significant quantities of renewable energy from generators north of our territory to demand centres in England, benefiting consumers well beyond our area. Due to the large volume of renewable energy required for Net Zero, we have a responsibility and network duty to facilitate these connections and transfer the large quantities of power south. We are undertaking innovation projects that align with this strategic reality via our customer-funded NIA activities.

Scottish Government's low-carbon hydrogen target for 2045 is

25GW

The NIA allows us to provide benefits to our customers by embedding world-class innovation into business as usual. We are leading projects, with support from our delivery partners, that align with our strategic priorities of network modernisation, system security and flexibility, network flexibility, and the digitalisation of networks - with two projects completed, 20 others ongoing, and 10 newly registered. Furthermore, we are participating in 13 collaborative projects led by other network licensees. Some key highlights include:

- Our newly registered 'Truly Sustainable Substation', 'Cyber-SAFEN', and 'Innovative Monitoring of GIS Cable Terminations' projects which are already providing us with initial learning. These projects will provide our customers with more resilient and robust substations and reduced risk of outages caused by cyber-attacks and switchgear cable faults.

- 'Project Synthesis' - an investigation into frequency response services and the potential for green hydrogen to mitigate curtailment payments to wind generators. This project seeks to mitigating these issues and support and enhance transmission network reliability for distributed energy resources. Further details of this project can be found on the ENA portal.

The outcomes from these projects will be incorporated into business as usual to improve the outcomes for our customers and stakeholders as we continue to deliver our ambitious and exciting T2 business plan.

Portfolio Summary

2 Completed projects

Live projects 20

Partner Led collaborations 8

SPEN Led projects 14

Our commitment to innovation

At SP Transmission, innovation is a core value which we use to help deliver the needs of our consumers and wider stakeholders. We understand and are prepared for the Net Zero journey and we are leading the way with our innovation activities; developing new technologies and solutions to enable the energy transition, promoted through our innovation engagement initiatives which are helping us address the opportunities and challenges ahead.

We are constantly innovating to provide the network of the future, which will facilitate the Net Zero economy, enable the connection of increasing levels of renewable generation, and ensure consumers' safety and security of supply. Indeed, we are a leading UK transmission network owner, facilitating the connection of around 7GW of new renewable generation over recent years. Innovation allows us to do more, for less, from making it easier to connect renewable generation, to improving the efficiency of our day-to-day operations and is crucial to achieving a "Better Future, Quicker".

Our innovation strategy builds on industry-wide innovation successes achieved during the RIIO-T1 price control period. In RIIO-T2, we are delivering even bigger and better innovation; empowering consumers and accelerating our way to achieving the UK's Net Zero targets.

Our commitment is to successfully deliver our innovation strategy in RIIO-T2 such that we can ensure that the smart networks of the future are resilient, flexible and affordable for all. In RIIO-T2 we are continuing to invest effectively in our network and maintain and improve its reliability and resilience for the benefit to our consumers.

The pace of change to Net Zero is bringing new opportunities and challenges which we're addressing by thinking differently and taking an innovative approach to our day-to-day business. We are continuing to improve and modernise our infrastructure and operations whilst meeting our regulatory obligations. Renewables, new connections to Europe, the fast-changing nature of demand, and the overall need to empower our consumers and provide them with a reliable and resilient service are at the heart of our innovation ambitions.

We have embraced innovation, because we know that the challenges we face cannot be solved by doing things the same way we did a decade ago. We need to work even more collaboratively and think outside the box to bring transformation in our business through innovation.

Strategic Focus Areas

The changes we are witnessing in power generation, distribution and demand are significant, with large coal plants being replaced with increasing numbers of small-scale renewable generation. Our forecasts also anticipate an increase in wind capacity across all future scenarios. Changes in the end-use of energy, such as the electrification of heat and transport, require us to investigate innovative approaches to support the transition to Net Zero.

Our RIIO-T2 Innovation Strategy focusses on the key energy transition challenges we foresee as facing our transmission network and reiterates our commitment to our customers and stakeholders. In our strategy we have developed 4 Innovation Clusters, mapped against the ENA Innovation Themes, which are guiding our innovation delivery and ensuring we develop a balanced Network Innovation Allowance portfolio:

- **Network Modernisation**
- **Network Flexibility**
- **System Security and Stability**
- **Digitalisation of Power Networks**

We are emphasising the challenges discussed above in our innovation projects to ensure a secure future for our consumers despite all the uncertainties involved. Our plan will ensure that the benefits of innovation-funded projects are fully realised in this and future price control periods as per our consumer and wider stakeholders' expectations. Our ultimate goal is always to deliver the benefits to consumers while maintaining security and quality of supply.

Network Innovation Allowance (NIA) funding continues to be at the core of our innovation strategy. Through NIA we are developing agile, smaller-scale projects and accelerating Technology Readiness Levels (TRL) to bring our innovations to the next level – whether that's further development through innovation funding mechanisms like the Strategic Innovation Fund, or direct into Business as Usual (BaU).

Project Highlights

The projects across our portfolio range in scale and scope to deliver the most impact and benefit to our customers and stakeholders. For this summary report we have focused in on 7 projects across two of our innovation clusters, providing a snapshot of the strategies being employed and the outcomes being delivered.

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System Security and Stability

Network Flexibility

Registered id:	Budget:	Start date:	End date:	Status:	Link
NIA_SPEN_0064	£243,500	May 2022	April 2026	Live	https://smarter.energynetworks.org/projects/NIA_SPEN_0064

Digitalisation of Power Networks

Cyber security for active and flexible energy networks (Cyber-SAFEN)

Developing an AI-enabled cyber security platform to enable a resilient digital power network.

Overview

Cyber-SAFEN aims to build and demonstrate an integrated cyber defence (ICD) platform to provide a foundation on which to build essential cyber safe and resilient functions for electricity networks PAC, WAMS and SCADA systems against advanced cyber-attacks. Cyber-SAFEN uniquely focuses on a combined intrusion detection (IDS) and intrusion response system (IRS) powered by advanced AI and machine learning technologies to build a dual defence system against advanced cyber threats.

Benefits

The energy system needs to transform significantly to reach our climate change targets at the lowest cost. In line with the UK government, UK Energy network and SPEN digitalisation strategies, Cyber security is a key enabler in the energy system transition as we move to digitise our networks to enable net zero. Having a secure infrastructure reduces the likelihood of successful attack and the harm caused.

The key benefits realised by undertaking this project include:

- Reduced risk of outages and damage caused by cyber attacks
- Enable increased digitalisation and automation across the network
- Builds a secure and resilient platform on which to rollout further applications

A reliable electricity supply is critical to the day-day society function. The 2015 Ukraine energy system cyber-attacks resulted in power outages for nearly 230,000 consumers in Western Ukraine. Cyber-SAFEN looks to develop systems to avoid such situations as well as mitigating any losses they could cause.

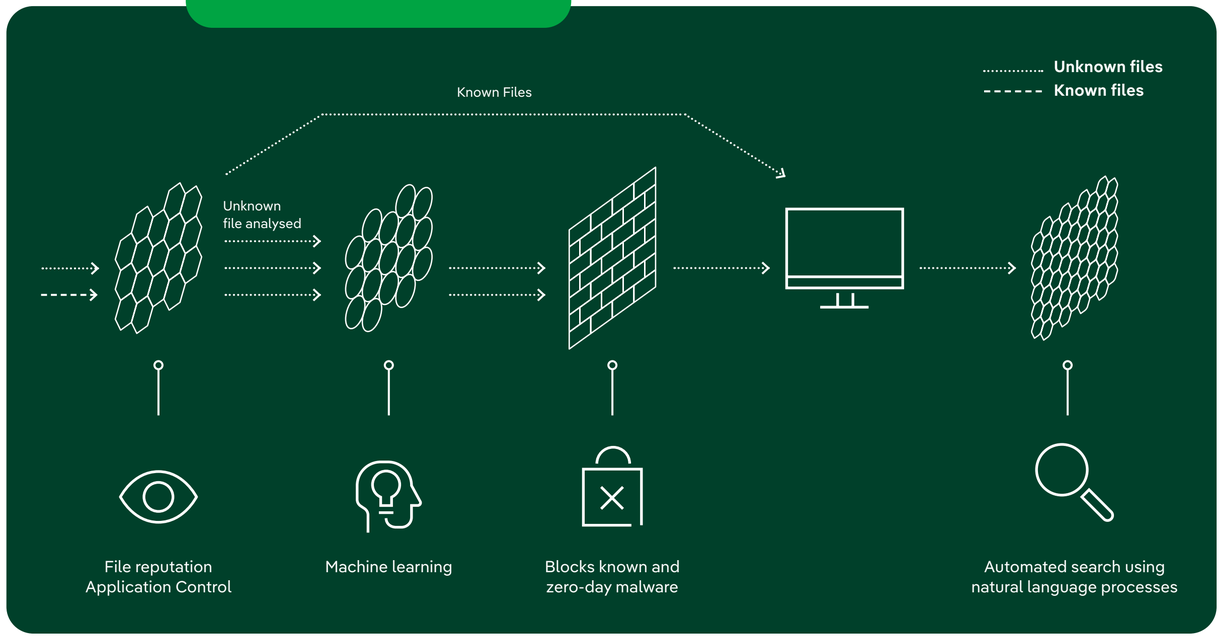
Cyber-SAFEN is an enabler to the digitalisation of substations. Based on the completed innovation project FITNESS (which looked to do this for the first time) the first UK digital electricity transmission substation will bring the following benefits over the next 15 years:

- 10% reduction of substation new-build and replacement costs, equating to £71m-£107m at the GB level
- 4-5% reduction of constraint payments equating to £27m- £80m.
- Carbon savings equating to £13m-34m through reduction in constraints and reduced use of copper in substations

Cyber-SAFEN therefore has the potential to build on these savings when enhancing digital substations.

Leveraging artificial intelligence to secure our networks

Credit: DeepArmor



Progress & Next Steps

- Study current state of the art and evolving technologies in the literature relating to cyber security issues and defence mechanisms as well as the corresponding tools.
- Identify suitable cyber security tools or strategies for digital substation and SCADA systems.
- Setup lab graded communication network infrastructure (equipment) based on Ethernet switches.

This output is due to be delivered in September 2023.

Registered id:	Budget:	Start date:	End date:	Status:	Link
NIA_SPEN_0071	£1,200,000	January 2022	March 2024	Live	https://smarter.energynetworks.org/projects/nia_spen_0071/

Network Modernisation

A Holistic Intelligent Control System for Flexible Technologies

Developing a unified controller for intelligent control of network devices

Overview

This project will investigate the potential use of a Holistic Intelligent Control System for the power network.As part of the transition to a DSO model, UK DNOs have been trialling different technologies for controlling network parameters like voltage, power flow and network topologies in real-time (e.g. Fun-LV, Active Response, LV Engine, Angle-DC and Equilibrium).

Typically each of these solutions has required its own controller which in principle aggregates the local/remote data and employs an optimisation algorithm to determine the set points for the controllable devices. Whilst there are similarities between these controller units in terms of function e.g. control algorithms and communication requirement, each solution is currently independently design, tested and performance checked due to a lock of a holistic smart control system.

A Flexible Holistic Intelligent Control System is a proposed solution that sets out the control signal hierarchy and overall network operation optimisation by considering the controllability and impact envelopes of controllable nodes and the customers flexibility offers through aggregators. It is envisaged that the HICS consists of the main controllers providing overall coordinated network optimisation and local control units providing fail-safe function and set point adjustments based on local data. This project aims to identify the system architecture, optimisation algorithms HCIS and trial of HICS within the distribution network demonstrating its performance at different voltage levels.

Benefits

The main project benefits will be in the improved roll-out of Control solutions, leading to:

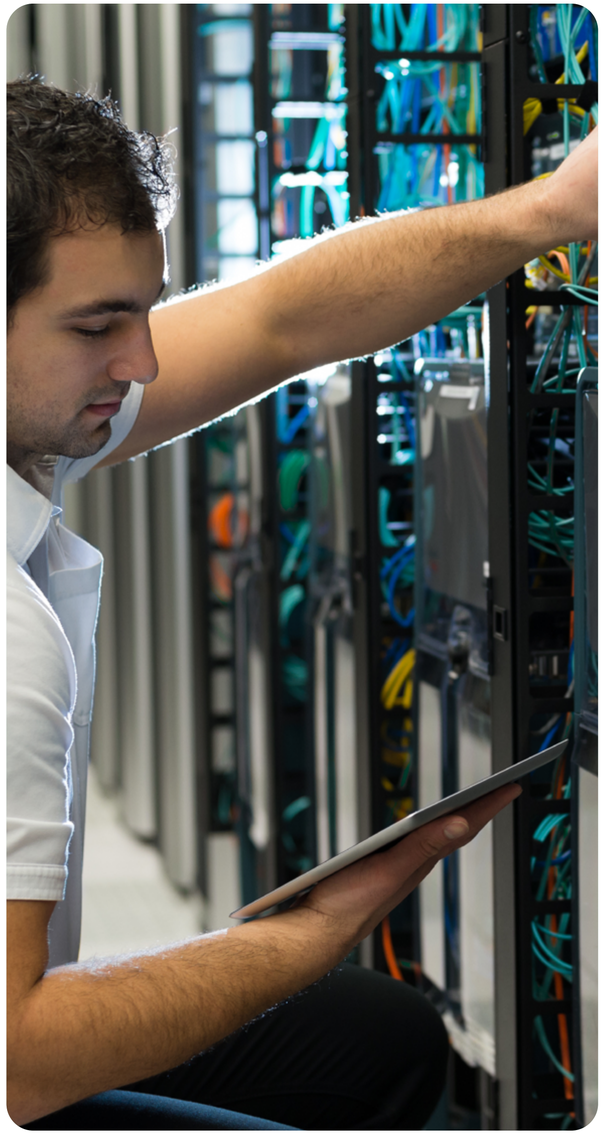
- Reduced costs as a result of:
  - Avoided duplication and additional costs of designing bespoke controllers for every solution
  - Reduced maintenance and staff training costs that would be required for systems from multiple vendors
- Faster implementation by reducing the time required for testing and refinement
- Optimised voltage profiles at HV and LV thanks to holistic operation

Progress & Next Steps

Our progress in this reporting period has focused on:

- Generalisation of the HICS system architecture for a wide range of Real-Time Controllable Devices.
- Implementation of a common message bus requirement which acts as an interface between the HICS Central controllers and HICS Platform servers.
- Inclusion of a generalised wide area control philosophy based on the Angle-DC HICS Central Controller.

In addition, a feasibility study has also been completed and, alongside the Technical Specification, will be uploaded to the ENA Smarter Network Portal for dissemination.



Significant learning

The project has learned that a technical specification for a HICS platform can be developed and used as a detailed scope for suppliers to design against. This scope allows for flexibility on:

- Local control and monitoring points
- Technology used for real-time control of the network
- Control philosophy used to govern each controllable network device
- Remote access route between the control centre and each controllable network device

Developing the technical specification also revealed the requirement for a common interface bus between all HICS Central Controllers and the SPEN EMS to avoid exponential increases in data exchange as the number of HICS central controllers grow.

Registered id:	Budget:	Start date:	End date:	Status:	Link
NIA_SPEN_0073	£80,000	April 2022	December 2023	Live	https://smarter.energynetworks.org/projects/NIA_SPEN_0073

Network Modernisation

Transmission OHL Crossing Protection Stage 1

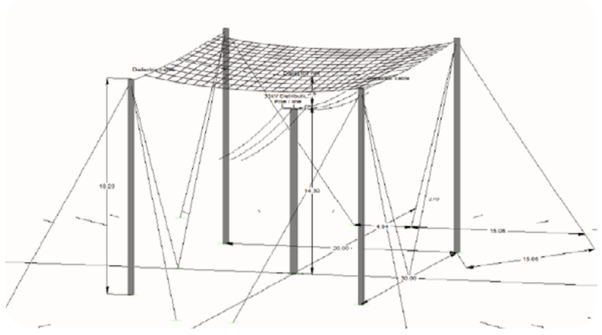
A novel system to avoid the need for under-grounding of distribution overhead lines during transmission reconductoring

Overview

This project will develop a protection system to protect transmission overhead lines (OHL) from inadvertent re-energisation from contact with Distribution OHL during reconductoring.

When reconductoring Transmission OHL, there can be issues when the transmission line crosses a section of Distribution OHL. It is critical that during work transmission OHL does not drop, make contact with the distribution line and become re-energised as such an event could cause harm to the operatives who are working on the isolated line. Currently, this is avoided by undergrounding the section of distribution line, but this can be very expensive once costs such as outages, excavation and reinstatement are factored in.

SBB proposed protective structure for crossing



Benefits

The benefits of this project will mainly be realised in Phase 2 once the device can be deployed. The main benefits will be in reduced cost of Transmission OHL reconductoring through the avoidance or reduction of undergrounding/diversion works.

Progress & Next Steps

A prototype design has been developed and the next step involves the demonstration and testing of the system. We will assess the suitability of the design by recreating a re-energisation by dropping an overhead transmission line onto a crossing with an out-of-service distribution line beneath it. This will enable us to identify any modifications required and to demonstrate that this system works on our network.

Following this we will seek to quantify the number of crossing this approach could be applied to.

Registered id:	Budget:	Start date:	End date:	Status:	Link
NIA_SPEN_0074	£365,000	April 2022	October 2023	Live	https://smarter.energynetworks.org/projects/NIA_SPEN_0074

Network Modernisation

Project Conan

Non-destructive testing of overhead line conductors for predictive maintenance

Overview
This project will develop a device for non-destructive conductor assessment to analyse the condition of ACSR and AAAC overhead line (OHL) conductors. The aim is to enable predictive condition-based interventions.

Benefits
The main benefits of the project will be:
- Reduction in costs associated with network downtime
- Greater visibility and understanding of conductor condition
- Reduced network downtime
- More efficient condition surveying, with less disruption to local community
- Safely extending asset life/reducing asset risk of failure through more effective assessment.

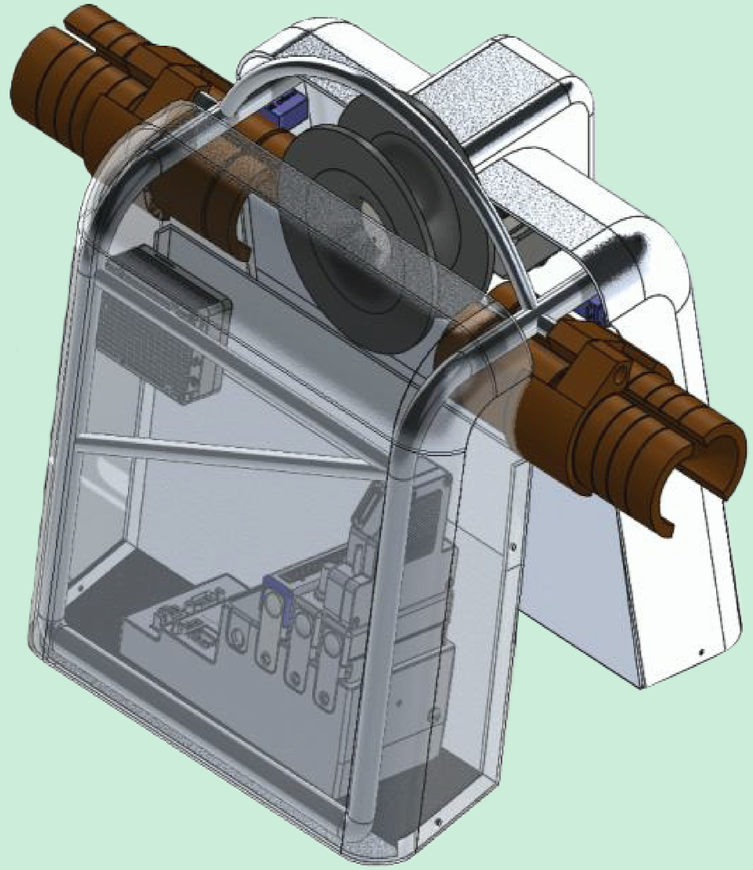
Progress
The detailed summary report of electrical and mechanical design has been complete. This design included the AAAC detector head which is a key deliverable of the project.

Following on from this, working prototypes were developed and assembled, which established a motor mechanism for connecting the device to the conductor and communication methods for upload of results. Bench testing of the device prototype has been complete, including validation of galvanising and aluminium measurement reliability, distance accuracy, maximum traversing speed, and maximum sampling rate amongst others.

Performance testing of the Conan device and the AAAC detector head has now been completed.

Next steps
- Testing and trials in a controlled environment
- Further network trials
- Finalising a user manual

£190k+
potential benefits



3D rendering of the Conan design concept

Registered id:	Budget:	Start date:	End date:	Status:	Link
NIA_SPEN_0075	£210,000	January 2022	March 2024	Live	https://smarter.energynetworks.org/projects/NIA_SPEN_0075

Network Modernisation

Landslide Protection Asset

Assessing landslide risk to secure our assets

Landslides or landslips are a relatively rare event but their impact can be catastrophic, in the recent past Scotland has experienced landslides which have caused serious impact to road and rail infrastructure.

Overview

This project will study the vulnerability of the transmission network to damage from landslips, landslides and prove the use of a landslide protection system. Landslides or landslips are a relatively rare event but their impact can be catastrophic, in the recent past Scotland has experienced landslides which have caused serious impact to road and rail infrastructure.

Benefits

The key benefit of this project is the protection of OHL assets to reduce the likelihood of damage to our OHL assets and therefore reducing outages and supply interruptions.

Progress

An initial desk study was completed on the Dalmelly to Windyhill MITS route. This study layered different geological tiles on top of each other to develop a terrain map before calculating a landslide probability for each area. The landslide risk scores (probabilities) were classed into three categories (red, amber and green) and a RAG report was generated. Those sites classed as having the highest risk, falling into the red category, were each visited to confirm the ground conditions on site. Based on those findings, a tower was identified for the second phase of the project.

Phase 2 of this project consisted of an onsite investigation of the selected site and an assessment of the damage potential should a landslide occur. For the selected tower, the impact was deemed negligible as the potential flow of debris would not achieve enough volume or velocity as to cause damage to that tower. As such, no recommendations for further action were made for this site.

Next steps

Building on the findings so far, we would seek to conduct full site assessments of the remaining high-risk (Red) sites identified in the first stage. We will develop a hierarchy of solutions, prioritising those which are nature-based, that can be used to reduce landslide risk in those areas of most significant concern.

Significant learning

The risk mapping phase of this project has highlighted the impacts that climate change is having on the growing vulnerability and landslide damage potential of sites across our network.

Understanding climate risk of transmission assets to enable timely intervention and mitigation

Registered id:	Budget:	Start date:	End date:	Status:	Link
NIA_SPEN_0077	£130,000	November 2022	March 2024	Live	https://smarter.energynetworks.org/projects/nia_spen_0077/

Network Modernisation

Truly Sustainable Substations

Taking a circular approach to substation design - minimising whole-life carbon emissions and promoting nature-based solutions.

Overview

Embedding sustainable principles at the earliest stages of a substation development project is critical for the future resilience of the electricity network and the protection of the natural environment and climate. This project will significantly increase our understanding of the environmental impacts associated with the development and operation of substations – and give a clear roadmap for how substations designs can be improved: minimising whole life carbon emissions, embedding the principles of the circular economy and developing nature-based solutions where possible.

Innovation will be targeted to develop the principles of circular design, minimise whole life carbon emissions and embed nature-based solutions to restore biodiversity and maximise the natural capital value around our substations.

Benefits

- Align with the UK and devolved Nations Net Zero targets, reducing the risk of retrofitting to bring substations in line with future carbon emissions targets providing costs efficiencies to customers
- Reduces UK Energy Networks reliance on global supply chains - increasing network resilience.
- Supports upgrading and re-purposing of substation components to ensure longevity and adaptability.
- Climate change adaptation through nature-based solutions - increasing the resilience and reliability of the network for customers.
- Carbon sequestration and biodiversity/ natural capital gain.

Progress & Next Steps

The project aims and timeline were established in the first meeting of the project Steering Group, made up of members from a range of stakeholders including representatives from energy networks, electrical equipment specialists, energy and environmental consultants, public and non-governmental organisations.

The next steps involve a desk study to produce a detailed report summarising the current state of:

- Substation whole life carbon emissions (by undertaking a whole life carbon assessment following principles and frameworks outlined in ISO 14040 and ISO 14044).
- Circular substation design (following a suitable methodology and material circularity indicator).
- Nature-based solutions in transmission and distribution substation.

The above will take into account substation assets across both transmission and distribution substation environments including:

- Transmission substations (typically 400kV to 132kV)
- Bulk Supply Points (typically 132kV to 33kV)
- Primary distribution substation (typically 33kV to 11kV)
- Distribution substation (typically 11kV to /230 volts)

Registered id:	Budget:	Start date:	End date:	Status:	Link
NIA_SPEN_0081	£400,000	March 2023	September 2024	Live	https://smarter.energynetworks.org/projects/nia_spen_0081/

Network modernisation

Innovative Monitoring of GIS Cable Terminations

Monitoring and early-warning system for cable contraction-related faults

Non-intrusive monitoring will reduce customer impacts from unplanned outages

Overview

There are cable terminations within our Gas-Insulated Substations (GIS) which may not have been adequately mechanically secured into the GIS. The perceived risk is that large and relatively fast load reductions could cause the cable conductor to contract along its length, causing the conductor and possibly insulation to pull back out of the termination. If that was to occur, it is feasible that the connection between cable and GIS would have high resistance, generating heat and arcing across the loose connection. After deterioration, as a side-effect of high heat and arcing, the termination insulation may become compromised leading to partial discharge activity.

There is currently no non-intrusive method for testing the terminations in situ to determine if they are adequately secured. This project proposes a monitoring system which would detect the effects of cable contraction using sensors that can be applied to the exterior of the cable, termination or GIS. The monitoring system would be linked to an alarm system to alert staff to the hazard of a termination that has suffered from cable contraction.

Benefits

- Early detection of faults before it causes unplanned outages and/or damages to assets.
- Avoidance of customer impacts from unplanned outages.

Progress

Our supplier has visited the selected site to investigate the current conditions of the cable terminations and conduct an assessment to mitigate any risks before works commence. Additionally, 2G and 4G signal surveys have been completed on site to confirm the availability of a suitable connection to facilitate data transmission.

We have successfully satisfied our internal governance processes, including a successful cyber security assessment, and have finalised the contract with our project partner.

Next Steps

- Our academic partners will conduct thermal modelling of Cable Sealing End (CSE) under fault conditions and prepare an analysis of the results.
- Development of an equipment specification and detail design.
- Monitoring equipment to be manufactured and validated, accompanied by live demonstrations of their capabilities.
- Following successful testing, the monitoring equipment will be installed on site which will be followed by a year-long evaluation of the outputs. Through this period, the monitoring equipment will be optimised to reduce the volume of “nuisance alerts”.

Our NIA 2022-23 Portfolio

These tables summarise our full NIA activities for the 2022-2023 year. Learn more and stay updated about an individual project by clicking the project link to the ENA Smarter Networks Portal.

Collaboration Projects	ENA Reference	Started
TOTEM (Transmission Owner Tools for EMT Modelling) Extension	NIA_SHET_0035	May-22
Inertia Measurement Method Optimisation	NIA2_NGESO023	Sep-22
Consumer Building Blocks	NIA2_NGESO026	Nov-22
Distributed ReStart – Redhouse Live Trial	NIA2_NGESO047	Feb-23
Impedance Scan Methods	NIA2_NGET0001	Jan-23
Novel methods for sealing SF6 leaks	NIA2_NGET0016	Jun-22
Co-Simulation	NIA2_NGET0020	Jul-22
Identification and quantification of C4F7N gas arcing by-products and their implication for GIS operation	NIA2_NGET0028	Nov-22

Closed Projects	ENA Reference	Started
Data and Digitalisation - Discovery Continuity	NIA_SPEN_0067	Feb-22
Asset Reuse and Recovery Collaboration (ARRC) – Discovery Continuity	NIA_SPEN_0070	Feb-22

Live Projects	ENA Reference	Started
DynaLoad – Dynamic loading of transformer insulation	NIA_SPEN_0062	Aug-21
Cyber Security for Active and Flexible Energy Networks (Cyber-SAFEN)	NIA_SPEN_0064	May-22
Predict4Resilience – Discovery Continuity	NIA_SPEN_0066	Feb-22
Net Zero Transport – Discovery Continuity	NIA_SPEN_0068	Feb-22
Heat – Discovery Continuation	NIA_SPEN_0069	Feb-22
A Holistic Intelligent Control System for flexible technologies (T2)	NIA_SPEN_0071	Jan-22
Project Synthesis – Effective Regional Inertia Monitoring and Automatic Control with a Whole System Approach (T2)	NIA_SPEN_0072	Apr-22
Transmission OHL Crossing Protection Stage 1 (T2)	NIA_SPEN_0073	Apr-22
Project Conan (T2)	NIA_SPEN_0074	Apr-22
Landslide Protection Asset (T2)	NIA_SPEN_0075	Jan-22
Truly Sustainable D&T Substations	NIA_SPEN_0077	Nov-22
Innovative Monitoring of GIS Cable Terminations	NIA_SPEN_0081	Mar-23

SP Energy Networks Distribution
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