SP Transmission

Network Innovation Allowance Annual Summary 2023-24

SP Energy Networks

Contents

SP Transmission has a vital role to play in accelerating the pace of the Net Zero transition in Scotland and the rest of the UK and meeting the national and devolved Governments' decarbonisation ambitions.

Our innovation strategy enables us to leverage our role as a Transmission Owner to deliver the Net Zero transition at the lowest cost for customers, whilst minimising the climate impact and ensuring the security and reliability of our network as we modernise and grow our asset base.

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

In this Annual Summary Report, we highlight the progress we've made in utilising the Network Innovation Allowance (NIA) to deliver against our RIIO-T2 Innovation Strategy during the 2023-24 regulatory year. Towards the end of this report, you will also find a summary of all our projects that were initiated, ongoing or completed in the period.

This is an exciting time for the electricity transmission sector and in the past few years we have seen how joined-up approaches to network planning and investment, such as the Holistic Network Design (HND), HND Follow up exercise (HNDFUE), transitional Centralised Strategic Network Plan (tCSNP) and Accelerated Strategic Transmission Investment (ASTI) framework are fast-tracking critical transmission infrastructure development to support the connection of 50GW of offshore wind to Great Britain by 2030 and a 64% forecasted increased in UK electricity demand by 2035.

Our network will be essential for connecting these new renewable energy sources and enabling the transport of energy from those new generation sources to the demand centres across our licence area and beyond. We are developing our NIA portfolio around these priorities to ensure our network and our people are fit to deliver the transformational growth of our grid and deliver customer benefits across four strategic clusters:

• Network modernisation
• System security and stability
• Network flexibility
• Digitalisation of power networks

We've advanced our capabilities across each of these areas since our last update:

• **Truly Sustainable Substations** has developed tools to help engineers visualise the environmental cost of Network Modernisation construction activities and identify opportunities to promote a circular economy.

• Building on the success of our Synergy trials – demonstrating restoration of the electricity system from a black start event using only renewable sources – we are now developing an **Electricity System Restoration Service Simulator** to support our engineers in delivering System Security and Stability.

• **Cyber-SAFEN** – with our partners at National Grid Electricity Transmission, the Energy Innovation Centre and the University of Manchester – is developing an end-to-end cyber defence platform to support the secure Digitalisation of Power Networks.

As we look towards the RIIO-T3 Price Control period, we will be embedding the learnings from our NIA portfolio into our business-as-usual operations to ensure our customer are receiving the best value. Our innovation in T2 has given us a head start for addressing some of the key challenges that we anticipate in T3, including: cybersecurity, digitalisation, accelerated network growth and continued modernisation of our assets.

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.

50GW
Supporting the UK target for offshore wind by 2030
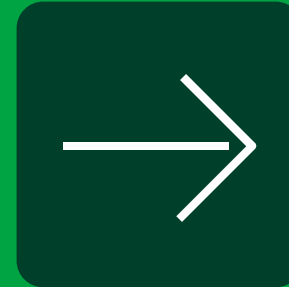
Network Innovation Allowance Portfolio Summary

SPEN Projects

17
Active SPEN Projects 2023/24

11
Ongoing Projects

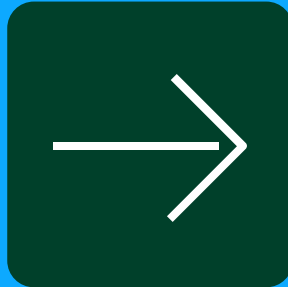**6**
Completed

2
New Registrations

Partner-led Projects

8
Active Collaboration Projects 2023/24

6
Ongoing Collaboration Projects

2
Completed Collaboration Projects

Our Commitment to Innovation

Innovation is vital for keeping the UK on track towards the 2050 decarbonisation goals. As the backbone of the electricity network in Central and Southern Scotland, our SP Transmission business is utilising the Network Innovation Allowance to modernise our operations and prime our network for the growth ahead.

In the 2023/24 year, we have continued to deliver against the innovation clusters we set out in our RIIO-T2 Innovation Strategy:

Network modernisation

The expansion of the transmission network is of strategic importance to facilitate new renewable generation and support the changing energy mix. We are deploying innovation to ensure we deliver a modern network with sustainability and climate resilience in mind:

— **Landslide Protection Asset** has improved our understanding of landslide risk for transmission towers and will inform potential mitigation strategies to improve our climate resilience.

— **Truly Sustainable Substations** is providing design engineers with the tools to seek carbon reduction opportunities in the infrastructure we build and embedding opportunities for increased circularity.

System security and stability

SP Transmission is the critical electricity service provider for 80% of Scotland's population. Ensuring our transmission systems continues to provide a reliable and resilient service is more important than ever as the demands placed on the UK energy system increase rapidly.

Our newly registered **Hardware in the Loop – Electricity System Restoration Service Simulator** will provide a realistic simulation of system restoration events to train our staff – bolstering our capability to respond to such an event.

Meanwhile, **Project Conan** is developing a non-destructive testing device for overhead conductors, facilitating a predictive maintenance regime that enables us to intervene before asset failures. Learn more on Page 09.

Network flexibility

A changing generation mix means we need to introduce new sources of flexibility onto the transmission system and develop a whole systems approach to network planning and operation.

The learnings from our **Net Zero Transport** NIA project have gone on to inform our SIF flagship **Resilient and Flexible Multi-Energy Hub Networks for Integrated Green Mobility** project. Helping us to demonstrate the feasibility of creating multi-energy hubs at UK railway stations for decarbonised rail and improved grid stability.

Digitalisation of power networks

Embedding digital technologies and advancing our data analytics capabilities is enabling us to develop new insights about our network operations and asset base. Our NIA portfolio is helping to pioneer data-driven approaches and embed a digital culture.

We've been developing **Innovative Monitoring of GIS Cable Terminations** – a non-intrusive means for continuously monitoring the health of our Gas Insulated Substation assets that leverages digital sensors and advanced modelling techniques to help minimise faults.

A digital network brings new risks so we're innovating in cyber security to stay ahead of potential threats. Investing in projects like **Cyber-SAFEN** to deliver advanced cyber intrusion detection and defence systems so we can protect our customers' information and their electricity supply.

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 spotlighted the projects with the most significant learnings, providing a snapshot of the strategies being employed and the outcomes being delivered.
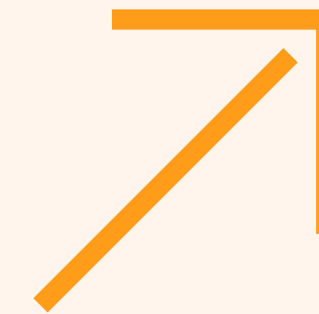
Network Modernisation

Landslide Protection Asset
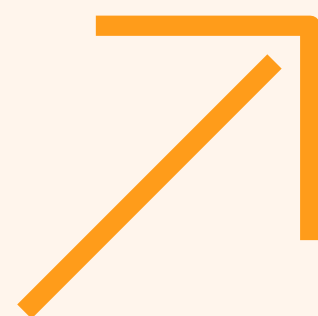**Pg 10**

Truly Sustainable Substations
Pg 11
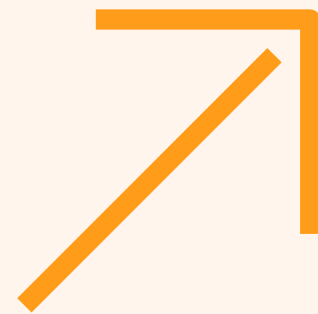
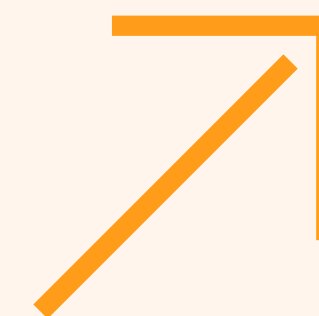## System Security and Stability

Project Conan
Pg 09

Network Flexibility

Digitalisation of Power Networks

Cyber security for active and flexible energy networks (Cyber-SAFEN)
**Pg 07**

Innovative Monitoring of GIS Cable Terminations
Pg 08

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 network 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.
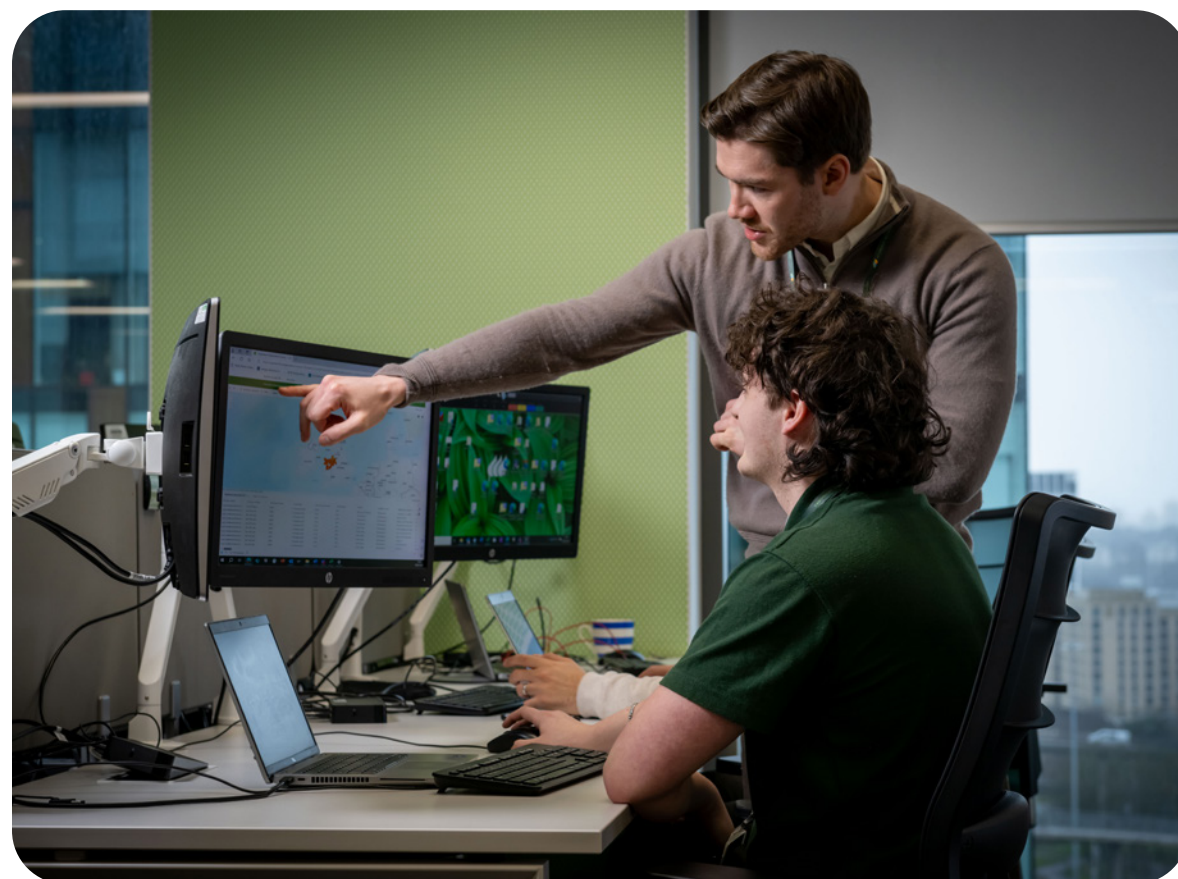
Benefits
Cyber security is a key enabler in the energy system transition as we move to digitise our networks to enable Net Zero. Having a secure infrastructure reduces the likelihood of successful attack and the harm caused.

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 everyday life. 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.

Progress
To achieve the aim of an Integrated Cyber Defence system, the project divides the deliverable objectives into four stages:
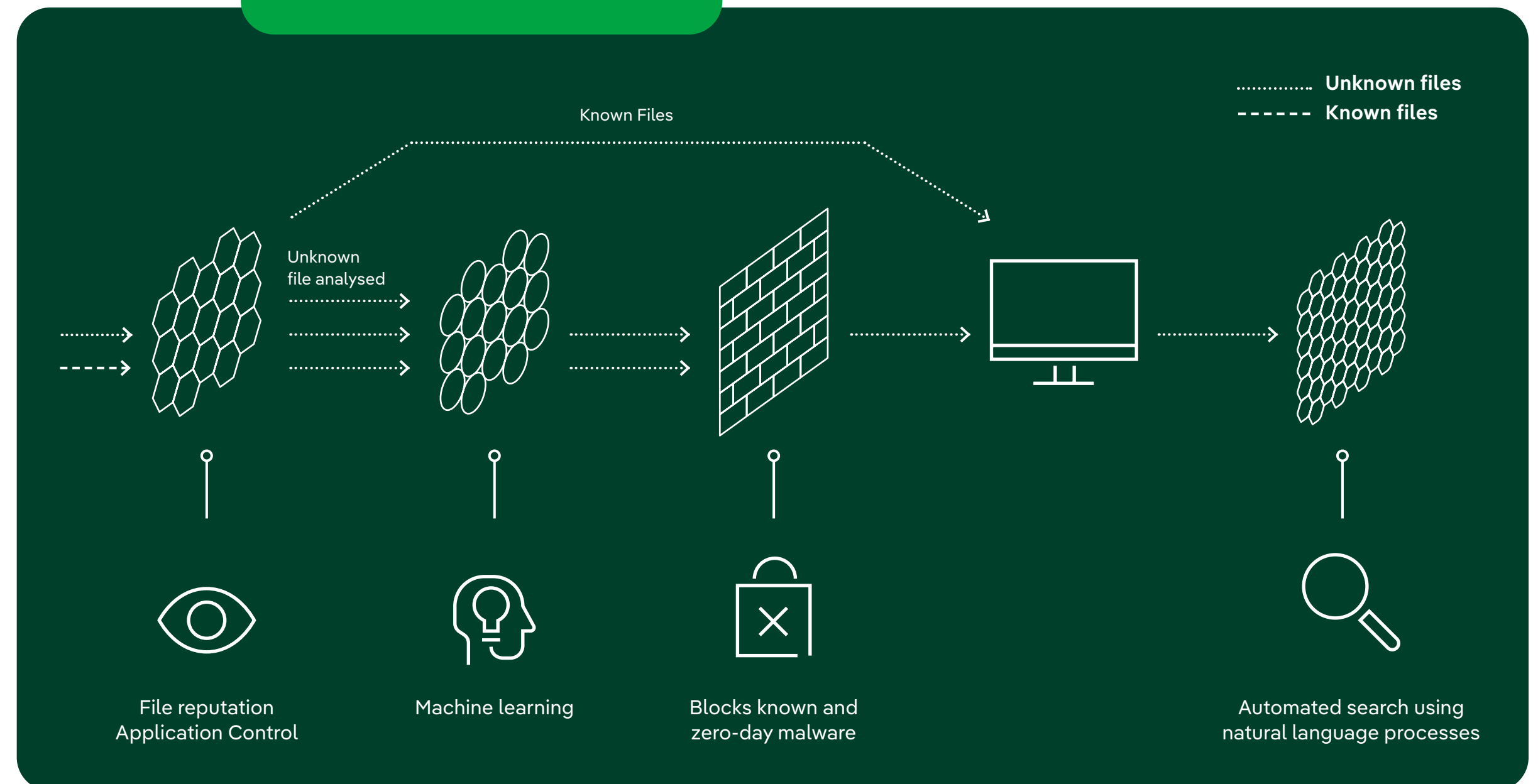- Network and data modelling
- Cyber Intrusion Detection System (IDS) design and specification
- Intrusion Response/defence System specification and development
- Performance evaluation and analysis of Cyber-SAFEN solutions

Since our last update, we've completed the first two work packages to design a novel Intrusion Defence System, based on adaptive machine learning, and demonstrated its accuracy in the test lab environment we have established at the University of Manchester.

The project is now advancing to development of the Intrusion Response System to ensure the designed system can accurately detect false positive or false negative outcomes from the IDS. By integrating the IDS and IRS in a single solution, we expect to be able to detect either known or unseen cyber intrusion events with a very high confidence.

Leveraging artificial intelligence to secure our networks

Credit: DeepArmor

Registered ID:	Budget:	Start date:	End date:	Status:	Link
NIA_SPEN_0081	£400,000	March 2023	October 2025	Live	https://smarter.energynetworks.org/ projects/nia_spen_0081

Digitalisation of Power Networks

Innovative Monitoring of GIS Cable Terminations

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

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

We've successfully completed the thermal model of the GIS cable terminations after we had to adapt our modelling approach to utilise expert assumptions due to the unavailability of certain material data. We conducted a sensitivity analysis to determine the impact of parameters that were based on expert assumptions. The results showed these parameters had minimal impact on the overall accuracy of the model.

Next Steps

In the next phase of the project we will further validate the model in lab testing. The results of which will help to calibrate the model to improve its accuracy. The project now advances to the sensor design stage, where we will develop the monitoring solution for the cable terminations.

Non-intrusive monitoring will reduce customer impacts from unplanned outages

£385k

estimated savings per fault avoided

Registered ID:	Budget:	Start date:	End date:	Status:	Link
NIA_SPEN_0074	£365,000	April 2022	September 2024	Live	https://smarter.energynetworks.org/ projects/NIA_SPEN_0074

System Security and Stability

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 anticipated benefits of the project include:
• 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
A detailed summary report of the electrical and mechanical design of the Conan device has been completed this year; including the design of the AAAC detector head – one of the key deliverables.

Building on this, working prototypes have been 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 prototype device has been completed, including validation of galvanising and aluminium measurement reliability, distance accuracy, maximising traversing speed and maximum sampling rate, amongst others.

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

£190k+
potential benefits

3D rendering
of the Conan
design concept
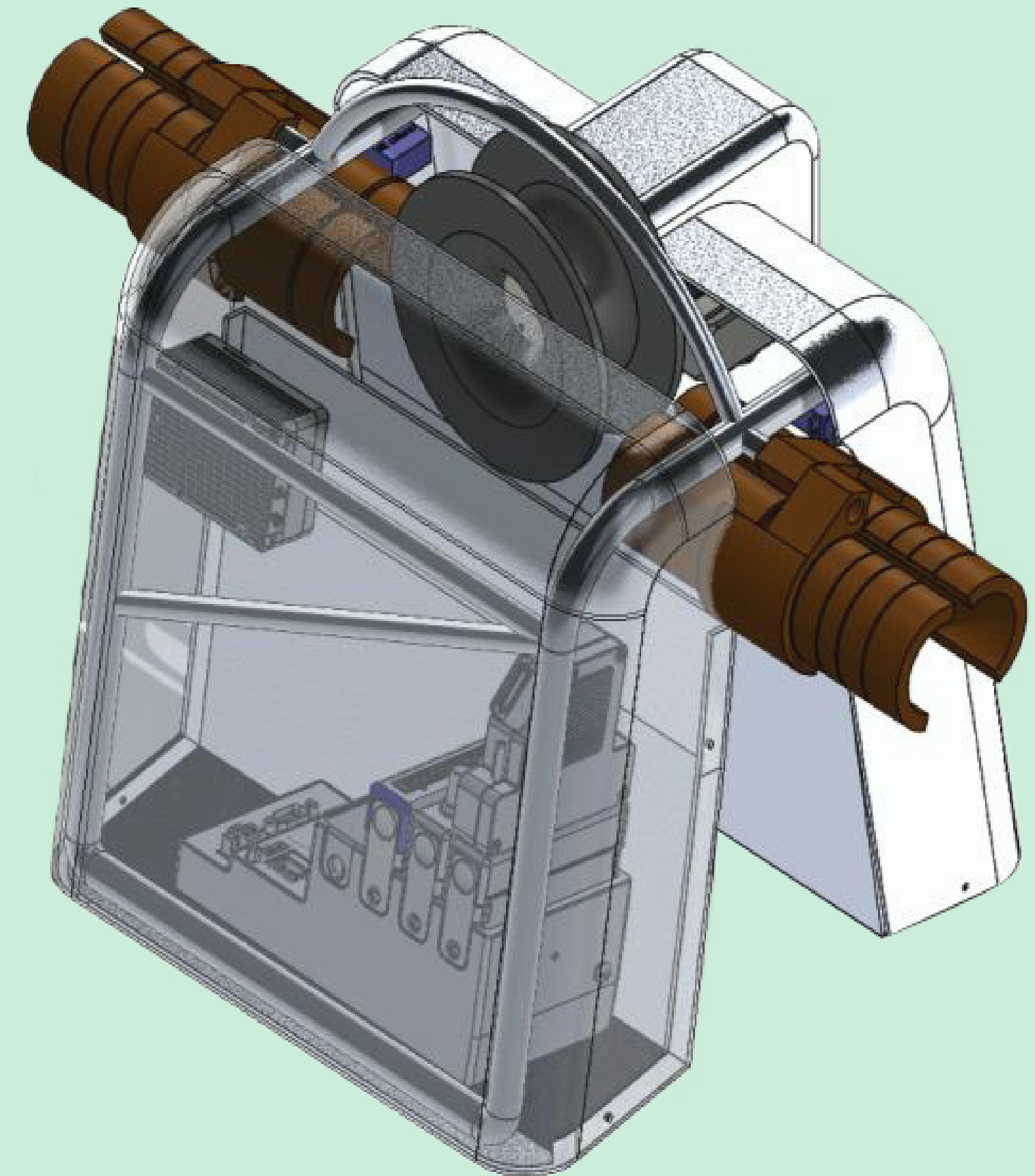
Registered ID:	Budget:	Start date:	End date:	Status:	Link
NIA_SPEN_0075	£210,000	January 2022	December 2024	Live	https://smarter.energynetworks.org/ projects/NIA_SPEN_0075

Network Modernisation

Landslide Protection Asset

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

Assessing landslide risk to secure our assets against climate change impacts

Overview
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.

This project will study the vulnerability of the transmission network to damage from landslips, landslides and prove the use of a landslide protection system.

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

Progress
Previously, we completed an initial desk study on the Dalmelly to Windyhill MITS route where we layered different geological tiles to create a terrain map and calculate landslide probabilities.

Engineering geologists have completed site inspections at **all 14 sites** identified as high risk of landslide events. Each site visit comprised visual observations of pylon location and the slopes above the pylon.

From these visits, the risk ratings for each site were either confirmed or reclassified – with six sites remaining on the high risk list.

Next steps
In the next stage, we have identified four sites for further investigation which will involve parameter gathering to inform slope stability modelling and may include LiDAR drone surveys to obtain an accurate 3D slope surface and localised ground investigations to understand ground and groundwater conditions. This would support slope stability assessments and an analysis of potential failure mechanisms. The outputs will help with recommendations for remediation or mitigation measures.

£1m
per incident in avoided repair costs

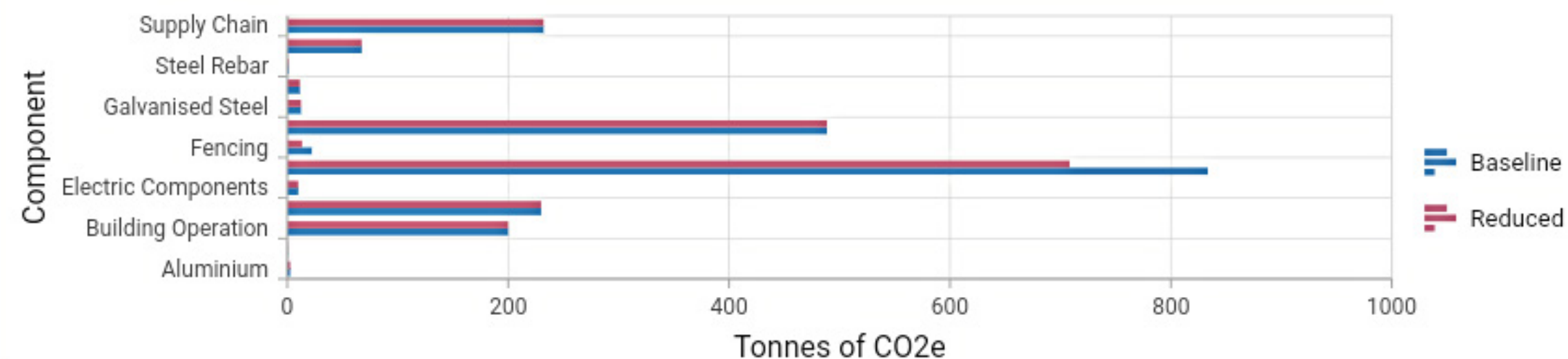| Registered ID:	Budget:	Start date:	End date:	Status:	Link
NIA_SPEN_0077	£150,000	November 2022	May 2024	Live	https://smarter.energynetworks.org/projects/nia_spen_0077

Network Modernisation

Truly Sustainable Substations

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

Credit: Centre for Energy Equality

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

To support the design of greener infrastructure, we've developed the VISualising SusTainable Assets (VISTA) tool which enables engineering teams to visualise the carbon impact of various interventions and design changes. This tool helps substation designers to identify the changes that they can make to minimise the impact of our buildings/ compounds on the environment.

We used the learnings from the opportunities register for increasing circularity in substation design and quantified the impact for each to develop the tool.

Our NIA 2023-24 Portfolio

These tables summarise our full NIA activities for the 2023-24 year.

Learn more and stay updated about an individual project by clicking the link to the ENA Smarter Networks Portal.

Completed Projects	ENA Reference	Start
Managing Uncertainty in Future Load Related Investment	NIA_SPT_1504	Feb-16
400kV Dynamic Cable Rating Retrofit Project utilising RPMA Communications Technology	NIA_SPEN_0044	Jul-19
All terrain low ground pressure access vehicle	NIA_SPEN_0051	Mar-20
Predict4Resilience – Discovery Continuity	NIA_SPEN_0066	Feb-22
Net Zero Transport – Discovery Continuity	NIA_SPEN_0068	Feb-22
Heat – Discovery Continuity	NIA_SPEN_0069	Feb-22

Live Projects	ENA Reference	Start
DynaLoad – Dynamic loading of transformer insulation	NIA_SPEN_0062	Aug-21
A Holisitic Intelligent Control System for flexible technologies (T2)	NIA_SPEN_0071	Jan-22
Landslide Protection Asset (T2)	NIA_SPEN_0075	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
Cyber Security for Active and Flexible Energy Networks (Cyber-SAFEN)	NIA_SPEN_0064	May-22
Truly Sustainable D&T Substations	NIA_SPEN_0077	Nov-22
Innovative Monitoring of GIS Cable Terminations	NIA_SPEN_0081	Mar-23
Hardware in the Loop (HiL) – T&D Operations Control Centre - Electricity System Restoration Service Simulator	SPEN_NIA_11098	Aug-23
Transformer Research Consortium – Phase 5: Future-proof Transformers in a Digital Twinning and Net Zero World	NIA_SPEN_0084	Nov-23

Collaboration projects

Collaboration is a core aspect of our innovation process and, as well as collaborating with partners on our own projects, we actively support other DNO-led projects that address key industry challenges. Below we have summarised our involvement in NIA projects led by other networks. To learn more about these collaborative projects led by our partners, please refer to the lead DNO Annual Report or visit the Smarter Networks Portal using project links listed below.

Collaboration – Completed	ENA Reference	Start
TOTEM (Transmission Owner Tools for EMT Modelling) Extension	NIA_SHET_0035	May-22
Distributed ReStart – Redhouse Live Trial	NIA2_NGESO047	Feb-23

Collaboration – Live	ENA Reference	Started
Novel methods for sealing SF6 leaks	NIA2_NGET0016	Jun-22
Co-Simulation	NIA2_NGET0020	Jul-22
Inertia Measurement Method Optimisation	NIA2_NGESO023	Sep-22
Consumer Building Blocks	NIA2_NGESO026	Nov-22
Identification and quantification of C4F7N gas arcing by-products and their implication for GIS operation	NIA2_NGET0028	Nov-22
Impedance Scan Methods	NIA2_NGET0001	Jan-23

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