



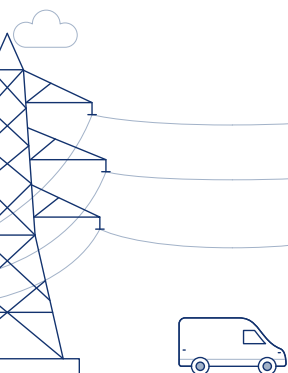
Scottish & Southern
Electricity Networks

TRANSMISSION

Annual Innovation Summary

2025/26

Contents

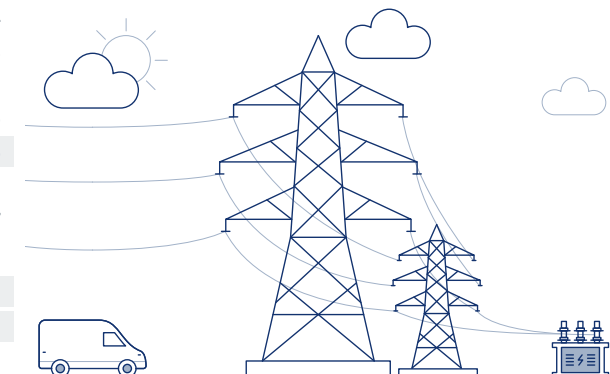


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About this Report

This report provides a short update on our innovation strategy, setting out the priorities that will guide our work over the coming years. It reflects the role innovation continues to play in helping us deliver a safe, secure and efficient transmission system, while supporting the transition to net zero.

It also summarises the impact we have delivered during the RIIO-T2 period to date and provides more detailed updates on the innovation projects that were live during 2025/26, across the Network Innovation Allowance (NIA), Strategic Innovation Fund (SIF) and Business Innovation projects. Together, these projects demonstrate how we are turning ideas into practical solutions that improve performance, reduce costs, manage risk and help create long-term value for consumers and the communities we serve.





About us

We are SSEN Transmission, the trading name for Scottish Hydro Electric Transmission. We are responsible for the electricity transmission network in the north of Scotland, maintaining and investing in the high voltage 132kV, 220kV, 275kV and 400kV electricity transmission network.

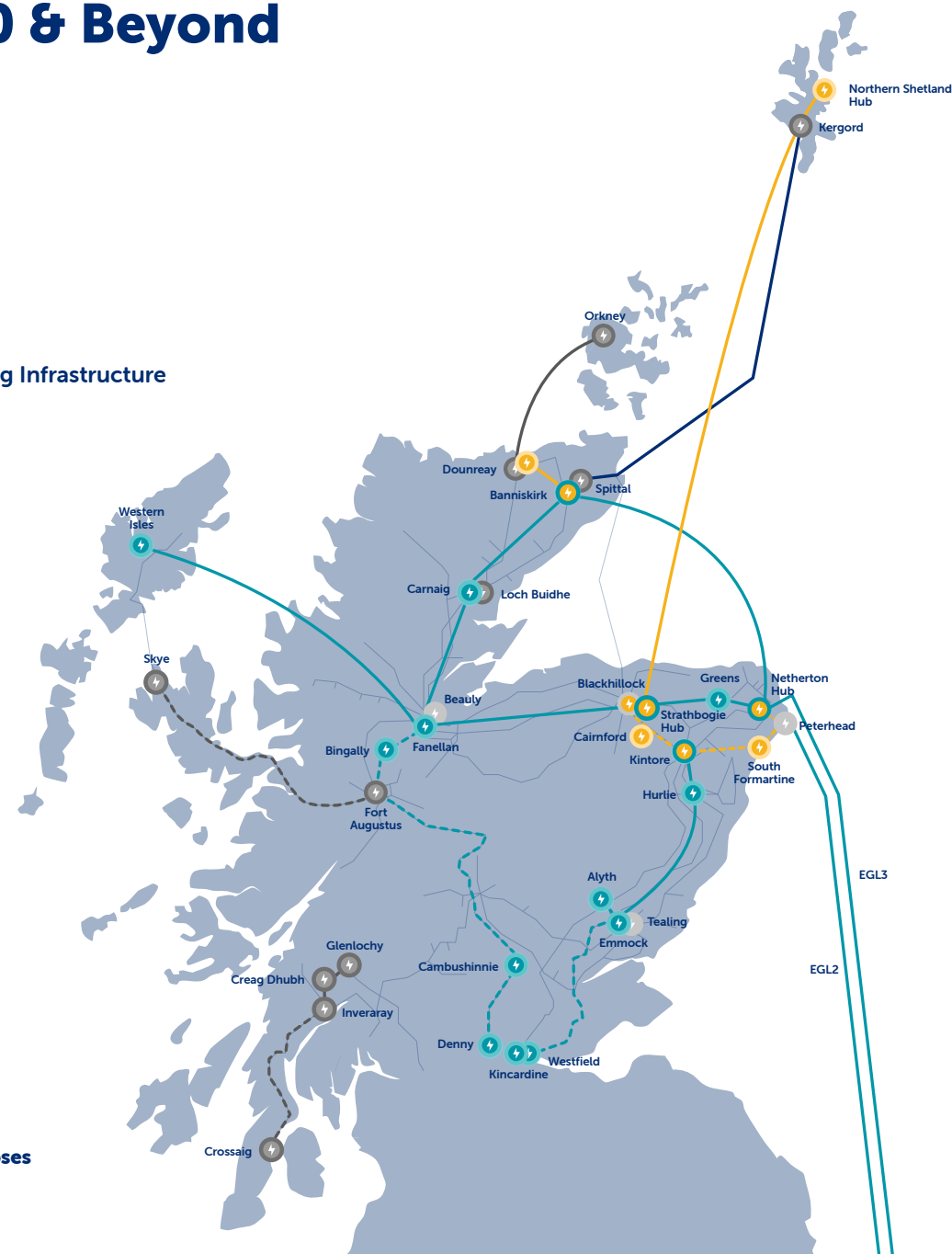
Our first priority is to provide a safe and reliable supply of electricity to our communities. We do this by taking electricity from generators and transporting it at high voltages over long distances through our transmission network for onwards distribution to homes and businesses in villages, towns and cities.

We are investing £29 billion during the RII0-T3 price control to upgrade the electricity transmission network across the north of Scotland. This will include the new overhead lines, substations, convertor stations, and subsea links which will be vital to unlocking Scotland's potential to be a clean energy powerhouse. Innovation will play a critical role in supporting the energy transition, continuing to make our network safe, secure and resilient for future generations.



Pathway to 2030 & Beyond

- Existing
- LOTI
- ASTI
- Beyond 2030
- New Infrastructure
- Upgrade/Replacement of Existing Infrastructure
- Existing Network



Foreword



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That spirit of collaboration continues to shape the next phase of innovation for our sector."



The scale of transformation – and the associated investment – now underway across Great Britain's electricity network is unprecedented. At SSEN Transmission, our £29bn investment plan for the RIIO-T3 price control period represents a once-in-a-generation opportunity: to deliver the infrastructure required for a secure, affordable and low carbon energy system, while doing so in a way that is safer, smarter and more efficient than ever before.

Innovation will be central to achieving that ambition.

As we move into the RIIO T3 period (2026–2031), we are not only building more infrastructure at pace, but rethinking how that infrastructure is designed, constructed and maintained. Across every aspect of our work, we are focused on embedding innovation that enhances safety, improves productivity and delivers better outcomes for customers and communities. This includes harnessing digital technologies, automation and new engineering approaches to ensure we can deliver at the scale required, while continuing to meet the highest standards of reliability and environmental stewardship.

And we're building on strong foundations.

During the RIIO T2 price control period, innovation became firmly embedded in our organisation – supported by a growing portfolio of projects, strong delivery capability, and an increasingly collaborative approach. Through initiatives funded via the Network Innovation Allowance and the Strategic Innovation Fund, we have explored new technologies, trialled new processes and demonstrated practical solutions to some of the sector's most complex challenges. Just as critically, we have worked in partnership with others across the industry, recognising that many of the barriers to delivering on energy security and clean power targets are shared, and that progress depends on collaboration at scale.

That spirit of collaboration continues to shape the next phase of innovation for our sector.

Ofgem, Innovate UK, and partners across the Energy Networks Innovation Taskforce have defined a new set of strategic innovation challenges for the Strategic Innovation Fund. These challenges reflect a coordinated, whole-system view of the transformation required – bringing together network operators, innovators, policymakers and wider stakeholders to focus on the outcomes that matter most for energy consumers and society as a whole.

The Strategic Innovation Fund itself is a vital enabler in this process. Delivered in partnership between Ofgem and Innovate UK, it is designed to unlock ambitious, large-scale innovation that can accelerate the energy transition while delivering tangible benefits for consumers. By supporting collaboration between network operators, technology developers, academia and supply chain partners, the programme helps to bring forward the ideas and solutions needed to reshape how our energy system operates.

Within this framework, one of the most significant opportunities lies in leading Challenge 2: Faster build and maintenance.

This challenge sets a clear and ambitious target – to deliver network infrastructure that is 50% faster to build and maintain, and 20% more cost-effective by 2035. Meeting that ambition is critical. The pace and scale of network expansion required to support the UK's clean energy transition demands a step change in delivery performance, underpinned by innovation across planning, engineering, construction and asset management.

At SSEN Transmission, we are committed to playing a leading role in meeting this challenge.

We are already working with partners across the supply chain and wider innovation ecosystem to identify and develop the solutions that will

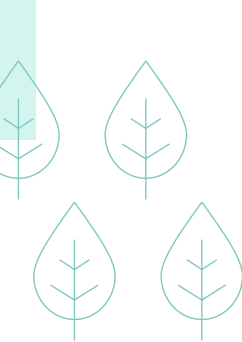
enable faster delivery without compromising on safety or quality. From new construction techniques and digital design tools, to advanced inspection methods and predictive maintenance, we are focused on ensuring that our innovative ideas have real-world impact – supporting efficient delivery today while building long-term capability for the future.

This year's Annual Innovation Summary demonstrates the depth and breadth of activity underway across our organisation. It highlights the progress we have made in developing and deploying innovative solutions, the partnerships we have built, and the outcomes being delivered for customers and communities. It also reflects the continued evolution of our innovation approach – from individual projects towards a more strategic, outcome-driven portfolio aligned with the priorities of our business in the next five years.

While there is still much to do, the direction is clear.

Embedding innovation at the heart of our delivery, working in partnership across the industry, and focusing on the challenges that matter most, will ensure that the network we build over the coming decade is fit for the future – supporting economic growth, enabling the energy transition, and delivering lasting benefits for the communities we serve.

Rob McDonald
Managing Director SSEN Transmission



Our Innovation Strategy

SSEN Transmission’s Innovation Strategy sets out our innovation purpose, vision and strategic direction, aligned with the [Energy Networks Association \(ENA\) Electricity Networks Innovation Strategy](#) and our [RIIO-T3 Business Plan](#).

Our Strategy provides a framework for identifying and delivering innovations that support the transition to a safe, secure and affordable electricity system, improving network performance and customer outcomes. It is guided by four innovation outcomes - Safer, Smarter, Greener and Faster - which define the value innovation should deliver.



Safer

Using innovation to push to be safer than we are today. We will focus on the security of the network, reducing physical hazards, promoting safe behaviours, and do so by designing out risk and designing in safety from the start.



Smarter

Becoming future ready by learning and adapting to maximise our assets. We will apply logic, data, and the right skills and experience to increase functionality and actively seek new ways of working and collaboration to improve efficiency.



Greener

Applying the test of sustainability to everything we do. We will use innovation to quantify and communicate our contribution to net zero, reducing environmental harm throughout the lifecycle of our assets.



Faster

Keeping pace, increasing productivity, and minimising delays through flexibility, agility, and empowerment. We will apply new tools and assets, focus on the output to remove barriers and champion efficient ways of working.

To achieve these outcomes, and building on the foundations in RIIO-T2, we have established Innovation Discovery Groups to identify, shape and assess opportunities against our strategic objectives.

These groups focus on three strategic priority areas aligned to our RIIO-T3 commitments, ensuring innovation investment is targeted where it can have the greatest impact on delivering a more efficient, resilient and future-ready electricity network.

Priority 1 - Maximising Network Capacity to Enable Faster, Lower Cost Connections

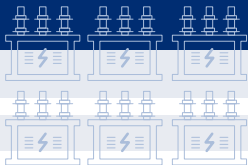
We will deepen our focus on developing new and emerging power flow technologies, supported by advance analytics, AI planning tools, and smarter design methods, to unlock more capacity on our network, enabling faster and lower-cost connections.

Priority 2 - System Stability and Security

We will focus innovation on investigating and tackling system stability challenges - voltage, inertia, and restoration - that will intensify as the network expands to integrate more non-synchronous renewable generation. At the same time, we will strengthen cyber resilience as greater digitalisation increases exposure to security threats, ensuring the system remains stable and secure.

Priority 3 - Infrastructure Delivery and Commissioning

We will focus innovation on the methods, tools, and processes that de-risk the unprecedented build-out of transmission infrastructure. This means developing new approaches for testing, commissioning, and system integration, avoiding delays, accelerating connections, and ensuring the network performs reliably at this scale.



Delivering Innovation Impact in RIIO-T2



Innovation enables us to rethink how we plan, build and operate the grid both now and in the future...”

Throughout RIIO-T2, we have continued to turn ideas into action. Working collaboratively with partners across industry, academia and supply chain, we are progressing projects that address real system challenges.

Innovation enables us to rethink how we plan, build and operate the grid both now and in the future - identifying ways to ensure we can maximise capacity, reduce constraints and outages, and ensure we can deliver the infrastructure needed at pace to support faster connections.

Embedding innovation into business-as-usual activity can unlock these tangible benefits. By deploying our innovation projects, we are strengthening the grid, improving system performance and monitoring, reducing both cost and environmental impact.

Alan Ritchie
Senior Manager
Innovation at SSEN Transmission



Maximising network capacity

As the electricity system continues to decarbonise, demand for network capacity is increasing rapidly. While we are investing in building the infrastructure required to support this transition, we are also focused on using innovative approaches to maximise the capacity of the existing network infrastructure, all with the aim of reducing system constraints, manage costs and mitigate, where possible, the need for additional reinforcements.

To support this, we are deploying a suite of grid-enhancing technologies that can enable faster, lower-cost connections by making better use of the network.

Projects such as [REVISE](#), is transforming how overhead line ratings are calculated through better use of regional weather data and testing. Early findings show significant potential to reduce operational constraints to potentially unlock 2-5% of additional capacity from a regionalised methodology.

We also are joining up with the other transmission owners to develop a consistent approach to rolling out [Dynamic Line Rating \(DLR\)](#). Currently, we have installed the technology across more than 300 kilometres of overhead line north of Beaulieu. By using real-time environmental data to calculate true live capacity, DLR can enable us to safely increase existing network capacity, help reduce system constraints that can help lower the overall cost of operating the network for consumers.

Improving system modelling and planning

As the electricity system evolves, it is becoming increasingly complex, with new technologies, changing generation patterns and greater system integrations. Understanding how the system will behave under these conditions is critical to maintaining stability and resilience.

Through projects such as [TOTEM](#), we are developing advanced modelling capabilities for GB-wide system events and help building a picture of how the future network will work. TOTEM is already supporting investigations of system events in collaboration with NESO and other transmission owners.

By improving how we model and understand the future system, we are enabling more informed planning decisions, reducing risk and ensuring the network can operate securely as we deliver a clean power system.



Turning weather data into smarter network decisions

Weather plays a critical role in how we design our assets, how the network performs, and how we undertake operational planning. We are continuing to identify smart ways to integrate the latest meteorological data to assist with planning the network.

Through our [Ice Mapping](#) project, we have developed a more sophisticated, layered model using detailed weather data that reflect local conditions more accurately to enable more accurate design assumptions and reducing over-engineering.

This approach has already delivered significant benefits, including an estimated £30 million saving on the Kintore to Dyce overhead line upgrade project. Across our wider portfolio, forecast savings are now estimated at over £125 million.

Leading on future HVDC networks

We are demonstrating global leadership in the development of future HVDC networks, which will play a critical role in integrating offshore renewable energy.

In a world-first, our [Aquila Lite](#) project demonstrated multi-vendor HVDC interoperability, enabling systems from different manufacturers to operate seamlessly together. This is aimed at removing the need for costly AC/DC conversion, and reduce reliance on single suppliers, strengthening supply chain resilience.

The project has also delivered a patented, multiterminal, multivendor HVDC control approach, marking a significant step forward in unlocking the potential of offshore HVDC networks to support clean power and energy security goals.

Accelerating delivery through smarter outage planning

As network activity significantly increases, we are developing tools that enhance planning efficiency and decision-making.

The [Year Ahead Outage Optimiser](#) uses advanced decision support algorithms to improve outage planning. By identifying clashes and risks early, it enables faster, better informed decisions and will support with the complexities of planning a renewable energy system.

The result is a more stable, coordinated and efficient approach to delivery, helping protect system security while accelerating the delivery of critical infrastructure.

Enabling smarter maintenance through robotics and AI

We are transforming how we inspect and maintain critical assets through the deployment of robotics and advanced analytics.

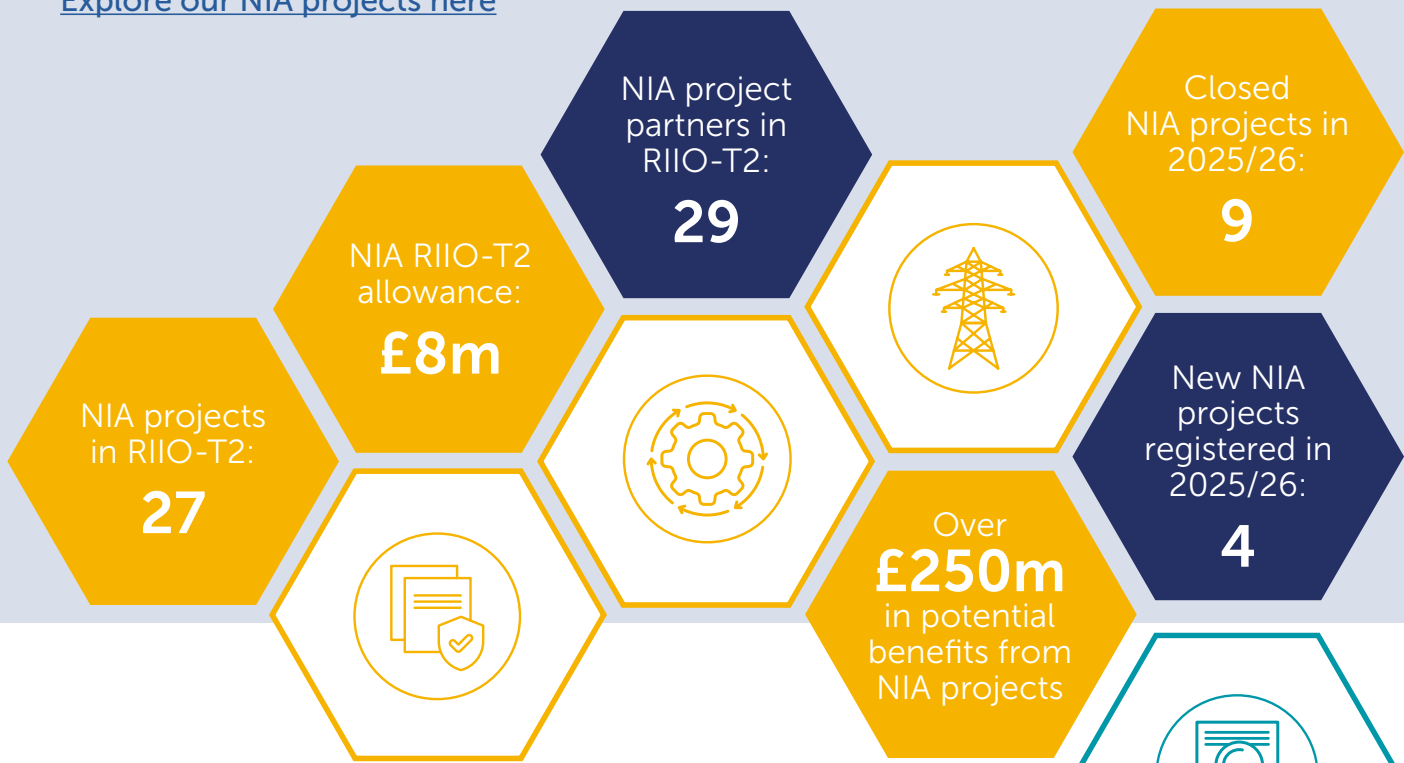
In 2024, we deployed an [autonomous robot at our Blackhillock HVDC converter station](#), the first deployment of its kind in Scotland. Named “Haggis” by a local primary school, the robot inspects equipment and identifies emerging issues without putting people at risk.

Building on this, the [ODIN](#) project is applying AI-driven analytics into insights from the live data captured in the HVDC halls. By combining robotics with AI, we are developing targeted condition-based maintenance tools designed to minimise outages, extend asset life and improve overall network resilience.

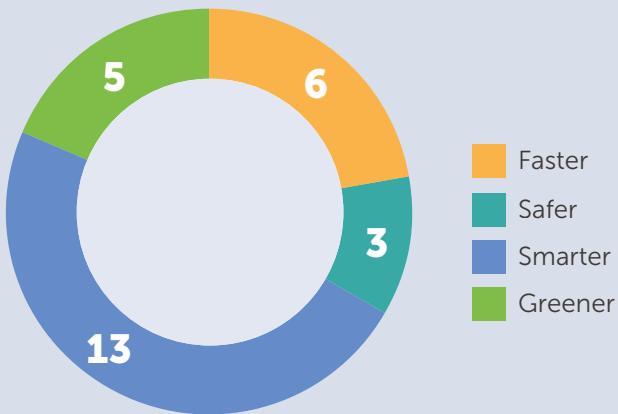
Innovation Dashboard

Key Innovation Metrics for Network Innovation Allowance (NIA)

[Explore our NIA projects here](#)

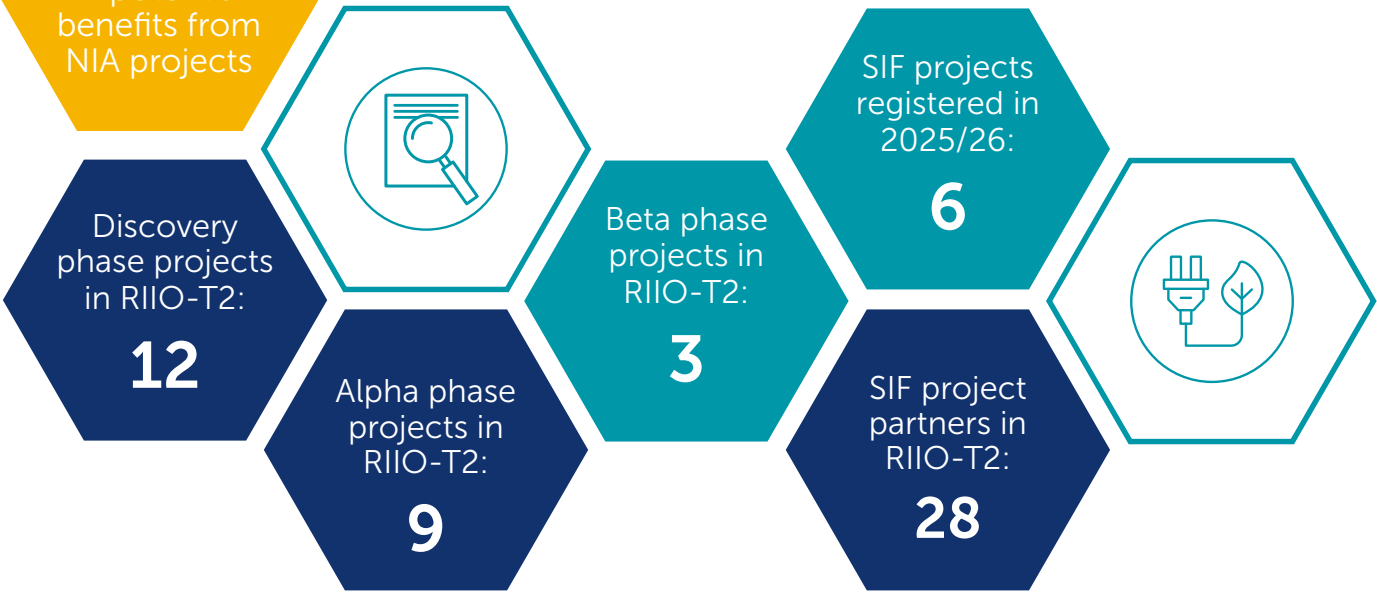


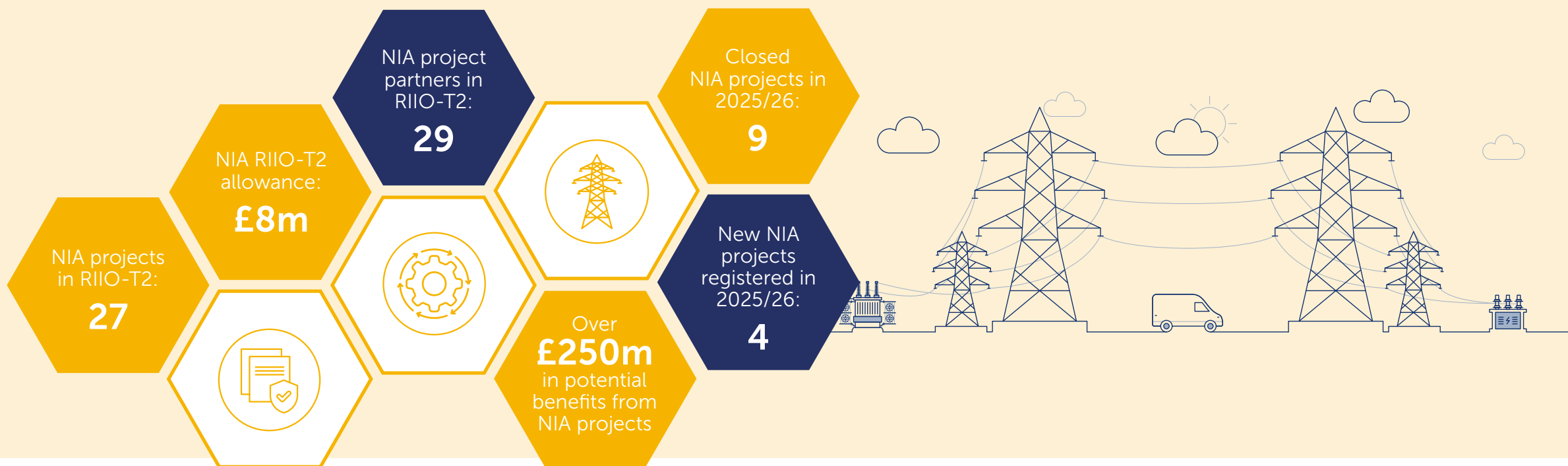
NIA projects by focus area in RIIO-T2



...and Strategic Innovation Fund (SIF)

[Explore our SIF projects here](#)





Network Innovation Allowance (NIA)

Ofgem's Network Innovation Allowance (NIA) is a set amount that we receive as part of our price control settlement. [Learn more about NIA here.](#)

Through the NIA, we are delivering targeted innovation projects that address our challenges head-on, guided by the eligibility criteria. Our NIA projects play an essential role within our innovation portfolio by increasing Technology Readiness Levels (TRL) and support the transition of innovation into business-as-usual.

In FY25/26, we registered four new NIA projects on the ENA's Smarter Networks Portal. Nine NIA projects were successfully delivered with project learnings being incorporated and disseminated, and progress being made to transition projects into business-as-usual:

- [Non-Intrusive Foundation Testing](#)
- [Proof of Concept Digitised Condition Monitoring](#)
- [Pollution Monitoring](#)
- [OHL Foundation Uplift](#)
- [Condition Assessment of SF6 Alternatives \(CASA\)](#)
- [Rapid Evaluation Areal Connection Tool \(REACT\)](#)
- [Virtual Energy System Data Sharing Infrastructure \(DSI\) Pilot – SSEN-T Component](#)
- [Pole Mounted Switchgear](#)
- [Year Ahead Outage Optimiser](#)

The following pages provide insight into the projects and progress we have made during the past financial year.



Protection Solutions to Perform for Lower Levels of Fault Current on AC Networks (PSL-FC)

Project overview:

The transition from traditional fossil fuels to renewable energy sources is changing the way the electricity transmission system behaves. Traditional generation provides strong fault currents, which current Protection and Control (P&C) systems are designed around to keep the network safe by monitoring and responding quickly. As these sources of energy are replaced by renewables which operate differently, it creates a new challenge for existing network protection approaches as signals are becoming harder to detect.

The PSL-FC project is exploring the effectiveness and reliability of new P&C equipment for a future electricity network with increased renewable generation and power electronic devices, using a combination of network simulation and open-loop device trials.

Project benefits:

The project aims to find smarter and more cost-effective ways to keep the network safe as it evolves. Potential benefits from the project include:

- Significant cost savings if P&C solutions could offer an alternative to synchronous condensers, which cost multiple £millions per installation, compared to lower cost protection system upgrades.
- Improved system resilience by ensuring the protection systems remain effective under evolving network conditions with reduced fault current levels.
- Supporting the continued integration of renewable generation without compromising network protection performance.

Progress to date:

The project has completed a simulated future network model, validated by University of Strathclyde. In addition, laboratory testing on relay settings has been conducted to evaluate P&C operation on a future lower-level fault.

During lab environment testing, when testing for the low-level fault activity, some of the original manufacturer's settings associated with the relays did not provide the expected results. Due to the technical complexity of each individual relay, the project experienced some delays in configuring settings. This was necessary prior to sending to the panel manufacturer for fitting, and to assure field trial success.

Next steps:

The project has been extended until September 2027. It is currently fitting the relays to panels before further analysis can be completed in an operational environment.

Project partners: The National HVDC Centre, University of Strathclyde

Funded: £717,000

Project timeline: July 2021 – September 2027

Project registration: https://smarter.energynetworks.org/projects/nia_shet_0033/

Focus areas:



Smarter



Greener



Proof of Concept Digitised Condition Monitoring

Project overview:

As the transmission network grows in scale and complexity, it is important to understand the condition of assets through active monitoring to maintain reliability, safety and performance. Substations host a wide range of components, and having a clear, consistent understanding how assets are performing is essential to help inform any maintenance, upgrade and replacement decisions.

This project has developed and trialled an innovative approach to modernising inspection processes. It introduced a prototype system that combines data capture, geo-tagging and a guided visual inspection routine for operatives that can be accessed via a handheld device.

Project benefits:

The project demonstrated strong potential to improve both operational efficiency and asset management practices through:

- Stronger data quality and consistency through structured, guided inspections.
- Enhanced asset health visibility that supports more informed decision-making on targeted maintenance and risks-based investment planning.
- Increased efficiency with the potential to significantly reduce time spent on data collection and processing through digitisation.
- Improved processes that provide clear records of when, where and how inspections were carried out, feeding into a centralised dashboard that can be shared between sites.

Progress to date:

The project developed, tested and validated a prototype digital condition monitoring system in an operational environment. The solution focused on Cable Sealing Ends (CSEs) within substations and introduced a guided visual inspection script, a data capture application, and a central database and dashboard. Field trials took place at two operational sites, with feedback from operatives directly influencing refinements.

The project also delivered hands-on training for thermal imaging and application testing. The successful development and trial of the system have increased the TRL from 5 to 6, demonstrating its viability in a real-world environment. It also highlighted opportunities to incorporate advanced technologies, such as computer vision, to further enhance automated analysis and insight generation.

Next steps:

Moving beyond proof of concept, the project is transitioning towards wider deployment. This includes expanding the approach beyond CSEs to other asset types across substations, enhanced system functionality, integrating with wider asset management systems, and improving usability and compatibility with a wider range of devices and tools.

Project partners: i4 Asset Management

Funded: £360,000

Project timeline: March 2024 - August 2025

Project registration: https://smarter.energynetworks.org/projects/nia_shet_0043/

[Click here](#) to watch our video.



Focus areas:

Smarter



Faster



SETTLE

Project overview:

Inverter-based resources (IBRs), such as wind and solar, introduce new complex network dynamics compared to traditional fossil fuel generation. These include oscillations that, if not effectively managed, can impact system stability and increase the risk of network outages.

SETTLE aims to deliver a real-time alert and control system for the system operator to reduce system stability risks by monitoring, detecting, interpreting and mitigating different types of power network oscillation events. The project bridges earlier work carried out under the INSIGHT project in the Discovery and Alpha SIF phases.

Project benefits:

The project aims to deliver a range of system-wide benefits including:

- Improved system resilience and stability through the ability to detect and mitigate oscillations, reducing the risk of outages
- Enhanced system understanding by improving modelling and classification of oscillation events which enables better network management
- Early identification and management of oscillations can support decarbonisation efforts by minimising reliance on carbon-intensive generation sources typically used during balancing actions

Progress to date:

The project has made significant early progress in developing the core modelling, analytical and measurement capabilities required to better understand and manage power system oscillations. This includes the development of advanced frequency-dependent device models, completing a classification of oscillation types and mechanisms, and progressing real-time simulation and monitoring approaches.

Next steps:

The project will continue progressing into integrated development and validation, including finalising advanced system models, expanding real-time network simulations, and bringing together modelling, monitoring and analytical tools into a single framework.

Project partners: The National HVDC Centre, Imperial College London, BVM Systems, University of Strathclyde

Funded: £98,245 Discovery | £252,553 Alpha | £1,187,416 NIA

Project timeline: April 2023 – July 2023 Discovery | October 2023 – April 2024 Alpha | January 2025 – December 2027 NIA

Project registration: https://smarter.energynetworks.org/projects/nia_shet_0051/

Focus areas:



Smarter



Safer

Virtual Energy System Data Sharing Infrastructure (DSI) Pilot – SSEN-T Component

Project overview:

This project formed part of the wider NIA2_NGESO081 project, focused on the initial implementation of Data Sharing Infrastructure (DSI) to enable more formal, secure and scalable data sharing between network operators and NESO. Our contribution to the overall pilot project centred on setting up the required DSI, preparing transmission outage planning data, and delivering a proof-of-concept within a sandbox environment.

The project aimed to demonstrate how a common, standardised infrastructure could move the industry away from manual, file-based data exchange processes towards a more automated, reliable and interoperable solution. This represents a key step in progressing the Virtual Energy System from concept into practical application.

Project benefits:

The outputs of the wider project, led by NESO, with contributions from SSEN Transmission and other project partners, have the potential to deliver system-wide benefits:

- Enabling a seamless process for search, find and consumption of data that can be scaled to support more frequent base model sharing requirements.
- Improved safety and grid resilience through more effective and frequent system modelling.
- Increased interoperability across the energy sector, providing a common framework for data exchange and improving coordination between network operators and stakeholders.
- Improving data quality and reducing inconsistencies, by ensuring consistent network models across organisations.
- Supporting open data and digital markets by establishing the foundations for wider digitalisation.

Progress to date:

The pilot successfully demonstrated the feasibility and value of a common DSI for the future energy system. By enabling a structured and standardised approach to sharing transmission outage and planning data, the project showed how the DSI concept can support improved modelling, analysis and coordination across the system. The pilot generated valuable insights, including the importance of early agreement on data standards, governance and security when developing shared digital infrastructure across organisations. Clear definitions of data ownership, access rights and responsibilities were identified as critical enablers for successful collaboration. This insight will help inform future scaling of the DSI and similar initiatives.

Next steps:

The DSI Pilot has captured essential knowledge that will help to evolve the technical design and implementation for a minimal viable product (MVP). With NESO taking ownership of collating feedback from the pilot, this will help de-risk the delivery of the MVP, ensuring that it will be able to scale and meets needs across a variety of use cases.

Project partners: National Energy System Operator (NESO), SSEN Distribution, National Grid Electricity Transmission

Funded: £111,000

Project timeline: January 2025 – August 2025

Project registration: https://smarter.energynetworks.org/projects/nia_shet_0053/

Focus areas:



Smarter



System Short Circuit Tests

Project overview:

The increasing integration of new power sources on the network is significantly altering system fault behaviour. Unlike traditional synchronous machines, these new sources do not provide high fault currents, presenting new challenges for system planning and protection. An accurate calculation of system short circuit currents (or fault levels) is an essential planning task to rate equipment, set protection and historically evaluate system strength during asset energisations.

To address these emerging challenges, Engineering Recommendation G74 was updated in July 2021 (G74-2) in GB. This project aims to validate the outcomes of the G74 review by recording system behaviour in response to the application of two separate fault disturbances carried out on the Transmission network.

Project benefits:

The project aims to ensure that protection systems can reliably detect and clear faults to deliver a safe and reliable transmission network. This project could:

- Strengthen confidence in how fault levels are calculated and applied in planning and protection as the GB system transitions to more power electronics and lower fault current contribution.
- Conduct system testing that has not been conducted on the transmission network for several decades, as the network's performance was previously well understood.
- Enable more accurate modelling in line with the new G74-2 guidance by collating data on network configuration, generation, and demand during tests
- Allow for a robust assessment of the accuracy of current short circuit calculation techniques.

Progress to date:

The short circuit test scoping document and draft test procedures for the first test have been completed. An internal review and approval are due from a senior System Short Circuit Tests governance group, set up to ensure the tests will be completed as planned.

Following the governance group review, the test procedures and scoping documents will be issued to NESO for review and acceptance. The project has been extended ensuring a robust, safe and technically compliant programme of works is delivered with technical experts involved from SSEN Transmission.

Next steps:

System short circuit tests are planned to be completed in 2026/2027 in line with project objectives, where system monitoring will be in place to record data. Following this, analysis and validation of the recorded data will take place.

Funded: £250,000

Project timeline: February 2025 – March 2027

Project registration: https://smarter.energynetworks.org/projects/nia_shet_0055/

Focus areas:



Smarter



Faster

Overhead Line Wind Speed Monitoring

Project overview:

As we deliver major investments to upgrade the network and connect renewable energy to the system, maximising the capacity and efficiency of the existing transmission network is critical. A key enabler of this is deploying a suite of grid-enhancing technologies.

Currently, wind speed data across overhead line (OHL) routes is limited, with few weather stations located near these assets. As a result, wind conditions are often estimated using regional data, which does not provide a fully accurate representation of real conditions experienced across the network. This creates a need to capture more accurate weather data to enable better asset, operational and monitoring planning.

This project is trialling the use of Distributed Acoustic Sensing (DAS) technology to capture real-time wind speed data along OHLs. The solution uses existing optical fibres embedded within Optical Ground Wire (OPGW) to detect vibrations caused by wind acting on the line and towers. These acoustic signals are analysed to infer wind speed along the full length of the line, without installing any sensors on the line or towers.

Project benefits:

The project could deliver significant benefits to the electricity network through:

- Increased network capacity through real-time wind speed data, supporting other grid-enhancing technology approaches, and enabling more power to be carried through the network when conditions allow
- Better utilisation of existing assets, helping minimise curtailment of renewable energy and lowering system costs for consumers
- Stronger understanding of how environmental conditions affect assets, improving reliability and safety of the network
- A novel approach to capturing wind speed data on the GB network, which will provide valuable insights by comparing this method with traditional weather station-based monitoring

Progress to date:

The project has carried out scoping, risk assessments and equipment delivery prior to undertaking the site installation of a panel at the substation which connects via a dark wire (unused existing fibre). This testing will be ongoing for one year to gather data.

Next steps:

At the conclusion of the trial, the project partner will deliver a comprehensive report analysing the captured wind speed data. This will be compared against data from the nearest Met Office weather station to assess accuracy and reliability.

If successful, the outputs of this project will provide windspeed data with positive implications for many of our grid enhancing technology projects such as Dynamic Line Rating (DLR), REVISE and Ice Mapping. Wind speed is a key component in DLR calculations and being able to increase the effectiveness of DLR via improved windspeed data could lead to an increase in grid capacity on our OHLs.

Project partners: Prisma Photonics

Funded: £150,745

Project timeline: March 2025 – August 2026

Project registration: https://smarter.energynetworks.org/projects/nia_shet_0054/

Focus areas:



Smarter



Safer



Transmission Owner Tools for EMT Modelling (TOTEM) 3

Project overview:

The UK's power system is rapidly evolving as greater levels of renewable energy are being connected, leading to a much lower level of system inertia and lower short circuit levels. The potential for adverse control interactions between these devices is rising and needs careful consideration within the context of a potentially weaker UK power system.

This project follows on from previous iterations of TOTEM to continue advancing innovative tools and resources for power system modelling. Under the TOTEM 3 project, the model is being enhanced to improve the performance of the simulation platform, alongside better representation of power system protection. This involves developing UK-standard protection models, creating tools for static and dynamic network equivalents, and model enhancement.

Project benefits:

The project will enable transmission operators to:

- Mitigate network blackout, localised disruption and small network events due to improved system stability assessment
- Effectively maintain an accurate model which will establish the correct reinforcements to maintain a safe and secure transmission network
- Reduce operational time by two hours per model from enhancements in TOTEM 3

Progress to date:

TOTEM has been successfully deployed as a core modelling and analysis tool, supporting a range of system studies and investigations across the GB network. The platform is being used to support analysis of system events and to inform planning and operational decision-making, in collaboration with NESO and other transmission operators. TOTEM 3 has so far established the Electricity Ten Year Statement (ETYS) model requirements and security measures. Project partners have also completed relevant data triage processes to establish smooth data transfer.

Next steps:

Once the ETYS model has been successfully transitioned from NESO to Manitoba Hydro International, the project will develop the newest models into PowerFactory with the aim to have access for all partners as we move through T3 and beyond to map the evolving GB power system.

Project partners: Manitoba Hydro International, SP Energy Networks, National Grid Electricity Transmission, National Energy System Operator (NESO)

Funded: £437,000 TOTEM Extension | £100,000 TOTEM 2 | £666,000 TOTEM 3

Project timeline: May 2020 – May 2022 – July 2023 TOTEM Extension | May 2024 – March 2025 TOTEM 2 | July 2025 – September 2026 TOTEM 3

Project registration: https://smarter.energynetworks.org/projects/nia_shet_0056/

Focus areas:



Smarter



Safer

Semi-Autonomous Subsea Cable Repair

Project overview:

As subsea power transmission infrastructure becomes increasingly critical, the need for faster, more resilient, and less weather-dependent repair solutions is growing. Traditional surface-based HVDC cable repair methods are often delayed by adverse marine and weather conditions, which could lead to extended outage time.

This feasibility project is investigating the technologies and methodologies required to enable in-situ repair of subsea HVDC cables, eliminating the need to bring the cable aboard a vessel. This includes developing a conceptual repair methodology suitable for subsea conditions, and exploring the potential application of AI in inspection, fault detection and repair processes.

Project benefits:

The Remotely Operated Vehicle (ROV) enabled, AI-driven subsea repairs for direct seabed level intervention could:

- Reduce weather-related delays by decoupling operations from surface assets.
- Automation enhances precision and safety, enabling flexible, continuous interventions in hazardous environments
- Improved system resilience from quicker and efficient maintenance programmes
- The project has also been designed to assess the viability of developing a universal, rapid repair solution that is not dependent on any specific cable supplier to enable future adoption from a range of network operators.

Progress to date:

The project is progressing well and performing strongly against primary objectives. Storyboards are being developed by the partners to identify the repair steps, associated challenges and potential solutions. These will be discussed and matured in a scheduled face-to-face workshop.

Next steps:

The project experienced a delayed start due to extended contract negotiations; these have now been successfully concluded. With five collaborating partners, the time required to reach a shared agreement was considered reasonable. This led to a change request being submitted to extend the end date of the project from April to July 2026.

Project partners: Carbon Trust, Arc Additives, Evolv Energies, Smarter Subsea

Funded: £100,000

Project timeline: November 2025 – July 2026

Project registration: https://smarter.energy/networks.org/projects/nia_shet_0057/

Focus areas:



Smarter



Faster



GSP Modelling

Project overview:

The increasing integration of Distributed Energy Resources (DER) and new loads are making the power system behaviour more complex since their dynamic behaviour depends heavily on the manufacturer design, which is mostly unknown to the system operator. Distribution-connected loads and generation can impact oscillation damping, contribute to delayed voltage recovery following disturbances, and in some cases feed fault current back into the transmission system, impacting protection schemes.

This impact of the distribution network on transmission-level dynamics places greater importance on how distribution networks are represented in transmission-level power system studies. Traditionally, distribution networks in GB have been modelled with simple static load models at Grid Supply Points (GSPs). However, this approach must be improved to accurately capture any system behaviour influenced by distribution-level dynamics.

This project will develop dynamic models of GB GSPs, made up of aggregated composite load and generation models. The project will also determine a methodology for the tuning and verification of the model through field tests.

Project benefits:

The project will improve the accuracy and capability of power system modelling and analysis through:

- Enhanced representation of system behaviour using composite load and generation models that capture both static and dynamic load and DER behaviour
- Improved stability analysis, enabling better understanding of real-world system performance under a range of operating conditions
- Better prediction of fault response, including voltage recovery and oscillation damping
- More informed decision-making to support targeted and efficient network investment
- Increased confidence in planning and operation as the system integrates more inverter-based and DER
- Improved system stability from implementing this innovation is expected to lead to an estimated lifetime net financial benefit of £28.6m in savings.

Progress to date:

The project is currently completing a literature review assessing advances in dynamic load modelling and the impact of future loads associated with electric vehicle charging, embedded generation and electricity demand across different sectors. Findings indicate there is a considerable opportunity to improve the modelling of load dynamics in wide-area electromagnetic transient (EMT) stability studies within the GB context.

The project team has engaged with key stakeholders SSEN Distribution, SP Energy Networks, National Grid Electricity Transmission and NESO to explore data sharing that will support the development and validation of new models.

Next steps:

The project is on track to progress into the model development phase in May 2026, which will build a GB composite load model at the GSP level. Detailed EMT models will be built and parameterised for the GB composite load model. Following this, the project will use EMT simulations to demonstrate use cases for the model in transmission system studies and develop a methodology for model verification and calibration.

Project partners: Imperial College London

Funded: £380,000

Project timeline: January 2026 – September 2027

Project registration: https://smarter.energynetworks.org/projects/nia_shet_0058/

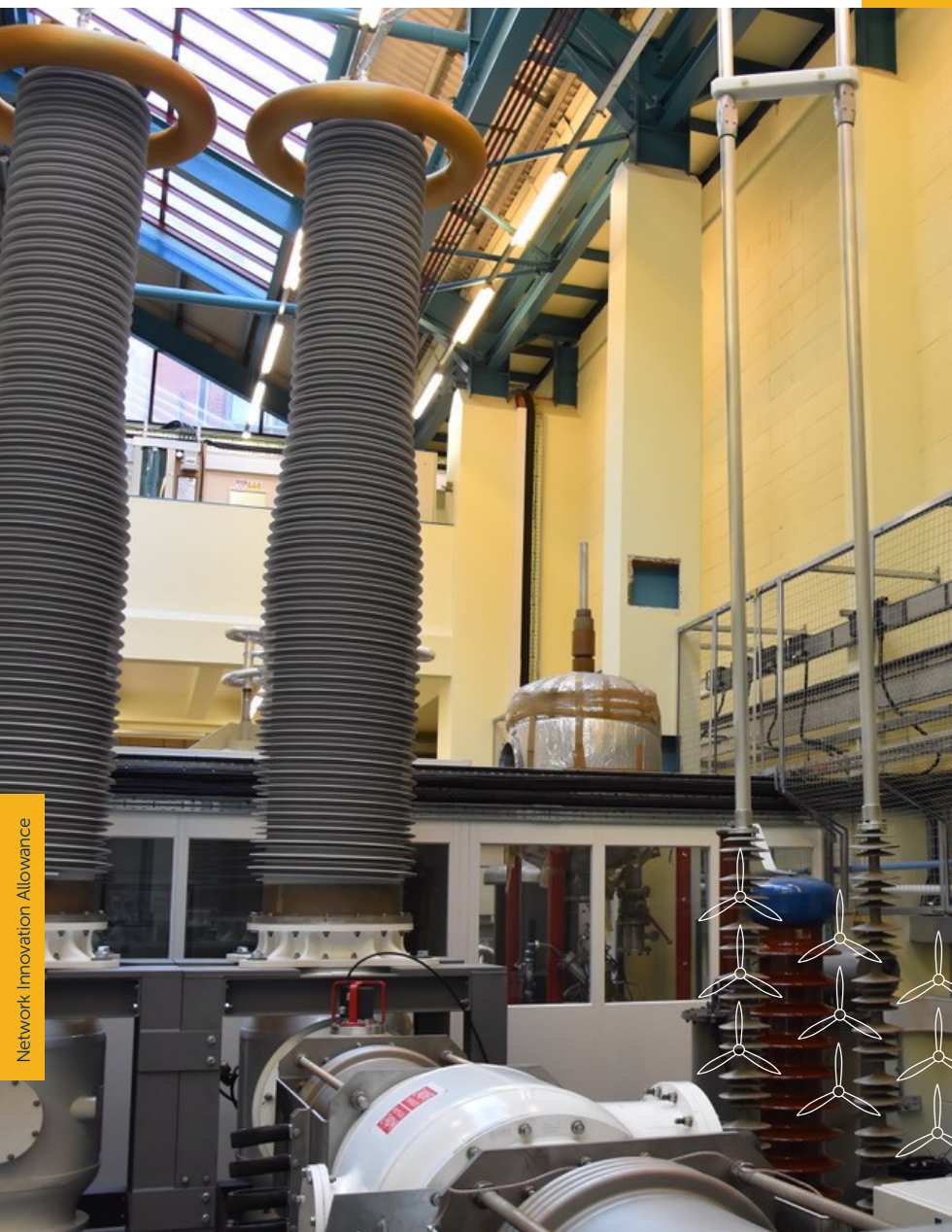
Focus areas:



Smarter



Safer



Condition Assessment for SF₆ Alternatives (CASA)

Project overview:

SSEN Transmission is migrating to alternative gases for Gas Insulated Systems (GIS) to support the decarbonisation of the transmission network. As the industry transitions away from sulphur hexafluoride (SF₆) gas in GIS, the CASA project has provided strong industry research on the characterisations of partial discharge (PD) properties in alternative gas mixtures.

Project benefits:

The CASA project can provide:

- Support in the decarbonisation of the transmission network by accelerating the adoption of SF₆-free technologies
- Improved understanding of asset performance by providing insights into how SF₆ alternatives perform under real operating conditions
- De-risking the adoption of new technologies

Progress to date:

The project investigated advanced techniques for detecting and characterising PD, as well as generating a comprehensive dataset and analysis suite. It demonstrated that advanced PD diagnostics enable earlier and more reliable identification of insulation defects and provides robust evidence that these gas mixtures can be safely monitored and managed throughout their operational life. This increases the likelihood of planned interventions rather than reactive repairs, thereby reducing outage risks, lowering the probability of asset failures, and improving system reliability.

Six technical papers published as part of the project, and findings have been presented at international industry conferences to share learning across the industry. Several important lessons were developed that will enhance the design and delivery of future projects, particularly those concerned with the transition to SF₆ alternative insulation systems:

- Early systems integration is essential for multi-sensor measurement approaches.
- Calibration activities require greater time, resourcing and iteration.
- Realistic defect models are critical to producing representative diagnostic data.
- Alternative gas mixtures cannot be interpreted using SF₆-based diagnostic assumptions, and phase-resolved PD analysis alone is insufficient for reliable classification across all defects.
- Machine learning techniques provide value but depend on high-quality labelled data.
- Structured stakeholder engagement enhances technical quality and industry acceptance and should be initiated early.

Next steps:

Reducing future SF₆ dependency across the transmission network represents a long-term environmental and financial benefit to consumers, as well as helping deliver SSEN Transmission's sustainability strategy. The next steps to progress the technology readiness level are based on a draft proposal for a follow-on project to conduct further testing.

Project partners: Cardiff University

Funded: £700,000

Project timeline: May 2022 – December 2025

Project registration: https://smarter.energynetworks.org/projects/nia_shet_0036/

Focus areas:



Greener



Smarter



OHL Foundation Uplift

Project overview:

The design approach for overhead line (OHL) foundations has remained largely unchanged since the 1920s, with the widely used 'frustum method' forming the basis of industry standards across the UK. However, initial research identified that this method is often overly conservative and, in some cases, may underestimate uplift capacity by up to 25%. This project set out to improve the current methodology for calculating the uplift capacity of steel lattice tower foundations. This included gaining a better understanding of the optimal shape and surface of OHL designs, as well as identifying opportunities to use less material and space for foundations.

Project benefits:

The project has delivered strong evidence to support more efficient, lower-carbon foundation design which could provide:

- Significant reduction in material usage and carbon impact, with optimised designs reducing concrete volumes by approximately 18% for a 30° chamfered edge, lowering embodied carbon and CO₂ emissions
- Improved foundation performance through design optimisation, with the introduction of chamfered geometries shown to increase uplift capacity by up to approximately 40% in granular soils under serviceability conditions, without increasing foundation size or depth
- More accurate and proportionate foundation design, enabled through validation of the Giampa (2019) uplift capacity method, increasing confidence in reassessment of existing foundations and reducing over-conservative design assumptions

Progress to date:

The project delivered comprehensive testing to improve understanding of foundation uplift behaviour across both clay and granular soils. In granular soils, extensive centrifuge and large-scale testing confirmed that the Giampa (2019) method can reliably represent uplift behaviour when applied correctly, providing a stronger evidence base for more proportionate design and reassessment of existing foundations.

The project also demonstrated that optimising foundation geometry, particularly through chamfered designs, can improve uplift performance and significantly reduce concrete volumes. This work provides a robust, evidence-based foundation for improving design methods, reducing material use in the process.

Next steps:

The project has established a clear pathway to transition into business-as-usual (BAU). The deployment of chamfered pad foundations will be progressed as a near-term BAU outcome, with engagement underway with OHL contractors to assess the structural design and constructability, with potential for a targeted trial plan.

Secondly, improved uplift design methodologies for clay soils will be developed to support future standards evolution. Further targeted research with the University of Dundee will refine uplift formulations and assess applicability of geometry based improvements in cohesive soils. A controlled adoption of the Giampa (2019) uplift method in granular soils will also be progressed.

Project partners: University of Dundee, National Grid Electricity Transmission

Funded: £584,307

Project timeline: December 2022 – May 2025

Project registration: https://smarter.energy networks.org/projects/nia_shet_0039/

Focus areas:



Greener



Smarter

Pollution Monitoring

Project overview:

Environmental pollution and harsh weather conditions remain a key challenge for overhead line (OHL) performance. Contaminants can accumulate on insulators and, when combined with moisture, form a conductive layer that can increase the risk of failure. Historically, there has been limited real-time data available to quantify pollution levels across the network, making it difficult to accurately assess risk or implement targeted mitigation.

This project addressed that gap by installing pollution monitoring sensors on a 132kV OHL to monitor leakage on insulators and capture environmental data remotely. The aim was to demonstrate how monitoring could be used to characterise pollution-related risk, inform asset design, and enable more proactive maintenance strategies, supporting improved network resilience as the system continues to expand.

Project benefits:

By monitoring the impact of pollution on the transmission network, it could provide benefits including:

- Early identification through monitoring enables preventative maintenance, reducing the risk of flashovers and unplanned outages
- Improved asset design and maintenance strategies through data-driven insights to support more informed decisions
- Lower operational costs and improved reliability by reducing the risk of fault-related unplanned outages

Progress to date:

Sensors were installed at a test use-case site across a section of 132kV OHL, with a two-year monitoring cycle providing insights into leakage current, environmental conditions and pollution levels. The project demonstrated that leakage current monitoring is an effective method for assessing insulator condition and identifying pollution-related risks.

Results showed that pollution levels at the selected site were lower than initially expected, with no significant flashover risk observed during the monitoring period. Advanced analysis identified factors such as heavy rainfall as key influences on insulator performance, with natural cleaning effects reducing pollution build-up.

A machine learning approach was also trialled to predict a small number of leakage current peaks, returning good results for the monitored dataset using regression techniques. However, the model was specific to this dataset and no flashover events occurred during the project. Therefore, the detection of high leakage current peaks cannot be guaranteed with this approach without using real data captured during such events.

Next steps:

There is potential for future projects to build on the findings through additional targeted studies. However, given the low levels of pollution observed at the test sites which were selected based on the expectation of higher pollution levels, large-scale implementation of this approach is not currently anticipated.

Project partners: La Granja Insulators

Funded: £220,000

Project timeline: July 2023 – March 2026

Project registration: https://smarter.energynetworks.org/projects/nia_shet_0042/



Focus areas:

Greener



Safer



Pole Mounted Switchgear

Project overview:

To connect new assets from an existing circuit, rather than direct from a substation, requires the use of a teed connection or switching station. In certain circumstances, there is a requirement to switch a teed circuit using a switching station. Currently the only option, at or above 132kV, would be to build a ground-based switching station to accommodate this. These are expensive, require long programme development time, longer construction time. It can also be a challenge to gain consent to construct a building in a remote location and is carbon intensive.

There are currently no overhead line mounted switching design solutions at or above 132kV in the UK, therefore, this project looks to consider solutions that offer value for new connections and make the best use of critical resources whilst protecting network operability.

This project explored an overhead line switching solution that can be applied to teed circuits to support the ambitions of providing quick and efficient connections. This initial NIA project was a feasibility assessment with two phases: initial visualisation and definition of functional requirements; and defining a conceptual design.

Project benefits:

The pole mounted switchgear can provide benefits including:

- A potentially more cost-effective alternative to connect new assets than a teed connection or a switching station
- Quicker deployment due to a reduction in the construction programme, helping reduce carbon emissions and connect more renewable energy
- Enabling faster renewable connections to the transmission network as a full switching station could take 3 to 4 years to design, consent and construct compared to 1 to 2 years for a pole mounted switchgear solution

Progress to date:

The project was a feasibility study to define whether the solution was practical and cost effective. The project has proven that a pole mounted solution can be designed. Throughout the project a Hazard and Operability Design was carried out to assess the ability to apply this technology.

Next steps:

The project successfully completed its objectives however as there are currently no viable use cases for a physical demonstration at this time, it was concluded that further development of this option was not beneficial at this time. Although the need for Pole Mounted Switchgear on the GB network is currently uncertain, this feasibility study has shown that in applicable situations the solution can reduce cost and build time significantly.

Project partners: Energyline

Funded: £61,000

Project timeline: December 2024 – October 2025

Project registration: https://smarter.energynetworks.org/projects/nia_shet_0049/

Focus areas:

Greener

Faster



Aquila Lite

Project overview:

To manage the integration of large amounts of offshore wind power connecting to the north of Scotland, new HVDC reinforcement is required. The project has demonstrated a world-first software interface to enable multi-vendor interoperability - allowing different manufacturers' systems, like controls and mains circuits, to work together.

The project also combines real-time digital simulation (RTDS), vendor-agnostic control architecture, and rigorous testing protocols to validate performance. Its innovative DC switching station topology reduces the need for multiple converter stations, lowering infrastructure costs and environmental impact.

Project benefits:

Aquila Lite has the potential to deliver strong benefits for the future HVDC network:

- Eliminating costly AC/DC conversions when transferring power, improving increased operational efficiency
- Improved system resilience by enabling interoperability across multiple HVDC vendors, reducing single-supplier dependency and enhancing competition in the supply chain
- Reduced infrastructure costs and environmental impact through the need for fewer convertor stations and optimised network design

Progress to date:

The project has recently delivered a detailed gap analysis and assessment of commercial, legal and liability considerations required to support future deployment. Additionally, an early-stage cost benefit analysis has been completed, indicating the potential for significant lifetime savings over a 45-year period.

Aquila Lite has been delivered by working closely with four principal HVDC manufacturers, demonstrating the importance of cross industry engagement to enable multi-vendor solutions. In recognition of its innovative nature, the project was awarded 'Best Innovation - New Technology Product' at the Green Energy Awards in December 2025. The project also aligns with international efforts, such as the EU's InterOPERA initiative, reinforcing Scotland's leadership in HVDC innovation.

Next steps:

The next phase of Aquila Lite will focus on scaling and further validating the solution in more complex configurations. Testing will be extended to a third HVDC vendor, moving from bilateral to true multi-vendor, multi-terminal interoperability. This will also include the continued use of RTDS and hardware-in-the-loop testing to assess dynamic performance, protection coordination and fault response. In addition, engagement with international interoperability initiatives to support standardisation and knowledge sharing will be ongoing.

Project partners: The National HVDC Centre

Funded: £625,074

Project timeline: December 2024 – October 2026

Project registration: https://smarter.energynetworks.org/projects/nia_shet_0050/

Watch our project video [here](#).

Focus areas:



Greener



Smarter



220kV Single Circuit Low Profile Designs

Project overview:

As the need to connect renewable energy continues to grow, both with increasing capacity and geographical density, existing low-profile overhead line (OHL) designs are no longer sufficient to accommodate large individual connections or clusters of renewable developments. In these cases, the network relies on using alternative infrastructure such as steel lattice towers, New Suite of Transmission Structures (NeSTS) or underground cables, that significantly increases construction costs. This project addresses this gap in infrastructure by developing new 220kV low-profile design that provides an increased capacity while maintaining the visual appearance, reliability and construction methods aligned to traditional wooden poles.

Building on the success of the [NIA 132kV Low Profile Steel Poles project](#), key learnings are being applied to create a solution capable of connecting large single-point windfarms, or aggregated renewable connections, particularly in low to medium altitudes. The project is also developing a reliability level 2 design for use on the Main Interconnected Transmission System (MITS).

Project benefits:

The 220kV low-profile design aims to deliver a more efficient and smaller alternative to conventional steel lattice towers and other high-cost solutions which could provide:

- Lower construction costs with an initial analysis indicating a possible 60% reduction in cost per km compared to traditional steel lattice towers
- Reduced environmental impact with an aim to lower material usage from steel and concrete in the design, and associated carbon emissions
- Accelerating renewable connections by enabling high-capacity connections at a lower cost
- A lower profile and less visually intrusive design could provide improved community acceptance, supporting consenting for renewable connections

Progress to date:

The project has made progress in developing viable 220kV low-profile designs, although challenges associated with scaling from a 132kV design to 220kV have influenced timelines, leading to a change request being approved to extend the project duration. Strategic decisions relating to the potential use cases for the 220kV pole have influenced the design approach, with constraints related to design specification, constructability, operation, and maintenance. The designs for reliability level 2 (angled, intermediate, and terminal structures) have been completed, with prototype drawings and 3D models developed.

Next steps:

Constructing the prototype structure is planned for the second half of 2026, with type approval testing to follow. The reliability level 1 detailed design will continue following the completion of the reliability level 2 drawings and models. A desktop stability study is being undertaken to validate the design philosophy of the reliability level 1 structures to provide confidence that the structural load specifications can be met. This is due to the reliability level 1 structure being designed to a less resilient use case (non-firm connections) compared to the reliability level 2 structure.

Project partners: Energyline, Norpower, PLPC, Allied Insulators

Funded: £1,430,000

Project timeline: March 2024 – September 2027

Project registration: https://smarter.energynetworks.org/projects/nia_shet_0044/

Focus areas:



Faster



Greener



Non-Intrusive Foundation Testing

Project overview:

Overhead line foundations are critical to the structural integrity of the transmission network. They require routine monitoring to support decisions about line refurbishment, upgrade and replacement. However, traditional inspection methods are often intrusive, costly and disruptive, often requiring excavation and subsequent site reinstatement. The Non-Intrusive Foundation Testing project has developed, tested and trialled a new, non-intrusive approach to foundation assessment. The project has used advanced echo-based techniques to assess foundation condition without the need for excavation, enabling a safer, faster and more efficient way to understand asset conditions.

Project benefits:

By adopting a Non-Intrusive Foundation Testing approach, it could support with:

- Reduced environmental impact by minimising the need for excavation and reinstatement
- Lower disruption for landowners and local communities during inspection activities
- Improved understanding of foundation condition offering better risk-based decisions on refurbishment, reinforcement and replacement of assets
- Increased efficiency and cost savings through less intrusive inspection methods

Progress to date:

Recent progress focused on the development and validation of an echo-based simulator model, using two full-scale test foundations (L8-D and PL16-D30). Testing was carried out to strengthen confidence in the model's ability to accurately represent real foundation behaviour. This included ultrasonic velocity measurements, impact source selection, sensor and impact positioning, and enhanced analysis methods.

Results from the full-scale testing demonstrated that the simulator model can reproduce the key features of the measured waveforms. In addition, the enhanced analysis method significantly reduces the error between measured and true foundation depth. Following successful laboratory and test-site validation, the project has refined the model, developed prototype hardware and integrated the system to a robust single, portable unit suitable for field deployment.

Next steps:

The project is now focused on transitioning towards business-as-usual. The non-intrusive testing approach is under review for integration into SSEN Transmission's wider asset management strategy. Adopting this approach, alongside existing inspection and monitoring techniques will help facilitate an increased assessment of asset health, enable necessary maintenance to be carried out and minimise our environmental impact in the process.

Project partners: Xytecs

Funded: £570,000

Project timeline: June 2024 – March 2026

Project registration: https://smarter.energynetworks.org/projects/nia_shet_0047/

Focus areas:



Faster



Greener



Year Ahead Outage Optimiser

Project overview:

Outage planning is becoming increasingly complex as the electricity system evolves, with growing volumes of renewable generation, network upgrades and competing operational priorities. Traditional, manual planning approaches are time-intensive and can struggle to efficiently manage the increasing number of constraints and dependencies.

The Year Ahead Outage Optimiser project has addressed this using advanced decision-support algorithms and optimisation techniques to support outage planning. The project designed and trialled a tool that provides optimised rescheduling solutions that balance competing operational priorities.

Project benefits:

The preliminary tests of the proof-of-concept optimisation engine are showing significant potential for improvement over historical, manually produced plans:

- Introducing optimised schedules can significantly reduce the number of outages:
 - 5-month planning: 29.1% reduction in outages and 5.4% reduction in outage-days with no loss of work delivery
 - 12-month planning: 34.8% reduction in outages and 7.4% reduction in outage-days while scheduling over 99.6% of requests
- The tool provides significant efficiency savings, as the time required to process outage changes from hours to minutes
- Reduced manual workload through automation and optimisation enables planners to focus on higher-value decision making
- Improved network availability through more efficient scheduling of outage activities

Progress to date:

The Year Ahead Outage Optimiser tool has developed three main features that support planners, tested against historical planning data:

- Outage Planning Validation: This module acts as a critical feasibility check, automatically scanning a plan to identify violations of operational and resource constraints, such as incompatible outages or daily switching limits.
- Outage Planning Optimisation: The core engine actively resolves these problems by generating a new, fully compliant schedule based on a multi-objective function. This function allows planners to weigh priorities like maximising delivered work, maximising network availability, and minimising shifting of requests from their original dates.
- Single Request Analysis: This module provides immediate decision support when a planner needs to schedule a new, urgent request, drastically reducing the time required to process a change.

The proof-of-concept demonstrated important insights that will inform future development, including how translating engineering knowledge can be successfully codified into algorithms to enable automation of complex planning tasks. In addition, the trial proved that automation of manual processing tasks can offer clear operational and financial benefits offering up to £5.7 million in lifetime savings.

Next steps:

The project is now moving into a fine-tuning iteration, looking at a phase two to further align the model's parameters. Future development for full production use will involve refining the user interface, improving functionality, and conducting further performance testing.

Project partners: N-SIDE

Funded: £382,000

Project timeline: September 2024 – September 2025

Project registration: https://smarter.energynetworks.org/projects/nia_shet_0048/

[Click here](#) to watch our dissemination session.

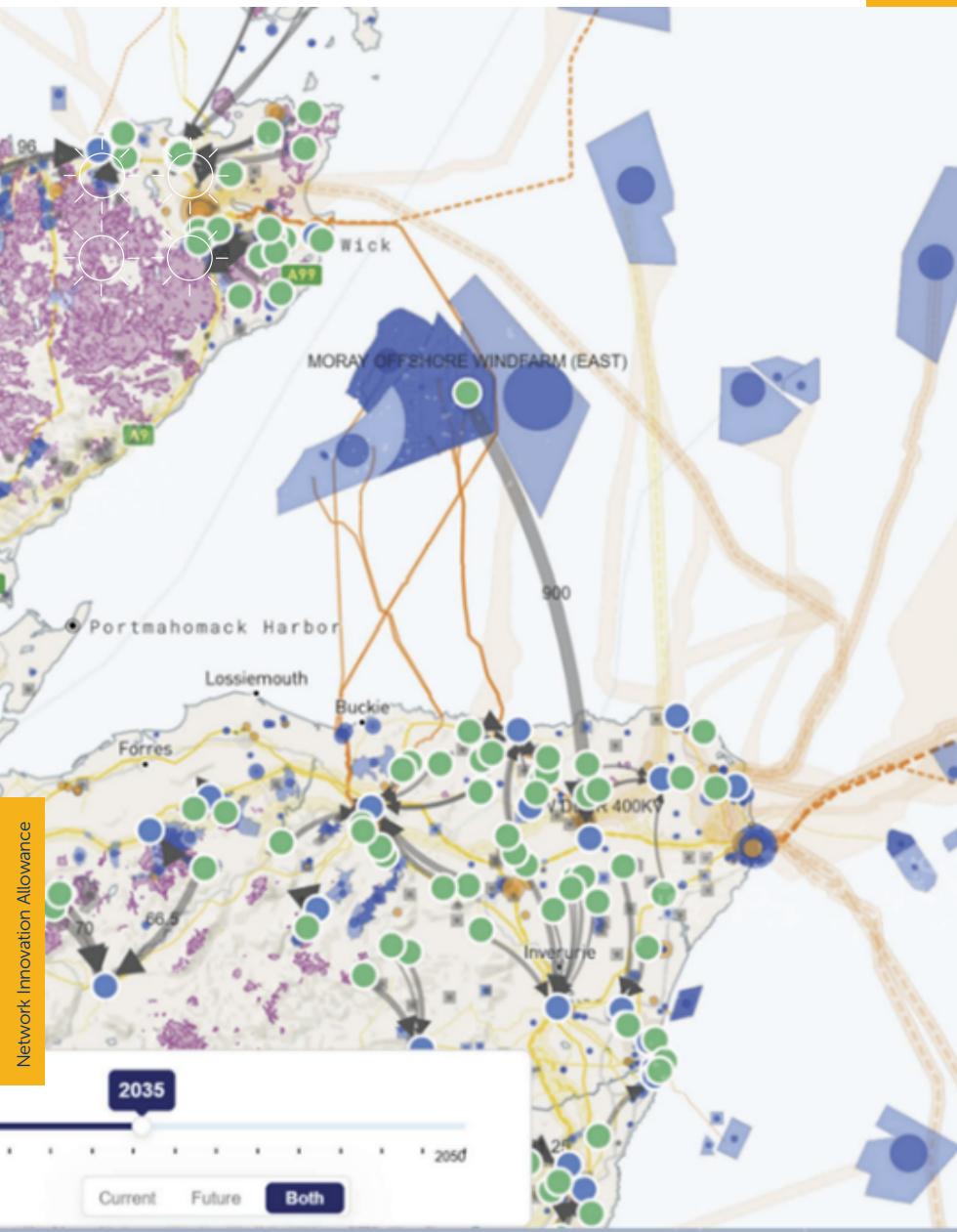
Focus areas:



Faster



Smarter



Rapid Evaluation Areal Connection Tool (REACT)

Project overview:

REACT is a geographic visualisation planning tool, designed to help stakeholders navigate the complexities of upgrading the power grid. By visualising power flows and analysing planned generation, demand and storage, including contracted substation pipelines, alongside other decarbonisation pathways, REACT enables the Network Licensee to optimise network development.

Project benefits:

The project could enable users to:

- Optimise demand and generation placement, maximising asset efficiency and supporting effective deployment of new infrastructure.
- Reduce costs for the network and consumers through a reduction in curtailment
- Minimise environmental impact by implementing a more holistic view of the network when considering connections.

How the project has progressed:

The project has significantly enhanced the existing REACT data analytic and visualisation platform (developed within SIF Alpha) to encompass the entire SSEN Transmission licence area. The digital model that drives the visualisation was enriched with functionality that met the needs of network planning, investment planning and insights teams.

This phase added new attributes, filtering, scenario exploration, visualisation and export options to the platform that were first tested offline through a demo gallery. This included the development of new scenarios to understand project status/likelihood cumulative context as well as other experimental features driven by internal team's user requirements.

The project was extended by four months to complete the planned scope, while also delivering additional user interface enhancements. These upgrades further refined the digital model and the zonal probabilistic analysis that underpins the front-end application.

Next steps:

The next steps are to explore the transition of the REACT platform, developed through the NIA project, into Business as Usual (BAU). This will require the ongoing maintenance and improvement of the data that underpins the digital model. Discussions are ongoing to develop a BaU proposal that meets business needs while clearly demonstrating value for money for consumers. In parallel, the project partners are engaging with the other Transmission Owners and NESO to broaden the applicability of both the platform and the associated learning.

Project partners: Olsights, MapStand

Funded: £169,409 Discovery | £553,671 Alpha | £1,080,000 NIA

Project timeline: April 2023 – July 2023 Discovery | October 2023 – April 2024 Alpha | January 2025 – March 2026 NIA

Project registration: https://smarter.energynetworks.org/projects/nia_shet_0052/

Focus areas:



Faster



Smarter



Strategic Innovation Fund (SIF)

These projects are funded by network users and consumers under SIF, an Ofgem programme managed in partnership with Innovate UK. [Learn more about SIF here.](#)

The SIF mechanism is designed to drive the innovation needed to transform gas and electricity networks for a low-carbon future. Funding is competitive and only awarded to those projects that demonstrate innovation, offer value for money to the consumer and will help deliver net zero in accordance with Government targets.

SIF consists of three project phases:

- **Discovery:** Feasibility studies to de-risk technical uncertainties associated with the project's area of interest.
- **Alpha:** Using the findings of the Discovery Phase to develop a proof-of-concept.
- **Beta:** Develop full-scale demonstrators towards a maturity that either achieves or approaches Business as Usual (BAU).

The following pages provide insight into the progress made on SIF projects during the past financial year.



Rapid Automated Planning for Infrastructure Development (RAPID)

Project overview:

The RAPID project is examining recommendations in the Winsor Report, which highlight the need to accelerate the delivery of new transmission infrastructure through improved standardised and automated route design processes. Currently, identifying optimal routes for new transmission lines is complex, time-intensive and varies across network operators. The three-month Discovery phase of RAPID explored how standardised methods, digital tools and automation techniques, including the use of AI can transform this process to unlock a range of system, consumer and societal benefits.

Project benefits:

Automated and standardising route design could:

- Significantly reduce the time required to identify and consent optimal routes
- Lower project development costs from reducing administrative burden on multiple teams
- Improve stakeholder and community confidence in infrastructure delivery, by providing a more transparent, evidence-based route design process.

Progress to date:

The Discovery phase assessed current practices and defined a future framework for automated corridor routing and route design to enable faster, more transparent and consistent planning of new infrastructure.

The project identified multiple key findings, including that routing automation tools have a high potential to increase efficiency in route planning by reducing the administrative burden on engineering, consenting, land and construction teams. It also has potential to increase collaboration through shared responsibility for mitigating common challenges such as data standardisation and data acquisition.

Additional lessons highlight that a phased rollout to validate tools before deployment is essential. A solution needs to consider the varying needs of stakeholders, such as system designers, environmental teams and community engagement teams.

Next steps:

RAPID is planned to progress to the Alpha phase in the next funding cycle. This phase will include further stakeholder engagement to quantify the value of the opportunities identified during Discovery and assess how they align with existing processes. It will also develop an ontology and a proof of concept for selected use cases to validate the solution's potential value to the sector.

Project partners: Arup, Voltquant, National Energy System Operator (NESO), SP Energy Networks Transmission, National Grid Electricity Transmission

Funded: £167,343 Discovery

Project timeline: June 2025 – September 2025 Discovery

Project registration: https://smarter.energynetworks.org/projects/shet-fnd-rapid-rd4_discovery/

[Watch](#) our Discovery end of phase webinar

Focus areas: Smarter

Faster

HVDC Wind Connect

Project overview:

The High Voltage Direct Current (HVDC) Wind Connect project aims to enhance the integration of offshore wind into the energy system by exploring multi-terminal HVDC systems, specifically developing innovative rigid and hybrid bipole configurations that reduce the need for Dedicated Metallic Return (DMR) cables.

Traditional HVDC systems rely on point-to-point connections and complex cabling arrangements, which increase cost and limit scalability. HVDC Wind Connect aims to overcome these challenges by developing standardised, modular and vendor-agnostic solutions that enhances control strategies, optimises converter coordination, and introduces efficient substation and cable designs, validated through economic impact assessment.

Project benefits:

HVDC Wind Connect has the potential to deliver significant benefits for consumers, the energy system, and the wider supply chain:

- By removing or minimising DMR cable requirements and optimising system design, the project could significantly lower the cost of HVDC infrastructure
- Reduced infrastructure requirements can also support with savings in carbon emissions from materials and site activity
- Advanced control and protection strategies can also enable a stable operation of multi-terminal HVDC systems, improving network resilience.

Progress to date:

The project was awarded funding for a six-month Alpha phase, focused on developing and validating core technical concepts that builds on relevant network innovation projects including Aquila Lite, INCENTIVE and BLADE. It is investigating features like grid-forming capability, black start, control strategy and equipment protection through a work package led by the National HVDC Centre. In addition, it is assessing how multi-terminal HVDC affects the AC grid at the point of interconnection/point of common coupling, evaluating potential converter integration and interaction challenges.

The project is using two real-world use cases for the project: Eastern Green Link 6 and the HansaLink. Initial cost benefit modelling has demonstrated strong potential whole-life savings compared to traditional HVDC configurations. HVDC Wind Connect is also engaging with international transmission operators, Original Equipment Manufacturers (OEMs), and offshore wind developers to validate requirements and ensure solutions are scalable and aligned with industry needs.

Next steps:

During the remainder of the Alpha phase, the project will focus on consolidating technical outputs and preparing for potential progression to Beta.

Project partners: WindGrid, Carbon Trust, National HVDC Centre

Funded: £449,996 Alpha

Project timeline: February 2026 – September 2026 Alpha

Focus areas:



Smarter



Greener



Optimisation and Diagnostics for Innovative Networks (ODIN)

Project overview:

As part of our previous [NIA AIM High project](#), we introduced an autonomous robot called “Haggis”, to perform monitoring tasks within an energised HVDC valve hall. The project demonstrated safe robotic operation in high electromagnetic field environments, providing new capability to collect continuous data from previously inaccessible areas. Following its success, more robots will be deployed as part of business-as-usual HVDC operations in July 2026.

The ODIN project builds on the success of the deployment, aiming to generate efficient data management and automated analysis collected by the robots. ODIN provides real-time operational insight and quantified efficiency metrics, supporting data-driven asset management, enhanced workforce safety, and reduced environmental impact through fewer site visits and extended asset lifespans.

Project benefits:

The ODIN project can support:

- Improved operational decision-making, by providing enhanced real-time visibility of network conditions and supporting more informed maintenance planning
- Enhanced system resilience through proactive network maintenance from consistent, high-quality data capturing
- Stronger and safer network planning from analysis of data over time to identify changes to asset health
- Reducing unplanned outages for maintenance, supporting reduction in cost

Progress to date:

The Discovery phase demonstrated the feasibility of automated interpretation and diagnostics in an operational environment, utilising data from “Haggis”, deployed at the Blackhillock HVDC converter station. The project proved that AI and statistical techniques could identify equipment, extract thermal features, and visualise operational trends. This confirmed that robotic data can be used to understand component performance dynamically rather than retrospectively, significantly reducing manual data processing.

Building on this foundation, the Alpha phase is trialling the integration of a condition monitoring solution, enhancing the Artificial Intelligence Data Analytics (AIDA) platform; a cloud-based system developed by Ross Robotics that integrates robotic, thermal, and operational data to provide real-time asset insights, enabling proactive detection of potential faults and data-driven maintenance decisions. The project has progressed component detection, tracking and temperature trending for priority HVDC assets. In addition, standardised data exchange interfaces have been implemented to integrate inspection outputs and load data. A central dashboard is mostly complete, with trend visualisation and alerting functionality progressing well.

Next steps:

The ODIN project is generating evidence to support condition-based maintenance and asset investment decisions. Completion of Alpha will provide evidence of operational value and readiness to progress towards Beta and wider deployment, supporting long term network reliability and consumer outcomes aligned to RIIO T3.

Project partners: Ross Robotics

Funded: £168,447 Discovery | £506,056 Alpha

Project timeline: May 2025 – August 2025 Discovery | February 2026 – August 2026 Alpha

Project registration: <https://smarter.energynetworks.org/projects/10179178/>

[Watch](#) our Discovery end of phase webinar

Focus areas:



Smarter



Greener



Revisiting and Evaluating Environmental Inputs on Line Ratings (REVISE)

Project overview:

The REVISE project is modernising how overhead line ratings are calculated across the GB electricity network. It challenges the long-standing calculation process that uses historical environmental data captured in the 1980s, which applies uniform environmental assumptions across the UK disregarding local/regional climate variations.

Combining high-resolution weather topographic data with advanced system-modelling techniques and physical validation, the project aims to deliver a new will deliver a new Energy Networks Association Technical Recommendation, replacing the outdated TGN26 methodology, ensuring a more accurate, future-ready approach to overhead line rating.

Project benefits:

By reflecting real local weather conditions, REVISE aims to:

- Unlock additional network capacity, making better use of existing infrastructure by delivering more accurate and future-ready line ratings.
- Reduce operational and consumer costs from curtailment impact by enabling more efficient use of the network.
- Inform smarter investment decisions related to future infrastructure projects from updated line ratings.
- Support the connection of increasing volumes of renewable generation to deliver a future network quicker.

Progress to date:

The project has evolved from recognising outdated assumptions, to quantifying their system impacts. The Discovery phase confirmed Leatherhead datasets were geographically unrepresentative. Alpha extended this, using measured current flows from 180 OHL circuits within the SSEN Transmission licence area in an analysis of UK-wide modern meteorological datasets showing:

- High-temperature, low-wind events, assumed frequent in the 1980s, occur far less often outside southern England.
- Only 27 of 180 circuits exceeded pre-fault seasonal limits for 0.03% of operating time (more than negligible periods, defined as 1 in 1,000,000 events), suggesting over-conservatism in current ratings.
- Wind speed is the predominant driver of line ratings, with strong regional variation in exceedance events.
- Modern datasets (MÉRA) provided reliable temperature data, with wind requiring further refinement using statistical and machine-learning corrections.

These findings confirmed uniform static line ratings under TGN26 underutilise network capacity in many regions. A regionalised methodology would release 2–5% capacity, reducing curtailment and improving safety.

Next steps:

The project was recently awarded funding for the Beta phase, which will continue progressing the project to deliver a regionally tailored, climate-responsive rating for transmission overhead lines.

Project partners: National Grid Electricity Transmission, National Energy System Operator (NESO), SP Energy Networks, Met Office, University of Strathclyde, Energyline

Funded: £171,300 Discovery | £433,149 Alpha | £6,547,348 Beta

Project timeline: March 2024 – May 2024 Discovery | October 2024 – April 2025 Alpha | March 2026 – September 2029 Beta

Project registration: <https://smarter.energynetworks.org/projects/10179080/>

[Watch](#) our Alpha end of phase dissemination session.

Focus areas:



Faster



Smarter



Superconducting fault current limiters Potential to limit Reactor Implementation within DC Network Topologies (SPRINT)

Project overview:

Protecting DC networks from short-circuit faults usually involves using DC Circuit Breakers (DCCBs), alongside DC Reactors (DCRs). These systems can be large, costly, and difficult to place, especially on offshore platforms, making it hard to scale HVDC networks efficiently.

The SPRINT project aims to enhance the protection and efficiency of HVDC networks by exploring the feasibility and benefits of integrating Superconducting Fault Current Limiters (SFCLs). The project builds on learning from the SIF [Network-DC project](#), and aims to address limitations in HVDC fault detection, providing a novel alternative to conventional fault current limiting equipment.

Project benefits:

SFCLs are an emerging technology for use within DC systems that have the potential to:

- Protect high value assets from damaging fault currents and enhance system stability across increasingly complex renewable led networks.
- Reduce the number and size of DCRs that are required, particularly offshore, offering environmental benefits both in terms of construction, installation, and maintenance.
- Improve system protection by limiting fault currents and allowing improved fault detection and location identification.

Progress to date:

An initial literature review has been completed to assess recent developments in SFCL deployment within power systems. This included examining behavioural differences between AC and DC applications and evaluating the technology readiness level of key SFCL sub-systems. In parallel, cost modelling was performed for DCCBs, DCRs, and SFCLs, providing inputs to an initial cost benefit analysis.

Electromagnetic transient (EMT) models were then developed using representative load flow scenarios, informed by the Network-DC Beta Phase project. A series of fault scenarios were applied, forming a parametric study of over 60 simulations to assess system behaviour with SFCL integration under a range of conditions.

Next steps:

Looking ahead, an Alpha Phase application is anticipated with early scoping discussions already underway. Potential areas of focus include protection algorithm development, definition of Hardware-in-the-Loop (HIL) test configurations, and a reliability assessment of SFCLs. In addition, SuperGrid will present the SPRINT project at the HVDC Operators Forum in June 2026.

Project partners: SuperGrid Institute, National HVDC Centre

Funded: £163,652 Discovery

Project timeline: January 2026 - May 2026

Project registration: <https://smarter.energynetworks.org/projects/10179100/>

[Watch](#) our dissemination session

Focus areas:



Smarter



Safer



Network-DC Circuit Breakers

Project overview:

The Network-DC project has explored the technologies, standards and commercial frameworks that will underpin future multiterminal High Voltage Direct Current (HVDC) networks. Direct Current Circuit Breakers (DCCBs) represent one of the most critical enablers of these future networks, by combining HVDC links that join two points in the network and an export cable from a wind farm in one hub, without needing to build additional convertor stations to change the electricity current from DC to AC and back.

The project investigated the use of DCCBs, developing industry knowledge on the available designs and their expected reliability and costs. It brought together international partners to accelerate the readiness of DCCBs for installation into the design of the emerging HVDC networks in GB and outline a clear pathway for the installation of the first DCCBs.

Project benefits:

Although not yet commercially mature, DCCBs have the potential to unlock more coordinated offshore transmission and benefits including:

- Improved system resilience and stability as DCCBs act when there is a fault to safely isolate the affected DC circuit section, or area, and allow the rest of the DC system to continue operating
- Minimised environmental impact through the reduction of additional convertor stations required
- Lower system costs through improved control and fault management of HVDC systems
- Accelerated connection of renewable generation through enhanced network capabilities

Progress to date:

Network-DC has developed and validated a vendor neutral control and protection philosophy for DC grids, advanced real-time and electromagnetic transient modelling capability, and produced new insights into reliability, system behaviour, and cost benefit impacts.

Through collaboration with NESO, academia, Original Equipment Manufacturers (OEMs), Ofgem, and international Transmission System Operators, the project has strengthened the evidence base for DCCBs and provided clarity on the technical constraints, operational requirements and pathways for integration into GB's future HVDC architecture.

Next steps:

Whilst significant success has been made to date, a decision to halt the project early has been made in conjunction with the regulator to review the marketplace, align proposed work, and streamline the programme. The knowledge developed from the project has delivered significant value and will directly inform future planning and design work across GB by supporting the development of future specifications, contributing towards global standard setting efforts.

Project partners: National HVDC Centre, Carbon Trust, University of Edinburgh, SuperGrid Institute, Mott MacDonald, National Energy System Operator (NESO)

Funded: £150,588 Discovery | £491,905 Alpha | £2,129,796 Beta

Project timeline: March – May 2024 Discovery | October 2024 – April 2025 Alpha | September 2023 – March 2026 Beta

Project registration: <https://smarter.energynetworks.org/projects/10067854/>

[Watch](#) our Beta end of phase dissemination session.

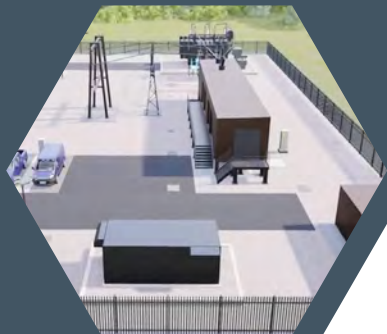
Focus areas:



Faster



Smarter

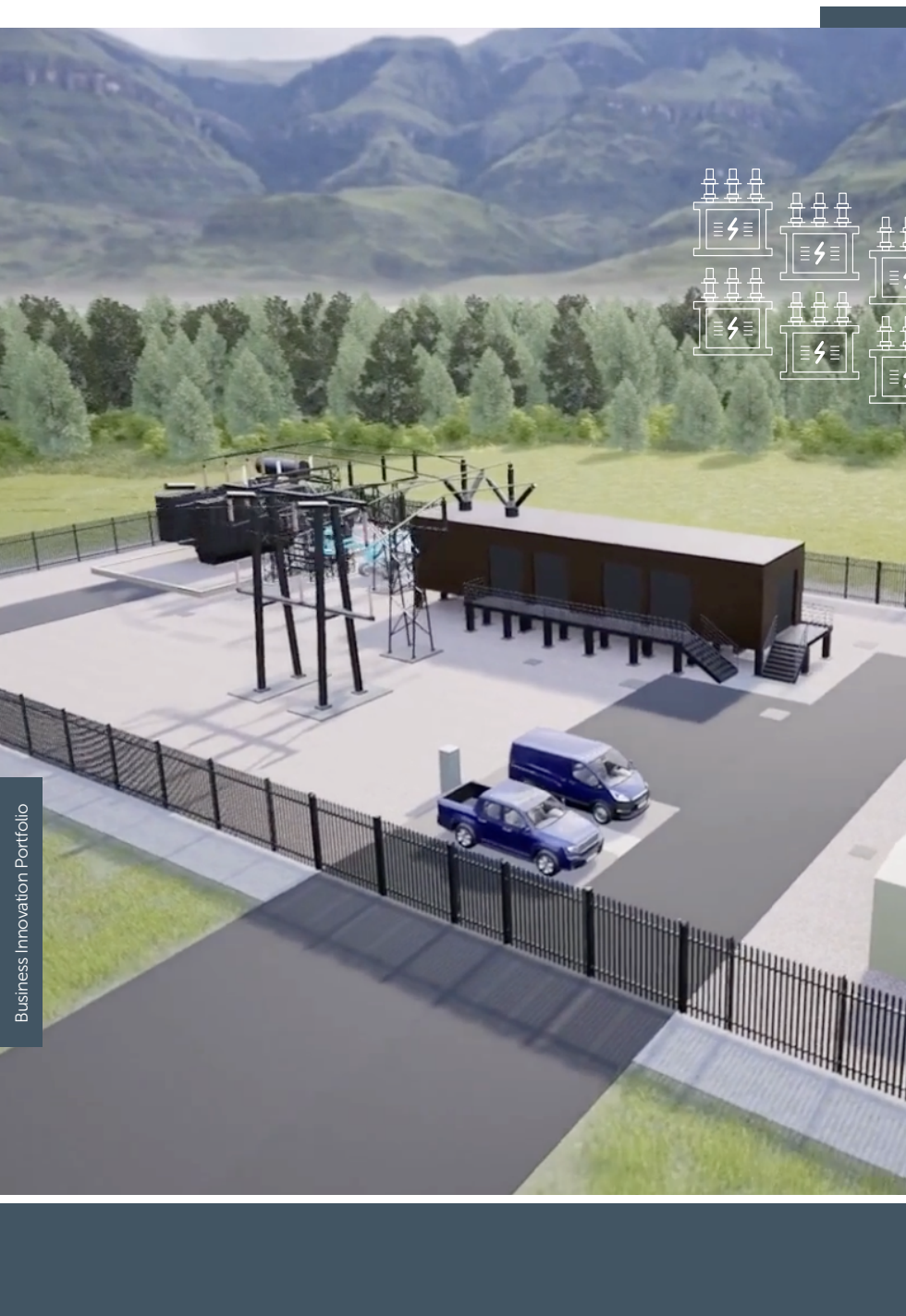


Business Innovation Portfolio

Our Business Innovation portfolio is funded from other sources that sit outside the regulatory landscape of NIA and SIF.

Our portfolio has a mix of projects, including those funded by SSEN Transmission, that are low-risk and high-maturity solutions that will add proven value to improve our network operations, and includes some projects that are funded through additional external financial mechanisms.

The next few pages of this report provide insight into some of the projects that SSEN Transmission is working on within our Business Innovation portfolio.



Modular Substations

Our new approach to substation delivery is leading the way, with standardised modular substations that enable much of the assembly, wiring, and testing to be completed off site before installation and commissioning. Designed to operate at 132kV and 33kV, the modular substations are ideally suited to smaller-scale grid connection projects, including individual windfarms and other renewable generation. We are now rolling out the modular substation programme across a large portion of our customer connection projects, with energisations beginning from Autumn 2028.

By carrying out much of the construction in controlled factory environments, modular substations offer clear benefits over traditional builds. These include a standardised and repeatable design, built in safer and cleaner conditions, resulting in higher quality build, as well as reduced site construction durations and a smaller site footprint. This reduces costs for customers and disruption for local communities, while still meeting the high safety, quality and reliability standards required for critical electricity infrastructure.

We have awarded a major framework agreement to Hitachi Energy UK Limited and GE Vernova, enabling the delivery of modular substations following a year-long competitive tender process.

[Learn more by watching our video.](#)



Transmission Network Digital Substation (TReNDs)

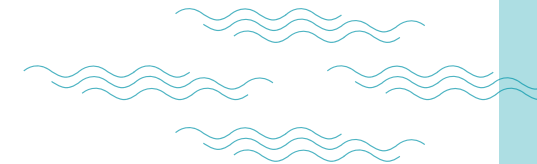
The TReNDs project is exploring the opportunities presented by a fully digital substation secondary system design, based upon the IEC 61850 and associated suite of standards.

With a move away from the conventional substation design, the TReNDs project involves the concept of replacing the bulk of traditional copper cables found in our substations with new fibre optic communications, increasing the speed of deployment and technological progress.

This technology comes with several advantages, not only providing significant savings in project delivery time, enhanced cybersecurity, and increased efficiency in control room footprint, but also reducing the environmental impact. As a testament to the pioneering work that will be delivered through this project, the project secured funding through Ofgem's RIIO-T2 Non-operational IT reopener.

The TReNDs team have been working collaboratively with other GB Transmission owners, digital substation solution providers, internal field unit stakeholders, and project teams to develop solution that can be delivered successfully for our pioneer digital substation project.

The project has been proven in a lab environment and is now under implementation at our Fetteresso 400kV substation. This installation is leading the way as it is our first site to implement a standardised, multi-vendor interoperable digital protection solution, setting a benchmark for our network and the whole industry.

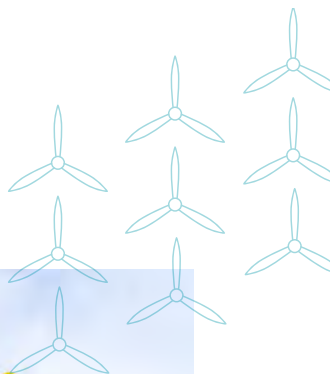
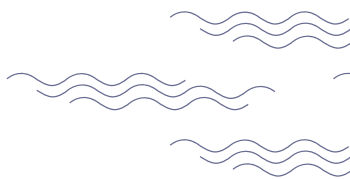


Modular Bunds

A modular bund is a containment structure designed to prevent environmental contamination from oil leaks or spills, typically used around electrical substations or transformers. Unlike traditional bunds, which are permanent, monolithic concrete structures, a modular bund is made up of prefabricated units (steel, concrete, or recycled plastics) that can be assembled, dismantled, and reused at different sites.

Mobile substations require a containment solution that can be quickly installed, dismantled, and reused. Modular bunds offer a quick, reusable solution that offer flexibility to move between sites and can protect sensitive environments.

This project looked at how modular bunds can be used to safely, efficiently, and sustainably to support mobile substation by balancing technical, environmental, and operational requirements to identify the best design solution.



Partner Projects

Project Name	Funding Stream	Link
Black Start Demonstration from Offshore Wind (BLADE)	SIF Beta	https://smarter.energynetworks.org/projects/sif_blade_beta/
SF ₆ Whole Life Strategy	SIF Beta	https://smarter.energynetworks.org/projects/10117736/
Early Signs of Oscillations	NIA	https://smarter.energynetworks.org/projects/nia2_neso121/





Ideas good, great, and small are all welcome.
Let's innovate together.

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