Electricity Transmission

nationalgrid

# Innovation Annual Summary 2023/24

# Welcome to our interactive Innovation Annual Summary

Look out for this symbol for the interactive content throughout the document. If you experience any difficulty viewing the interactivity, click **here** for the online version.



**Who we are and what we do**

National Grid Electricity Transmission (NGET) owns and maintains the high voltage electricity transmission network in England and Wales.

Every time a phone is plugged in, or a switch is turned on, we've played a part, connecting you to the electricity you need.

We take electricity generated across England and Wales, including from windfarms and nuclear power stations, and transport it through our network, consisting of more than 7,000 kilometres of overhead line, 700 kilometres of underground cable and over 300 substations, on to the distribution system, so it reaches homes and businesses.

We're investing in the network, connecting more and more low-carbon electricity – it's a crucial role and pivotal in turning the UK's net zero ambitions into reality.

# Welcome to our Innovation Annual Summary

**The United Nations has described the transition to a net zero world as one of the greatest challenges humankind has faced – calling for a complete transformation of how we produce, consume, and move about. As the source of around three-quarters of greenhouse gas emissions today, the energy sector holds the key to averting the worst effects of climate change.**

At NGET, we're well aware of the vital role innovation can play in accelerating the transition to net zero. It's reflected in our plans to support a significant ramp-up in large-scale capital work within our business as we develop electricity infrastructure for a low-carbon future.

It's also reflected in our growing and evolving portfolio of innovation projects. This year, we added a further 27 projects to our Network Innovation Allowance (NIA) portfolio, taking our total portfolio to 67. We're also working on two significant Network Innovation Competition (NIC) projects and multiple Strategic Innovation Fund (SIF) projects. These projects are in addition to innovation taking place in our business every day, which has created new ways of managing our transmission network.

Our role in the industry-wide effort to decarbonise electricity in the UK involves getting more from our existing assets, using scarce resources more efficiently and getting our customers connected to our networks faster. It also involves delivering a network that enables the transition to net zero, is resilient for future generations, and is delivered with a lower impact than ever before.

Our innovation work has delivered new ways of reducing the emission of greenhouse gases, created tools that have enabled more capacity to be used on the existing networks, and led to the implementation of the world's largest pour of cement free concrete. These are solutions that have delivered real benefits for consumers and stakeholders, reducing the costs they bear and the impact that operating our network has on the planet.

Our innovation work will, among other things, provide greater protection for assets at risk of rising sea levels, enable the construction of more compact substations, and facilitate faster and cheaper cable repairs.

Throughout this report, you'll find examples of how we're applying fresh thinking to the greatest engineering challenge of our times.

You'll also discover how we're collaborating with others on this journey. That's crucial to us, because achieving net zero is a collective challenge. As you read this report, I hope it will spark ideas and thoughts. Innovation is a continuous process. It involves one idea leading to another and disagreements that challenge current thinking, forming new thoughts and paths.

So, we would love to hear your thoughts, ideas, disagreements, and opinions. I have no doubt that our work can be greatly improved through that diversity of thought. Together, we can achieve collective success and we look forward to working with you more over the coming year.

**Mark Lissimore**
Director of Infrastructure Development and Delivery

**"We're well aware of the vital role innovation can play in accelerating the transition to net zero. Throughout this report, you'll find examples of how we're applying fresh thinking to the greatest engineering challenge of our times."**

# Meet the team

**We're always on the lookout for new ideas and opportunities to partner on innovation projects. If you'd like to find out more about the way our innovation process works, the NGET Innovation team would be happy to speak to you and share details of our innovation portfolio. Hover over the images to find out more details on our colleagues.**

## Net Zero Innovation team

**Simon Orr**
Head of Strategy and Innovation

**Gary Stockdale**
Net Zero Innovation Manager

**Xiaolin Ding**
Senior Innovation Engineer

**Kerri Hayes**
Associate Innovation Engineer

**Gemma Pead**
Innovation Stakeholder Lead

**Amrit Sehmbi**
Regulatory Innovation Lead

**Gordon Wilson**
Senior Innovation Engineer

**Ibukunolu Oladunjoye**
Innovation Engineer

**Tinashe Chikohora**
Innovation Engineer

**Muhammad Shaban**
Innovation Engineer

**Hamid Shahrouzi**
Innovation Engineer

**Aisha Ali**
Associate Innovation Engineer

**Nathan Brown**
Associate Innovation Engineer

**Stephen Mbisike**
Innovation Engineer

**Neha Moturi**
Associate Innovation Engineer

## Deeside team

**Sean Coleman**
Deeside Centre for Innovation Manager

**James (Jimmy) Deas**
Senior Innovation Engineer

**Ibrahim Iddrissu**
Lead Test Engineer

**Prem Ranjan**
Senior Innovation Engineer

**Hadassah Clough**
Innovation Contract Lead

**Ana Antelava**
Innovation Engineer

**Steven Pearson**
Test Engineer

# We're developing for the future; our highlights from this year include

Click each diamond for more information

Evolving our innovation strategy and portfolio

Working with others

Awards and recognition

Our NIA highlights

Our SIF highlights

Our NIC highlights

**Simon Orr**
Head of Strategy and Innovation

**"We're at a pivotal moment in our industry. Demand on the grid will grow dramatically and is forecast to double by 2050 as heat, transport and industry continue to electrify. This means innovative thinking is more important than ever and has a crucial role in developing a transmission network for the future."**

# Evolving our innovation strategy and portfolio

**Over the past year, we've continued to evolve our innovation portfolio, making sure we maintain a sharp focus on how specific projects will help achieve net zero emissions.**

The focus on net zero has prompted us to challenge ourselves whether we're being sufficiently ambitious or planning for 25 years from now.

This reflects a move towards a completely new network planning process – Centralised Strategic Network Planning and the Strategic Spatial Energy Plan – which will call for a longer-term approach to energy requirements across the entire industry. It's a move that provides a solid basis for future innovation plans. It also complements our starting point for innovation – to help meet specific priorities that our business is facing.

Last year we published our new innovation strategy, which reflects this direction of travel and the focus on net zero outcomes. It's forming the foundation for an evolving portfolio, which has seen us spend £12.1m on NIA work during the year.

Net zero construction is now one of our thriving portfolios, comprising seven projects that stem from business challenges.

As an example, one of our NIA projects is examining how we could reduce carbon emissions from our construction activities by exploring low-carbon alternative materials. You can read about this project on page 24.

We've also been developing our portfolio of resilience projects – and in particular, climate resilience projects which focus on risks ranging from lightning to extreme heat and flooding. Our Environmental Risk and Assurance (ERA) project, for example, involves developing an automated weather alert tool to provide an 'early warning system' for imminent flooding risk. You can read about this project on page 23.

There are other areas of our portfolio we know we need to develop further, such as customer connections. This, together with other priorities our business is facing, will be an area of focus for us as we evolve our innovation strategy.

## How stakeholders help shape our approach

There's a sequence to how we shape our strategy and approach. We need to know we're working on the right things, so we continually engage with a wide range of stakeholders – from Ofgem and other networks to SMEs, academia and bodies such as the Energy Innovation Centre (EIC) and Energy Networks Association (ENA).

This engagement and our stakeholders' views are helping how we evolve our strategy and shape our RIIO-T3 plans. By taking this approach, we know our plans are influenced by you, our stakeholders.

## Developing our ways of working

We've been improving the way we work, such as developing a better way for prospective partners to collaborate with us. We've made our procurement process simpler, so we can encourage the broadest range of innovators to come to us with solutions – notably if they're low risk and we need an agile approach to development and testing.

This has included developing a positioning paper for prospective suppliers that summarises terms and conditions in plain English. And we've introduced earlier engagement with those potential suppliers – discussing intellectual property arrangements and what the contract would mean for NGET and for the supplier. It sets the scene for constructive negotiations.

**Gary Stockdale**
Net Zero Innovation Manager

**"We've invested in growing our team so we can deliver innovation that supports the increased scale of work within our business and the drive towards net zero."**

# Working with others

**Our strategy focuses to a large degree on the challenges we face and what we need to do to achieve our objectives. A big part of how we'll get there lies in our ways of working – and collaboration is central to our approach.**

## Industry working groups and partnerships

Some of the people in our team are members of industry working groups and panels that are focused on innovation, such as the Electric Power Research Institute (EPRI), the International Council on Large Electric Systems (CIGRE), the Infrastructure Industry Innovation Partnership (i3P), the Institute of Electrical and Electronics Engineers (IEEE), the Energy Innovation Centre (EIC) and the Energy Networks Association (ENA). You can find out more about their roles in 'Meet the team' on page 4.

## University partnerships

Our partnership framework with six UK universities is helping us decarbonise the electricity system in Great Britain and accelerate progress towards net zero.

We've worked with researchers, analysts and academics from Cardiff, Edinburgh, Exeter, Manchester, Southampton and Strathclyde Universities, harnessing their expertise to help us solve specific engineering challenges.

**Hover to read about our Real-world challenge for master's student**

**Read more on LinkedIn**

## Exploring new ways to promote our engineering challenges

Our 'calls for innovation' help promote our engineering challenges – seeking ideas and innovative solutions from prospective partners.

For example, through our partnership with I3P we launched an innovation challenge in collaboration with Innovate UK Business Connect and the UK Environment Agency. This challenge sought innovative and cost-effective ways to maintain our concrete structures, extend their useful life and build confidences around their longevity.

These calls for innovation are an example of our strategy in action, where we are innovating to meet specific business challenges. It means starting with a problem statement and then seeking solutions that we can test if they're promising.

It's also another example of how we're trying to make it easier for prospective partners to work with us and building a thriving community of innovation through productive relationships with suppliers.

We know we can't innovate alone – we want to work with others who can bring fresh perspectives, bright ideas and smart solutions.

## EIC calls for innovation

Another route for our calls for innovation is through the Energy Innovation Centre (EIC), whose wide-ranging stakeholder base helps bring us closer to SMEs and gives us the opportunity to collaborate with networks. Expanding the ways we can work with different suppliers from across the spectrum is an important objective for us.

During the year we launched two calls for innovation through the EIC, helping us connect with innovators to progress two NIA projects. These were:

- Assessment Framework – Supply Chain Impact on Nature and Biodiversity
  This project is looking to establish an assessment methodology across the electricity transmission and distribution sector, addressing shared environmental risks with global suppliers.
- Coastal Flooding and Erosion Challenge
  Through this project, we're aiming to find a way of managing the significant impact of adapting or relocating assets and sites at risk from flooding or coastal erosion. The solution will include robust modelling techniques, combining data from a wide variety of sources.

Through our partnership with the EIC, we have a transmission collaboration group comprising three transmission operators that are working closely on

- **Net zero substations**
- **$SF_6$ alternatives**
- **Consumer vulnerability.**

# Working with others continued

## Leading Edge Only partnership

Through our partnership with Leading Edge Only, we launched five calls that generated innovative ideas from the innovation community. One of these, which has progressed to a project, is looking at the design and manufacture of infrastructure foundations in a more sustainable and efficient way by integrating the benefits of 3D printing technology and low-carbon concrete.

## ENA basecamp

We've developed an NIA project in response to one of the challenges we set at ENA's 2023 basecamp. Our Transmission Heat Effects, Resilience Measures to manage Asset Lifecycles (THERMAL) project is developing a tool to forecast the impact of temperature events on asset behaviour. The tool will also assess implications for overall network performance, risk and resilience. Through this project, we're working with SSEN-T, Frazer-Nash Consultancy Limited, TNEI Services and the University of Edinburgh.

The ENA ran its second basecamp in March 2024, which gave networks the opportunity to share challenges and innovators a single platform to engage with networks to address specific challenges.

As part of our whole system approach, we're working closely with other transmission owners to support challenges they submitted. These include an automated routing of infrastructure challenge launched by SSE, which requires collaboration among all TOs in Great Britain to deliver a statement of requirements on this topic.

## Dissemination and engagement events

During 2023/24, we were involved in shaping and delivering a wide range of events. This included both hybrid and virtual events, which provided us with the flexibility to reach ever-wider audiences, meeting them in ways that best suit their needs.

Events we helped shape and deliver included Utility Week Live, where, in collaboration with our National Grid Electricity Distribution Innovation colleagues, we exhibited an array of our innovation projects and had the opportunity to present on how we are innovating to deliver net zero. We also disseminated at the Energy Innovation Summit (EIS), which showcased Ofgem-funded innovation projects from the UK's gas and electricity networks.

We also sponsored the International Symposium on High Voltage Engineering (ISH 2023) – one of the most influential and well-attended international conferences by researchers and academics in the field of high voltage engineering and insulation technology. The event was held at the University of Strathclyde, where we shared learnings on our Energy Water Nexus projects and $SF_6$ whole life strategy.

At some of these events we've been joined by the partners we're working with on specific innovation projects, so they can provide their perspective and expert knowledge when talking to stakeholders about the work we're doing together and how we're supporting the drive to net zero.

**We welcome ideas, feedback and your views on how we engage with you.**

**If you'd like to get in touch, you can find our contact details on the final page of this report.**

# Awards and recognition

**We're delighted to have received external recognition for some of the work we've been doing.**

In collaboration with KeenAI and sees.ai, we were awarded the Eason Award for Digital Innovation at the Asset Management Excellence Awards 2023 in London for our Network Innovation Allowance funded project: VICAP.

The project team has made significant breakthroughs in automating the inspection of steelwork on electricity transmission towers.

The automated process uses semi-autonomous drones flown 'beyond visual line of sight' to gather close-quarter imagery of tower steelwork, which is then processed using artificial intelligence.

This project will help us keep up with the throughput of condition monitoring that we're going to need as we build more infrastructure.

It's an example of how we're looking to do things differently, finding new and efficient ways of making sure our assets are in good condition now and in the years to come.

# Portfolio overview

## Our NIA projects

Our NIA projects are delivering ambitious innovations that will help us achieve our net zero targets.

They're clearly aligned to the specific engineering outcomes we've set out in our innovation strategy.

During 2023/24, we increased our portfolio, spending £12.1m on NIA projects during the year.

We registered 27 projects, which brings our total of live NIA projects during the RIIO-T2 period to 67. We're also collaborating on eight NIA projects that are being led by other networks.

**Click to read more about our NIA projects on page 20**


## Strategic Innovation Funding

Through Strategic Innovation Funding (SIF), we delivered five projects for £1,440,000 this year.

We were given the green light to progress one project to the first 'discovery' phase. Hybrid-Network Improvement & Reliability Enhancement (HIRE) is researching new state-of-the-art condition monitoring to improve the commissioning and operation of offshore cables.

Two of our projects advanced to the Alpha phase of funding. These include development of a long-term strategy to remove electrical insulating gas sulphur hexafluoride ($SF_6$) from the network, and a project to assess whole energy system resilience.

**Click to read more about our SIF projects on page 19**

## Our NIC projects

Our Deeside and Retro-Insulated Cross-Arms (RICA) projects are two significant areas of work that have continued from RIIO-T1.

For our RICA project, we have now built a test tower and are manufacturing full-sized prototypes. We're also drafting procedures for installation and maintenance.

Our Deeside Centre for Innovation continues to offer its facilities as a test ground for important innovation projects that don't require high voltage.

**Click to read more about our NIC projects on page 13**

# Developing a culture of innovation

**As our innovation portfolio matures and projects conclude, new ways of working and fresh technology will be introduced to our business.**

We believe it's important that innovation is a core part of our culture, so our people both develop and are receptive to new ways of working and technology.

In our innovation strategy, we describe our ambition for NGET to be the most innovative and pioneering energy network company in the world, with innovative mindsets and capabilities part of our DNA.

Having the right culture will be critical in enabling this.

To support delivery of our ambition, NGET and other networks are collaborating with UK Research and Innovation (UKRI) and Ofgem to determine what a good innovation culture looks like, as well as the practical steps we can all take to get there.

As one of the lead networks involved, we will be able to develop a NGET-specific plan for improving our culture.

## Innovation exemplar

Over the past year, this work has involved looking at our existing culture and developing an 'innovation exemplar' – in other words, a model of what an ideal innovation culture should look like.

Based on this, we've identified five areas we need to work on, ranging from how we ensure our leadership embraces innovation, through to how we embed an innovative mindset throughout NGET.

We're now working through these actions – some are long-term cultural change plans, which we're looking at how to approach; others are more readily achievable, such as how we embed innovation into business as usual.

This will be a big focus for us over the coming couple of years because we're coming close to finishing many of the innovation projects we're working on and looking ahead to RIIO-T3 and beyond. So, our approach to driving and embedding innovation and change will be reflected in our refreshed innovation strategy.

# Our innovation in numbers

## NIA Projects

**67**
RIIO-T2 NIA live projects

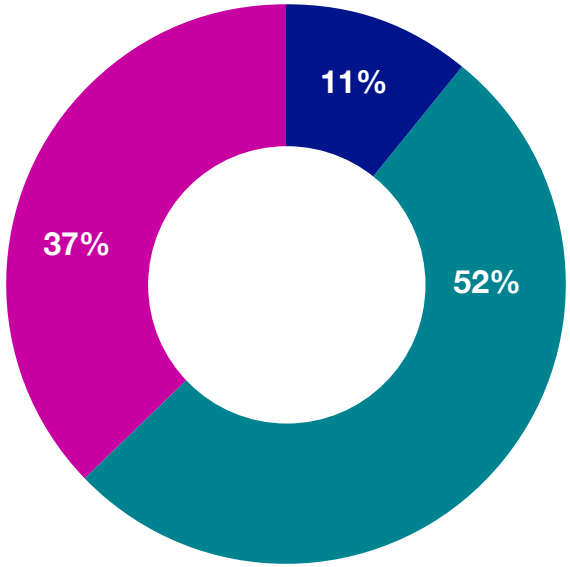
**£12.1m**
spend on NIA projects in 2023/24

**66**
collaborators involved in our RIIO-T2 NIA live projects, including suppliers, partners and supporters

**13**
FTEs working on NIA innovation projects

**27**
NIA projects registered in 2023/24

**£22.8m**
forecast spend on NIA projects in 2024/25




**Distribution of Technology Readiness Level (TRL) by volume of NIA projects in RIIO-T2**

- Research (TRL 2-3)
- Development (TRL 4-6)
- Demonstration (TRL 7-8)

## NIC Projects

**2** ongoing NIC projects

## SIF Projects

**2** SIF-led alpha projects registered 2023/24

**1** SIF-led discovery projects worked on

# Deeside Centre for Innovation

In 2015, we secured £12m in funding through Ofgem's annual Electricity Network Innovation Competition (NIC), to create the Off-grid Substation Environment for the Acceleration of Innovative Technologies (OSEAIT) project.

We combined this with an additional £14m of National Grid investment to convert a decommissioned substation into a unique research and innovation facility – the Deeside Centre for Innovation (DCI).

The first of its kind in Europe, DCI will help us optimise investments in a controlled off-grid environment, 24 hours, seven days a week. It aims to deliver benefits to consumers by accelerating the deployment of innovative technologies that may be able to reduce both the carbon footprint and cost of present and future energy networks.

At its core are substation, cables and overhead line test areas designed to facilitate live trials at existing distribution and transmission voltages. This will enable us and all GB network licensees to test assets associated with electricity networks, and trial new technologies and methods to address climate change and maintain security of supply.

While operational, the centre will also collect valuable data by monitoring performance of assets on site.

## Progress during 2023/24

While we finalise work on the substation, our Deeside Centre for Innovation has continued to offer its facilities as a test ground for important innovation projects that don't require high voltage. We expect to complete the substation later this year.

Projects undertaken at DCI during 2023/24 have included autonomous drone testing and site monitoring using 5G technology.

## Overhead line sagging monitoring using 5G signals

At DCI, we've been investigating the feasibility of using 5G cellular signals to monitor line sag – a non-intrusive technique, requiring no sensors or circuit outages. This makes it more cost-effective than existing techniques. It's never been explored before, so we're breaking new ground with this work. You can read more about the project on page 33.

## Autonomous Aerial, Thermal Inspections of Substations (AATIS)

DCI has also hosted our AATIS project, which is investigating how we can use drones and artificial intelligence (AI) to automatically monitor the thermal condition of our substation assets. If successful, the project will enable manual condition monitoring surveys to be replaced by autonomous drone inspections.

## Collaborating with the University of Manchester

The DCI team also supported trials in collaboration with one of our academia partners – the University of Manchester. Specifically, DCI hosted a group of MEng students working on a project to develop a condition monitoring platform for substation autonomous vehicles.

This included:

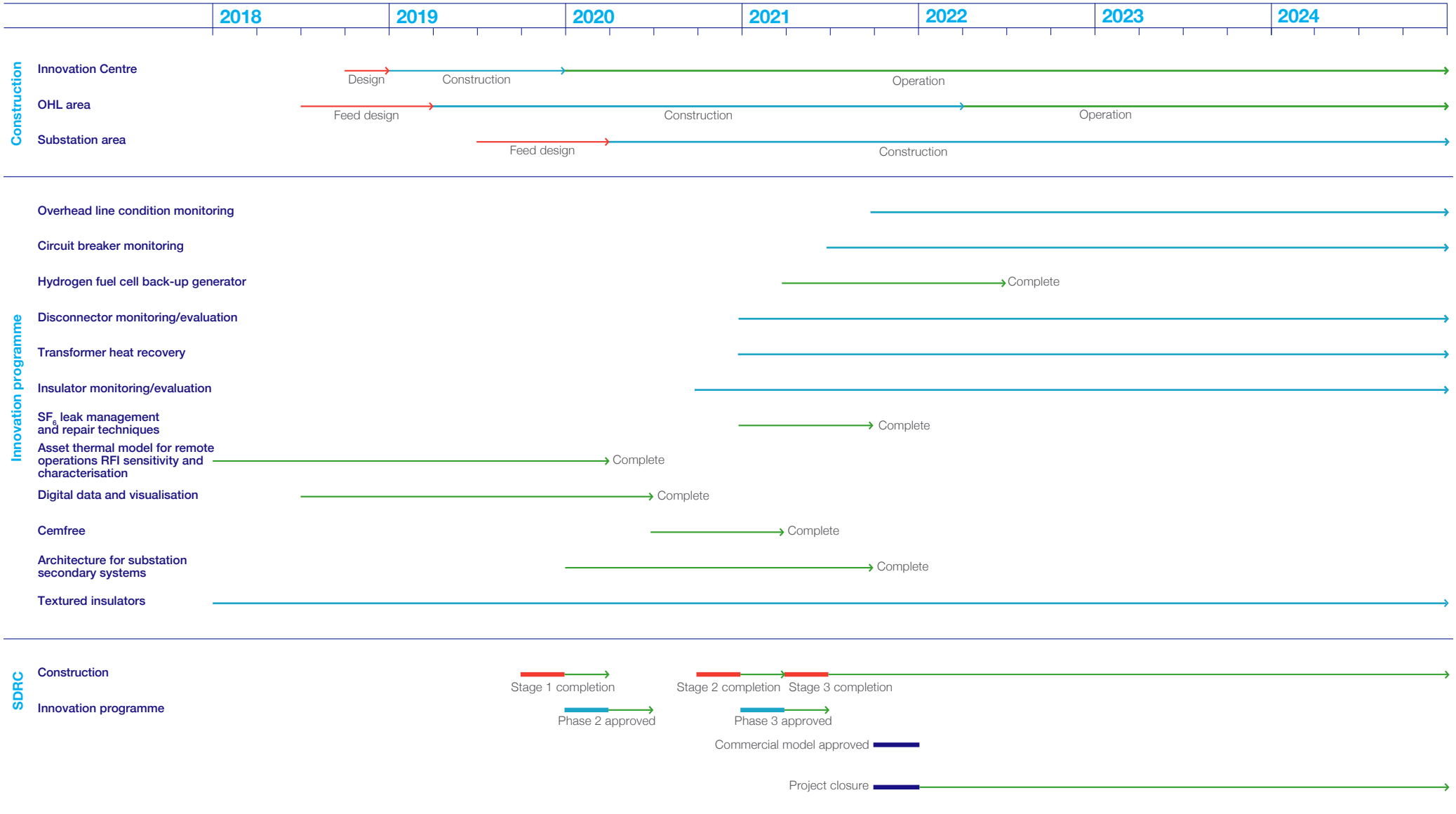
- a safety induction to understand the hazards and safety of high voltage environments and substations
- a tour of the DCI to show its testing capabilities and substation assets
- providing an environment for the students to test a robotic device and gain experience in developing a risk assessment and method statement (RAMS).

## Events

We presented DCI at the Utility Week Live 2023, and the 2023 Energy Innovation Summit in Glasgow, giving us the opportunity to promote its benefits to customers and stakeholders. The Energy Innovation Summit is the only event of its kind, designed to bring together the UK's energy networks, industry and energy system innovators.

# Deeside Centre for Innovation continued

## Delivery Programme



# Deeside Centre for Innovation continued

## Successful delivery reward criteria reference table

| Ref | Criteria | Description | Status |
|---|---|---|---|
| 9.1 | Formal agreement on Terms of Reference with Technical Advisory Board members | In order to achieve the efficiency required to meet the project's objectives it is essential that the other Transmission Licensees fully engage in the Technical Advisory Board. An early indication that this project will succeed will be the Board agreeing the Terms of Reference. | Complete |
| 9.2 | Detailed design of the facility completed and approved | The completion of both the infrastructure and technical layout designs is an important milestone on the way to delivery of the overall project as it will determine the level of testing and evaluation that can be carried out and at which stage. | Complete |
| 9.3 | Design, develop and publish internet site | One of the fundamental knowledge and dissemination channels for the project is the utilisation of the facility website, which will provide a secure area to share the outputs with the other Transmission Licensees. | Complete |
| 9.4 | Scope of work for the Phase 1 innovation programme approved | With there being a phased handover of assets it is essential to the project's success that a detailed plan be put in place, based on the assets available and trials proposed during this phase. This plan will include costs of the proposed trial projects, the estimated benefits and justification for how the trials satisfy the Electricity NIC criteria. The plan will also include any NIA projects that are able to be undertaken at this time. | Complete |
| 9.5 | Completion of Stage 1 construction works | The completion of the Innovation Centre building renovation and the transfer of the protection and control panels to the telecoms and control room are key milestones to the effective functioning and monitoring of the facility. | Complete |
| 9.6 | Scope of work for the Phase 2 innovation programmes approved | The continuation of the phased handover of assets is essential to the project's success and a detailed plan is to be put in place, based on the assets available and trials proposed during this phase. This plan will include costs of the proposed trial projects, the estimated benefits and justification for how the trials satisfy the Electricity NIC criteria. The plan will also include any NIA projects that are able to be undertaken at this time. | Complete |
| 9.7 | Completion of Stage 2 construction works | The completion of the construction of the internal access road is a key milestone to the effective functioning of the facility, as this will enable the necessary vehicles to access all areas of the facility. Completion of OHL test area is a key milestone to deliver innovation programme for OHL technologies. | Complete |
| 9.8 | Scope of work for the Phase 3 innovation programme approved | The continuation of the phased handover of assets is essential to the project's success, as is having a detailed plan in place, based on the assets available and trials proposed during this phase. This plan will include costs of the proposed trial projects, the estimated benefits and justification for how the trials satisfy the Electricity NIC criteria. The plan will also include any NIA projects which can be undertaken at this time. | Complete |
| 9.9 | Commencement of Phase 3 innovation programme | The delivery of the innovation programme testing and evaluation is a key milestone within the project and the ability to commence operations at the facility is fundamental to the measurement of its success. | Complete |
| 9.10 | Completion of Stage 3 construction works | The completion of the construction of the substation area is a key milestone to the effective functioning of the facility, as this will enable the delivery of HV equipment testing and evaluation projects. | Nov-24 |
| 9.11 | Approval of model for enduring facility | The Technical Advisory Board will determine, based on the flow of projects, the future of the facility. | Complete |
| 9.12 | Project close down | All project learning will be consolidated and disseminated appropriately. | Mar-25 |

# Retrofit Insulated Cross Arms (RICA)

**Our Retrofit Insulated Cross Arms (RICA) project is a NIC project. It aims to find innovative ways to deliver network capacity – providing increased value for money to consumers and accelerating the drive towards a low-carbon future.**

Insulated cross arms replace the standard metallic cross arms from which insulators and conductors are attached and/or suspended. Retrofit insulated cross arms enable network owners to upgrade the voltage rating on their existing towers from 275kV to 400kV, which has the potential to increase transmission capacity by more than 40%.

The project provides a pathway for Britain's first full-scale implementation of RICA technology, by mitigating technology risks and accelerating its adoption onto the network.

Using RICA could decrease emissions through avoiding use of steel and concrete required for new OHL builds, potentially delivering a 39kt reduction of net carbon emissions by 2050.

RICAs can provide new network capacity without the need for new build OHL. This leads to shorter project timeframes, reducing constraint costs earlier (saving £180m per year) and enabling faster connection of renewable generation. The capability to operate at higher voltages also means lower losses and associated emissions. Wider benefits to stakeholders include reduced customer impact due to lower construction volumes and better visual amenity of towers compared with new build alternatives.

## Partnership approach

Through our innovation partnership with insulator manufacturer Shemar and overhead line contractor Wood, we've progressed the RICA project over the past year.

## RICA progress

During the past year, we built a test tower at our Deeside Centre for Innovation, where the RICA prototype will be subject to environmental and electrical testing and monitoring in a controlled environment. We also developed an initial draft specification for prototype RICAs.

Full-sized prototypes are now being manufactured with a delivery due in August 2024. We'll install these at our Eakring training facility, so we can demonstrate installation and maintenance procedures for training and development. We're currently drafting these procedures.

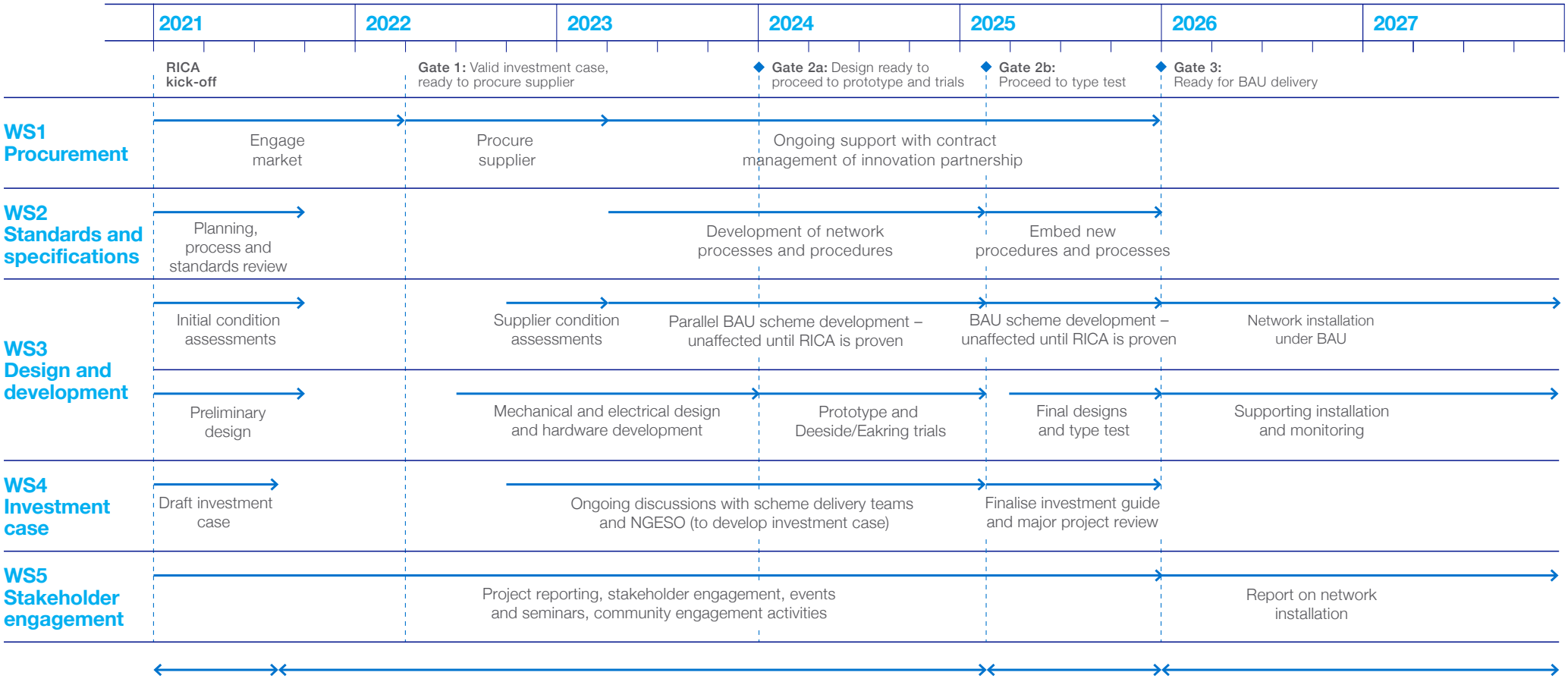
We've shared and promoted RICA's innovative technology at stakeholder events in the UK, including the Energy Innovation Summit and Utility Week Live 2023. A RICA project paper was accepted for the CIGRE Conference at Paris in 2024.


**Jimmy Deas**
Senior Innovation Engineer

**"The RICA project is a notable example of how National Grid is harnessing innovation to increase network capacity and find solutions that contribute to the UK's net zero ambitions."**

# Retrofit Insulated Cross Arms (RICA) continued

## Delivery Programme




**Stage 1**

NGET project team will engage with wider business, framework service providers and universities, and potential RICA suppliers

**Stage 2a**

NGET project team will work with chosen supplier and alongside the wider business departments to develop, de-risk and ready the technology design and the investment option

**Stage 2b**

Final designs and type testing

**Stage 3**

NGET project team will support the wider business and witness the implementation of RICA on the networks as BAU

# Retrofit Insulated Cross Arms (RICA) continued

## Successful delivery reward criteria reference table

| Ref | Criteria | Description | Status |
|---|---|---|---|
| D.S1.1 | Detailed requirement definition | • Report consisting of all the information required for potential suppliers to accurately gauge the level of work that will be involved in Stage 2<br>• Shared with licensees through TAB. | Delivered 01 Jul-21 |
| D.S1.2 | Preliminary investment case | • Report on the preliminary investment case<br>• Shared with licensees through TA<br>• Workshop with TAB members to review benefits from technology on their networks. | Delivered 01 Jul-21 |
| D.S2a.1 | Draft functional specification | • Draft functional specification<br>• Workshop with stakeholders to incorporate feedback into specifications<br>• Disseminated through TAB. | Delivered Mar-24 |
| D.S2a.2 | First generation product design portfolio | • RICA designs for first generation<br>• Workshop with stakeholders to review impact of different design choices on investments and applications<br>• Disseminated through TAB. | Aug-24 |
| D.S2a.3 | Report detailing trial outcomes and lessons learned | • Report on hardware trials of RICAs<br>• Evidence of workshops and lessons learned from trials<br>• Non-confidential information disseminated through industrial conference or journal<br>• Report disseminated to licensees through TAB. | Jul-24 |
| D.S2b.1 | NGET processes and procedures for RICA | • Updated technical specifications<br>• Guidance note on rationale behind specification<br>• Guidance on investment case development<br>• Installation practices recorded in report<br>• Disseminated to licensees through TAB, and non-confidential information through industrial conference or journal. | Aug-24 |
| D.S2b.2 | Detailed uprate methodology (final investment case) | • Report on scheme delivery plan and methodology<br>• Disseminated through TAB to licensees<br>• Final guidance on investment case development<br>• Non-confidential learnings disseminated through industrial conference or journal paper. | Jun-25 |
| D.S2b.3 | Full suite of documentation issued | • Final technical specifications published<br>• Final guidance note on rationale behind specification<br>• Final installation practices recorded in report<br>• Materials disseminated through TAB. | Feb-25 |
| D.S3.1 | Enhanced stakeholder engagement | • Record of RICA engagement with stakeholders<br>• Materials for stakeholder engagement posted publicly. | Dec-25 |
| Common | Comply with knowledge transfer requirements of the Governance Document | • Annual Project Progress Reports which comply with the requirements of the Governance Document<br>• Completed Close Down Report which complies with the requirements of the Governance Document<br>• Evidence of attendance and participation in the Annual Conference as described in the Governance Document. | Dec-25 End of development |

# Our Strategic Innovation Funding projects

## About SIF

Strategic Innovation Funding (SIF) is delivered in partnership with Innovate UK, part of UK Research and Innovation (UKRI). It funds ambitious, innovative projects that have the potential to accelerate the transition to net zero.

Discovery is the first of a three-phase funding application. This stage comprises a solution feasibility study to identify challenges and benefits to end consumers.

Successful delivery of this phase opens up the opportunity to receive further funding in Alpha and Beta phases to develop and demonstrate the solutions.

We progressed three projects that were granted SIF funding for discovery in 2022/23. Two of these projects advanced to the Alpha phase during 2023/24.

These projects demonstrate how National Grid and its partners in industry and academia are tackling some of energy's biggest challenges with ambitious thinking.

### Super Conducting Overhead Lines (SCOHL)

Through this project, we investigated the potential use of high-temperature superconductor (HTS) technologies as an alternative to our current overhead line technology to increase power flow capability. The project reached the Discovery phase only.

### Whole Energy System Resilience Vulnerability Assessment (WELLNESS)

This project advanced to SIF's Alpha phase and will establish the foundations to develop the first resilience vulnerability assessment for the whole electricity system in Great Britain. This will allow a standardised approach to large 'Black Swan' events (low probability events that have serious consequences).

### $SF_6$ Whole Life

This project, which advanced to the Alpha phase, will develop an economic, efficient, holistic replacement and management strategy for the greenhouse gas Sulphur Hexafluoride ($SF_6$). The project will help realise Great Britain's ambition to deliver a clean energy system.

During 2023/24, we applied to Ofgem for SIF funding to deliver the Discovery phase of Hybrid-Network Improvement and Reliability Enhancement (HIRE). This project is researching new state-of-the-art condition monitoring to improve the commissioning and operation of offshore cables. This new, robust system will mitigate the risk of failure, overcome limitations in factors such as cable length, and aid network operators in decision-making for a more flexible grid.

**Sean Coleman**
Deeside Centre for Innovation Manager

**"With SIF funding, we're able to progress a handful of exciting innovation projects, including putting a new lens on network resilience to help strengthen it in future, and work to reduce and eventually eliminate our dependency on the greenhouse gas $SF_6$. Our innovation activity is playing an important role in helping to shape progress towards net zero in Britain, and in ensuring our energy networks are fit for the future while keeping costs down for consumers."**

# Our NIA innovations

- Tackling oil leaks on transformers
- Use of alternative cooling to enhance cable rating in tunnels
- Automated alert tool to predict flood and erosion risk
- Reducing carbon emissions in construction
- SCISSORs provides cutting-edge solution
- Faster and more efficient repairs for $SF_6$ leaks
- Insight into how V2G can help manage peak demand
- Using AI modelling to distinguish corrosion grades on towers
- A smarter approach to improve electricity system restoration after a shutdown
- Optimising substation battery banks to improve resilience
- Investigating a centralised protection, automation and control system for substations
- A way of assessing the benefits of electrolysers
- Applying 5G technology to monitor overhead line sagging
- Embracing ultra-high voltage solutions

Case Study

# Tackling oil leaks on transformers

**Title:**
Sprayed Metal for Effecting Leaking Transformer Repairs (SMELTeR)

**Project number:**
NIA2_NGET0049

**Engineering outcome:**
Maintain the health of an ageing asset base efficiently and economically.

**Tactical priority:**
Improve understanding of the condition of our assets and failure modes.

## Project overview

Transformers play a vital role in converting voltage on the transmission network. They're also prone to leaking mineral oil, requiring significant maintenance intervention to keep oil levels topped up and assets operational. This project aims to identify a technical solution for leaking oil that can be easily deployed and does not require oil to be removed from the transformer.

It builds on previous work with supply chain partner Rawwater. The company has developed a way of sealing leaks using low melting point alloys, known as M3. Rawwater's M3Spray has already been deployed successfully on the network to tackle leaks of the greenhouse gas Sulphur Hexafluoride ($SF_6$).

## How has the project progressed?

The SMELTeR project focuses on two common locations for transformer oil leaks – the flanged lid and the radiator bank. As the first step, we conducted small-scale laboratory testing to simulate transformer conditions. Visits to potential pilot sites then identified two assets suitable for development tests and monitoring over a period of three months.

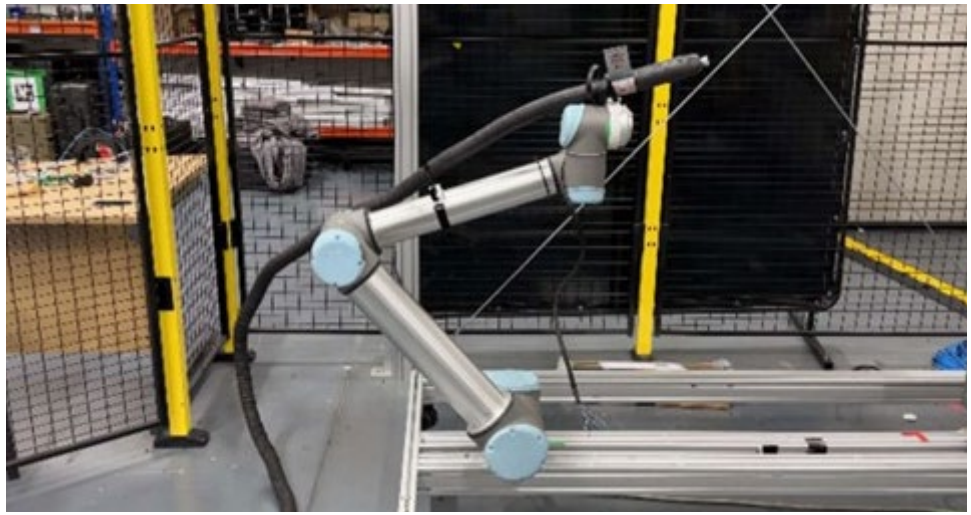
The project is developing both manual and semi-autonomous robotic solutions. The M3Spray can be applied manually via a nozzle, while partner Createc, which specialises in robotics, is leading the development of a robotic arm. This would enable operators to access difficult-to-reach surfaces on transformers to apply a sealing solution with precision.

The temperature profile of transformers means that a different alloy, with a higher melting point, is required compared with the $SF_6$ application. Alloy 12 is suitable for operational use at temperatures below 65°C.

## What are the key benefits and next steps?

The key benefit of this project is in improving overall asset health. It will help to extend the life of transformers, which are difficult to replace with a lead time of over two years for new assets. Transformer replacements in the RIIO-T2 period are budgeted at more than £240m.

We also expect to significantly reduce the 700,000 litres of mineral oil currently needed each year to top up leaking transformers.



**Muhammad Shaban**
Innovation Engineer

**"This project has identified a potential solution that will keep our transformer assets in good health for a longer period."**

# Use of alternative cooling to enhance cable rating in tunnels

**Title:**
Cable Alternative Cooling Technologies for Underground Systems (CACTUS)

**Project number:**
NIA2_NGET0023

**Engineering outcome:**
Maximise the use of our current network capacity.

**Tactical priority:**
Enable significant uprating of existing transmission routes.

## Project overview

High voltage cables are installed within tunnels at points on our network. The power carried by these underground cables is limited by the amount of heat that can be dissipated. Unlike overhead lines, which are cooled by natural airflow, confined tunnels have no such cooling available. Poor heat transfer through the surrounding air means that cables in tunnels are often a 'thermally limiting' section of circuits.

If reinforcement is required, the construction of additional tunnels can be costly and time-consuming. The CACTUS project aims to tackle this problem by using simulation and targeted experiments to investigate a variety of potential cooling methods to enhance cable rating in tunnels.

## How has the project progressed?

The project investigated several cooling solutions, including established technologies such as cooling inlet air, as well as novel techniques like liquid nitrogen cooling systems. The team used a combination of finite element analysis (FEA) models and experiments to assess each option.

Initial experiments demonstrated that liquid nitrogen systems were impractical, while cooling inlet air also posed issues with very low cable surface temperatures, leading to potential failure issues. However, an alternative proposed method of installing water pipes in the tunnel did allow significant ratings increases.

The concept would involve installing 125mm plastic pipes along the tunnel length, with water being cooled via heat exchangers at the end of each shaft and sent back through the pipework system. We found that an inlet water temperature of around 25°C would give the desired level of additional cooling.

Significantly, the project also demonstrated that an additional cable circuit could be installed on a tunnel wall, and the rating of the original circuit could be maintained through the suitable use of water pipes. No modifications were required to the original circuit.

## What are the key benefits?

The project has delivered a valuable proof of concept using simulation. We have established that significant increases in the power flow capacity of cable tunnels appear feasible through appropriate cooling technologies. Further investigations will now take place.

**Hamid Shahrouzi**
Innovation Engineer

**"Ultimately, the cooling methods could offer a quicker and cheaper alternative to network reinforcement as power demand continues to rise."**

Case Study

# Automated alert tool to predict flood and erosion risk

**Title:**
Environmental Risk and Assurance (ERA)

**Project number:**
NIA2_NGET0005

**Engineering outcome:**
Ensure we can maintain resilience against a more challenging external threat landscape, from both natural climate events and cyber events.

**Tactical priority:**
Understand and develop mitigation measures for network and asset resilience in the face of climate change.

## Project overview

Extreme weather events including severe storms, flooding and erosion are becoming more frequent. They pose a threat to vulnerable assets on our network such as substations with potential disruption to electricity supply.

The Environmental Risk and Assurance (ERA) project, which we reported on for the first time last year, involves developing an automated weather alert tool to provide an 'early warning system' for imminent flooding risk.

Until recently, we relied on weather notifications in the form of heatmaps that needed to be interpreted and categorised by human specialists. This was a time-consuming and complex process, and we needed to identify a more reliable and effective way to predict environmental risk.

## What stage is the project at now?

Through ERA, we've worked with three external partners (Frazer-Nash Consultancy Limited, University of Liverpool and Previsico Limited) to create a bespoke modelling tool that can predict specific points on the network at risk of flooding five to seven days ahead of time. It also provides us with long-term erosion forecasts for the next 30 years and beyond.

This year, we've made significant progress on the project. We've completed the installation of 55 flood sensors on vulnerable assets across 30 sites on the network. This gives us a valuable stream of real-world data on which to base operational decisions.

The weather alert tool itself is now fully developed and is undergoing final trialling within Electricity Transmission. It's already being used by our Transmission Network Control Centre (TNCC), for example, allowing engineers to monitor and intervene if severe weather events threaten to affect network resilience.

Over the next few months, we'll continue to integrate the tool and promote into our 'business as usual' operations.

## What are the key benefits?

The ERA project is all about improving network resilience in the face of climate change. It gives us much better situational awareness so we can pinpoint where and when network assets could be at risk from severe weather and decide how to manage the emergency. It will be an important tool in helping us to maintain uninterrupted electricity supplies.

**Tinashe Chikohora**
Innovation Engineer

**"We all recognise that severe weather events are happening more often. The ERA project will help us to protect vulnerable assets and keep power flowing to customers."**

Case Study

# Reducing carbon emissions in construction

**Title:**
Use of innovative materials and construction techniques in the substation environment to accelerate transition to net zero

**Project number:**
NIA2_NGET0045

**Engineering outcome:**
Reduce the emissions of construction activity to achieve net zero targets by 2026.

**Tactical priority:**
Low-carbon materials for construction.

## Project overview

This project is examining how we could reduce carbon emissions from our construction activities by exploring low-carbon alternative materials. The primary materials used in electricity substations are aluminium, concrete and steel. These materials are energy-intensive to manufacture, heavy and difficult to transport. Concrete, for example, is responsible for eight per cent of global carbon emissions.

Finding low-carbon alternatives to these traditional materials will contribute significantly to National Grid's commitment of carbon neutral construction by 2026.

## How has the project progressed?

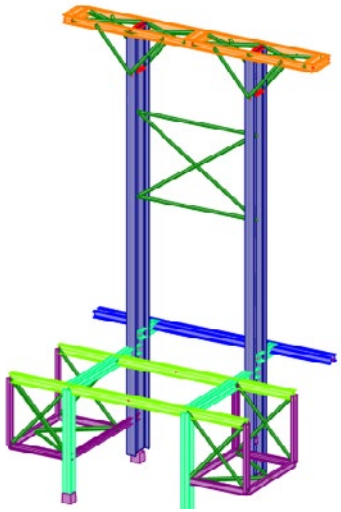
We focused on eight potential structures and civil engineering solutions. Working with supply chain partner Kelvin Construction, we completed eight different feasibility studies to examine each concept in detail, considering issues such as carbon impact, supply chain, material availability and maintenance techniques.

From that feasibility work, we have narrowed the field of potential solutions to six:

- **Graphene-enhanced concrete:** Adding graphene to concrete reduces the amount of cement needed to achieve the required strength, lowering carbon intensity.
- **Weathering steel for structures:** Weathering steel creates a protective, rust-like coating on the steel surface, which doesn't flake away over time, removing the need for painting or galvanising.
- **Lightweight foam foundations:** Expanding foam provides a more sustainable alternative to concrete for the foundations of lightweight structures.
- **Generative design:** This would enable us to create the lightest structure possible given a set of parameters.
- **3D printing of structures:** Adoption would allow the design and 3D print of lightweight structures.
- **Polymer structures:** Polymers could potentially be used as a replacement for steel in equipment support structures.

## What are the key benefits?

The six solutions will now be designed, tested and trialled at live substation sites. Over a 10-year period, we estimate £1.5m of societal value by saving 705 tonnes of concrete, 323 tonnes of $CO_2$ and 62 tonnes of metals. Overall, the innovations could substantially lower the carbon impact of our construction activities.



**Muhammad Shaban**
Innovation Engineer

**"The project is all about how we can make the next generation of the supergrid greener by using innovative alternative materials."**

Case Study

# SCISSORs provides cutting-edge solution

**Title:**
Swarfless Cut Isolation System for $SF_6$ Outages and Repairs (SCISSORs)

**Project number:**
NIA2_NGET0032

**Engineering outcome:**
Maintain the health of an ageing asset base efficiently and economically.

**Tactical priority:**
Improve understanding of the condition of our assets and failure modes.

## What problem is the SCISSORs project looking to solve?

Sulphur hexafluoride ($SF_6$) has a global warming potential that's around 25,000 times that of $CO_2$. So, when we're repairing small-bore pipework associated with $SF_6$-filled high voltage equipment, secure processes are paramount.

There are deliberately no isolation valves between devices such as pressure gauges or $SF_6$ topping-up points and the HV equipment. This makes sure they're not inadvertently isolated from the equipment they're designed to monitor.

However, without the option to isolate gas in the main gas chamber, repairs to the small-bore pipework, such as replacing corroded valves, require removal of all the $SF_6$ from the equipment under outage. This can take between one day and a week, depending on the volume of $SF_6$ within the equipment – which makes these repairs costly.

## What progress have you made?

Through this collaborative project, we've developed a system to cut into stainless steel small-bore pipework – without creating swarf – and introduce an isolation valve. An important objective has been to maintain the integrity of the insulation system throughout the process.

The system involves two bespoke cutting blades, developed by our project partner, fluid control innovation specialists NLB Engineering. One blade makes two small notches to a defined depth; and then the other punches through using a hydraulic ram. That section of pipe is flattened and pushed out securely and removed. We can then introduce an isolation valve.

## How has testing gone?

We've tested the system successfully. In fact, NLB Engineering believes the test may have been the first-ever swarfless cut into pressurised pipe. The system offers great potential, not just for our industry, but for others that need to cut pipes and avoid swarf – the food and chemicals industries, for example.

## What are the next steps for the project?

We're currently introducing some safety systems for the equipment to make it easier for trained staff to apply the process without the risk of $SF_6$ loss.

We'll then trial it on live equipment and assess the results before we consider a plan for its roll-out.

**Gordon Wilson**
Senior Innovation Engineer

**"The SCISSORs project will help reduce repair costs and gas call-outs for $SF_6$ top-ups, while avoiding new $SF_6$ emissions."**

Case Study

# Faster and more efficient repairs for $SF_6$ leaks

**Title:**
Novel Methods for Sealing $SF_6$ Leaks

**Project number:**
NIA2_NGET0016

**Engineering outcome:**
Reduce the emissions associated with our $SF_6$ inventory to achieve net zero by 2050, as well as interim reduction targets.

**Tactical priority:**
Leak detection and repair.

## What has this project involved?

Emissions associated with leakage of $SF_6$ gas from our assets are a significant contributor to NGET's Scope 1 and 2 emissions.

This project involves developing two flexible methods for sealing $SF_6$ leaks from equipment that are currently difficult to address with available solutions. They are:

- a low melting point metal alloy cast with a modular design of mould for small-bore pipework
- a graphene-impregnated elastomer that can be applied as a tape and in a spray to address flange leaks from gas insulated busbars.

## How has the project progressed over the past year?

For the metal alloy cast solution, we carried out live trials, while SSEN transmission also carried out tests of their own. Through collaboration with EIC, Cardiff University, and by using our Deeside Centre for Innovation, Rawwater's innovative technology is being rolled out into business as usual.

For the other part of this project with the University of Manchester, we've developed and tested graphene-impregnated elastomers showing that they can seal $SF_6$ leaks. We've then characterised the material through other tests to show it would be a practical application over a reasonable period of time.

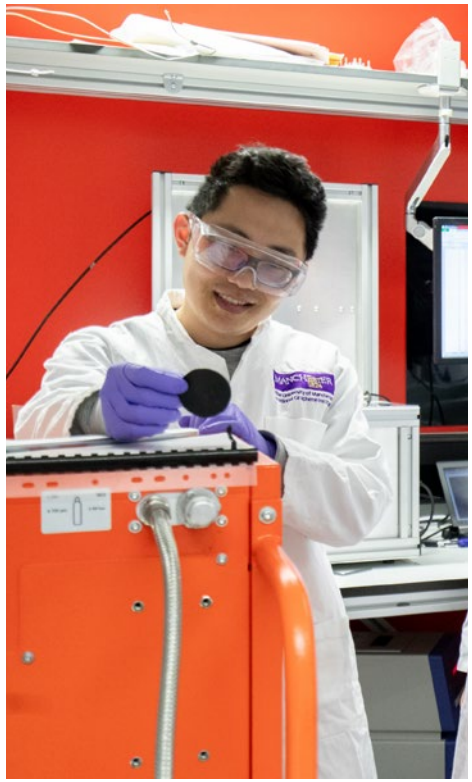
## Is any further work needed on the elastomer?

Although the tests were a success, there's more work to do to develop a complete solution for managing flange leaks. Flanges are bolted and where the two metal surfaces come together, we can apply the tape to fix a leak. However, the gas will find a way through the bolted connection.

The leak sealant can be sprayed or painted on but the spray tests didn't work as well as we hoped. However, the painted solution is looking promising. Next, we'll test it in the laboratory before carrying out field tests.

## In addition to reducing $SF_6$ leaks, are there any further benefits stemming from the project?

Thanks to everything we have learned on the alloy cast solution, we think we can reduce the lead time for creating a suitable mould for a fix from about six weeks to two. That provides a practical benefit in terms of resource efficiency in our operations.



**Gordon Wilson**
Senior Innovation Engineer

**"The technology we've developed through this project will help reduce $SF_6$ emissions and enable us to fix leaks faster."**

Case Study

# Insight into how V2G can help manage peak demand

**Title:**
System Value from V2G Peak Reduction in Future Scenarios Based on Strategic Transport and Energy Demand Modelling

**Project number:**
NIA2_NGET0017

**Engineering outcome:**
Understand the role of whole energy system solutions and their impact on the transmission system.

**Tactical priority:**
Develop and understand capabilities of whole energy system modelling.

## What's the potential for vehicle-to-grid (V2G) to help reduce peak demand?

Ofgem has suggested that smart charging of EVs and V2G together could reduce peak demand by as much as 32 GW by 2050 – potentially more than offsetting the additional peak demand from EVs (estimated at 19-26 GW in 2050).

## How will this project contribute towards a positive outcome for V2G?

The success of V2G is dependent on factors like consumer behaviour, charging point availability and the range of tariffs on offer.

Through this project, we've developed a strategic transport and energy demand (STED) model that investigates the impact of V2G on peak demand across the whole GB system under different credible decarbonisation scenarios.

## What has the project involved?

We used evidence from consumer behaviour research to develop inputs for an initial model – an important part of the project. We then used this to illustrate the impact of V2G on local and system peak demand under a range of different behavioural scenarios. It's quite unique in that we modelled a real-world area – some 40km$^2$ in the Nottingham area – and scaled it up to represent the rest of the GB system.

The impact of battery degradation was something brought up by EV drivers through surveys. We assessed the technical risks to V2G – the impact of battery degradation on vehicle capacity – and developed parameters we could factor into the modelling.

Finally, we assessed the whole system benefits from V2G. This included projecting future energy and ancillary services prices via a scheduling model, impact assessment of fast EV charging stations, and planning of the GB transmission network under long-term uncertainties.

## Who did you work with or engage throughout the project?

Frontier Economics, Warwick University and Imperial College London helped us develop the model.

We also engaged National Grid ESO, as there's potential for EV batteries to participate in system services such as Firm Frequency Response, Short Term Operating Reserve and Demand Turn Up.


**Neha Moturi**
Associate Innovation Engineer

**"Engaging with V2G technology provides benefits for both network operators and EV drivers – ultimately helping manage the demand on the network brought by EV uptake."**

Case Study

# Using AI modelling to distinguish corrosion grades on towers

**Title:**
Visual Inspection and Condition Assessment Platform for OHL Steelwork 2 (VICAP 2)

**Project number:**
NIA2_NGET0048

**Engineering outcome:**
Maintain the health of an ageing asset base efficiently and economically.

**Tactical priority:**
Improve understanding of the condition of our assets and failure modes.

## Project overview

NGET owns 21,900 steel lattice towers in England and Wales, which require regular inspection for corrosion. Every year, we capture thousands of high-definition images by helicopter or drone. The images are then assessed and graded manually on a scale of one to six by inspectors. It's a time-consuming task and where classification is marginal, there's a risk of inconsistency.

A previous VICAP innovation project proved that drones could successfully replace helicopters for asset condition monitoring, enabling us to identify the presence of corrosion via an AI model. VICAP 2 goes a step further. Through this project, we're aiming to train the AI model to automatically grade corrosion, providing a much more accurate snapshot of asset health. We're also feeding historical data into the model to enable it to forecast how future corrosion is likely to develop.

## How has the project progressed?

Starting with the base corrosion model from the first project, we've meticulously labelled more data to teach the model to distinguish between corrosion grades. We're now able to detect baseline corrosion with much greater success in different weather, lighting and background conditions.

Achieving the required precision on different corrosion grades is challenging. Corrosion is a continuous process; large volumes of data samples are needed to improve the model's accuracy, and certain grades of corrosion occur in small patches, making them difficult to detect.

We've experimented with a model that can distinguish between all six grades, as well as a combination of grades, with promising results.

We've also analysed historical assessments for 3,000 towers, collecting climate and weather data for each location. The subsequent steelwork forecasting models perform significantly better than the current guidance we use.

## What are the key benefits?

The project will help to improve system reliability by providing a more accurate picture of asset health, so that we minimise outages and intervene in a timely way.

It will reduce the need for drone/helicopter flights and dramatically speed up the assessment of corrosion via automated assessment using AI models.

We'll also be able to forecast future corrosion with greater certainty.

**Stephen Mbisike**
Innovation Engineer

**"This new approach could potentially transform our asset management process, giving us valuable data on corrosion grades to inform decision-making."**

Case Study

# A smarter approach to improve electricity system restoration after a shutdown

**Title:**
Network Intelligence through Probabilistic Risk Assessment Methodology (NIPRAM) to improve electricity system restoration

**Project number:**
NIA2_NGET0038

**Engineering outcome:**
Ensure we can maintain resilience against a more challenging external threat landscape, from both natural climate events and cyber events.

**Tactical priority:**
Understand and develop mitigation measures for network and asset resilience in the face of climate change.

## Project overview

A total or partial shutdown on the National Electricity Transmission System is a high-impact, low-probability event. NGET has detailed and rigorously tested plans to ensure an effective response in such an event. Local Joint Restoration Plans (LJRPs) detail the agreed methods and procedures which we use to restore the electricity system following a total or partial shutdown. They define the critical assets and substations needed to re-energise the network safely and efficiently.

The number of LJRPs across our network is likely to increase under new government directives and as network infrastructure investment scales to meet rising demand amidst the energy transition.

In the event of a major outage, speed of response and assurance of the re-energisation process is critical to NGET and our customers. The NIPRAM project sought to find the optimum network routing and asset selection to restore power using complex mathematical models.

## How has the project progressed?

NIPRAM started in August 2023 and aimed to improve the resilience of LJRPs through a one-off, short-term project lasting six months. It was successfully completed by end of January 2024. Working with US-based partner, the project used probabilistic risk assessment (PRA) techniques on a use case based on one of Great Britain's electricity interconnector LJRPs.

This was strategically selected to provide a variety of asset classes, substation design and network complexity. In total, 11 transmission substations and 17 transmission circuits were subjected to detailed PRA to identify three most optimal restoration routes.

The project has provided an opportunity to change the business-as-usual approach from qualitative analysis of assets to one based on PRA – using modelling and quantifiable data to verify the best restoration route with available assets.

## What are the key benefits?

The current approach of system operators to restoring the network following a shutdown is largely based on pre-defined asset capabilities and electrical parameters.

It does not adequately consider the criticality or condition of assets such as substations or transformers, for example. This standard approach makes it difficult to select the most efficient and lowest risk combination of assets for re-energisation.

NIPRAM has proven the value of using PRA to increase the resilience of system restoration. The proof-of-concept methodology, approach and technique is transferable, not only to a wider LJRP family but to other business areas requiring similar decision analysis and optimisation.

The project qualified that PRA application resulted in considerable time/cost savings and regulatory compliance.

**Tinashe Chikohora**
Innovation Engineer

**"We believe the results of this effort have provided one of the most mathematically rigorous assessments undertaken on the National Electricity Transmission System. The NIPRAM work gives us the data and methods to make better-informed operationally critical decisions. Embedding these methods into our planning process will reduce network risk and maximise the effectiveness of network interventions."**

Case Study

# Optimising substation battery banks to improve resilience

**Title:**
Characterisation and Optimisation of Battery Banks in Substations (COBBS)

**Project number:**
NIA2_NGET0039

**Engineering outcome:**
Effectively interface and integrate new transmission and customer equipment across the network.

**Tactical priority:**
Increase useful capacity of existing substation and overhead line assets.

## Project overview

Substation battery banks provide back-up power supplies in the event of an unplanned shutdown. They also participate in black start recovery processes if there's a significant loss of supply on the transmission network.

Until now, the design of battery banks hasn't been optimised to meet the specific requirements of each substation. This means that battery banks can be oversized or undersized and are dominated by a single lead acid type.

No deep assessment has been carried out into alternative technologies, while the typical demand profile for very short-term or 'transient' operations isn't well understood.

Through the COBBS project, we're working with Cardiff University to investigate how we can improve battery bank design, tailor batteries to evolving substation loads, and potentially introduce innovative battery chemistries with less carbon footprint.

## How has the project progressed?

In the initial phase of work, an international benchmarking exercise examined how batteries are used on the GB electricity network and beyond. The project team also worked with National Grid engineers to survey and understand the use of substation battery banks on our network.

We're developing a system of sensors that, for the first time, will be deployed at substations to provide online condition monitoring, enabling us to optimise battery operations. We're also investigating higher density battery banks, capable of storing more power while taking up less space.

The next stage of the project will focus on the feasibility of new battery chemistries. New battery designs could be particularly useful for specialised applications, for example, in isolated communities hampered by high installation, transport and maintenance costs.

## What are the key benefits?

The main benefit is in improving substation auxiliary supplies resilience so we can keep power flowing on the network constantly with best practice service. The project will enable us to optimise battery bank design – reducing the carbon footprint, lowering maintenance costs, and achieving savings in battery and charger sizing. Exploring low-/no-carbon alternatives in this space ultimately reduces reliance on conventional carbon intensive materials with their associated processes.


**Tinashe Chikohora**
Innovation Engineer

**"The project offers new coordinated battery bank designs that are cost-effective and more reliable to support the energy transition."**

Case Study

# Investigating a centralised protection, automation and control system for substations

**Title:**
Centralised Protection, Automation and Control (PAC)

**Project number:**
NIA2_NGET0004

**Engineering outcome:**
Facilitate system access for all work as demand grows.

**Tactical priority:**
Develop technology to enhance understanding of real-time system performance.

## Project overview

Protection, automation and control (PAC) systems play a vital role in ensuring the safety and reliability of the network. Deployed in transmission substations, they detect and isolate failures, provide back-up protection, and reduce the amount of manual intervention needed for the substation to operate efficiently.

Currently, substations are equipped with a large number of devices which must work in harmony to deliver the required PAC for the transmission system. This can lead to issues with obsolescence, the need to maintain bespoke hardware and software platforms, and complex asset management.

The project aims to research ways to centralise and virtualise substation PAC functions with the creation of a single, real-time hardware platform. It also addresses challenges around developing a resilient and cyber secure system that can be scaled to meet the requirements of a full transmission substation.

## How has the project progressed?

The project is focused on the creation of a proof of concept for a centralised PAC system. The solution would consist of merging units (which connect analogue and digital signals), a process bus network and a centralised PAC platform.

Working with our supply partner, we've investigated a range of innovative software and hardware options. We've used this work to inform design specifications and requirements.

We've also conducted laboratory trials using a small-scale demonstrator to prove the concept and to analyse the performance of various elements of the system. This included testing the ability of the technology to process 'sampled values' messages – digital current and voltage signals within the substation.

We're aligning potential solutions with the IEC 68150 standard for 'digital substations'. This makes sure protection and control systems can communicate effectively with other intelligent electronic devices within substations.

## What are the key benefits?

If successful, centralised PAC will bring multiple benefits. Suitable for deployment on all transmission substations, it will give us a single view of protection, automation and control performance. It will also simplify hardware and software requirements, reduce capital expenditure and support better cyber resilience. We estimate a net present value of £7m through to 2031.

**Ibukunolu Oladunjoye**
Innovation Engineer

**"Centralising protection, automation and control brings many benefits, including reduced capital expenditure, less manual intervention and greater flexibility."**

Case Study

# A way of assessing the benefits of electrolysers

**Title:**
The role and value of electrolysers in low-carbon GB energy system

**Project number:**
NIA2_NGET0002

**Engineering outcome:**
Understand the role of whole energy system solutions and their impact on the transmission system.

**Tactical priority:**
Develop and understand capabilities of whole energy system modelling.

## Can you tell us a little about the background to this project?

To achieve decarbonisation, the electricity system will integrate increasing amounts of variable renewables and inflexible nuclear generation while enabling the electrification of the heat and transport sectors. However, this integration requires sufficient transmission network capacity and system balancing flexibility.

Electrolysers – which are critical technology for producing green hydrogen from renewables – have a role to play in this. They can help improve system flexibility, reduce renewable curtailment, provide system-balancing services and relieve congestion.

To date, though, the benefits and implications of electrolysers in the future GB system haven't been quantified and comprehensively assessed. This was addressed by comprehensive analysis against various net zero scenarios using the integrated whole system model developed in this project.

## What sort of factors did you consider when developing the model?

The model aims to optimise the portfolio and locations of electrolysers for the future energy system. To help us do that, we took on board factors that included system constraints, the end-use application of hydrogen, transportation costs and water availability.

## What have been the outcomes of the project?

We found that electrolysers can reduce system integration costs for renewables by providing sector-coupling flexibility. They can provide flexibility to the system operator as a supplementary approach for system balancing and to provide ancillary services such as frequency response and network constraint management.

Electrolysers allow electricity to be converted to hydrogen, which can be stored efficiently. This reduces the curtailment of renewable energy and improves its capacity factor, which means greater volumes of wind and solar PV can be integrated cost effectively.

In a system with low flexibility, electrolysers can reduce system costs by billions annually – mostly from avoided investment and operating cost for blue hydrogen production, reduced carbon storage cost and increased electricity exports. The system benefit is less significant when flexibility is high, because other flexibility sources and energy storage can reduce the need for power-to-gas (P2G).

**Xiaolin Ding**
Senior Innovation Engineer

**"Planning ahead to optimise the portfolio of electrolysers and their locations will provide energy system benefits and potential cost savings."**

Case Study

# Applying 5G technology to monitor overhead line sagging

**Title:**
Overhead Line (OHL) Sagging Monitoring Using 5G Signals

**Project number:**
NIA2_NGET0013

**Engineering outcome:**
Maximise the use of our current network capacity.

**Tactical priority:**
Increase useful capacity of existing substation and overhead line assets.

## Project overview

To make sure our overhead line network operates safely and reliably, lines must maintain a statutory clearance to ground. One important parameter we monitor is line sag – the vertical distance between the transmission tower and the lowest point of the conductor.

Currently, we monitor line sag in several ways. We use helicopters equipped with LiDAR (light detection and ranging) technology, as well as sensors placed on the line and tower to measure temperature and sag directly. We also take calculations from nearby weather stations.

It can be costly and complex because outages are required to install the sensors, which must also be checked manually.

Access to the land where lines and towers are located can also be difficult. In addition, power transfer on some circuits needs to be restricted because with higher power transfer, lines get hotter, which in turn increases sag.

This project is investigating the feasibility of using 5G cellular signals to monitor line sag without the need for sensors.

## How has the project progressed?

This is an early-stage research project (TRL2) designed to prove the concept of using 5G signals to monitor line sag. We investigated using 5G radio waves to capture an 'image' of the line due to reflection and diffraction as waves pass around the object (line). We've developed a machine learning algorithm capable of extracting a distinctive sag profile for further analysis.

We've also studied two differing methods that could be employed – radio distance and radio imaging. We conducted field tests at the Deeside Centre for Innovation and follow-up tests on a live circuit on the network. The results are promising, but more work will be required to develop the technology for future deployment.

## What are the key benefits?

The potential use of 5G radio waves to monitor line sag is non-intrusive, requiring no sensors or circuit outages, making it more cost-effective than existing techniques. It would remove the need for manual surveys of line sag and provide more accurate, real-time measurement, enabling lines to operate at higher power capacity.

**Xiaolin Ding**
Senior Innovation Engineer

**"Using 5G signals to monitor overhead line sagging has never been explored before, so we are breaking new ground with this project."**

Case Study

# Embracing ultra-high voltage solutions

**Title:**
Ultra-high voltage onshore energy highway

**Project number:**
NIA2_NGET0034

**Engineering outcome:**
Deliver significant new onshore and offshore network capacity while minimising impact on communities and the environment.

**Tactical priority:**
Explore ultra-high voltage technology for use on the onshore network.

## What role can ultra-high voltage (UHV) transmission technologies play in the future energy system?

The UK's energy sector is undergoing a fast pace of transition towards net zero. Electricity transmission networks are the backbone of this transition. Significant upgrades are required to ensure the network has the right capacity and capability to facilitate the country's energy transition and meet future energy needs.

UHV transmission technologies such as 765kV AC and 800kV HVDC have the potential to play an important role in helping us achieve the required network capacity.

The deployment of these technologies will enable a future 'super-super' grid with bulk power transfer capability to deliver clean energy from big energy sources like offshore wind to demand centres with reduced transmission losses.

## What challenges are involved in deploying UHV technology?

Despite the potential benefits, the current available technology solutions for UHV transmission networks demand a much larger footprint.

This will potentially have a greater impact on the environment and communities and bring challenges on deliverability and consenting risks. Additionally, there's no technical solution commercially available for a section of a UHV circuit that needs to be undergrounded.

## How will this project address these challenges?

Specifically, the VoltXpanse project will investigate solutions for compact UHV pylon designs, cable sections, strategic location of future UHV circuits and optimal delivery strategies that can be deployed in the UK.

The solutions will be economically viable and technically efficient with minimal impact on the environment and community, resulting in maximal benefits for the consumers.

## Who will you be working with on this project?

Our project is being jointly delivered by Arup, University of Manchester and University of Strathclyde. We are also working closely with our project partners from ScottishPower Energy Networks (SPEN), Scottish and Southern Electricity Networks (SSEN), and the National HVDC Centre in Cumbernauld.

## What stage are you at now?

Although we're at the early stage of the project, there has been good progress on the feasibility studies of compact pylon designs. Furthermore, the technological maturity of UHV cables and alternative technical solutions for UHV cable sections was investigated. Initial findings have been shared with our project partners via a workshop this spring.

## What cost savings could the project achieve?

UHV transmission circuits will have much fewer power losses than the current 400kV circuits. It is anticipated that the saving could be around £1bn for 20 years duration after the UHV technology is deployed across the transmission boundary area of B6, B7a and B8.

**Xiaolin Ding**
Senior Innovation Engineer

**"VoltXpanse will help us develop onshore energy highways capable of transferring bulk power from big energy sources such as offshore wind to demand centres."**

# Live project portfolio

| Project Ref. | Name | Collaborators (includes suppliers, partners and supporters) |
|---|---|---|
| NIA2_NGET0001 | Impedance Scan Methods | Cardiff University, ESO |
| NIA2_NGET0002 | Role and value of electrolysers in low-carbon GB energy system | I C CONSULTANTS LIMITED, ESO, NGGT |
| NIA2_NGET0003 | Retrofitting Oil Source Heat Recovery to Transformers | ThermaMech Ltd, The University of Manchester, SSE Energy Solutions |
| NIA2_NGET0004 | Centralised PAC | UK Grid Solutions Limited |
| NIA2_NGET0005 | Environmental Risk and Assurance (ERA) | Frazer-Nash Consultancy Limited, The University of Liverpool, Previsico Limited, Energy Innovation Centre Limited (EIC) |
| NIA2_NGET0006 | Non-invasive In-situ Monitoring and Interpretation of $SF_6$ Alternatives in GIS Equipment | The University of Manchester |
| NIA2_NGET0007 | EPRI Research Collaboration on Electric & Magnetic Fields Health & Safety (P60) 2021-25 | EPRI |
| NIA2_NGET0008 | EPRI Substations (P37) and Analytics (P34) 2021–2025 | EPRI |
| NIA2_NGET0009 | Visual Inspection and Condition Assessment Platform for OHL Steelwork (VICAP) | Keen AI, sees.ai |
| NIA2_NGET0010 | Non-intrusive Tower Foundation Inspections using UGW (NITFI) | The Welding Institute Ltd (TWI) |
| NIA2_NGET0011 | Alternative Approaches to Tower Painting Preparation | Hive Composites Ltd |
| NIA2_NGET0012 | EPRI Research Collaboration on Underground Transmission (P36) 2021–2025 | EPRI |
| NIA2_NGET0013 | Overhead Line Sagging Monitoring Using 5G Signals | The University of Warwick |
| NIA2_NGET0014 | Secure Edge Platform | Capula Ltd |
| NIA2_NGET0015 | Fibre Health Monitoring | EXFO Europe Ltd, ADVA Optical Networking |
| NIA2_NGET0016 | Novel methods for sealing $SF_6$ leaks | Rawwater Applied Technology Limited, The University of Manchester, Cardiff University, SPEN, SSEN Transmission, EIC |
| NIA2_NGET0017 | System value from V2G peak reduction in future scenarios based on strategic transport and energy demand modelling | Frontier Economics, Imperial College London, The University of Warwick |
| NIA2_NGET0018 | Autonomous Aerial, Thermal Inspections of Substations | Frazer-Nash Consultancy Limited, HEROTECH8 |
| NIA2_NGET0019 | Aerial E-field Inspection System for Live Overhead Transmission Assets | The University of Manchester |
| NIA2_NGET0020 | Co-Simulation | Manitoba Hydro International, SPEN, SSEN, NGESO |

# Live project portfolio continued

| Project Ref. | Name | Collaborators (includes suppliers, partners and supporters) |
|---|---|---|
| NIA2_NGET0021 | New online tools for Assessment of Bushing Condition | Doble PowerTest |
| NIA2_NGET0022 | Switch Oil Markers | The University of Manchester, Nynas Limited |
| NIA2_NGET0023 | Cable Alternative Cooling Technologies for Underground Systems (CACTUS) | The University of Southampton |
| NIA2_NGET0024 | Insulating Dielectrics: Esters & Alternative Liquids | The University of Southampton |
| NIA2_NGET0025 | Wide Area Control Framework | SIEMENS PUBLIC LIMITED COMPANY |
| NIA2_NGET0026 | Energy water nexus | Energy Systems Catapult, PSC |
| NIA2_NGET027 | Enhance Power Flow Control Capability of GB Network | University of Exeter, ESO |
| NIA2_NGET0028 | Identification and quantification of C4F7N gas arcing by-products and their implication for GIS operation | Cardiff University |
| NIA2_NGET0029 | Silicone Oil Diagnostics: Marker Investigation | EA Technology |
| NIA2_NGET0030 | Voltage Interaction and Thermal Dynamics of Tertiary Connection | The University of Manchester |
| NIA2_NGET0031 | Understanding the Whole System Impacts of Nuclear Co-Generation on Electricity Transmission Infrastructure | ESC, ESO |
| NIA2_NGET0032 | Swarfless Cut Isolation System for $SF_6$ Outages and Repairs (SCISSORs) | NLB Engineering |
| NIA2_NGET0033 | Digital Twin Enabled Innovation for Network Restoration | Arup |
| NIA2_NGET0034 | VoltXpanse: Ultra-high voltage onshore energy highway | Ove Arup & Partners Ltd, The University of Manchester, SPEN, SSEN, The National HVDC Centre |
| NIA2_NGET0035 | Green Heat for Local Communities | Arup, SGN |
| NIA2_NGET0036 | Grid forming modelling and stability | Cardiff University, ESO |
| NIA2_NGET0037 | Optimum Wide Area Power Flow Control Solutions | Smart Wires |
| NIA2_NGET0038 | Network Intelligence through Probabilistic Risk Assessment Methodology (NIPRAM)to improve electricity system restoration | Aerospace Technical Services, NGED, UKPN |
| NIA2_NGET0039 | Characterisation and Optimisation of Battery Banks in Substations (COBBS) | Cardiff University |
| NIA2_NGET0040 | Surge Arrestors Health Assessment by monitoring partial discharge (SAHARA) | EA Technology, The University of Manchester |
| NIA2_NGET0041 | Wet Weather Data for OHL Noise Prediction | Met Office |

# Live project portfolio continued

| Project Ref. | Name | Collaborators (includes suppliers, partners and supporters) |
|---|---|---|
| NIA2_NGET0042 | Analysis of the Thermal Influence of Cable Surroundings (AnTICs) | University of Southampton, Ørsted |
| NIA2_NGET0043 | Aerial Inspection of OHLs from BVLOS | sees.ai |
| NIA2_NGET0044 | Improving the determination of safety and induced effects in earthing systems | Cardiff University |
| NIA2_NGET0045 | Use of Innovative Materials and Construction Techniques in the Substation Environment to Accelerate Transition to Net 0 | KELVIN CONSTRUCTION COMPANY LIMITED |
| NIA2_NGET0046 | CrystalClear – Lifecycle Analysis of $SF_6$ Alternative Technologies and Crystal Formation Impacts | The University of Manchester, EPRI |
| NIA2_NGET0047 | Cable Oil DEcontamination by BaCteria (CODEC) | BioNRec |
| NIA2_NGET0048 | Visual Inspection and Condition Assessment Platform for OHL Steelwork 2 (VICAP 2) | DSCIENCE LTD (trading as KeenAI) |
| NIA2_NGET0049 | Sprayed Metal for Effecting Leaking Transformer Repairs (SMELTeR) | Rawwater Engineering Company Ltd |
| NIA2_NGET0050 | Condition Assessment of Long Interconnected Cable Systems | University of Southampton, Ørsted |
| NIA2_NGET0051 | Interaction of Megawatt e-Trucks with Transmission System (I-MeTTS) | Cardiff University, NGED, ESO |
| NIA2_NGET0052 | Detailed Analysis of Transformer Ageing Mechanisms for Intelligent Estimation of Reliability – DATAMInER | The University of Manchester, University of Southampton |
| NIA2_NGET0053 | Optimise Fault Infeed | ESO, SPEN |
| NIA2_NGET0054 | Transmission Heat Effects, Resilience Measures to manage Asset Lifecycles (THERMAL) | TNEI Services Ltd, Frazer-Nash Consultancy Limited, The University of Edinburgh, SSEN Transmission, National Grid Electricity Distribution (NGED) |
| NIA2_NGET0055 | Knowledge Elicitation of Risks to Assets Under lightning Impulse Conditions (KERAUnIC) | University of Bath, NGED |
| NIA2_NGET0057 | Benthic Life: Understand the impact of Electromagnetic Fields from Interconnectors (BLUEFIN) | University of Southampton, SSE |
| NIA2_NGET0058 | HVDC Assets Life Cycle Assessment (HVDC – LCA) | DNV Services UK Ltd, SPEN, SSEN |
| NIA2_NGET0059 | Anticipating Gas Insulation Leaks from Electrical assets AGILE | Elimpus Ltd, University of Strathclyde, EPRI |
| NIA2_NGET0060 | Robot, AI and Drone Enhanced Detection of Discharge (RAIDEDD) | Cardiff University, Chronos Technology Ltd, University of Strathclyde, Elimpus Ltd |

# Live project portfolio continued

| RIIO-T2 Collaborative Projects | | |
|---|---|---|
| **Project Ref.** | **Name** | **Collaborators (includes suppliers, partners and supporters)** |
| NIA_CAD0088 | Digital Exclusion | Led by Cadent. Partner: Frazer-Nash Consultancy Limited, Energy Innovation Centre |
| NIA_NGGT0175 | 5G – The art of the possible | Led by National Gas Transmission. Partner: Digital Catapult |
| NIA_SPEN_0064 | Cyber Security for Active and Flexible Energy Networks (Cyber-SAFEN) | Led by SPEN. Partner: The University of Manchester |
| NIA_SHET_0039 | OHL Foundation Uplift | Led by SSEN |
| NIA_NGGT0184 | Gas and electricity transmission infrastructure outlook | Led by National Gas Transmission. Partner: Guidehouse |
| NIA_SHET_0035 | TOTEM (Transmission Owner Tools for EMT Modelling) Extension | Led by SPEN |
| NIA_SPEN_0084 | Transformer Research Consortium Phase 5: Future-proof Transformers in a Digital Twinning and Net Zero World | The University of Manchester, EPRI, SGB-SMIT Group, Shell, Weidmann |
| NIA_SPEN_0090 | Cyber Risk Impact Awareness System Tool (Cyber – RIAST) | Led by SPEN. Partner: The University of Manchester |

## How our projects are funded during RIIO-T2

**We receive funding for our innovation portfolio from two main sources – the Network Innovation Allowance (NIA) and Strategic Innovation Funding (SIF).**

**Hover to read about NIA**

**Hover to read about SIF**

# Live project portfolio continued

| SIF Project Portfolio | | | |
|---|---|---|---|
| **Project Ref.** | **SIF phase and round** | **Name** | **Project partners** |
| **10027585** | Discovery – Round 1 | Eye in the Sky – Application of satellite data to improve grid resilience | Spottitt Ltd, NGGT, ESA, Cranfield University |
| **10027503** | Discovery – Round 1 | SEGIL – Sustainable Electrical Gas Insulated Lines | Ørsted, Scottish Power Transmission (SPT), NGESO, General Electric (GE), J. Murphy & Sons Limited, The University of Manchester, Frazer-Nash Consultancy Limited |
| **10027601** | Discovery – Round 1 | SCADENT – Super Conductor Applications for Dense Energy Transmission | Ørsted, Western Power Distribution (WPD), Scottish Power Transmission (SPT), UKPN, University of Strathclyde, The University of Manchester, Nexans, American Superconductor (AMSC), Frazer-Nash Consultancy Limited |
| **10037439** | Alpha – Round 1 | Eye in the Sky – Utilising satellite data to improve grid resilience | National Grid Gas plc, Spottitt Ltd, DNV |
| **10037761** | Alpha – Round 1 | SCADENT – SuperConductor Applications for Dense Energy Transmission | University of Strathclyde, The University of Manchester, Frazer-Nash Consultancy Limited, Western Power Distribution PLC, UK Power Networks (Operations) Limited, SP Transmission PLC, Nexans France, AMSC |
| **10061033** | Discovery – Round 2 | Whole Energy System Resilience Vulnerability Assessment (WELLNESS) | The University of Manchester, Imperial College London, Ove Arup & Partners Ltd, Electricity North West Limited, University of Cyprus |
| **10061159** | Discovery – Round 2 | SCOHL | University of Strathclyde, VEIR |
| **11061098** | Discovery – Round 2 | $SF_6$ Whole Life Strategy | The University of Manchester, Imperial College London, Ove Arup & Partners Ltd, Electricity North West Limited, University of Cyprus |
| **10084569** | Alpha – Round 2 | $SF_6$ Whole Life Strategy | The University of Manchester, DNV Services UK Limited, DILO Armaturen und Anlagen GmbH, Scottish Hydro Electric Transmission plc |
| **10084557** | Alpha – Round 2 | Whole Energy System Resilience Vulnerability Assessment (WELLNESS) | University of Cyprus, Imperial College London, Ove Arup & Partners Ltd, Electricity North West Limited, The University of Manchester |
| **10103531** | Discovery – Round 3 | HIRE – Hybrid Network Improvement and Reliability Enhancement | The University of Manchester, Scottish Hydro Electric Transmission plc, DNV Services UK Limited, High Voltage Partial Discharge Limited |

# Contact us

We'd really like to hear from you – our communities, consumers, customers, employees, investors and stakeholders. We want to make sure we're focusing on the right areas and delivering the right results.

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