Innovation
Annual Summary
2020/21
Contents

02 About us
03 Welcome to our Innovation Annual Summary 2020/2021
04 A year of broadening our horizons
07 Our innovation in numbers
08 Reflecting on RIIO-1
09 Collaboration
12 Deeside Centre for Innovation
16 Retrofit Insulated Cross Arms (RICA)
19 Our focus in RIIO-2
21 NIA project case studies
35 RIIO-1 project portfolio

About us
Welcome to our innovation annual summary 2020/2021

In this year’s report, we reflect not just on the work we’ve done in the final year of RIIO-1, but also on how our innovation work has evolved over the eight-year regulatory period. It’s been a time of remarkable change, characterised by rapid technological growth and an increasing emphasis on the transition to a low-carbon economy.

Our Zero 2050 project is a good example of how our work is increasingly linked to the decarbonisation of transport, heat and industry – in this case, partnering with network providers to speed up progress towards making South Wales carbon-free by 2050. You can read more about this on page 31.

In our Innovation Annual Summaries, we always highlight how important collaboration is to the way we work. And like most other businesses, we’ve had to find new ways to talk to our stakeholders and customers during an extraordinary and challenging year.

As you can read on page 10, the impact of Covid-19 led us to re-think how we used digital technology to provide people with a host of different ways to engage with us. Ultimately, we want to reach as many stakeholders and customers as possible, so we can broaden debate, seek opinion and gather ideas.

Putting innovation at the heart of the way we work has gained significant momentum over the past year. Our new innovation forum (see page 4) brings together people throughout our business to discuss how innovation can help them achieve great outcomes for our customers. And, as you can read on page 19, our NGET Board Innovation Charter both demonstrates our leadership commitment and helps set the tone for an innovative culture.

All this is helping build the momentum we need to meet the challenges of the energy transition. A carbon-free transmission system will be an integral part of an energy landscape that looks very different to the one we’ve been used to for so long.

Alice Delahunty
President of National Grid Electricity Transmission

“A carbon-free transmission system will be an integral part of an energy landscape that looks very different to the one we’ve been used to for so long.”
Over the past year we’ve been developing the breadth of our innovation ambition and portfolio, gearing both to meet the challenge of the Government’s target of achieving net zero carbon emissions by 2050.

We’ve also been further developing a culture of innovation within our business, finding new ways for people to explore creative potential. Our new innovation forum brings together key stakeholders from throughout National Grid Electricity Transmission. The forum is providing the means for them to share their challenges and priorities, while showing them how innovation can help meet business needs.

The forum is also helping stimulate a culture where our people talk more naturally about innovation, promoting it as a topic that’s an integral part of our way of working.

“A year of broadening our horizons”

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“An increasingly mature innovation culture will be crucial for us as we look to develop long-term benefits for consumers and decarbonise the industry and society.”

Paul Gallagher
Head of Innovation,
National Grid Electricity Transmission
Our highlights for the year include…

Continuing to deliver innovative projects
Throughout the year we have progressed 45 Network Innovation Allowance (NIA) funded projects, discovering innovative solutions across diverse areas to deliver better outcomes for consumers.

Zero 2050
This pioneering innovation project, which aims to speed up the progress of decarbonisation in South Wales, demonstrates our commitment to multi-stakeholder engagement. A partnership between network providers in South Wales, it’s co-funded by Wales and West Utilities, Western Power Distribution and National Grid, and is backed by the Welsh Government and the South Wales Industrial Cluster.

Zero 2050 is a great example of how the nature of innovation is evolving, encompassing crucial work to explore whole system pathway options and ideas rather than specifying technical solutions. Although Zero 2050 relates to South Wales, it also demonstrates an approach we can apply to the wider decarbonisation agenda.

Deeside Centre for Innovation
We’re now into the completion phase of constructing the Innovation Centre facilities that should start 24/7 commercial operation this year. We’re also moving forward with a number of innovation projects that will use this new facility, including plans to examine how an alternative gas to SF₆ performs.

The Deeside Centre for Innovation will enable a lot of the work we want to do during RIIO-2, including our efforts to meet the net zero ambition. It will also provide an opportunity for the rest of the industry to develop and test important innovations.

A year of broadening our horizons continued
A year of broadening our horizons continued

SF₆
Replacing SF₆ in our equipment with low carbon alternatives, and reducing its leakage on our network, is the biggest direct environmental intervention that we can make.

We’re at a transition phase with this work – moving from alternative gas technologies being on the horizon, to now preparing for replacing SF₆ equipment on our network. We expect to see alternative gases appearing on our network for the first time over the next couple of years, and we’ve been looking at the risks and issues we’ll need to tackle in managing the transmission system safely and efficiently with this equipment.

We’ve also been continuing to find ways to reduce SF₆ leakage during the transition and minimising its impact when leakages occur.

RICA project funding
In November 2020 we were successful in securing £8.12m of funding from Ofgem’s Network Innovation Competition (NIC) to develop innovation for the uprating of overhead lines.

The Retrofit Insulated Cross Arms (RICA) solution will allow over 40 per cent more power to be transported over existing lines with minimal construction interventions.

Sharing our priorities
We have a clear vision to be at the heart of a clean, fair and affordable energy future and have been promoting our strategy for how innovation will play a crucial role in this.

In February, E&T Magazine published an article about our strategy.

RICA project funding
Click here to read more about this work

Sharing our priorities
Click here to read more about sharing our priorities

In February, E&T Magazine published an article about our strategy.

Click here to read about our strategy in the E&T Magazine article
Our innovation in numbers

- **184** Network Innovation Allowance (NIA) projects in RIIO-1 period
- **£7.21m** spent on NIA projects in 2020/21
- **7** new NIA innovation projects started in 2020/21
- **12** RIIO-1 projects in delivery and will complete during 2021/22

**Percentage of projects aligned to strategy in RIIO-1**
- Corporate Responsibility: 44%
- Efficient Build: 21%
- Managing Assets: 21%
- Service Delivery: 14%

**Distribution of Technology Readiness Level by volume of NIA projects in RIIO-1**
- Research (TRL 2-3): 64%
- Development (TRL 4-6): 31%
- Demonstration (TRL 7-8): 5%

- **£5.5m** forecast spend on NIA projects in 2021/22, including £1m of CNIA from RIIO-1
- **88%** of NIA allowance spent in 2020/2021 with an additional 12% being spent in 2021/22
- **14** FTEs dedicated to leading our innovation projects and engaging with NGET teams and external stakeholders to deliver the desired outcomes
The eight-year RIIO-1 regulatory period came to an end on 31 March 2021. It’s been a period where we’ve seen our whole approach to innovation evolve, while developing an innovation programme that provides asset, network and service delivery solutions in a responsible way.

Innovation in RIIO-1 came through three different funding streams: Network Innovation Allowance (NIA), Network Innovation Competition (NIC) and our innovation partnerships.

Through NIA funding, we delivered a total of 184 projects. Additionally, in 2015 we secured £12m in Ofgem funding, through its annual Electricity Network Innovation Competition (NIC), and invested a further £14m to convert a decommissioned substation into a unique research and innovation facility – the Deeside Centre for Innovation.

We’re proud of our achievements in progressing innovative ideas into roll-out across the network. For example, we introduced Smart Wires (SW) technology that will help decarbonise the UK by providing more control and flexibility over the power flow across our transmission boundaries, while enabling us to transmit more renewable energy to consumers at a lower cost.

And we’ve come a long way in the work we’ve done on preparing our network to replace SF₆, which you can read about by clicking on the link below.

Recognition

We’ve been nominated for a range of awards, making the shortlists on two external awards for our innovative textured insulators (these are designed to extend the lifetime of composite insulators by using a textured surface). And our application of the Novel Transformer Dehydration Using Membranes won an Electric Power Research Institute (EPRI) Technology Transfer Award, recognising the work we’ve done to move EPRI research into practice.

Robin Gupta
Regulatory Innovation Manager, National Grid Electricity Transmission

“Our ambition remains to promote innovation across the breadth of everything we do at National Grid Electricity Transmission – challenging ourselves to find new solutions and be more aspirational in the ways we achieve outcomes for customers.”

**How our focus has evolved**

When the RIIO-1 regulatory period began, many of our innovation projects centred on improvements to conventional transmission technology. But our focus has evolved over time to encompass areas such as the environment; enabling the energy transition; and digitising our operations to help us make better decisions, improve how we manage our equipment, and deliver cleaner and cheaper energy for consumers.

In addition to the changing nature of technical solutions, we’ve also been extending the way we innovate. For example, by developing policies that allow us to operate our equipment differently, or to extend its lifespan, we’re maximising the benefits the equipment offers.

Similarly, our Forward Resilience project is less about technical innovation and more about how we approach a challenge – in this case, a topic that’s strongly linked to the energy transition due to the technical and process issues it encompasses.

Robin Gupta
Regulatory Innovation Manager, National Grid Electricity Transmission

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Collaboration

Collaboration is a crucial part of the way we innovate in National Grid Electricity Transmission. Sharing and being open to new ideas from across industries and academia allows us to develop projects to transform energy systems and bring the greatest possible benefits to our customers, stakeholders and end consumers.

We make better decisions by being flexible, innovative and working together. For us, that involves finding the right specialist partners to work with us on the right challenges, while giving stakeholders plenty of time and opportunity to contribute and influence our decision-making.

Supply chain

Through our corporate level membership of, and collaboration with, the Electric Power Research Institute (EPRI), we leveraged research funding from more than 100 international electricity utilities so that each £1 we invested in 2020 generated nearly £18 worth of research.

We’ve also collaborated with academic institutions in the UK to leverage wider funding available through the Engineering and Physical Sciences Research Council (EPSRC).

We joined the Energy Innovation Centre (EIC) in 2020, and its wide-ranging stakeholder base gives us new opportunities to engage with forward-thinking suppliers and innovators. It also provides us with a forum to work together with other networks on common challenges that centre on SF₆, vulnerable customers and digital substations.

Additionally, we have continued engaging with innovative organisations through our membership of the Infrastructure Industry Innovation Partnership (i3P). Its large network of experts and innovators is helping drive transformation within the infrastructure and construction industry to deliver infrastructure for the future.
Stakeholders
Like many other organisations, the Covid-19 pandemic and resulting lockdown posed challenges for our stakeholder engagement activities.

Although we particularly value the benefits of face-to-face engagement with our stakeholders, we adapted and found ways to replicate our activities using digital technology. This included our involvement with the Energy Networks Innovation Conference (ENIC), which showcased the most significant Ofgem-funded innovation projects from the UK’s gas and electricity networks.

Our attendance at Utility Week Live – the first of its kind as a virtual event – was another great opportunity for us to collaborate and network with stakeholders using digital platforms.

We saw high attendances at some of our project-related online events for stakeholders – showing us that in the future we need to consider balancing more traditional face-to-face events with digital ones, allowing us to engage with a potentially wider audience.

We also made enhancements to our website, making it easier for stakeholders to get in touch.

“Collaborating with our stakeholders is part of the way we work and will be crucial if we are to be successful during RIIO-2. The energy transition needs innovative solutions, and we can’t meet the challenges alone.”

Gemma Pead
Innovation Stakeholder and Communications Officer, National Grid Electricity Transmission

Stakeholder webinar
On Tuesday 30 March we held a webinar for our stakeholders. In addition to presenting our innovation strategy themes and updates on some of our work, including the Retrofit Insulated Cross Arms (RICA) project and progress on the Deeside Centre for Innovation, we ran a series of polls that highlighted areas in which our stakeholders wanted to be engaged during RIIO-2.

At the virtual Energy Networks Innovation Conference (ENIC), we showcased a number of our innovation projects and RIIO-2 innovation strategy.
Collaboration continued

Academia
We currently have three strategic academic partners: The University of Manchester, Cardiff University and the University of Southampton. We’re working with them on a wide range of innovation areas including exploring alternatives to SF₆, network resilience and whole system modelling. We have also worked with other universities on specific one-off projects such as Imperial College London on impedance modelling.

Click here to read more about Imperial College London and impedance modelling

For RIIO-2, we’re setting up a new framework for a wider range of UK universities to work with us on delivering the energy transition and addressing consumer vulnerabilities. In addition, while we continue to work with framework UK universities we will have connections with a wider range of research institutions in the UK and overseas.
Deeside Centre for Innovation

Project update
In 2015, we secured £12m in Ofgem funding, through its annual Electricity Network Innovation Competition (NIC), to create the Offgrid 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 aims to deliver benefits to consumers by accelerating the deployment of technologies able to reduce both the carbon footprint and cost of present and future energy networks.

At its core are substation and overhead line test areas designed to facilitate live trials at existing distribution and transmission voltages, and beyond. It will enable us and all GB Network Licensees to:

- Test assets associated with electricity networks
- Trial new technologies and methods to address climate change and maintain security of supply while optimising investments in a controlled, off-grid environment, 24 hours, seven days a week
- Collect valuable data by monitoring performance of assets on site.

The facility will underpin the effort we, along with energy industry stakeholders, are investing in innovation and will play an essential role in delivering innovations in RIIO-2 and beyond.

Over the past 12 months the project has made significant progress. We finished construction of the overhead line test area, which is ready to launch testing of insulator and conductor technologies at voltages up to 400kV. Availability of the test area provides opportunities for us and other stakeholders to verify new solutions. It also enables the updating of lifecycle models that predict end-of-life for overhead line assets – improving investment decisions, maintenance costs and reliability of the power system.

In the substation test area, the groundworks have been progressed so we can get the site ready for installing test equipment. The site will have five areas for testing high voltage assets with capabilities up to 400kV/4,000A and even up to 600kV single phase. One of the test areas is designed to test DNO assets.

In addition to the site work, we presented DCI at the Utility Week Live and Energy Networks Innovation Conference (ENIC) conferences in November–December 2020, engaging with a wider innovation stakeholder audience. And in October 2020 we chaired the Technical Advisory Board meeting to share the results of the work with stakeholders, including representatives from universities, utility companies and National Grid experts, and to approve the third phase of innovation trials for the year ahead.
Deeside Centre for Innovation continued

Hydrogen power cell generator
We have engaged with a start-up company called GeoPura that developed a hydrogen power cell solution to replace our diesel generators – this has been successfully applied at our construction site for the Viking Link. We now want to investigate if a hydrogen-based solution can replace diesel generators providing emergency power that we have installed in all our substations. If the trial demonstrates technology compatibility with our existing systems, we can roll it out across the network, replacing retiring diesel generators, or use it as a standard solution in future substations. While reducing our dependence on fossil fuel, we are also creating more opportunities for hydrogen fuel applications.

Transformer heat recovery project
We’ve teamed up with a heat supplier company to investigate using our transformer electrical losses as a heat source for local consumers. Our normal operation transformer oil is maintained at 40-50 degrees and during peak load times can get above 70 degrees, when the oil has to be cooled by fans. While oil heat helps to raise water temperature, a heat pump warms up it further to the temperature required. Applying this solution supports decarbonisation of heat since each 400kV transformer can provide enough heat to supply an apartment building for a whole year.

Sensors for asset monitoring
To improve understanding of our assets’ condition, we need to conduct more frequent measurements or monitor the stresses that are placed on them. We have partnered with the Electric Power Research Institute (EPRI) to investigate the effectiveness of sensor technology to assess an asset’s condition and stresses. Currently, we’re preparing to trial sensors for three applications:
- Leakage current measurement, which will help determine the condition of insulators
- Load cell sensors to measure stresses on conductors
- SF<sub>6</sub> leak detection, and to accelerate repair and reduce our greenhouse gas emissions.

SF<sub>6</sub> leak management and repair techniques
We have engaged with a start-up company called Rawwater, which has developed a solution for rapid repair of pipe leaks, mainly used in gas systems. We want to determine if this solution can be used to repair SF<sub>6</sub> leaks on our circuit breakers. If the trial is successful, this solution, together with fast leak detection technologies, can help significantly reduce emissions stemming from SF<sub>6</sub> loss.

Next steps
Construction work at the site has seen delays due to a range of factors, including the effects of the Covid-19 pandemic. Managing safety due to interactions with other transmission assets installed around the centre have reduced access to part of the site. We are, however, now pressing forward with all construction work across the site and innovation trials with the aim of completion of the project by October 2021. Over the coming months, we’ll continue to lay the foundations for future benefits for the industry, customers and consumers, implementing a commercial model to operate the centre after October 2021.
### Deeside Centre for Innovation continued

#### Delivery programme

<table>
<thead>
<tr>
<th>Year</th>
<th>Construction</th>
<th>Innovation Programme</th>
<th>Successful Delivery Reward Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>Innovation centre</td>
<td>Overhead line condition monitoring</td>
<td>Construction</td>
</tr>
<tr>
<td></td>
<td>OHL area</td>
<td>Circuit breaker monitoring</td>
<td>Innovation programme</td>
</tr>
<tr>
<td></td>
<td>Substation area</td>
<td>Hydrogen fuel cell back-up generator</td>
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<td></td>
<td></td>
<td>Transformer heat recovery</td>
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<td></td>
<td></td>
<td>Insulator monitoring / evaluation</td>
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<tr>
<td></td>
<td></td>
<td>SF₆ leak management and repair techniques</td>
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<td></td>
<td></td>
<td>Asset thermal model for remote operations/RFI sensitivity and characterisation</td>
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<td></td>
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<td>Digital data and visualisation</td>
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<td></td>
<td></td>
<td>CemFree</td>
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<td></td>
<td></td>
<td>Architecture for substation secondary systems</td>
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<tr>
<td></td>
<td></td>
<td>Textured insulators</td>
<td></td>
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<tr>
<td>2019</td>
<td>Design</td>
<td>Feedback</td>
<td>Phase 1 completion</td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td>Construction</td>
<td>Phase 2 approved</td>
</tr>
<tr>
<td></td>
<td>Operation</td>
<td>Operation</td>
<td>Model approved</td>
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<tr>
<td>2020</td>
<td>Design</td>
<td>Construction</td>
<td>Phase 3 approved</td>
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<td></td>
<td>Construction</td>
<td>Operation</td>
<td>Project closure</td>
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<tr>
<td>2021</td>
<td>Design</td>
<td>Construction</td>
<td>Operation</td>
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<tr>
<td></td>
<td>Construction</td>
<td>Operation</td>
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#### Key:
- Tender
- Design approval
- Completion

Continued on next page
## Deeside Centre for Innovation continued

### Successful Delivery Reward Criteria reference table

<table>
<thead>
<tr>
<th>Ref</th>
<th>Criteria</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.1</td>
<td>Formal agreement on Terms of Reference with Technical Advisory Board members</td>
<td>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 in this Board agreeing the Terms of Reference.</td>
<td>Complete</td>
</tr>
<tr>
<td>9.2</td>
<td>Detailed design of the facility completed and approved</td>
<td>The completion of both the infrastructure and technical layout designs are an important milestone on the way to delivery of the overall project as they will determine the level of testing / evaluation that can be carried out and at which stage.</td>
<td>Complete</td>
</tr>
<tr>
<td>9.3</td>
<td>Design, develop and publish internet site</td>
<td>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.</td>
<td>Complete</td>
</tr>
<tr>
<td>9.4</td>
<td>Scope of work for the phase 1 innovation programme approved</td>
<td>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, their estimated benefits and justification for how the trials satisfy the Electricity NIC criteria. The plan will also include any Network Innovation Allowance (NIA) projects which are able to be undertaken at this time.</td>
<td>Complete</td>
</tr>
<tr>
<td>9.5</td>
<td>Completion of stage 1 construction works</td>
<td>The completion of the Innovation Centre building renovation and the transfer of the protection and control panels to the telecoms and control room are a key milestone to the effective functioning and monitoring of the facility.</td>
<td>Complete</td>
</tr>
<tr>
<td>9.6</td>
<td>Scope of work for the phase 2 innovation programmes approved</td>
<td>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, their estimated benefits and justification for how the trials satisfy the Electricity NIC criteria. The plan will also include any Network Innovation Allowance (NIA) projects which are able to be undertaken at this time.</td>
<td>Complete</td>
</tr>
<tr>
<td>9.7</td>
<td>Completion of stage 2 construction works</td>
<td>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</td>
<td>Complete</td>
</tr>
<tr>
<td>9.8</td>
<td>Scope of work for the phase 3 innovation programme approved</td>
<td>The continuation of the phased handover of assets is essential to the project’s success and that a detailed plan is put in place, based on the assets available and trials proposed during this phase. This plan will include costs of the proposed trial projects, their estimated benefits and justification for how the trials satisfy the Electricity NIC criteria. The plan will also include any Network Innovation Allowance (NIA) projects which are able to be undertaken at this time.</td>
<td>Complete</td>
</tr>
<tr>
<td>9.9</td>
<td>Commencement of phase 3 innovation programme</td>
<td>The delivery of the innovation programme testing / 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.</td>
<td>Sep-21</td>
</tr>
<tr>
<td>9.10</td>
<td>Completion of stage 3 construction works</td>
<td>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 / evaluation projects</td>
<td>Jun-21</td>
</tr>
<tr>
<td>9.11</td>
<td>Approval of model for enduring facility</td>
<td>The Technical Advisory Board will determine, based on the flow of projects, the future of the facility.</td>
<td>Mar-21</td>
</tr>
<tr>
<td>9.12</td>
<td>Project close down</td>
<td>All project learning will be consolidated and disseminated appropriately.</td>
<td>Oct-21</td>
</tr>
</tbody>
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Retrofit Insulated Cross Arms (RICA)

Project update

In December 2020 Ofgem awarded us £8.1m funding through the Network Innovation Competition (NIC) to deliver our Retrofit Insulated Cross Arms (RICA) project.

The UK has set an ambitious, but necessary, target of net zero carbon emissions by 2050. Achieving this target will require an increase in renewable generation and the electrification of transport and heat, leading to the need for the increased transmission network capacity.

At the same time, it’s becoming more difficult to deliver increased transmission capacity when it’s needed, while meeting environmental and community objectives.

Through our RICA project, we’re aiming to find innovative ways to deliver network capacity at minimum credible cost – providing better value for money to consumers and accelerating the drive towards a low carbon future.

Insulated cross arms replace the standard metallic crossarms from which insulators and conductors are suspended. Retrofit insulated cross arms enable licensees to upgrade the voltage rating on their existing towers from 275kV to 400kV, increasing transmission capacity by over 40 per cent.

This project will provide a pathway for Britain’s first full-scale implementation of RICA technology, by mitigating technology risks and accelerating its adoption onto the network. The project will remove the current process, technology, and specification hurdles that have prevented licensees from adopting RICA previously.

In the first few months since the project launch, we worked with the project’s Technical Advisory Board (TAB) to establish working groups, which will focus on two deliverables for the project – a RICA functional specification to procure a supplier, and a preliminary investment case to identify a range of unknown factors that may have a bearing on future investments.

Next steps

Over the coming year we’ll select a supplier to deliver a RICA solution, including insulated cross arm designs for a range of tower types, installation, maintenance policies and techniques to address lifecycle performance.

“The Retrofit Insulated Cross Arm (RICA) Project is both interesting and technically challenging. I am excited to deliver a novel innovation, benefitting a broad range of customers and stakeholders.”

James Deas
RICA Senior Innovation Engineer, National Grid Electricity Transmission
### RICA continued

#### Delivery programme

<table>
<thead>
<tr>
<th></th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
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<tbody>
<tr>
<td><strong>Stage 1</strong></td>
<td>NGET project team will engage with wider business, framework service providers and universities, and potential RICA suppliers</td>
<td><strong>Stage 2a</strong></td>
<td>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</td>
<td><strong>Stage 2b</strong></td>
<td>Final designs and type testing</td>
<td><strong>Stage 3</strong></td>
</tr>
<tr>
<td><strong>Stage 2a</strong></td>
<td>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</td>
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<td><strong>Stage 2b</strong></td>
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<tr>
<td><strong>Stage 3</strong></td>
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#### WS1 Procurement
- **Engage market**
- **Procure supplier**
- **Ongoing support with contract management of innovation partnership**

#### WS2 Standards and specifications
- **Planning, process and standards review**
- **Development of network processes and procedures**
- **Embed new procedures / processes**

#### WS3 Design and development
- **Initial condition assessments**
- **Supplier condition assessments**
- **Parallel BAU scheme development – unaffected until RICA is proven**
- **BAU scheme development – unaffected until RICA is proven**
- **Network installation under BAU**

#### WS4 Investment case
- **Draft investment case**
- **Ongoing discussions wth scheme delivery teams and NGESO (to develop investment case)**
- **Finalise investment case and major project review**

#### WS5 Stakeholder engagement
- **Project reporting, stakeholder engagement, events and seminars, community engagement activities**
- **Report on network installation**

#### WS5 Stakeholder engagement
- **Ongoing discussions wth scheme delivery teams and NGESO (to develop investment case)**
- **Finalise investment case and major project review**

#### Gate 1: Valid investment case, ready to procure supplier

#### Gate 2a: Design ready to proceed to prototype and trials

#### Gate 2b: Proceed to type test

#### Gate 3: Ready for BAU delivery

### Network installation under BAU
- **Final designs and type testing**
- **Supporting installation and monitoring**

### BSU scheme development – unaffected until RICA is proven

### BAU scheme development – unaffected until RICA is proven

### Network installation under BAU
## Successful Delivery Reward Criteria reference table

<table>
<thead>
<tr>
<th>Ref</th>
<th>Project Deliverable</th>
<th>Evidence</th>
<th>Deadline</th>
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</table>
| 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.  
• Shared with licensees through TAB                                                    | Jul-21   |
| D.S1.2| Preliminary investment case                            | • Report on the preliminary investment case  
• Shared with licensees through TAB  
• Workshop with TAB members to review benefits from technology on their networks                                                        | Jul-21   |
| D.S2a.1| Draft functional specification                          | • Draft functional specification  
• Workshop with stakeholders to incorporate feedback into specifications  
• Disseminated through TAB                                                                                     | Sep-22   |
| D.S2a.2| First generation product design portfolio               | • RICA designs for first generation  
• Workshop with stakeholders to review impact of different design choices on investments and applications  
• Disseminated through TAB                                                                                     | Dec-22   |
| D.S2a.3| Report detailing trial outcomes and lessons learned     | • Report on hardware trials of RICAs  
• Evidence of workshops and lessons learnt from trials  
• Non-confidential information disseminated through industrial conference or journal  
• Report disseminated to licensees through TAB                                                                 | Jul-24   |
| D.S2b.1| NGET processes and procedures for RICA                  | • Updated technical specifications  
• Guidance note on rational behind specification  
• Guidance on investment case development  
• Installation practices recorded in report  
• Disseminated to licensees through TAB and non-confidential information through industrial conference or journal | Aug-24   |
| D.S2b.3| Full suite of documentation issued                      | • Final technical specifications, published  
• Final guidance note on rational behind specification  
• Final installation practices recorded in report  
• Materials disseminated through TAB                                                                                      | Feb-25   |
| D.S2b.2| Detailed uprate methodology (final investment case)      | • Report on scheme delivery plan and methodology  
• Disseminated through TAB to licensees  
• Final guidance on investment case development  
• Non-confidential learnings disseminated through industrial conference or journal paper                                                                 | Feb-25   |
| D.S3.1| Enhanced stakeholder engagement                         | • Record of RICA engagement with stakeholders  
• Materials for stakeholder engagement posted publicly                                                                 | Mar-25   |
| Common| Comply with knowledge transfer requirements of the Governance Document | • Annual Project Progress Reports which comply with the requirements of the Governance Document.  
• Completed Close Down Report which complies with the requirements of the Governance Document.  
• Evidence of attendance and participation in the Annual Conference as described in the Governance Document | End of Project |

RICA continued
Our focus in RIIO-2

As the pace of climate change and its effects increase, we can expect the technology evolution and delivery of the energy transition to accelerate. Responding to this challenge will mean having to think very broadly about the art of the possible.

The energy transition presents us with both a unique challenge and the opportunity to really make a difference. Although the transition covers a greater timeframe than the regulatory period, RIIO-2 is a critical time for us to take a bold approach – being willing to take a greater risk approach around the type of innovation we take forward.

To achieve success, we need to be open to new ways of doing things. We'll need to further increase our collaboration efforts and our engagement activities – listening to the views of stakeholders, as well as insights from a wide range of subject matter experts throughout the industry and beyond.

Our innovation strategy for RIIO-2 identifies two strategy areas for innovation:

**Delivering cleaner energy**
We’ll create a road to net zero by reducing our carbon footprint and helping industry and society to decarbonise activities.

**Delivering cheaper energy**
Through a long-term innovation programme, we’ll deliver a whole energy system net zero strategy at lowest achievable cost.

These areas will be critically enabled through our third strategy area:

**Delivering an innovative culture**
We’ll develop a more externally referenced, collaborative, open and innovative approach across all of our organisational disciplines, while building capability and unlocking our people’s potential.

Within National Grid Electricity Transmission, we recognise the importance of leadership commitment to innovation. Which is why we now have an NGET Board Innovation Charter. This charter sets out the Board’s commitment to our innovation ambition and approach set out in our RIIO-2 business plan.

Our ambition – to innovate collaboratively, to deliver a safe and reliable net zero carbon energy system at lowest cost for consumers.

Our approach – to deliver greener and cheaper energy through embedding an innovative culture.

All this helps set the tone from the top – delivering a strong message that encourages and empowers people throughout our business to incorporate innovation into their business activities, resulting in a culture of innovation becoming part of our DNA.
Our focus in RIIO-2 continued

We’ll achieve success in our strategy by being agile and creating robust solutions around our six key priorities:

**Transforming the business through digitisation**
We’ll develop tools and techniques that allow the digitisation of many of our processes, and overall management of data, as well as exploring the application of artificial intelligence across many of our activities.

**Facilitate decarbonisation of wider industries**
We’ll collaborate with and support industries cross-sector to decarbonise transport, explore opportunities for achieving net zero in industrial clusters, explore the appetite for transition to a hydrogen economy and the implications on network providers.

**Provide long-term system benefits through Deeside Centre for Innovation**
We’ll open the innovation centre up to a wide range of stakeholders to allow improved development, better testing and faster implementation of low-carbon technologies.

**Being responsive to customers**
We’ll create new construction and installation techniques that will improve our agility for connecting renewable energy customers, while and delivering better customer experience.

**Reducing the environmental impact of our activities**
We’ll develop options for driving down greenhouse gas emissions from SF₆ and other emitters, identify methods for minimising impact of construction, utilise novel materials, and develop new techniques to monitor and measure our performance.

**Continue to deliver technical innovation**
We’ll continue to technically innovate on the equipment and technologies we utilise across the network to drive down costs, minimise carbon impacts and deliver the levels of reliability that our stakeholders require.

To find out more…

- Click here to visit the strategy section of the Electricity Transmission website
- Click here to watch the Innovation Strategy Film or scan the QR code
NIA project

Case studies
Developing protection against cyber threats

Project overview
Thomas Charton, Senior Innovation Engineer, talks about the work we’ve been doing to better understand the extent and nature of cyber security risks to digital substation technology.

What risks do cyber threats pose to the network?
A cyber breach of our infrastructure could have a significant impact on our business and customers. It has the potential to shut down part of the grid in the worst case.

That’s why innovating in cyber security is so important. With the ongoing digitalisation of substation secondary equipment, we need to be more aware of the risks and vulnerabilities associated with the technology before embarking on a widespread rollout. We need to ensure that appropriate mitigation measures are in place.

Who have you worked with on the project?
We worked with a team from the University of Manchester, as well as a range of stakeholders from the industry – including GE, SEL and Siemens – to examine the best ways to protect the business.

Products we’ve identified as effective control measures include cryptography, data flow controllers, firewalls and intrusion detection systems based on various technologies, including artificial intelligence.

How severe is the risk of a cyber attack?
The risk is small, but very credible – and a significant attack on our infrastructure could have a huge impact. The wrong kind of attack could lead to a blackout – we’ve already seen that in Ukraine, where thousands were left without electricity after hackers hit electrical substations.

What comes next for the project?
One of the next steps could be to further develop the concept of collaborative defence mechanisms. We could work on trials with a supplier partner to discover what the added value of such defence mechanisms could be.
Protecting our legacy equipment

Project overview
The gradual switch over from traditional substations to digital technology has brought with it huge benefits. Digital substations are more efficient, easier to operate, and safer.

While the latest modern digital equipment provides the required cyber security features, some of the older equipment was designed at a time when cyber security wasn’t too much of an issue. Hundreds of older electrical substations still use this equipment, though. They’ll continue to play a crucial role in supporting our critical power infrastructure for many years to come.

Cyber threats are now an increasing risk to our network, so it’s vital to make sure these assets are secure.

This project has involved assessing the potential risk these older substations face from hackers, working with the University of Manchester to find possible solutions.

What have we learned?
The project team looked at what equipment is being used, how it’s connected, and what technology is currently available to protect these devices. The work included a risk assessment of legacy equipment, categorising it, ranking them according to relative risk, and putting forward options to make them more secure.

Most of the equipment is still in use, so we can’t simply disconnect it. Some software can be updated, but this is usually only possible on newer devices. The solution we adopt is likely to be based on strict security zones with firewalls, so we can inspect the network traffic and make sure anyone who communicates with that device has the right authentication. A firewall can also check messages coming out of the device.
Ensuring a stable power flow for renewables

**Project overview**

When power flows from renewable energy sources come onto the electricity transmission network, there’s a risk of integration issues that can potentially lead to unplanned outages.

This project, which has been delivered in partnership with Imperial College London, has involved developing a methodology that anticipates these integration issues. The aim is to help us anticipate power conversion problems so we can take steps to avoid them.

The methodology encompasses modelling and measurement tools designed to find the root cause of any instability factors, such as high loading conditions or a fault in the nearby transmission line.

By ensuring a more stable power flow from renewable sources, we’ll be able to avoid delays in connections projects and prevent future outages. Stability guidelines arising from this project could also help avoid grid reinforcement work that would be needed to solve control interaction problems – between £5m and £10m for each renewable source connecting to the network.

**What have we learned?**

This study will contribute to helping achieve the Government’s net zero goal, as it gives us a greater understanding of problems associated with new renewable connections, and how we might solve them.

Although currently in the academic phase, there’s potential for the outputs from the project to be used in the network, integrating the coding we’ve developed into our current simulation software.

The methodology can benefit all TNOs and DNOs in the UK.

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**Title:** Risk Mitigation of Power Electronics Connections: Impedance Modelling

**Consumer value theme:** Efficient build

**Project number:** NGET0045

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“We see this core ideology becoming an important part of a future toolset that’s needed to ensure system stability, particularly with more renewable energy sources coming onto the network.”

Mingyu Sun
Associate Innovation Engineer,
National Grid Electricity Transmission
Advanced weather reports

Project overview
Dynamic line rating (DLR) allows us to vary the capacity of an overhead transmission power line dynamically, depending on environmental factors such as wind speed, wind direction, ambient temperature, and solar radiation.

If weather conditions cool conductors sufficiently, we can push more power through our lines, helping us meet the country’s energy needs. We already know from previous innovation projects that we have certain circuits that can carry more capacity if conditions are favourable.

Through this project, we’re looking to exploit the significant advances in weather forecasting by assessing the feasibility of integrating a cloud-based weather forecasting service into our present line rating calculation methodology. With more accurate and granular weather data, we can better determine where and when we can boost capacity.

It also means that we can become less reliant on fossil fuel-based generation, avoiding constraint payments to generators when we need to address grid congestion.

What stage is the project at now?
We’ve developed the first version of the demonstrator system. We’ve determined that it’s feasible to integrate the forecasting technology and that it can help ease constraints in the network if we carry out all the necessary validations before putting it into regular use. In our initial validation of the forecasting data against historical measurement data, we also confirmed that urban and dense vegetation areas would need more vigilance when considering uprating a line using DLR, as they lack sufficient cooling conditions.

As with any forecasting method, there’s a degree of uncertainty around the data, and this can potentially influence our computed ratings. We’ll need to explore these uncertainties in depth and validate them on some sections of the network, either by installing local weather stations only or by combining these with OHL measurement sensors.

“Significant improvements in weather forecast accuracy alongside novel approaches to quantifying uncertainty in the forecast can be applied to increase confidence in uprating decisions to help achieve the flexibility requirements on our path towards net zero.”

Ian Pearman,
Senior Scientist,
Met Office

“Weather forecasting has improved significantly over the past 20 years and holds great potential to improve OHL ratings through dynamic line rating (DLR) technology. We’ll need to carry out further research and trials to build in-depth understanding and confidence levels in this technology.”

Anusha Arva
Innovation Engineer,
National Grid Electricity Transmission
A holistic approach to resilience

“Through our holistic approach to developing these resilience tools, we can now look beyond the immediate horizon. It’s a strong proof of concept that has the potential to allow us to better anticipate, absorb, adapt and rapidly recover from disruptive events.”

Ben Kuchta
Associate Innovation Engineer, National Grid Electricity Transmission

What does this project involve?
Given the pace and extent of change to the energy landscape, the resilience requirements of electricity networks need to evolve. Drawing on global best practice, we’ve developed a resilience assessment framework and model that combines qualitative and quantitative assessments, as well as forward-looking measures.

Throughout the project we’ve focused on the current and future resilience of the electricity transmission network across England and Wales. The holistic framework enables decision-makers to understand the system’s current resilience performance, identifying opportunities for development and continuous improvement. We’ve also developed a quantitative model that helps inform resilience decision making around current and future hazards and network stresses, such as extreme weather.

These new tools integrate with established resilience processes and allow business to respond to disruptive events – ensuring electricity continues to reach consumers safely, reliably and efficiently.

What sources have you used to determine best practice?
The Government and the NIC’s vision for integrated infrastructure resilience demonstrates the growing momentum to move beyond resilience theory into practice.

To inform our approach, we’ve explored best practice across the energy sector and other infrastructure sectors, such as the Dynamic Resilience Framework from the World Energy Council, the Energy Resilience Framework, the US Transmission Resilience Maturity Model and the UK Energy Research Partnership.

What are the next steps for the project?
We’ve developed the concept of resilience further and established a strong foundation for making positive change. As we review the project’s outputs in detail and consider implementation, our continuing development work will reflect the interconnectedness of the energy industry.
Preparing our network for greener gases

SF₆ is an effective insulator with unique characteristics that’s been used in substation equipment for some 50 years. It’s proven very difficult to substitute.

However, work to find an alternative gained pace in recent years. In 2014, GE was the first to announce a breakthrough, unveiling g₃, its ground-breaking solution for replacing SF₆ in high-voltage equipment.

This represented a significant shift in gear for SF₆ research and development, heralding a period of rapid evolution in associated technology and products.

Exploring the suitability of the new alternative gases for our network has been a hallmark of our innovation work during RIIO-1.

SF₆ Management and Alternative Gases (NIA reference: NGET0163)

During 2016/17 we energised our Green Gas for Grid (g₃) project at Sellindge in Kent, becoming the world’s first 400 kV network to use g₃, which has a global warming potential 98% lower than SF₆.

The project gave us an opportunity to gain an early understanding of the technology, so we could make sure we were ready to adopt it as early as possible when it became commercially available. We also wanted to demonstrate its use to the industry and market, encouraging wider adoption of all SF₆-free technologies, including g₃.

Since then, our project team has closely monitored the g₃-filled equipment at Sellindge to gauge its long-term reliability.

We’ve also continued our work to look at other potential gases, such as CF₃I, testing their dielectric and long-term stability properties. However, we haven’t established further alternatives for a single gas that meets all our needs.
We’re now planning to develop further monitoring techniques so we can understand more about what happens when the gas breaks down. We plan to do this through a fresh project, using our new Centre for Innovation at Deeside. The project will be a natural fit for the facility, which has been designed for enabling high voltage testing of full-scale equipment.

Given the scale of retro-filling our assets, we anticipate launching pilot projects during RIIO-2, leading to wider deployment in RIIO-3 and beyond.

Our collaborative project with the University of Manchester and 3M has been about finding the right balance between testing the right mix of 3M’s Novec™ 4710 and CO₂, and finding the right operating pressure at which its performance most closely mirrors that of SF₆.

As we reported last year, we’ve found that we can mirror the performance of SF₆ using a roughly 80/20 mixture of CO₂ and Novec™ 4710. Since then, we’ve done further work to test operating pressure and develop our understanding of the mixture we could potentially use.

Alternatives to SF₆ for retro-filling existing equipment. (NIA reference: NGET0199)

If we’re to remove SF₆ from our operations by 2050, there are two main options open to us. We could replace our assets with new ones that are designed to be compatible with alternatives to SF₆. But we believe a more efficient way – and one that comes at significantly less cost to consumers – is to use an alternative gas in our existing assets wherever we can.

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Emissions of sulphur hexafluoride (SF₆) make up a large proportion of our carbon emissions. Replacing it on our network is one of the biggest environmental contributions we can make – and our ambition is to do so entirely by 2050, helping meet the Government’s target of net zero carbon emissions.
Preparing our network for greener gases continued

Long Term Stability of Alternative Gases (NIA projects NGTO002 and NGTO051)

While we want to retro-fill existing assets wherever possible, we’ve also been doing work to examine gases being offered in new equipment.

This has involved understanding how the gases – mixtures based on C₄F₇N and C₅F₁₀O – perform over the long term under operational stresses. It’s also looked at which by-products are created when the gases degrade, together with how this affects performance and implications for safety.

The work has shown us that if we take the same precautions we take for SF₆ by-products, our approach will be appropriate for the alternative gases. It gives our future approach the scientific backing we would need to proceed safely.

Evolution in the technology market during the project meant that the C₅F₁₀O option became less relevant for our needs.

The project is now complete and its findings being drafted ready for publication.

Looking ahead

For RIIO-2, we expect to continue examining the application of alternative gases – especially as more of it comes onto the network. Our focus will be on preparing our assets, considering health and safety, long-term performance, degradation and monitoring techniques.

Development of alternative gases is happening at pace across the globe – we intend to be as well prepared for its widespread introduction as we can.

Click here to hear our webinar about the long-term stability of alternative gases
Senior Innovation Engineer Gordon Wilson tells us about a unique study into electrical phenomena at one of our gas insulated substations (GIS).

**Can you tell us a little about GIS?**

They’re substations where all the high voltage equipment is encapsulated in a high-pressure sealed environment, using SF₆ gas as the insulating medium. They need less space than a conventional substation. And because they’re enclosed, they’re less sensitive to pollution and the weather.

**What’s the background to this study?**

Normal switching operations generate an electrical discharge that can go from zero to maximum voltage in about 250 microseconds. By comparison, lightning goes to its maximum in about one microsecond.

At our Swansea North substation, we detected some unusual discharges occurring during switching that were taking only two nanoseconds (0.002 microseconds) to peak. Called very fast transients (VFTs), they put a lot of stress on the insulation and have been linked to failures.

When a failure occurred at Swansea North, we needed to understand the cause of these VFTs, confirm they were responsible for the failure and find a way to prevent them causing further failures. That’s been the focus for this study with Cardiff University, which has NIA top-up funding, and funding from the EPSRC.

**What has the study found?**

The research has developed and validated a method for modelling VFTs in a way that wasn’t possible before. We now know VFTs of sufficient magnitude can contribute to insulation ageing and, eventually, failure. We’ve reduced the risk of this happening by adopting an alternative switching sequence. The model can be adapted to other GIS installations where we experience VFTs.

However, this doesn’t solve the root cause of the issue at Swansea North – and we have some way to go to really understand it. The research is set to continue and is helping inform a CIGRE working group looking at VFTs in GIS.
A carbon-free path for South Wales

Project overview
Through this project, which we described in last year’s report, we’re partnering with network providers operating in South Wales to speed up progress towards making the region carbon-free by 2050.

Co-funded by Wales and West Utilities, Western Power Distribution, and National Grid, the project is also backed by the Welsh Government and the South Wales Industrial Cluster (SWIC) – a group of major industrial and manufacturing companies who aim to develop a world-leading, sustainable industry.

Zero 2050 is a notable example of how our innovation portfolio is evolving, in this instance encompassing crucial work to explore options and ideas rather than specifying technical solutions. It has spanned areas that include cities, industry, transport, generation and network reinforcement, as well using the combined outputs to develop optimised pathways for various decarbonisation scenarios.

What have we learnt from the project?
In June, we published reports from the different working groups on the project website. The project’s recommendations encompass both electricity and gas, taking a whole-system approach to decarbonising the region. They centre on a progressive move to a resilient future, highlighting the need to monitor economic factors and approaches taken elsewhere as decarbonisation evolves more widely.

Specific measures relating to electricity include increasing onshore wind and solar capacity, incentivising commercial and industrial energy efficiency, and delivering a coordinated electric vehicle charging rollout programme. The report also recommends further consideration of opportunities for industry co-location and circular economy.

“While this hugely collaborative project relates to South Wales, it also demonstrates an approach we can apply to the wider decarbonisation agenda.”

Xiaolin Ding
Senior Innovation Engineer,
National Grid Electricity Transmission

Title: Zero-2050: South Wales (Whole System Analysis)
Consumer value theme: Corporate responsibility
Project number: NGTO040
Improving asset maintenance

Title: Electrical characterisation of silicone oil (ECOSO)
Consumer value theme: Managing assets
Project number: NGTO009

“The findings of this project have much improved our knowledge on the potential failure mechanisms in the electrical degradation of the silicone oil-solid insulation system used in the CSEs.”

Dr Siyu Gao
Innovation Engineer,
National Grid Electricity Transmission

Project overview
Managing the replacement strategy of our cable sealing ends (CSEs), which are used at the termination of our cables, is a time-consuming and expensive task. With thousands in the network, understanding the conditions that cause them to degrade over time is vital.

Silicone oil is used as both a coolant and an insulator in the assets and comes in two forms: high and low viscosity. This project sought to better understand the degradation mechanism and aging process for these two types of silicone oil and the best ways to maintain and replace them, so we can extend the life of our assets.

What stage is the project at now?
We’ve now completed the project, which was carried out in conjunction with the University of Manchester. The university is currently drafting a journal article, and the findings were shared at the Cable Research Workshop conference in 2020.

What have we learned?
We were able to successfully replicate one of the aging phenomena of the CSE in the lab, which improves our knowledge on the effect of contamination on the degradation process in the insulation system of the CSEs. With the replacement of 153 sets of CSEs estimated to cost over £10m, and over 1,200 spread across the network, improved management of our silicone-filled assets could result in large savings over their lifetime.

What are the next steps?
We’re proposing to extend the scope of this research based on the findings from ECOSO for RIIO-2. One proposal is to look to a longer-term test to provide more in-depth results in the University’s new lab.
Unlocking new capacity with PEETs

**Project overview**
Power electronic enabled transformers (PEETs) have the potential to unlock additional capacity from our transformers that could reduce the need to build additional substations at new locations.

SGT transformers have three windings, and our customers can currently connect to two of these. The tertiary windings are usually not used for connections since there is no tap changer to control the voltage. This is where PEETs could come in – these devices can adapt to a range of inputs and stabilise the output.

**What stage is the project at now?**
This project, run in conjunction with the University of Manchester, is now complete and the team is currently writing a paper to present the findings.

**What have we learned?**
We haven’t used tertiary windings for connections due to the limitations of available technology, but that could now change with PEETs. This project found no evidence that PEETs would affect the stability and reliability of the grid when operated correctly. PEET can help to stabilise the system frequency and voltage effectively. A 10% increase in the maximum rating of a transformer would result in a cost saving of £6m for consumers per site.

**What are the next steps?**
We’re now looking into the wider investigation of these early findings since now we have mitigated the potential risks. We used the data from one substation, so the next steps could be to involve more substations in the study.

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"This project shows that we may be able to find more options for our customers’ connections using our existing infrastructure. With further research, this could potentially result in a lowering of our tariffs and customer savings – while also avoiding the need to build more expensive substations."

Dr Siyu Gao
Innovation Engineer, National Grid Electricity Transmission
Mingyu Sun, Associate Innovation Engineer, provides an overview of pioneering work to test augmented reality (AR) within our operations.

What can you tell us about the technology you’ve been testing?

“HoloLens2 is wearable technology featuring an AR lens that operates via wireless communication. Team members can wear the lens from home or the substation and show others what they’re seeing – equipment, objects and documents. Remote users can also remotely assist and convey information, instructions and guides to colleagues at work on site in real time.

“The original plan was to employ HoloLens2 for a specific range of benefits, but it’s also been useful during the pandemic, as it’s allowed us to connect while working remotely.”

What benefits does the lens bring?

“It has lots of practical applications. It helps engineers on-site and at home and allows us to communicate quickly across teams. It offers the user great functionality and flexibility. For example, when a substation team does maintenance checks, a document outlining the job details is needed. The engineer has to carry this on their laptop or have a printed version to hand – and this can be difficult if they’re wearing PPE. With the lens they can access that documentation easily.

“If you factor in travel, the technology can change a two-day site visit into a two-hour footage review from an office. That reduces asset down-time and potentially saves up to £0.5m annually on each scheme.”

What was the outcome of the trials?

“We’re currently assessing an implementation plan, but what we do know is that the technology is practical – and it works. We’re excited about the opportunities it offers.”

Title: Assessing Wearable Technology Applications for Transmission Operation and Design

Consumer value theme: Managing assets

Project number: NGTO052

“We’re unaware of any other organisation delivering this scale of test in the utilities sector. This is the latest generation technology and we’re proud to be pioneering it for the industry with our tests.”

Mingyu Sun
Associate Innovation Engineer, National Grid Electricity Transmission

“Although impressive today, this technology is clearly only at the beginning of delivering on its full potential to boost productivity, stream insights, and unlock safer more situationally aware working. The challenge for energy networks will be making sure their asset data and integration capabilities are good enough to extract these performance benefits.”

Peter Amos
Senior Product Development Engineer, Strategy & Innovation
Here is our full list of NIA projects throughout the RIIO-1 period. To find out further information about any of our innovation projects please click on the project name.

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<th>PRN list</th>
<th>Name</th>
<th>Partners</th>
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<td>Simulation of multi-terminal VSC HVDC system by means of Real Time Digital Simulation (RTDS)</td>
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<td>Optimised Location for Surge Arresters on the Transmission Network</td>
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<td>Detection and Measurement of ACSR Corrosion</td>
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<td>Induced voltages and currents on transmission overhead lines under NSI 4 working practices</td>
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<td>Tablet interface for a SF6 mass flow top-up device</td>
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<td>Feasibility Study for Sustainable Substation Design</td>
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### Project Portfolio

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<td>Cable Extraction</td>
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<td>NIA_NGET0091</td>
<td>Impact Assessment of Seismic Analysis on Electricity Towers and Substation Equipment/Structures</td>
<td>Mott MacDonald</td>
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<td>Partial Discharge on Existing HV Cable</td>
<td>Elimus Limited, NDG Technologies, Pyrmarian Cable and Systems Limited, DoBle PowerText</td>
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<td>Online Gas in Oil Analysis on Existing HV Cables</td>
<td>Doble, ISL, and C3 Global</td>
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<td>Computer Vision For Cable Tunnels</td>
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<td>Thermal Efficiency Trials</td>
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<td>13kV Shunt Reactor Refurbishment</td>
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<td>Modelling the tape corrosion process for oil-filled underground cables</td>
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<td>Proof of Concept for IEC61850 Process Bus Technology</td>
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<td>Stakeholder attitudes to electricity infrastructure</td>
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<td>Incident Investigation Review</td>
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<td>Bushing and Instrument Transformer Test Tap Connection Condition Assessment Tool</td>
<td>Elimus Limited, Elysion Engineering, GE Grid Solutions, Invisible Systems, Process Parameters</td>
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<td>Enhanced AC and DC safety voltage limits assessment</td>
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<td>Control of Debris and Dust from the Treatment of Grade 4 Tower Steelwork, NGTI</td>
<td>CLC Contractors Ltd, Spencer Coatings Ltd, PDC Protective &amp; Decorative, Fountains Environmental Limited</td>
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<td>Combustible Gases in Redundant Oil Filled Cables</td>
<td>Utilise Environmental</td>
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<td>Bulk Oil Circuit Breaker Bushing In Situ Refurbishment</td>
<td>NAREC Electrical Networks or Narec Development Services</td>
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<td>Understand and Improving Condition, Performance, and Life Expectancy of Substation Assets</td>
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<td>Identification and Mitigation of Large Equipment Transport Issues</td>
<td>Wynns LTD</td>
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<td>Determining a threshold for magnetophosphenes perception at 50Hz</td>
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<td>UltraWire</td>
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<td>Identifying Opportunities and Developments in Electric and Magnetic Fields Research</td>
<td>Formex Archive Services Ltd, Torrance Ltd, Market Opinion Research Ltd, RESOURCE STRATEGIES LTD</td>
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<td>J.M. Brulé &amp; Kijser</td>
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<td>OHL Condition Assessment</td>
<td>Brunel University, Armex OWR</td>
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<td>Topcon Structure and Composite Insulator Testing</td>
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<td>Transient and Clearances in the Future Electrical Transmission Systems</td>
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<td>Assessment of Electronic (analogue and Numeric) Protection equipment and end of life mechanisms</td>
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<td>Condition Monitoring of Power Assets (COMPASS)</td>
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<td>SF6 Management and Alternative Gases</td>
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<td>VSC-HVDC Model Validation and Improvement (ICASE)</td>
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<td>NIA_NGET0186</td>
<td>Condition Monitoring of Circuit Breakers - CASE</td>
<td>University Of Liverpool</td>
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<td>NIA_NGET0189</td>
<td>Security Assessment of Industrial Control Systems (ICS)</td>
<td>The University Of Birmingham</td>
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<td>NIA_NGET0190</td>
<td>EPRI Research Collaboration on Cyber Security 2016 (P183)</td>
<td>EPRI</td>
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<td>NIA_NGET0191</td>
<td>EPRI Research Collaboration on Grid Planning (P 49)</td>
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<td>NIA_NGET0194</td>
<td>Detailed design of 400 kV 24MVA Mobile Substation Bay</td>
<td>Abb Ltd (Alliance)</td>
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<td>NIA_NGET0195</td>
<td>EPRI Research Collaboration on Substations 2016 (P37)</td>
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<td>NIA_NGET0196</td>
<td>EPRI Research Collaboration on Overhead Lines 2016 (P56)</td>
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<td>NIA_NGET0197</td>
<td>Development of fittings analysis model</td>
<td>Amey Ovar Ltd</td>
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<td>NIA_NGET0198</td>
<td>Cost effective removal of conductor crossing clearance constraints</td>
<td>Jacobs U.K., Limited</td>
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<td>NIA_NGET0199</td>
<td>Alternatives to SF6 for retro-filling existing equipment</td>
<td>The University Of Manchester</td>
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<tr>
<td>NIA_NGET0200</td>
<td>Study into the Concept of High Impact, Low Probability Events</td>
<td>The University of Oxford, Strathclyde University, EA Technology, and Ernst &amp; Young (EY)</td>
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<td>NIA_NGET0201</td>
<td>Portable Earthing Device</td>
<td>Aldercoce Limited</td>
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<tr>
<th>PRN list</th>
<th>Name</th>
<th>Partners</th>
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<tr>
<td>NIA_NGET0202</td>
<td>Development of a Universal Bushing</td>
<td>BTRAC</td>
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<td>NIA_NGET0203</td>
<td>Novel acoustic attenuation feasibility study</td>
<td>WSP Environmental Ltd</td>
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<td>NIA_NGET0204</td>
<td>Frequency Response Analysis for Transformer Characterisation and Objective Interpretation of Results</td>
<td>The University Of Manchester</td>
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<td>NIA_NGET0205</td>
<td>Novel methodology for assessing environmental exposure of OHL routes</td>
<td>Digital Engineering</td>
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<td>NIA_NGET0207</td>
<td>Development of Tools for the Assessment and Control of Impressed Voltage</td>
<td>P&amp;G Hire Electrical</td>
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<td>NIA_NGET0208</td>
<td>EPRI Research Collaboration on Electric &amp; Magnetic Fields Health &amp; Safety, (P35) 2017-2021</td>
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<td>NIA_NGET0209</td>
<td>EPRI Research Collaboration on Overhead Lines (P35) 2017</td>
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<td>NIA_NGET0210</td>
<td>EPRI Research Collaboration on Substations (P37) 2017 - 2020</td>
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<td>NIA_NGET0211</td>
<td>Controllable Series Impedance at 275 and 400kV (CIS)</td>
<td>Smart Wire Grid Inc</td>
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<td>NIA_NGET0212</td>
<td>Positioning ballast screening on substation sites</td>
<td>none - project never started</td>
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<td>NIA_NGET0213</td>
<td>Condition and Climatic Environment for Power Transformers (ConCEPT)</td>
<td>University Of Southampton</td>
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<td>NIA_NGET0214</td>
<td>Transformer and Transformer Oil Life Optimisation and Management Through Analysis and Modelling</td>
<td>The University Of Manchester, University of Southampton</td>
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<td>NIA_NGET0215</td>
<td>Automated assessment of steelwork condition using innovative imaging techniques</td>
<td>Nottingham Trent University</td>
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<td>NIA_NGTO005</td>
<td>EPRI Research Collaboration on Information and Communication Technology (P185)</td>
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<td>NIA_NGTO007</td>
<td>EPRI Research Collaboration on Electric Transportation (P18)</td>
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<td>NIA_NGTO001</td>
<td>Electric Road System for Dynamic Charging of Electric Vehicles</td>
<td>Cardiff University</td>
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<td>NIA_NGTO002</td>
<td>Long Term Stability of Alternative Gases</td>
<td>Cardiff University</td>
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<tr>
<td>NIA_NGTO006</td>
<td>Automated identification of failures in HV assets</td>
<td>University of Manchester</td>
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<tr>
<td>NIA_NGTO003</td>
<td>EPRI Research Collaboration on Overhead Lines (P30) 2018-2021</td>
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<tr>
<td>NIA_NGTO031</td>
<td>Feasibility study in to unlocking flexibility within UK Steel Works</td>
<td>Cardiff University</td>
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<td>NIA_NGTO008</td>
<td>The FMEA Studies and Risk-based Maintenance for Emerging Power Electronics Assets within OHL Power Networks</td>
<td>The University Of Manchester</td>
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<td>NIA_NGTO009</td>
<td>Electrical Characterisation of Silicone Oil (ECOSi)</td>
<td>University of Manchester</td>
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<td>NIA_NGTO010</td>
<td>Liquids for cable sealing ends (LiCaSE)</td>
<td>University Of Southampton</td>
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<td>NIA_NGTO011</td>
<td>Energy Highways</td>
<td>BMT Defence Services</td>
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### PRN list

**NIA_NGTO012**  
The application of Parametric Design to automate substation development  
Atkins

**NIA_NGTO013**  
Predicting Vibration Fatigue for Overhead Line Conductor Systems  
The University Of Manchester

**NIA_NGTO014**  
Advanced Line Rating Analysis (ALiRA)  
Digital Engineering

**NIA_NGTO015**  
CSE fault analyses by 3D monitoring  
The University Of Manchester

**NIA_NGTO016**  
WATTs – Weather Analytics for The Transmission System  
Digital Engineering

**NIA_NGTO017**  
Voltage source converter based series controlled impedance technology  
Smart Wire Grid Inc

**NIA_NGTO018**  
Harmonic Compliance  
Power System Consulting Ltd

**NIA_NGTO019**  
Unlocking Transmission Transfer Capacity  
Quanta Technology

**NIA_NGTO020**  
IEC 61850 Cyber Resilient Electric Substation Technologies  
The University Of Manchester

**NIA_NGTO021**  
Decarbonisation vision for South Wales  
Progressive Energy Limited

**NIA_NGTO022**  
High frequency earthing and its impact on the transmission system  
Cardiff University

**NIA_NGTO023**  
Increasing Transmission Boundary Power Flows using an Active Power Control Unit  
Siemens Transmission & Distrib Ltd

**NIA_NGTO024**  
Investigation into the Properties and Behaviour of Liquid Soil (LS) Technology  
Cardiff University

**NIA_NGTO025**  
Substation Time Synchronisation to Safeguard the Network  
National Physical Laboratory

**NIA_NGTO026**  
Health Monitoring of cables using Acoustic Emission Measurement Techniques  
Cardiff University

**NIA_NGTO027**  
Smart Gas Grid  
Cardiff University

**NIA_NGTO028**  
EPRI Research Collaboration on Underground Transmission (P36 + P34 part)  
EPRI

**NIA_NGTO029**  
Assessment of Wireless Technologies in a Substation Environment  
Affs

**NIA_NGTO030**  
Overload Rotation to Increase Capacity of Transmission Boundaries  
The University Of Manchester

**NIA_NGTO031**  
Novel O-ring Designs (NORD)  
Cardiff University

**NIA_NGTO032**  
Environmental Exposure of Overhead Lines: Data Delivery for Physical Testing  
Digital Engineering

**NIA_NGTO033**  
Power Electronic Enabled Transformers (PEETs)  
University of Manchester

**NIA_NGTO034**  
Optimised Infra-Red Image Systems (OdiRIS)  
NATIONAL PHYSICAL LABORATORY LIMITED

**NIA_NGTO035**  
Multi energy vector modelling  
University of Manchester

**NIA_NGTO036**  
The application of Parametric Design to automate substation development  
Atkins

**NIA_NGTO037**  
Predicting Vibration Fatigue for Overhead Line Conductor Systems  
The University Of Manchester

**NIA_NGTO038**  
Advanced Line Rating Analysis (ALiRA)  
Digital Engineering

**NIA_NGTO039**  
CSE fault analyses by 3D monitoring  
The University Of Manchester

**NIA_NGTO040**  
WATTs – Weather Analytics for The Transmission System  
Digital Engineering

**NIA_NGTO041**  
Voltage source converter based series controlled impedance technology  
Smart Wire Grid Inc

**NIA_NGTO042**  
Harmonic Compliance  
Power System Consulting Ltd

**NIA_NGTO043**  
Unlocking Transmission Transfer Capacity  
Quanta Technology

**NIA_NGTO044**  
IEC 61850 Cyber Resilient Electric Substation Technologies  
The University Of Manchester

**NIA_NGTO045**  
Decarbonisation vision for South Wales  
Progressive Energy Limited

**NIA_NGTO046**  
High frequency earthing and its impact on the transmission system  
Cardiff University

**NIA_NGTO047**  
Increasing Transmission Boundary Power Flows using an Active Power Control Unit  
Siemens Transmission & Distrib Ltd

**NIA_NGTO048**  
Investigation into the Properties and Behaviour of Liquid Soil (LS) Technology  
Cardiff University

**NIA_NGTO049**  
Substation Time Synchronisation to Safeguard the Network  
National Physical Laboratory

**NIA_NGTO050**  
Health Monitoring of cables using Acoustic Emission Measurement Techniques  
Cardiff University

**NIA_NGTO051**  
Smart Gas Grid  
Cardiff University

**NIA_NGTO052**  
EPRI Research Collaboration on Underground Transmission (P36 + P34 part)  
EPRI

**NIA_NGTO053**  
Assessment of Wireless Technologies in a Substation Environment  
Affs

**NIA_NGTO054**  
Overload Rotation to Increase Capacity of Transmission Boundaries  
The University Of Manchester

**NIA_NGTO055**  
Novel O-ring Designs (NORD)  
Cardiff University

**NIA_NGTO056**  
Environmental Exposure of Overhead Lines: Data Delivery for Physical Testing  
Digital Engineering

**NIA_NGTO057**  
Power Electronic Enabled Transformers (PEETs)  
University of Manchester

**NIA_NGTO058**  
Optimised Infra-Red Image Systems (OdiRIS)  
NATIONAL PHYSICAL LABORATORY LIMITED

**NIA_NGTO059**  
Multi energy vector modelling  
University of Manchester

**NIA_NGTO060**  
The application of Parametric Design to automate substation development  
Atkins

**NIA_NGTO061**  
Predicting Vibration Fatigue for Overhead Line Conductor Systems  
The University Of Manchester

**NIA_NGTO062**  
Advanced Line Rating Analysis (ALiRA)  
Digital Engineering

**NIA_NGTO063**  
CSE fault analyses by 3D monitoring  
The University Of Manchester

**NIA_NGTO064**  
WATTs – Weather Analytics for The Transmission System  
Digital Engineering

**NIA_NGTO065**  
Voltage source converter based series controlled impedance technology  
Smart Wire Grid Inc

**NIA_NGTO066**  
Harmonic Compliance  
Power System Consulting Ltd

**NIA_NGTO067**  
Unlocking Transmission Transfer Capacity  
Quanta Technology

**NIA_NGTO068**  
IEC 61850 Cyber Resilient Electric Substation Technologies  
The University Of Manchester

**NIA_NGTO069**  
Decarbonisation vision for South Wales  
Progressive Energy Limited

**NIA_NGTO070**  
High frequency earthing and its impact on the transmission system  
Cardiff University

**NIA_NGTO071**  
Increasing Transmission Boundary Power Flows using an Active Power Control Unit  
Siemens Transmission & Distrib Ltd

**NIA_NGTO072**  
Investigation into the Properties and Behaviour of Liquid Soil (LS) Technology  
Cardiff University

**NIA_NGTO073**  
Substation Time Synchronisation to Safeguard the Network  
National Physical Laboratory

**NIA_NGTO074**  
Health Monitoring of cables using Acoustic Emission Measurement Techniques  
Cardiff University

**NIA_NGTO075**  
Smart Gas Grid  
Cardiff University

**NIA_NGTO076**  
EPRI Research Collaboration on Underground Transmission (P36 + P34 part)  
EPRI

**NIA_NGTO077**  
Assessment of Wireless Technologies in a Substation Environment  
Affs

**NIA_NGTO078**  
Overload Rotation to Increase Capacity of Transmission Boundaries  
The University Of Manchester

**NIA_NGTO079**  
Novel O-ring Designs (NORD)  
Cardiff University

**NIA_NGTO080**  
Environmental Exposure of Overhead Lines: Data Delivery for Physical Testing  
Digital Engineering

**NIA_NGTO081**  
Power Electronic Enabled Transformers (PEETs)  
University of Manchester

**NIA_NGTO082**  
Optimised Infra-Red Image Systems (OdiRIS)  
NATIONAL PHYSICAL LABORATORY LIMITED

**NIA_NGTO083**  
Multi energy vector modelling  
University of Manchester
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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