Electricity Transmission

Innovation
Annual Summary 2018/19

nationalgrid

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About us

We are National Grid Electricity Transmission (NGET).

We own and maintain the high-voltage electricity transmission network in England and Wales. That includes around 7,212 kilometres of overhead line, about 2,280 kilometres of underground cable and 346 substations.

We move electricity from where it's generated, down the 'motorway' of the electricity system, to our direct customers and to the distribution companies who deliver that power to homes and businesses. We play a vital role in connecting millions of people to the energy they use, safely, reliably and efficiently.

Welcome to the innovation annual summary for 2018/19

"At National Grid, we're focused on making possible the energy systems of tomorrow."

David Wright
Director of Electricity Transmission
Group Chief Electricity Engineer

Our society is living in times of rapid change. The world is evolving at unprecedented speed. The whole electricity system is becoming more integrated. Other sectors are becoming ever more dependent upon energy as, collectively, we drive towards net zero emissions.

At National Grid, we're focused on making possible the energy systems of tomorrow. We're working hard to deliver a clean, reliable energy system while keeping bills low for consumers. But we can't do this alone.

That's why, as Director of National Grid Electricity Transmission (NGET), I spend much of my time engaging with a broad range of customers and stakeholders, learning about their ambitions and sharing ours. I hear not only how, through collaborative working, we can help achieve these, but also what their concerns are.

The feedback I am receiving is clear – that we need to work at greater pace and more transparently, making it easier for small and medium-sized enterprises (SMEs) to work with us, and that we need to develop the electricity network into one which supports a progressive society in the most intelligent and revolutionary way. And it is feedback which is fundamental to how we are structuring and operating our business.

So how do we collectively deliver for tomorrow? The key is innovation today.

Such is the importance of innovation to our collective future that we are benchmarking to evidence what innovation excellence means to our stakeholders. In parallel, I'm investing in creating an exciting innovation culture throughout NGET. And I'm also growing my innovation team, ensuring they have the resource to identify and deliver the rapid and significant changes required. We'll deliver all of this without jeopardizing security of supply, safety and the reliability our stakeholders have grown to expect from NGET.

This is particularly important in a net zero context. As smart cities, and society at large, become ever more reliant on technology, clean energy sources and, of course, the availability of electricity, the demand for new levels of coordination and integration will intensify. We need look no further than the growth in electric cars on our roads as proof that future technologies are already shaping our lives today. And one thing is certain about these future technologies – they will need electricity, will become increasingly digital and even more low-carbon.

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But as systems become more dynamic and responsive, they also run the risk of becoming more vulnerable, which is why we are building greater security and resilience into our designs and operations.

Looking further into the future, the environment and driving economic growth in a circular-economy built on digital technologies will be key. Delivering cleaner energy, thereby achieving the net zero targets by 2050, is a necessity if we want to protect our planet for future generations. As is ensuring we keep energy affordable. To ensure NGET plays its critical role to the full in helping achieve these, there are three priority areas in which we will be focusing our efforts:

- Firstly, we'll place consumers at the heart of our thinking, developing new agile solutions which enable them to live the lifestyles they want without thinking about their electricity needs.
- Secondly, we will identify and embrace the opportunities that digital technologies offer. By increasing our collaboration with equipment manufacturers, providers of programs and services, as well as energy retailers, we will develop a whole-energy systems approach which considers long-term societal needs, short-term impact and affordability. Plus we'll ensure that we develop an integrated and digitalised energy network which allows electricity, gas, transport, heat and agriculture to work effectively across vectors and support each other.
- And thirdly, we will work more collaboratively across industry, legislators, regulators, utilities and customers to redefine business models and frameworks. This will drive more creative and economic network solutions.

You'll see evidence of this in our annual summary, where you will find further information of the work we have done in RIIO-T1 and our aspirations as we look forward to RIIO-2 and beyond.

Our society may be living in times of rapid change, but at National Grid, we are innovating to influence this change. This will not only steer today's energy industry but also create greater network efficiencies and develop the agile, evolutionary approach that will revolutionise the way we all connect with the transmission network in the years ahead.

Report summary

In a world where continuous change is part of life, innovation becomes key to meet the expectations of our customers

Our goal is to provide a clean and reliable energy system and deliver even **greater value**

Introducing National Grid Electricity Transmission

National Grid's overall purpose 'Bring Energy to life' not only means getting the heat, light and power that customers rely upon to their homes and businesses. It also means supporting the communities that we are a part of to help steer the economic growth and sustainability of our wider society, now and in the future.

In a world where continuous change is part of life, innovation becomes key to meet the expectations of our customers and stakeholders. We are therefore focusing our efforts, becoming more targeted and value driven in the way we deliver our innovation programme – a programme that supports the creation of a decarbonised society whilst at the same time researches and develops technologies to support our customers and consumers for generations to come.

Innovation is key

At National Grid Electricity Transmission (NGET) innovation is not only about foreseeing energy trends and meeting consumer needs, it's also about bringing our teams together internally and connecting the brightest ideas and future thinking across the organisation. Innovation helps us do two things – improve what we are doing now and engage in future energy challenges.

We want to help lead and enable innovation in the UK, sharing our thoughts and visions for the future to bring our customers the low-carbon, low-cost solutions they want. Our innovation strategy covers key areas which you can read more about on page 10.

Prioritising collaborative ways of working

Collaborating with other organisations in specialist functions helps us to address the growing complexity of today's innovation challenges in order to speed up implementation and achieve excellence in everything we do.

Our vision is to provide a clean and reliable energy system and deliver greater value. We work collaboratively to achieve this with academic partners including Manchester, Cardiff and Southampton Universities and partners throughout the whole of our supply chain such and Siemens, BMT Systems, and Render and Digital Engineering. In this section of our report we demonstrate how we are encouraging an atmosphere of collaboration, trust and understanding and what that means for ourselves, our industry, our stakeholders and our consumers.

A responsibility to be transparent

To date we have attempted to engage with our stakeholders through attending conferences, organising workshops and writing reports. However, we understand that in a world of social media, and one where our stakeholders span further afield than our natural suppliers, this is not enough. We see considerable scope for improving how we communicate with our customers and stakeholders, from sharing information through more relevant and accessible channels to engaging in new and insightful ways to tell our story. Greater transparency and openness will help demonstrate how, where and why we are investing in

Innovation is not only about foreseeing energy trends and meeting consumer needs, it's also about bringing our teams together internally and externally from within and outside our industry. Connecting the brightest ideas and future thinking.

innovation, whilst making the benefits of those investments clear and straightforward for everyone. It's all about providing the right information, in the right way and at the right time. This will help explain how we are going to deliver energy safely and reliably to those who need it, now and in the future. On page 18 you can read more about the values and best practices that guide us as a responsible, customer-first organisation.

Instigating a culture of transformation

Utilities like ourselves are generally compared to large oil tankers; traditional, slow and difficult to shift in direction. Changing the culture within our organisation supports our commitment to being the agile electricity transmission network our world and our consumers need.

Looking at where we are now and where we want to be has helped us identify performance gaps and understand where we can make improvements that truly reflect and support an ever more energy dependent world. Our report explains that part of that process has been to create Bright Sparks, a programme to embed innovation into the DNA of NGET. We have also benchmarked our performance to learn how we can achieve our goal to speed up the implementation of innovative, creative thinking. You'll find more detail on our cultural change on page 21.

Working with the wider National Grid Group

Electricity Transmission is part of a wider Group. National Grid Group consists of National Grid Ventures, National Grid Partners, Gas Transmission, US Business and Electricity System Operator. NGET and our customers and consumers also benefit from investment in innovation within the wider National Grid Group. The purpose of these partnerships is to make annual investments to drive not just company, but also industry wide innovation.

Corporate Venture Capital (CVC) investing, such as that provided by NG Partners, provides insights into technological trends and influence from external partners to drive investment into the electricity industry, allowing us to accelerate our rate of innovation and the value it brings at no extra cost to our business. The sheer scale of investment this partnership brings is unprecedented and means we are in a strong position to address bigger, more complex challenges that the energy industry is facing.

Future focused

We believe innovation is key if we are to deliver excellent value to our customer and stakeholders. We have therefore set ourselves ambitious challenges. As part of our commitment to achieving them, in RIIO-T1 we are designing and building the Deeside Centre for Innovation a state-of-the-art research centre in Wales allowing us to investigate and trial new technologies and ideas off-grid. All with zero system and network disruption.

By replicating real world conditions in order to thoroughly test groundbreaking innovation and to deliver powerful new data with the capacity to drive large scale decision-making. You can read about this project and more future facing innovation on page 28.

Prioritising these key working practices will help us move forward at the necessary pace to support and anticipate our rapidly changing world. It will make NGET a more dynamic, forward-thinking organisation with the ability to predict and prepare for the needs of our consumers and environment. It will breed stronger, more effective partnerships and harness the most intuitive innovation to deliver a powerful positive impact on our world.

Report Summary

"With two years remaining, we are at a cross-roads between the past and the future. We look back at what we have achieved, the good and the bad, and think how we can improve moving forwards. We have taken this opportunity to innovate with this report. I really hope you enjoy it; your feedback is really important to me so let us know your views. Our email is on the back page."

Iliana Portugues,
Head of Innovation

RIIO-T1, our most ambitious venture yet

RIIO-T1 is our current regulatory period running from 1 April 2013 to 31 March 2021. Throughout this period we have focused on developing an innovation programme that ensures we are agile and robust enough to meet the challenge of accommodating rapid change both within our energy system and across clean energy solutions for other industry sectors. To do so our innovation strategy has centred on four crucial areas of consumer value: Managing assets, Efficient build, Service delivery and Corporate responsibility.

Managing assets focuses on learning more about how to increase the performance and lifespan of our assets so that we can maintain them at the lowest cost and least amount of disruption.

Efficient build concentrates on channeling innovation to reduce the cost and time associated with building new infrastructure through trial of new products, the adoption of more flexible equipment and improving network design.

Service Delivery examines present and future expectations of the service we provide enabling us to develop the right product and service that our customers and consumers need and want.

And a focus on **Corporate Responsibility** has helped improve the safety of our working practices and the environmental and social impact of our network, including looking at the entire build and maintenance process.

To date, through our Network Innovation Allowance (NIA) we have delivered 159 projects at a total cost of £47.3m shared between consumers and ourselves. The whole portfolio is expected to deliver a return of £7 for every £1 spent on innovation during the same period, with associated value continuing and growing in the future. The benchmark for a typical innovation programme delivers a return of £4 for every £1 spent.

For the remainder of RIIO-T1 our attentions are turning to RIIO-2 focusing how we transfer the knowledge we have amassed from RIIO-T1 into RIIO-2, to allow us to build on our successes and ensure we are best placed to meet the ambitious objectives we have set ourselves for RIIO-2.

RIIO-2, the opportunity to make an even bigger impact

National Grid's overarching strategy is to 'exceed the expectation of our customers and our communities today and make possible the energy systems of tomorrow'. We are currently prioritising communication with our customers and stakeholders to explain what we do and how we do it, and clearly demonstrate the value for money that we are creating for them.

In RIIO-2 we aim to build on our strategy and focusing on three proposal areas:

Delivering cleaner energy through reducing our carbon footprint and helping others reduce theirs and accelerating the testing; rollout of new technologies at our Deeside Centre for Innovation.

Delivering cheaper energy through a long term innovation programme to deliver a net-zero whole energy system solution at minimum cost.

Creating the future by embedding innovation into our culture and increase collaboration with other organisations, enabling us to deliver maximum value from our innovation programme.

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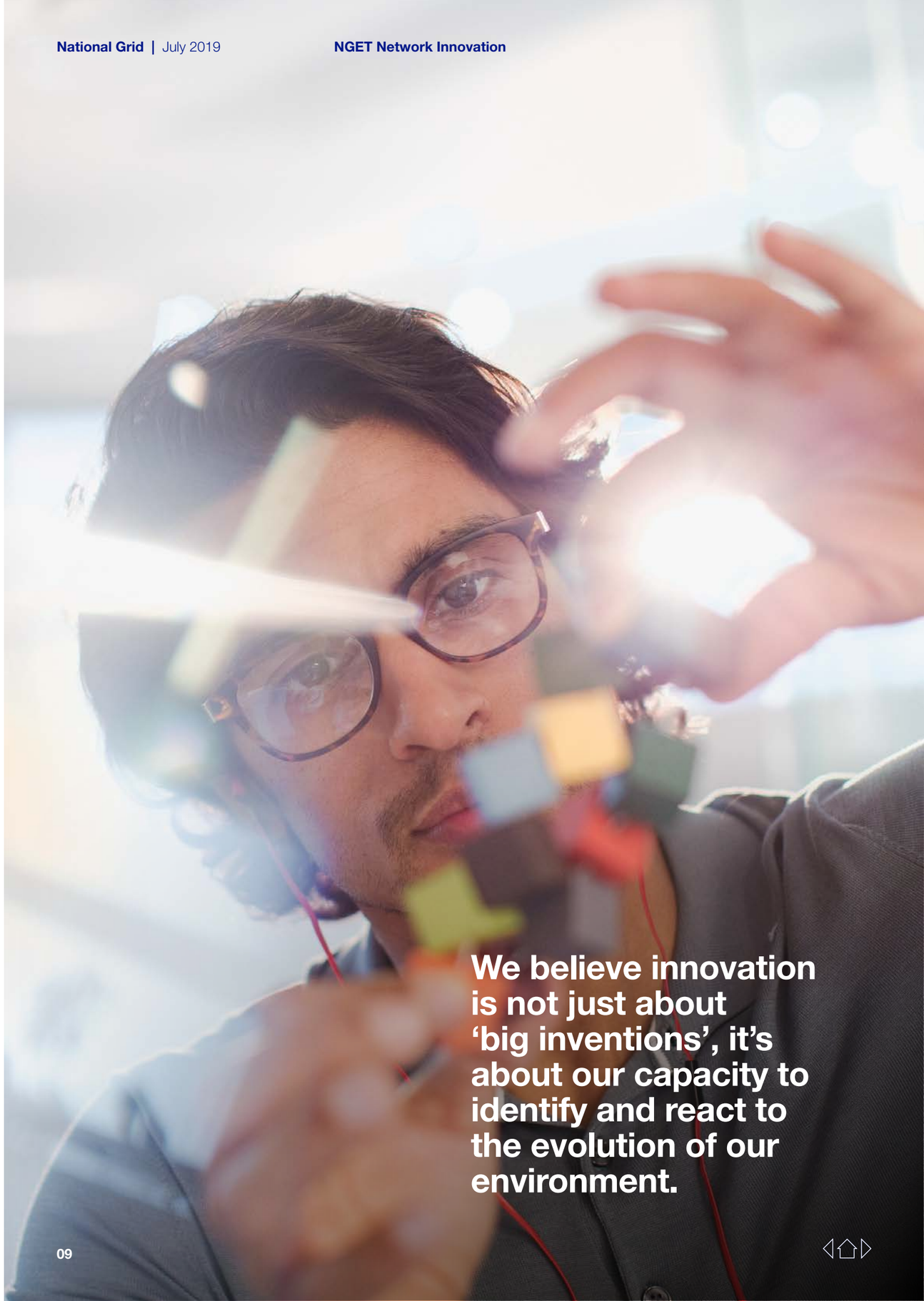
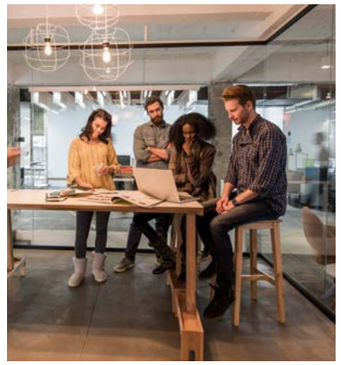


We believe innovation is not just about 'big inventions', it's about our capacity to identify and react to the evolution of our environment.

Innovation

Innovation to add value with real meaning

Innovation is key to the sustainable growth of any organisation; but it is even more important in a company responsible for transmitting electricity to a nation. What we do in innovation, and how we do it, not only impacts our customers and the end consumer but also the economic growth of the UK, political targets and the research and development standing of our academic institutions in this area.



The best, most significant innovation happens when great minds come together, and bring different experiences and thinking.

Moving forward we have an ambition for innovation to be part of what everyone across the organisation does. One of our favourite stories is when John F. Kennedy visited NASA Space Centre. He saw a janitor and asked him what he was doing. The janitor responded: 'I'm helping put a man on the moon'. We want everyone in our organisation to feel this way.

Great minds don't always think alike and that's something we value. We have some way to go, but our aspiration is to include everyone within our organisation and beyond in helping us create, develop, design and improve our ideas and technologies. The best, most significant innovation happens when great minds come together, and bring different experiences and thinking.

We believe innovation is not just about 'big inventions', it's about our capacity to identify and react to the evolution of our environment. Innovation allows us to capitalise on new opportunities and make the most of the resources we have and those we're developing. Innovation also allows us to make meaningful change. Embedding it into our business in such a way that it becomes sustainable whilst deriving the most value from its global reach allows us to make the biggest, most beneficial impactful on our society; in particular if this technology is developed and commercialised from the UK.

There are two key components that drive the success of innovation within our organisation – our people and the processes we use. To embed a prospering culture of innovation, we're fostering the right environment and developing a balanced project portfolio. From a process perspective, the portfolio includes a pipeline of continuous new technologies that we can pioneer.

Our new projects also aim to encourage greater engagement across our supply chain and support emerging technology throughout its development to ensure our innovation remains focused on improving our consumers' experience. Working on projects that allow us to push the boundaries of what we know and can do, gives us the best opportunity to capitalise on the most positively disruptive innovation.

Meeting the UK's energy challenge

The UK is facing a critical energy challenge – how do we maintain a secure and reliable supply of electricity, particularly given that a quarter of our old power stations are due to close over the next decade. The answer lies in sourcing new locations for energy generation and mobilising new, clean-energy technologies - we are at the forefront of this activity, developing our infrastructure to be ready to surmount the challenge.

As we go into RIIO-2 we are focused on building on the achievements of RIIO-T1. Innovation in RIIO-2 will be bigger and better and that means learning from success and failure alike. Failing fast is an important part of moving forward at pace. There are 14 NIA projects we have decided not to implement because they have proved that they will not deliver strong enough benefits to our consumers. However, these projects still bolstered our understanding of new technologies, expanded the range of suppliers we work with and helped us inform our entire industry about specific energy concerns.

As we shift towards the energy system of the future, we also need to provide a reliable service for our customers and consumers. Part of that is improving how we make decisions under increased uncertainty. We regularly make both investment and operational decisions under uncertain conditions, such as climate change, but we're able to do this by using data, information and expert engineering judgement.

In the future, there will be more decisions for us to make and we will have less time to make them. So, it's important we improve the data and models that we use to inform RIIO-2 innovation strategies.

During 2019 The Energy Innovation Centre (EIC) has developed an innovation measurement framework specifically for use across electricity transmission and distribution networks to help measure the outcomes and impact of innovation. This crucial insight will help steer where, when and how we innovate so that we can be sure we deliver the energy network that supports tomorrow's world.

In July this year, a new international standard on Innovation Management also came into play. We collaborated throughout the consultation process to help shape and determine those industry standards and we're fully committed to being the first organisation to achieve them.

Moving forward our attention is on becoming a leader in innovation and an organisation that plays a central role in making it happen. Transforming our business through digitisation means developing sensors, technologies and artificial intelligence algorithms that provide the data needed to operate the electricity systems of the future. We will utilise this data to understand how a more integrated energy network that combines electricity, gas, heat and transport, could work and how integration will support the national zero-carbon footprint we aim to achieve by 2050.

National Grid Partners

Leveraging our wider group

"We are well on our way towards driving a smart and digital energy future for tomorrow's socially-conscious consumer."

Lisa Lambert
Chief Technology and Innovation Officer
Founder and President
National Grid Partners

We invest in the potential of energy

National Grid Partners (NGP) is the venture investment and innovation team of National Grid plc. NGP undertakes an important innovation role across National Grid by investing and managing equity investments in strategically relevant start-up ventures aimed at disruptive innovation.

NGP are investing in these start-ups with the aim of generating a return on investment across the portfolio of these companies. The organisation focuses on innovation, incubation, corporate venture capital, and business development, providing a multi-functional approach to change the status quo. NGP is the utility industry's first Silicon Valley-based investment and innovation firm. With a venture capital fund aiming to invest $250M over three years and an investment focus in early and growth-stage companies, National Grid is disrupting itself and the industry. Together with its team of professionals in Boston, New York, London, Los Gatos, and San Francisco, NGP intends to make investments annually to drive company and industry-wide innovation.

National Grid Partners is also in the process of creating an innovation centre of excellence. The aims of this are establishing a shared understanding of the value innovation can bring to National Grid, ensuring consistent execution and tracking of innovation, enhancing collaboration on innovation across National Grid and supporting adoption of an innovation mindset.

$250m
to invest.
17 investments
to date

Innovation

Ideas come from all sorts of places, including our own work internally or from partnerships with universities, R&D labs and incubators. Our Innovation Team leads global-scale disruptive innovation projects such as new technology and product development, monetisation strategies, new business models, and spin-ins/outs.

Incubation

Invests in companies that are at the prototype stage of development in the start-up lifecycle, companies with minimally viable products who require seed capital to launch their venture, and investors that can help them accelerate their growth. This is the eyes and ears function of NGP helping the Group anticipate disruptive changes to its business.

Corporate Venture Capital

Invests in expansion and growth-stage companies in the start-up lifecycle that can deliver the maximum strategic value to businesses across the Group and deliver strong financial returns to the portfolio.

Business Development

Our Business Development (BD) function performs a critical role, supporting both the investment and innovation teams. Its goal is to create and unlock value for our portfolio companies across the Group, while accelerating their business growth. This function helps start-ups, business units, and the wider external stakeholders to work more closely together to maximise strategic returns for our portfolio and innovation projects.

National Grid Partner investments

Audio Analytic
AutoGrid
climacell
copperleaf
IQ CAPITAL
PIXEOM Leading Edge Computing
ENERGY IMPACT PARTNERS
SITETRACKER
JVP
Aporeto
OMNIDIAN

Collaboration

Prioritising the benefits of collaborative working relationships

Collaboration is vital to successful innovation. By sharing the lessons we learn, by being open to ideas from across industry and academia, and by understanding each other's needs, priorities and ambitions, we can build projects that transform the gas and electricity systems and bring the greatest benefits.

Satisfying customers in this rapidly-changing landscape requires us to be flexible, innovative and collaborative. More than that, we believe we make better decisions, in the interest of customers, consumers and all of our stakeholders, when we work together.

Understanding and prioritising the diverse benefits of collaboration helps us build a culture of trust and understanding. And focusing on the relevance of working with the right partners – at the right time and on the right challenges – optimises the solutions we create. Our goal is to involve stakeholders in a timely manner. This means ensuring that the people we collaborate with are provided with sufficient context and opportunity to positively influence our decisions.

Through a smarter programme of engagement – with lively dialogue, opportunities for challenge, review and iteration – we are approaching the most complex of challenges with clear direction and relevant, innovative thinking. This will empower us to deliver the most valuable benefits to our stakeholders, our workforce and our customers.

Our commitment to collaboration is illustrated by the scope and value of projects that we've been involved in throughout RIIO-T1.

Through collaboration with the Electric Power Research Institute (EPRI) utilities, we have leveraged a total of £111m from over 100 international electricity utilities through 21 projects. And through the Engineering and Physical Sciences Research Council (EPSRC) we have leveraged over £120m through collaboration with academic institutions in the UK and over 300 UK and international organisations. We have also supported our suppliers and other UK infrastructure companies, such as Highways England, in ideation workshops as part of an Open Innovation programme.

As well as engaging with the innovative new i3P platform, that allows experts from across a range of industries to collaborate to deliver infrastructure for the future.

We understand that small and medium-sized enterprises (SMEs) find it daunting and difficult to engage with us and our procurement processes. We have therefore also joined the Energy Innovation Centre (EIC), a non-profit organisation to leverage their extensive knowledge and experience in closing the gap between these organisations and ourselves.

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Over £230m of innovation leveraged through international collaborations and academic collaborations

Collaboration

Prioritising the benefits of collaborative working relationships

Open innovation is a decentralised approach to the development of new and innovative ideas, which invites different perspectives from external and internal partners to solve key challenges. The inclusive and participatory nature of open innovation is why it forms part of our innovation strategy.

Over the years, we have refined and evolved our approach to open innovation. Asking more challenging questions, we're able to solve increasingly complex problems.

Whilst we continue to encourage involvement from external parties, we now also encourage an atmosphere of collaboration internally, putting our trust in people from across our organisation to harness limitless thinking and generate ideas. Our culture transformation programme, called Bright Sparks, empowers our employees to play a key role in innovation. We've given them permission to voice their ideas, the tools to develop them, and the time to bring their innovations to life.

We also work closely with some exceptional external organisations, and encourage them to be proactive in the way they engage with NGET. Morgan Sindall reached out to us and asked, 'What are your innovation challenges?'. We told them that we wanted to hide all existing infrastructure and make new infrastructure invisible – at no greater cost than current solutions. Morgan Sindall opened up this challenge to everyone within their company and held a conference specifically to develop ideas. They returned with multiple innovative solutions, which are currently under research and development, with a view to rolling out the strongest solution.

Our vision is to work even more openly with a greater number of dynamic innovation partners, using ideation and collaboration tools to accelerate and improve the process so that together we can guide our resources to ensure the solutions are more robust.

Academia

Collaborating with partners in industry and academia continues to be crucial. The close relationships we've developed have already helped us extend the operational life of our assets, integrate more renewable generation on the network, and manage the effects of low inertia and intermittent energy resources. We've also worked with experts in machine learning and analytics to improve how we forecast generation and future demand, which is vitally important as these patterns become increasingly unpredictable.

Academic institutions want us to contribute through insights, people and financial resource in their research projects to help them create impact and become world-leading in their areas. They also want us to support the development of future engineers, providing them with skills and experience, which will improve their education.

Through collaboration with our key academic partners, we are playing a part in research and development, which will benefit the environment, increase efficiencies and ultimately deliver value to stakeholders and end consumers.

We currently have three strategic academic partners: The University of Manchester, Cardiff University and the University of Southampton. We also have projects running with 17 other academic institutions across the UK.

As a responsible business, we continue to investigate and develop new ways to manage and reduce the impact of our network, business activities and operations on the environment. Working with Cardiff University, the University of Manchester and other partners, we are exploring alternatives to SF_6 – an effective electrical insulator with significant advantages over alternative materials, which is also a greenhouse gas. These alternatives include gas insulated lines, alternative gases and capture techniques.

As more intermittent and embedded weather-related generation connects to the network, a more 'flexible' approach to ratings is required to enhance the circuit rating and associated transmission boundary capacity if the weather conditions are agreeable.

Applying these concepts remains difficult to implement in planning and operational timeframes. In conjunction with Southampton University and other partners, we are aiming to develop and demonstrate a proof of concept to provide flexible enhanced circuit ratings, using a combination of wide area monitoring, predictive ratings and dynamic energy security.

Supply chain collaboration

Whenever possible, we work with the local communities, in which we operate, to make a positive difference to them – now and in the future. We play an active role in increasing employment, forging links with schools and colleges, promoting skills development and supporting local charities.

We also try to engage with small and medium-sized enterprises (SMEs), offering them local supply chain opportunities to boost the local economy, collaborating with them to share best practice as well as to forge close working relationships with them. In turn, SMEs offer us agility, unique solutions and passion, as well as their local and specialist expertise, which enriches our business and services.

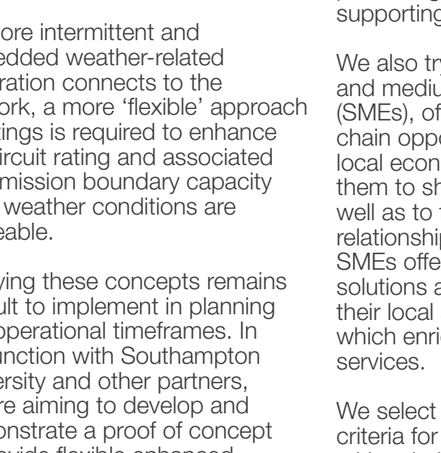
We select SMEs using different criteria for different requirements, taking their expertise into consideration. In the innovation space, it's often equally as important that they're able to adopt an agile approach to the challenges we face.

We want our supply chain to feel that we value their work and ideas – and we want them to value us as a client. We want them to value our business, too, so we try to engage with their discussions and conversations around the energy landscape, market and new regulatory regime, to help them grow their market.

With over 5.7 million SMEs in the UK, effectively over 99% of all businesses registered, the latent potential to drive increased value to our customers and consumers through their active participation in the energy industry is huge.

We therefore want to improve our engagement with SMEs and help them understand and explore the commercial opportunities available. We are working across the organisation to develop procurement processes and communication methods to develop.

Our membership with the Energy Innovation Centre (EIC), is one of these routes we are progressing.



"To deliver the future, we are going to need even more participation, more creativity, new contributions from our partners, old and new – more entrepreneurship of every kind. To achieve this, we will need to excel at collaboration, be more transparent and open than we've ever been before."

Responsibility

Defining our environmental priorities

The transition to a low-carbon economy is one of the defining issues of the 21st century. Clean, low-carbon energy is needed to meet the global ambition to limit warming to just below two degrees. The government's new 25-year environment plan aligns with many aspects of our own environmental sustainability programme and what's important to us. The UK government calls it 'A Green Future' and that's a title we can all relate to.

To meet new customer-driven affordability, reliability and security demands we must adapt our networks quickly. But as we evolve, we must also ensure we are environmentally responsible in the ways we operate our network. In our role to support the decarbonisation of energy we need to embed sustainability into our decision making and ways of working and deliver projects that contribute to the realisation of low-carbon energy.

Our strategic vision is to build a sustainable electricity network that makes a positive contribution to the environment which unlocks the energy systems of the future.

We will prepare our network to be fit for a low carbon future

The life-span of our projects can be up to 40 years, which means the future impact of our current investment decisions need to be considered. The decisions we make today are going to shape the infrastructure we have as a country up to and beyond 2050. So we have an obligation to embed sustainability systematically within our business.

We will enable the decarbonisation of the electricity system

Energy drives our economy and sustains our society. But for too long, energy production and use has been the largest source of global greenhouse-gas (GHG) emissions. We are working to meet ambitious low-carbon energy targets and connect new sources of energy to the people who use them.

NGET is at the heart of decarbonisation. The energy sector has been fundamental in helping the UK to achieve the carbon reductions made to date, with 75% of emission reductions since 2012 coming from the power sector. Britain has produced record amounts of renewably-generated electricity and NGET has been instrumental in connecting these new sources of low-carbon generation to the network. Today, the UK is a world leader in the adoption of low carbon energy, with renewables accounting for around 35% of installed generation.

There is a need for monumental change. In Electricity Transmission, we have already started on this journey. Since 2012/13 we have reduced our controllable carbon footprint by 15 per cent. In 2016/17 we were the first transmission network in Europe to trial an innovative alternative to SF_6: Green Gas for Grid in our Sellindge substation in Kent. This new gas mixture reduces the Global Warming Potential (GWP) ratio from 22,800 to 345.

Our responsibility is to accommodate increasing levels of renewables and other generation by expanding electricity network capacity and creating the best value for our consumers. We will proactively support the UK's progression to a decarbonised economy and provide sustainable energy to empower people, businesses and societies, helping to unleash their potential without having to worry about harming the planet.

Sources: https://www.nationalgrid.com/group/news/britains-clean-energy-system-achieves-historic-milestone-2019

[i] Electricity generation data from January 2009 to May 2019, comparing fossil fuels (gas + coal) vs zero carbon sources (wind, solar, nuclear + hydro). Imports via interconnectors classified using generation mix in connected country.

[ii] BEIS public attitudes tracker, March 2019: 80% of the public are concerned or very concerned about climate change.

[iii] All figures, unless otherwise stated, are from YouGov Plc. Total sample size was 2,038 adults of which 1,521 are concerned about climate change. Fieldwork was undertaken between 10th and 11th June 2019. The survey was carried out online. The figures have been weighted and are representative of all GB adults (aged 18+).

[iv] National Grid analysis of UK and European electricity markets.

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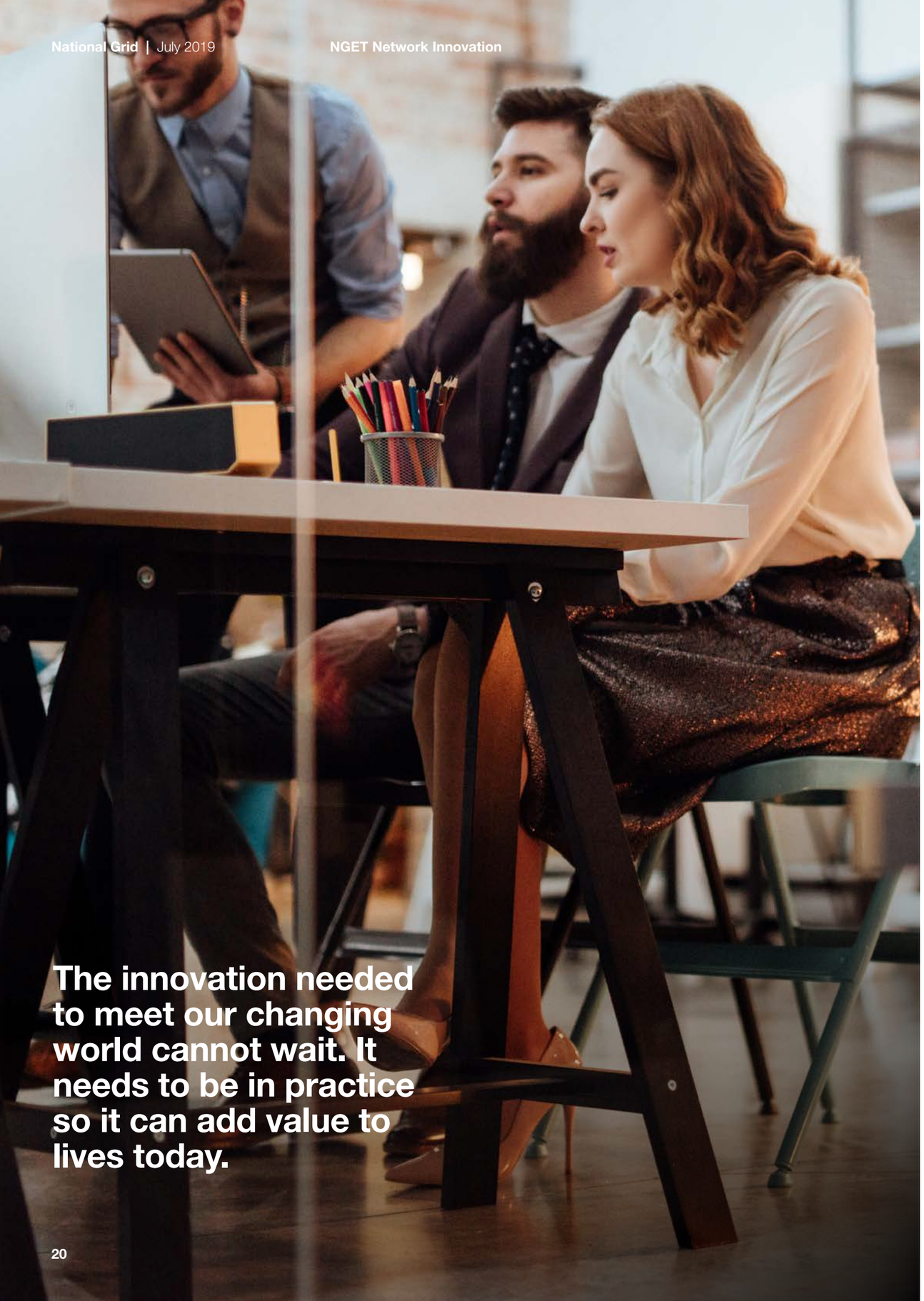
Since 2012/13 we have reduced our controllable carbon footprint by 15 per cent. In 2016/17 we were the first transmission network in Europe to trial an innovative alternative to SF_6



The innovation needed to meet our changing world cannot wait. It needs to be in practice so it can add value to lives today.

Cultural transformation

Creating the best culture to support innovation

The culture of a business is an amalgamation of the values, behaviours and beliefs of its people. It's what they stand for, what defines them and what makes them different from other businesses. Cultural transformation, therefore, is the dynamic process of irreversibly changing this culture, carving out a new path for the future, in order to make it more effective.

We have identified a need for a cultural transformation within our business, driven by the needs of the world and our consumers. Our world is changing at a rapid rate and at NGET, we have to be best placed, with tried-and-tested solutions to support us and a culture that inspires innovation.

The innovation needed to meet our changing world cannot wait. It needs to be in practice so it can add value to lives today. In order to deliver this, we have to be more entrepreneurial, open to ideas from everyone and engaged with the right research, the right infrastructure and the right partners.

Throughout RIIO-T1, we've already started to deliver a culture change within our organisation. Embedding a culture of performance excellence to empower our people to find innovative ways of delivering their work at lower cost.

It's our responsibility, as the organisation which transmits energy across the UK, that we encourage every one of our team to look for solutions for tomorrow's problems. So, when we're driving more electric cars, reading more e-books and streaming more entertainment, we will be providing the future-fit energy solutions that support this way of life. With this in mind, we're encouraging our people to approach their work with a more entrepreneurial spirit and with a calculated measure of risk for each activity. To drive this we have started a two-day workshop on entrepreneurship and ideation based on an award-winning system. These 'Think Box' workshops support entrepreneurship, generating, developing and selecting ideas.

We've also conducted innovation conversations with senior managers and held workshops to understand the innovation culture and what actions we need to take. In order to gain insight relevant to our innovation program, we have commissioned bespoke consumer research to understand consumers' usage and attitudes towards energy and other 'hot topics'. We must also be more transparent – communicating openly and more regularly with our customers and consumers to help them understand what we do. Throughout RIIO-T1 we've systematically increased our stakeholder engagement on innovation, enabling us to embed feedback into our yearly plan.

With activities including two stakeholder workshops per year, sharing and collaboration through industry forums, sharing of information through our podcasts, and regular communication on social media.

Today our innovation culture is mainly associated with technical innovation. Our ambition is that innovation is part of what everyone does, and that's why we've embarked on this journey of cultural transformation.

RIIO-T1
Overview

Shaping the future of energy in the UK

£110.5m
invested to date on innovation.

More than **£34m** in continuous improvement through business wide programmes.

During RIIO-T1 our goal is to develop an innovation strategy that is agile and robust enough to embrace the rapid change both within our energy system and across the clean energy solutions of a wide range of industry sectors.

Our strategy for achieving this focuses on four consumer value themes: Managing assets, Efficient build, Service delivery and Corporate responsibility. We evenly split all activities throughout RIIO-T1 between innovations that would directly impact the customers' perception of National Grid, for example projects that focused on our assets, service and the customer themselves, and innovations that are largely out of the customers' view, for example projects concerning our systems, processes and strategies.

Innovation in RIIO-T1 comes through three different funding streams; Network Innovation Alliance (NIA), Network Innovation Competition (NIC) and our innovation partnerships.

Through our NIA we have delivered a total of 159 projects to-date, co-funded eight projects and supported the implementation and roll-out of a further 41 projects across the UK. We also supported suppliers and other UK infrastructure companies such as Highways England in ideation workshops as part of our Open Innovation programme.

The success of these projects emphasise the value of implementing stakeholder insight, therefore we will be increasing the number of parties we engage and collaborate with to promote greater and better use of innovation and to pave the way for future success. Throughout RIIO-T1, and as an ongoing agenda, we want to systematically boost stakeholder engagement on an innovation level, in order to improve our activity. To support this we aim to collaborate with other companies to enhance our capability and capacity. So, it is important that this is reflected in our innovation strategy. Not only does collaboration leverage considerable funding, over £70m from international utilities to-date, but it also provides us with access to the learning and outputs from those given projects.

From a regulatory innovation perspective, RIIO-T1 has been a strong success so far. We've learnt some valuable lessons that will inform future projects and enable us to perform both more effectively and efficiently. It became apparent that to successfully deliver innovation in a specific regulatory period, some innovation projects will be required to enable innovation benefits in future price controls. This is something which we have considered when developing our innovation strategy for RIIO-2.

Although we have achieved a great deal with innovation in RIIO-T1, our activity is largely confined to technical innovation. Going forward we want to establish an inclusive culture of innovation that penetrates every job role, irrespective of department, throughout NGET.

Our RIIO-T1 innovation in numbers

Electricity Innovation Strategy

159
number of Network Innovation Allowance (NIA) projects T1

Organisation and culture

62
Number of external parties involved in NIA innovation projects in T1

10.2
Number of FTEs working on innovation projects in 1819FY

0.57%
Percentage of annual revenue spent on innovation projects in 1819FY

Capability and technology

32.8
Annual average number of NIA innovation ideas that progress into projects

450 days
Average time taken to deploy NIA projects that completed in and after 2017

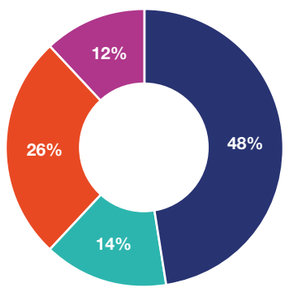
Results and outcomes

97.3%
Percentage of NIA ideas taken forward since 2017

£770m
Forecast and delivered innovation benefits in T1

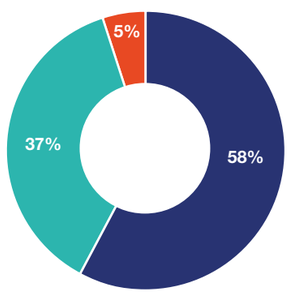
45%
Percentage of innovation projects that have been implemented in T1

Percentage of projects aligned with strategy



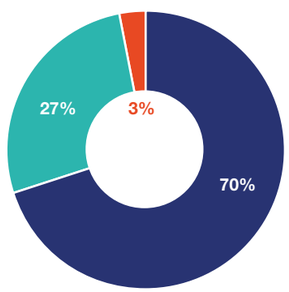
Key:
- Managing Assets
- Efficient Build
- Corporate Responsibility
- Service Delivery

Distribution of the readiness levels of NIA projects by funding



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

Distribution of the readiness levels of NIA projects by volume



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

RIIO-T1

Decarbonisation of South Wales: A vision for a future energy system

We've all heard of Net Zero, Decarbonisation of Heat and Transport, whole-system thinking... but how do we do all this in light of the uncertainties around us and at the least cost to society? We are working together across industry, academia, local and regional governments to develop a realisable vision for the future of South Wales. You can find out more, and follow us on our website www.zero2050.co.uk

To reach UK Government targets of net zero by 2050, decarbonisation requires unprecedented, rapid and far reaching changes in all aspects of society. It must also happen in all key areas of our society – transport, homes, city, industry and agriculture.

At NGET, we know that helping society to decarbonise is the biggest contribution we can make to the environment. When we address decarbonisation challenges, a significant reduction in emissions can be achieved and the impact electricity, oil and gas companies have on the environment will be reduced. Our consumers will benefit, too – not just from an overall reduction in greenhouse gas emissions, but also from greater flexibility. This can include increased accessibility of charging points for electric vehicles and greener living options, such as ground and air source heating in the home.

We have five ongoing projects totalling £0.9m looking at the decarbonisation of industry, transport and heat from a transmission perspective. One completed project has focused on understanding the carbon footprint of South Wales to then develop a roadmap for net zero, with an investment of £135.6k.

Working together with the UK Government, academia and both large and small enterprises through their programmes for decarbonisation, we focused our attentions on South Wales – a priority for decarbonisation and renewable energy innovation. This unlocked the opportunity to work on the first decarbonisation project on a regional scale and directly address one of the largest decarbonisation challenges in the UK. It also provides greater scope for learnings about the whole energy challenge and best practice innovation that can be implemented across further priority decarbonisation regions nationwide.

The findings of our South Wales Decarbonisation project demonstrated that in order to reduce carbon emissions in the region, the energy mix needed to change significantly.

South Wales provides the ideal platform to leverage high-level understanding. The renewable potential here can be found in Wind Offshore, Wind Onshore and Solar PV. Offshore wind speeds and seabed conditions are ideal for wind farm development – and the best areas for solar generation in Wales are in the south of the region, where solar PV capacity is expected to increase significantly.

ZERO 2050 South Wales

National Grid | July 2019 NGET Network Innovation

The project demonstrated that in order to reduce carbon emissions in the region, the energy mix needed to change significantly.

RIIO-T1
Dynamic and predictive circuit ratings in the UK

We know that renewable and clean energy is the future – so we're prioritising their development, adoption and potential.

One way we are doing this is by developing a dynamic rating demonstration system. This project has evolved from several innovation projects that have taken place during RIIO-T1, and will give us the opportunity to apply significant learning to our daily processes and future objectives.

Evolving energy generation and consumer demand are affecting energy flow within the transmission network and increasing constraint costs. Building more circuits or increasing circuit capacity is both time consuming and costly. So instead, we are exploring the opportunity of utilising our existing network more effectively by enhancing our asset thermal capability through Dynamic Line Ratings (DLR) – which, in turn, allows us to maximise the efficiency of renewable energy.

This particular project is all about optimising the use of the assets we already own and maximising the investment that consumers have already made. We want to make our grid more flexible, enabling better, more diverse functionality to allow more renewables to be used more often and to ensure that the cheapest energy is being prioritised.

The aims of this project are to:

1. Develop a dynamic rating demonstration system
2. Perform research on weather analytics for a dynamic rating system – identifying critical measures and error margins to deliver value whilst minimising cost
3. Develop detailed specifications and requirements for a full-scale system deployment in the future

Each asset on our system has a rating which indicates how much power can flow through it. Ratings are determined by the prevailing weather conditions and the Static Ratings (SR) which we currently apply are based on the worst case scenario for a given season in the year. When it comes to overhead lines, based on conventional SR methods, the actual current carrying capability of overhead conductors is often underestimated – so it is not working most efficiently.

The concept of DLR recognises that the capacity of a component varies greatly as a result of external influences, such as diverse weather conditions, health of the asset, and how much electricity it is conducting at a given time. Using DLR, assets would be rated based on a method that allows system operators to run the circuits closer to their actual real-time capacity. The significant benefit to consumers would be the ability to make operational decisions that reduce the cost of operating the system and potentially avoid or defer reinforcement works following the connection of new, clean generation.

This programme of work is developing a DLR system that uses live feed weather data to provide a best practice model that optimises the power capacity of our assets, mainly overhead lines, cables and transformers.

Our ongoing Dynamic and Predictive Circuit Ratings project will develop and deliver a parallel ratings system which can be used to demonstrate the benefits from DLR.

We are now in the assessment stage of our project where we are analysing the specifications, benefits and required performance of the new system. Once fully trialled, we will role out our proposal across our network in the UK and work with other licensees to share the outcomes of this research throughout the energy industry, delivering benefits across the UK.

National Grid | July 2019 NGET Network Innovation

"We believe innovation is not just about 'big inventions', it's about our capacity to identify and react to the evolution of our environment."

Iliana Portugues,
Head of Innovation

RIIO-T1
Project update: Deeside

Deeside Centre for Innovation

In 2015, we were successful in securing £12m in Ofgem funding, through Ofgem's annual Electricity Network Innovation Competition, for the Deeside Centre for Innovation. We combined this with an additional £14m of National Grid investment, to convert a decommissioned substation into a research and innovation facility.

The Deeside facility will be the first in Europe, where assets associated with electricity networks can be tested off-grid – 24 hours a day, seven days a week. It provides a controlled test environment and will collect valuable monitoring data throughout its life, and allows us and other companies, to trial technologies and new practices, without putting customer supply at risk.

Over the last 12 months the Deeside project has made significant progress but has also experienced some delays. As a result of deferred outages and system access issues, the decommissioning work and migration of circuits from Deeside to Connah's Quay substation has been delayed and is now due to complete in October 2019. For the Deeside Centre for Innovation this means that access to the substation area will not be available prior to this date. However, progress has been made in a number of areas that did not require access to the substation.

The building work for the Innovation Centre including the control room, telecommunication room, office and meeting facilities was progressed and moved from the design stage to construction with completion on track for August 2019. Work on the Overhead Line (OHL) test area has started in July.

In order to ensure the safety of our staff and contractors, we had to address a number of issues including contaminated ground, unsafe existing structures in or close to the construction site and engage with stakeholders whose assets may be impacted by our work. Whilst this has delayed the start of construction work, it has ensured that the construction phase can be delivered safely and without lengthy interruptions. We have also prepared the delivery of key infrastructure such as the substation control system, the telecommunication connections and the power supply to the site.

In parallel to the site work we have pursued investigations off-site in collaboration with the University of Chester. We have achieved to simultaneously study tension, heat and vibration on conductor systems for the first time.

Whilst we are constructing the facilities at Deeside we are already delivering a number of innovation projects, to ensure best value for consumers and wider industry. These projects are designed to deliver benefits in three key service areas – accelerating innovation, research and development, and extending asset life.

Laying the foundations for future benefits

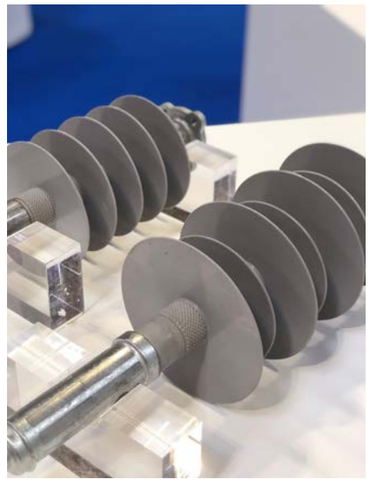
To date, in RIIO-T1 we have commenced five innovation projects, which have already delivered over £24m of avoided costs. In addition to these five active projects, we have an additional 100 proposals, collected from conversations with our stakeholders and within our organisation, also under consideration. The impact of these projects on our performance will not be fully visible in RIIO-T1 yet – due to the fact they will not complete until 2020. However, the implementation of these innovation outputs across the whole of the UK will deliver the following benefits to the industry, customers and consumers:

Retrofit Cable Sealing Ends

Recent failures of 132 kV Cable Sealing Ends have resulted in National Grid implementing risk management hazard zones across the network, instituting additional condition monitoring surveys and developing a large replacement programme to ensure our staff and the public are kept safe. Given the scale of the risk mitigations that were put into place, we started an innovation project to investigate reducing the cost and operational impact of these measures.

National Grid | July 2019 NGET Network Innovation

This project set out to deliver a retrofit Cable Sealing End (CSE), new condition monitoring techniques and an investigation of the underlying reasons for recent CSE failures. The investigation of CSE failures revealed a design defect, which now identified, will help deliver up to £24m of benefits. Condition monitoring reinforced the value of monitoring as viable research method; a new test rig was assembled to replicate degradation in our in-service assets, and it will inform our safety management systems.



Textured Insulators

Working with the University of Cardiff and Allied Insulators, we're developing, optimising and delivering the world's first textured insulator – specifically designed with texture imbued into the surface of the insulation material. The installation of longer lasting textured composite insulators across multiple sites is expected to deliver £12.4k savings per circuit km. This technology could also be used to replace oil filled porcelain insulators, making our network safer and enabling more efficient investment. So far we have manufactured 33kV insulators for testing and aim to also produce versions for higher voltages.

Non-invasive Tower Foundation Inspections

This project sought to test multiple methods of assessing the condition of overhead line tower foundations. Ensuring foundations are in good condition is essential to keeping the public safe and our infrastructure resilient. Non-invasive inspection technologies may provide a clean and simple way to understand the condition of tower foundations, avoiding the need for digging, which would provide significant savings of approximately £1.4m per year. However, as the tower foundations at Deeside are not representative of those used elsewhere on the transmission network these investigations were not formally launched however the idea will be followed up as a separate project.

Rapidly Deployable Scaffold

This project examines pre-fabricated scaffolding as a way to save time and costs. A key factor when carrying out this type of replacement work is to have safe work areas and access to assets at an elevated height. Initial cost estimates show that scaffolding would be a major part of the replacement costs. One way to make cost savings for this type of work is to pre-fabricate scaffolding. Removing the need for repeated redesign would help reduce outage times and costs. However, due to the successful reduction of the required work delivered as part of the CSE project the business case for the scaffolding project will need to be re-assessed.

Modular Bunds

Modular bunds offer the opportunity to deliver cost savings and reduce installation times when building new bunds for transformers and other large, oil-filled assets. The key components of these bunds can be built more efficiently off-site and then assembled once in position. We will validate the savings in terms of installation time and construction cost as part of the Deeside substation works in 2019/20.

Project roundup:

Despite the delays with the construction work for the overhead line test area and the substation, the project remains on track to deliver the benefits outlined in the original bid by October 2020. The majority of innovation projects have been successfully implemented and are delivering value while construction of the main substation facility is ongoing.

Progress with key milestones and project risks are reported in tables 1 and 2 respectively on the following pages.

Delivery programme

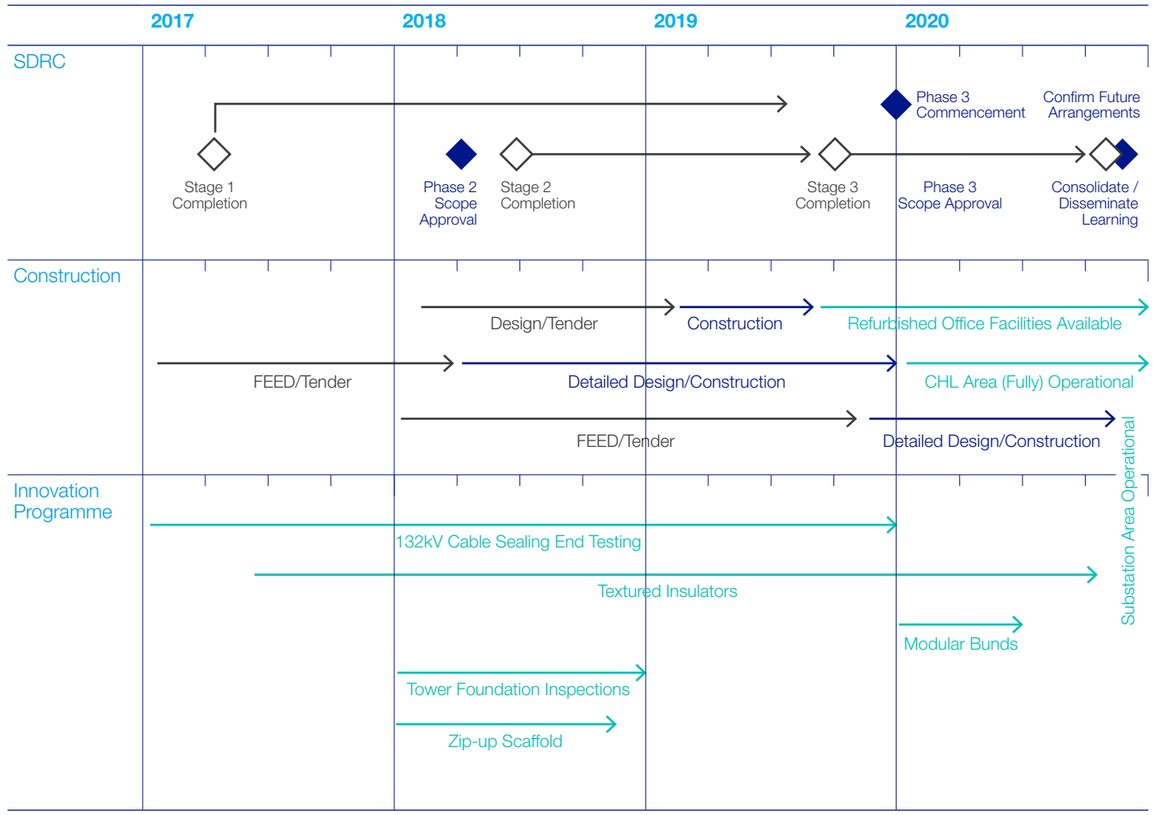


Table 1. SDRC reference table

Ref	Criteria	Description	Status
9.1	Formal agreement on Terms of Reference with Technical Advisory Board members.	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.	Complete
9.2	Detailed design of the facility completed and approved.	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.	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 one 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 during this phase. This plan will also include any relevant Network Innovation Allowance (NIA) projects that can be undertaken at this time.	Complete
9.5	Completion of stage one construction works.	The completion of the construction of the buildings and the transfer of the protection and control panels to the new control room are a key milestone to the effective functioning and monitoring of the facility, as is securing the perimeter of the overhead line enclosure.	Due: June 2017 Forecast: Now on track for delivery in August 2019.
9.6	Scope of work for the phase two innovation programme 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 during this phase. This plan will also include any relevant NIA projects that can be undertaken at this time.	Due: March 2018 Completed: May 2018 Phase 2 projects partially complete or new target date agreed.
9.7	Completion of stage two 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.	Due: May 2018 Forecast: Oct 2019 To be delivered as part of OHL area.
9.8	Scope of work for the phase three innovation programme approved.	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 during this phase. This plan will also include any relevant NIA projects that can be undertaken at this time.	March 2019 Moved to Jan 2020 post OHL completion.
9.9	Commencement of phase three innovation programme.	The delivery of the innovation programme testing/evaluation is a key milestone in the project and the ability to start operations at the facility is fundamental to the measurement of its success.	April 2019 Moved to Jan 2020 post OHL completion.
9.10	Completion of stage three construction works.	The completion of the construction of the Gas Insulated Switchgear enclosure is a key milestone to the effective functioning of the facility, as this will enable the delivery of GIS and SF_6 testing/evaluation projects.	May 2019 Forecast: April 2020 Delayed by decommissioning and handover of Deeside substation to Oct 2019
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.	October 2020
9.12	Project close down.	All project learning will be consolidated and disseminated appropriately.	October 2019

Table 2. Risk table

Area	Risk description	Consequence	Current			Target			Action planned (Accept, Avoid, Reduce, Transfer)
			L	I	O	L	I	O	
Delivery	Conflict of interests at TAB with regards to direction of projects.	Project stalls and delays are caused.	4	4		2	2		Adequate Terms of Reference and direction of project are agreed upfront with key stakeholders. Project Manager will need to steer the TAB back on track.
Outputs	Facility is not sustainable by the end of the NIC funding period.	Facility will close down, with land and assets sold or dismantled.	3	3		2	3		Reduce – understand stakeholder appetite from start and develop sustainable plan through funding.
Delivery	More innovation projects identified than can be planned.	May have to extend the project.	2	2		2	2		Reset the project direction, or request a project duration extension or reject additional projects.
Technical	The design of the facility does not allow value to be maximised.	Opportunity is lost as many innovations cannot be accelerated into implementation.	2	4		1	1		Detailed design of facility developed with stakeholder engagement and TAB approval required.
Finance	Estimated costs are substantially different to actual costs.	Potential project funding gap. Alternative funding required.	2	3		1	3		Reduce – ensure cost estimates are thorough, realistic and reflect full scope of work. Validate estimates based on tenders and market knowledge. Appropriate contingency to be included. Scope and capability of facility to be prioritised by TAB, as real price information is available through tender.
Delivery	Delayed installation and commissioning because of local problems. *Likely delay in handover of substation.	The project is delayed.	4	4		4	2		Reduce – careful and detailed up-front planning and liaising with the various associated schemes. Develop a dynamic innovation programme to allow modifications if required. *Further detail provided to Ofgem sponsor.
Outputs	Outputs are not disseminated appropriately to maximise benefit.	Reduction in value of investment. Lessons learnt are not shared.	2	2		1	2		Reduce – stakeholder engagement plan in place for adequate knowledge dissemination processes and methods.
Delivery	Failure to recruit essential skilled staff.	Quality of work reduces and/or delays delivery.	2	2		1	1		Key resources identified and committed. Technical experts, specialists and engineers within the business allocated time to support if/when required.
Delivery	Staff turnover.	Staff turnover causes delays to project.	3	2		2	2		Staff turnover possibility must be accepted. Engagement and standard business practices will be followed to retain staff.
Delivery	Planning permission.	Control room cannot be built and offices can undergo only minor refurbishment.	2	4		1	2		CLOSED – planning permission no longer required.
Delivery	CDM area dates extended.	Delay in building the external storage unit and innovation centre.	3	3		2	2		CLOSED – building works delayed to remove interaction.

RIIO-2

Exceeding expectations in RIIO-2

Our long-term priority as an organisation is to decarbonise our industry and ensure net zero 2050 carbon targets are met. We will achieve this by delivering cleaner and cheaper energy for our customers and enabling future innovation. Facilitating innovation at every level will form the basis from which industry-shaking disruptions can be seamlessly implemented for the benefit of customers, the industry and environment as a whole.

RIIO-T1 has been hugely successful; however one of the main challenges we faced with Innovation was integrating new learning and technologies into business as usual practices. The electricity sector is leading the transition to clean energy, and innovation will play a pivotal role in making this possible. It will drive efficiencies that reduce costs and improve the overall outcomes for consumers, as well as equipping our networks to accommodate for cleaner technologies.

For RIIO-2, we are proposing two mechanisms which will assist us in pursuing, delivering, and implementing disruptive innovation into our industry. The first mechanism is part of our Totex plan and aims to generate value within the regulatory period through technology developments. The second mechanism will drive change in the industry and the energy system to ensure national decarbonisation ambitions and targets are met by the 2050 deadline and innovation is sustainable within our organisation.

By focusing on driving continuous, sustained innovation, we are able to develop new solutions and services, discover new methods to drive efficiency, and ensure that we maintain momentum and keep progressing as an organisation. Establishing a culture of continuous innovation at NGET will help build the foundation for those industry changing disruptions that have the power to propel consumer value to the next level.

RIIO-2 will also see a change in how we track innovation projects. Using new software which we are developing at present, will enable us to track and review our performance in a much more responsive and agile manner. This software will provide us with a more accurate and detailed report of ongoing and closed projects to support the implementation of the outcomes and our stakeholder interactions.

Delivering cleaner energy

Transitioning from an over reliance on fossil fuels and exploring new environmentally friendly alternatives will be central to achieving decarbonisation.

Our Deeside Centre for Innovation will take charge of discovering, trialling and ensuring these materials adhere to safety and environmental parameters before they are rolled out. We know that decarbonisation is the most effective way to tackle society's impact on the environment, so we will also use our expertise to engage with and support other industries to decarbonise their processes.

Delivering cheaper energy

Embracing digitisation will help create an energy system that is fit for the future. To overcome future challenges, our energy system will have to be more dynamic, interactive and responsive than ever before.

Future customers will demand quicker and more convenient access to the system to enable them to produce as clean energy as is possible. RIIO-2 will see us develop tools which will allow us to better serve the needs of our customers. In addition, we will also put a contingency plan in place to protect our most vulnerable customers and make sure no one is left behind during the transition.

Case studies

Over the next few pages you can read more about some of our projects and where our collaborations and research have led us.

National Grid | July 2019 NGET Network Innovation

Case study

Building our understanding of thermal and electrical resistivities

Smart Geo Grid

Project reference number: NIA_NGTO027

Consumer value theme: Service Delivery

"This could also enable us to connect customers faster than ever before, by unlocking additional capacity in the network. This could allow us to be more agile for our customers and provide better suited connections."

Oliver Cwikowski
Senior Innovation Engineer

The soil that surrounds buried electrical cables performs a number of vital functions that are important for safety and successful asset management. One of those functions is to dissipate heat efficiently enough to prevent thermal overloading of the cables. However, there is a level of uncertainty in predicting the behaviour of soils and their consequential impact on the safe functioning of key assets.

This project, the first of its kind, started by constructing a test system at Cardiff University to carry out a feasibility study into soil resistivity (the measure of how much the soil resists the flow of electricity). However, soils are highly complex materials and can differ in compound quite dramatically from site to site.

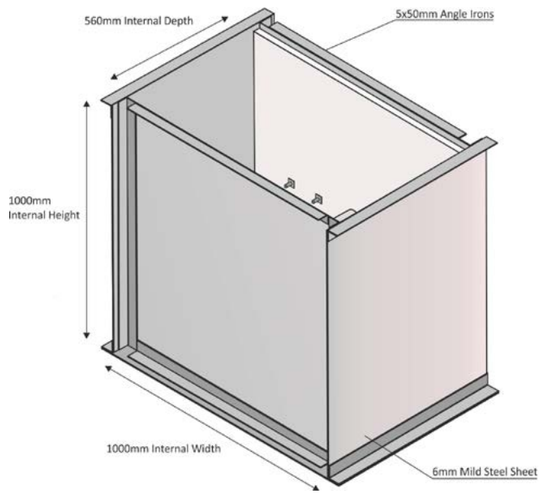
Envisaging and accounting for the potential different soil types surrounding the cables is a highly challenging and potentially costly task. For instance, both the thermal and electrical resistivities of soils are highly dependent on the water content and in the event that a soil mass dries out, both it's thermal and electrical resistivities will rise considerably limiting it's capacity to dissipate heat and electricity. Taking into account the challenges of climate change, in particular the potential for longer, drier summers there is a need to safeguard against scenarios like this via cost effective research and testing methods.

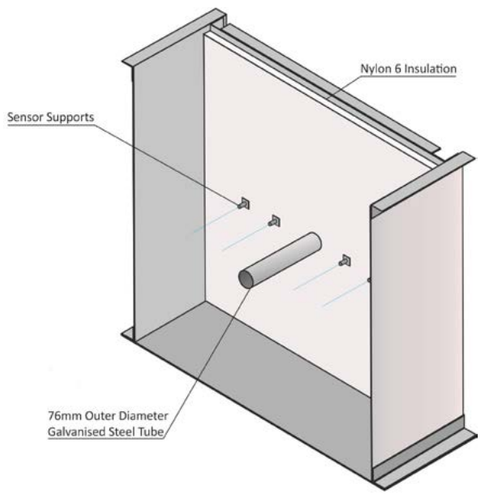
At the heart of this project is the idea that whilst data acquired directly from site provides an invaluable insight into the local conditions of the soil mass, when used in isolation of future climate predictions, it does not deliver a true and detailed enough picture of the environment conditions. Combining the two streams of data provides a highly effective approach to enable us to take mitigating action before a critical condition is reached.

Whilst in the previous section we have talked about the value of dynamic ratings, being able to improve the static ratings of underground cables on its own has significant value for our customers and consumers as it can delay or defer the need to invest in new infrastructure. Furthermore, improvements can also alleviate constraint payments in a very short space of time. Both of these outputs reduce the cost of electricity and allow us to provide a better service to our customers.

Furthermore, our research findings can also be adopted by other electricity networks, both at transmission and distribution level. The work does not stop here however and the outcomes of this project have been fed directly into the underground innovation programme and are being considered for follow on projects.

National Grid | July 2019 NGET Network Innovation





Case study

Unlocking more network capacity

SmartWires

Project reference number: NIA_NGTO017

Consumer value theme: Managing Assets

"Our collaboration with SmartWire's in their early phase of technology development has enabled us to understand and address risks associated with the technology before we decide to deploy it within our networks. If successful, the technology will be a promising alternative to traditional power flow control devices."

Robin Gupta,
Senior Innovation Engineer

Changes in electricity generation and demand are leading to changes in how power flows through our networks. To reflect the changes and meet increased demand some parts of the network will need to be reinforced through building new infrastructure. However, if we can identify a suitable way to control the power flow we can avoid the need for costly reinforcement work.

At present, we can control the power flow by constraining generators connected at different points on the network, or by using big, heavy pieces of equipment called quadrature boosters (QB's) or series reactors to modify the electrical characteristics of circuits on the network. The ability to modify the characteristics of these circuits at different times based on requirements can release capacity on the network.

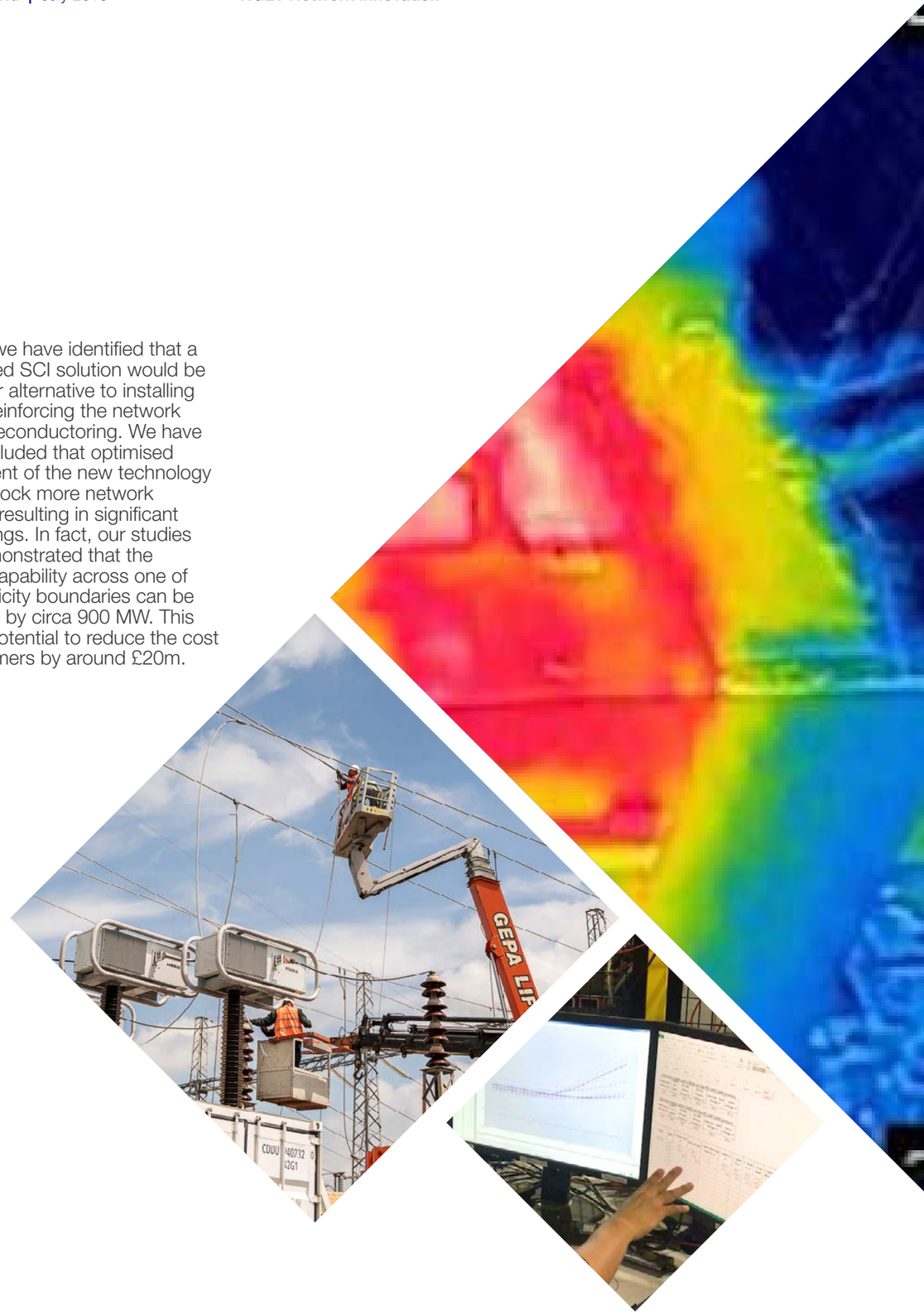
However, once installed, QB's and series reactors can't be moved or modified quickly enough to match the pace of change affecting the network. So, they would need to be overrated, compared to the initial power flow requirement, or replaced if the power flow over the network changes further. Both of these options cost money.

So, working with SmartWires, US based pioneers in grid optimisation solutions, we looked at developing an alternative solution for controlling power flow using voltage source converters (VSC) in each phase. Adopting VSC based series controlled impedance (SCI) technology has many potential advantages:

- Cheaper than QBs
- Unlocks more system capacity than QBs
- Greater controllability
- Easy mobile redeployment
- Wireless control

The project is helping us build our understanding of VSC based SCI devices and confirm adequate system performance can be maintained should this new technology be installed across the network. We are carrying out an in-depth system evaluation to fully scope and demonstrate system performance under a range of credible and extreme scenarios. Using electromagnetic transient (EMT) studies we are gaining insight into the control behaviour of the device which we are validating further with real-time simulations performed on a real time digital simulator (RTDS) platform. We are also carrying out cyber penetration testing to asses the risk to cyber security.

To date, we have identified that a VSC based SCI solution would be a cheaper alternative to installing QB's or reinforcing the network through reconductoring. We have also concluded that optimised deployment of the new technology would unlock more network capacity, resulting in significant cost savings. In fact, our studies have demonstrated that the transfer capability across one of our electricity boundaries can be increased by circa 900 MW. This has the potential to reduce the cost to consumers by around £20m.



Case study

Moving forward with Energy Highways

NGET Energy Highways

Project reference number:
NIA_NGTO011

Consumer value theme:
Efficient Build

For timely uptake of Electric Vehicles, we require considerable investment to support the electrification of highways and an overhaul of the existing electricity network.

Energy Highways have been proposed in other parts of the world as normal motorways and lorry roads that have integrated energy harvesting, energy storage and charging technologies for electric vehicles of all shapes and sizes.

As the number of electric and hybrid vehicles increase year on year, we are working with British Military Transport (BMT), to understand how we could deliver these innovative energy highways in the UK. Our initial study has focused on designing the most cost-effective and efficient, retroffitable, electrical charging system for heavy good vehicles travelling on the M5 between Bristol and Birmingham. As part of the study, we also looked at the long-term performance, risks and opportunities of the available technologies and solutions.

With this preliminary project completed, we are now looking at the impact of solutions across the UK and as part of the whole-system thinking required to achieve our net zero target.

Case study

Smarter asset management to cut costs

Advanced Line Rating Analysis (ALiRA)

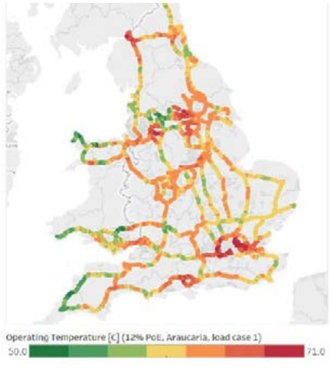
Project reference number:
NIA_NGTO014

Consumer value theme:
Managing Assets

The Network Options Assessment (NOA) plays an important role in helping us develop an efficient, coordinated and economic system of electricity transmission. The 2017/18 NOA report recommended reinforcement of the network across seven overhead line routes, between 2019 and 2025.

Between July 2018 and April 2019, we used Advanced Line Rating Analysis (AliRA) to understand how the environment affects our overhead lines in different locations. This has enabled us to show geographic variations due to weather and highlight areas that are more or less prone to adverse weather conditions. Areas like the south-west of England and Wales. If we were able to defer the investment required for four of the routes identified in the 2017/18 NOA report, we could realise savings in excess of £9m.

The result is that we can now make informed decisions about the upgrading potential of individual lines. It may also help us to unlock extra capacity in the existing transmissions network, without having to replace the wires of existing lines or construct new transmission lines. Ultimately this will help reduce the cost of electricity for consumers.



“Implementation of the results of this project could allow us to defer load related investments identified in the Network Options Assessment, resulting in multi-million pound savings for the consumer. We will use the output to review our line ratings to ensure we continue to operate our OHL assets with optimal efficiency.”

Ben Muncey
Senior Innovation Engineer

Case study

Valuable time and cost savings for substation design

The application of Parametric Design to automate substation development

Project reference number: NIA_NGTO012

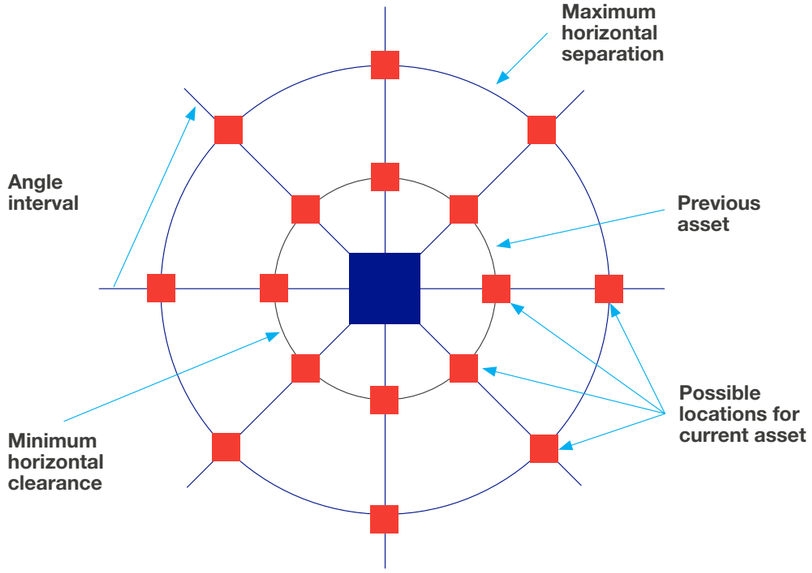
Consumer value theme: Efficient Build

Parametric design, a method guided by a set of parameters and their relation to one another, can minimise error and save time, increasing the overall accuracy and consistency of designs. It also involves a degree of automation, which makes it a suitable approach for the design and specification of substations.

Considering only the Front End Engineering Design (FEED) costs for a complex scheme, this could result in a saving of £75k for an individual project. Assuming that 40% of National Grid's development costs could benefit from this approach, the savings could be in the region of £840k per annum.

Our feasibility study revealed that parametric design could allow a level of automation during the design process, with a view to saving several million pounds by driving efficiency in the Network Development Process. This not only makes parametric design a possibility for National Grid, but for other Transmission and Distribution Operators, too.

The diagram illustrates the range of possible placement locations for an asset (red) relative to the previously places asset (blue)



Case study

Maintaining our OHL conductor systems with optimal efficiency

Predicting Vibration Fatigue for Overhead Line Conductor

Project reference number:
NIA_NGTO013

Consumer value theme:
Managing Assets

Vibration on overhead line conductor systems caused by wind or stormy weather can have an adverse effect on the performance of our conductors. Identifying what characteristics amplify the affects of vibration, such as the condition of the conductor, and the severity of weather conditions has helped us better inform testing parameters, so that we can ascertain a truer picture of conductor life expectancy and quantify the risk of failure.

We partnered with the University of Manchester to develop technology that identifies the conductor systems that are particularly at risk of being affected by vibration fatigue.

Previous tools designed to address these challenges have proven insufficient. Whilst it has been found that CIGRE-EBM is accurate in predicting uniform conductors, made from a single material, and ACSR conductors with single steel strand core, the technology over-estimates the vibration amplitudes and fatigue on ACSR conductors with multi-layered steel cores.

Furthermore, current practices are not applicable to power lines that have multiple conductors, or bundles, as there is no approach for identifying energy interactions between the conductors in bundle formation.

Knowledge we have gained from the technology we've created will enable us to pinpoint and predict with a greater accuracy which overhead line conductor systems require maintenance and when they will need it, this in turn allows us to focus our maintenance budget on the conductors most in need of repair.

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"In this project we aimed to develop a finite element analysis model to identify the properties that make conductor systems immune to vibrations and therefore those that are particularly at risk of being affected by vibration fatigue".

Case study

Developing a new approach to compliance management

Harmonic Compliance Management

Project reference number: NIA_NGTO018

Consumer value theme: Managing Assets

"A new approach to harmonic compliance management will enable a more efficient whole system solution which can bring around £100m cost savings to consumers and improve customer services."

Xiaolin Ding
Senior Innovation Engineer

Power electronics devices and other non-linear loads and generators affect the quality of the sinusoidal waveform we use to transmit alternating current through our network. This impacts the efficiency of our network as well as our operations and which is why a Grid Code specifies what can and cannot be connected.

The existing harmonic compliance management is based on the 'polluter' being responsible for 'cleaning' or minimising harmonic pollution in order to be compliant with the Grid Code harmonic limits. However, the current approach is facing a big challenge – how can we maintain harmonic compliance in a rapidly changing energy environment. In recent years there has been a significant increase in the penetration of harmonic emitting plants, such as wind farms, interconnectors, batteries, traction load and PVs and the number of harmonic emitting plants is expected to rise as we see more and more electric vehicles on our roads requiring charging points. This will make it harder to assign responsibility for minimising harmonic pollution to an individual customer.

Feedback from customers has informed us that the current approach can be complex and very demanding on their resources. Furthermore, we are confident that economical whole-system solutions can be found if harmonic compliance is managed strategically rather than by an individual customer.

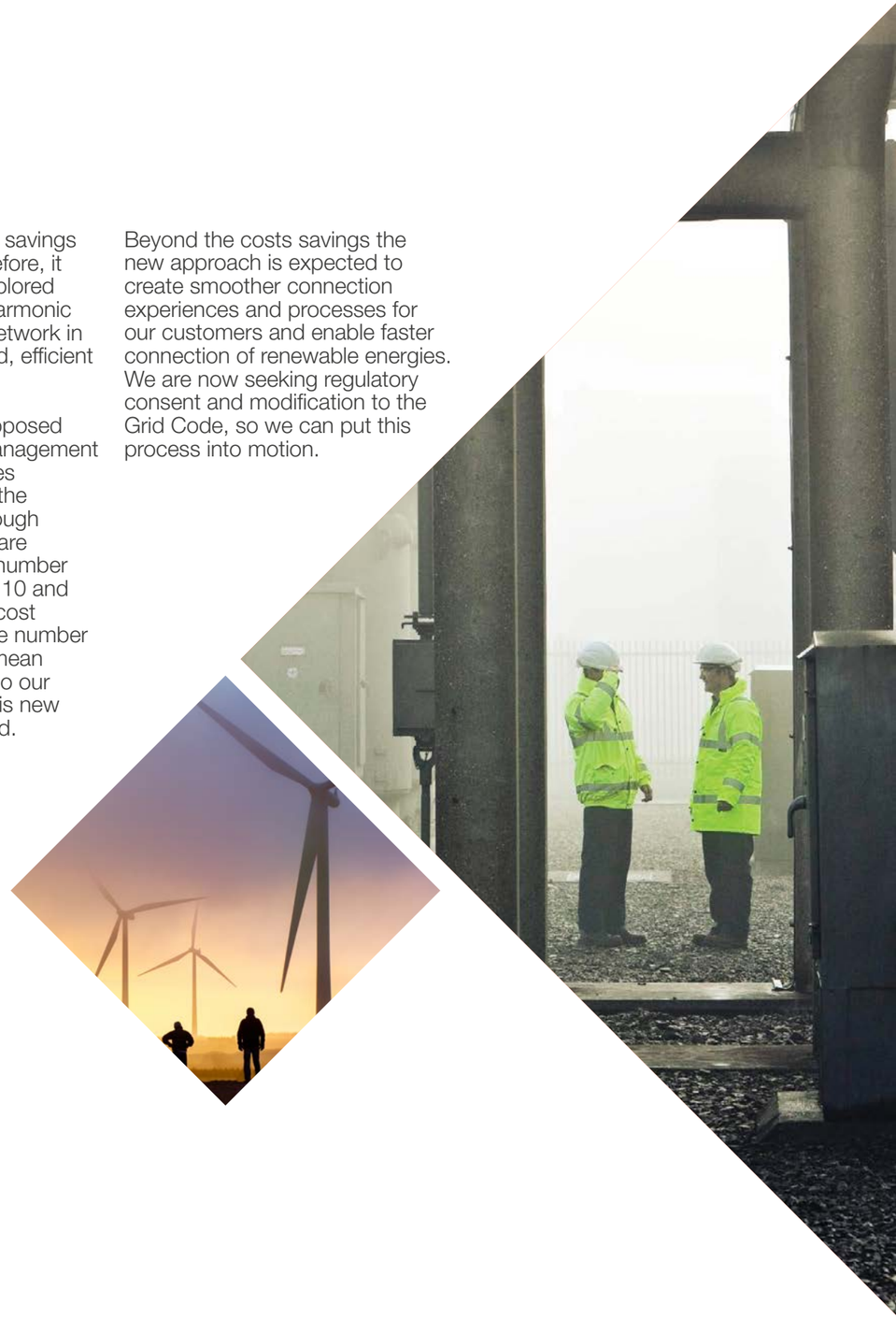
Our project investigated alternative methods to manage harmonic compliance in order to deliver the most valuable benefits to both our customers and consumers. It also aims to investigate the feasibility of implementing such a system here in the UK.

Currently, to be compliant with the existing Grid Code requirement on harmonic management, most wind farms and interconnectors must install harmonic filters. This means that in the five year RIIO-2 period 10 new offshore wind farms and interconnectors would require the installation of an estimated 31 harmonic filters.

The current approach can mean that the consumer is paying for the construction of these large, necessary filters for each polluter on the network. Whereas the new approach would enable finding a strategic whole-system solution which generates savings for our consumers. Therefore, it was essential that we explored new ways of achieving harmonic compliance across the network in a much more coordinated, efficient and economical manner.

The result is our new, proposed harmonic compliance management approach, which manages harmonic compliance of the network as a whole. Through coordinated working we are expecting to reduce the number of new filters to between 10 and 18. Harmonic filters can cost £5m-£10m. Reducing the number of filters required would mean a saving around £100m to our consumers in RIIO-2 if this new approach can be adopted.

Beyond the costs savings the new approach is expected to create smoother connection experiences and processes for our customers and enable faster connection of renewable energies. We are now seeking regulatory consent and modification to the Grid Code, so we can put this process into motion.



Case study

New measures in place to enhance site safety

Development of tools for the assessment and control of impressed voltage

Project reference number: NIA_NGET0207

Consumer value theme: Corporate Responsibility

Impressed Voltage (IV) is one of the hidden dangers of working close to the high voltages within an electricity substation or overhead line environment. All that is required is the presence of three elements – an energy source, a coupling mechanism, and a receptor. With the presence of these three elements it is possible for energy to be transferred indirectly by magnetic fields (induction), by electrical fields, by stored energy, and by transferred potentials. The hazard therefore can exist outside of the apparatus footprint so, even without direct contact, people can be at risk.

This phenomenon is therefore of great importance for us. Though the magnitude of impressed voltage (IV) in a substation could be significant enough to cause personal harm and, in extreme cases prove fatal, most IV scenarios only result in causing nuisance or minor shocks.

Current tools available to detect and mitigate the risks of IV have proved difficult to use. As such we have identified an opportunity to improve our understanding of IV and develop a tool kit for measuring and improving the way we mitigate the risks from IV within high and low voltage substations.

We've already achieved the majority of the project's objectives – the live detectors have been shortlisted and tested in a laboratory environment and the IV toolkit has been designed. Prototypes have also been produced and our site engineers are familiarising themselves with the developments.

An early clamp design

We have identified an opportunity to improve our understanding of IV and develop a tool kit for measuring and improving the way we mitigate the risks from IV within high and low voltage substations.

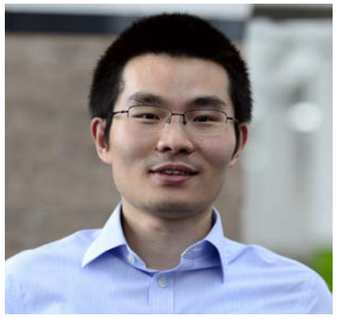
Case study

Keeping future energy systems well protected

Feasibility study on sustainability of protection policy for future energy scenarios

Project reference number: NIA_NGET0182

Consumer value theme: Managing Assets



"The feasibility study will enhance our understanding on the existing protection performance with future green network scenarios and prioritise the work to maintain reliability of our protection system."

Linwei Chen
Innovation Engineer

Historically, the protection strategy and methodology used in electricity transmission has been very effective at providing a reliable and safe network. However, the increasing use of power electronic converter-based technology such as wind turbines, HVDC links and solar power through photovoltaics is significantly changing the type of system faults we are experiencing and how we detect them.

More and more often we are seeing new scenarios where the existing protection strategies and methods may not be sufficiently reliable to detect and clear faults, which can affect the stability of the wider network. As a result, we have recognised a need to establish the effectiveness of current protection strategies for the electricity transmission system in order to be identify and be ready to address arising energy scenarios with best practice solutions that will better protect our transmission grid.

In developing and deploying cost-effective solutions for future protection strategies, the first step is to analyse the capability of existing protection solutions. We therefore started this project to investigate the various options.

To do so we have carried out a feasibility study focusing on a small section of our network dominated by renewable generation.

The study has informed and developed a simulation network model which we can use to test different future scenarios, for example, reduced system inertia and fault level. We have conducted simulations and lab testing to assess and better understand the technical performance of the existing protection solutions, including differential, distance and overcurrent protection.

Our research found that the differential protection is able to maintain reliability at different penetration levels of renewable generation. However, the performance of distance and overcurrent protection would be affected by the reducing fault levels due to renewable generation. This issue may be partially resolved by changing the protection settings. However, as the fault level reduces, the distance and overcurrent relays in extreme cases may become inadequate even with setting changes. A new or more sensitive protection method is needed.

The next step is to develop or trial cost-effective solutions which can maintain reliability of our protection systems in a future network dominated by renewable generation and decarbonised demand.

Our feasibility study to date has formed the scope and specification of a Protection Settings and Coordination review. In addition, we intend to review our protection policy statements, technical specifications and guidance notes once we have fully completed the work.

Case study

Transformer robot inspection

Transformer robot inspection technology project

Project reference number:
NIA_NGET0210

Consumer value theme:
Managing Assets

Power transformers are a critical component of the electric power transmission system. They are also one of the most difficult and costly pieces to replace. As such, they must undergo inspection and maintenance to ensure they are working at optimum capacity and protect their longevity.

Current tools and processes used for inspecting the insides of transformers can be time consuming, complex and potentially hazardous. To inspect the transformers they must be drained of oil, which can lead to unintentional and unpredictable consequences. Entering such an uncertain environment comes with an element of risk. This dissatisfaction with our existing inspection methods lead to research into developing a new safer and quicker approach. As a result this transformer inspection robot project was born. It sought to find a feasible way to inspect transformer internals without lowering the oil levels.

In this project we have trialed transformer robot inspection technologies that can perform an internal inspection without draining the oil inside to significantly reduce outage length.

The requirements of the robotic technology are that it is commercially viable in terms of being; deployable, retrievable, versatile, manoeuvrable, small enough to access compact areas, operable in limited visibility, and cost effective. To cope with the challenges posed by inspections, the robot needs; sufficient battery life, cameras for maximum visibility, an intuitive controller, variable buoyancy, adjustable lighting, and a fail-safe mode.

Of the solutions we analysed, the swimming robot, was deemed to be the best fit. It provided visibility under oil, could be easily controlled and although it was not as quick as first hoped, it still outperformed inspections that required the oil to be drained.

Based on this experience we are confident to use a swimming robot where internal inspections using this method is beneficial, saving both time and money.

“Of the solutions we analysed, the swimming robot, was deemed to be the best fit.”

Case study

Using drying protection technology to safeguard substations

EPRI Research collaboration on substations (P37) 2017-2020

Project reference number:
NIA_NGET0210

Consumer value theme:
Managing Assets

Water in transformers can be a life-limiting problem; in the short term, there is a risk of bubble generation when the transformer is operating at high loads – this can lead to partial discharge activity. Longer term, the presence of moisture in the solid insulation may lead to accelerated ageing as the water causes hydrolysis of the cellulose. Moisture in transformers is managed using devices to prevent it from getting into the transformer but over time some water can get in and it is also produced as insulation ages over many years.

Drying transformers is often a one-off activity and there are a number of options which have to balance cost and long term effectiveness. We started this project back in 2013 and aims to produce something which is effective over the long-term and also inexpensive over the life of the transformer.

The method researched uses hollow fibre technology whereby the oil flows down the fibre and water is able to pass through the wall of the fibre. Gases and moisture can permeate through the thousands of fibres used. Air flows over the fibres to extract the moisture from the surface of the membrane. This is more effective with vacuum but it removes gases, which are important diagnostically, as well as moisture. Using a chiller makes the technology more selective for moisture. The process is slower but can be used from installation and keep the transformer dry for life.

We initially showed the technology to work in the laboratory before moving to field trials. The novel membrane research addressed the need to prove life-long transformer dry-out with no need for cartridge replacements. It also assessed field data to inform and improve the final prototype with a view to generating research results that could be used commercially.

Throughout this project we worked closely with EPRI to facilitate the rollout of this initiative by locating a pilot site suitable for enhanced dehydration and experimentation to expand product capability.

We have already successfully installed a membrane dryer at our substation in Acton Lane, London and now plan to install two more drying units with monitoring capability throughout our substation network.

National Grid | July 2019 NGET Network Innovation

Case study

Strengthening cyber resilience for substations

Cyber Resilient Electric Substation Technologies (CREST)

Project reference number: NIA_NGT0020

Consumer value theme: Managing Assets

This research project aims to address potential cyber security issues related to the digitisation of substations. This includes looking at new techniques to manage cyber security risks, improving the resilience of the systems and equipment, investigating various intrusion detection systems and recovery from cyber-attacks. This project also focuses on the application of international standards to achieve required cyber security targets.

Through this project we will reduce the cost associated with the prevention of a cyber-attack as well as help us manage and reduce cyber risks. However, as you can expect with this type of work, there is limited information we can provide as to how we will achieve this.

In addition however, we aim to develop our confidence to deploy and roll out digital substations, resulting in less outage time compared to conventional substations. Digital substations are normal substations where operation is managed between distributed intelligent electronic devices interconnected by communications networks, simplifying connections and improving data and information exchanges. Whilst they offer huge potential in terms of cost reductions and savings, the communications aspect of them introduces cyber risks which have impacted our deployment of them.

We will use the outcomes of this project to inform future policy, configurations and designs providing the appropriate level of cyber resilience for the transmission network.

National Grid | July 2019
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“Our cyber security programme will help us deliver the benefits of digital substation solutions and improve the resilience of our secondary systems.”

Thomas Charton
Deeside Manager

Project portfolio

Table reference to go here

Project reference	Project name	Partners
NIA_NGET0003	Simulation of multi-terminal VSC HVDC system by means of Real Time Digital Simulation (RTDS)	University of Birmingham
NIA_NGET0010	Optimised Location for Surge Arresters on the Transmission Network	Cardiff University
NIA_NGET0011	Detection and Measurement of ACSR Corrosion	HYDRO-QUÉBEC
NIA_NGET0012	Induced voltages and currents on transmission overhead lines under NSI 4 working practices	Cardiff University
NIA_NGET0013	Tablet interface for a SF6 mass flow top-up device	The University of Herfordshire, DILO
NIA_NGET0014	Transformer & System Reliability	The University of Manchester
NIA_NGET0015	Dinorwig Thermal Cycling and Cable Rating	Doble Powertest Ltd, University of Southampton
NIA_NGET0017	Oil/Paper Insulation HVDC Performance	University of Southampton
NIA_NGET0018	Potentials and profiles around earth electrodes and opposite-side injection for large-area earthing	Cardiff University
NIA_NGET0019	Reliability Assessment of System Integrity Protection Schemes (SIPS)	The University of Manchester
NIA_NGET0024	Composite Cross-Arms Study	The University of Manchester
NIA_NGET0025	Feasibility Study for Sustainable Substation Design	Ove Arup And Partners Ltd
NIA_NGET0033	Wireless Condition Monitoring Sensors with Integrated Diagnostics	The University of Strathclyde
NIA_NGET0034	Fibre-optic Acoustic Monitoring	Optilan, Optasense and Liverpool University
NIA_NGET0035	Long Term Performance of Silicon Based Composite Insulators	The University of Manchester
NIA_NGET0036	ThermoMechanical Forces in XLPE Cable	University Of Southampton, Mott Macdonald, Cable Consulting Incorporated
NIA_NGET0038	Design of a smart tool for detecting hidden errors in protection setting files	The University of Strathclyde, Alstom Grid
NIA_NGET0040	Magnetic Models for Transformers	The University of Manchester, Cardiff University
NIA_NGET0042	HVDC EngD – Richard Poole	The University of Hertfordshire
NIA_NGET0043	Live Line Working Equipment	Bond Helicopters Europe
NIA_NGET0044	Transformer Oil Passivation and Impact of Corrosive Sulphur (TOPICS)	University of Southampton, Doble
NIA_NGET0045	Multi-terminal VSC HVDC operation, control and ac system integration	The University of Manchester
NIA_NGET0046	Flexible rating options for DC operation	University of Southampton
NIA_NGET0047	Dynamic Ratings for improved Operational Performance (DROP)	University of Southampton
NIA_NGET0048	Cables with Long Electrical Sections	University of Southampton
NIA_NGET0051	33kV Superconducting Fault Current Limiter	Applied Superconductor
NIA_NGET0053	RESNET	The University of Manchester
NIA_NGET0054	Load cycling and radial flow in mass impregnated HVDC Submarine cables	Sintef Energy and NTNU (Trondheim) via a consortium with Statnett & Tennet
NIA_NGET0055	Electromagnetic transients (EMT) in future power systems – Phenomena, stresses & modelling	Sintef Energy As
NIA_NGET0056	Humber Smartzone Pilot Project	The University of Manchester
NIA_NGET0057	DC Circuit Breaker Technologies	The University of Manchester, Ampacimon
NIA_NGET0060	Application of DC circuit-breakers in DC Grids	Cardiff University
NIA_NGET0064	Alternative Bus Bar Protection Solution	Schweitzer Engineering Ltd
NIA_NGET0065	Voltage Optimiser Pilot	EMS Powerstar
NIA_NGET0067	Trial & Performance Assessment of ACCR Conductor (3M)	3M
NIA_NGET0072	Alternative Differential Unit Protection for Cable only and Cable & OHL hybrid installations	Cooper Power System
NIA_NGET0073	Partial discharge monitoring of DC cable (DCPD)	University of Southampton
NIA_NGET0074	SF6 Capture & Leakage Repair	The University of Liverpool, Furmanite, Belzona, Siemens
NIA_NGET0075	Temporary Oil Containment	Industrial Apparatus Consultants
NIA_NGET0079	Rapid Deployment Ballistic Screens	Doble, RADNOR, Redman Composites
NIA_NGET0080	400kV Synthetic Ester Filled Transformer Pilot Project	Alstom, M & I Materials

Project reference	Project name	Partners
NIA_NGET0082	Rating Impact of Non-isothermal Ground Surface (RINGS)	Doble, C3, University of Southampton
NIA_NGET0083	Cable Oil Regeneration	Enervac Corporation, JSM Construction
NIA_NGET0087	Cable Installation Design & Innovation Project (CIDIP)	University of Southampton
NIA_NGET0088	Transformer Research Consortium	The University Of Manchester
NIA_NGET0089	Impact of HVDC Cable Operation on Telecommunication Lines	Powersure Technology Limited
NIA_NGET0090	Cable Extraction	JSM
NIA_NGET0091	Impact Assessment of Seismic Analysis on Electricity Towers and Substation Equipment / Structures	Mott MacDonald
NIA_NGET0092	Partial Discharge on Existing HV Cable	Elimpus Limited, NDB Technologies, Prysmian Cable and Systems Limited, Doble PowerTest
NIA_NGET0093	Online Gas in Oil Analysis on Existing HV Cables	Doble, ISL and C3 Global
NIA_NGET0098	Computer Vision For Cable Tunnels	none - project never started
NIA_NGET0099	Thermal Efficiency Trials	Rook Services
NIA_NGET0102	13kV Shunt Reactor Refurbishment	ABB
NIA_NGET0103	Modelling the tape corrosion process for oil-filled underground cables	University Of Leicester
NIA_NGET0104	Proof of Concept for IEC61850 Process Bus Technology	ABB
NIA_NGET0107	Stakeholder attitudes to electricity infrastructure	University Of Exeter
NIA_NGET0108	Incident Investigation Review	Taproot, Sigma
NIA_NGET0109	Bushing and Instrument Transformer Test Tap Connection Condition Assessment Tool	Elimpus Limited, Elysis Engineering, GE Grid Solutions, Invisible Systems, Process Parameters
NIA_NGET0112	Enhanced AC and DC safety voltage limits assessment	Cardiff University
NIA_NGET0113	Control of Debris and Dust from the Treatment of Grade 4 Tower Steelwork (G4T)	CLC Contractors Ltd, Spencer Coatings Ltd, PDC Protective & Decorative, Fountains Environmental Limited
NIA_NGET0115	Cable Stripping Truck	Utilise
NIA_NGET0116	Combustible Gases in Redundant Oil Filled Cables	Utilise Environmental
NIA_NGET0117	Bulk Oil Circuit Breaker Bushing In Situ Refurbishment	NAREC Electrical Networks or Narec Development Services?
NIA_NGET0118	Understand and Improving Condition, Performance, and Life Expectancy of Substation Assets	The Watt Consultancy
NIA_NGET0122	Identification and Mitigation of Large Equipment Transport Issues	Wynns LTD
NIA_NGET0123	EPRI Research Collaboration on Substations	EPRI
NIA_NGET0124	EPRI Research Collaboration on Electromagnetic Fields and Radio Frequencies	EPRI
NIA_NGET0126	EPRI Research Collaboration on Overhead Circuits.	EPRI
NIA_NGET0130	Determining a threshold for magnetophosphenes perception at 50Hz	Lawson Health Research Institute
NIA_NGET0132	UltraWire	University of Cambridge
NIA_NGET0133	Identifying Opportunities and Developments in Electric and Magnetic Fields Research	Formex Archive Services Ltd, Torrance Ltd, Market Opinion Research Ltd, RESOURCE STRATEGIES LTD
NIA_NGET0135	Enhanced Sensor Development (ICASE Award)	The University of Manchester
NIA_NGET0136	Impact of Seabed Properties on Ampacity and Reliability of Cables (ICASE Award)	University Of Southampton
NIA_NGET0137	Noise Assessment of ACCR Conductor	3M, Bruel & Kjaer
NIA_NGET0140	OHL Condition Assessment	Brunel University, Amey OWR
NIA_NGET0141	T-pylon Structure and Composite Insulator Testing	LAPP/Mosdorfer,Pfisterer and Allied Insulators, STRI (Sweden) & CEPRI (China), EPL Composites (England), MIRA, University of Southampton, University of Cranfield (England)
NIA_NGET0143	Transient and Clearances in the Future Electrical Transmission Systems (ICASE Award)	The University Of Manchester
NIA_NGET0146	Assessment of Electronic (analogue and Numeric) Protection equipment end of life mechanisms	Quanta Technology, The University of Manchester University, Nottingham University

Project portfolio

Table reference to go here

Project reference	Project name	Partners
NIA_NGET0147	Condition Monitoring of Power Assets (COMPASS)	The Watt
NIA_NGET0148	Network Reliability Asset Replacement Decision Support Tool	The University of Manchester
NIA_NGET0149	Investigation of Aeolian Insulator Noise	Cranfield University School of Management, University of Manchester, Campbell Associates
NIA_NGET0150	EPRI Research Collaboration on Underground Transmission	EPRI Solutions Fx Usd
NIA_NGET0153	Life Cycle Costing and Value Optimisation (ICase Award)	University Of Bath
NIA_NGET0157	EPRI Research Collaboration on Substations	EPRI
NIA_NGET0158	EPRI Research Collaboration on Overhead Transmission Lines Project	EPRI
NIA_NGET0160	Feasibility of Risk based Network Planning	The University Of Manchester
NIA_NGET0162	Digital Substation – Virtual Site Acceptance Testing & Training	The University Of Manchester
NIA_NGET0163	SF6 Management and Alternative Gases	Cardiff University
NIA_NGET0164	Evaluation of a Novel Variant of ACCC HTLS Conductor	Nexans Benelux SA, LAPP Insulators GMBH
NIA_NGET0165	Transformer Rating Modelling Tool Enhancement	Oxford Computer Consultants, Southampton Dielectric Consultants, University of Southampton
NIA_NGET0166	VSC-HVDC Model Validation and Improvement (iCASE)	The University Of Manchester
NIA_NGET0168	A New Independent Methodology For P&C Coordination Studies Using Real Time Digital Simulation	Birmingham University
NIA_NGET0171	EPRI Research Collaboration on Electric and Magnetic Fields Health and Safety	EPRI
NIA_NGET0172	EPRI Research Collaboration on Substations	EPRI
NIA_NGET0173	EPRI Research Collaboration on Overhead Transmission Lines Project	EPRI
NIA_NGET0176	Feasibility study on the application of advanced materials	The University Of Manchester
NIA_NGET0178	Environmental Containment solutions for Midel 7131	WSP-PB, Adler and Allen
NIA_NGET0179	Travelling Wave Fault Locator Trial	Qualitrol
NIA_NGET0180	EPRI Research Collaboration on Electric & Magnetic Fields Health & Safety (P60) 2016	EPRI
NIA_NGET0181	Classification of Wind Exposed Overhead line Spans	Digital Engineering
NIA_NGET0182	Feasibility study on suitability of protection policy for future energy scenarios	The University Of Manchester, Quanta Technology
NIA_NGET0184	Identify opportunities and developments in EMF Research (2016-2018)	Formex Archive Services Ltd, Torrance Ltd, Market Opinion Research Ltd
NIA_NGET0185	Investigation of transient and safety issues in gas insulated systems	Cardiff University
NIA_NGET0186	Condition Monitoring of Circuit Breakers - iCASE	University Of Liverpool
NIA_NGET0189	Security Assessment of Industrial Control Systems (ICS)	The University Of Birmingham
NIA_NGET0190	EPRI Research Collaboration on Cyber Security 2016 (P183)	EPRI
NIA_NGET0191	EPRI Research Collaboration on Grid Planning (P 40)	EPRI
NIA_NGET0194	Detailed design of 400 kV 240MVA Mobile Substation Bay	Abb Ltd (Alliance)
NIA_NGET0195	EPRI Research Collaboration on Substations 2016 (P37)	EPRI
NIA_NGET0196	EPRI Research Collaboration on Overhead Lines 2016 (P35)	EPRI
NIA_NGET0197	Development of fittings analysis model	Amey Owr Ltd
NIA_NGET0198	Cost effective removal of conductor crossing clearance constraints	Jacobs U.K. Limited
NIA_NGET0199	Alternatives to SF6 for retro-filling existing equipment	The University Of Manchester
NIA_NGET0200	Study into the Concept of High Impact, Low Probability Events	The University of Oxford, Strathclyde University, EA Technology, and Ernst & Young (EY)
NIA_NGET0201	Portable Earthing Device	Aldercote Limited
NIA_NGET0202	Development of a Universal Bushing	BTRAC
NIA_NGET0203	Novel acoustic attenuation feasibility study	WSP Environmental Ltd
NIA_NGET0204	Frequency Response Analysis for Transformer Characterisation and Objective Interpretation of Results	The University Of Manchester

Project reference	Project name	Partners
NIA_NGET0206	Novel methodology for assessing environmental exposure of OHL routes	Digital Engineering
NIA_NGET0207	Development of Tools for the Assessment and Control of Impressed Voltage	P&B Weir Electrical
NIA_NGET0208	EPRI Research Collaboration on Electric & Magnetic Fields Health & Safety (P60) 2017 -2021	EPRI
NIA_NGET0209	EPRI Research Collaboration on Overhead Lines (P35) 2017	EPRI
NIA_NGET0210	EPRI Research Collaboration on Substations (P37) 2017 - 2020	EPRI
NIA_NGET0211	Controllable Series Impedance at 275 and 400kV (CSI)	Smart Wire Grid Inc
NIA_NGET0212	Positioning ballistic screening on substation sites	none - project never started
NIA_NGET0213	Condition and Climatic Environment for Power Transformers (ConCEPT)	University Of Southampton
NIA_NGET0214	Transformer and Transformer Oil Life Optimisation and Management Through Analysis and Modelling	The University Of Manchester, University of Southampton
NIA_NGET0215	Automated assessment of steelwork condition using innovative imaging techniques	Nottingham Trent University
NIA_NGTO005	EPRI Research Collaboration on Information and Communication Technology (P161)	EPRI
NIA_NGTO007	EPRI Research Collaboration on Electric Transportation (P18)	EPRI
NIA_NGTO001	Electric Road System for Dynamic Charging of Electric Vehicles	Cardiff University
NIA_NGTO002	Long Term Stability of Alternative Gases	Cardiff University
NIA_NGTO006	Automated identification of failures in HV assets	University of Manchester
NIA_NGTO003	EPRI Research Collaboration on Overhead Lines (P35) 2018-2021	EPRI
NIA_NGTO0031	Feasibility study in to unlocking flexibility within UK Steel Works	Cardiff University
NIA_NGTO008	The FMEA Studies and Risk-based Maintenance for Emerging Power Electronics Assets within GB Power Networks	The University Of Manchester
NIA_NGTO009	Electrical Characterisation of Silicone Oil (ECOSO)	Unviersity of Manchester
NIA_NGTO010	Liquids for cable sealing ends (LiCaSE)	University Of Southampton
NIA_NGTO011	Energy Highways	BMT Defence Services
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 analysis 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	UnlockingTransmission 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 Geo Grid	Cardiff University
NIA_NGTO028	EPRI Research Collaboration on Underground Transmission (P36+ P34 part) 2018 - 2021	EPRI
NIA_NGTO029	Assessment of Wireless Technologies in a Substaion Environment	Affini
NIA_NGTO030	Overload Rotation to Increase Capacity of Transmission Boundaries	The University Of Manchester
NIA_NGTO032	Novel O-ring Designs (NORD)	Cardiff University

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.

We invite you to get in touch via e-mail: box.NGETInnovation@nationalgrid.com

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