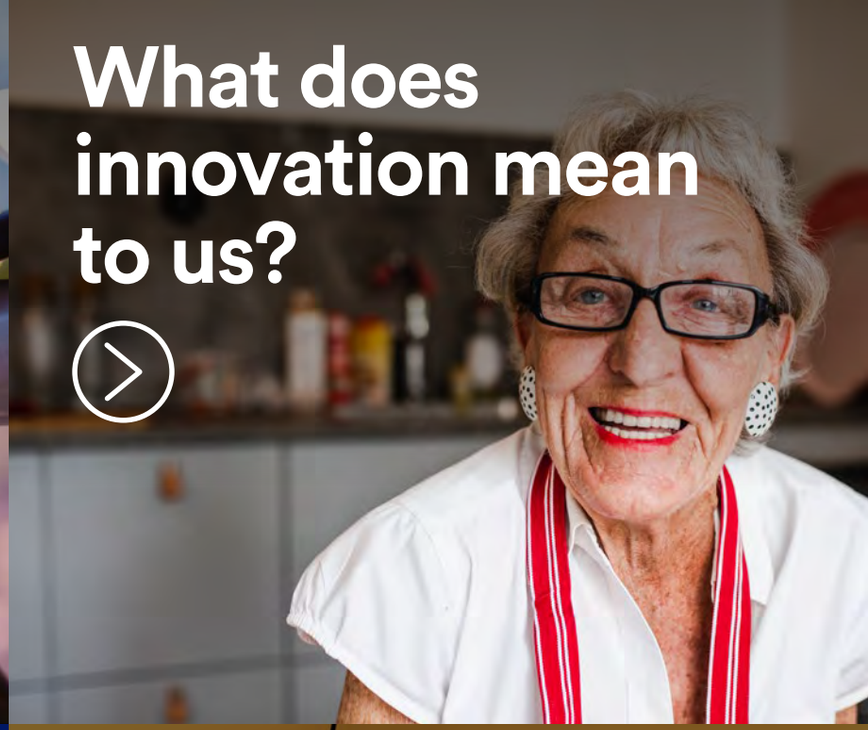
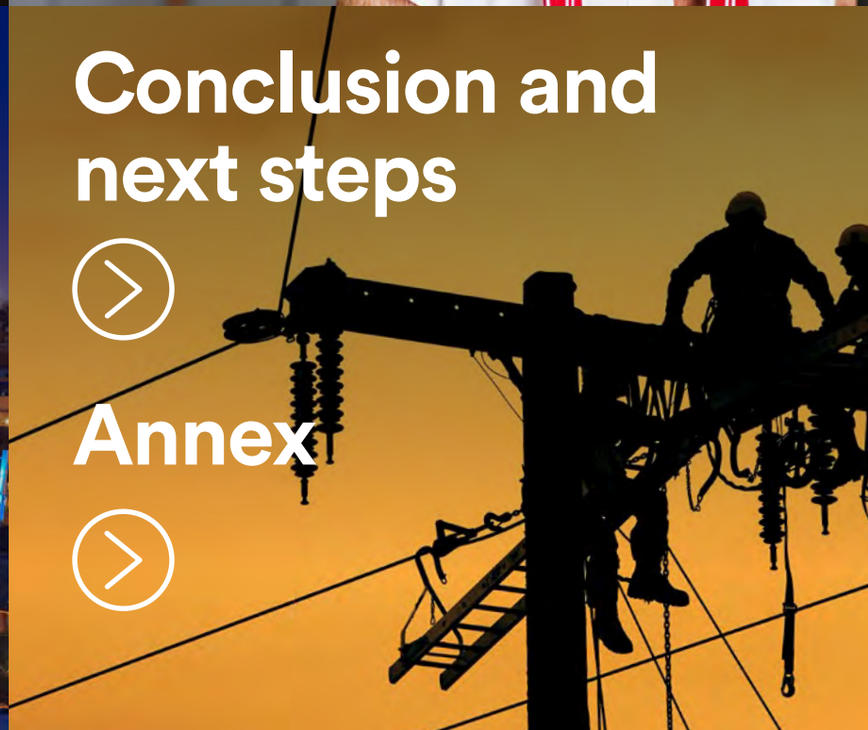
Innovation strategy
ED1 refresh

Dec 2020 >





This document updates our innovation strategy that we laid out in 2014 before the start of RIIO-ED1 (April 2015). It should be read in the context of that document.

Our innovation priorities are decarbonisation, reliability and value for money within a balanced portfolio.

Foreword

In our ED1 business plan we made a commitment to deliver more for less: to improve outputs and reduce costs in every key area. It would not be possible for us to achieve this if we did not continue to find new ways of improving performance and, in some cases, solving problems that we do not yet know that we will face. Delivery on all of our output targets depends to some level on innovation.

We have a strong track record of finding and deploying innovations that enable this and we are confident that the routines that we have in place to challenge our standards, our designs, our procurement contracts and our delivery teams will continue to drive the innovation necessary to keep delivering an efficient service.

Innovation is about improving service we provide as a business, finding ways to be more efficient and productive, or developing the services we offer to meet changing demands on our electricity network and the energy system. As we head towards the close of this regulatory period, it is clear that some of the drivers and pressures on our business are constant, whereas others have evolved since we published our previous strategy.

The previous strategy from 2014 concentrated on four themes: creating a smarter powergrid, smart meters, web services and affordability.

Since then, the transformation that our industry is facing has driven a shift in our focus. Facilitating decarbonisation has become an ever more prominent part of the service we provide in light of the Government's commitment for the country to achieve net zero carbon emissions by 2050. Digital technology – an everyday part of the way we live today – makes data and digitalisation integral to how we provide that service. This is driving our innovation priorities to ensure that we remain responsive to emerging challenges and opportunities as the low carbon, digitalised world evolves, whilst ensuring that during this transition our services remain reliable and affordable for customers. These key areas of interest have been developed in line with our stakeholders' views and priorities.

Digital technology – an everyday part of the way we live today – makes data and digitalisation integral to how we provide that service.

Foreword

As a result, our refreshed strategy is designed to focus our attention on the most pressing challenges that we expect to face for the remainder of the ED1 period, whilst looking to our next regulatory period starting in 2023, RIIO-ED2. We are in the process of writing our ED2 business plan so have an eye on the longer-term challenges that our innovation activities must respond to, alongside what our regulator Ofgem is expecting us to focus on in the next price control period.

This document aims to set out the broader direction of our refreshed strategy for 2021-23, whilst giving us the opportunity to consult with stakeholders on our plans to help to shape and refine the strategy we will put forward in our ED2 business plan.

The principal audiences of our innovation strategy are:

— current and potential partners (e.g. local authorities, energy companies, community groups and other infrastructure providers) and both current and potential suppliers, for them to understand opportunities to collaborate with us on innovation projects;

— our regulator Ofgem, to meet our licence obligation;

— our colleagues, acting as guidance in planning our innovation programme; and

— all of our other external stakeholders, including direct and indirect customers, and other members of the public.

We are in the process of writing our ED2 business plan so have an eye on the longer-term challenges that our innovation activities must respond to...

Our innovation focus at a glance

Decarbonisation

A low carbon energy system

Decarbonisation is a critical priority for society. The risk of not acting is very high. We have a clear long-term objective and, while the exact pathway to meet it is uncertain, certain key attributes are understood.

— Electrification will be a key part of any route to decarbonising.

— Activities that generate flexibility and option value are likely to be particularly beneficial.

— Data and digitalisation underpin efficient decarbonisation of the energy system. We need innovative ways to capitalise on the value of this information for our customers.

Reliability and resilience

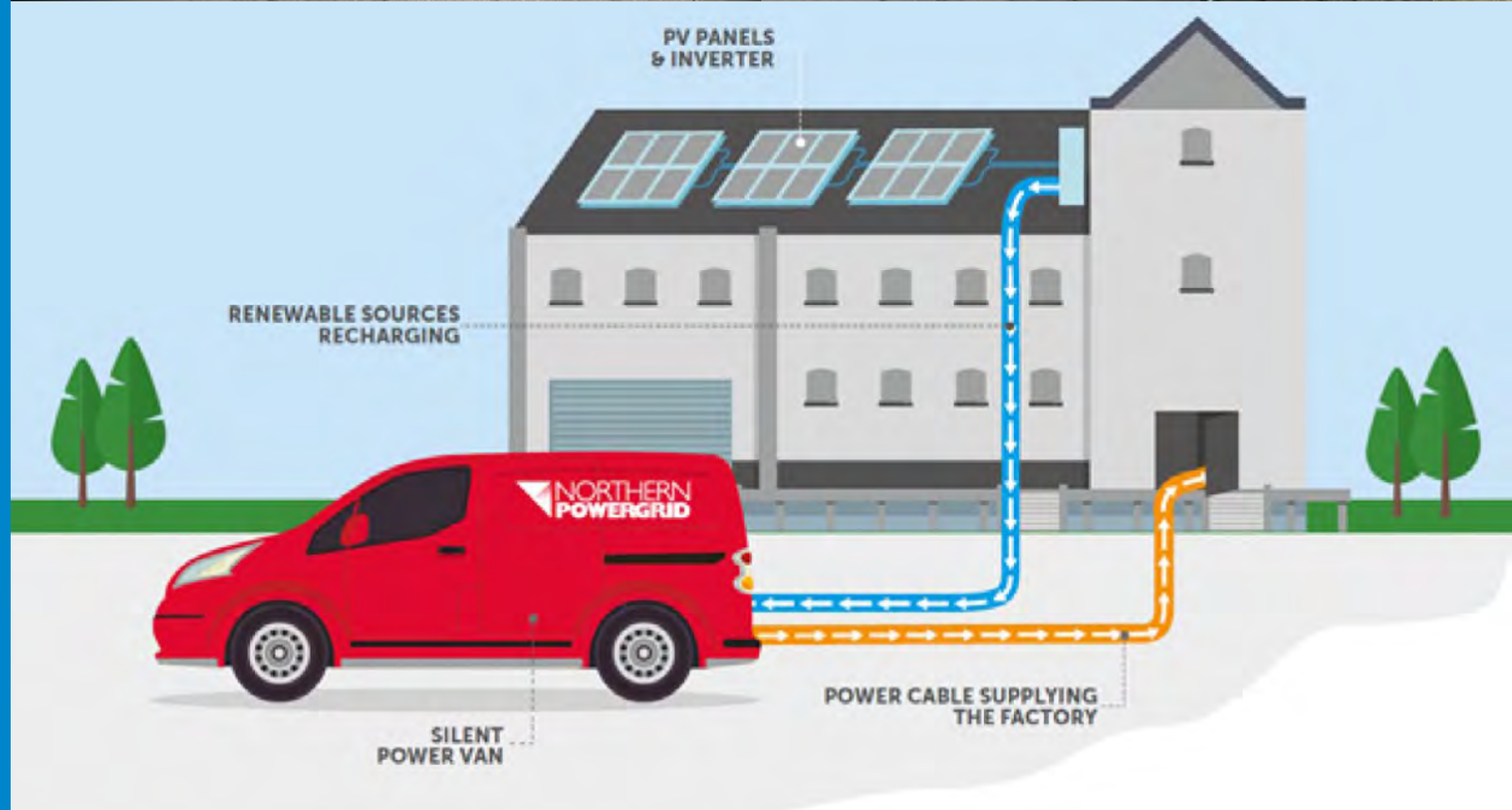
A dependable energy system

Reliability of our day-to-day service is a stakeholder priority – especially for our vulnerable customers.

— It is ever-more important in an energy system more reliant on electricity as carbon fuels are phased out.

— Increased dependability of our electricity system must mirror our increased dependance on it for a successful energy system transition.

— Building on the successes of the recent years, we must continue to improve reliability while we make the network net zero ready.



Value for money

An affordable and fair energy system

The low carbon transition will cost money. We need to make sure that this is as cost-effective as possible for our customers and does not unfairly disadvantage vulnerable customers or those on low incomes.

— Seeking efficiency is a key driver of innovation in all areas of our business.

— Using new technology and techniques to enhance productivity is central to sustainable cost control.

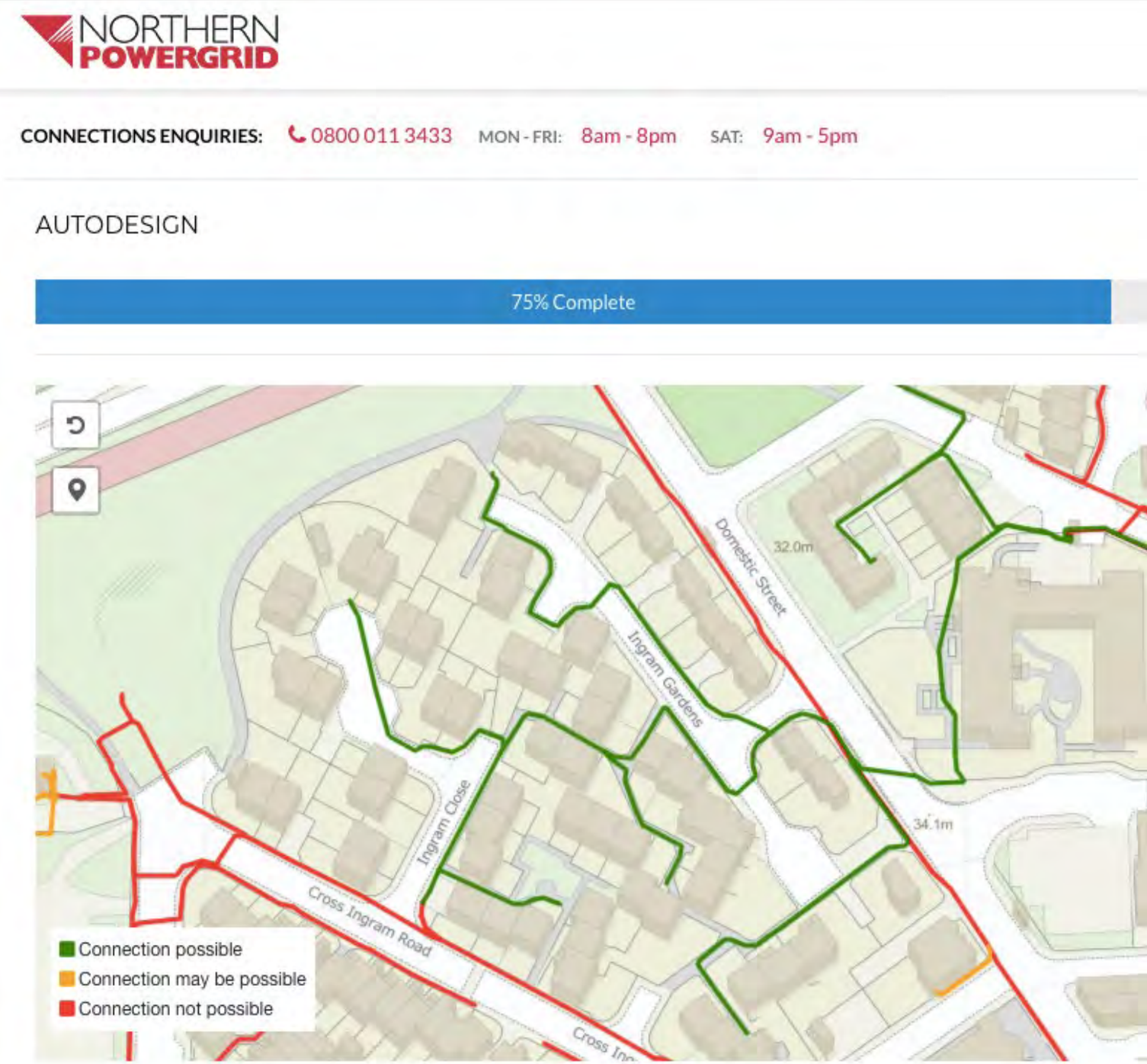
— In particular, data and digitalisation technologies have already improved costs, and service, in this regulatory period and this will only grow.

Digitalisation is a key enabler for each of our three innovation priorities

As we publish this latest version of our innovation strategy, we have published a Digitalisation Strategy and Action Plan in parallel.

The Digitalisation Strategy and Action Plan is a set of options that reflect the ambition of the business and that should enable the delivery of our ambitions though the 2020s. As you will see in that action plan, we have a great deal of detail in each of the initiatives that will allow us to refine them down as we get closer to delivery of our business plans. This will allow us to focus on a smaller selection of the most impactful and relevant digital ideas, enabling the greatest consumer value and aligned to the wider need of the business, particularly innovation.

Our digital delivery propositions will come in due course. We already know there is a 'baseline' set of initiatives that represent the work we know we need to do to simply meet our most basic objectives. As we develop beyond these propositions, however, we will continue to do so with engagement from our stakeholders, consumer panels, technical specialists and our regulator, all of whom have had significant input into the Digitalisation Strategy and Action Plan as it stands today. By engaging in this way, we have been able to hone our propositions to ensure they meet the expectations of those who consume our services, who ensure we are doing so in line with regulations and who have the ability to challenge us to be the best we can be. We do so fully embracing a digital world, enriched by high quality data and new techniques.



What does innovation mean to us?

What does innovation mean to us?

We define innovation as the process of improving the quality, performance, value and range of our services to our customers. This involves identifying challenges and opportunities, and collaborating with stakeholders to seek solutions through new or different approaches to how we do things.

As an electricity distribution business, our regulatory and funding context means that innovation for us is typically focused on later stage innovation and evolutionary development, rather than more risky revolutionary innovation that might be appropriate in a cutting edge technology company.

Innovation benefits are of course only realised when the solutions and learning from innovation are rolled out. Therefore, it is not just learning new techniques or developing new tools, but the process of improving our services offered to customers and communities and reducing the cost of those services.

Innovation is embedded in our business. It happens along a continuum, from small incremental changes building continuous improvement, through to larger strategic projects requiring specific investment and management. This is discussed further in the 'How do we put our innovation strategy into action?' section.

Innovation benefits are of course only realised when the solutions and learning from innovation are rolled out.

We also produce benefits for our customers by learning from innovation projects from outside our company and outside our industry and implementing others' good ideas.

What does innovation mean to us?

Our challenges: why do we need to innovate?
We provide an essential service to the customers and communities in which we operate. Innovation has always enabled us to make incremental improvements to this service and what that service costs.

Since the beginning of the ED1 period in 2015, innovation has facilitated:

£23m
an estimated £23m of total cost savings so far, including the managed connections offered to generators, which saved our customers £14m of connection costs.

420k
around 420k customer interruptions and 18m customer minutes lost prevented by the high voltage automatic power system restoration and low voltage fuse technology programmes, a reduction of around 3% in power outages.

4GW
of capacity made available for domestic generation without the need for reinforcement.

CO_2
a reduction in CO_2 emissions associated with our direct operations, mainly vehicle fleet, of 276t.

24,750
litres of oil prevented from escaping into the environment.

What does innovation mean to us?

Faced with decarbonisation, the electricity networks, and the wider energy and transport sector, are all undergoing their most significant transformation in decades. This presents a significant challenge and opportunity for our business.

We want to lead by example in this area. To facilitate society to meet the net zero target, we need to understand changing customers' requirements of our services, and we need to develop our capability to meet those requirements accordingly. These changes are driven by growing low carbon demand and generation due to the move to power more of our energy and transport requirements with electricity. Additionally there is an increasing realisation that an understanding of energy use patterns may be useful to society as a whole; for example, in wider urban or transport planning.

We are central to facilitating whole-system decarbonisation. As we become more dependent on electrical energy as part of this transformation, the capacity, reliability and resilience of the electrical network becomes increasingly important. We will need innovative solutions to build on our existing service levels to successfully transition to a low carbon energy system.

This transformation will cost money and impact customers in different ways. We need innovative solutions to facilitate this decarbonisation of our energy system and the provision of energy data services as cost-effectively as possible and to provide new income streams to those who can assist us in this transformation. We want to ensure that this transition is accessible to all of our customers and does not disproportionately disadvantage our most vulnerable customers. Driving productivity and controlling costs is a critical part of this.

Innovation is the process of improving the quality, performance, value and range of our services to our customers.

What does innovation mean to us?

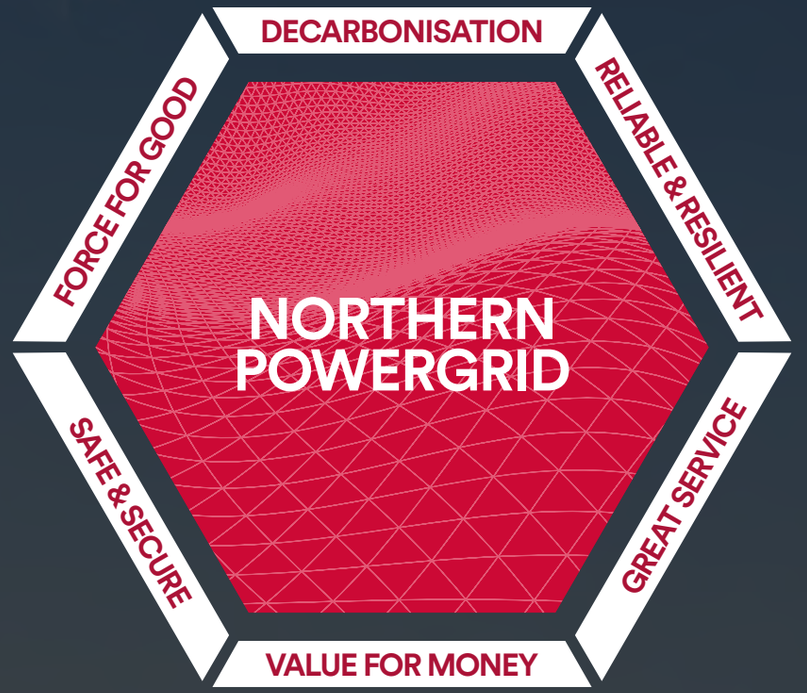
Our goals: what are we aiming for through innovation?
Innovation has long been core to achieving our objectives. It has been the force behind delivering improvements in safety, reliability, customer service and cost gained since privatisation. To date in ED1 several key innovation projects have had a transformational effect on the way we do business, including AutoDesign, which allows customers to instantly design their own connections for free as opposed to the previous practice of paying for a ten-day service (see Annex 1).

In September 2020 we published our Emerging Thinking on our ED2 business plan. In this, we launched our company vision that puts innovation at the heart of how we will seek to achieve our objectives; a vision derived from what we have heard are the highest priorities for our stakeholders, aligned with what we want to achieve as a company.

Our vision is to power our region with sustainable, long-term investments that unleash the potential of **innovation,** information, our people and collaboration to:

— lead the drive towards decarbonisation
— operate a highly reliable and resilient network
— delight our customers with outstanding service
— provide remarkable value for money
— ensure world-class levels of safety and security, and
— be a force for good throughout our region and beyond.

In this vision, innovation is a cross-cutting enabler, which we see as essential to enabling us to achieve all of the six key elements, and we aim through innovation to progress all of these elements to some extent.



What is our innovation strategy?

It is clear in our vision that we seek to innovate across all areas of our business and know that there will be benefits to our customers in all areas. But the most pressing need, and the greatest opportunity for benefits, is in three distinct areas.

What is our innovation strategy?

Our innovation strategy prioritises decarbonisation, reliability and value for money within a balanced portfolio.

1 Decarbonisation

A low carbon energy system

There are many unknowns regarding how decarbonisation will unfold. Therefore, the opportunities for adding value through innovation – and the risks posed by not doing so – are high.

In terms of energy demand, achieving net zero requires decarbonisation of electricity, heat and transport. For us, that includes both decarbonising our own operations and facilitating the decarbonisation of the energy sector as a whole.

We will decarbonise our own operations by simple deployment of new technologies such as electric vehicles in our fleet, and through low carbon alternatives to mobile generation such as SilentPower, our lithium battery based mobile microgrid.

More importantly, however, we will facilitate the wider decarbonisation of our customers' energy use. Energy supply is likely to change from predominantly large, centralised power station production to more locally generated, renewable production, such as wind and solar energy. We need to make sure that our network is optimised to manage these shifts in traditional supply and demand patterns.

Central to this facilitation is our future role as a Distribution System Operator (DSO), which is key to a decarbonised whole energy system. To ensure that our customers are able to extract the maximum value from existing network assets, our innovation programme around decarbonisation will focus on ensuring that every kilowatt-hour of green energy is used efficiently, by developing a flexible, decentralised network in which customers can be engaged with their energy usage and generation. You can read more about our plans, work to date in this area and how we have been engaging with our stakeholders in our Distribution System Operator Transition Plan v1.1[1].

Data and digitalisation are integral to our DSO plans and our wider decarbonisation efforts.

They underpin effective and efficient decarbonisation. We need innovative ways to release the value of the information about our network for our customers.

Preparing our network for decarbonisation requires collaboration across our industry, continuing the successful partnerships we have made over ED1 including autonomous energy network control systems with Smarter Grid Solutions, generator alternatives with HyperDrive, and better understanding of the DSO proposition with Imperial College, Bath University and Newcastle University through our Customer Led Distribution System project.

[1]Ref DSO v1.1

What is our innovation strategy?

Our innovation strategy prioritises decarbonisation, reliability and value for money within a balanced portfolio.

2
Reliability and resilience
A dependable energy system

Reliability of our day-to-day service continues to be a top stakeholder priority and is ever-more important in an energy system more reliant on electricity. For the energy system transition to be successful, customers must be able to rely on electricity as it becomes an ever-more critical energy vector. This is especially true for our vulnerable customers.

We need to maintain and continue to improve reliability whilst making the network net zero ready. This will include both evolutionary "business as usual" improvements and more revolutionary innovative thinking on how the energy system might run in a decarbonised world. Much of this will be technical improvement, but it is not limited to this; evolving commercial arrangements and data flows to support flexibility will also be needed to optimise the reliability of the network.

3
Value for money
An affordable and fair energy system

We need to make sure that the energy system transition is as cost-effective as possible for our customers and does not unfairly disadvantage vulnerable customers or those on low incomes.

We can only facilitate the bulk of the transition and, to ensure that customers willingly take the opportunity to decarbonise, we must aim to do so at the lowest cost to consumers. As well as finding better ways to deliver the appropriate decarbonisation outputs, we are committed to continuing to find ways to keep general downward pressure on the costs of doing business. We will continue to look for both commercial and technological innovations that lower the cost of working on our assets or running our business support functions.

Balancing the priorities

These three priority areas that make up our innovation strategy are heavily interlinked; en route to decarbonisation we must remain reliable and affordable for customers to succeed in a socially inclusive transition that does not leave anyone behind.

The nature of innovation activity is that we do not necessarily know the outcomes when we embark on a new project. It's therefore part of our innovation routines that we continually review our portfolio in order to create the best impact.

How do we put our innovation strategy into action?

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We create a culture where innovation is part of how we operate.

The majority of our innovation is small projects embedded throughout the business, with some larger strategic projects driving transformational change. Innovation starts with the tone at the top, with colleagues at all levels empowered to identify opportunities where innovation could drive improvement.

We have a dedicated innovation team that supports teams across the business to pursue innovation projects and implement changes that result from them. Whilst all colleagues contribute routinely to continuous improvement and business as usual development innovation, a more formal structure is in place for project-level innovation activity.

A dedicated central innovation team ensures that managers of individual innovation projects are receiving support from the wider business and that they are delivering innovation projects in line with regulatory expectations.

A subset of directors accountable for ongoing innovation projects meets monthly to review progress.

Project managers and their teams address the day-to-day management of innovation projects. Project managers are drawn from relevant parts of the business so that adopting innovation benefits is a smoother process.

Our Innovation Advisory Board provides oversight and strategic direction at an innovation portfolio level. This cross-functional team has oversight of the concept, mobilisation, implementation and transfer to business as usual of innovation projects. Individual directors sponsor and provide resource to projects that will potentially improve their business area.

How do we put our innovation strategy into action?

We collaborate with stakeholders and external parties.

We believe a collaborative approach is vital to successful innovation – outside knowledge and expertise are essential for new perspective and improvement. Our role in collaborations varies:

- We lead some projects directly relating to our network; for example, MicroResilience[2], developing the use of microgrids based on our assets that provide resilience to faults.
- We support other DNOs with external third parties providing knowledge and expertise; for example, GenDrive[3] and Reliability as a Service[4] .
- We play a supporting role on projects that relate directly to the use of our network, e.g. Nissan's e4Future project[5], examining the commercial offering for vehicle to grid.

In the wider business we continuously undertake extensive stakeholder engagement and in particular we are in the process of engaging with our consumers, businesses and technical experts on our ED2 plans. We are always listening for problems identified that innovation could address, or for ideas from stakeholders that could spark an innovation project.

We have worked with leading research agencies and engagement experts within and beyond utilities to ensure a best practice approach to our engagement to give a robust, representative outcome. An experienced, independent research agency has been commissioned to review our prioritisation research over the last five years, helping us to understand trends over time, as well as emerging priorities, to inform future engagement.

[2]This NIA funded project aims to keep our connections to customers' houses on even when our higher voltage networks are off. This is part of the switch in focus from a 1950s grid-centred view of electricity to a modern customer-focused view.

[3]This InnovateUK funded project aims to explore the potential through gamification to offer a novel method to engage V2G (Vehicle to Grid) consumers.

[4]This NIC funded project examines the potential for buying battery-based wide-area reliability services from third party providers as an alternative to internal provision.

[5]This InnovateUK funded project tests and demonstrates how storing and sharing electricity in vehicles' batteries can generate additional revenue for participant companies as well as supporting the power grid.

How do we put our innovation strategy into action?

We invest in innovation through both routine expenditure and specific regulatory allowances.

Internally funded
As a regulated business, our funding is agreed by our regulator Ofgem through the price control process. As innovation is integral to our culture, this means that it can be funded through incremental spending, driving cost efficiencies that enable us to allocate funds to small-scale innovation projects.

An example of a project funded through our cost base is our second-generation Geographic Information System (GIS) electronic records system, eAM Spatial. In addition to the operational benefits of the improved availability of electronic records and a single data source covering both the asset register and the geographic location of our equipment, this has provided the backbone on which developments such as AutoDesign can be built offering a faster, cheaper and improved connections service.

We expect this type of innovation funding to be a really significant part of the type of innovation that we undertake during ED2.

Network Innovation Allowance (NIA)
The NIA was introduced by Ofgem in ED1 to encourage innovation sharing between DNOs. As part of the ED1 price control we were awarded 0.6% of our revenue as funding for NIA projects – a specific regulatory allowance on top of our total expenditure for more uncertain innovation projects.

An example of an NIA project that we have undertaken in ED1 to date is the Distributed Storage and Solar Study. This showed that co-locating solar generation and storage in domestic properties could provide a financial benefit to residents of those properties and simultaneously allow a concentrated deployment of generation and storage in an area without the need for reinforcement.

We expect NIA funding to continue in ED2. We are interested in our stakeholders' thoughts on potential NIA projects and innovation priorities for this funding area for the remainder of ED1 and going into ED2.

How do we put our innovation strategy into action?

We invest in innovation through both routine expenditure and specific regulatory allowances.

Competitive bids

A further source of innovation funding is through competitive bids for projects through the Network Innovation Competition (NIC), also provided by Ofgem. The NIC is designed to support larger projects closer to normal business as usual deployment through their final development, as opposed to the smaller projects slightly earlier in their development that NIA might support. Generally, NIC projects are expected to build on earlier NIA work. Throughout ED1 to date, we have participated successfully in competitive bids for NIC funding and through InnovateUK (the UK Government's innovation agency).

An example of a competitive bid project that we have participated in is e4Future, our bid with Nissan to InnovateUK. The e4Future project is examining the commercial potential of electric vehicles to provide network services to the distribution and transmission networks.

Looking to the longer term, a similar competitive bid fund is expected to be in place for ED2, called the Strategic Innovation Fund (SIF). We are interested in our stakeholders' views on what types of project we could seek funding for through a competitive process.

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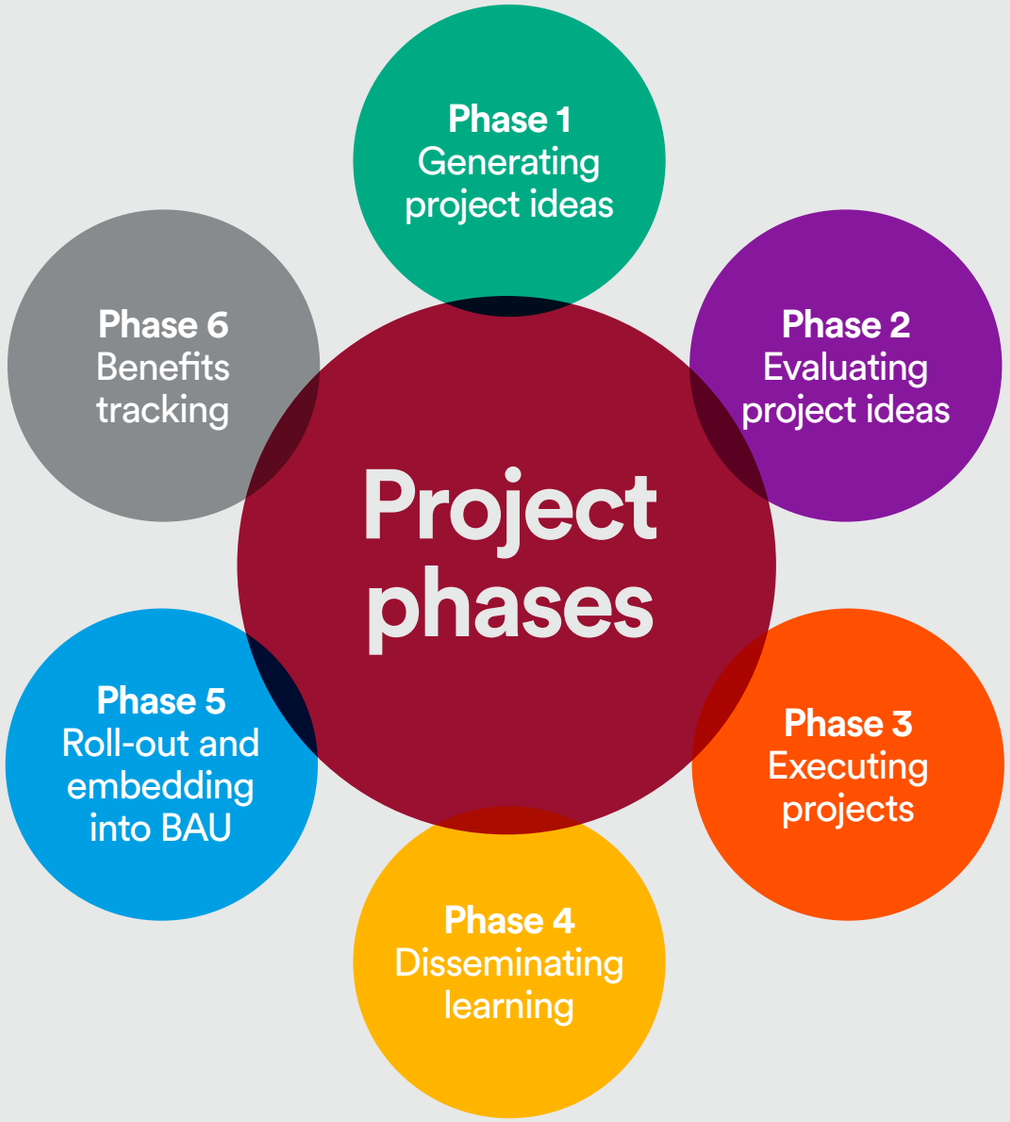
How do we put our innovation strategy into action?

Throughout the innovation project lifecycle we are focused on the performance benefits and value for money improvement. The way we undertake each stage is designed to maintain that focus.



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Project description

- Project proposals come about as a result of:
  - seeking to solve a problem that has been identified
  - third parties seeking funding and collaboration opportunities
  - building on earlier innovation projects (of our own or other parties).
- Sources of proposals include: research projects; other parties' innovation projects; suggestions from internal and external stakeholders; scientific papers; and benchmarking activities.
- "Horizon scanning" enables us to identify developments elsewhere in our industry and beyond the energy sector.
- We share information with other companies in our ownership structure on issues and solutions other network companies are facing through the group-wide Grid Innovation Collaborative.

How do we put our innovation strategy into action?

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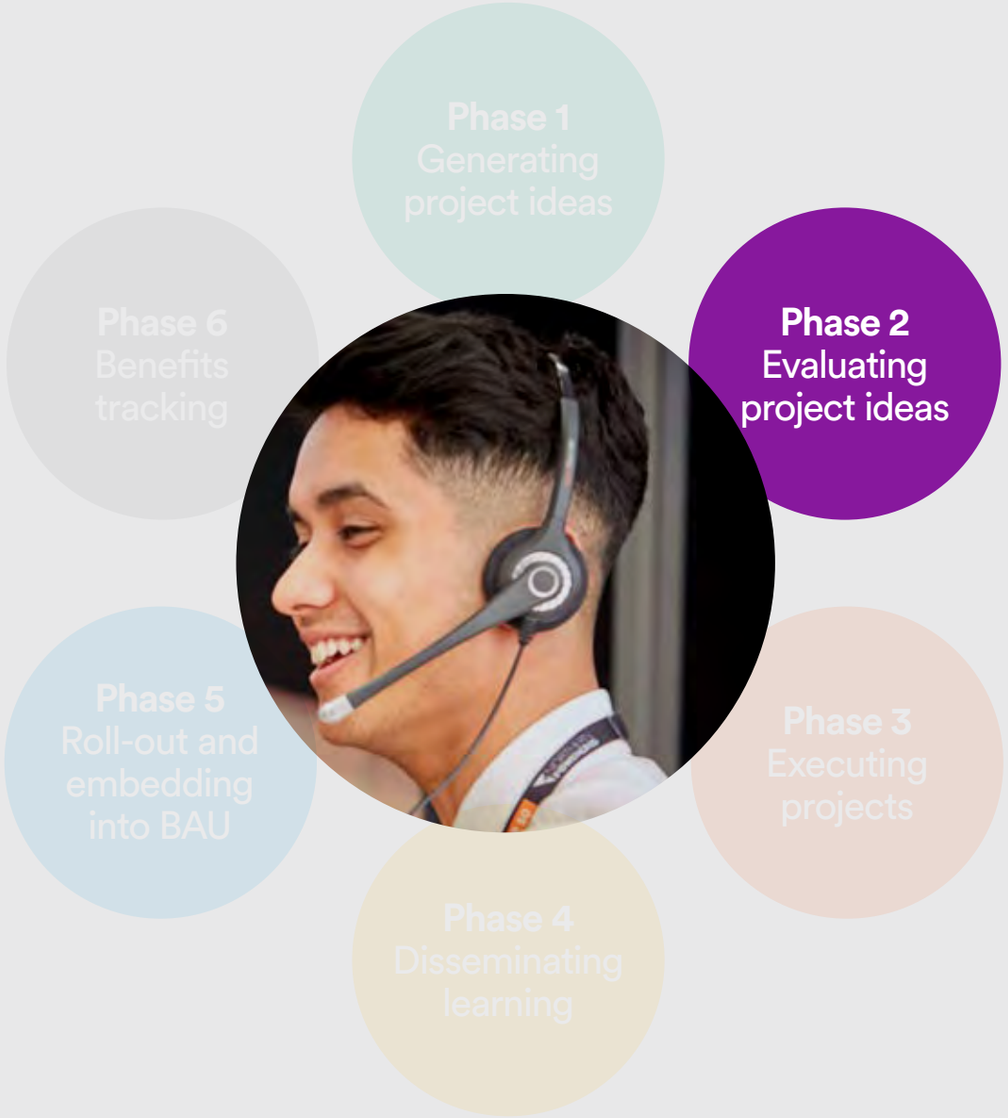


Project description

- Assessing a possible project includes determining whether it is strategically aligned with our company vision, investment appraisal and risk assessment.
- Evaluation is undertaken at a level commensurate with the scale of the project, with Board level evaluation for larger projects.
- Any project or programme that we intend to implement in our business plan is subject to rigorous scrutiny and appraisal to ensure that the expenditure is justified. Our established appraisal process has distinguished us as one of the most efficient businesses in our sector, and this process ensures our customers and stakeholders get the best value for money from our innovation activities.

How do we put our innovation strategy into action?

Throughout the innovation project lifecycle we are focused on the performance benefits and value for money improvement. The way we undertake each stage is designed to maintain that focus.

Project description

- Delivery partners are frequently identified as part of the project generation phase. Examples include academic institutions, other network operators, and manufacturers.
- They are formally incorporated into the project via our authorisation and tendering process at the beginning of the execution phase.
- Smaller projects are managed by one individual as part of their general workload whilst larger projects involve a project team and project board structure. All projects have a responsible senior manager and executive sponsor.
- Project managers, teams and sponsoring managers and directors are drawn from across the business. While earlier stage projects are generally looked after by the innovation team, projects that end with a product ready to roll out are managed by the business area that will change its working practices as a result; these are the people who see the benefits in business as usual (BAU) roll-out.

How do we put our innovation strategy into action?

Throughout the innovation project lifecycle we are focused on the performance benefits and value for money improvement. The way we undertake each stage is designed to maintain that focus.

Project description

— Dissemination is a key part of the innovation process. It includes sharing learnings with employees and internal stakeholders through internal communications initiatives.

— There is a formalised sharing process with peers via the NIA to ensure that investment in innovation is efficient across our industry so that all consumers across GB can reap the benefits of innovation funded through this mechanism.

How do we put our innovation strategy into action?

Throughout the innovation project lifecycle we are focused on the performance benefits and value for money improvement. The way we undertake each stage is designed to maintain that focus.

Project description

— At this stage we define business benefits that we expect to gain from the innovation project.

— We identify business benefit owners responsible for making sure these benefits of the innovation project are rolled out.

— We provide training on technical standards and other developments, e.g. IT changes implemented through innovation to ensure that staff members are equipped to realise the benefits of innovation.

How do we put our innovation strategy into action?

Throughout the innovation project lifecycle we are focused on the performance benefits and value for money improvement. The way we undertake each stage is designed to maintain that focus.

Project description

- Benefits are tracked and monitored against a benefits realisation plan.
- For externally facing innovations, stakeholder feedback, including suggestions for improvement, forms part of the benefits tracking.
- Post-implementation reviews are carried out by the innovation team after project close. For general business improvements, it is expected that benefits are captured within 3-6 months, whereas for some longer-term innovation projects, e.g. those associated with energy system transition, the post implementation review might require iterative updates for a longer period of time. This period and those responsible for undertaking the review are defined in the closure of the rollout project.

Conclusions and next steps

Conclusions and next steps

Our innovation strategy is designed to tackle the most significant issues facing our sector and related sectors now, for the remaining years of ED1, and into the 2020s as we prepare for ED2.

We have the right culture and systems in place to make sure that innovation is integral to how we operate, so that customers can reap the benefits from our innovation investment in terms of the service they receive and what it costs.

This document is intended simply to update our strategy for the remainder of the ED1 period (i.e. until March 2023) – but given we are deep into the planning process for our ED2 plan (for April 2023-March 2028), we want to make the most of the opportunity to seek stakeholder feedback on this strategy with an eye on the longer-term impact of innovation.

In the summer, we set out our Emerging Thinking for ED2[6] in the context of our evolving views on the 2023-28 period. Early in the new year, we will set out our views on how innovation is directly affected by that.

We are interested in stakeholders' views and invite comment in answer to the following questions, which will influence that document:

- Do you agree that our innovation strategy is focused in the right areas?
- What should our ED2 innovation strategy focus on?
- How can we improve our collaboration to get the most out of innovation opportunities?
- What is the balance we should strike between facilitating and driving decarbonisation and the energy system transition?
- What else would you like to see in our ED2 innovation strategy?
- Have we missed anything fundamental?

We have the right culture and systems in place to make sure that innovation is integral to how we operate...

[6]https://engage.northernpowergrid.com/documents/

Our portfolio of key current and recent innovation projects and activities.

Annex

AutoDesign

The headlines

The UK transport sector is predicting significant growth in electric vehicle (EV) sales in the near future, with 36 million expected on UK roads by 2040[1]. Distributed Network Operators (DNOs) are responsible for facilitating the charging infrastructure and grid capacity to enable this growth.

Until now, the process of approval for new low voltage grid connections like EV chargers could take up to ten days with a cost to the customer of up to £150 per application, stretching the capacity of Northern Powergrid's engineering resources over relatively routine design work. The AutoDesign project was born out of a need to accelerate this process, provide better customer service, and enable the rapid deployment of electric vehicle chargers.

AutoDesign is a free online tool that will help users identify the most cost-effective locations on the Low Voltage network for new charging point locations using a red/amber/green indication signal, and provide an indicative connections quote in a matter of minutes. It will save users time and money and Northern Powergrid will benefit from increased engineering capacity to focus on more complex queries.

The tool can actually be used to provide quotes for all small works and we will phase a launch to other sectors (i.e. housebuilders).

[1]National Grid – Future Energy Scenarios

What is it?

Concept
AutoDesign is a free online tool that enables users to identify cost-effective locations for new low voltage grid connections. This can include: EV chargers, heat pumps or new buildings. The tool provides an indicative guide to network capacity and a guideline connections cost in under 10 minutes.

Scale
The AutoDesign tool is able to determine new connection locations across Northern Powergrid's patch of Yorkshire, the North East and northern Lincolnshire, serving all of its 8 million customers.

Partners
Auto Design was produced with extensive stakeholder feedback from local authorities across Northern Powergrid's operational area.

Why are we doing it?

— The UK transport sector is predicting significant growth in electric vehicle (EV) sales in the near future, with National Grid predicting there could be 36 million EVs on UK roads by 2040. It is the responsibility of DNOs to facilitate the deployment of charging infrastructure to support this growth.

— The connections design departments in DNOs are facing unprecedented pressure as customers seek to connect novel new loads. EVs are just one potential connection. With new low-carbon technologies like electric heat pumps, domestic solar PV and domestic energy storage, Northern Powergrid's engineering capacity is stretched across routine design work.

— Enabling the transition to EVs has wide a range of benefits. EV's can provide grid flexibility which will become an important factor in demand-side management and distributed energy storage.

— An increasingly decarbonised and decentralised grid ultimately creates a democratised energy system under which renewable energy is supported and 'flexed' by EVs and energy storage, and results in a fairer, cleaner and cheaper network for all.

— AutoDesign, will both accelerate the transition to a low carbon transport and energy network, and enable Northern Powergrid to better utilise its engineering resources to deliver a superior energy network.

What are we doing?

— Assess the quality of available data and the feasibility of implementing it into the production of the online AutoDesign tool.

— Identify and assess appropriate and efficient algorithms to perform the network assessments of the low voltage network.

— Phased pilot introduction and implementation of tool to internal users: including rolling testing, user feedback, modification and post development.

— Development of fully functional customer friendly tool.

Annex

AutoDesign (continued)

What are the project's key outputs?

- Fast track the planning process and deployment of EV chargers across our region to serve the growing number of EV drivers.
- Empower local authorities by giving them near instant access to knowledge of the most cost-effective charging locations to ensure that the cost of planning proposals are kept to a minimum.
- Ensure that developers are considering charging provisions as part of all their projects and generate a quicker turnaround on planning applications for those provisions.
- Continue to collect data to inform updates, reparations and reinforcement of the low voltage network to account for a growing number of distributed energy assets such as renewable generation, heat pumps and smart two-way chargers.
- Reach net zero carbon targets by overseeing and facilitating the transition to a low carbon transport sector through enabling vital charging infrastructure.

What benefits will consumers see?

- The DNO will ensure that customers who own EVs have their charging needs met across the region.
- By facilitating the widespread adoption of EVs, consumers will benefit from a decarbonised transport system and cleaner air due to the removal of pollution from exhaust fumes.
- EVs can offer benefits in terms of grid flexibility and when utilised effectively, EVs will be a vital resource for demand side management and balancing the local demand and supply of energy across the grid.
- More of Northern Powergrid's engineering resources will be freed up from traditionally time-intensive, routine connections request. This results in more capacity for other network operations which ultimately deliver a safe, reliable and secure network for customers.

What next?

- The AutoDesign project is finished and the fully functional customer friendly tool is complete and available for public use following a launch to Local Authorities for the purpose of EV use, and will be rolled out across 2020 for other small works customers.
- Northern Powergrid and its partners will continue to monitor the AutoDesign tool and underpinning data, and engage with stakeholders about where and how the tool can be improved and updated to account for newly emerging technologies.

Additional materials

The AutoDesign tool can be found here

Annex

Customer-led Distribution System (CLDS)

The headlines

The transition from distribution network operator (DNO) to distribution system operator (DSO) is a complex issue with many possible options and choices for how to deliver it effectively and efficiently. We want to maximise value for our customers and stakeholders.

Identifying the most appropriate way forward that can achieve the best whole system outcome requires advanced understanding of interplays between the operation of markets for energy and for network services, network operation, infrastructure development and the growth of distributed energy resources (DERs).

Throughout this the customer's needs and wishes must remain at the heart of the solution.

What is it?

Concept

Carry out studies and develop tolls to understand distribution system operations from the customer's point of view, and with particular regard to operations at the customer/distributor edge. Establishing methods to best:

- Enable the optimisation of network and Distributed Energy Resources (DERs) (Small scale Generation, EVs, solar panels, domestic battery storage and the like);
- Enable third party providers to realise maximum value of DERs through market-enabled energy and network products; and
- Enable the uncertainty and complexity of the supply system to be substantially reduced by a distributed and coordinated market and network solution.

Scale

NPg have invested £1.8m to test the relative attributes of different structures, the scale and beneficiaries of the value added by DSO solutions, and the electricity network and services required to support customer low carbon uses.

Partners

Northern Powergrid are working with Newcastle University, Bath University, Imperial College London and WSP to progress the various elements of this work.

Why are we doing it?

- To establish the route to a low carbon, low cost energy system for our customers.
- To ensure our DSO position, strategy and transition plan are based on solid evidence.
- To determine how we should develop our investment plans to accommodate changes in customer capabilities, needs and behaviours in the ED2 period, and to reflect this in the DSO and decarbonisation sections of our ED2 business plan.
- To determine how these changes may play out in 2030-2050 in our region and in the North of Tyne area in particular, as a basis for engaging with our stakeholders on decarbonisation to 2050.
- To understand the value to customers of optimisation across the whole electricity system and how we can change our approach to investment planning to deliver that.
- To understand the processes, tools and skills we require to deliver a customer- led distribution system, starting with the delivery of a low carbon planning tool that incorporates the potential of customer participation, and a proposal for an enhanced LCT planning tool that incorporates whole system effects.

What are we doing?

- Develop low voltage (i.e. the 240v network) scenario model with demand flexibility included.
- Whole GB electricity system modelling.
- Understanding how to operate layered distribution systems with operational zones and functionality to optimise network and energy system utilisation.
- Understanding co-ordination between DER markets, networks and energy sectors.

Annex

Customer-led Distribution System (CLDS) (continued)

What are the project's key outputs?

- A study showing the relative value of DSO via energy utilisation improvements and network services optimisation (complete)
  - The potential value on offer via local energy market utilisation is 22 to 63 greater than via network services – Bath University
- A report on possible future industrial structures for the distribution sector that promote an efficient and coordinated and flexible energy system (complete)
- A report on possible market designs and market structures for DER energy products (complete)
- An investment planning tool that takes account of customer flexibility, and a proposal for a tool that also takes account of whole system effects
- Report on co-ordination between distribution networks and the energy sector to inform network operations and investments to optimise whole energy system value
- A report on how the operation of a DER energy market might change DER behaviour and its impact on network operations and on the market for network services to inform the potential for network investment to open up energy markets
- A roadmap of DER growth, market development, infrastructure development and skills, to inform and support the stakeholder engagement
- A case study of DSO and decarbonisation in the North of Tyne region in 2030-50 showing
  - Value for customers
  - Investment and actions needed by the DSO
  - Investment and actions needed by the energy retailer
  - Investment and actions needed by flexibility providers
- Report on value of a Customer-Led Distribution System: how customer participation in new markets in the distribution sector can deliver value for stakeholders, with a focus on value to customers, drawing together all CLDS learning on value
- Dissemination and engagement activities, including close engagement with the Open Networks project so that CLDS can support, enhance and extend the work of the Open Networks project

What benefits will consumers see?

- A new energy system that delivers decarbonisation while keeping bills as low as possible.
- Cheaper roll-out of EVs and more value for home storage and generation.
- Opportunities to optimise their use of energy and sell services back to the energy system.

What next?

- The focus of the project going forward is on how the DSO role may be used to optimise value for our customers in the changing net zero energy system out to 2050.
- It will cover the 'size of the prize' in terms of the value on offer as well as how that may be realised through operation/co- ordination of markets and investment from networks.
- It gives us more insight into the whole energy system value of the actions we need to take to service the requirement of an increasingly flexible system and customers.

Annex

e4Future

The headlines

e4Future brings together the leading players in vehicle to grid (V2G) technology in a large scale demonstration project across representative networks to prove the commercial viability of the technology and identify and solve the practical problems in getting there.

It will unlock the storage equal to a day and a half of GB electricity demand inherent in, and that will have already been paid for by the owners of, electric vehicles by 2040.

This will improve the performance of the electricity system, reduce electricity system costs and provide an extra income stream for energy consumers – also reducing transport costs.

What is it?

Concept

e4Future is a large scale demonstration of vehicle to grid (V2G) technology.

Scale

£10m investment in a network of over 1000 V2G chargers, monitoring equipment and commercial and academic analysis to prove the commercial case for V2G.

- The project is sized so it can demonstrate that V2G can play in the transmission grid services market.
- Chargers will be split between Northern Powergrid's and UK Power Networks' licensed areas, including Heathrow.

Partners

Involving the leading industry players in the elevant sectors: Nissan, Northern Powergrid, Newcastle University, Imperial College, UK Power Networks and National Grid.

Why are we doing it?

- If today's 30m cars were replaced by Nissan LEAFs, then the summation of those 40kWh batteries (a total of 1.2TWh) represents storage equivalent to around a day and a half of GB electrical energy use. Only a quarter of that storage will be used for driving each day (10kWh per car on average miles). It would be almost criminal if we do not find out how to make best use such a resource. We want to enable our customers to realise the value embedded in their vehicles.
- This trial will prove the case for V2G, a technology that we believe has significant potential to unlock this storage to support both transmission grid services (e.g. frequency response and balancing) and also customer demand, particularly in fault or network maintenance conditions.
- This and our own V2G and Silent Power projects are borne out of a strategic partnership between Nissan, the leader in V2G vehicles, and NPg. We are partnering with UKPN on this project because between our two companies we have a mix of networks, customer types and locations that is truly representative of GB.
- The academic partners represent the forefront of EV and flexible network thinking.

What are we doing?

- The trial is split into three phases:
  - 350 chargers for low mileage public and commercial fleets; fast frequency response services
  - 300 chargers for all mileages residential, public and commercial fleets; stacked services
  - 300 chargers for all mileages residential, public and commercial fleets and leased vehicles; stacked services

Annex

e4Future (continued)

What are the project's key outputs?

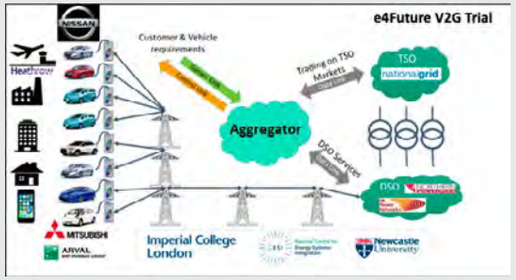
- Proven V2G aggregation methods and protocols for large scale replicable deployment.
- Definition of TSO and DSO services.
- Tested model contracts for V2G income streams for EV owners.
- Tested model contracts for reduced cost EV with V2G lease.
- Definition of the cybersecurity and privacy maintenance requirements.

What benefits will consumers see?

- On successful completion this project will make the commercial case for the mass roll-out of V2G enabled EVs, including addressing the mass communication and cybersecurity issues.
- This will allow electrical motorists to enjoy lower cost car use either via:
  - selling services from a vehicle they own, or
  - lower leasing cost of vehicles supplied with the assumption or V2G participation.
- Longer term the technology will improve the reliability and resilience of electrical supplies to customers and cyber security will be built in from day one.

What next?

- A change of project partner with Eon replacing NUVVE as aggregator means that the project is only kicking off in earnest this month.
- Work this year will be to recruit EV owning fleets to participate in the phase one trial and start to deploy monitoring to collect data on how the commercial incentives change their behaviour.



Annex

InTEGReL (Integrated Transport Electricity and Gas Research Laboratory)

The headlines

InTEGReL is a whole energy system demonstrator collaboration between Northern Gas Networks working Northern Powergrid and Newcastle University, to explore and test new energy technologies, strategies and processes which bring transport, electricity and gas together.

It will lead to a low carbon energy and transport system with lower bills and opportunities for new income streams for customers, while improving resilience of electricity and gas networks and transport systems, and the legacy of a permanent test site to allow SMEs to develop whole energy systems further.

What is it?

Concept

The UK's first combined gas and electricity monitoring and control system to understand how the electricity and gas networks can be co-ordinated and work to support each other.

- A fully integrated whole energy systems development and demonstration facility
- A live, industrial-scale test environment for industry, academia, SMEs and government to explore and test new energy technologies, strategies and processes which bring transport, electricity and gas into one place.

Scale

NPg and NGN have put £700k to initial projects testing the relative attributes of gas and electricity energy storage. This is merely prologue to the £17m investment that Newcastle University are intending to make to develop the site into a permanent energy systems test environment.

Partners

A collaboration between Northern Gas Networks working Northern Powergrid and Newcastle University, in partnership with the EPSRC National Centre for Energy Systems Integration (CESI).

It is on the site of the former gas board research facility in near Gateshead where the work to transition the UK gas network from coal gas to north sea gas was carried out in 60s and 70s.

Why are we doing it?

- To explore the potential for electricity, heat and transport to work together as one system optimising "across vectors", enhancing the resilience of each sector and keeping the total cost of the UK's energy system as low as possible
  - In the UK the electricity, gas and transport systems work largely isolated from one another.
  - The need to decarbonise the economy, support the roll-out of electric vehicles and find long term solutions for heat mean that's already starting to change.
- Through collaboration with industry and academia, we are breaking down traditional barriers between gas, electricity and transport sectors to use their assets in order to deliver a more secure, affordable, low carbon energy system.

What are we doing?

- Building an integrated test network with:
  - power and heat storage (electro-chemical and thermal batteries);
  - vehicle to grid chargers; and
  - an electrolysis plant, H2 storage and a fuel cell to allow transfer between energy vectors.
- Exploring how to make these systems work together and optimise for outputs across them.

Annex

InTEGReL (Integrated Transport Electricity and Gas Research Laboratory) (continued)

What are the project's key outputs?

- Quantified understanding of the technical merits of gas and electricity storage, including guidance on which vector is preferred in different storage scenarios.
- Guidance on storage stacking to produced low cost, long term storage with fast response times and ramp rates.
- Proof of full cycle cross-vector energy transfer (electricity to gas as well as gas to electricity)
- A test facility run by Newcastle University / CESI to allow SMEs to develop and test whole energy system technologies and techniques in a "safe" environment.

What benefits will consumers see?

- A low carbon energy system with lower bills
- Cheaper roll-out of EVs
- Opportunities to optimise their use of energy and sell services back to the energy system
- Enhanced resilience of electricity and gas networks and transport systems

What next?

- We are biding with Newcastle University for an £17m ISCF bid which, if successful, will:
  - Expand the site with a complimentary academic research facility including space for both staff and students
  - Develop a hydrogen / natural gas mixing research facility
  - Create a virtual hydrogen pipeline to the Scotswood heat network
  - Prove the business model of providing heat as a service, and optimise the coordination of electricity/natural gas/hydrogen to power the heat network and cogeneration to the electrical network (including provision for variable heat content as hydrogen and natural gas are mixed in varying concentrations in real time based on energy optimisation)
  - Develop the network control system to use real time nodal pricing to influence usage in each energy vector in each location to ensure the flows in each network remain within their respective operational limits
- We are recruiting other partners including Siemens, Eon, ITM Power, and Newcastle and Gateshead councils

Annex

Lightning prediction

The headlines

Lightning strikes are an inherent danger and concern to the electricity distribution system. Although there are systems available to detect lightning strikes that have already occurred, and to some extent forecast lightning from a wider perspective, there are currently no lightning strike prediction tools that can indicate the likelihood of a lightning strike within the next hour within a nominated 1km2 area.

The ability to better predict lightning strikes would ensure a safer operational environment for field staff and would help Northern Powergrid to plan how best to deploy resources to those areas of the network where asset damage, as the result of lightning, was expected.

This project seeks to develop a web-enabled software tool, building on existing and new data sets, to predict lightning activity to a geographic area of 1km x 1km.

What is it?

Concept
Using present and historical data to improve lightning-related safety and reduce potential asset damage by accurately predicting the likelihood of a lightning strike within the next hour in a nominated 1km² area.

Scale
The project covers all Northern Powergrid assets at all voltages potentially subject to damage from lightning strikes.

Partners
Northern Powergrid partnered with the consultancy EA Technology, who support the energy industry to become more cost effective and reliable.

Why are we doing it?

— From a safety perspective, approximately 60 people a year are struck by lightning in the UK with a number of them being fatal. Extensive network equipment damage is also caused by strikes with the consequences ranging from supply outages to delays in planned maintenance work, with tens of thousands of faults caused by lightning per year.

— The ability to better predict lightning strikes would ensure a safer operational environment for field staff and would help Northern Powergrid to plan how best to deploy resources to those areas of the network where asset damage, as the result of lightning, was expected.

— Additionally, predictions would influence planning and investment to harden those parts of the network most at risk from repeated damage. This would result in a safer and more reliable network and provide a system to assess the impact of climate change on network operations.

What are we doing?

— Identifying and developing suitable existing data sets and data analysis techniques which could be used to anticipate faults caused by lightning strikes.

— Using the datasets and analysis techniques identified above, in addition to historical lightning data and real-time data, to develop a mobile tool with a web interface.

— Using the tool to predict lightning activity in specific locations and the subsequent risk to people and network assets, compared to currently available systems.

— Field testing, verifying, and refining this tool, and assessing implications for the tool to support the improved notice and analysis of lightning strike locations.

Annex

Lightning prediction (continued)

What are the project's key outputs?

— A comprehensive database which brings together existing and new data sets to predict lightning activity in a 1km x 1km geographical area.

— A fully tested and verified predictive online tool.

— Once the requirements for an initial lightning strike and field testing have been fulfilled, the tool can be used in ongoing field operations inside and beyond Northern Powergrid's operating region.

What benefits will consumers see?

— The project will facilitate investment in parts of the network most at risk from lightning damage, meaning the network will be more reliable for customers.

— Predications will enable Northern Powergrid to allocate network reinforcement resources to areas most at risk of lightning strikes. This maximises efficiency and reduces the need for unnecessary upgrades, keeping network maintenance costs low for customers.

What next?

— This application is now fully developed and has undergone user acceptance testing. All bugs have been rectified and the application is in a state where it can now be used. However, due to the requirement for an initial strike, the safety department is reluctant to release the application for use in the field. This has effectively extended the project and delayed initial field trials.

— Northern Powergrid is working with the safety department to come up with a safe way of testing and using the application. Once this has been determined, the tool will be tested, verified and refined, and the final assessment of how the tool outcomes will be assessed.

Additional materials

Smarter Networks project page.

Annex

Silent Power

The headlines

Currently, DNOs deploy diesel generators to backup power during power cuts or planned works. Silent Power – a self-contained battery system within a van – was conceived to find a cleaner, quieter and more versatile alternative to fuel inefficient, noisy and costly diesel generators.

Each van carries battery storage systems, capable of powering three homes for up to 24 hours without any carbon emissions or noise/air pollution. Compared to diesel generators, Silent Power vans offer greater mobility, reduce CO2 by 199kg a day, and completely eliminate the 77 decibels of noise created.

This will enable DNOs to support some of their most remote and vulnerable customers – including those on the Priority Services Register, which incorporates those who are medically dependent on electricity.

What is it?

Concept
Silent Power – fully contained energy storage systems within a fleet of vans which are easily deployable in a wide range of scenarios – aims to demonstrate the efficacy of a more reliable, green, and deployable alternative to noisy and polluting diesel generators to provide back-up power during power cuts or planned work.

Scale
Three prototype vehicles with battery inverter generator units of 40kVA output. The fleet of electric vehicles will be used on network faults affecting an estimated 1 to 7 domestic customers on single or three phase networks across Northern Powergrid's regions.

Partners
Northern Powergrid partnered with two of the UK's most foreword-thinking battery technology SMEs, Hyperdrive Innovation and Offgrid Energy.

Why are we doing it?

— Northern Powergrid deploys generators approximately 2,500 times a year in response to power cuts or planned works. Standard diesel generators are extremely fuel inefficient, noisy and costly. Additionally, they cannot be easily deployed to remote homes or integrated with homes that export as well as consume power – such as those with solar panels.

— Similar-sized diesel generators burn 76 litres of diesel every 24 hours. Each Silent Power van therefore saves 199kg of carbon emissions a day. If rolled out across Northern Powergrid's patch, this delivers an impressive saving of 300 tonnes of CO_2 every year – equivalent to charging your phone over 38million times[1].

— An average diesel generator emits 77 decibels of noise. This is over double the government permitted noise level (34 decibels) when dealing with nuisances. Understandably, as generators often run through the night, customers or their neighbours may complain. As the name suggests, the Silent Power system is completely silent.

— Silent Power is much more versatile and mobile than diesel generators, enabling Northern Powergrid to drive right up to a customer's property without specialist transport. It can also be integrated with homes that both consume and export energy. As a result, power restoration is not only feasible in these circumstances, it's advantageous – allowing the vehicles to complement solar generation and provide clean power for longer.

What are we doing?

— The trial is split into three phases:

1. Work with partners to integrate the battery assemblies within a standard fleet vehicle.
2. Assess the full system in operation and report its performance.
3. All three partners publish a joint closedown report and disseminate the knowledge generated to the wider industry.

[1]EPA: Greenhouse Gas Equivalencies Calculator

Annex

Silent Power (continued)

What are the project's key outputs?

— Determine whether it is possible to integrate the battery assemblies within a standard sized fleet vehicle and ensure drivability and safe payload carrying limits are satisfied.

— Fully tested communications, tracking and control systems to ensure compatibility with current or modified operational approach.

— Determine operational characteristics of such a vehicle, assessing carbon footprint, fuel usage, support time, recharge motor utilisation, noise pollution, maintenance regime, and battery life.

— Establish the operating economics of such a vehicle, across the full asset life cycle, and make comparisons with alternative approaches.

— Assess the efficacy of this approach for all generator applications and make recommendations for broader adoption, with the target of replacing 50% of the current fleet of diesel generators.

— Take the technology from Technology Readiness Level (TRL) 6 to TRL 8, meaning a full-scale demonstration had been completed in a working environment and the technology is prepared for large-scale commercial deployment.

What benefits will consumers see?

— The project will make the commercial case for the mass roll-out of this fully contained, turnkey technology, enabling customers to access to reliable backup power en mass while also enjoying improvements to noise and air pollution and reduced carbon emissions.

— DNOs will be better placed to support some of their most remote and vulnerable customers – including those on the Priority Services Register, which incorporates those who are medically dependent on electricity.

— There is no risk of fuel leaks outside customer's homes.

What next?

— Phase one of the project – integrating the battery assemblies within a standard fleet vehicle – is now complete, meaning Northern Powergrid is currently undertaking a full assessment of the technology in real-world scenarios in order to report on its performance.

— Northern Powergrid and its partners will co-create a closedown report to disseminate the knowledge gained to the wider DNO community, with the aim of catalysing wide-scale adoption.

Additional materials

Video available here.

Annex

Drones Within Visual Line of Sight

The headlines

Traditionally, Northern Powergrid, as well as other distribution network operators (DNOs), has inspected its overhead line network via foot patrols and/or helicopters.

Northern Powergrid has over 400,000 wooden poles and almost 28,000km of overhead lines on its network so covering this ground is a significant undertaking in terms of both time and cost. By using drones, the electricity distribution industry could save around £10m per annum.

The Drones Within Visual Line of Sight (DWVLOS) project set out to determine the feasibility of using drones as an alternative to the above methods. The aim is to assess a number of potential benefits ranging from reduction in cost, increased speed of delivery and improved safety.

The project will also comply with Civil Aviation Authority (CAA) rules that require drone inspections to be conducted WVLOS, defined as within 400 feet vertically and 500 metres horizontally whilst maintaining a safe distance from people, buildings and vehicles. The effectiveness of operating drones within these rules will be assessed.

What is it?

Concept
A trial to establish the cost, efficiency and safety improvements of using drones to inspect overhead powerlines in place of expensive and time-consuming foot / helicopter patrols.

Scale
Northern Powergrid purchased four drones of differing types in April 2018 and conducted a nine-month trial program. Trials were undertaken primarily in rural operating zones to assess how drones can be used in a range of current operational and asset management and maintenance activities.

Partners
None.

Why are we doing it?

- Northern Powergrid has over 400,000 wooden poles and almost 28,000km of overhead line on its network. The use of drones to inspect this critical network infrastructure is now becoming recognised as a viable alternative to traditional foot and helicopter inspection methods. Utilising drones can potentially provide a number of benefits ranging from reduction in cost, increased speed of delivery and improved safety. £1.65m per annum could be saved at Northern Powergrid and £10m per annum across the whole the electricity distribution industry.
- CAA rules require that drone inspections are conducted WVLOS defined as within 400 feet vertically and 500 metres horizontally whilst maintaining a safe distance from people, buildings and vehicles.
- WVLOS restrictions could impact the potential improvement that can be achieved through the adoption of drone inspection techniques. Northern Powergrid aims to test the limitations of these flight regulations to determine whether or not the use of drones is an efficient and economical alternative to traditional inspection methods. It will also establish a baseline of performance that can be compared with the current approaches.

What are we doing?

- A nine-month trial programme used the drones to carry out a select number of routine network inspections, ad-hoc inspections, and fault management to help identify the location of a specific faults.
- The trials of DWVLOS will look to assess the drones' effectiveness under varying circumstances. These include weather (i.e. visibility (clear skies, cloudy, night), wind (none to high), precipitation (rain, snow)). route type (i.e. urban, rural, no fly zones, pole, tower), and line type (i.e. >5km, >15km).
- The effectiveness of the drones will be judged against criteria including:
  - Their ability to provide consistent and quality information including photographs, videos, infrared and LiDAR.
  - The ability to integrate them into (and/or enhance and/or replace) existing business processes.

Annex

Drones Within Visual Line of Sight (continued)

What are the project's key outputs?

— Demonstration of safe WVLOS operations, approved by the civil aviation authority and accepted into business as usual practice.

— Determine the effectiveness of drone technology in routine network inspections, ad-hoc inspections, and fault management.

— Identify new tasks suitable for this technology and any associated operational issues that may be caused by adoption of the technology.

— Assessment of the economics to develop a 'versus buy analysis'. This would assess each potential business process to decide the best deployment solution.

— Take the technology from Technology Readiness Level (TRL) 6 to TRL 8, meaning a full-scale demonstration had been completed in a working environment and the technology is prepared for large-scale commercial deployment.

What benefits will consumers see?

— Northern Powergrid could save £1.65m per annum on operational costs, having a significant impact on customers' bills.

— The improved access to challenging terrains and quicker mobilisation of inspections, enables Northern Powergrid to mobilise resources more effectively, maximising the opportunity to predict faults before they occur and minimising the time taken to locate and identify existing faults. This improves customer service and minimises disruption.

What next?

— This year, Northern Powergrid trained 10 staff to operate drones for inspections of the network.

— It is now working on the ability to live-stream images from drones straight back to control centres to increase efficiencies even further.

— The technology also opens the door to improve other inspection capabilities, for example, Northern Powergrid is exploring the use of 3D site surveys for substation modelling and to give greater insight into coastal erosion.

Additional materials

Latest progress report available here.

Project referenced within our 'delivering on promises' report.

Annex

Foresight

The headlines

Northern Powergrid's game-changing Foresight project can enable the network operator to reduce restoration times from a few hours to just a few minutes.

The technology is taking a creative, world-first approach by working to observe real, active pre-fault behaviour with low cost sensing devices – like the way an ECG can show an irregular heartbeat before cardiac arrest. It will enable engineers to pinpoint likely fault locations on the low voltage (LV) network and carry out planned maintenance before customers are affected.

This will enable the power network operator to increase network reliability, plan maintenance more effectively, and cut costs for its 8 million customers across the North East, Yorkshire and northern Lincolnshire.

What is it?

Concept
Foresight – a project to improve Northern Powergrid's understanding of indicative LV cable pre-fault behaviour and enable faults to be identified, located and repaired in a cost-effective and planned way before a power outage occurs.

Scale
The project's critical monitoring components have been installed in X locations across Teesside and North Yorkshire.

Partners
Northern Powergrid partnered with consultancy, EA Technology Limited (EATL) to develop the approach and technology.

Why are we doing it?

— Northern Powergrid currently replaces entire 250m circuits following four permanent faults to ensure the issue is permanently resolved. This costs money, takes significant time and often results in roads being dug up and traffic delays.

— Mature cable designs installed over the last 50 years mean LV network fault management is becoming increasingly difficult and expensive.

— Restoration times can be lengthy, as the majority of the LV network isn't comprehensively monitored or automatically controlled.

— Fault responses tend to be reactive in response to power outages, as the LV cable condition is often unknown and there's no capability of predicting the timing and location of a fault before it occurs. This means effective planning engineer resources is difficult and inefficient.

What are we doing?

— Northern Powergrid manages a population of LV networks based on consac and aluminium waveform cables, which can present different fault types to other cables.

— This project is taking a creative, world-first approach by working to observe real, active pre-fault behaviour with low cost sensing devices – like the way an ECG can show an irregular heartbeat before cardiac arrest.

— The project is also developing Northern Powergrid's knowledge of managing LV automated switching and operating mesh networks to minimise losses and increase capacity for low carbon technology connections.

Annex

Foresight (continued)

What are the project's key outputs?

— Foresight can enable the network operator to reduce restoration times from a few hours to a few minutes.

— At the outset, the aim was to capture some network performance data and possibly some pre-fault activity. Unexpectedly, Northern Powergrid and EATL found that 96% of circuits were showing pre-fault activity.

— In total, to 27 September 2018, there were 8,258 waveforms covering 7,935 network events captured from the 190 circuits monitored across 136 substations. On average, there are 28 pre-fault events captured for every logged trip event.

— Foresight enabled 196 successful recloser events. That's 196 potential fuse-blows where rapid response teams didn't have to attend, and power was automatically restored within three minutes. This would normally take several hours, saving a total of up to three weeks of engineers' time.

— From the data captured, the fault energy can be calculated from pre-fault activity. This information can also be used to identify the equipment that could be used on site, such as cable sniffer or thermal imaging camera to narrow down the fault location, and be used to minimise network losses.

— This data interpretation work will effectively identify the 'fingerprint' of future faults and circuit replacement priorities. Northern Powergrid expects to see completion by early 2020.

What benefits will consumers see?

— Foresight will help engineers identify what different fault signals mean, and – crucially – how to pinpoint the source to effectively repair and replace faulty components as part of a planned programme of work before a customer's power is disrupted.

— The ultimate aim is to reduce the frequency and length of unplanned power outages and deliver cost savings for consumers.

What next?

— The next stage of the project is to continue monitoring by installing the first batch of prototype substation guards. They will act as an early alarm for pre-faults at substation level.

— The data could be used to create an assessment of the condition of the individual circuits to be used to prioritise circuit replacements and indicate how much cable needs to be replaced.

— The learnings will be relevant to all types of LV cable network management. Northern Powergrid and EA Technology plan to disseminate the findings to other DNOs to ensure learnings are shared across the sector.

Additional materials

Annex

Geospatial PV mapping

The headlines

Because It is not requisite to register rooftop solar installations with us, we have not had oversight of every solar installation on our network. With more customer engagement with the network that ever before brining opportunity for both customer and network, gaining this insight has been a priority.

The Geospatial PV Mapping project utilises satellite imagery to identify existing rooftop solar installations. These are integrated with Ordnance Survey digital mapping and overlaid on our own network map. The aim to is to calculate potential photovoltaic (PV) output for existing PV installations, and plan for a more secure electricity network.

The introduction of the Feed in Tariff (FIT) led to a significant number of PV residential panels connected to the Low Voltage (LV). Residential PV panels are usually connected to the LV network without a Distribution Network Operator's (DNO's) prior knowledge, making it difficult to identify connection points. DNOs therefore have limited knowledge of where panels connect to the LV network, what potential there is in an area to add more panels, or whether there will be network management issues caused by a high PV concentration.

What is it?

Concept
Utilisation of satellite imagery and Ordnance Survey data to identify existing and potential rooftop solar installations. Modelling based on this as well as weather forecasting and time of year / day allows accurate predictions of solar PV impacts on the network capacity in both planning and operational timeframes.

Scale
Geospatial datasets will be acquired for four trial areas in Northern Powergrid's and SP Energy Networks' license areas, which are typical of the UK network. Actual and potential PV installations at individual property level will be determined.

Partners
None.

Why are we doing it?

— The introduction of the Ofgem Feed in Tariff (FIT) has led to a significant number of PV residential panels connected to the network across large urban geographical areas. In 2016, around 800,000 British homes had solar panels installed. Even as FIT is reduced, PV panel affordability, coupled with carbon-friendly policies, will inevitably lead to an ever-increasing number of PV panels connected to the network.

— Residential PV panels are usually connected to the low voltage network without a DNO's prior knowledge, making it difficult to identify PV panel connection points. DNOs therefore have limited knowledge of where panels connect to the LV network, what is the potential in an area to add more panels, or whether there will be network management issues caused by a high PV concentration.

— Network management issues caused by this include: PV panels not able to export due to the LV network voltage rise, leading to PV panel inverters tripping off; Potential reverse power flows through the transformers; Difficulties in planning network maintenance and outages due to potential reverse power flows; and the need to forecast PV panel energy generation.

— This project allowed greater visibility of the changing impacts of actual and potential solar energy flows, enabling more effective operational planning which mitigate the above challenges.

What are we doing?

— The project is split into four work packages:

1. PV panel mapping, including satellite imagery and other geospatial datasets to provide information on roof size, slope, orientation, shading and roof obstructions. Ordnance Survey maps and addresses were used to create a database of the actual and potential PV installations at individual property level. Existing PV panel installations in the Northern Powergrid database were also compared with the Ofgem FIT database, and findings were summarised in a comparison report.
2. PV panels mapped into a Geographic Information System (GIS) LV network and modelling software was developed. From this, an interactive tool was developed to enable DNOs to model different PV energy input scenarios.
3. Improving solar irradiation forecasting. Existing solar irradiation data was integrated with the modelling software and improved solar irradiation forecasting models were developed for medium and longer-term timeframes. The PV energy generation forecasting model was tested to predict energy generation from installed (and potential) PV panels on the network at various timescales.

Annex

Geospatial PV mapping (continued)

What are we doing? (continued)

4. A final report, detailing the methodology undertaken, the project results, deliverables and economics. This will be disseminated to the wider industry to help other DNOs improve best practice.

What are the project's key outputs?

— A GIS database of existing and potential solar output, at a property-by-property level, in each study area.

— A dynamic software model of the LV networks in each study area, where changing impacts of actual and potential PV energy flows can be simulated, and future uncertainties quantified.

— An improved solar irradiation forecasting method and software.

— Assess the economics and efficacy of using satellite data for this and similar types of application.

What benefits will consumers see?

— The interactive tool improves the ability to predict the impact of changes in PV output (in the short-, medium- and long–term) on network performance and safety. This will allow prevention of network issues caused by high concentration of PV in one area, benefiting customers as there will be fewer disruptions to the network and their supply.

— Increased knowledge about the location of PV connections will allow customers with solar PV uninterrupted export to the network, allowing them to keep saving money on their energy bills.

What next?

— A closedown project is underway. When finished, it will detail the methodology undertaken, the project results, deliverables and economics. This was disseminated to the wider industry to help other DNOs improve best practice

Additional materials

More info.

Northern Powergrid website page.

UK ERC page.

Annex

ISCM – Integrated Substation Condition Monitoring

The headlines

Integrated Substation Condition Monitoring (ISCM) aims to make the distribution network safer and more reliable by improving the performance of substation circuit breakers.

It is the first project in the UK to monitor the condition and performance of circuit breakers in real time so Northern Powergrid can make better decisions on maintenance and replacement.

All network operators could benefit from ISCM. Northern Powergrid alone could save £700,000 a year if the data enables it to safely extend the lifetime of substation assets by five years.

What is it?

Concept
The UK's first project to monitor substation circuit breakers in real time and analyse key variables to identify any correlation with trends in performance.

Scale
The £573,000 project will monitor 96 circuit breakers at seven primary substations for a minimum period of two years.

Partners
The project is wholly funded by Northern Powergrid through the NIA. Siemens and other third parties are involved.

Why are we doing it?

- The reliable operation of circuit breakers is crucial to the dependability and safety of the distibution network.
- If a circuit breaker fails to trip to protect the network, electricity supply must be interrupted at the next level up, resulting in a greater number of customers losing power and a greater financial impact on the business.
- Northern Powergrid is committed to making greater use of asset condition and performance data to inform asset management decisions. Greater use of real time monitoring and diagnostics on the distribution system will facilitate more accurate intervention strategies and better investment decisions.

What are we doing?

- Integrating different sensors into one ISCM system to monitor condition and performance of circuit breakers. It will record:
  - partial discharge activity;
  - DC trip coil profiling including battery voltage;
  - operating/breaking currents and times;
  - operating environment – temperature and humidity.
- Installing ISCM equipment to 96 11kV circuit breaker panels at seven primary substations – Hartlepool; Newcastle-upon-Tyne; Sheffield; Hebden Bridge; Hull; Stannington; Barnsley.
- Collating data on a central server and analysing it to identify correlations between key variables and trends in circuit breaker performance.

Annex

ISCM – Integrated Substation Condition Monitoring (continued)

What are the project's key outputs?

— New ISCM equipment including control and communications systems and software.

— Establishment of acceptable operating profiles for each circuit breaker type and thresholds for triggering alarms.

— Initiation of remedial work and other interventions to improve circuit breaker performance.

— Production of asset performance reports to inform maintenance policy and decisions on refurbishment or replacement.

What benefits will consumers see?

— A safer, more reliable system with fewer power interruptions.

— Net financial benefits from a more cost-effective, well planned and efficient distribution service.

What next?

— ISCM could be applied to the substation assets of all network operators.

— The expected cost of the monitoring equipment is £50,000. This is likely to fall significantly if take-up is high.

Annex

Holistic Fault Prediction

The headlines

Historically, network fault location has been reactive, utilising protection systems that interrupt fault current in a short space of time to limit damage, maximise safety, and minimise interruptions to customers' supplies. This applies equally to the low voltage (LV) network and the high voltage (HV) network.

In the interests of improving customer service, this project will proactively use data to minimise unplanned interruptions by anticipating when a circuit's performance is rapidly degrading. This enables anticipation of when a fault will occur, meaning live line work or an interruption to repair a circuit can be planned before the fault becomes either intermittent or permanent. This will provide both an improvement to customer service and, as a result of replacing reactive with proactive interventions, should also improve operational planning and efficiency.

What is it?

Concept
The project will uncover, evaluate, and prototype a range of deep data analysis techniques which could be used to anticipate network faults within a Distribution Network Operator's (DNO's) system.

Scale
The most promising opportunities for this approach have not yet been identified and as such all datasets relevant to assets at any voltage level are deemed within scope.

Partners
None.

Why are we doing it?

— A reactive approach to network fault identification has a number of disadvantages. It is impossible to plan ahead for these faults, meaning operational planning and efficiency is not optimised. Additionally, network current faults can, even over a short period of time, damage network infrastructure and create hazardous and unsafe conditions. Further, customers can experience periods of unexpected outages, allowing them no time to plan ahead. Predicative methods of fault detection mitigate all of these risks.

— Large amounts of network data are currently available at all voltages and associated with many different types of assets. Traditionally, the data is viewed in isolation, usually when identifying a specific and active fault. However, viewing all of the data holistically could give additional insights; e.g. disturbances on the LV network can be interpreted by looking at HV network information. This provides indications of impending faults that would not be detected by looking at any single dataset.

What are we doing?

— Identifying suitable existing data sets and data analysis techniques which could be used to anticipate network faults. The datasets are available from within Northern Powergrid, including current NIA projects, and/or from other DNOs and external sources related to previous Low Carbon Networks Fund (LCNF).

— Making recommendations to improve the process of capturing suitable data for fault anticipation and interpretation.

— Auditing the fault data and monitoring systems which are currently deployed and/or under development at Northern Powergrid in order to determine the requirements and activities needed for fault anticipation. This will also provide knowledge and understanding of practical ways to access data in real-time for fault anticipation.

— Researching and developing holistic, multivariable data analysis algorithms that can interpret signals and their interactions to help identify complex degradation in advance of faults.

— Developing prototype software and end user case studies.

— Developing an appropriate commercial development and deployment strategy.

— Reporting on the findings from the project and disseminating to other DNOs and interested parties.

Annex

Holistic Fault Prediction (continued)

What are the project's key outputs?

— The project will uncover, evaluate and prototype a range of deep data analysis algorithms and techniques which could be used by Northern Powergrid and other DNOs to predict network faults before they occur.

— Prototype software and end user case studies, which will aid commercial development and practical deployment strategies.

— Practical deployment and commissioning issues will be identified to support adoption of the program into "Business as Usual".

What benefits will consumers see?

— The system enables engineers to predict where and when possible faults on the low voltage network are likely to occur, making network planning more efficient and effective.

— Engineers will be able to intervene before customers are affected by outages, improving both safety and the service customers receive.

— Identifying and stopping potential power cuts before they happen will allow Northern Powergrid to deliver on their promise to achieve 20% shorter and 8% fewer power cuts by 2023.

What next?

— Suitable data sources have been reviewed, and an understanding of techniques for fault anticipation has been gained. Data analysed so far has included LV network electrical data that was previously collected in Northern Powergrid's Customer-led Network Revolution CLNR project, historic Northern Powergrid network fault data, and Met Office weather records. Northern Powergrid's trip coil waveform data continues to be analysed.

— The project has identified suitable data analysis techniques. However, progress in fully applying these techniques has been limited by a lack of access to high sampling rates from existing network electrical data sources.

— In order to gain maximum benefit from this project, the project needs to obtain access to high sampling rate network electrical waveforms. Therefore, a priority is to arrange access.

Additional materials

Smarter Networks project page.

Progress report (March 2018).

Annex

Development of self-healing oil-filled cable additive

The headlines

Fluid-filled cables were deployed across 8,000km of the UK's electricity network in the 1960s and 70s. The fluid forms a key part of the cables' insulation, prevents the formation of voids and aids the transfer of heat away from the conductor, enabling the cable to run more efficiently.

When damaged, these cables may begin to leak cable fluid, subsequently causing the cable insulation to fail and damaging the surrounding environment. Maintenance of this issue costs approximately £2.8m a year across the industry.

This project established the first technology which can self-repair damaged cables, without the need for disruptive and often expensive repair works – an increase in efficiency which could save Northern Powergrid up to £20m over the next five years. The technology functions much like blood when it forms a scab around a wound, and therefore prevents leaks and protects the surrounding environment.

What is it?

Concept
A demonstration that adding a mixture including tung oil and metal soaps to cable fluid enables it to form a strong, cohesive mass or self-healing fluid (SHF) when exposed to air.

Scale
Based on current analysis, this innovation could be deployed on all poor condition 132kV, 66kV and 33kV oil-filled cables across all GB distribution network operators (DNOs), subject to a case-by-case cost benefit analysis.

Partners
The project was managed by the Energy Innovation Centre and saw Northern Powergrid and UK Power Networks carry out research in partnership with system developer Gnosys.

Why are we doing it?

- Fluid-filled cables are deployed across 8,000km of the UK's electricity network. When damaged, these cables may begin to leak cable fluid, subsequently causing the cable insulation to fail.
- Leaking cable fluid can also be damaging to the surrounding environment. This is a concern to the network operator, to the public and importantly the Environment Agency which could enforce the closure of cable circuits or impose limits on their operation.
- Once cable leakages have been detected, locating the source of the leak is a difficult process. In many cases it may not be possible to inspect the cable in inaccessible environments. Where cables can be inspected, damage can be non-obvious.
- Maintenance of this issue costs approximately £2.8m a year across the industry. Therefore, In-situ cable self-repair is seen as invaluable. It allows low-cost improvements to the condition and reliability of cables, reducing failures and outages, and significantly reducing the liability costs of outage and environmental pollution.
- Self-healing cables could save Northern Powergrid up to £20m over the next five years.

What are we doing?

- Research and identify potential repair technologies.
- Evaluate the preferred options using practical experiments.
- Build and trial a working prototype of the preferred technology.
- Produce recommendations on the best route to commercialisation for the preferred technology.

Annex

Development of self-healing oil-filled cable additive (continued)

What are the project's key outputs?

— Construction and commissioning of laboratory fluid leak containment test rig.

— Evaluation of the properties of the self-repair fluids that have successfully contained fluid leakage from test cables.

— Elmeridge Cable Services (ECS) was selected as the host company for the cable test rig due to their technical expertise and knowledge of fluid filled cables and the fact that it developed the final designs for the test rig.

— Field trials to confirm satisfactory operation of the new Self-healing fluid developed.

— Ensure supply chain of self-healing fluid production can provide sufficient quantity and quality at industrial level.

What benefits will consumers see?

— The project will make the commercial case for the mass roll-out of this low-cost technology, enabling DNOs to maximise network resilience and reliability, while also making significant efficiency savings that can be passed onto customers.

— Once rolled out, customers will have a more reliable network, with fewer outages and disruptions due to faults and/or major works.

— Fewer leakages will occurs, meaning local environmental become less vulnerable to pollution and damage.

What next?

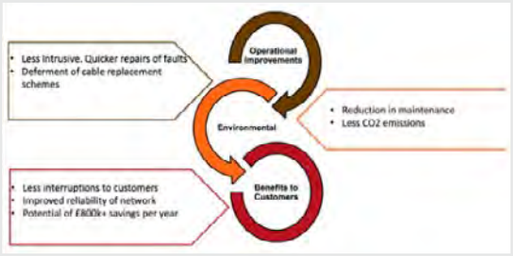
— A further development phase is currently being undertaken by UKPN with the help of the Energy Innovation Centre (EIC) and Gnosys. In parallel to this activity Northern Powergrid is undertaking field trials of the oil-filled cable additive and these are scheduled to take place during the second half of 2019.

— A program has been developed to move the technology readiness level (TRL) to 8, i.e. closer to commercialisation. To do this, the next phase should include laboratory tests of cable samples extracted from the DNOs' networks and also a number of field trials to allow for a quick transition to business as usual.

— Based on current analysis, this innovation could be deployed on all poor condition 132kV, 66kV and 33kV oil-filled cables across all GB DNOs subject to a case-by-case cost benefit analysis.

Additional materials

Close down report available here.



Annex

Pragmatic Security

The headlines

Traditionally, network operators have maintained security of supply by reinforcing the network in response to increased demand, but new technologies now offer alternative approaches which may be more cost-effective.

This project will develop a pragmatic tool allowing system engineers to identify the most economical approach, comparing traditional reinforcement with smart network solutions and with solutions using non-network assets such as distributed generation, energy storage, demand side response and load transfer.

The project will support the transition of Distribution Network Operators into Distribution Systems Operators proactively seeking new, more efficient ways of securing customer demand. It could save £8.26 million in the cost of running the GB distribution system over 16 years.

What is it?

Concept

Pragmatic Security is a desktop based research project developing a tool that will help design engineers identify the most-cost effective solutions for maintaining network security – whether that be infrastructure upgrades or the use of smart network solutions e.g. demand side response.

Scale

£280,000 project will develop learning that can be used by network operators throughout GB. Implementation will affect the whole Northern Powergrid network, particularly extra-high-voltage (EHV) and high-voltage (HV) systems.

Partners

Northern Powergrid will work with Imperial College, London, and Newcastle University.

Why are we doing it?

— New technologies offer a range of solutions to maintaining security of supply using a combination of network and non-network assets, but detailed cost-benefit analyses are complex and time-consuming.

— This project aims to develop a pragmatic method which allows design engineers to evaluate different solutions and identify the most cost-effective way to meet technical requirements.

— The tool is expected to save Northern Powergrid £1 million over 16 years and could save £8.26 million if implemented across the GB distribution network.

What are we doing?

— The project will assess the potential security contribution of resources connected to the extra-high-voltage and high-voltage network, including: wind farms and other distributed generation; energy storage; demand side response providers; and network transfer capacity. It will assess combinations of network and non-network solutions.

— It is split into four consecutive stages:

1. It will review existing research to establish the way of assessing network security; conduct a detailed analysis of supply interruptions at two substations; and identify which factors are most important in assessing network risk.
2. It will assess the risk of supply interruptions at the two substations and how this will change as network demand increases; assess the effectiveness of different ways to mitigate risk; develop methodology for comparing network and non-network solutions.
3. Test, refine and simplify the method by applying it to a further eight substations.
4. Document the method and deliver it in a format which can easily be used by network design and planning engineers.

Annex

Pragmatic Security (continued)

What are the project's key outputs?

— A plain English document for design engineers describing the method for assessing the security contribution from network and non-network solutions.

— A spreadsheet or look-up table tool that design engineers can use to identify the most cost-effective approach.

What benefits will consumers see?

— The project will enable Northern Powergrid to identify more-cost effective ways to ensure security of electricity supply.

— By identifying alternatives to traditional network reinforcement, it will reduce disruption.

What next?

— The tool is expected to be integrated into Northern Powergrid's standard procedures after the project concludes in December 2020.

Annex

Resilient Homes

The headlines

Power cuts can cause problems for all customers, particularly for those registered on the Priority Services Register (PSR), 12% of which are medically dependent on electricity. Even a short power cut can have a significant impact to the health or wellbeing of these customers, and they are unlikely to have the means to address this issue themselves.

Northern Powergrid is seeking to deliver a low-cost customer-focussed solution to temporary disconnections, making use of re-purposed electric vehicle batteries to protect customers from any negative impact of a break in supply.

This project will enable DNOs to support some of their most remote and vulnerable customers – including those on the Priority Services Register or customers who rely on electrically powered medical equipment – such as ventilators or infusion equipment – for their health and wellbeing.

In total, 30 Nissan batteries will be installed into the homes of customers relying on electrically powered critical medical equipment to assess their viability and effectiveness.

What is it?

Concept
This project will assess the technical and economic feasibility of installing re-purposed electric vehicle batteries to protect vulnerable customers from any negative impact of a break in supply.

Scale
The project proposes to install 30 Nissan batteries into the homes of customers relying on electrically powered critical medical equipment and to assess their viability and effectiveness.

Partners
Northern Powergrid partnered with National Energy Action (NEA), the national charity working to end fuel poverty in England, Wales and Northern Ireland, and Newcastle University.

Why are we doing it?

— Due to the geographic nature of where some communities live (such as a rural or outlying coastal area), customers may experience more power cuts than others, and this project will work towards ensuring they receive the same quality service as all other customers across the network.

— Across the UK, around 2 million people are on the PSR, of which 240,000 are medically dependent on electricity. Power cuts are especially problematic for these vulnerable customers and can have a significant impact on their health and wellbeing.

— Northern Powergrid wants to ensure it is protecting the most vulnerable customers using the best available technology to deliver network resilience.

What are we doing?

— The trial is split into three phases:

1. Investigate the feasibility of the project and determine the project design. This phase will determine what equipment is required and identify the willingness of target customers to be involved in the trial, and how they might be educated and supported with regard to the technology. The technical, practical, and social implications of installing the batteries into homes will be investigated.
2. Install 30 batteries into homes and evaluate the benefits to the customer. Determine whether this approach delivers an appropriate level of customer service, by looking at social benefits and performance of batteries. Identify any issues which could prevent broader scale roll-out of this solution.
3. An additional objective of the trial is to design a technical and economic approach for a higher volume roll-out of the technology across a wider area. The roll-out itself will not form part of this project.

Annex

Resilient Homes (continued)

What are the project's key outputs?

— Information relating to the customers' requirements, such as identification of the critical devices required, where these are located, and whether the battery needs to supply just these critical devices or the whole home.

— Determine how critical devices would be connected to a battery and the approximate length of time the battery may be needed for.

— Determine customers' views on safety risks, inconvenience, location and size of installations.

— Identification of the costs involved in installation, dependent on the customers' above requirements.

What benefits will consumers see?

— The improved technology-based resilience will benefit the most vulnerable customers by preventing them from losing essential power. This is increasingly important as customers become more electricity-dependent in their everyday lives.

— Improved peace of mind and a reduction in anxiety associated with power outages. These benefits will be most pronounced with those who are medically dependent on electricity, as well as their carers.

— By ensuring the most vulnerable customers do not go without supply during a power outage, Northern Powergrid can direct more resources towards fixing the issue, minimising disruption for all customers on the network.

What next?

— All research work for the project has been completed including the performance, constraints, monitoring and visibility of batteries, switch, and inverter requirements.

— Following research, technical assurance, and installation requirements, Northern Powergrid has decided to use new Tesla batteries in place of second-life Nissan batteries. This is because the Tesla battery can provide a continuous supply of electricity to the whole of the property, and it can be installed externally. This provides benefits over the Nissan battery, which could only be installed internally and would only provide power to certain circuits within the home.

— The feasibility study (phase one of the project) was completed in September 2019.

Additional materials

Project document.

Annex

Smart Network Design Methodologies

The headlines

The growth of low-carbon technologies, such as solar PV and electric vehicles, could see a rapid increase in demand on Low Voltage (LV) networks.

Because design and modelling tools on the LV network are traditionally simplistic, load-centric and passive in nature, they may cease to be suitable for designing efficient and secure networks as they become more complex, for example with the introduction of half-hour metering and increasing numbers of exporting assets such as solar panels.

The roll out of smart metering and substation network monitoring offers a rich source of data to gain a more detailed picture of demand on the LV network and improve design practices.

This project developed smart network design methodologies which will enable Northern Powergrid to better target its investment and develop innovative solutions, helping it to achieve expected savings of £5 million on network reinforcement as a result of smart metering.

What is it?

Concept
The project developed methodologies to use smart meter data to improve the design and planning of LV networks and to develop a holistic understanding of interactions between all voltage levels.

Scale
£400,000 project with learnings that can be used by all UK district network operators.

Partners
Capgemini and the Northern Energy Initiative (TNEI).

Why are we doing it?

— Government targets for decarbonising heat and transport are seeing increasing adoption of low-carbon technologies, including generation connected to the LV and HV (high-voltage networks.

— Smart meter data and new monitoring technologies are able to produce more accurate estimates of demand on the LV system, leading to better planning and more targeted investment.

— Present design and modelling tools for LV systems are simplistic, based on worst case demand scenarios using typical end user demand or annual consumption figures. They do not take into account seasonal factors or the location and condition of infrastructure. They do not model actual power flows or enable analysis of interdependencies between the LV network and higher voltage networks.

— Because present tools are based on pessimistic assumptions of LV system utilisation and operating conditions they can lead to inaccurate and over-engineered solutions.

— Rudimentary assumptions about voltage can lead to over-reinforcement in urban areas and under-reinforcement in some rural networks. A holistic, multi-voltage approach can provide a more cost-effective response to network issues.

Annex

Smart Network Design Methodologies (continued)

What are the project's key outputs?

1. New LV analysis techniques based on smart meter data

— The project developed a rigorous, risk-based method to assess demand more accurately in LV networks.

— It models customer demand distributions, using data from Northern Powergrid's Customer Led Network Revolution (CLNR) project which can be updated with new smart meter data when it is available.

— It discovered a way to process large amounts of smart meter data on consumption in a useful form while preserving customers' privacy.

2. New multi-voltage analysis

— The project has developed an efficient methodology for building a Multiple Voltage Level model to explore voltage behaviour across different levels (EHV/HV/LV) on typical urban and rural networks.

— Scripts have been developed to process, merge and cleanse network data from a range of existing models as well as demand data from substation network monitoring and demand forecast models.

— This will enable studies of voltage interactions at different levels (132kV, 66kV, 33kV, 11kV and LV) so that the effect of equipment

What benefits will consumers see?

— The methodologies will enable better design of the network and more targeted investment. They will contribute to estimated savings of £5 million from the use of smart metering data.

What next?

— Northern Powergrid is working to develop a software tool which implements the LV analysis methodology.

— It is continuing to examine the effectiveness of its multi-voltage models for carrying out strategic studies.

— The project outputs will help Northern Powergrid assess whether its equipment sizing standards need to be changed as it transitions its networks into a smarter grid.

Additional materials

Annex

Smart Network Design Methodologies

The headlines

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Because design and modelling tools on the LV network are traditionally simplistic, load-centric and passive in nature, they may cease to be suitable for designing efficient and secure networks as they become more complex, for example with the introduction of half-hour metering and increasing numbers of exporting assets such as solar panels.

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This project developed smart network design methodologies which will enable Northern Powergrid to better target its investment and develop innovative solutions, helping it to achieve expected savings of £5 million on network reinforcement as a result of smart metering.

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£400,000 project with learnings that can be used by all UK district network operators.

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— Present design and modelling tools for LV systems are simplistic, based on worst case demand scenarios using typical end user demand or annual consumption figures. They do not take into account seasonal factors or the location and condition of infrastructure. They do not model actual power flows or enable analysis of interdependencies between the LV network and higher voltage networks.

— Because present tools are based on pessimistic assumptions of LV system utilisation and operating conditions they can lead to inaccurate and over-engineered solutions.

— Rudimentary assumptions about voltage can lead to over-reinforcement in urban areas and under-reinforcement in some rural networks. A holistic, multi-voltage approach can provide a more cost-effective response to network issues.

What are the project's key outputs?

— New LV analysis techniques based on smart meter data

1. The project developed a rigorous, risk-based method to assess demand more accurately in LV networks.
2. It models customer demand distributions, using data from Northern Powergrid's Customer Led Network Revolution (CLNR) project which can be updated with new smart meter data when it is available.
3. It discovered a way to process large amounts of smart meter data on consumption in a useful form while preserving customers' privacy.

— New multi-voltage analysis

1. The project has developed an efficient methodology for building a Multiple Voltage Level model to explore voltage behaviour across different levels (EHV/HV/LV) on typical urban and rural networks.
2. Scripts have been developed to process, merge and cleanse network data from a range of existing models as well as demand data from substation network monitoring and demand forecast models.
3. This will enable studies of voltage interactions at different levels (132kV, 66kV, 33kV, 11kV and LV) so that the effect of equipment specifications, operating points and innovative solutions can be examined holistically.

Annex

Smart Network Design Methodologies (continued)

What benefits will consumers see?

— The methodologies will enable better design of the network and more targeted investment. They will contribute to estimated savings of £5 million from the use of smart metering data.

What next?

— Northern Powergrid is working to develop a software tool which implements the LV analysis methodology.

— It is continuing to examine the effectiveness of its multi-voltage models for carrying out strategic studies.

— The project outputs will help Northern Powergrid assess whether its equipment sizing standards need to be changed as it transitions its networks into a smarter grid.

Additional materials

Annex

Switchgear enhanced rating

The headlines

Electrical switchgear is assigned a 'normal rated' current by the manufacturer, indicating the maximum load current it can carry continuously. Switchgear does not normally have a certified overload rating. However, indoor 11 and 33 kV primary and distribution switchgear can in theory be temporarily operated higher than its normal load current rating if kept within its thermal capacity.

It is predicted that switchgear installed on distribution networks could have a higher thermal capacity than the assigned rating which, if known, could be exploited for short-term overloading.

Being able to occasionally exceed the normal rated current of the switchgear for short periods would benefit network operators by enabling them to defer expensive network upgrades.

This project seeks to develop a methodology and calculator tool to assess what overload capacity, if any, a particular type of switchgear has, based on its temperature rise type test results. The solution will ensure DNOs use a consistent and proven approach when applying temporary overloading to high voltage (HV) switchgear.

What is it?

Concept
A project to develop a tool to assess what overload capacity, if any, a particular type of switchgear has, based on test results which indicate its true thermal capacity.

Scale
Up to 5 types of commonly used primary HV switchgear and distribution switchgear would be reviewed in the project.

Partners
None.

Why are we doing it?

— Indoor 11 and 33 kV primary and distribution switchgear can in theory be temporarily operated higher than the manufacture's recommended normal load current rating. This is true providing it does not compromise the thermal time constant – a measurement captured in the temperature rise test for that particular switchgear. There is currently no guidance on how this should be assessed and what should be taken into account.

— Being able to occasionally exceed the normal rated current of the switchgear for short periods would benefit network operators by making the most of existing infrastructure and deferring expensive, and disruptive network upgrades.

— There is no currently published National/ International Standards for this problem or simple tool for justifying the operation of switchgear at higher than normal rated current for short periods.

— A simple, easy to use tool to assess what overload capacity, if any, a particular type of switchgear has would ensure DNOs use a consistent and proven approach when applying temporary overloading to HV switchgear.

What are we doing?

— The project is split into four stages:

1. Carry out desktop research to identify common types of HV switchgear, suitable for this project.
2. Gather temperature rise type test results, and data to allow thermal time constant to be calculated for the identified switchgear from the Original Equipment Manufacturer (OEM) or DNOs.
3. Build basic model in Microsoft Excel with easy to use front end and functionality to prevent incorrect entry.
4. Produce a Report, which will include guidance for using the model and will document the results for the types of switchgear selected and modelled.

Annex

Switchgear enhanced rating (continued)

What are the project's key outputs?

— Database of common types of HV switchgear and their associated temperature rise type test results.

— Microsoft Excel-based tool with easy to use front end and functionality to prevent incorrect entry.

— Take the technology from Technology Readiness Level (TRL) 3 to TRL 8, meaning a full-scale demonstration had been completed in a working environment and the technology is prepared for large-scale commercial deployment.

— It's predicted the tool will be used by DNOs to justify reinforcement of network, as part of business case.

— Network operators are also expected to use the tool to defer asset replacement.

What benefits will consumers see?

— Being able to occasionally exceed the normal rated current of the switchgear for short periods would enable DNOs to defer expensive network upgrades, meaning network planning can be more efficient and effective, saving customers money on bills and producing a more reliable and resilient grid.

What next?

— The project is proceeding towards completion. Stages 1 to 3 have been successfully completed, meaning research has been conducted and the resulting data has been modelled into a basic tool.

— Stage 4, the final report, is substantially complete, and the outputs are currently in review.

Additional materials

Latest progress report available here.

Annex

Vehicle to Grid (V2G)

The headlines

Northern Powergrid will install electric vehicle (EV) and vehicle-to-grid (V2G) chargers at a number of its own sites as part of a series of new initiatives aimed at growing its understanding of the impact of fleet electrification.

V2G provides an opportunity for EV owners to earn income from their car battery through the provision of grid services, initially to National Grid, via an aggregator.

What is it?

Concept
This is a network impact and technology demonstration project to investigate the challenges and opportunities of bidirectional/ V2G chargers on distribution networks.

Scale
A total of 16 (3 phase 10kW) chargers at 5 different fleet locations across Northern Powergrid's regions will be deployed.

Partners
Northern Powergrid partnered with NUVVE, a developer of in-car chargers for V2G, and Newcastle University.

Why are we doing it?

— Transport accounts 26% of UK greenhouse gas emissions and affects air quality. Government legislation inhibits the sale of new petrol and diesel cars from 2035, meaning up to 35 million EVs could be on UK roads by 2050.

— Electrification of transport could add an additional 6.5GW to evening peak energy demand. However, EVs can be considered as a form of distributed energy storage to support the network. Using V2G to discharge energy from EVs to the grid could offset peak EV demand by up to 85% by 2050. This provides income streams for customers while also reducing the need for expensive network upgrades and carbon-intensive energy supply during peak demand.

— However, the impact of bi-directional flows between EVs and the network (both charging of the vehicle from the grid, and discharging back to the grid) are not currently well understood. The project will determine whether, and to what extent, V2G can support networks during constraint periods, by being allowed to discharge onto the network during periods of high load and being inhibited from fully charging during constraint periods.

What are we doing?

— The trial is split into three phases:

1. Examine whether Northern Powergrid's designers and connections processes are able to accept a V2G bi-directional EV charger under Electricity Network Association (ENA) guidelines before the need for reinforcement is triggered.
2. Understand what the benefits of these chargers are and how they can support the distribution network. For example, the project will examine the extent to which EV batteries, coordinated by an aggregator, can alleviate network stress peak loading.
3. Assess the effect of V2G chargers on the supply power quality.

Annex

Vehicle to Grid (V2G) (continued)

What are the project's key outputs?

- A revised connections process for the connection of V2G chargers.
- Inform the process for connecting V2G chargers to the network and provide design guidance for V2G connections, feeding into Northern Powergrid's wider design policies.
- Produce guidance on where and how V2G may be used to mitigate network issues.
- Determine how V2G chargers can be externally controlled, enabling them to be operated below maximum capability. These learnings will be applied to further investigate external control of V2G chargers.
- If conclusive, this learning will be fed into Northern Powergrid's design policies and also into the review of Engineering Recommendation P5.

What benefits will consumers see?

- Individuals or businesses will be able to use V2G to take advantage of variable rate tariffs, allowing them to charge vehicles when energy is cheapest, and sell it back to the grid when both the demand and cost of energy is highest.
- V2G technology will allow EVs to be fully integrated into the network, helping to improve the network's flexibility, resilience. This will make renewable sources more widely available and affordable for customers.
- Understanding how V2G can be used to mitigate network issues will allow Northern Powergrid to delay the need for network infrastructure upgrades, keeping costs and disruption to customers' services at a minimum.
- This project will determine a range of connection cost options for the consumer, depending on their total income, requirements, pay-back period expectations, and other business model considerations.

What next?

- Work is currently focussed on installations and on identifying outputs from learnings about the connections and design processes. Newcastle University continues to support on the design of the trial and planning for monitoring and analysis of the installations.
- The project originally sought to roll out 1100 V2G units. The cost and short supply of V2G enabled chargers on the market has resulted in a reduction of this target. Plans were amended and 16 chargers were deployed at 5 different fleet locations in Q3-4 2019. Data monitoring began in early Q4 2019.
- The project is now part of a separate non-NIA project which will be able to feed additional information into the original project.

Additional materials

More info.

Annex

Distributed Storage & Solar Study (DS3)

The headlines

The growth of domestic solar, with peak generation usually in the middle of the day when demand is low, can increase pressure on some areas of the local power network. Most solutions, such as digging up the road to lay fatter cables, are costly and disruptive.

The Distributed Storage & Solar (DS3) project in Barnsley demonstrated how clusters of home batteries can increase capacity on the electricity network and enable more homes to install solar panels, without the need for costly network upgrades. The batteries smooth out how much solar power is exported to the grid at any one time, enabling more homes to have solar panels.

Energy storage installed alongside domestic solar can also save customers money on their energy bills, cut carbon emissions, and make the local power network more efficient, green and affordable to run. In this case, a number of the customers taking part in the trial were living in social accommodation and were vulnerable to fuel poverty. The trial allowed them to save £60 p.a. on bills by generating and storing their own energy.

What is it?

Concept
The DS3 study investigates the impact that distributed residential energy storage can have on a Distributed Network Operator (DNO) network where large clusters of residential solar panels are present. It evaluates whether this impact is sufficient to amend network design policies to include storage, allowing the connection of more domestic solar without the need for costly reinforcement of the network as a result.

Scale
The project monitored 40 batteries installed across 36 homes and connected to 27 sets of rooftop solar for a period of 2 years.

Partners
Northern Powergrid partnered with Moixa, the developer of smart software for domestic battery and electric vehicle (EV) charging, and the community energy provider Energise Barnsley.

Why did we do it?

- In 2016 around 800,000 British homes had solar panels installed[1]. In the Northern Powergrid DFES 'community renewables' forecast, uptake of solar PV could increase to 2,067MW by 2040. Where solar panels are clustered, voltage issues can occur on the low voltage distribution network, leading to stress on the network and a reduction in the service customers receive.
- Home batteries are commercially available now, with installation costs expected to fall 50-66% by 2030[2]. Northern Powergrid expects their use alongside solar will grow, initially as retrofits and eventually as part of the initial installation, so testing their impact at scale is important.
- Battery storage systems have the potential to absorb excess generation during the day and use it in the evening when demand is highest. This trial provided insight into the scale at which batteries could deliver this benefit.

What did we do?

- As part of the project, 40 domestic scale Moixa battery energy storage systems (0.43kW/2-3 kWh) were installed in 36 households in a social housing complex in Oxspring, Barnsley, of which 27 also had a PV system (2.7-3.68 kW) already installed.
- The trial ran from 2017 to 2019 and was made up of four monitoring periods; winters of 2017/2018 and 2018/2019 and summers of 2017 and 2018.
- Data collection focused on a number of criteria across two core areas:
  - Household: consumption, generation, power flow, SoC, voltage (AC).
  - Substation: feeder and transformer current, voltage, and temperature.
- Network modelling of different solar and battery penetration levels and different demand profiles was carried out.
- A detailed cost-benefit analysis was carried out to establish whether network reinforcement or installation of batteries provides the best value for money for customers.

[1] The Solar Trade Association
[2] IRENA. (2017). Electricity Storage and Renewables: Costs and Markets to 2030. Abu Dhabi: International Renewable Energy Agency.

Annex

Distributed Storage & Solar Study (DS3) (continued)

What are the project's key outputs?

— DS3 demonstrated that battery storage systems can mitigate voltage issues caused by increased solar penetration to the network, reducing the need for network upgrades.

— Installing storage systems alongside domestic solar demonstrated peak-shaving capability for supply and demand profiles, and thus could help the network cope with the expected increase in evening peak demand caused by the electrification of transport and heat. This effect would be 'super charged' by smart meters which would enable charging / discharging to be based on consumption patterns and weather forecasting.

— The trail recommended that batteries should be installed alongside new domestic solar and retrofitted into homes wherever possible to achieve a future flexible grid.

— The project gave valuable insight into the combined impact of domestic solar and storage on the network. The findings can now be utilised by design engineers when connecting new domestic solar to local substations.

What benefits will consumers see?

— Customers taking part in the trial saved up to £60 p.a. on bills by generating and storing their own energy – particularly elderly residents who were at home and using cheap solar energy during the day. By reducing the need to upgrade network infrastructure, energy bills will remain low and disruption caused by reinforcement works will also be prevented.

— Previously, customers were unable to install solar panels due to voltage constraints. With batteries, more customers will be able to install solar panels and save money on their energy bill, whilst maximising their use of renewable energy.

— Solar panels have the potential to save customers up to 50% on energy bills. Batteries could push this up to as much as 80%[3].

What next?

— Continued analysis the project's data to extract additional value and further explore the models developed, including cost-benefit analysis, network impact, and monitored data models.

— Future trials will be designed to explore interesting aspects of the DS3 project in more detail, including battery rightsizing, dynamic control, business case trial, batteries and time-of-use tariffs.

— Preliminary findings were presented at national and international conferences, including LCNI 2019 in Glasgow, CIRED 2019 in Madrid, and the Electricity Innovation Forum 2020 held at ENA in February 2020. The findings will feed into upcoming plans ahead of the next regulator price control period (RIIO-ED2), and

— Northern Powergrid will continue to disseminate the knowledge gained to the wider DNO community, via further conferences and reports.

Additional materials

Summary presentation.

Final report.

Video available here.

Northern Powergrid website.

Leaflet on outcomes.

DS3 Project Outcomes

[3] FT: Yorkshire village to pioneer solar battery power

Annex

Health index electrical energy storage systems

The headlines

Electrical energy storage (EES) systems, usually in the form of batteries-based technologies, are increasingly being connected to the distribution network to support the broader electricity system and to provide local network support and resilience.

EES systems will become an increasingly important element of the overall electricity system. Batteries are used across the system at multiple scales – from onsite EES which allows businesses and customers to store cheap energy to use during peak times, to grid-scale batteries aimed at managing peak demand and enabling renewables. Each time one of these systems is charged or discharged, it degrades, marginally reducing energy density and overall performance. As such, it is important that the general condition of EES systems is understood in the same way that other asset types are through health indices.

Northern Powergrid is running a health index study on EES systems. Through this, we can ascertain the overall health of the network and the risk of EES systems failing at any point in time, putting supply at risk. Appropriate actions can then be taken to manage that risk and ensure a safe and uninterrupted electricity supply to our customers.

What is it?

Concept
Health index study on EES systems – the six-month project assessed the health condition of electrical energy storage systems which are used in grid storage applications.

Scale
The project is a small-scale literature study and development of a health index tool in line with others already deployed by Distributed Network Operators (DNOs).

Partners
None.

Why are we doing it?

— As we move to an energy system dependent on intermittent renewable energy, distributed assets such as EES will play a greater role in storing excess energy during times of peak generation (e.g. on a windy or sunny day) to provide flexibility to the grid and to supply electricity during times where there may be excess demand. Therefore, the health of any EES system will impact the whole distribution and energy network.

— The technologies studied here are sufficiently mature and expected to become more prevalent across the network as distributed energy systems are increasingly deployed over the next five to ten years. In fact, if we are to achieve net zero carbon by 2050 the UK will require an estimated 30GW of energy storage capacity[1]. Projects like this could provide opportunities for DNOs to practically strengthen their technical knowledge of energy storage and assist in their decision making when choosing EES technology alternatives and/or planning for future usage and maintenance.

— The project represents an initial attempt to understand asset life optimisation for an emerging technology and as such will help to ensure the best possible economic efficiency.

What are we doing?

— The project is split into three stages:

1. A literature review will be conducted to summarise the current state of EES system technology, available health condition criteria and relevant health monitoring methods.
2. The technology to be assessed will be identified, a criteria by which to assess its health condition will be defined, and a suitable monitoring method will be chosen.
3. A case study will be developed to assess the health condition of the chosen technology, using data provided by Northern Powergrid.

[1] https://www.current-news.co.uk/news/gb-needs-to-increase-energy-storage-tenfold-to-meet-net-zero-goal

Annex

Health index electrical energy storage systems (continued)

What are the project's key outputs?

- A summary of existing literature of energy storage system technology (e.g. types of batteries, power electronics etc.) for grid storage applications from technical, legislative, environmental and/or economic perspectives.
- The project will identify an EES technology, relevant parameters (for instance, age, likelihood of failure, dependability, capacity, system design, usage etc.) and define health condition criteria i.e. significant factors that are key for further investigation.
- Analyse the existing state of health monitoring methods (for instance, classification, characteristics, challenges, advantages, limitations, underlying concept and mathematic formulas) of individual methods that are applicable to ESS technology;
- Determine the health index of the chosen technology by defining health condition criteria and applying the most suitable health monitoring method in the project.

What benefits will consumers see?

- By increasing its knowledge and understanding of an emerging distributed technology, the DNO can prepare to incorporate this technology into the network at the lowest cost to the consumer when the technology increases is prevalence, as is predicted.
- The project will enable the DNO to operate the most efficient and technologically advanced network which will keep costs lows for consumers while championing clean and distributed energy technology.
- A distributed energy network will work to reduce the number of unplanned power cuts and reduce the amount of time that power is out – creating a more reliable and resilient network for all.

What next?

- The data from the project, health indices, criteria and case study will be made available publicly for other DNOs to carry out similar research using our framework.

Annex

Measuring the social impact of network activities

The headlines

Essential network interventions such as excavations in roads and on customer property can have adverse effects on the local social environment. Impacts include traffic congestion, noise, dust, interruptions to local business and also various currently undetermined health impacts. However, there are also benefits to society in terms of employment, investment and working utilities.

Traditional cost-benefit analysis often fails to take into account overall societal costs & benefits.

There is no single framework for measuring the societal impacts associated with proposed network interventions. As a result, these are not fully considered when evaluating new network activities.

This unique project brings together four utility networks in the North East of England; Northern Powergrid, Northumbrian Water Ltd, Yorkshire Water Ltd & Northern Gas Networks, to assess the societal impacts of network activities from both a benefits and costs perspective.

The project is now complete, and a comprehensive technical report has been published. The recommendations within that report cover potential immediate and medium-term actions that build towards greater understand of the impacts that network activities have on customers and communities, and more consideration of social impacts into the decision-making process. The report also recommended longer term supplementary research.

What is it?

Concept
Research project to assess the societal impact of network interventions across four utility networks.

Scale
A comprehensive research project, aimed at determining the feasibility of developing a replicable methodology for calculating societal impact of network interventions. It has the potential to bring about a step-change in understanding of how network operators impact local populations and stakeholders.

Partners
The project was a collaboration of four utility networks in the North East of England: Northern Powergrid, Northumbrian Water Ltd, Yorkshire Water Ltd & Northern Gas Networks (NGN). The project was also undertaken in collaboration with the Energy Innovation Centre (EIC).

Why are we doing it?

— Often, interventions to network maintenance, replacement or extension have obvious societal costs (such as traffic congestion, noise, dust and also various currently undetermined health impacts) and benefits (such as employment, investment and reliable networks). However, there are also less-obvious and less-quantifiable impacts – both positive and negative – on societal stakeholders that are not accounted for in a traditional cost-benefit analysis.

— This project is unique within the sector as it brings together four networks with a significant footprint across the North of England. By collaborating on the project, the four networks will enable a framework that ensures the consistent evaluation of societal impact across all utilities which can be applied across the UK.

— Due to the dispersed nature of the available data, lack of direct measures and diversity of the area a research, a feasibility study is required before developing any calculation methodology. This project sets

What are we doing?

— The project is split into four stages:

1. Stage 1: Workshops; Interviews; Literature Review: Existing information around societal impact of network activities or related activities will be assessed for applicability in meeting operator needs.
2. Stage 2: Data Indicators; Impacts: Information will be gathered on quantitative variables that influence societal impact and result from different network activities.
3. Stage 3: Gap Analysis: Gaps in the evidence base will be identified and along with areas that require further research to provide a comprehensive picture of societal impact.
4. Stage 4: Recommendations; Final Report: Recommendations will be provided that outline the next stages for network operators to develop a final report and robust and cohesive framework.

Annex

Measuring the social impact of network activities (continued)

What are the project's key outputs?

— Comprehensive understanding of existing information for quantitative and qualitative societal impacts related to network activities, essential work and innovative projects.

— Identified gaps in the data in the form of undocumented societal impacts. using a traffic light system to indicate confidence in existing data, gaps could be identified, allowing us to highlight areas that have been previously overlooked in cost-benefit analysis.

— A final report, identifying the feasibility of creating a robust framework. The report also recommends next steps to practically develop a framework to develop the methodology so that it could one day be used across utility networks to determine the societal impact of future network maintenance and innovation.

What benefits will consumers see?

— By understanding the impact essential works have on members of the public including businesses, road users, pedestrians and home owners, the network operators can proactively alter how they work in an effort to minimise the negative effects that they may have on health, business activity and customers in general.

— The project will enable the DNO to undertake network maintenance and innovate on new network projects in a way that enables the most benefit to customers and society, while also minimising the financial and societal cost.

— By providing replicable research the framework could be utilised across the UK, creating learning opportunities for other providers and promoting a novel approach to network activity that accounts for all societal impacts.

What next?

— The project is complete and several reports, databases and templates were produced which culminated in a final summary report, outcomes presentation, and an interactive workshop involving all partners.

— The close down report can be found here.

— The project is yet to determine a robust framework that is consistent across all utilities, but all utilities are applying the learnings to current and future cost-benefit analysis.

Additional materials

A full close down report can be found here

Annex

Microresilience

The headlines

Significant advances have been made in restoration of supplies by smart methods over recent years, in particular very short-term restoration which is considered to be an increase in resilience.

However, smart techniques have contributed less to increases in true resilience, i.e. situations where customers never experience an outage of any length in the first place.

Microresilience, a first of its kind £1.7 million programme, is looking to change this by demonstrating how a combination of small-scale distributed smart technologies in microgrids can help maintain power supplies to critical infrastructure and isolated communities during power cuts.

Four initial locations have been targeted as part of the Microresilience project. Each site either presents a unique set of challenges during a power cut, is at higher risk of sustained power outages or has significant implications for emergency services during a power cut.
The sites include: RNLI emergency services at Spurn Point and Sunderland Harbour, the iconic Newcastle Swing Bridge and a remote forest community.

What is it?

Concept
Micoresilience will assess the technical viability and comparative economics (including non-financial benefits) of smart-technology in microgrids to deliver true resilience in key high-risk circumstances.

Scale
£1.7 million programme to demonstrate increased resilience under four critical circumstances after they are cut off from the National Grid (location listed above).

Partners
Northern Powergrid is collaborating with Smarter Grid Solutions, a flexible smart grid innovation and Open Field Message Bus (OpenFMB) interoperability solution specialist, and Turbo Power Systems, a company that will provide an innovative flexible control and islanding device.

Why are we doing it?

- The threat of power cuts from weather events and cyber-attacks is on the rise:
  - A recent study by the Solar Energy and Building Physics Laboratory found that Extreme hot spells made increasingly likely by climate change could reduce reliability of power supply by 16 percent which can easily lead to blackouts resulting huge economic losses.[1]
  - A Worldwide Threat Assessment of the US Intelligence Community report, published in 2019, noted that “China, Russia, Iran, and North Korea increasingly use cyber operations to threaten both minds and machines in an expanding number of ways to steal information, to influence citizens, or disrupt critical infrastructure”.[2]
- Northern Powergrid’s ambition is to achieve true resilience for its 8 million customers across 3.9 million homes and businesses in the North East, Yorkshire and north Lincolnshire.
- This revolutionary project will use bespoke smart technologies to develop microgrids that improve the service to vulnerable people, including those medically dependent on electricity, and to the emergency services to potentially save lives.
- The aim is that, in the instance of a power cut, the sites will be transitioned on to the microgrid systems without any blip in supply.

What are we doing?

- Trialling innovative smart technologies at four key locations. Each location either presents a unique set of challenges during a power cut, is at higher risk of sustained power outages or has significant implications for emergency services during a power cut. The sites include:
  - Byrness village, Northumberland: A forest community with 50 residential properties. The area is supplied by only one overhead power cable which can be damaged and cause power outages. Currently local wind turbines switch off in a power cut, because there is nowhere for the power to go. Microresilience will enable these renewables to stay on and maintain power to the community.
  - Newcastle Swing Bridge: The iconic swing bridge is currently supplied with power from another bridge, which doesn’t comply with modern safety standards. The bridge will have a lithium ion battery system and tidal generator installed.
    The River Tyne’s twice daily six meter swell will power the tidal generator, charge the battery and provide enough power to open and close the bridge.

[1] https://phys.org/news/2020-02-extreme-weather-overload-urban-power.html
[2] https://www.dni.gov/files/ODNI/documents/2019-ATA-SFR---SSCI.pdf

Annex

Microresilience (continued)

What are we doing? (continued)

- Humber RNLI lifeboat station at Spurn Point: Spurn Point, the three-mile nature reserve on a peninsula at the mouth of the River Humber, houses one of the busiest lifeboat stations in the UK. Power outages often coincide with storms, when lifeboats are most needed. Emergency diesel generators are relied upon for backup power but are highly polluting; a solar and energy storage system will reduce the amount of diesel required. The battery will be able to provide power for 6-12 hours.
- RNLI lifeboat station at Sunderland harbour: The station door and the winch to get the boat into the water – which can be 20ft below the pier – is most at risk of a power cut during storms – exactly when an emergency at sea is most likely. This could take the RNLI up to 10 minutes longer to get to sea. Northern Powergrid will be installing a battery at the site, to power up quickly in the event of an outage.
- Technology installed as part of the activity will include energy storage systems, new renewable generation and innovative OpenFMB communications technology.

What are the project's key outputs?

- Comprehensive understanding of existing information for quantitative and qualitative societal impacts related to network activities, essential work and innovative projects.
- Identified gaps in the data in the form of undocumented societal impacts. using a traffic light system to indicate confidence in existing data, gaps could be identified, allowing us to highlight areas that have been previously overlooked in cost-benefit analysis.
- A final report, identifying the feasibility of creating a robust framework. The report also recommends next steps to practically develop a framework to develop the methodology so that it could one day be used across utility networks to determine the societal impact of future network maintenance and innovation.

What benefits will consumers see?

- Provide important learnings about how to deliver true resilience across Northern Powergrid's operational area and the UK more broadly.
- Demonstrate the benefits and challenges of microgrids and the various smart technologies that they comprise of, and their appropriate application.
- It will support Northern Powergrid's DSO transition by providing valuable learnings into more general issues of network flexibility and system operation.
- The findings will help Northern Powergrid prepare its regional economy for rapid growth of electric vehicles, domestic heat pumps and renewable power.
- The level of resilience improvement will be assessed alongside the level desired by the customers. For example, critical customers on a vulnerable connection may have different requirements to a microgrid implementation with a significant degree of embedded generation.

What next?

- Once complete, the project's results will be collated and shared with the industry.

Additional materials

Annex

Centralock

The headlines

Physical access to network assets for maintenance is a critical activity for Northern Powergrid – both ensuring that the right people have appropriate access at the right place and time and also in ensuring those who should not have access are kept out. Assets are currently primarily accessed using physical, mechanical keys, which is increasingly difficult to manage and reduces overall security.

Alternative technologies can potentially deliver a whole new range of useful capabilities alongside traditional security. Software enabled locking systems are available but do not provide the levels of flexibility or security that are required.

This project aims to further develop, modify, and trial a system based on technologies currently used in the banking sector that may be able to address the shortcomings of the mechanical key approach – a technology dubbed Centralock.

What is it?

Concept
Design of a remote access lock management system for assets to replace a standard iron key system.

Scale
Up to 10 different types of door will initially be investigated. Following this, a slightly larger trial in an exemplar area (yet to be determined) on the Yorkshire or North East network will be implemented to test network configurations and reliability.

Partners
Northern Powergrid has partnered with the construction company Hodgson Sayers, and architectural and surveying consultant, RT Design.

Why are we doing it?

— Access to network assets is a critical activity for networks - both ensuring that the right people have appropriate access at the right place and time and also in ensuring those who should not have access are kept out. There are currently around 10,000 iron keys in service, of which 200 are lost or stolen each year, with subsequent reduction in overall system security and implications for national infrastructure. Additionally, due to expiry of patent protection on key designs and the resulting risk to security, the entire suite of keys needs to be replaced at regular intervals, which is costly.

— Contractors and other workers require temporary access to network assets, which is difficult to manage as physical keys need to be distributed and then returned on completion of contracts. When support from other DNOs is required (e.g. during inclement weather), access management is slow, and potentially impacts the speed at which the network can be repaired.

— This project will eradicate the use of insecure physical keys, replacing them with virtual keys with a variety of selectable characteristics, such as one-off use, that can be created remotely and immediately. The use of digital keys will also provide auditable records of their use, which will beneficial for both the safety of personnel and security of assets.

What are we doing?

— Developing a desktop simulation of a remote access management system, based on systems used for high security remote applications (e.g. bank automatic teller machines (ATMs)). The system will be developed so it can be facilitated in the field through mobile telephones with security enabled software.

— Trialling the technology and assessing its potential to overcome the problems associated with the current physical system. The trial will incorporate loss prevention standards and legacy issues associated with the current system.

— The system's capabilities will be assessed against key requirements and security standards, paying regard to the issues associated with the current physical system. The potential for long term cost savings, both in terms of the asset life cycle and improvements in operational efficiency will also be assessed.

[1] https://phys.org/news/2020-02-extreme-weather-overload-urban-power.html
[2] https://www.dni.gov/files/ODNI/documents/2019-ATA-SFR---SSCI.pdf

Annex

Centralock (continued)

What are the project's key outputs?

- Assessment of the requirements for the management of operational procedures and assets for Northern Powergrid, but also for other licenced network operators. Design of a remote access system, based on these requirements.
- Determine whether a remote access system can be developed for utility use, and whether it can be retrofitted to current door systems.
- Assessment of the capabilities of the Centralock system and its suitability to be deployed across a range of access management applications in electricity networks and other utilities. A functional specification for the remote access system will also be produced to allow the development of similar systems by other interested parties.
- Identification of operational benefits and evaluation of the economic impact of the Centralock system on operational costs.

What benefits will consumers see?

- It is anticipated that the Centralock system would save around 30% of the current replacement cost associated with the iron key approach. This provides a saving of around £4m to the customer for each key replacement cycle for Northern Powergrid. A further saving of £180k per year would be saved from reduced costs of ownership and replacement of locks. Both of these benefits can be passed on to customers through the normal price control mechanisms.
- Customer service would be improved, through a reduction in restoration times during periods of extreme network stress (e.g. due to storms), minimising disruption for customers.
- Enhanced security will discourage malicious trespassing, reducing the risk and injury to trespassers, and the damage caused to network assets. This will benefit customers by preventing disruptions to supply.

What next?

- The initial small-scale trial is now complete, and all planning, costing and operational adjustments learnt from this have been applied to the second larger scale trial. The summary of the first trial and proposal for the second trial was presented in Q3 2019.
- Modifications of how the system will be implemented have been made and the second trial will now be a web-based trial with a wider number of users.

Additional materials

Smarter Networks page.

Progress report (August 2018).