# Annex 5.1
# Innovation Strategy

Northern Powergrid: our business plan for 2023-28

# Contents

# Foreword

Right from the outset, our plan for 2023-28 recognises the fantastic opportunity and great responsibility that we are being presented with as we look ahead. Living up to the demands of efficiently delivering a top-class service where the lights stay on, the network stays healthy and our customers enjoy outstanding, ever-improving, levels of personal service has always relied on innovation. We have always relished the challenge and are proud of what we have achieved. The fact that those challenges and responsibilities have become even more significant sets the context for our innovation program; it has to fit into that wider strategic context.

Our touchstone for every element of our plan explicitly recognises that our aspirations for the future depend on innovation. It is one of the strategically critical enablers we have identified as being essential to creating a future in which we:

- 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.

It is clear that all six of these elements of the way we see the future will rely on innovation in order to become a reality. But our stakeholders have been clear that ensuring our region can decarbonise is paramount. Our organisation, and the innovative solutions we bring together with our partners are central to ensuring this is done in a dependable, affordable manner that is responsive to the needs of all members of society. That significant challenge must be met at the same time as we bring forward a whole host of other improvements for our customers across every area of our business. That includes higher levels of reliability and resilience, more targeted support for those members of our community who need it the most and even higher levels of customer satisfaction than the nine out of ten rating we already deliver.

The three cross-cutting enablers we have identified as essential to meeting that ambition, cutting-edge innovation, transformational use of data and digital technology, and a highly-skilled diverse team, are not independent. This innovation strategy is reliant on taking our use of digital platforms to the next level to provide a dependable and efficient service for our region, optimised across the whole energy system, moving on from the electricity distribution network centric view of the past. It will need the talents and widening skillset of a dedicated workforce to make it happen and we should not assume that that workforce will be solely within our company; innovation through the next few years will be more collaborative and diverse than ever before.

A particular innovation focus will be to accelerate the creation of revolutionary energy systems balancing targeted development and deployment of potentially transformational techniques to unlock hitherto unimagined benefits for next-generation energy system customers. Our 2023-28 plan contains a highly ambitious programme of actions to develop our functions of distribution system operation (DSO)[1]. These enabling actions will ensure we release the consumer value of flexibility in the energy system, leading to significant customer benefits from avoided costs in our service as well as the wider whole system, for example reduced balancing costs from the electricity system operator (ESO). Digitalisation of the low voltage (LV) network and delivering enhanced insight from data are the foundations of these developments – all will require significant collaborative innovation in our services and underlying processes and systems.

[1] See our DSO Strategy annex

We approach innovation mindful of the fact that creating benefits for customers matters more than the approach we take. An innovative solution is a waste of money if it isn't:

- solving a problem and/or creating an opportunity for customer benefit; and
- superior to a solution that we already have at our disposal.

Where innovation is the right answer; it may not necessarily be technical in nature. For instance, although an innovative solution will often deliver technical changes, for example reduced reinforcement to connect low carbon technologies (LCTs) or faster restoration of customers' power for heat, transport and lighting, it's the benefit that the customers see that matter most. There will be technical solutions, information and data based techniques, commercial agreements and other methods that enable those changes, and all are within the scope of our innovation strategy.

A key feature of the decarbonisation journey will be increasing reliance on electricity for transport and heating, and perhaps intensified the need for dependable power for increasing numbers of people who work from home. These are developing applications and are mirrored by evolving social norms and societal preferences. Understanding these not just as technologies but as requirements and flexibilities that provide user benefits, and interacting with them on that basis will be critical. At the same time we will need to create an ever more dependable electricity supply to maintain dependable energy supplies as internal combustion engines and natural gas boilers are retired. In simple terms, customers will not install low carbon electric heating if it is not dependable during winter storms. Our stakeholders have been clear that the lack of dependability would block the adoption of many low carbon technologies in the wider economy.

And as we innovate, we will harness the learning, techniques and technologies developed to provide even better support for those in our communities who need our help the most. Decarbonisation is a whole society issue, and one that can only be progressed with the active consent of all of society, the solutions have to ensure all customers benefit. Our strategy must promote and safeguard the interests of all customers, regardless of their knowledge of energy systems, their inclination to participate in markets or their funds for low carbon technology purchases. Ensuring no one is left behind is not a 'nice to have'; it is essential in building the critical mass of decarbonisation.

There are innovation activities and benefits entwined throughout our business plan. We are rolling out completed innovation projects to drive efficiency savings across our plan, and we are relying on future inovation to produce benefits from things we do not yet know how to do. Our analysis shows that, without innovation, this business plan would have cost the customer over £300m more when totex efficiency savings, connections process savings and customer energy bill savings are accounted for. We expect a similar level of benefit in the following plan period 2028-33.

Our track record gives us confidence in harnessing the benefits of innovation. We have saved more than £24m of actual costs in the first six years of the 2015-23 period, with more to come by rolling out innovation learning associated with developments such as improved LV fault management, flexible connection arrangements, and perfluorocarbon oil leak tracers into business as usual. Voltage management created four gigawatts (GW) of capacity for customers to install domestic solar generation. The strategy does not stand in isolation. Innovation appears throughout the plan and as might be expected, the totex-funded elements in particular are merely documented and referenced here while being driven by other output areas.

This innovation strategy, developed collaboratively with our customers and stakeholders, lays out the high-level areas of focus for innovation in the 2023-28 period. IT is aligned with, and complementary to, the Ofgem's innovation vision[2] and the industry's joint innovation strategy[3]. It covers both totex funded innovation and that funded by Ofgem's network innovation allowance (NIA), and addresses both the new innovation areas that will build the learning to enable us to capture customer benefits, and the roll-out activities that will deliver those benefits.

[2] https://www.ofgem.gov.uk/sites/default/files/docs/2021/05/innovation_vision_2021-2025_final_24may2021.pdf

[3] https://www.energynetworks.org/assets/images/Resource%20library/At%20A%20Glance%20Summary%20-%20Gas%20and%20Electricity%20Network%20Innovation%20Strategy%202020.pdf

While specific to the 2023-28 period, it builds on the innovation strategy document dated December 2020[4], which covered the strategy for the remainder of the 2015-23 period. There is considerable continuity as our innovation strategy moves forward, where we were already looking to the clear objectives around decarbonisation and safeguarding of vulnerable customers.

## Our innovation focus at a glance

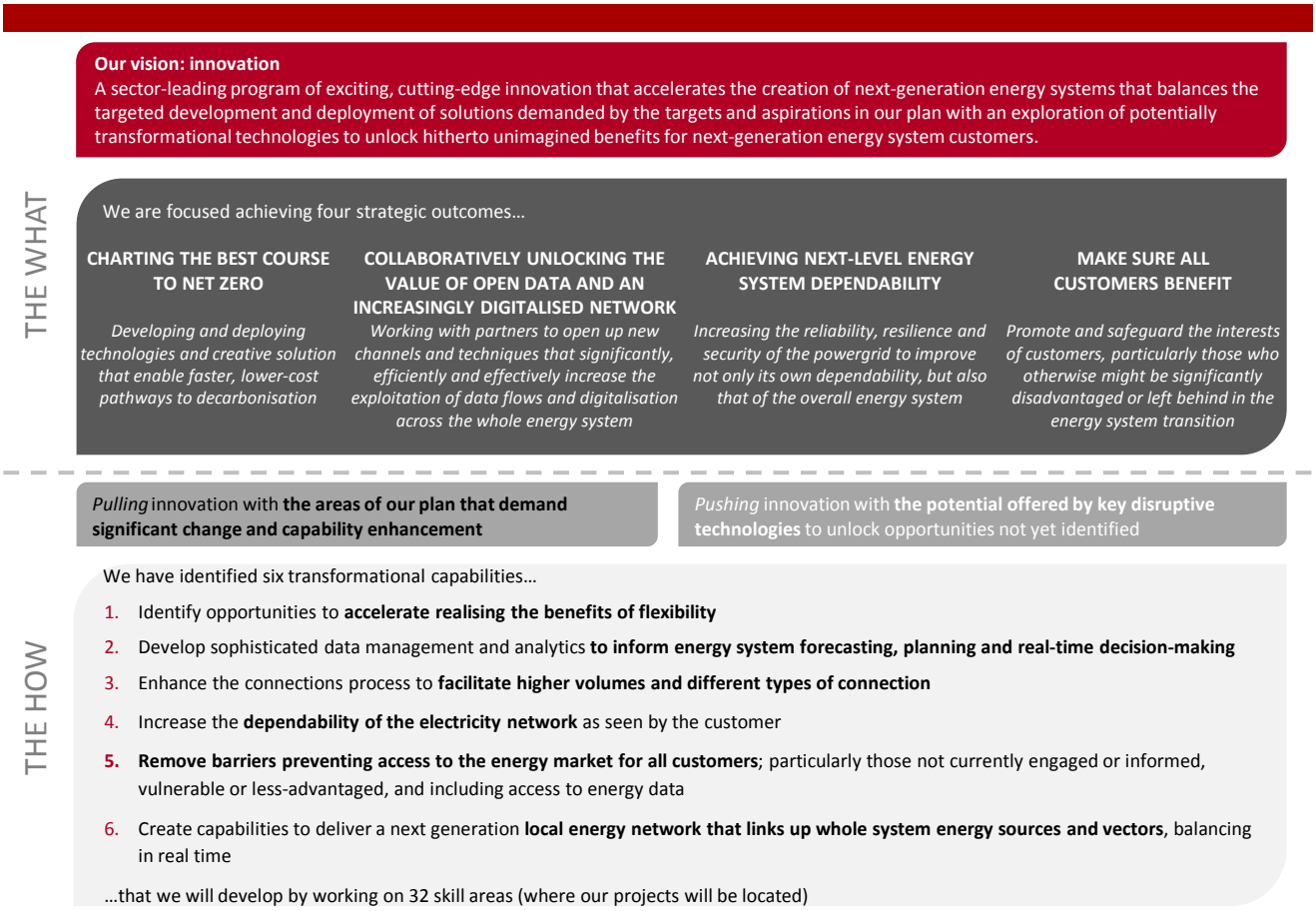


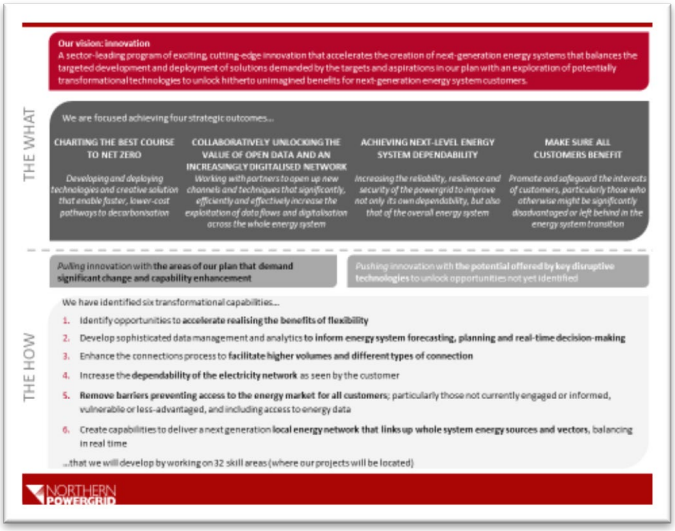

***Figure 1: Innovation focus at a glance***

[4] https://www.northernpowergrid.com/asset/1/document/2496.pdf

# Our innovation strategy

Our innovation strategy prioritises the learning and transformation needed to decarbonise while safeguarding vulnerable customers.

Addressing the decarbonisation challenges, we will seek to provide higher value and better services, connecting increased numbers of electric vehicles (EVs) and heat pumps, and catering for the resultant increased demand, while maintaining downward pressure on costs and ensuring we do not disadvantage the vulnerable. The innovation related savings in our business plan build on already high level of deployment within the current period. We plan to accelerate the deployment of innovation benefits as the programme matures though the later part of this period and into the future.




It is clear in our vision that we seek to innovate across all areas of our business, and we know that there will be benefits to our customers in all areas.

But the most pressing needs, and the greatest opportunity for benefits, will be in the areas that directly address issues around decarbonisation and customer vulnerability.

We will always approach innovation mindful of the fact that the customer benefit matters more than innovation itself, or the innovation method where one is required to deliver the benefit. We are aware that as a electricity distribution company the benefits to our customers will often be technical or financial, perhaps lower costs, better reliability or easier addition of low carbon equipment to their homes and businesses, but the methods by which we achieve this will be data driven, commercial, and collaborative as well as technical. Put simply we do not rule out up front any initiative that would assist our customers.

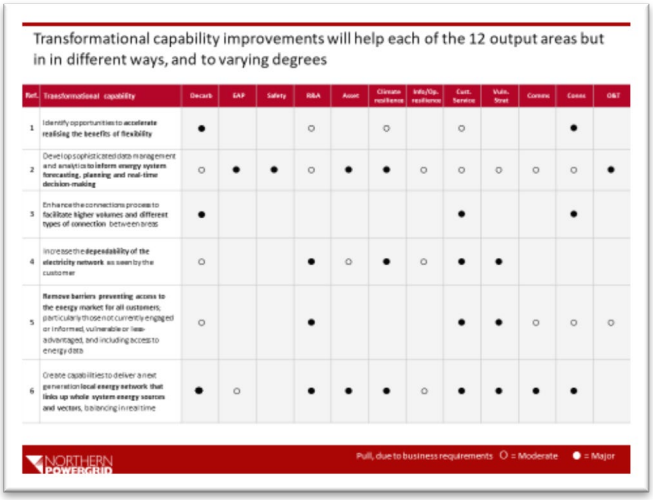
We will do this through a focus on four strategic outcomes that are necessary if we are to succeed in our overall challenge:

- charting the best course to net zero: developing and deploying technologies and creative solutions that enable faster, lower cost pathways to decarbonisation;
- collaboratively unlocking the value of open data and an increasingly digitalised network: working with partners to open up new channels and techniques that significantly, efficiently and effectively increase the exploitation of data flows and digitalisation across the whole energy system;
- achieving next-level energy system dependability: increasing the reliability, resilience and security of the power grid to improve not only its own dependability, but also that of the overall energy system; and
- ensuring all customers benefit: promoting and safeguarding the interests of customers, particularly those who may otherwise be significantly disadvantaged or left behind in the energy system transition.

Additionally, we will embrace our central role in the energy system by looking beyond the services that have been familiar to our sector, applying our thinking to the whole energy system and its supply chain, assisting communities and charities in their decarbonisation work, and adopting data techniques, traditional or novel assets as appropriate for efficient and effective investment.

## The six key transformational capabilities required

### Identify opportunities to accelerate the release of benefits of flexibility




The capability will allow us to:

- develop economic and technical modelling, design and building;
- better understand procurement of customer flexibility; and
- develop complementary flexibility and energy markets through collaboration and cooperation with third parties to drive whole-system benefits.

The capability is required because:

- it will unlock the benefits of a deep and liquid flexibility market for customers and energy companies;
- it will minimise scope for market players to game flexibility markets and unfairly increase costs for consumers; and
- it will understand the potential for whole-energy systems solutions in the provision of flexibility.

Innovation activities include promoting the understanding of and access to customer flexibility, how it supports the energy system and the practical ways/methods to use and engage with it.

Building this capability will fuel our flexibility first approach whereby we will to seek to manage rising demand on the network with customer and network flexibility before we use reinforcement. Our 2023-28 investment[5] baseline expectation is that flexibility at all voltage levels will be routinely be used to defer network reinforcement on the extra-high voltage (EHV) system. In contrast, greater use of innovative trials will be required to develop the capability and knowledge of effectiveness of LV flexibility to manage emerging network constraints on the LV system. This is shown below.

| | | | |
|---|---|---|---|
| **Flex used as a solution: Network level** | **LV** | | **UNPROVEN/UNCERTAIN**<br>*Most complex – thousands of customers accessed through aggregators*<br>• Technology and visibility need to develop<br>• Localised requirement – customers needed on specific phase – limits market size<br>• **High innovation requirement** |
| | **EHV/ HV** | **Business as usual**<br>*Mirroring what happens today - with the ESO and some DNOs with larger customers*<br>• **Low innovation requirement** | **HIGHLY LIKELY IN 2023-28**<br>• Location less of a problem due to wider spread of customers possible<br>• **Moderate innovation requirement** |
| | | **EHV/HV** | **LV** |
| | | **Source of flex – customer connection type** | |

***Table 1: Likely locations of constraints addressed by flexibility against source location of the flexibility that addresses the constraint***

[5] See scenarios and investment annex

Flexibility innovation is required to further develop the operational technology toolkit, explore the use of more short term flexibility trading markets and provide the capability to scale up and automate. We anticipate the 2020s will see significant expansion in the routine use of flexibility but the 2030s will see another step up in market volume. Therefore innovation in the 2023-28 period is needed to both embed the routine use of flexibility as well as prepare for the increase in scale.

Benefits:

- Lower costs, including:
  - allowing the use of low-cost energy at times of plentiful generation; and
  - containing networks' costs by avoiding reinforcement.
- Improved customer service, by:
  - facilitating faster connections and installations of customer equipment;
  - minimising disruption at times of reduced network or generation availability; and
  - improving scheduling of asset reinforcement and renewal – lowering costs, reducing disruption to customers, creating smarter works coordination.
- Improved operational performance by:
  - creating a richer understanding of the implications and benefits of flexibility, how best to deploy it and the mechanisms to use it most effectively.

***Customer led distribution system*** is a project focused on understanding the future shape of a flexible, low carbon, customer centric energy system and the network and markets that support it.

The project is providing understanding and guidance on the interplay between different system uses and needs:

- Resistive heating vs heat pumps – particular during cold spells.
- Sensitivity of investment to sources of flexibility - smart EV charging, smart thermal storage, batteries.
- Sensitivity of investment to main generation sources – egg offshore wind.
  Investment sensitivity to the degree of whole systems thinking – energy system vs distribution system.

Making the right choices will save significant investment costs.

**Develop sophisticated data management and analytics to inform energy system forecasting, planning and real-time decision-making**

The capability is required to:

- maximise the potential value of improved data flows from across the energy sector;
- meet future volume of LCT connected to the network; and
- meet our stakeholders' expectations that the data and analysis tools we use may be made available in an open and accessible format.

Activities include developing sophisticated forecast models and an associated knowledge base, and investing in data and digitalisation technology, resources and skills.

The monitor, manage and reinforce approach that we set out in the investment section of our plan is key to us delivering on decarbonisation while also improving reliability and keeping costs under control. Our LV monitoring investment, our harnessing of smart meter data (see the DSO strategy annex) and our use of data analytics to fill in the gaps will enable us to know what is happening at the local level, optimise reliable service, accommodate more low carbon load (electric vehicles and heat pumps) and connect more community renewables.

To manage the data from the proliferation of sensors, innovation in new tools is essential in order to absorb, store and analyse data that allow us to manage this new information and provide enhanced insight and decision-making capability.

We see a clear progression in the maturity of the ways in which we will increase digitalisation on our network[6]. This progression is certain to take us through increasingly sophisticated stages of data management and digitalisation during the rest of the decade and into the 2030s. The pace of change will be determined by the need and the availability/cost of the technology.

In the 2023-28 period we expect to significantly expand our use of data for planning and operation of network and customer assets. Routine functionality on our grid will include automatic control of our devices and customers' flexible assets using network data. In some areas, our innovation will push the boundaries further by also using external data as input to automated network management by deploying cutting edge network solutions. For example, our planned initiatives for next generation local energy systems (microgrids) and voltage optimisation (using smart meter data).7

As we move towards 2028 we expect far greater use of open network data for non-network benefits and vice versa. Network data might be melded with real-time maps and navigation systems for EV drivers. Network interruption data might be channelled direct to emergency services and support agencies to enlighten them about developing situations, while fire service data might allow us to disconnect properties before firefighters arrive with the safety benefits that entails. We expect this area to grow significantly, and two-way data flows and closed loop control systems distributed across various data owners, providers and processors becoming the norm in the longer term. We have started this with our Boston Spa energy efficiency trial (BEET) project using customers' smart meter data, through the Data Communications Company (DCC) into our control and telemetry systems to optimise the voltages received back at those metering points – but this is a simple project compared to the potential for such thinking.

In creating our plans for the period to 2028 we are mindful of this maturity progression pathway into the 2030s. Our 2023-28 investment will be extensible in functionality, scalable in volume and capable of integration with the investment to follow on later as we innovate further and manage increased levels of low carbon electrification in local energy systems.

Benefits:

- Lower costs, including:
  - reductions by using artificial intelligence in place of labour-intensive processes;
  - more targeted, lower-cost reinforcement and flexibility purchasing; and
  - allowing energy matchmaking in the connections process, reducing connections costs.
- Improved operational and safety performance by:
  - interconnecting systems to give faster speed of response, more efficient processes and easier access to information (e.g. AutoDesign, field communications and fault response);
  - creating new opportunities to exploit mass data streams through integration and access to key information; and
  - supporting real-time flexibility options.
- Improved customer service by:
  - improving the scheduling of asset reinforcement and renewal – lower cost, disruption to customers, smarter works coordination.

[6] See our Digitalisation strategy and action plan
[7] Described more fully as deliverables WS3.1 and WS3.2 in our Whole systems strategy

### Enhance the connections process to facilitate higher volumes and different types of connection

The capability is required to meet future demand for increasing number of LCT connections to the network.

Activities include developing complex forecast models and a knowledge base, and investing in data and digitalisation technology, resources and skills.

Benefits:

- lower connections costs.
- improved customer service, thanks to:
  - a quicker and more tailored connections service, for improved customer satisfaction;
  - longer opening hours and more convenient access to our services; and
  - transparency of connections design and pricing decision making.
- improved operational performance, by:
  - creating greater internal capacity to facilitate more LCT connections that contribute towards our net zero ambitions.

### Increase the dependability of the electricity network as seen by the customer

The capability is required to:

- maintain the dependability of energy supplies as we move to fewer energy vectors and intermittent and seasonal renewable energy sources.

Activities include proactively promoting the reliability, resilience and security of our network and the wider energy system, in collaboration with energy system partners; and anticipating and addressing future risks to the energy network.

Benefits:

- improved customer service, because customers will:
  - know they can depend on the whole-energy system to provide power to meet their needs as they become more reliant on electricity;
  - support the work programmes and initiatives we run to manage the network; and
  - be more inclined to transition to LCTs.
- reliability, because:
  - energy remains dependable even with a reduced number of energy sources; and
  - customers can expect power to their homes particularly when they need it most (e.g. during storms).
- security of supply, because:
  - power for all uses including heat, transport, and information systems will be available throughout the seasons; and
  - summer minimum and winter maximum demands and corresponding generation loads will both be catered for.

**Remove barriers preventing access to the energy market for all customers; particularly those not currently engaged or informed, vulnerable or less-advantaged, and including access to energy data**

The capability is required to:

- ensure all customers and society benefit from the transition to a low-carbon energy system.

Activities include safeguarding, educating, and engaging customers who otherwise might be significantly disadvantaged by or left behind in the energy system transition.

Benefits:

- Improving customer service, by:
  - helping all customers to understand the benefits of a smart flexible energy system and know how to access them; and
  - facilitating a fair and equitable transition to a low-carbon energy system.
- Creating a faster route to net zero with more customers able to access low-carbon energy.

**Create capabilities to deliver a next-generation local energy network that links up whole-system energy sources and vectors, balancing in real time**

The capability is required to:

- take steps to maintain the effective reliability of customers' energy supply, which would otherwise reduce as the number of energy sources available reduces.
- activities include:
  - developing techniques to keep local networks on supply during disruptions to the wider energy system (e.g. storms, flooding, blackstart);
  - understanding the evolving characteristics of modern demand, generation and storage; and
  - integrating the technical and commercial solutions across the energy sector to protect a local area.

Benefits:

- Lower costs, because:
  - future energy use concepts and designs will be developed with whole-energy systems in mind, to lower overall costs and optimise performance.
- Security of supply, because:
  - energy will remain dependable even though the number of alternative energy sources reduces;
  - customers can expect power to their homes particularly when they need it most (e.g. during storms); and
  - power for all uses including heat, transport, and information systems will be available throughout the seasons.
- The creation of mutual support networks in local communities.

# A strategic approach to the industry's challenges

### What does innovation mean to us?

We define innovation as the process of improving the quality, performance, value and range of the services we provide 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 learnings are rolled out. Therefore, innovation for us is not just a case of learning new techniques or developing new tools, but the process of improving services 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.

The nature of innovation has changed in the 30 years since privatisation. It has always been about doing things better or cheaper, but immediately after privatisation it was dominated by process and management changes to reduce costs. This moved on to technical innovation on assets and distribution network operator (DNO) owned control systems much of it around reliability improvements. Today it is about power electronics, automation and data management. As we look ahead data flows, data analytics, jointly owned solutions and whole energy system solutions will become the focus. As part of this we will see a move from solely improving network costs and performance to additionally facilitating better solutions in wider society.

And this means that innovation will fundamentally be about collaboration. We never had a monopoly on good ideas and the different viewpoints of individuals outside our organisation is likely to strengthen any good ideas we do have. The people we need to drive innovation may well not be found in our organisation and in some cases would not wish to be part of it. Working with collaboratively opens the potential ways to innovate and the diversity of benefits available. As the energy sector becomes more aware of whole systems solutions and our thinking evolves from distribution networks via electricity networks, energy networks, and energy systems to the wider ecosystem energy services support we may be facilitating innovation that benefits our customers, but where we neither implement the innovation nor deliver the benefits. This facilitative innovation role is only possible via collaboration and we must cherish it.

## Guiding principles of innovation

Our innovation programme is driven by some important guiding principles to ensure that it meets the strategic vision for our business:

- innovation is not just about technological improvement. Commercial, regulatory, social and process improvements are key objectives;
- we design innovation to be at the heart of the way the business is run;
- innovation is aligned with the strategic drivers that affect our business;
- we build an innovative culture across the organisation – it is an attitude and a capability for the company, not a department;
- we apply our best-practice disciplines of financial control and project management to our innovation projects;

- we always have a clear view of how to implement any innovation project we undertake, and we require that each project establishes specific recommendations to guide implementation;
- we look to explore and stimulate change, as well as being responsive to challenges;
- we look outside ourselves and outside our sector to discover best practice;
- we engage with and collaborate with other parties both in identifying and carrying out innovation work – and recognise that this is a skill in itself;
- from the senior level downwards, anyone in our company with an innovative idea can bring it forward;
- we do not dismiss projects where benefits are not known at the outset or where the pathway to success is not clear;
- we do subject these projects to more rigorous scenario analysis; and
- we seek to understand our options and the range of potential outcomes, in order to maximise the chances of success.

## Our challenges: why do we need to innovate?

We provide an essential service to our customers and the communities in which we operate. Innovation has always enabled us to make incremental improvements to this service and what that service costs.

Since 2015, innovation has facilitated:

- an estimated £24m of total cost savings so far, including the managed connections offered to generators, which saved Northern Powergrid customers £14m of connection costs;
- the prevention of both around 420,000 customer interruptions and 18 million customer minutes lost (a reduction of around three percentage points in power outages), because of the HV automatic power system restoration and LV fuse technology programmes;
- the availability of 4GW of capacity for domestic generation without the need for reinforcement;
- a reduction in $CO_2$ emissions associated with our direct operations, mainly related to our vehicle fleet, of 276 tonnes; and
- prevented 24,750 litres of oil from escaping into the environment.

Moreover, the innovation learning we have developed ourselves and acquired from others means that the totex costs in this plan are around £260m smaller than it would otherwise have been; and it will provide a more flexible and customer centric service at the same time. Additionally, innovation we have undertaken will also directly reduce customer's energy bills and connections costs. Dynamic voltage optimisation will reduce energy bills by £14.5m at a roll out cost of £7.9m by 2028. Our customers using the connections process will save £5.4m in the 2023-28 period due to automation of our connections interactions, which will additionally lead to improved service levels.

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.

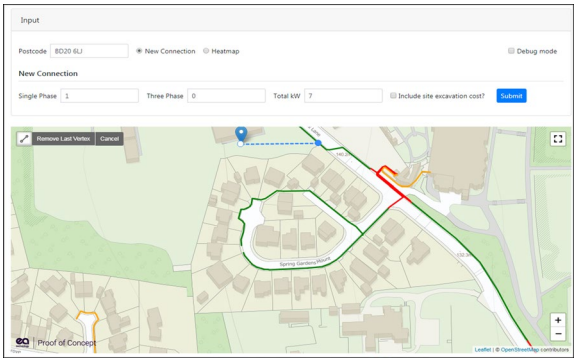
We want to lead by example in this area. To facilitate meeting the net zero target, we need to understand customers' changing requirements of our services, and we need to develop our capability accordingly to meet those requirements. These changes are driven by growing demand for low carbon generation and supporting LCTs, because of 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.[8] 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 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.

***AutoDesign*** has reduced connections costs and allowed over 2,850 budget estimate designs to be produced by customers to generate indicative connections costs, reducing timescales from 10 days to just a few minutes. AutoDesign also allows customers to choose the cable route on their property and see relative costs of different routes.

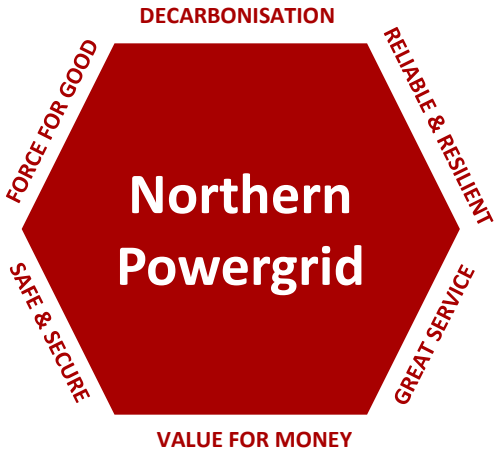



## Building the 2023-28 Innovation Strategy

Innovation has always been core to achieving our corporate objectives. It has been the force behind delivering improvements in safety, reliability, customer service and cost gained since privatisation. To date, 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 10-day service.

In September 2020, we published our emerging thinking on our business plan.[9] 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 our stakeholders' highest priorities, which align with what we want to achieve as a company.

We made it clear that we see innovation as a cross-cutting enabler that is essential to achieving all of the six key elements our aspiration to power our region with sustainable, long-term investments that unleash the potential of innovation, digitalisation, 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.

Feedback from customers and stakeholder groups on this first view of our plan led to four strategic innovation objectives.

[8] As increased use of our network facilitates decarbonisation, we will use whole system solutions to optimise carbon reduction and improve performance at an affordable price.

[9] "Building our plan for 2023–2028, Emerging Thinking August 2020"

| Strategic innovation objective | Commentary |
|---|---|
| Charting the best course to net zero: developing and deploying technologies and creative solutions that enable faster, lower cost pathways to decarbonisation. | There is clearly driver on the energy sector to find ways to make it easy to decarbonise. This is in Ofgem's guidance for the price control and is reflected in their Innovation Vision (May 2021). Out with our regulatory relationship, decarbonisation is clear governmental and societal concern. It would be remiss not to have this front and centre in our thinking. |
| Collaboratively unlocking the value of open data: working with partners to open up new channels that significantly, efficiently and effectively increase the exploitation of data flows across the whole energy system. | Data is similarly at the heart of Ofgem's views on innovation. However in this case it is the possibilities opened up by the advances in data management and analytics and the merging of information technology and the electronics and operational technologies in our equipment and telemetry systems that make this area interesting. The ability to automate knowledge work and to analyse systems and events far faster will led to cost savings and performance enhancements which will in turn benefit customers. |
| Achieving next-level energy system dependability**:** increasing the reliability, resilience and security of the power grid to improve not only its own dependability, but also that of the overall energy system. | For decarbonisation to be successful, customers have to believe that it is reasonable to switch from diesel and petrol cars and natural gas central heating systems to the low carbon alternatives. In many cases those alternatives will be electrical in nature and we will need to ensure that the single electrical vector is as dependable as the three energy vectors they previously used (gas, diesel or petrol and electricity). In simple terms this means an improvement in the dependability of electricity in the home. If we do not do this customers will on balance be less keen on decarbonisation. |
| Ensuring all customers benefit: promoting and safeguarding the interests of customers, particularly those who may otherwise be significantly disadvantaged or left behind in the energy system transition. | Ofgem also asked distribution customers to focus on vulnerable customers. 'Vulnerable customers' is a broad and fluid definition ranging from the traditional considerations for those dependent on electrically powered medical devices to the fuel poor, but also encompassing more transiently vulnerable individuals such as families with new-borns or even customers who are off supply. There is perhaps a sliding scale of vulnerability, but we task ourselves especially with trying to address those either directly disadvantaged by the energy system particularly as it transitions to a lower carbon model or not able to take advantage of the opportunities offered by that energy system transition. |

***Table 2: Our strategic innovation objectives***

In considering these objectives, we additionally embrace our central role in the energy system by looking beyond the services that have been familiar to our sector, applying our thinking to the whole energy system and its supply chain. Additionally assisting communities and charities in their decarbonisation work, adopting data techniques, traditional or novel assets as appropriate for efficient and effective investment.

## Considering and mitigating the impact on vulnerable customers

The impact on vulnerable customers is worthy of specific attention given our company's character as an engineering centric organisation. The vast majority of our staff are engineers, craftsmen and staff who support them in their engineering roles. Unless we make a conscious effort to consider impacts on vulnerable customers, we can have tendency to see issues and technical problems to be solved and cost challenges to be reduced.

Innovation's part in ensuring vulnerable customers are considered has two key elements.

Firstly, because innovation projects are agents of change, they have the potential to disadvantage those least able to adapt to the changing energy environment. Examples of where that might manifest itself in practice are:

- the fuel-poor to respond to flexibility by scrimping on heating when they really need it; and

- those who cannot afford PV (i.e. solar generation), good insulation and flexible-load arrangements to pay more for energy than those who can afford these efficient energy measures.

Secondly, and conversely, innovation projects have the potential to address the arbitrary nature of the present energy environment by creating opportunities such as:

- microgrids, which can make rural supplies as strong as urban ones; and

- digital connections services, which can both assist those who can use them while also freeing staff to assist those less comfortable with energy connections.

In balancing our portfolio, we will ensure that we address the disadvantages where possible, minimising the potential downside for vulnerable customers while accentuating the benefits for all. We will also consider specific projects that assist those who, through no fault of their own, and for whatever reason, are on the margins of the energy environment, bringing them into the mainstream, reducing whole energy costs to them, and improving the energy performance of the below-average parts of the network.

In this portfolio, the role of community energy is important. Our LV networks literally hardwire communities together. Through projects around peer-to-peer trading and microgrids, and support for initiatives exploring community generation, storage and use, we can help create decentralised, more dependable and more affordable energy solutions. It is incumbent upon us to invest in exploring this.

## A framework for delivering the objectives

The strategic innovation objectives are clearly desirable but they are not stated at a level to make them clearly deliverable. In order to produce this we went through a process of better defining the areas of innovation activity required.

The majority of our innovation activity is associated with the areas of our plan that demand significant change and capability enhancement, which we refer to this as pull innovation. Strong pull factors include:

- the need to manage rapid load growth on the existing network, particularly at low voltage, driven by decarbonisation;

- the need to be able to model flexibility power flows and benefits, especially to address low voltage constraints;

- the requirement to analyse, understand and respond to changes in load diversity caused by mass adoption of low carbon technologies and the flexibility techniques that we expect to emerge; and

- the desire to enhance the notification and connections process to facilitate increased low carbon installation and multi-vector load use (e.g. hybrid heat pumps).

Innovation is also driven by the development of new technologies and techniques, or potentially social norms, often with the potential to disrupt traditional approaches. This push innovation is harder to quantify as it is generally associated with emerging technologies or changing lifestyles. In the past this would include the rise of electric vehicles as a serious transport choice. Going forward, artificial intelligence (AI), fifth generation mobile technology (5G) and internet of things (IoT) solutions are likely to create new opportunities, as are self-driving vehicles, or home working patterns. But there will be other technologies as yet unknown that might be just as important. We need to remain agile and ready to seize the opportunities they will offer.

Data and digitalisation is particularly relevant because it will offer both push and pull opportunities, especially as we move to a DSO world. Initially it will improve the way we deliver our existing services – connecting customers' load, keeping the lights on and facilitating decarbonisation. But we expect this to evolve to enable a host of wider whole system benefits for customers and some of the two-way automated interfaces we will need are yet to be conceived. Network data will transform our business operations and those of others. Other people's data will transform our

network operations combining network and customer data to drive automated system optimisation in a blended data closed-loop control system.

Through an iterative process internally, with our non-executive director with responsibility for innovation and with our external technical panel these "*pull*" capability requirements were refined to the set of six listed in the table below. The six transformational capability areas are supported by 32 skill areas (see appendix 1) where our projects will be centred. We also explicitly considered what the benefits we expected to achieve on the back of improvements in the capabilities and which of the plan sections would be expected to benefit.

| Ref. | Innovation Transformational Capabilities | Benefits | Impact on plan sections | |
|---|---|---|---|---|
| | | | Major | Minor |
| IN1 | Identify opportunities to accelerate the benefits of flexibility | – Allow use of low cost energy at times of plentiful generation.<br>– Contain network costs by avoiding reinforcement.<br>– Facilitate faster connections and installations of customer equipment.<br>– Minimise disruption at times of reduced network or generation availability.<br>– Improved scheduling of asset reinforcement and renewal – lower cost, disruption to customers, smarter works co-ordination.<br>– A richer understanding of the implications and benefits of flexibility, how best to deploy it and the mechanisms to use it most effectively. | Decarbonisation connections | Reliability and availability<br>Climate Resilience<br>Customer service |
| IN2 | Develop sophisticated data management and analytics to inform energy system forecasting, planning and real-time decision-making | – Cost reduction via artificial intelligence in place of labour-intensive processes.<br>– More targeted, lower cost reinforcement and flexibility purchasing.<br>– Allow energy matchmaking in the connections process, reducing connections costs.<br>– Interconnected systems giving faster speed of response, more efficient processes and easier access to information.<br>– New opportunities to exploit mass data streams through integration and access to key information.<br>– Improved scheduling of asset reinforcement and renewal – lower cost, disruption to customers, smarter works co-ordination. | Asset resilience<br>Decarbonisation<br>Reliability and Availability<br>Openness and transparency<br>Climate resilience | Physical and cyber resilience<br>Customer service<br>Vulnerability strategy<br>Our communities<br>Connections<br>Environmental action plan<br>Safety |
| IN3 | Enhance the connections process to facilitate higher volumes and different types of connection | – Applies to both new connections and additional load on existing connections.<br>– Ensure that the electricity network is not a barrier to decarbonisation.<br>– A lower cost for connections.<br>– A quicker and more tailored connections service, for improved customer satisfaction.<br>– Longer opening hours and more convenient access to our services.<br>– Transparency of connections design and pricing decision-making.<br>– Greater internal capacity to facilitate more LCT connections that contribute towards our Net Zero ambitions. | Connections decarbonisation<br>Customer service | |

| Ref. | Innovation Transformational Capabilities | Benefits | Impact on plan sections | |
|---|---|---|---|---|
| | | | Major | Minor |
| IN4 | Maintain the dependability of the energy system as seen by the customer during the energy system transition and decarbonisation | – Energy remains dependable even with a reduced number of energy sources.<br>– Customers can expect power to their homes particularly when they need it most (e.g. during storms).<br>– Power for all uses including heat, transport, and information systems will be available throughout the seasons.<br>– Summer minimum and winter maximum demands and corresponding generation loads catered for. | Reliability and availability<br>Asset resilience<br>Climate resilience<br>Customer service<br>Vulnerability Strategy | Decarbonisation<br>Physical and cyber resilience |
| IN5 | Remove barriers preventing access to the energy, including access to energy data; particularly for those not currently engaged or informed, vulnerable or less-advantaged | – Customers know they can depend on the whole energy system to provide power to meet their needs as they become more reliant on electricity.<br>– Customers support the work programmes and initiatives we run to manage the network.<br>– Customers are more inclined to transition to low carbon technologies. | Vulnerability Strategy<br>Decarbonisation<br>Customer service | Reliability and availability<br>Our communities<br>Connections<br>Openness and transparency |
| IN6 | Create capabilities to deliver a next generation local energy network that links up whole system energy sources and vectors, balancing in real time | – All customers understand the benefits of a smart flexible energy system and know how to access them.<br>– Facilitating a fair and equitable transition to a low carbon energy system.<br>– A faster route to Net Zero with more customers able to access low carbon energy.<br>– Enhanced energy system reliance to physical and cyber disruption. | Decarbonisation<br>Reliability and availability<br>Asset resilience<br>Customer service<br>Vulnerability strategy<br>Communities<br>Connections | Climate Resilience<br>Environmental action plan<br>Physical and cyber resilience |

***Table 3: Our transformational capability propositions objectives***

Considering each of the likely scenarios during the period to 2028 the predictable extremes involve more rapid decarbonisation than the base case or more clustered decarbonisation; that is in line with the base case overall but faster in some areas and slower in others. The transformational capabilities we have outlined address this, but the emphasis will change. On flexibility we will pursue LV flexibility to address LV constraints more vigorously. Our dependability work will be guided by where clusters are appearing, in cities or rural areas. In essence the strategy will remain but the tactical approach will respond to the emerging situation.

We then considered the *push* innovation potential. While it is clear that emerging disruptive technologies and techniques will push innovation and unlock new opportunities, they can be difficult to define – some of them we cannot yet imagine:

- new technologies and approaches open up opportunities for doing things more efficiently or in new ways that contribute towards our business goals (e.g. reducing environmental impact or improving customer satisfaction); and

- new social norms such as working from home or active transformation may change energy use patterns significantly as we saw in spring 2020.

Our proactive project generation process (see the innovation project life cycle section below) identified the candidates listed on the right and we systematically assessed them for potential use cases and benefits, where appropriate undertaking desktop assessments of the concept.

However it is likely that many of the push innovations will not yet be identified, by the nature of them. We must therefore stay open-minded, alert and agile in this space; something our innovation management methodology assists us with.

The culture of innovation we have nurtured within the organisation and with our stakeholders is reinforced by the processes built to support it. Innovation is a strategically vital process and that is reflected by our Board having instigated an independently-chaired innovation advisory board (IAB), which is set up to provide scrutiny, challenge and oversight of the overall innovation program. It is led by a non-executive director, who is a leading academic in the field of sustainable energy systems and reports routinely to the Board on progress, issues and opportunities to improve. The group comprises the key senior managers and directors with specific responsibilities that are particularly relevant to the innovation program. This culture and the structures around it are discussed further in the section on Promoting innovation by creating the right culture, supported by the right processes (see page 21)

Pushing innovation with the potential offered by key disruptive technologies to unlock opportunities not yet identified

- Proactive 'horizon scanning' identifies new, disruptive technologies and approaches which are systematically assessed for potential use cases and benefits that are then *'pushed'* out from the centre to areas of the business that can derive most value from them
- This includes:
  - BHE business: Our well-established collaborative programme with our US businesses has a dedicated workstream which assesses new technologies for implementation opportunities. Recent examples include 5G network, drones and vehicle to grid
  - Educational institutes: We work with universities (including Newcastle and Bath) on existing innovation projects and have access to their emerging areas of research and development
  - Strategic partnerships: We have access to multi-national technology specialists through our IT delivery partnerships (TCS, Capgemini), as well as third party organisations who we have worked with on past innovation projects (Nissan, EIC, EATL, SGS)
- Some of the major technologies we expect to be deploying and utilising in ED2 include:
  - Internet of things (low cost connected sensors): mass data collection becomes ever cheaper
  - Data Analytics: new tools and capability to quickly and efficiently interrogate large data sets
  - Artificial Intelligence and Automation Machine Learning: pervasive process automation and improvement
  - Field automation and robotics: improvements to safety, access, working time
  - Edge / Fog Computing: de-centralised IT infrastructure that can be used for an intelligent / self-healing network and semi-autonomous system operation
  - Augmented Reality: that could be used in areas such as maintenance work, inspections, training
  - Application Programming Interface (API) ecosystem: sophisticated and deliberate use of multiple API connections as a core feature in our approach to open data
  - Digital Twins: digital representations of network and asset data for network planning and management
  - 5G network: significantly faster telecommunications capabilities across the network
  - Superconductors: reduced losses, increased capacities, potential magnetic applications

## Stakeholder input

Stakeholder engagement is both an ongoing part of our business process and a specific activity associated with building our business plan submission.

In normal ongoing business practices, stakeholder engagement is a continuous process that forms our opinions on priorities and areas of interest. For innovation, engagement focuses on what solutions innovation can provide and, vice versa, what issues does the wider business need to address.

***Boston Spa Energy Efficiency*** is a project proposed to us by a customer that has the potential to reduce customer energy bills. It uses smart meter data and existing information infrastructure, power system assets and control a systems to optimise voltages as the customers' premises, reducing over consumption of energy by around £20 per annum for each customer supplied by a primary substation where the scheme is installed. Previous innovation projects by ENW suggest that customers will see no adverse effects and are likely to be unaware of the new voltage regime except in a slightly lower bill. The customer who proposed the idea has accepted a position on the project board to assist in overseeing the project.

We periodically consult internal and external stakeholders to better understand their views, and through this we seek to understand the potential for innovation to meet stakeholders' needs. By involving stakeholders and customers at the early stage in the development of ideas, we can maximise the opportunity to access external funding and collaboration to complement the range of incentives for innovation that exist within our regulatory framework.

It is in the confluence of these engagement flows that the innovation portfolio and projects are defined.

In a typical year around two thirds of the innovation investment we make is on ideas suggested by third parties.

This is low-key valuable engagement and will continue during the next period as it has during this current one.

With regard to this business plan itself specific stakeholder engagement has been undertaken. Along with our overall vision our innovation strategy has been developed from this stakeholder engagement and reflects our customer and stakeholders' top priorities. The engagement has involved:

- working 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;
- commissioning an experienced, independent research agency to review our prioritisation research over the past five years, helping us to understand trends over time, as well as emerging priorities, to inform future engagement; and
- conducting best practice prioritisation research with large representative groups of domestic customers and wider stakeholders to understand their changing priorities, identify gaps and help us prioritise improvement initiatives identified through more in-depth engagement.

Innovation engagement has also focused around how and where innovation can support the output plan sections, directly engaging with the technical panel, stakeholder panel and IAB - feedback has informed the set of transformational capabilities that have been developed

Given innovations' position as an enabler for many future activities, much of the engagement done in output plan sections indirectly supports the 'need' for innovation in order to deliver propositions in those sections. Since innovation touches all areas of our business, all stakeholder groups are impacted by our approach to innovation and we have focused our innovation engagement activities across all 12 output areas of our plan, as well as the other enablers.

In summary, when asked about innovation stakeholders have told us:

- Most participants felt that Northern Powergrid should look to potential outcomes for consumers as the primary factor in allocating its innovation budget, to avoid investment in areas that would not reflect its customers' priorities. We note that in the wider company-wide engagement exercises decarbonisation and affordability were key.
- Reliability is the highest priority area where we should pursue innovation as it's central to our role as a DNO. This is perhaps unsurprising given a reliable low carbon energy supply will be a prerequisite for decarbonising heat and transport.
- Innovation spend should be driven by projects that will deliver the best customer outcomes.
- Funding for innovation through network charges is acceptable.
- We need to avoid jargon when explaining innovation and technical aspects of the projects to focus on customer benefits and outcomes, making it understandable in layman's terms.
- Flexibility is increasingly important for a successful energy transition.
- Open data with greater availability of network data is supported.

- Invest “ahead of need” to support flexible connections.
- Preparations to develop a network for the future must underpin net zero.
- Future energy services and data sharing is supported.
- Developing an integrated future energy network is a priority.

Key messages from our stakeholders are reflected in plans through:

- Our strategic objectives recognising innovation as a key enabler in operating a dependable network that facilitates a net zero future for all customers, making use of new techniques particularly data driven methods to reduce cost through increased productivity and efficiency and improve customer service; and
- The transformational capabilities (see page five) that have emerged where innovation will be crucial in enabling the delivery of the propositions in the output areas of our plan; having to identify new methods to achieve targets and lower costs.

Ultimately, however, the innovation portfolio is not a pre-packaged proposal at the time of the development of this innovation strategy and there will be scope for stakeholders to provide direction to our efforts as we go forward. Our key engagement objects going forwards are therefore to:

- continue to inform stakeholders to allow them to make reasoned input to our plans; and
- use the input obtained to the balance and re-direct our innovation portfolio.

A full view of our can be found here our detailed engagement findings.

# Implementing our innovation strategy

**Promoting innovation by creating the right culture, supported by the right processes**

Innovation is a key element of our culture, originating from the executive leadership team and found throughout the organisation, empowering colleagues at all levels to challenge the status quo. It is driven top down by our executive via oversight meetings, and bottom up by engagement in the field with staff at the workface and is embedded throughout the organisation.

We believe that the most valuable innovation tends to cut across many aspects of our business, and to support this we aim to create and foster an environment that encourages all of our employees to bring new ideas to the table. To do this, we need to establish the necessary process and routes through which innovative ideas can be generated, evaluated and implemented.

***Resin Mixing*** is a project that was proposed by one of our cable jointers. Our senior managers make regular visits to see craftsmen and engineers in the field to better understand, and where possible address, the challenges they face. During one such visit it was suggested that a better method of mixing the resin used to protect cable joints (joints require multiple bags of resin weighting many kilograms) would reduce the physical strain on craftsmen and lead to more consistent mixing and better joint protection. The benefits are mainly to cable reliability, but there are also health benefits to the craftsmen. https://www.northernpowergrid.com/innovation)

We consider the innovation culture to be a continuum that spans small continuous improvement actions and business as usual developments looked after by individuals, though to project teams working on improving specific key business activities (KBAs) and large externally funded projects. It is not restricted to a single section or funding stream.

While 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:

- 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.
- A small, 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 on-going innovation projects meets monthly to review progress.
- Quarterly this group of directors and the head of innovation report to the independently-chaired IAB, which itself reports to the Board. This creates a forum to discuss progress and set direction at the 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.

Much of our large-scale strategic innovation work is undertaken with external partners including research institutions, other industry peers and manufacturers, with around 85 per cent of our regulatory funded innovation investment being expended by others. Refer to page 31 for details on how innovation funding works.

Continuous innovation demands that we are agile to change in the way that we manage our business. It is the responsibility of our executive team to make sure that projects investigating changes that affect multiple parts of our business are implemented effectively and efficiently, to ensure that the full benefits of innovation are achieved.

As part of our annual business planning round, we set specific corporate goals, including objectives related to innovation. We differentiate these management goals between those that can be delivered by an incremental improvement, and those that need us to make a step change. Step-change projects reflect high-priority targets for our business, and tend to require significant executive input. These targets are reflected in our senior managers' personal objectives, meaning our leadership teams have strong incentives to implement new ideas successfully.

### *The innovation project life cycle*

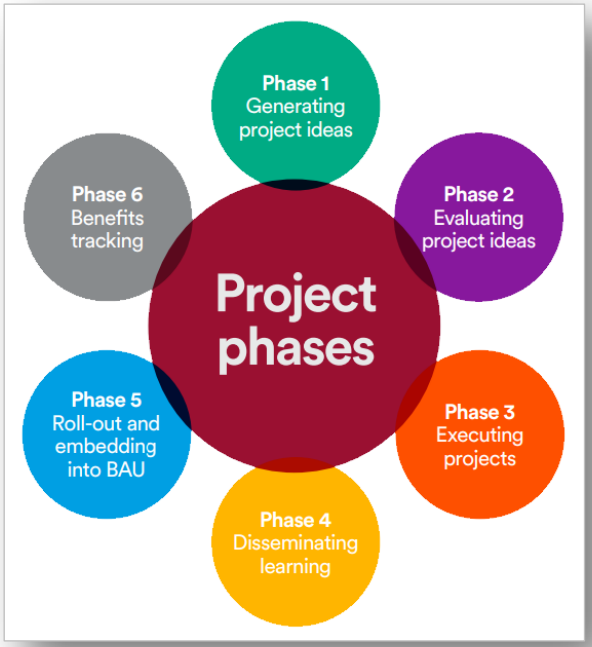



*Figure 2: Innovation project life cycle*

| Project phase | Description |
|---|---|
| Generating project ideas | – Project proposals arrive through:<br>▪ seeking to solve problems;<br>▪ third parties seeking funding and collaboration opportunities; and<br>▪ building on earlier innovation projects (of our own or other parties).<br>– Sources of proposals include research projects, other parties' innovation projects; suggestions from internal and external stakeholders; scientific papers; and benchmarking activities.<br>– 'Horizon scanning' enables us to identify developments elsewhere in our industry and beyond the energy sector.<br>– 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.<br>– We expect that as the energy sector becomes more whole systems orientated we may be facilitating innovation that benefits our customers, but where we neither implement the innovation nor deliver the benefits. We expect that third parties will propose these to us and we will encourage them to do so via ongoing stakeholder events and our existing direct contact channels. |

| Project phase | Description |
|---|---|
| Evaluating Project ideas | – Assessing a possible project includes determining whether it is strategically aligned with our company vision, investment appraisal and risk assessment.<br>– Evaluation is undertaken at a level commensurate with the scale of the project, with board-level evaluation for larger projects.<br>– 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. Our processes therefore ensure that customers and stakeholders get the best value for money from our innovation activities. |
| Executing projects | – Delivery partners are frequently identified as part of the project generation phase. Examples include academic institutions, other network operators, and manufacturers.<br>– They are formally incorporated into the project via our authorisation and tendering process at the beginning of the execution phase.<br>– Smaller projects are managed by one individual as part of their general workload while larger projects involve a project team and project board structure. All projects have a responsible senior manager and executive sponsor.<br>– 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.<br>– Where projects are brought to us be third parties the third party will normally be offered the opportunity to be involved. For subject matter experts (SMEs), academics or consultants that might be as project partners; for customers it is more likely to be as part of the project board. |
| Disseminating learning | – Dissemination is a key part of the innovation process. It includes sharing learnings with employees and internal stakeholders through internal communications initiatives.<br>– 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 the country, not just in our regions, can reap the benefits of innovation funded through this mechanism. |
| Roll-out and embedding into 'business as usual' (BAU) | – At this stage, we define business benefits that we expect to gain from the innovation project.<br>– We identify business benefit owners responsible for making sure these benefits of the innovation project are rolled out.<br>– 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.<br>– We note that for whole systems innovation we may not be the party rolling out the learning. |
| Benefits tracking | – Benefits are tracked and monitored against a benefits realisation plan.<br>– For externally facing innovations, stakeholder feedback, including suggestions for improvement, forms part of the benefits tracking. |

| Project phase | Description |
|---|---|
| | – 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 three to six 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.<br><br>– While we may not be the party rolling out the learning for some third-party or whole systems innovation we will attempt to record the benefits to understand how our customers have benefited from our involvement, though we accept this may be difficult in some situations. |

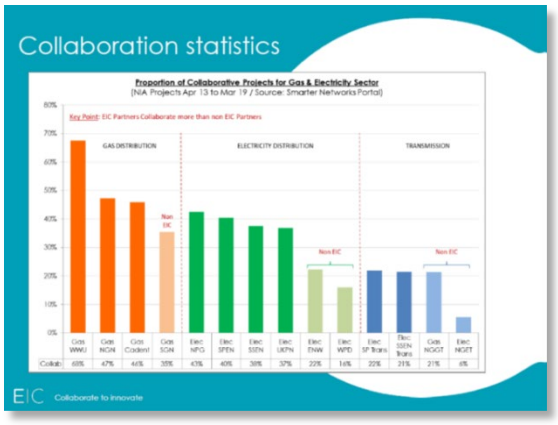
*Table 4: The innovation project lifecycle*

## To ensure the maximum benefit of innovation for our region, the industry and wider sectors, collaboration is at the heart of our strategy

### Generating project proposals

Northern Powergrid innovation fits into a wider innovation environment and our interaction with other players is immensely valuable. We will always benefit from the exchange of information and knowledge with others addressing similar problems.

Innovation is deliberately not siloed within Northern Powergrid. We source ideas widely across our organisation, from other companies within our ownership group, and from our customers and stakeholders




The open-innovation ethos of the NIA encourages this learning from and building on the knowledge and work of others. We take pride in the fact that some of our key projects are based on other people's proposals, including a present project suggested to us by a domestic customer that has the potential to save energy consumers millions of pounds.[10] That customer remains in a non-executive role on that project.

Culturally, we are committed to ensuring an environment within our business where new technologies and learnings are sought out, shared and embraced to provide a modern local energy network where improvements are always being made.

Our ownership structure plays an important role in how innovation projects are generated. As part of the wider Berkshire Hathaway Energy group (BHE), we benefit from exchanging information on the issues network companies face and the solutions they are finding in a number of regulatory jurisdictions.

This is completed formally through the group-wide grid innovation collaborative, but the relationships built by this collaborative also allow a less-formal exchange of ideas with Canada and the US. In the recent past, this has resulted in a number of formal best-practice-sharing projects in areas such as low carbon loads, procurement,

**Our ownership structure opens possibilities**

We note that Ofgem's Innovation Vision mentions proposals around small nuclear generation plant. As a regulated distributor, it is exceedingly unlikely that Northern Powergrid would pursue such innovation; but another part of the Berkshire Hathaway Energy organisation to which we belong is doing exactly that now. The ownership structure allows us to make the wider group aware of Ofgem's interest and to assist them in understanding how they might approach the GB energy market – a benefit to Ofgem's vision and GB energy customers.

[10] Boston Spa energy efficiency trial (BEET) – potential savings of up to £500m per annum across all GB customers.

capital investment management, customer service management and safety management.

We have a well-established ethos of partnership and collaboration with a diverse range of organisations; our portfolio[11] including customer-led distribution system (CLDS), ACE, SilentPower, InTEGReL, AutoDesign and MicroResilience is testament to that. The Energy Innovation Centre has ranked us as the most collaborative electricity network (see the EIC diagram above)

This is set to continue as we develop existing relationships and actively seek out new partnerships and opportunities to collaborate. In a typical year around two thirds of the innovation ideas are suggested by third parties and 85 per cent of our innovation investment is with third parties. All innovation proposals we undertake will continue to be subject to review by our non-executive director with innovation oversight.

As part of our whole system approach to decarbonisation, it is essential that our collaboration includes other network companies and companies from other sectors. This includes working together to develop innovation projects but also disseminating the learning from the projects of others. We are doing that already through our work at InTEGReL and with Nissan, our discussions with the rail sector, and our dissemination of DS3 learning to developers who are putting proposals their together. We encourage our teams to look at business models and approaches outside our company. This has resulted in innovative ideas for new services that enhance the customer experience, and new working models that allow greater flexibility for handling customer enquiries. This will only increase as we go forward.

**SilentPower** has allowed us to use a carbon-free alternative, to reduce running costs and support customer's solar generation in 25 per cent of the small faults previously restored by mobile diesel generators.


This 'horizon scanning' also means that we continually look for new developments elsewhere in the industry. As part of our annual business plan review we benchmark our performance against our peers to seek opportunities for improvement. This approach aims to:

- identify new ideas that might improve our business, based on tried-and-tested solutions; and
- build partnerships with other organisations that have different capabilities and are willing to help us generate ideas, solve problems in different ways and pursue more ambitious projects.

As we go forward, Ofgem's new strategic investment fund (SIF) presents an excellent method of drawing third-party ideas into energy systems innovation, particularly the wider energy ecosystem innovation that might not be best served by the NIA with its network focus.

We welcome this additional formalisation and instituationalisation of collaborative innovation.

### Filtering, testing and evaluating ideas

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, and innovation projects are no different.

Within our business, detailed quantitative investment appraisal and risk analysis drives the selection of investment projects, policies and schedules of work. The appraisal process supports the fundamentals of cost optimisation and by driving consideration of alternative options. We apply the same fundamental approach to innovation projects. On completion of an innovation project the same appraisal process applied to business as usual investments requires us to consider any cost or performance benefits revealed by the innovation project that might benefit the customer either in

[11] https://www.northernpowergrid.com/innovation

reduced bills or inceased service performance. These benefits are significant and are discussed further in the funding innovation, roll out and capturing benefits section (see page 29).

Our established appraisal process has distinguished us as one of the most efficient businesses in our sector, and we believe our discipline on quantified investment appraisal is second to none.

We have established strong processes that will ensure customers and stakeholders get the best value for money from our asset investment activities. To evaluate innovative business ideas, we apply those same techniques for rigorous assessment and appraisal.

We develop a clear proposition, assess project costs and understand the benefits that the investment is expected to deliver. We also consider alternative methods of achieving the same outcome, the availability of internal and external resources and project risks before validating any item of expenditure.

Competing options, including costs and benefits, are then tested against the guiding principles of innovation that are laid out above (see page 10).

We know that innovation projects, particularly those that introduce additional complexity to our operations, can introduce new risks to our business. To manage these risks effectively, our evaluation of innovation projects incorporates a strong focus on the practical implications of adopting a new idea or process, and an assessment of any associated technical risks. We ensure that we test new technologies thoroughly to understand their properties and evaluate their benefits.

For example, we might restrict the deployment of new, untried technology to a limited number of sites, and ideally we would select locations on the network that have relatively low criticality if the new equipment were to cause problems. Once we have built up a period of service history and track record, we roll out the successful innovations more widely.

Where a new technology, process or procedure introduces new risk or practical complexity, it must clear a higher hurdle, in terms of the benefits it will deliver, before we decide to implement it. We think this is a prudent and sensible approach to take, both commercially and in terms of delivering benefits to customers.

Projects that do not presently meet the hurdle may be revisited in the future as circumstances change and, either the benefit improves or the risks diminish.

### Executing projects and working collaboratively

It is very unusual that innovation can be undertaken by one party in isolation. There is a truism that if you are trying to change your practice or develop a novel technique within your operations, then it is unlikely that your existing skillset will be sufficient. These are, after all, things you do not presently know how to do.

We believe it is vital to approach project delivery and development collaboratively and we are committed to continuing to pursue projects in collaboration with external parties as part of our approach to implementing innovation.

We collaborate in a number of ways on innovation projects. We lead some projects directly relating to our network, supporting other DNO's on others, but always with external third parties providing knowledge and expertise. We also play a supporting role to external parties on projects that relate directly to the use of our network, but indirectly to the network itself: for example, Nissan's e4Future examining the commercial offering for vehicle to grid.

As well as bringing benefits in breadth of outlook and capability, external involvement can also increase delivery risk and require more complex project management. Our experience of working collaboratively on projects such as the customer-led network revolution (CLNR) or our web services development programme (WSDP) taught us that we need to adapt our managerial routines if we are working across external organisations. Issues such as intellectual property rights, confidentiality and the apportionment of delivery risk all have to be dealt with up front – and they are things that we do not need to worry about when we are working on our own.

We have already noted the benefits we believe the SIF will bring and indeed it builds on our own practice in the most recent rounds of network innovation competition (NIC) submissions with both FlexR[12] in 2020 and Community DSO[13] in 2021 being third party led projects that we commended to the NIC process. We also expect to see more diverse projects, for example potentially supplying real time information on network loading on supplies to motorway service stations to allow mapping providers to advise drivers where charging might be easiest or cheapest.However much orf this will be geenrated externally and we cannot see the full scope that might apply at this time.

Using loading data to predict charging availability is one example of an open data based project. We expect this area to grow significantly and two-way data flows and closed loop control systems distributed across various data owners, providers and processors becoming the norm in the longer term. Our BEET project using customers' smart meter data, to optimise the voltages is a simple project which starts to explore the potential for such thinking.

We fully support the collaborative approach and as part of that support we understand that SMEs, academics and communities might not be best placed to underwrite some of the obligations that go with energy systems innovation. In particular we would expect to maintain control of and responsibility for safety, legal and regulatory obligations and for collaborative projects to be designed with this in mind.

### Disseminating successes and failures

Innovation does not happen in isolation. Sharing the results, impacts and benefits of our innovation projects is vital to improving the services that our customers receive. At the same time, supporting ongoing wider industry improvement, and ensuring we take part in peer-to-peer learning, are both critical steps in the evolution from innovation to business as usual.

For our stakeholders, quality dissemination of our innovation leads to a deeper understanding of the projects and technologies and enchances customer engagement with the product – ultimately delivering a smarter, more effective and more efficient service. At a national and international level, dissemination of our innovation successes and failures across the industry contributes to wider improvement and helps the sector move forward together, and at pace.

As we move into 2023-28, we will:

- evaluate and evolve the way we share information about our innovation programmes;
- build on past successes;
- learn from activity that has not been as effective as we had hoped;
- listen to stakeholders about how they want to receive information; and
- take advantage of new digital communication best practice.

There are three core ways in which we will disseminate information in 2023-28: events, media and digital communications, and co-creation workshops.

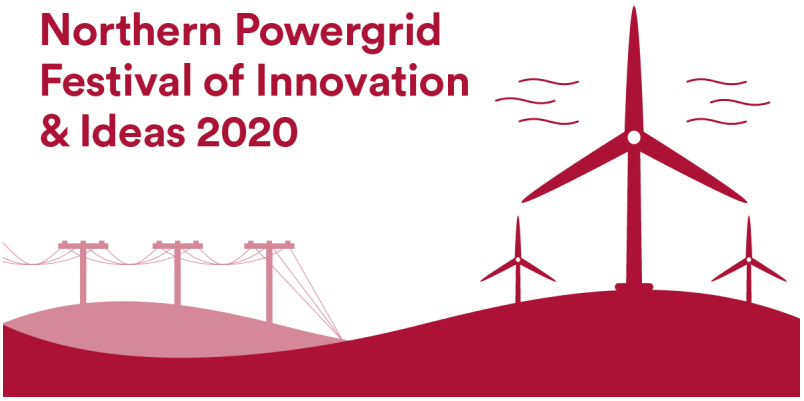
[12] Flexr was a proposal led by Elexon to innovate towards the DNOs' collective provision of a common GB energy system data platform and set of tools, thereby enabling third party access to data on network assets and customer flexible resources – both standing data and near real-time

[13] This project proposed by Delta-EE and TNEI will develop and trial approaches for integrating the operation of community and other smart local energy systems with the management of the lower voltage levels of a DNO's network. This will empower communities and other local stakeholders to pursue their own energy ambitions, without having adverse impacts on the distribution networks and allow DNO's to facilitate the achievement of net-zero. This will require DNOs to embrace a new role in which they act with communities to jointly create local "Community DSO" zones on existing network assets.

### Events

Events play a big part in sharing our findings. Northern Powergrid is a frequent contributor to national events such as the Low Carbon Networks and Innovation Conference (LCNI) and the Energy Networks Innovation Conference (ENIC), where we benefit from the opportunity to engage with our peers from the wider UK energy and utilities sectors. We will continue to be a big presence at these conferences throughout 2023-28, as well as at the International Conference on Electricity Distribution (CIRED), which gives us further opportunties to meet with peers on a global stage. In 2023-28 it will offer worldwide perspective and participation in peer-to-peer learning. At CIRED we are presently demonstrating our Foresight innovation project, with the aim that our innovation success could contribute to wider network development and enhancement.

At a regional level, we will take part in the Northumbrian Water Festival of Innovation – an annual event at which we engage with our peers across the wider utilities to share learning and developments that can improve our services and benefit our shared customers. We will also host our own Festival of Innovation & Ideas to demonstrate our projects, innovation and technologies to all interested parties. Our 2020 festival brought together close to 300 stakeholders – from academia to local authorities and low carbon technology (LCT) enthusiaists – to whom we demonstrated the technologies that are shaping their local power infrastructure and supporting the transition to net zero. As we move into the next price control period (2023-28) we intend to evolve this festival to include external guest speakers and offer stakeholders the opportunity to engage with wider industry experts on the subjects that interest them.




### Media and digital communications

We will also continue to disseminate innovation information through local, national and digital media to ensure that our customers can engage with new developments through traditional media or digital channels of their choice; and we will host peer-to-peer learning sessions for stakeholders such as local authorities to engage with our innovation developments. We will adopt a digital-first approach to sharing information to offer wider dissemination to more people around the region, country and globe. We will create compelling digital content:

- sharing it across our channels;
- boosting it via paid amplification;
- using it for direct bi-direction stakeholder conversations via an extensive tagging campaign embedded into many of our key innovation programmes in 2023-28; and
- supporting the above activity with webinar events.

### Co-creation workshop

When launching our flagship AutoDesign innovation tool, we hosted an electric vehicle (EV) co-planning workshop with 29 local authority representatives who tested live EV projects using the new tool. This event enabled us to gather

feedback and recommendations for future iterations in real time. The event received a 100 per cent positive feedback rating and in 2023-28 we will explore opportunities to host similar co-creation and co-planning sessions.

## Funding innovation, roll out and capturing benefits

Innovation is fundamental to running our business ever more efficiently. We invest in innovation expressly to reap future benefits by improving performance and services, and driving down the costs of our activities.

To deliver against these headline objectives, it is essential that we control and coordinate the rollout of innovation into business as usual. As such, we created and follow a benefits capture plan for each project.

As part of this benefits capture plan we assign responsibility for the realisation of benefits to the director with operational and investment responsibility in the area of our organisation where the benefits will manifest. These directors are key to successful innovation benefits as they are both the internal customers for and the suppliers of benefit from innovation. As members of the IAB, these directors are involved in reviewing innovation proposals, appraising the investment and assessing the project's capacity to unlock future savings, before an investment is made. Once the project is live the focus of the role, relative to that particular innovation project, is capturing the service and financial benefits during roll out of the innovation learning.

The assigned director is responsible for ensuring that we realise the benefits of the innovative solution, as well as recording and quantifying what it has delivered for customers and its impact on our cost base. This informs a statement of the captured benefits of innovation for that particular solution that is submitted to the quarterly innovation advisory board (IAB) meeting for scrutiny. The outputs of the IAB session are reported directly to our Board in a report given by the independent non-executive director who chairs the IAB.

For example, the asset management director with his responsibility for design was key to assessing the value of AutoDesign's automation budget estimate process and is delivering and recording the benefits from it, which will be over £1m by 2023 in addition to further benefits in the 2023-28 period. Our operations director is driving the roll out of SilentPower and capturing the restoration benefits associated, which is already making modest savings of around £20k and 90 tonnes of $CO_2$ per annum relative to the diesel generator alternative; benefits that will only grow as we roll out more units.

We will invest at least three times as much in creating new learning and innovative solutions (on a per annum basis) in the next regulatory period as we have in the current one. The majority of it will be totex funded, and we will invest significant funds in rolling out learning from earlier innovation projects to capture the benefits of innovation.

We will also be participating in the strategic innovation fund arrangements; a substantial and meaningful development from the previous NIC arrangements.

While we presently plan to invest £178m in innovation development and roll-out, the benefits in the period will be over 35% more at £283m, split between totex savings (£263m), connections benefits (£5m) and reduced energy bills (£15m).

| 2023-28 Period[1] (£m)<br>*Plan section* | Investment in BAU innovation and roll-out | Net benefit from innovation |
|---|---|---|
| Decarbonisation | 53.5 | 120.3 |
| Reliability and availability | 21.4 | 23.7 |
| Asset resilience | 20.1 | 77.9 |
| Climate resilience | 3.5 | 0.7 |
| Environment | 36.5 | 40.3 |
| Safety | 11.2 | - |
| Physical and cyber resilience | 12.1 | - |
| Customer service | 2.6 | - |
| Vulnerability | 1.9 | - |
| Communities | 1.0 | - |
| Openness and transparency | - | - |
| **Total - Totex** | 163.8 | 262.9 |
| Connections customer savings[2] | 6.0 | 5.4 |
| Energy bills savings[3] | 8.1 | 14.5 |
| **Total** | 178.4 | 282.8 |

*1. Excludes 2023-28 NIA costs and benefits*
*2. Net Present Value of benefits in line with our Open data CVP and Autodesign benefits from ED1 rollout*
*3. Net Present Value of benefits in line with our Voltage Optimisation CVP*

***Table 5: Innovation costs and benefits***

Those savings will continue to accrue into later regulatory periods and we expect a similar level of benefit in each of those periods.

Key benefits are mainly from the roll-out of previous innovation learning, and of particular note are the totex savings made via flexibility and energy bill reductions (from smart-meter-based dynamic voltage management). Both these areas of benefit owe their existence to the innovation projects across a number of DNOs, including Northern Powergrid, which have been amalgamated and built upon to form finished benefits applications. It is rare that single project produces benefit without cross-fertilisation from other innovation investment.

### Our budget for projects internally funded from totex is £178m – realising £283m of customer benefit

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 plan to invest £163.8m of totex related innovation rollout and BAU innovation expenditure in the 2023-28 period.

- Of this £135.0m is on rolling out innovation which will deliver a net benefit of £262.9m of efficiency benefit in the plan. This innovation strategy describes the processes we have followed to move innovation into business as usual to generate these savings, and will continue to follow as we generate further innovation learning.

- A further £28.8m drives non-financial performance related benefits, for example in safety and customer service, and benefits that will be realised for customer benefit by third parties.

We are also spending £14.1m on rollout out of two direct customer benefits:

- Automating our connections interactions will lead to an improved service, but it will also save customers using the connections process £5m (net).

- Our dynamic voltage optimisation technique based on information from smart meters will reduce energy bills customers £15m (net) by 2028 and by the time it is fully rolled out in 2035 and the project will have generated £214m of benefits for customers.

### Our budget for projects funded from the NIA is £25m – the benefits of this will mainly fall beyond 2028

The NIA was introduced by Ofgem for the 2015-23 regulatory period to encourage innovation sharing between DNOs. As part of the current price control, we were awarded 0.6 per cent of our revenue (just over £4m per annum) as funding for NIA projects – a specific regulatory allowance on top of our total expenditure for more uncertain innovation projects.

NIA funding will continue in the next regulatory period. While the majority of our innovation is totex funded, NIA funding is still required for areas where: there is considerable potential but also considerable uncertainty with regard to the level of benefits; the benefits are delayed by one or more regulatory periods; or where there may be significant whole-energy system benefits but lower network-related benefits. These projects are still worth doing, indeed they may be the most useful for the whole-country energy system, but they do not pass the test for totex funding.

Distributed storage and solar study (DS3) was an NIA-funded project in 2015-23. 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.
While there will be little direct benefit to Northern Powergrid, the learning will reduce costs for our customers interested in installing low carbon energy technology and speed decarbonisation.

Thus innovation funded by 'business as usual' (BAU) will not be sufficient on its own to address the needs we have for developing new solutions and we have further NIA-funded innovation to supplement the totex funded BAU efforts. We apply the same rigorous approach that is set out above to the development, management and delivery of any innovation project, regardless of its funding source.

Additionally, where the learning brings benefits appropriate for all GB network customers, or indeed whole-energy system customers, an open innovation framework is appropriate. NIA is one of the best examples of an open innovation framework, where investment and learning, particularly around the development and deployment end of innovation, in Yorkshire and the North East is made freely available across all GB customers and vice versa. This prevents a postcode lottery regarding the availability of improved performance and lower cost techniques.

We plan for Northern Powergrid's NIA-funded expenditure to be £25m for 2023-28 (roughly equivalent to current funding levels after allowing for inflation), around 40 per cent of which is already identified and all of which will be aligned with our areas of transformational capability. This is somewhat less than the Organisation for Economic Co-operation and Development (OECD) and government aspirations of around two per cent of gross domestic product (GDP) on research and development, but NIA expenditure is not the totality of our innovation expenditure and once totex funded innovation and participation in external innovation competitions covered below is taken into account it does not feel unreasonable. We would look for NIA funding to be covered by a single allowance for the whole period.

We expect to make a 10 per cent contribution towards our NIA funding proposals. This level is equitable for three reasons:

- the NIA-funded projects will tend to be the higher-risk, higher reward projects at an earlier stage of maturity. Less risky projects deploying more mature innovation into BAU will be funded via totex;
- NIA project tend to repeat rewards in subsequent periods. This means that due to the regulatory reset during a price control process customers, not shareholders, get the vast majority of the benefit; and
- the open innovation nature of NIA means that competitive advantage of NIA is limited to being the first mover; where the risk is also greatest.

Our NIA –funded projects will focus on innovation associated with decarbonisation and the activities which support it including customer vulnerability and ensuring customers can depend on their decarbonised energy supply. This will only be selected parts of the six transformational capability areas (other parts will be addressed via totex or competition funded innovation). More on the areas of focus of our NIA-funded innovation, including high-level costs and benefits, can be found in the appendices to this annex.

### Further innovation projects will be funded through competitive bids

Throughout the 2015-23 period we have funded innovation via competitive sources, either in our own right or by supporting third parties who wished to bid. Competitive funding bodies approached include Ofgem's Network Innovation Competition (NIC), the UK innovation agency Innovate UK, the European Commission's Horizon2020 programme, and the Department for Business, Energy and Industrial Strategy (BEIS).

Looking to the future, most of these competitive funds will remain, but NIC will cease to exist – however, a slightly more structured Ofgem competitive bid fund is expected to be in place, called the Strategic Innovation Fund (SIF).

Competitive funding has seen us participate in reliability as a service with Scottish and Southern Electricity Networks (SSEN), activating community engagement with GenGame and Newcastle University, and e4Future with Nissan. We led the industry's FlexR bid to develop rich data provision, standardisation and triage benefiting sustainability, affordability and reliability of our networks. We are supporting local energy with our Community DSO bid, and we have supported numerous academic bids considering early stage industry developments.

We will make competitive bids for funding where appropriate. This will be based on the match between our innovation interests and the areas of innovation funding in each competition and the nature of the benefits.

## The impact of innovation on skills and workforce

We also note in delivering this strategy, and the projects and in and roll out of learning it entails, we should not assume that the required skills will reside in our present workforce. Where a missing skillset is required long-term and is best placed within our organisation we will train or recruit accordingly. This is likely to see a greater proportion of data literate staff in the future, and engineers with higher skillsets.

However in many cases skills will be required short-term or do not sit well in our organisation. Some of these we will contract for traditionally, others will require a flexible approach. We expect to see more innovative approaches to workers being based partly in academic institutes and partly Northern Powergrid, and staff shared between consultants and ourselves.

Moreover while innovation will require us to learn new skillsets to address the new technologies and techniques we work with, it will also, through obsolescence or automation, remove the need for some skills. AutoDesign and automated power system restoration are already examples of that and we expect engineers to tend to become overseers of processes rather than implementers in many areas, with their skillsets migrating away from practitioner engineer towards engineering manager. Similarly data clerks will become data analysts.

This is discussed further in the workforce resilience annex.

# Appendix 1 – Focus areas/ Skills areas

Required areas of skill development by transformational capability area, including whether the innovation activity is likely to be push or pull innovation.

| Ref. | Transformational capability and required skill area | Strategic Outcomes | | | |
|---|---|---|---|---|---|
| | | Course to net zero | Open data | Next-level energy system dependability | All customers benefit |
| **1) Identify opportunities to accelerate the benefits of flexibility** | | | | | |
| 1.1 | Ability to model power flow effects of flexibility | ● | ○ | | ○ |
| 1.2 | Benefit quantification | ● | ● | | ○ |
| 1.3 | Evolving our network operation and control operations to support real-time DSO | ● | | ○ | ● |
| 1.4 | Development of commercial frameworks with third parties | ● | ● | ○ | ● |
| 1.5 | Understanding of the interaction of the flexible energy market and flexible network services market | ○ | ● | ○ | ○ |
| 1.6 | Development of call off procedures for contingency, in advance and reactive flexibility support | ● | ○ | ● | ● |
| 1.7 | Forecast of electric heating & EV charging patterns | ● | ○ | | ○ |
| 1.8 | Understanding the locational load shift caused by temporal load shift | ○ | ○ | | ○ |
| 1.9 | Understanding seasonal transport and heating shifts | ○ | ○ | ○ | ○ |
| **2) Develop sophisticated data management and analytics to inform energy system forecasting, planning and real-time decision-making** | | | | | |
| 2.1 | Speed of communications and data provision | ○ | ● | ● | ○ |
| 2.2 | Data stream integration | □ | ■ | □ | □ |
| 2.4 | Inter-seasonal energy planning | ○ | ● | ○ | ○ |
| 2.5 | Transparent and digitalised interactive capacity information requirements and provision | ○ | ● | | ○ |
| 2.6 | Externally focused smart asset records | | ● | ○ | ● |
| 2.7 | Automation | □ | | □ | ■ |
| **3) Enhance the connections process to facilitate higher volumes and different types of connection between areas** | | | | | |
| 3.1 | Two way open data platforms linking energy system data, user data and planning data | ○ | ● | ○ | ● |
| 3.2 | Dynamic data platforms | ○ | ● | | ● |
| **4) Increase the dependability of the electricity network as seen by the customer** | | | | | |
| 4.1 | Local reliability and resilience from a single energy vector | ○ | | ● | ○ |
| 4.2 | Local year-round security of supply from renewable energy sources | ● | | ● | ○ |
| **5) Remove barriers preventing access to the energy market for all customers; particularly those not currently engaged or informed, vulnerable or less-advantaged, and including access to energy data** | | | | | |
| 5.1 | Identify and deliver real benefit opportunities | ○ | ● | | ○ |
| 5.2 | Identify potential market failures | □ | □ | □ | □ |
| 5.3 | Safeguard customers whose vulnerability is increased by the pace of change | | ○ | ○ | ● |
| 5.4 | Make new energy offerings attractive to all | ○ | ● | | ○ |
| 5.5 | Ensure availability of information on benefits to relevant customer groups | | ● | | ● |
| 5.6 | Support passive customers | | ○ | ○ | ● |
| **6) Create capabilities to deliver a next generation local energy network that links up whole system energy sources and vectors, balancing in real time** | | | | | |
| 6.1 | Mobile demand and generation | ○ | ● | ● | ○ |
| 6.2 | Whole energy system batteries | ○ | | ● | ○ |
| 6.3 | Optimisation of industrial and commercial customers' future equipment | □ | ■ | □ | □ |
| 6.4 | Optimisation of domestic customers' future equipment | □ | ■ | □ | □ |
| 6.5 | Microgrid technology | ■ | | ■ | ■ |
| 6.6 | Voltage optimisation for energy efficiency | ● | | ● | ● |
| | ***Total* ●■** | ***9*** | ***16*** | ***8*** | ***12*** |
| | ***Total* ○□** | ***18*** | ***8*** | ***13*** | ***19*** |

**Pull, due to business requirements - ○=Moderate, ●=Major**

**Push, due to new technologies or business environment - □ =Moderate, ■ =Major**

# Appendix 2 - Known Innovative Initiatives and Roll Out of previous Innovation

| Plan Section | Outcome / Asset plan | Ref | Summary | Costs | Benefits | Qualitative benefits |
|---|---|---|---|---|---|---|
| **Totex** | | | | | | |
| ***BAU Innovation Investment*** | | | | | | |
| Decarb – DSO | Outcome | DSO1.1 | Build on existing information management capabilities to expand network data and integrate datasets including capturing more detailed data more regularly, purchasing data to enhance network visibility, and cleaning, structuring and storing data more effectively | 9.3 | 0.0 | • A robust dataset will allow data techniques to be developed that will improve dependability and reduce cost |
| | | DSO2.4 | Refine power flow models, and supplement forecasting and scenario modelling (such as DFES), using analytics engines to predict future power flows under different scenarios and therefore improving network planning and gaining operational insights | 8.0 | 0.0 | |
| | | DSO3.3 | Establish network flexibility and customer flexibility solutions enabled by control systems to manage thermal, voltage and fault level constraints | 0.2 | 21.6 | |
| | | DSO4.1 | Collaborate with the wider energy industry (via the ENA) to facilitate non-DSO services and network access rights | 4.3 | 0.0 | |
| | | DSO5.3 | Publish our improved forecasting information via our Network Development Plan and expanded Long Term Development Statement (LTDS) we share with stakeholders. Publish details of customer energy resources connected to our network via Embedded Capacity Register and details of network utilisation via heat maps. | 2.5 | 0.0 | |
| Environment | Outcome | EP1.5 | Implement charging infrastructure, at major sub-stations, depots and employees ' premises, to support ULEV vehicles on fleet | 1.9 | 0.0 | |
| | | EP2.2 | Install super low-loss amorphous core transformers | 0.0 | 0.0 | • losses reduction contributing to carbon footprint targets |
| | | EP2.4 | Improve the energy efficiency of our sub-stations | 0.0 | 0.0 | |
| Physical & Cyber Resilience | Outcome | PC2.1 | Design and implement core OT system and major substations network sensors | 3.0 | 0.0 | • Protecting our customers' power supply from physical breaches |
| | | PC2.3 | Invest in automated event response technology to help us quickly respond to cyber-attacks | 1.4 | 0.0 | |
| | | PC2.3 | Implement Endpoint Detection and Response (EDR) on our core systems ☐ | 1.4 | 0.0 | |
| | | PC4.1 | Deploy a resilient mobile communication system for our critical field colleagues | 6.4 | 0.0 | |
| | | PC4.2 | Establish vehicle deployable emergency communication hubs (deployable resilience) | 0.5 | 0.0 | |

| Plan Section | Outcome / Asset plan | Ref | Summary | Costs | Benefits | Qualitative benefits |
|---|---|---|---|---|---|---|
| Safety | Outcome | S1.4 | Deploy digital solutions to transform the process of safety data acquisition, processing and analytics to better inform improvement and intervention areas, including virtual reality training | 0.0 | 0.5 | • Improved safety performance. |
| | | S2.2 | Integrate hazard and near miss reporting systems through API solutions | 4.6 | 0.0 | |
| | | S4.2 | Ensure that new fleet vehicles are supplied with the latest available safety features as standard so that drivers are supported in avoiding accidents | 0.9 | 0.0 | |
| | | S4.3 | Ensure our fleet vehicles are equipped with the latest telematics technology to enable data-based interventions to support driver behaviour changes ☐ | 0.5 | 0.0 | |
| | | S5.4 | Enable the agricultural sector to reduce the number of contacts with overhead lines by developing an innovative technology solution to alert workers to the location of overhead lines | 0.0 | 0.0 | |
| Vulnerability | Outcome | VN1.3 | Give our vulnerable customers more choice in how they engage with us by creating a fully digitised 'one-stop-solution' to enable a more accessible, faster and convenient route to contact us and access our services. This will also free up capacity for a more responsive telephone-based service for those who prefer it | 1.9 | 0.0 | |
| Decarb - Whole systems | Outcome | WS4.1 | Collaborate with organisations supplying equipment and solutions to industrial and commercial (I&C) customers, and their trade bodies. This will ensure that standards for future I&C customer equipment and network infrastructure is specified for optimised performance and costs | 0.0 | 0.0 | |
| | | WS4.2 | Collaborate with organisations supplying equipment and solutions to domestic customers for use "behind the meter" and their associated trade bodies. This will ensure that standards for network optimisation and home optimisation complement each other, and that system planning keeps pace with changing customer demands | 0.0 | 0.0 | |
| Asset Resilience | **Asset plan -** Smart fault level switching schemes | | Use of sequential switching of circuit breakers and protection co-ordination to manage the imposed duty on switchgear and cable assets | 0.5 | 2.8 | |
| Reliability & Availability | **Asset plan -** HV cable monitoring | | We are exploring the use of portable Partial Discharge monitors. | 0.3 | 3.2 | |
| Asset Resilience | **Asset plan -** Re-sealing damaged cut outs | | We are working with our current cut-out supplier to develop a means of re-sealing damaged cut outs without the requirement to complete a cut out change. This option is relatively low cost and could potentially be completed with minimal operational activity. | 1.2 | 3.6 | |
| | **Asset plan -** Drones for overhead line and substation inspections | | Innovations into our inspection programmes including the use of drone technology as an alternative to helicopters. There are multiple use cases which will drive the specific type of deployment - "beyond visual line of site" vs "within visual line of site, autonomous vs non autonomous, fixed wing vs quad copter. | 0.1 | 0.6 | |
| | **Asset plan -** Machine learning for image processing and trend analysis | | Examine where the technology can be incorporated into the review of data from our inspection programmes e.g. reviewing hi-res imagines of overhead lines, switchgear profile testing | 0.3 | 0.5 | |
| | **Asset plan -** Smart metering data | | Data analytics to identify high risk cut outs | 2.7 | 10.7 | |
| Environment | **Asset plan -** Self-healing cables | | For fluid filled cables we will explore the use of a 'self-healing cables' additive. | 4.2 | 10.5 | |

| Plan Section | Outcome / Asset plan | Ref | Summary | Costs | Benefits | Qualitative benefits |
|---|---|---|---|---|---|---|
| Environment | **Asset plan -** Alternative technology / material solutions for substation building and civils | | Investigation into and adoption where feasible of lower carbon building material. | 0.1 | 0.1 | |
| Customer Service | Outcome | | To give customers the ability to book same day / next day appointments online, with the flexibility to extend these appointments to evenings and weekends | 1.6 | 0.1 | |
| ***Rollout of previous BAU innovation projects*** | | | | | | |
| Environment | Outcome | EP2.3 | Install low-loss (i.e. over-sized) LV and HV cables | 0.0 | 0.0 | |
| Decarb - Scenarios & investment | Outcome | SI2.4 | We will deploy DNO-contracted flexibility to shift peaks in demand on our network to enable deferment of traditional reinforcement | 1.8 | 14.0 | |
| Safety | Outcome | S1.3 | Complete an independent study into arc flash work-wear technology developments and renew our work-wear contract to ensure colleagues benefit from the latest technology | 5.2 | 0.0 | |
| Environment | **Asset plan -** SF6 alternatives | | In response to the decarbonisation agenda and to support the business to achieving net zero we will move away from the use of SF6 in new switchgear where practicable. | 10.5 | 10.5 | |
| Customer Service | Outcome | CS1.1 | Using digital solutions in order that customers can contact us 24/7. This means, a range of self-service options and offering the customer the choice to use their preferred contact method/channel | 1.0 | 0.0 | |
| | | CS1.5 | The increased use of RPA to streamline back office functions for improvement to customer facing activities. | 0.0 | 1.1 | |
| ***Rollout of previous funded innovation projects*** | | | | | | |
| Communities | Outcome | CO1.2 | Review potential social schemes using our social mapping tool | 1.0 | 0.0 | |
| Decarb - DSO | Outcome | DSO1.3 | Deliver targeted installation of LV load monitoring equipment and harvest data from other monitoring sources and integrate to form new datasets | 0.0 | 0.0 | |
| | | DSO3.1 | Create a Customer Flexibility system with Network Operation processes which enables us to automatically dispatch flexibility services by integrating systems (such as Power on Fusion) with our flexibility platform (Flexible Power Platform) | 7.4 | 21.6 | |
| | | DSO3.2 | Enhance our Active Network Management (ANM) coordination and control to manage thermal, voltage and fault level constraints using a central and/or local management system to control flexible customer assets | 2.6 | 21.6 | |
| | | DSO4.2 | Develop, cost and procure flexibility products that are fit for purpose, taking a 'flexibility first approach' | 5.7 | 21.6 | |
| | | DSO4.3 | Develop a flexibility services communication, engagement and trading platform that allows third parties such as flexibility providers and aggregators to keep track of flexibility services related information such as service requirements, procurement methods, contracts and outage visibility | 5.0 | 21.6 | |
| Decarb - Scenarios & investment | Outcome | SI2.1 | We will run flexibility tender exercises where we will seek to use flexibility to defer reinforcement at our major substations whilst continuing to seek to harness flexibility to defer reinforcement across all voltage levels | 0.0 | 0.0 | |

| Plan Section | Outcome / Asset plan | Ref | Summary | Costs | Benefits | Qualitative benefits |
|---|---|---|---|---|---|---|
| Reliability & Availability | Outcome | RA.9 | Expand Silent Power mobile battery units to support during planned and unplanned interruptions | 0.0 | 0.0 | |
| Vulnerability | Outcome | VN2.3 | Roll-out regional use of Net Zero-ready Silent Power self-generation vehicles to support temporary restoration during planned and unplanned outages | 0.0 | 0.1 | |
| Decarb - Whole systems | Outcome | WS3.1 | WS3.1) Undertake the first stage deployment of the blueprint for the next generation energy system to enhance system resilience, particularly for remote customers, by rolling out innovative microgrid technology in some of the most remote parts of our network | 6.7 | 0.7 | |
| Reliability & Availability | **Asset plan** - LV monitoring | | Distribution substation monitoring provides a platform for network data to inform planning decisions on interventions and potentially platform for flexibility dispatch. Substation monitoring and separate fault monitoring devices will provide additional and more proactive asset intelligence (e.g. frequent and granular fault and pre fault data) targeted at our worst performing circuits and/or cable types. | 21.1 | 41.9 | |
| Asset Resilience | **Asset plan** - Fault current limiters | | Use of fault current limiting technology at primary substations based on available and cost effective solutions available in the market | 3.3 | 3.8 | |
| Asset Resilience | **Asset plan** - Real time thermal ratings and automatic load transfers | | On the 132kV & EHV networks using a combination of smart grid techniques to increase available capacity from existing assets. | 3.8 | 9.0 | |
| Asset Resilience | **Asset plan** - Enhanced transformer ratings | | Use of advanced cooler management techniques at EHV and deployment of improved cooling systems at distribution substations | 0.7 | 7.4 | |
| Climate Resilience | **Asset plan** - LiDAR | | Use of LIDAR inspections to identify overhead line clearance issues, defects and for management of vegetation. | 3.5 | 4.2 | |
| Asset Resilience | **Asset plan** - Wood pole assessments | | Our recent foot patrols and the use of our new assessment device (Thor hammer) will provide us with an opportunity to better target the older poles in worst condition within our replacement and inspection programmes. | 0.5 | 42.1 | |
| Asset Resilience | **Asset plan** - Oil re-generation | | Use of mobile and on-line transformer oil re-generation as part of mid-life refurbishment to provide asset life extension. | 4.5 | 12.4 | |
| Asset Resilience | **Asset plan** - Online DGA | | Use of online dissolved gas analysis for the management of our 132kV and EHV transformers. This is enhanced condition monitoring for asset life extension. | 2.4 | 5.3 | |
| Environment | **Asset plan** - PFT | | For fluid filled cables we will increase use of per fluorocarbon tracers (PFT) as a leak detection technique. | 19.7 | 53.7 | |
| **Connections** | | | | | | |
| ***BAU Innovation Investment*** | | | | | | |
| Connections | Outcome | CN1.1 | Develop our digital platforms for customers who want to self-serve and provide enhanced upfront support for those who prefer to talk to us before making an application | 1.3 | 3.1 | • Further options for customers on how to engage with us<br>• Transparency of costs and timescales<br>• Quicker, more efficient connections<br>• Improved customer service |
| Connections | Outcome | CN2.1 | Develop AutoDesign functionality to enable customers to self-serve and generate quotations for LV demand and load increases and budget estimates for new generation connections | 1.3 | 3.1 | |
| Connections | Outcome | CN2.3 | Introduce new automated systems to streamline the notification/ application process for LCTs and facilitate mass uptake | 1.3 | 3.1 | |
| Connections | Outcome | CN3.1 | Make improvements to our HV and EHV network capacity heat maps to include the provision of integrated Long Term Development Statements (LTDS) information that can forecast changes in capacity availability | 0.0 | 0.0 | |

| Plan Section | Outcome / Asset plan | Ref | Summary | Costs | Benefits | Qualitative benefits |
|---|---|---|---|---|---|---|
| Connections | Outcome | CN4.3 | Develop a bespoke AutoDesign platform for ICPs/IDNOs with non-contestable costs | 1.3 | 3.1 | • Promotes competition<br>• Increased levels of information available to customers<br>• Improved customer service |
| Connections | Outcome | CN5.3 | For EHV connections, where a flexible solution could avoid the need for additional network reinforcement, we will have a detailed discussion within 14 days of receipt of a compliant application and provide the customer with the information they need to make an informed choice on the options available | 0.0 | 0.0 | • Account management / Single Point of Contact<br>• Improved customer service |
| Decarb - Whole systems | Outcome | WS1.2 | Collaborate with other network operators in our region to create an open register and a process that allows interested parties with complementary energy needs to find each other – 'energy match-making'. We will facilitate the initial engagement between parties, who can then work together to produce whole system benefit, such as reduced utilisation of the network, reduced probability of constraints and greater value that is possible by enhanced coordination □CVP | 0.4 | 0.0 | |
| **Energy Bills** | | | | | | |
| ***Rollout of previous funded innovation projects*** | | | | | | |
| Decarb - Whole systems | Outcome | WS3.2 | Optimise network voltage to improve energy efficiency delivering a reduction in customer energy bills and carbon emissions by dynamically managing voltage on our LV network | 7.9 | 14.5 | |
| **NIA** | | | | | | |
| Decarb - DSO | Outcome | DSO2.1 | Use analytics and machine learning to emulate high quality and granular time-series data sets for low voltage networks | 5.4 | 0.0 | • Transform our analysis capabilities to enable data-driven decision-making in planning and operational timescales to drive value for customers |
| Decarb - DSO | Outcome | DSO2.2 | Utilise analytics engines and machine learning to enhance and verify time-series data sets for high and extra high voltage networks | 2.4 | 0.0 | • A robust dataset will allow data techniques to be developed that will improve dependability and reduce cost |
| Decarb - DSO | Outcome | DSO2.3 | Create a static strategic planning model of the network which integrates historical and real-time data from various OT/IT systems | 5.9 | 0.0 | • Data techniques will improve dependability and reduce cost |
| Decarb - DSO | Outcome | DSO4.4 | Create a system to automatically validate flexibility service provision, calculate remuneration and issue relevant invoices or compensation | 1.6 | 0.0 | • Flexibility will be properly and accurately rewarded at minimal cost to the DUoS customer |
| Decarb - DSO | Outcome | DSO5.1 | Build enhanced functionality on top of an open data platform to unlock additional customer benefits. This will include a set of free analytical tools to help processing data and enhance self-service CVP | 0.0 | 0.0 | • Unlock new capabilities and benefits for customers through provision of open energy system data and engaging in joint planning with our stakeholders |

| Plan Section | Outcome / Asset plan | Ref | Summary | Costs | Benefits | Qualitative benefits |
|---|---|---|---|---|---|---|
| Decarb - Whole systems | Outcome | WS1.1 | Undertake an NIA funded innovation project informed by inter-seasonal energy requirements (ref WS2.3) to determine the system impact of and commercial options for inter-seasonal storage. This will provide commercial and technical energy policy insights to drive this future market | 0.3 | 0.0 | • Building understanding that will allow a market to develop to meet the need for the summer harvesting and winter deployment of energy |
| Decarb - Whole systems | Outcome | WS2.2 | Develop new network planning tools to improve our modelling of the impact of flexibility and mobile loads, and therefore improve our network planning process. We will work with other DNOs and build on previous learning | 1.1 | 0.0 | • Improved network planning that will improve dependability and reduce cost |
| Decarb - Whole systems | Outcome | WS2.3 | Undertake an NIA funded innovation project to develop techniques to understand the differing summer and winter loads as electric heat develops and generation becomes dominated by renewables, and the requirement for summer harvested energy to be stored for winter use (enabling inter-seasonal storage ref. WS1.1) | 0.1 | 0.0 | • Understanding of the difference in summer and winter generation and demand profiles including heat and transport will allow us to define the need for summer harvesting and winter deployment of energy |
| Decarb - Whole systems | Outcome | WS2.4 | Building on NGN's Winlaton hydrogen and our joint INTEGREL projects, we will collaborate with NGN and other partners to develop cross-vector energy storage technologies to allow energy optimisation between vectors and provide additional value to our customers offering these services | 0.2 | 0.0 | • Accelerated decarbonisation minimising the costs via appropriate choices of energy vectors and flexible transfer between them |
| Connections | Outcome | CN2.2 | Utilise AutoDesign technology to develop a LV network availability heat map that utilises LV monitoring and smart meter data to enable real-time system planning | 1.3 | 3.1 | • Further options for customers on how to engage with us<br>• Transparency of costs and timescales Quicker, more efficient connections<br>• Improved levels of customer service |
| Connections | Outcome | CN3.2 | Create a front-end online portal into Enterprise ANM to allow ANM connected customers to access network information and curtailment operations | - | - | • Digital enabler of flexibility |

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