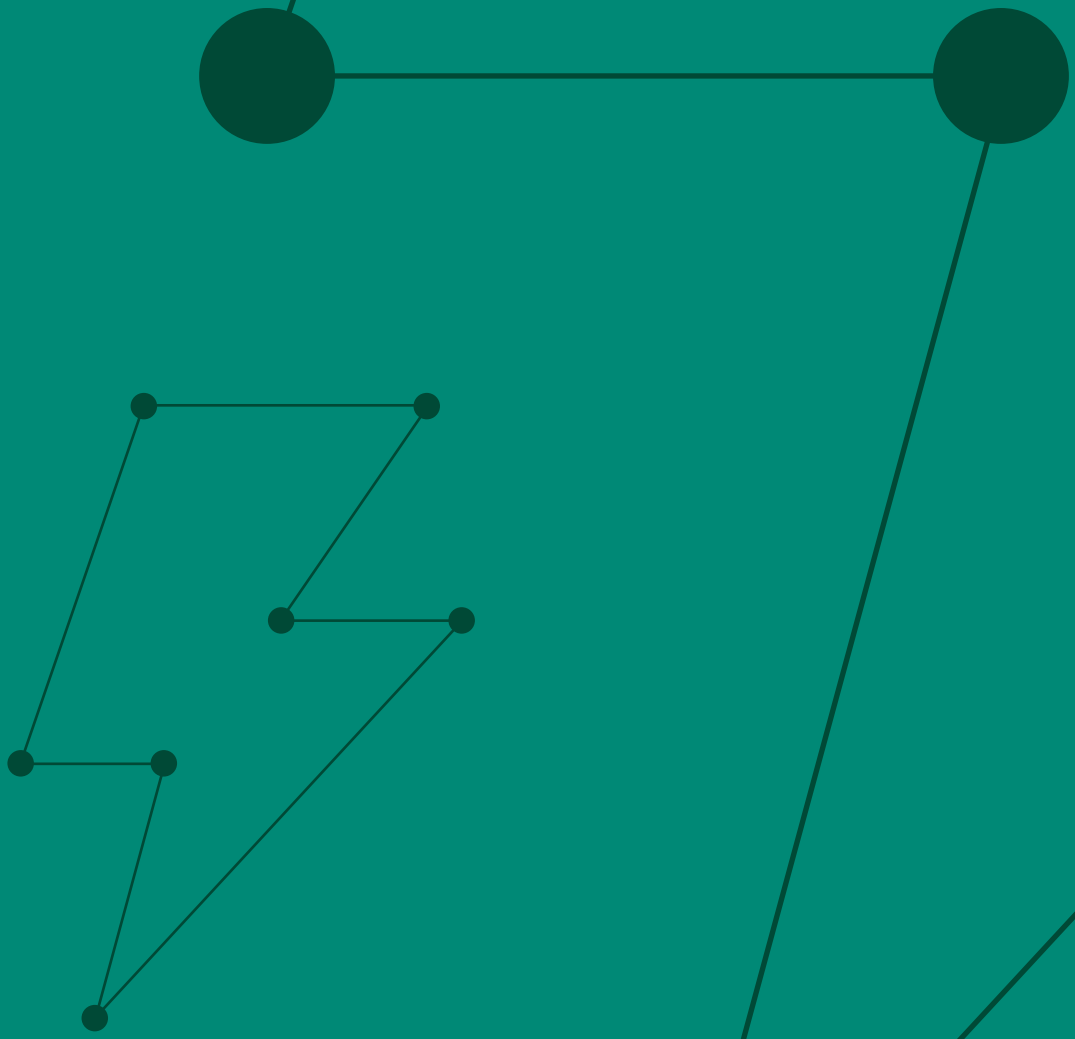
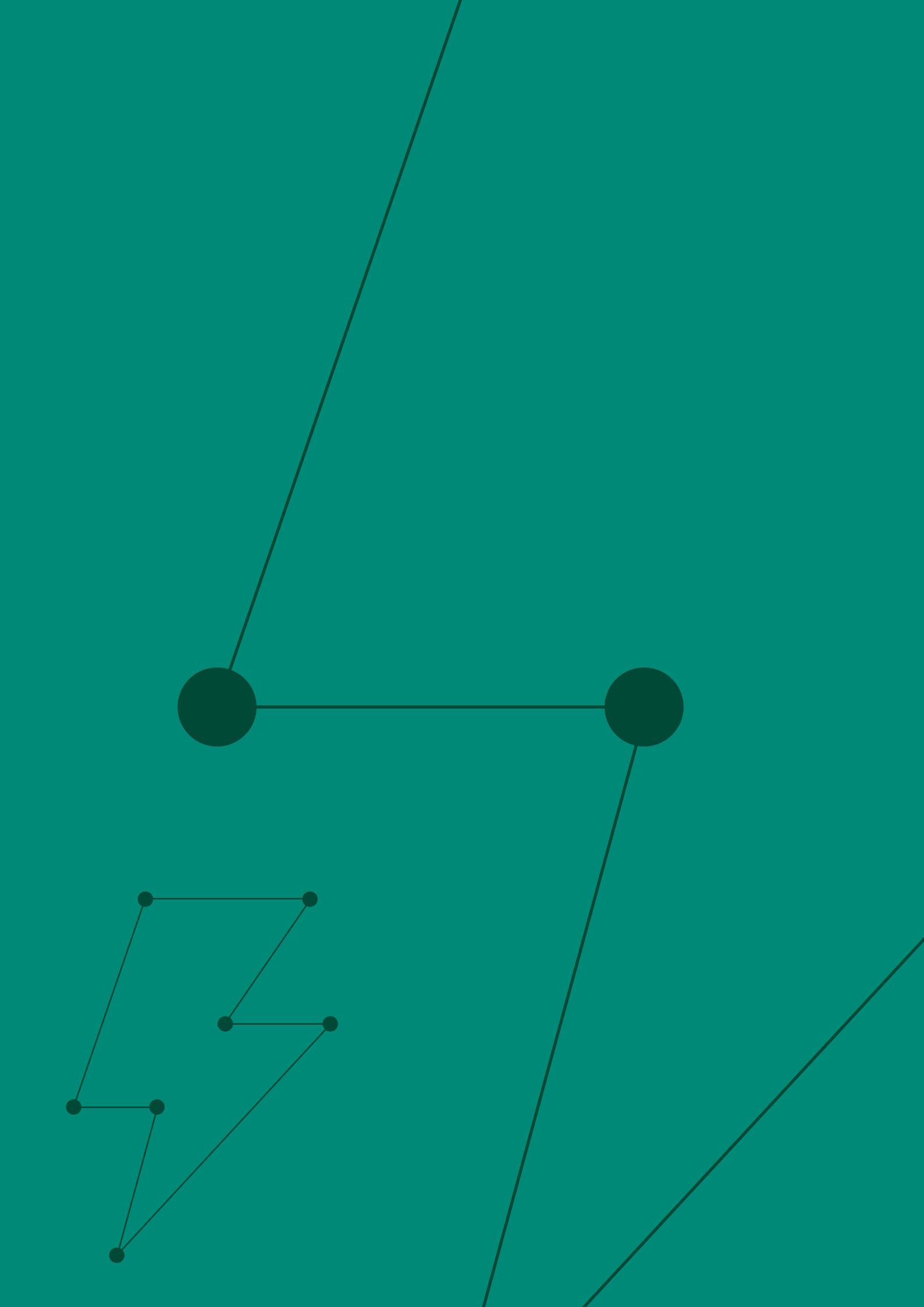
The Voice of the Networks

energynetworks association

# Electricity Network Innovation Strategy

March 2018





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# Foreword

SP ENERGY NETWORKS

NORTHERN POWERGRID

electricity north west
Bringing energy to your door

Scottish & Southern Electricity Networks

UK Power Networks
Delivering your electricity

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

nationalgrid

**The publication of the gas and electricity Network Innovation Strategies is the latest chapter in Great Britain's energy network innovation success story. Since funding was first introduced in 2007, Great Britain's energy networks have developed a world leading reputation for innovation. A variety of transformational projects have enabled network companies to deliver greater efficiency, improved performance and respond to the challenges and opportunities presented by the decarbonisation of our energy market.**

Innovation projects allow network operators to better understand how to integrate new technologies into our energy networks, help them identify new opportunities for their use and speed up their wider adoption. They also reflect our commitment to build an efficient, smarter, cleaner energy system fit for Britain's homes and businesses.

The current RIIO price control mechanism, which includes the Network Innovation Allowance and the Network Innovation Competition, has been key to driving success forward. Continued support for innovation has been vital to embedding a culture of innovation within our energy networks so that innovation is a permanent fixture in the network landscape. Smart network solutions connected through the Low Carbon Network Fund alone have already enabled close to £1bn of cost savings for customers within the electricity sector.

This progress is part of a wider, fundamental change to the way our network infrastructure operates that is now taking place which is driven by new technology. Across the country, innovation will help network companies to enable new markets and provide new opportunities for consumers to have greater control over their energy bills. Projects have the potential to develop a truly world-leading Whole Systems Approach that brings the way our gas and electricity networks work more closely together. This will be crucial as we find new ways to meet the UK's carbon budgets, because if our power, heat, transport and waste sectors are all interdependent, then so must the solutions to their decarbonisation. Our role is to deliver the integrated energy infrastructure that Britain needs to underpin those essential pillars of our economy.

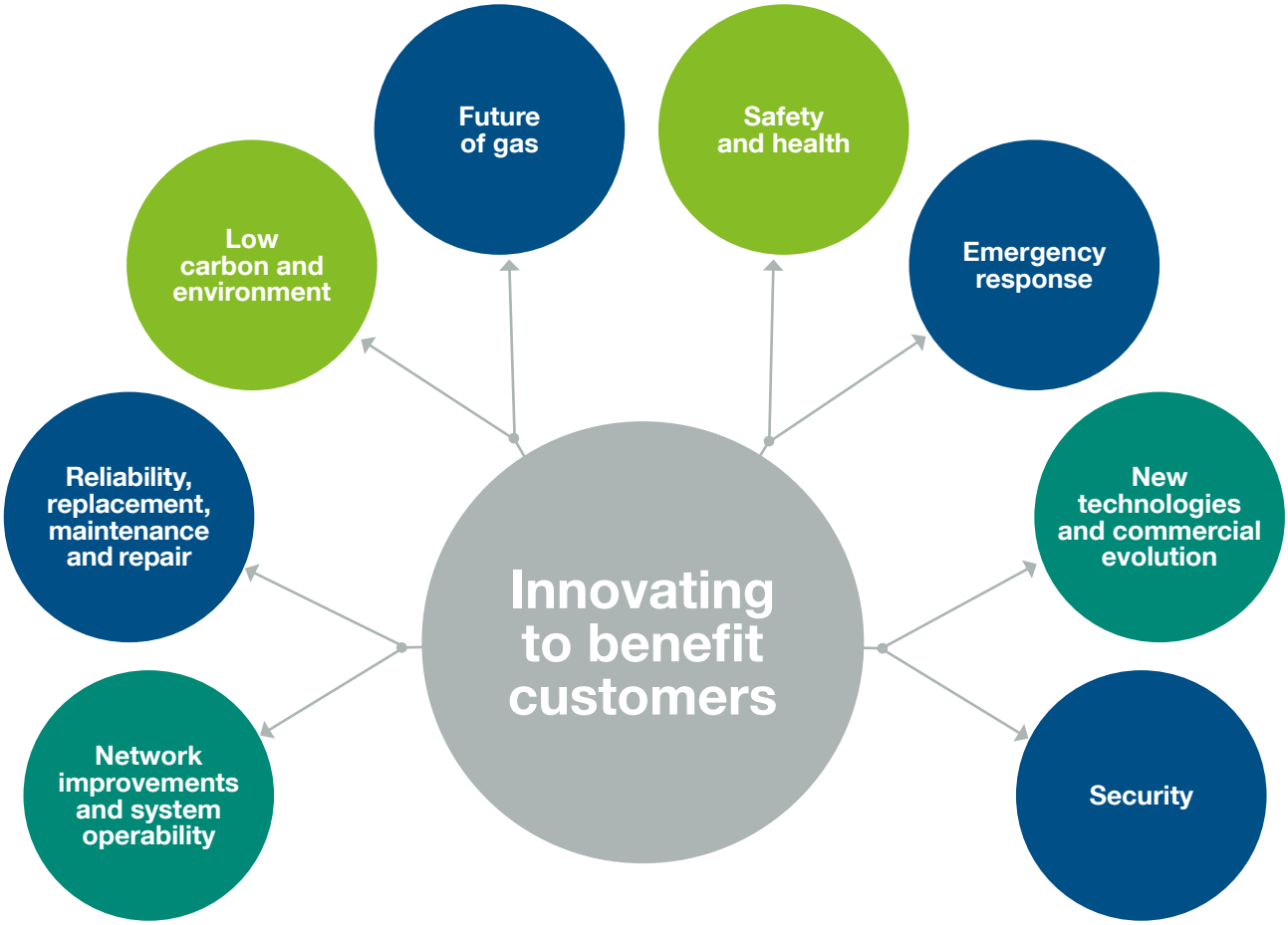
These Strategies set out the areas of focus where network companies are looking to provide value to customers from the innovation projects they are undertaking and how they will share the lessons learnt from those projects with other organisations. This transparency is key to ensuring that network companies continue to focus on areas for innovation investment which can deliver most benefit to the wider energy system in the most effective way possible.

Network companies cannot deliver this innovation alone. We want network infrastructure to act as a platform for new energy technologies and services that will put Great Britain at the forefront of the global low carbon transformation. Whether they are end-users, technology developers or service providers, network companies want to work with these innovators who have the best and the brightest ideas of how we can harness the potential of energy technology. These opportunities extend to communities and businesses across the country, ensuring that the economic as well as practical benefits are spread far and wide.

As the pace of network innovation continues to accelerate, then so will the importance of this work. The publication of the first joint Network Innovation Strategies is an important milestone and we look forward to working with our innovation partners to ensure our network infrastructure, our wider energy system and our customers benefit from new technology and approaches.

**Huw Sullivan**
Cadent
Chair, ENA Gas Innovation & Governance Group

**Phil Swift**
Western Power Distribution
Chair, ENA Electricity Networks and Futures Group




**Key**

- Common themes
- Electricity themes
- Gas themes

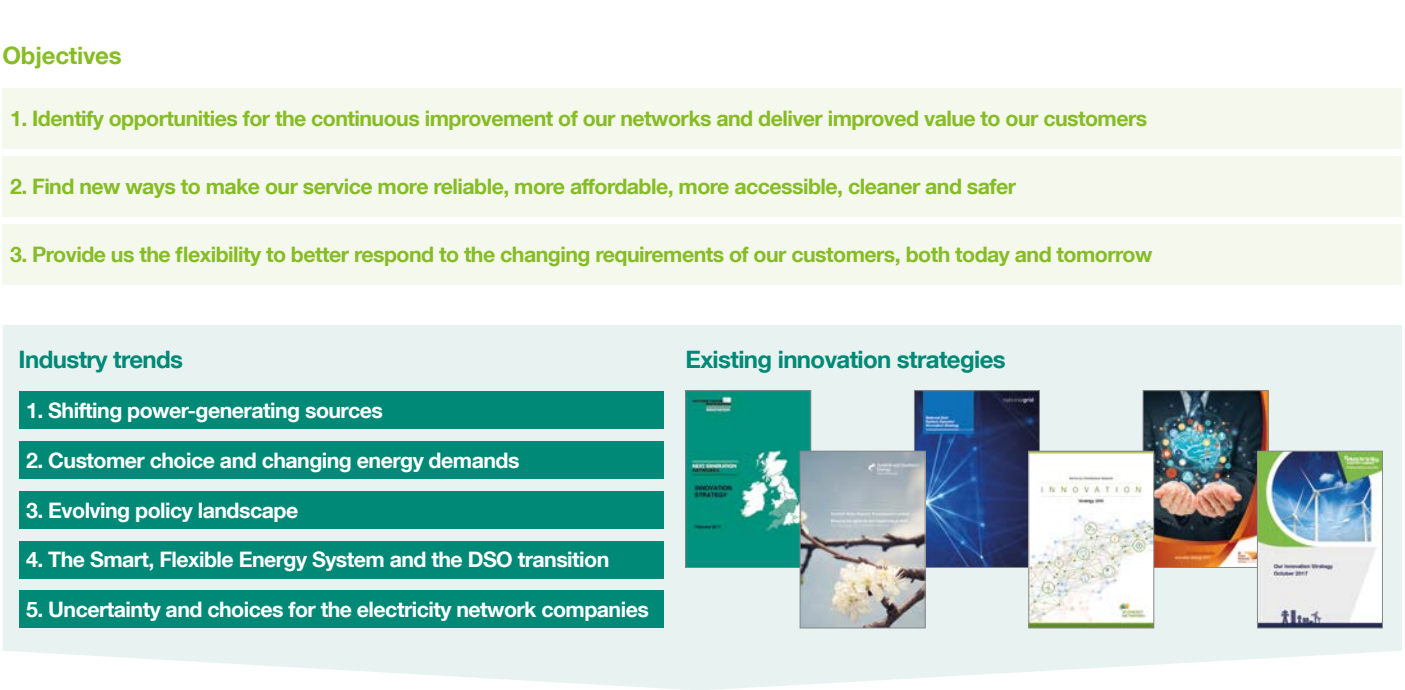
# Executive Summary

**Innovation is a key consideration for electricity network operators as we transition to a smarter, more economical, more flexible energy system that can support the decarbonisation of heat and transport. It is also a crucial element of the Great Britain regulatory framework for electricity networks, which includes funding and incentives that help us innovate for our customers' benefit, as well as deliver value for the network in the long term. Since 2004, we have delivered more than 1,300 innovation projects, and we will continue to deliver innovation that can benefit our customers.**

This Electricity Network Innovation Strategy has been developed to set out a jointly-agreed approach as to how innovation can best accommodate the future requirements of the energy system in its entirety, and can lead to the effective delivery of benefits in a collaborative and cost-effective way.

A rapidly changing environment requires new innovative strategies from all participants, including fundamentally different approaches to business and to serving customers, and embracing a range of technical and commercial innovations to do so effectively. Key drivers for the changing energy system in this context include: shifting power generation sources, changes for customers in terms of choice and demand, policy drivers related to decarbonisation of heat and transport, a greater focus on sustainability, and regulatory trends to ensure a smart, flexible system with greater local system operation responsibilities for Distribution Network Operators (DNOs). These trends will give rise to the need for further innovation from us, the electricity network companies, and will simultaneously pose a number of challenges, which we have synthesised into five themes as shown below in Figure 1.

**Figure 1:**
**Innovation themes based on industry trends and challenges**



## Strategic focus

By considering the current level of innovation and future innovation opportunity, in consultation with our stakeholders, we have established a set of priority outcomes and a timeline, as shown in Figure 2. Given this roadmap and the analysis undertaken for each innovation theme, the following represent our key future focus areas:

| | |
|---|---|
| **INNOVATE** | Focus on innovation areas with maximum innovation opportunity which need to be addressed in the short to mid term. |
| **IMPLEMENT** | Maximise transition of proven innovation to Business as Usual (BAU) to realise the full potential benefit for customers. |
| **COLLABORATE** | Enhance strategic collaboration by increasing project partnerships, improving the sharing of knowledge, and using forums more effectively. |

Innovation benefits from effective collaboration across the industry, so we have valued the feedback and engagement provided by many stakeholders throughout this innovation strategy process.

For more information and to stay engaged, please contact Energy Networks Association at **innovation@energynetworks.org** or visit our website **www.energynetworks.org.**

**Figure 2:**
**Innovation strategy outcomes and roadmap**

### Facilitate change

- Ensure resilience of the system under emergency conditions
- Enable real-time visibility of the LV network
- Develop solutions that interact with customers
- Improve flexibility services to customers with mutual benefit
- Coordinate the deployment of EV charging points
- Maximise benefits of network services provided by electric vehicles and storage
- Identify and counter internal and external cyber threats
- Use smart technologies to maximise capacity within the power system
- Make network information more readily available
- Development of safer and more efficient working practices

**Now until 2019**

### Smarter Networks

- Develop forecasting methodologies for changing behavioural patterns and new technologies
- Develop asset inspection techniques that reduce manual workload
- Develop means to manage tighter capacity margins and develop market signals for new investment
- Effectively utilise all available data to counter potential threats to the system
- Provide aligned, financial incentives through innovative or flexible tariffs
- Facilitate new customer-focused products and services from suppliers

**2019 to 2022**

### Whole System

- Collaborate with other energy sectors (including gas, transport and heat) to optimise across multiple sites and vectors
- Expand planning and operational activities to incorporate heat, transport and gas
- Manage significant penetration of EVs and electrified heat
- Increase use of artificial intelligence to make decisions on a more dynamic network

**2022 onwards**

# Introduction

**This Electricity Network Innovation Strategy has been produced by Energy Networks Association (ENA) and the GB Electricity Licenced Network Operators (LNOs), which include all of the Distribution Network Operators (DNOs), the Transmission Network Operators (TOs) and the System Operator (SO). ENA is our voice, representing the 'wires and pipes' transmission and distribution network operators for gas and electricity in the UK and Ireland (known as Member Companies).**

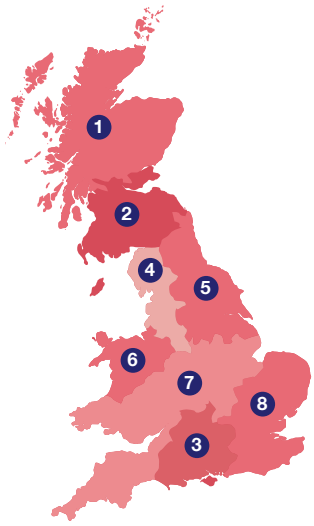
Innovation is a key element of the RIIO[1] regulatory framework, which includes funding and incentives to enable innovation in order to deliver customer benefit and long term network value. Since 2004, we have embraced innovation, as evidenced by the more than 1,300 projects that have been delivered. Innovation will remain a central focus in our plans for the remainder of this price control period, as well as in the long term.

The independent 2016 evaluation of the Low Carbon Networks Fund (LCNF[2]), which was commissioned by Ofgem, highlighted that the LCNF succeeded in encouraging us to innovate and served to move our level of innovation from a 'low' base to a 'moderate' level[3]. The potential future net benefit from LCNF projects is estimated to be between 4.5 and 6.5 times the funding costs. We want to further improve this.

**Figure 3:**
**Electricity Network Licence Holders**

### Electricity distribution

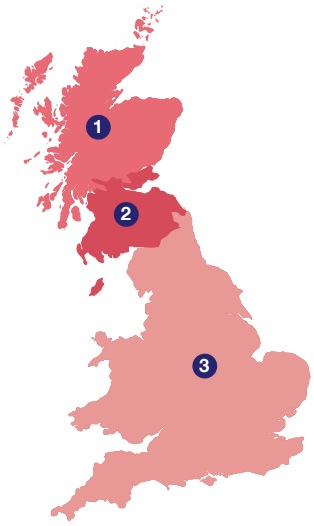
1. Scottish & Southern Electricity Networks
2. SP Energy Networks
3. Scottish & Southern Electricity Networks
4. Electricity North West
5. Northern Powergrid
6. SP Energy Networks
7. Western Power Distribution
8. UK Power Networks




### Electricity transmission

1. Scottish & Southern Electricity Networks
2. SP Energy Networks
3. National Grid

National Grid are also the System Operator for the Transmission Network across GB.



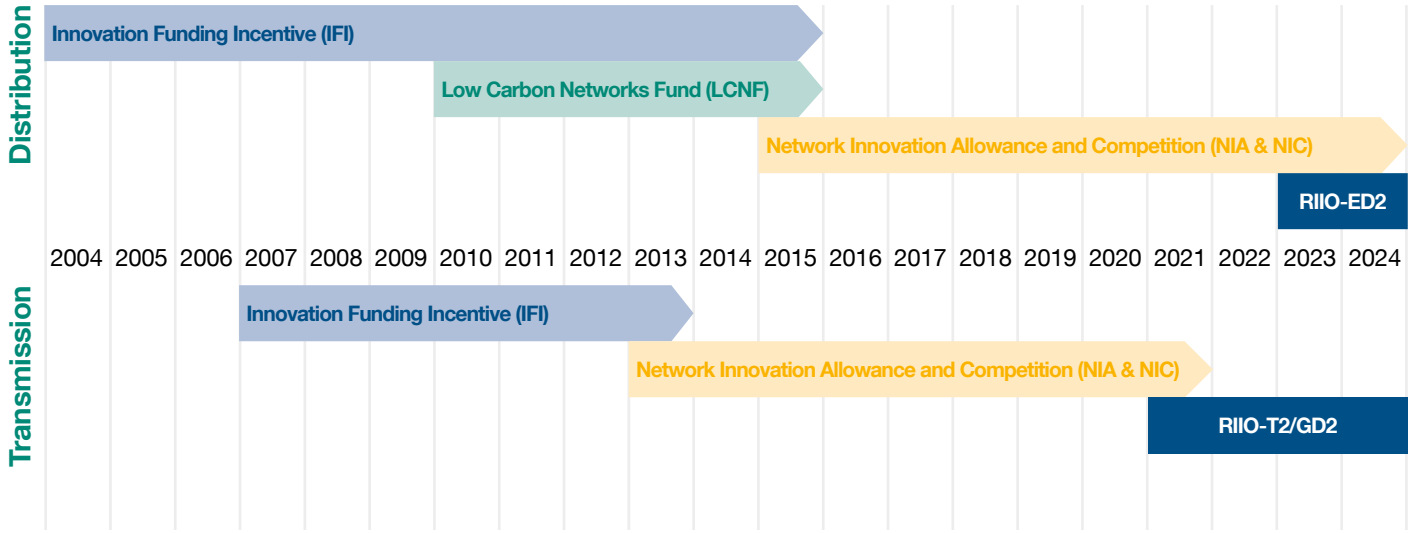

[1]RIIO is the current regulatory framework: Revenue = incentives + innovation + outputs. See Ofgem website for details
[2]The LCNF was a £500m fund available to the DNOs to encourage innovation, and was the precursor to Ofgem's present innovation funding mechanisms, which are available to network companies
[3]https://www.ofgem.gov.uk/system/files/docs/2016/11/evaluation_of_the_lcnf_0.pdf

## Recommendations from independent evaluation of LCNF (2016)

- Ofgem should continue to fund network operator innovation with consideration given as to how support for network innovation can best accommodate the future requirements of the whole, low carbon, energy system
- We, the network companies, should be required to jointly develop and publish an 'innovation roadmap'
- There should be greater focus on the sharing of project knowledge and learning (including that from unsuccessful projects) to maximise the benefits and value of LCNF initiatives and innovation
- Reporting requirements associated with any future innovation funding should be reviewed to facilitate the future assessment of quantitative benefits

In addition to the success stories, the evaluation also highlighted the importance of a more joined-up approach to network innovation across the entire industry. We have improved the way we coordinate innovation projects and share learning, which allows us to 'fast follow' from other networks. This ultimately leads to bigger cost reductions and benefits for customers.

**Figure 4:**
**Ofgem innovation funding timeline**



## Innovation funding timeline

Ofgem has incentivised innovation on our networks since 2004 and currently provides funding under RIIO1 mechanisms. Figure 4 shows a timeline of how Ofgem funding mechanisms have evolved over time. Other available industry funding mechanisms are described in Current Level of Innovation.

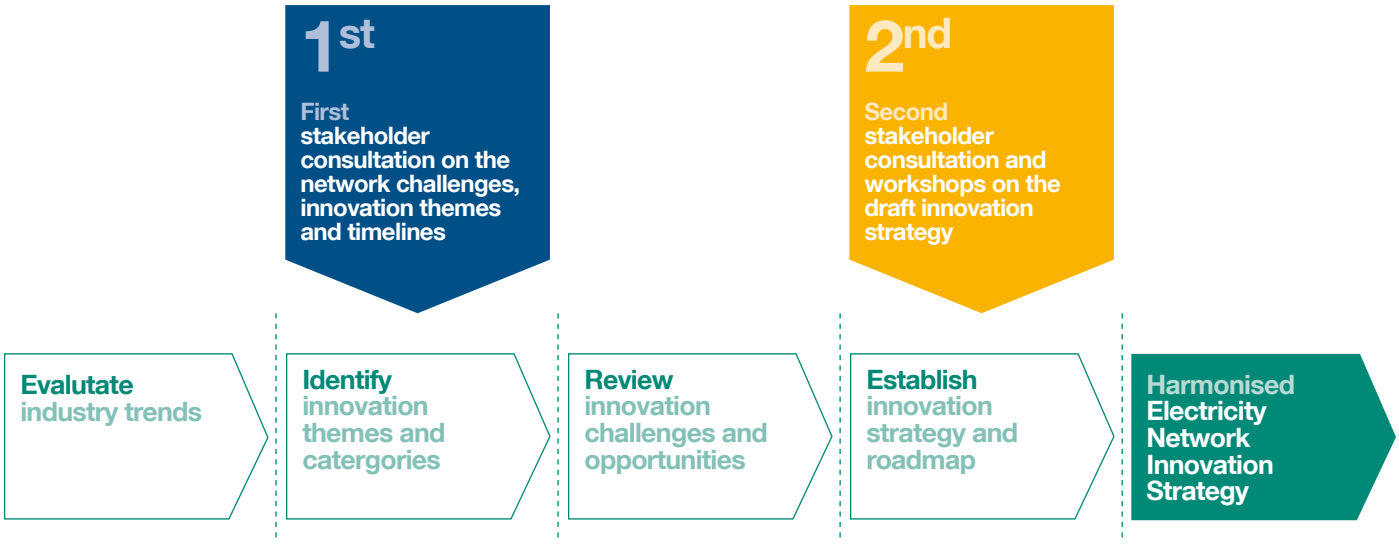
## Strategy development process

To develop the Electricity Network Innovation Strategy, we have shared information with each other, and solicited feedback from a wide range of stakeholders. A key consideration has been to develop an inclusive strategy, which takes into consideration the whole energy system and its participants.

The methodology we used to develop the strategy is shown in Figure 5.

There are regional variations in innovation project themes and solutions, which are driven by regional requirements and difference. We therefore intend to use this strategy to help inform the individual innovation strategies, which we will maintain over the course of the current price control period. This strategy allows us to have a better aligned set of innovation projects, so the process of learning rapidly from another project and implementing it into BAU will improve. There will also be ongoing scope for proactivity in our innovation, seeking views from stakeholders on a continuous basis to ensure we are leading and learning from international innovation trends. We will review and update this strategy every two years[4], which will allow us to build in regular horizon scanning and to reflect the dynamic developments in the electricity sector.

**Figure 5:**
**The process of developing the innovation strategy**




## Public stakeholder consultations

In developing the Electricity Network Innovation Strategy, we sought stakeholder feedback to ensure that we devised a strategy that is representative of people who use the networks, and addresses issues faced by the entire industry. The process, which is shown in Figure 5, includes a first public consultation to support the categorisation of challenges. A second consultation, together with stakeholder workshops in London, Glasgow and at the LCNI conference, then provided more in-depth opinion to further improve the draft strategy and roadmap. For the results from stakeholder consultations, please refer to the ENA website[5].

[4]As required by the Electricity Act 1989, Section 11A(2) available at https://www.ofgem.gov.uk/ofgem-publications/116068
[5]http://www.energynetworks.org/electricity/futures/network-innovation/electricity-networks-innovation-strategy.html

# Electricity Industry Trends

# Electricity Industry Trends


**The drivers for innovation in electricity networks are aligned with the energy trilemma which balances energy security, affordability[6] and sustainability as we transition to a low carbon energy system. Traditional network management solutions, such as network reinforcement, are no longer considered the only viable or most economical solution to network development. A rapidly changing electricity sector requires new and innovative strategies from all participants, including fundamentally different approaches to our business and the way we are serving customers, as well as a range of technical and commercial innovations.**

We have identified five trends that are changing the way electricity is produced and consumed. These trends are driving the need for us, and other players in the energy value chain, to innovate.

## 1. Shifting power-generating sources

For the first time since the 1880s, coal, once the mainstay of our generation sector, was absent from GB's operating electricity generation mix on the 21st April 2017. A month later, on the 26th May, solar generation was meeting nearly a quarter of all electricity demand in GB. In the near term, it is expected that the majority of new capacity in the GB energy system will come from renewables, primarily wind and solar.

In response to this, network operators will need new tools and resources to deploy and optimise flexible response to the intermittent output of renewable energy sources. Although storage is becoming increasingly available, greater capacities will be needed to help manage the inherent intermittency in renewable generation. As the role of storage continues to develop, we expect more reliance in the short term on grid interconnection and active network management, to manage both generation and demand as we move towards DSO. Cross-sector energy management and planning will be required to efficiently manage interactions between electricity, gas and heat networks. Furthermore, from a system operation perspective, we will need to adapt ancillary services provisions to match the evolving system requirements.

## 2. Customer choice and changing energy demands

Through the deployment of a wide variety of new technologies, such as smart thermostats, solar photovoltaic panels, and electric vehicles, customers are increasingly able to control their electricity usage and spend, as well as the type of power they buy and when they use it. Some customers want the ability to self-generate and sell that power back to the grid. The demand profile for our customers is changing, and is expected to change even more drastically with the forecasted uptake in electric vehicles and the decarbonisation of heat in the early parts of the next decade.

As a result of this, we will need to develop commercial models and technical solutions that will facilitate customer choice in a cost-effective way, while at the same time managing the impact on the networks. We believe that at the forefront of our ability to serve our customers' evolving needs is increased engagement and communication, as well as transparency and efficiency in our plans and priorities.

## 3. Evolving policy drivers

In addition to the Climate Change Act, whereby the government has committed to reduce greenhouse gas emissions by at least 80% of 1990 levels by 2050, the Paris Climate Agreement will have a significant long term impact on energy networks. The agreement, which has been ratified by the UK government, focuses on limiting global warming to below 2°C by the year 2100. Decarbonisation of electricity generation, heat and transport are all crucial components.

Other recent policy decisions include plans announced by the government to ban the sale of new petrol and diesel cars in Britain by 2040. This will clearly impact the growth of electric vehicle sales. Heat is also a critical element of Britain's Clean Growth Strategy and is a high priority for future decarbonisation activity, including greater use of green gas, potential for increased use of hybrid heating systems or electric heat pumps.

We will facilitate these ambitions, and manage the potential impacts on our customers through innovation and whole energy system-thinking. We recognise that energy, environment and transport policy are very closely linked, and we will ensure that we have a productive contribution to aid the implementation of these policy objectives.

[6]Energy affordability has been growing in importance for a number of years and this trend will continue as the industry needs to protect vulnerable customers and ensure value for money.

## 4. The Smart, Flexible Energy System and the DSO transition

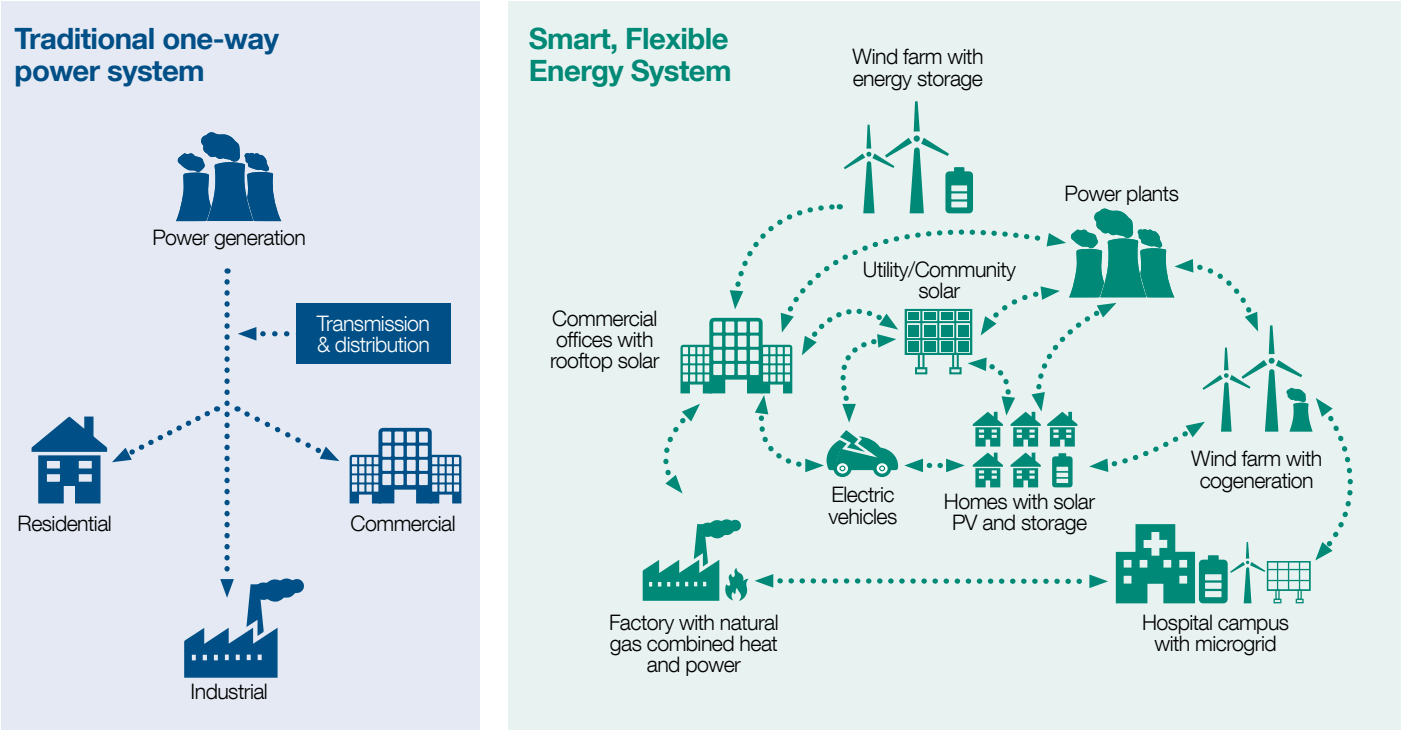
The requirement for a cleaner, distributed, and smart energy system is becoming very evident. Fuelled by significant increases in Distributed Energy Resources (DER) and storage, these changes will affect policy and regulation, business models, and the way the grid is operated in the UK. Figure 6 visualises the evolution to a Smart, Flexible Energy System.

A central pillar of Ofgem's and BEIS' consultation and call for evidence on the Smart, Flexible Energy System[7] is the suggestion that we need to focus more on coordinated whole system planning and operations. We will therefore have an increased role in the delivery of an "efficient, economical and coordinated wider system".

To achieve this, there needs to be far greater coordination between transmission and distribution, and as DNOs, we must transition to become DSOs. This role includes active management of the network, and increased communication and collaboration with 3rd parties, such as the TOs, other DSOs and the SO.

We are preparing for this shift to a smarter electricity grid. The Open Networks Project has been established by ENA to enable industry-wide coordination in this transition. We see multiple opportunities to leverage innovation in this transition, as evidenced by recent Network Innovation Allowance (NIA) and Network Innovation Competition (NIC)-funded projects that focus on the future DSO arrangements.

**Figure 6:**
**Example of evolution to a Smart, Flexible Energy System**




[7]https://www.ofgem.gov.uk/publications-and-updates/smart-flexible-energy-system-call-evidence

## 5. Uncertainty and challenges for the electricity networks

As highlighted in Ofgem's call for evidence on the Smart, Flexible Energy System, we will need to change in order to make sure we meet the demands of all of our stakeholders in future. There is a wide spectrum of possible scenarios for us, which will largely be driven by external factors over which we have limited control.

As DNOs and TOs, we need to make significant investment decisions in the face of an ageing network and a historically non-flat investment profile. Our networks could evolve in different directions, such as a gradual evolution towards using smart solutions for system development, or fundamental change towards a role of a platform facilitator, able to manage and provide value-adding services for generators, electric vehicle (EV) owners, storage owners, microgrid operators, peer-to-peer traders and demand response providers.

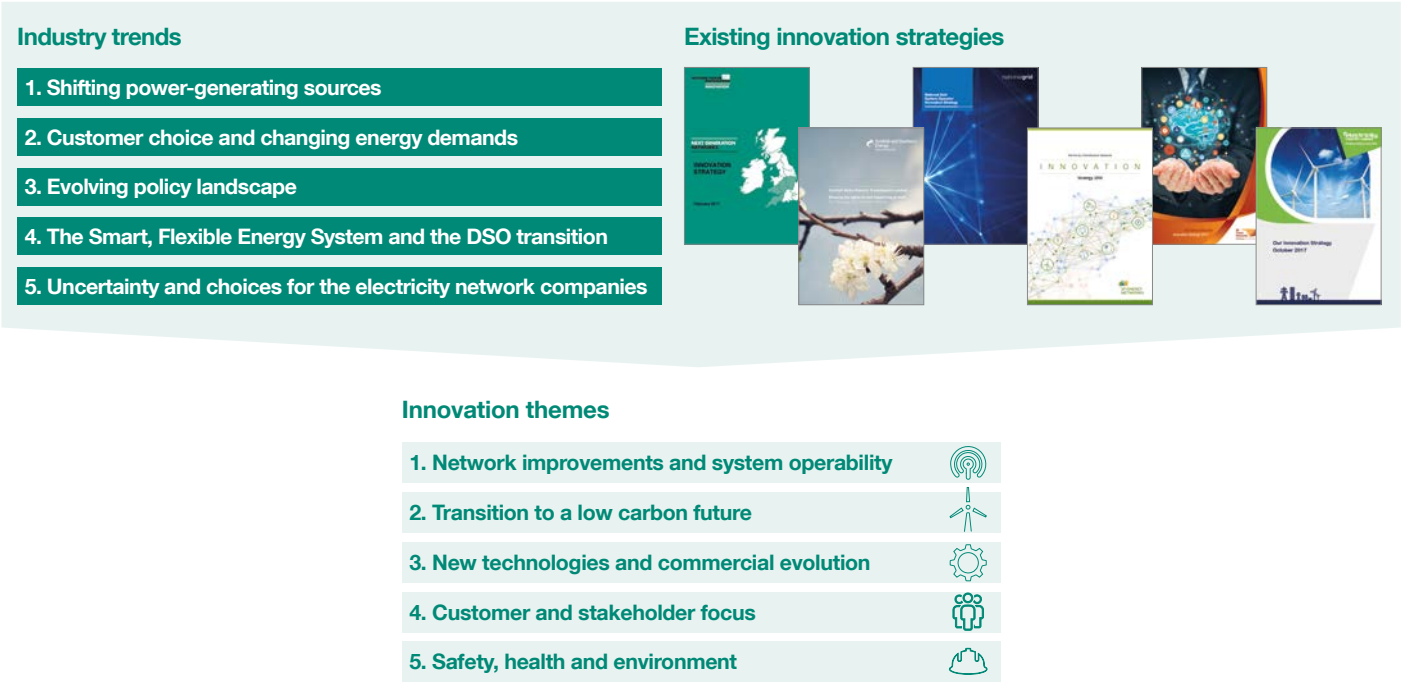
The transition to a smarter grid has the potential to bring many benefits for customers, but this is not a given. It is therefore important that we have a clear plan and a roadmap for the future. This roadmap includes innovation that supports the need to act differently and seeks new customer solutions, embracing the changing circumstances to set a positive course for the energy sector in GB. It must be highlighted that innovation is a process that involves incremental learning by doing and the optimal way to transition is often to trial potential solutions and roll-out the successful ones as BAU, which allows us to derive most benefits for customers.

# Innovation Challenges

## Innovation themes

The macro trends identified in the previous section will give rise to the need for further innovation, and will simultaneously pose several challenges. The development of this Electricity Network Innovation Strategy identifies those challenges and presents a vision for addressing those that have not been completely met by innovation projects to date. Figure 7 shows the process behind identifying the overarching innovation themes.

**Figure 7:**
**Development of innovation themes**




## Challenge categories

This section gives an overview of the categories of challenges identified. The five innovation themes have been synthesised from our individual Innovation Strategy documents. These challenges have been compiled from our individual strategies and the wider trends affecting the GB energy industry. We have grouped and categorised the individual challenges in Figure 8 below, and grouped them by the innovation themes.

Based on the analysis of our past innovation projects, and the feedback from the online stakeholder consultation, we have made the following observations:

- Projects often do not align to only one theme. While the main focus may be one theme, many projects impact some or all of the others, so there may be multiple themes per project and multiple projects per theme in practice
- All projects have a customer benefit – the projects currently listed under customer focus are solely customer focused projects
- Customer and commercial themes were a priority area in the stakeholder consultation and may benefit from increased innovation activity
- New technologies and commercial evolution has had a relatively low representation in innovation projects, so may also benefit from increased innovation focus
- Projects categorised under the Network Improvements and Transitioning to a Low Carbon Future themes will still play an important role, despite the increasing emphasis on customer and commercial themes

**Figure 8:**
**Key innovation themes**

| Innovation theme | Challenge categories |
|---|---|
|  **Theme 1** Network improvements and system operability | 1.1 Improve network resilience to avoid unplanned power outages (particularly when moving towards the low carbon world)<br>1.2 Improve demand and generation forecasting, and network planning processes<br>1.3 Improve network visibility and controllability<br>1.4 Improve asset management processes<br>1.5 Maximise the value and capacity of existing assets<br>1.6 Optimise cross-sector coordination between DNOs, TOs, and SO, as well as licensees from other sectors (e.g. gas) and other countries |
|  **Theme 2** Transition to a low carbon future | 2.1 Efficiently facilitate the adoption of low carbon technologies supporting the electrification of heat and transport<br>2.2 Enable flexibility in the GB low carbon transition (e.g. increasing role of demand side response)<br>2.3 Facilitate the transition from DNO to DSO, enabling the provision of new platforms, market participants and value streams<br>2.4 Create value from the introduction of smart meters and work collectively to deliver the wider public policy and public interest benefits from data<br>2.5 Develop advanced whole energy system planning and forecasting methodologies |

| Innovation theme | Challenge categories |
|---|---|
|  <br>**Theme 3**<br>New technologies and commercial evolution | 3.1 Maximise cyber security and data protection in respect of privacy and commercial sensitivity<br>3.2 Maximise benefits provided by new technologies, with particular focus on network services provided by electric vehicles and energy storage<br>3.3 Facilitate the adoption of commercial business models that leverage low carbon technologies<br>3.4 Extract value from continued growth in digital-enabled services, new and improved sources of data, and artificial intelligence<br>3.5 Shape and comply with evolving regulations and standards<br>3.6 Inform the development of, and ensure compliance with, new markets and structures that allow greater competition in the energy markets<br>3.7 Facilitate sharing of services and business functions between DNOs, TOs, and SO<br>3.8 Leverage cross-sector "smart technology" benefits and lessons |
|  <br>**Theme 4**<br>Customer and stakeholder focus | 4.1 Improve involvement of customers in the delivery of the innovation work<br>4.2 Continuously improve customer experience and affordability, and support the fuel-poor<br>4.3 Improve the understanding of future employee skill and resource requirements<br>4.4 Improve the understanding of changing customer needs, particularly in regard to the electrification of heat and transport<br>4.5 Enable customer choice<br>4.6 Actively seek collaboration with stakeholders and partners<br>4.7 Maximise the transparency of information and the quality of accessible data<br>4.8 Facilitate community energy<br>4.9 Facilitate behavioural change initiatives to promote energy conservation and sustainability |
|  <br>**Theme 5**<br>Safety, health and environment | 5.1 Improve the safety and health of the public and workers<br>5.2 Further improve safety and health and reduce impact on the environment<br>5.3 Reduce the visual and noise impacts of assets |

# Current Level of Innovation

## Network innovation under RIIO

The NIA and NIC funding incentives were set up by Ofgem to fund new technical, commercial, or operational projects that have the potential to deliver a range of benefits to us and to our customers. Innovation projects must have the potential to have a direct impact on our networks or the operations of the SO. They involve research, development, or demonstration of at least one of the following:

- A specific piece of new (i.e. unproven in GB) equipment (including control and communications systems and software)
- A specific novel arrangement or application of existing electricity transmission and/or electricity distribution equipment (including control and/or communications systems and/or software)
- A specific novel operational practice directly related to the operation of the GB Transmission System and/or the GB Distribution System
- A specific novel commercial arrangement

Within the GB energy industry, there are a range of other bodies and funding platforms that are heavily involved in energy industry innovation. These bodies are funding, planning, developing and rolling out innovation projects, and it is critical that the Electricity Network Innovation Strategy consider these and align strategies as much as possible. These bodies include Innovate UK[8], Energy Systems Catapult[9], the Industrial Strategy Challenge Fund[10], and the Engineering and Physical Sciences Research Council (EPSRC)[11].

**Figure 9:**
**Number of innovation projects**

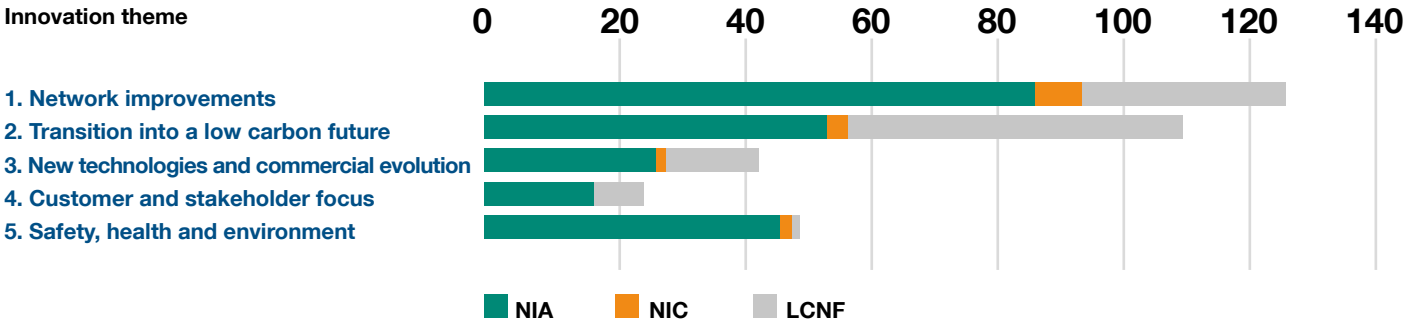
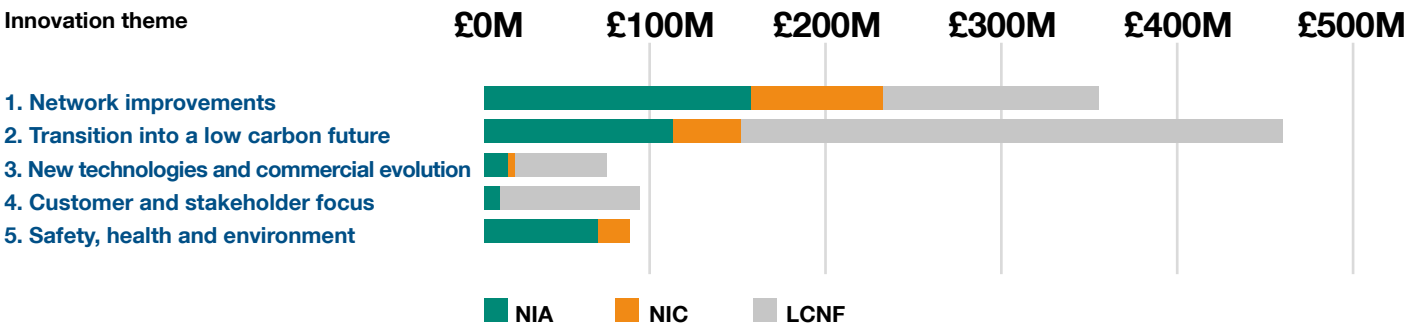



**Figure 10:**
**Value of innovation projects**




[8]https://www.gov.uk/government/organisations/innovate-uk
[9]https://es.catapult.org.uk/
[10]https://www.gov.uk/government/collections/industrial-strategy-challenge-fund-joint-research-and-innovation
[11]https://www.epsrc.ac.uk/funding/

## Innovation projects

**190**
Network Innovation Allowance projects

**14**
Network Innovation Competition projects

**67**
Low Carbon Networks Fund projects

## Previous innovation projects

Our analysis focused on innovation projects delivered via NIA, NIC and LCNF mechanisms because they are the main source of funding for our innovation projects[12]. Other funding sources for innovation exist and we fund some innovation activities from our own budgets. For this strategy, projects have been grouped per innovation theme based on their total number and total value.

Figure 9 shows that the majority of projects were conducted in the Network Improvements domain. This reflects the fact that traditionally we have been essentially asset management businesses. There is a robust and well-established supply chain for this area, which has been able to bring best practice from other geographies to the UK. When the innovation funding started, the focus was put on developing the technology to enable innovation in other categories. This has changed over time as the understanding of our requirements has improved. Furthermore, the bulk of our income is based on the management of our network, and this area still has the potential to yield benefits to our customers. It will therefore continue to be a focus.

The transition to a low carbon future has also received significant attention. This reflects the emphasis that we have placed on innovation that has helped us adapt to changing customer needs. Out of all the categories, the least number of projects were conducted around the Customer and Stakeholder focus. Although we have delivered some interesting projects under this innovation theme, we see this as an area that may benefit from a greater focus in the future.

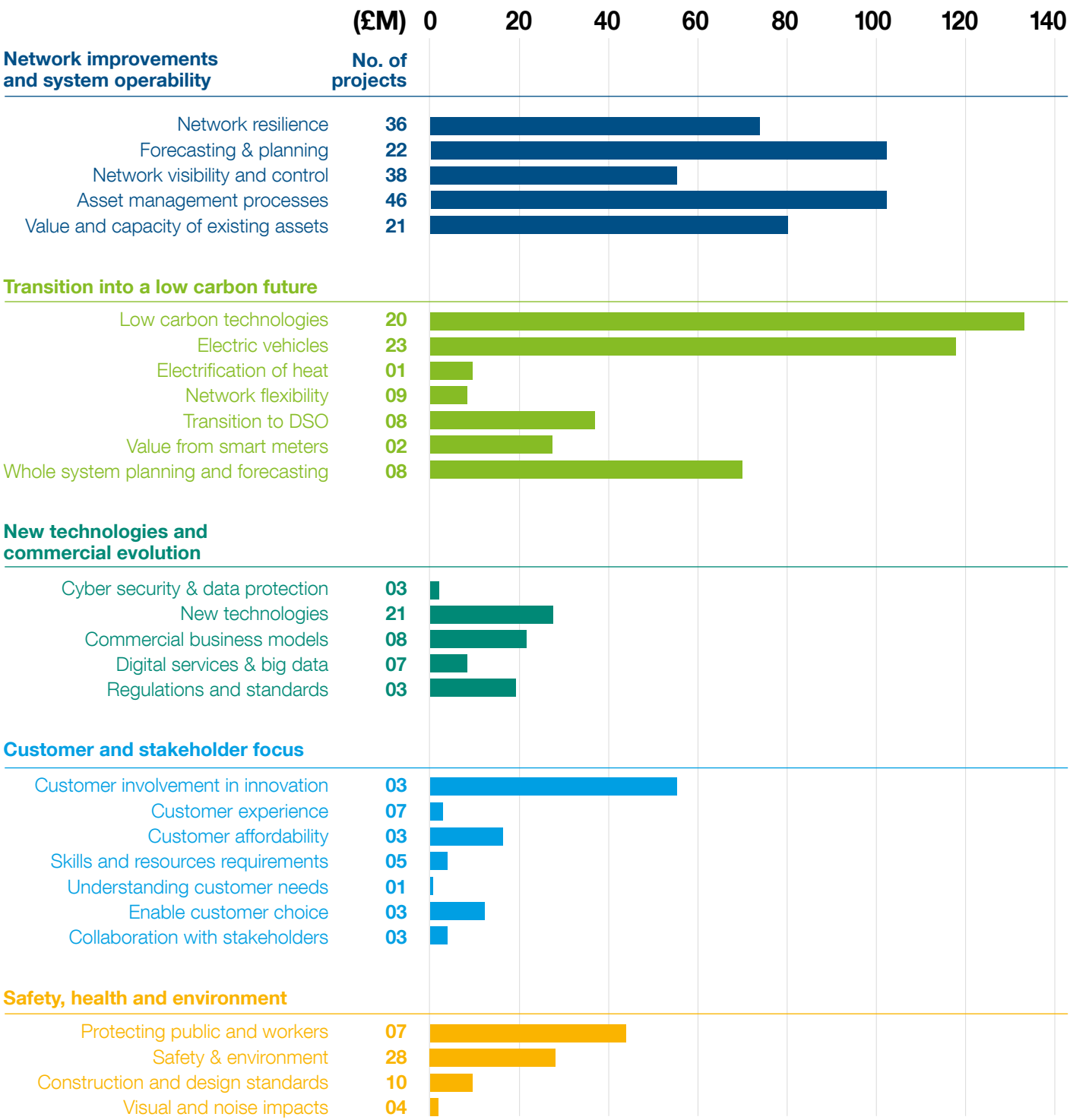
Looking forward, we expect that innovation in the Network Improvements theme will continue. Furthermore, there is still an opportunity to build on the benefits achieved from previous innovation projects under all of the innovation themes; new innovation opportunities will arise as technology evolves and tipping points are reached that affect our industry.

A review funded by HubNet and UKERC[13], and written by the University of Strathclyde, shows that the lessons from innovation projects are impacting our BAU activities in a positive way, which is helping to facilitate the Low Carbon transition. The rollout of successful innovation to BAU is key to the success of the innovation programme, and this process is supported by ENA, the activities of which also includes the creation of new standards. The report shows we are making progress, but that there is still some scope for improvement.

Figure 10 shows the value of all conducted innovation projects under NIA, NIC and LCNF. It must be noted that a positive cost-benefit analysis (CBA), indicating benefits to customers where projects are successful and deployed, is a requirement for funding to be awarded.

[12]The Innovation Funding Incentive (IFI) was the precursor to NIA, NIC and LCNF initiatives, however it was discontinued prior to 2010 and therefore was not included in our analysis.
[13]"A Review and Synthesis of the Outcomes from Low Carbon Networks Fund Projects" Damien Frame, Keith Bell and Stephen McArthur, 17/08/2016

**Figure 11:**
**Breakdown of NIC, NIA and LCNF projects by theme[14]**




[14]Note that many projects fall across several themes. Our analysis considers the main themes only.

## Evaluating innovation priorities

Historically, innovation project spending has prioritised Network improvements and Transition into a low carbon future (as shown in Figure 10). Challenges relating to asset management, improving network resilience, improving forecasting and maximising the value of existing assets have been the subject of several NIA and NIC projects. This is because we have been able to demonstrate that projects that address these challenges deliver significant direct benefits to us and to our customers. Projects related to overall safety of the public and staff, design standards and environmental protection show a relatively low proportion in the overall volume of projects. Customer and stakeholder consultation and New technologies and commercial evolution have been the sole focus of relatively few innovation projects.

On this basis, and based on the five electricity industry trends, we have made the following observations on the innovation project coverage with respect to the innovation challenge themes.

The utilisation of large volumes of data from **smart meters** has become a prevalent innovation subject; however, this depends on individual approaches to LV monitoring and the availability of smart meter data[15].

Enabling **customer choice** has been the sole focus of few innovation projects.

**Cyber security** is becoming an increasingly important issue and more focus may be required in future innovation projects. However, in some cases, Ofgem funding mechanisms are not suitable for cyber security innovation projects due to the restricted nature of the information and learning.

Given global trends, predictions, and the rapid emergence of **electric vehicles**, we expect to see more projects in this area.

There is an opportunity for more activity in understanding **changing customer needs** and improving affordability for customers.

There is an opportunity to increase activity in using new technology to develop and optimise **commercial business models**.

The **electrification of heat** is an under-represented topic in terms of practical activities, however uptake in this area is lower than predicted.

[15]The smart meter data available to us is dependent upon the deployment roadmap and the granularity data that can be shared.

# Innovation Strategy and Roadmap

# Innovation Strategy and Roadmap

**For each innovation theme, we have included a description of the key issues, highlighted current innovation activity, and shown the relative potential for innovation projects in each of the challenge categories.**

We also provided a roadmap to show when innovation will be required as a priority for each of the challenge categories. This section explains the methodology behind the scoring and assessment of the aforementioned criteria.

## Assessment methodology

The current level of innovation was determined by mapping the innovation activity from NIA, NIC and LCNF projects against the challenges in each of the themes and subcategories identified.

### Current level of innovation

| Low | Medium | High |
|---|---|---|
| Emerging innovation area | Developing innovation area | Significant innovation to date |

Future innovation opportunity is an assessment based on industry trends identified, potential benefits for UK customers and the stakeholder consultation, as well as the analysis of innovation priorities in the previous section.

### Future innovation opportunity[16]

| | | |
|---|---|---|
| • Relevant element to enable industry progress<br>• Moderate potential benefits[17] from future innovation<br>• Supported by stakeholders | • Significant element to enable industry progress<br>• High potential benefits from future innovation<br>• Highlighted by stakeholders | • Crucial element to enable industry progress<br>• Major potential benefits from future innovation<br>• Significant focus from the stakeholders |

The below high-level timeline was structured such that short term projects are the ones that should be conducted immediately and adequate resources exist to launch them. Medium term includes projects that should be planned for completion by the end of RIIO1 and long term means plans for the RIIO2 price period and beyond.

### Timeline

| Short | Medium | Long |
|---|---|---|
| Now until 2019 | 2019-2022 | 2022 onwards |

[16]All categories included in this strategy have a notable future innovation opportunity. This rating is used to identify the relative importance of each innovation category.
[17]Benefits refer to improvements for the customer such as customer service, reliability, cost and environmental impact.

# Theme 1
# Network improvements and system operability

**This theme focuses on how to achieve a reliable, dynamic and adaptable network to support future electricity demand and generation requirements, and the resulting volatility in energy flows. The theme encompasses maximisation of existing capacity by increased utilisation of the network, network visibility and control.**

The goal of innovation in this area is to further develop asset management strategies to minimise the costs of managing ageing assets and network risk. Significant challenges lie in the activities of the SO and emerging DSOs. As networks become more highly-utilised and capacity headroom decreases, it will become increasingly important to share network information between our companies for maintenance and construction purposes.

Furthermore, to reduce the time required to connect new assets, we will need to develop active management of generation output based on network constraints.

## What our stakeholders said

**"Optimisation of cross coordination is the most important challenge, followed by improvements in forecasting."**

**"Cross-sector coordination requires effort in the medium term to enable benefits to be delivered in the long term."**

## Innovation potential

| | Current level of innovation | Future innovation opportunity | Timeline (Short / Med / Long) |
|---|---|---|---|
| 1.1 Improve network resilience to avoid unplanned power outages (particularly when moving towards the low carbon world) | High | | |
| 1.2 Improve demand and generation forecasting, and network planning processes | High | | |
| 1.3 Improve network visibility and controllability | Low | | |
| 1.4 Improve asset management processes | Medium | | |
| 1.5 Maximise the value and capacity of existing assets | Low | | |
| 1.6 Optimise cross-sector coordination between DNOs, TOs, and SO, as well as licensees from other sectors (e.g. gas) and other countries | Medium | | |

Case study
**Transmission Network Topology Optimisation**

National Grid Transmission Operator

This project explores the use of algorithms to 'fine tune' the network by rerouting power flows away from heavily congested circuits to the rest of the system, where there is spare capacity. The technique could improve thermal capacity by 5-10% across critical network boundaries.

Case study
**ANGLE-DC**

SP Energy Networks

The principal objective of Angle-DC is to bring the benefits of HVDC to Medium Voltage networks. As an active system, a Medium Voltage DC interconnector will increase the interconnecting circuit capacity by 24%, minimise wider network losses, help satisfy network constraints and maximise capacity headroom for distributed renewable generation.

## Examples of planned innovation projects and ideas

- LV connectivity modelling and mapping
- New reactive power services
- Distribution operability framework
- Develop network analogues
- HV power electronics test laboratory
- Primary network power quality analysis
- LV operational monitoring and control
- System coordination of power electronics
- Develop power quality adaptive filtering
- Develop adaptive protection and control
- Manage assets throughout their lifecycle
- Manage the consequences of decreasing inertia
- Improve fault response performance
- Optimise assets specification and performance
- Manage ageing networks

## Innovation strategy outcomes

### Facilitate change

- Deliver solutions that maximise the use of low carbon generation at optimal overall cost
- Implement smart reinforcement solutions into BAU investment appraisal decisions
- Ensure resilience of the system under emergency conditions (given LCT uptake)
- Enable real-time visibility of the LV network

**Now until 2019**

### Smarter networks

- Leverage communications infrastructure of the future
- Develop forecasting methodologies for changing behavioural patterns and new technologies
- Develop asset inspection techniques that reduce manual workload
- Develop effective methods for system restoration and new techniques for Black Start
- Develop means to manage tighter capacity margins and develop market signals for new investment

**2019 to 2022**

### Whole System

- Expand planning activities to incorporate heat, transport and gas
- Provide mechanisms by which planning can be coordinated between all appropriate parties to drive optimisation
- Assess the impact of gas and other energy vectors when producing forecasts

**2022 onwards**

# Theme 2
# Transition to a low carbon future

**The requirement to connect more low carbon technology (LCT) and distributed generation will necessitate a more active network and provision of network access without resorting to 'overbuilding' assets. Innovation is aimed at providing essential flexibility as we prepare our networks for the transition to a decarbonised energy system. One of the main elements of providing flexibility is the demonstration of demand side response solutions to assist in allowing for faster network connections.**

LCT will require an active role in the operation of our networks, which can be achieved by facilitating DNOs to become DSOs. Future DSOs will be expected to bring access to new information about network performance close to real time, allowing whole system optimisation and establishing an interface between distribution and transmission. This can be achieved through developing new techniques and utilising enhanced data for more dynamic network control (which includes the data from smart meters).

The result will provide customers with new services, enable faster response to outages and establish a more intelligent network. Crucial elements in supporting future electricity demand and generation requirements will be to develop whole system planning and forecasting methodologies.

## What our stakeholders said

**"Enabling flexibility and facilitating the DSO transition are the most important innovation areas."**

**"We must future-enable our systems and markets to unlock the benefits and to do that we must bring about change in a more flexible and responsive manner."**

**"It must be made clear to the DNOs how easily they will be able to access the data and at what level of detail."**

## Innovation potential

| | Current level of innovation | Future innovation opportunity | Timeline (Short / Med / Long) |
|---|---|---|---|
| 2.1 Efficiently facilitate the adoption of low carbon technologies supporting the electrification of heat and transport | Medium | | |
| 2.2 Enable flexibility in the GB low carbon transition (e.g. increasing role of demand side response) | Medium | | |
| 2.3 Facilitate the transition from DNO to DSO, enabling the provision of new platforms, market participants and value streams | Low | | |
| 2.4 Create value from the introduction of smart meters and work collectively to deliver the wider public policy and public interest benefits from data | Low | | |
| 2.5 Develop advanced whole energy system planning and forecasting methodologies | Low | | |

Case study
**The National HVDC Centre**

Scottish and Southern Electricity Networks Transmission

The National HVDC Centre is an NIC funded testing facility, supporting all HVDC schemes connecting to Great Britain's grid system. The centre simulates and resolves potential issues before they impact the real network, using some of the world's most powerful simulators. Our safe and secure modelling environment, combined with our experience of delivering the Caithness-Moray HVDC project, ensures that we can provide robust solutions and practical training.

Case study
**PV Monitoring**

National Grid System Operator

We launched a series of projects to investigate whether the acquisition of new and different types of PV monitoring data, as well as applying advanced analytics and machine learning, could reduce our mean PV forecast error. To date, half-hourly national and regional solar output feeds have reduced error by approximately 100MW.

## Examples of planned innovation projects and ideas

- Smart meter data for network operations
- DSO/TSO shared services
- H2 energy balance
- Lower capacity margins
- New constraint optimisation techniques
- Managing flexibility scarcity
- Improve long term demand profiles
- Enhance monitoring and settlement
- Improve forecasting (generation, supply, demand)
- Preparing network for LCTs and EVs
- Faster, easier, more efficient connections

## Innovation strategy outcomes

### Facilitate change

- Develop solutions that interact with customers
- Improve flexibility services to customers with mutual benefit
- Coordinate the deployment of EV charging points
- Introduce technical solutions that allow us to quickly release capacity in our network
- Improve forecasting processes and disaggregate DER

**Now until 2019**

### Smarter networks

- Maximise benefits from smart meter data
- Effectively utilise all available data to counter potential threats to the system
- Coordinate connected resources to maximise system security and the use of low carbon generation at optimal overall cost
- Improve advanced whole energy system planning and forecasting

**2019 to 2022**

### Whole System

- Manage significant penetration of EVs and electrified heat

**2022 onwards**

# Theme 3
## New technologies and commercial evolution

**The future electricity network will increasingly employ commercial arrangements, as customers adopt greater use of apps and smart technology to interact with us. The variety of new technologies deployed on the networks will require the system to be interoperable and adaptive such that new solutions can be readily integrated. New automation schemes on the LV network will allow faster restoration of customers using embedded intelligence.**

Leveraging new technologies such as electric vehicles, smart appliances, electricity storage, market platforms, blockchain platforms, peer-2-peer transactions, and big data will require new commercial models, including flexible tariffs, new methods for settlement and market structures. All these activities will multiply the amount of data flows leading to the need for increased cyber security.

Finally, innovation will focus on better processes, as well as equipment and technology that will ensure continued efficiency and performance in the new realm.

### Innovation potential

| | Current level of innovation | Future innovation opportunity | Timeline (Short / Med / Long) |
|---|---|---|---|
| 3.1 Maximise cyber security and data protection in respect of privacy and commercial sensitivity | Low | | |
| 3.2 Improve demand and generation, maximise benefits provided by new technologies, with particular focus on network services provided by electric vehicles and energy storage | Medium | | |
| 3.3 Facilitate the adoption of commercial business models that leverage low carbon technologies | Low | | |
| 3.4 Extract value from continued growth in digital-enabled services, new and improved sources of data, and artificial intelligence | Low | | |
| 3.5 Shape and comply with evolving regulations and standards | Low | | |
| 3.6 Inform the development of, and ensure compliance with, new markets and structures that allow greater competition in the energy markets | Medium | | |
| 3.7 Facilitate sharing of services and business functions between DNOs, TOs, and SO | Medium | | |
| 3.8 Leverage cross-sector smart technology benefits and lessons | Low | | |

Case study
**ENTIRE**

Western Power Distribution

ENTIRE is a four-year project that will build on the lessons learned from the commercial trials within Project FALCON. The project seeks to address the conflicts between a DNO and the SO contractual requirements.

Case study
**Customer Load Active System Services (CLASS)**

Electricity North West Limited

CLASS seeked to demonstrate an innovative, easily implemented solution to enable DNOs to cost-effectively accommodate LCTs and the changing patterns of demand on their networks. The goal was to demonstrate that demand for electricity can be reduced, without customers noticing a difference to their supply.

## Examples of planned innovation projects and ideas

- New construction techniques
- Smart network islanding
- Alternative transformer technologies
- DC network feasibility
- Emergence of DSOs
- Innovation in markets
- Innovation in ICT
- Unlocking the potential of big data
- Cyber security
- Modernisation of work practices and business systems

## Innovation strategy outcomes

### Facilitate change

- Identify and counter internal and external cyber threats
- Use smart technologies to maximise capacity within the power system
- Use smart technologies to accommodate connections
- Maximise benefits of network services provided by electric vehicles and storage

**Now until 2019**

### Smarter networks

- Provide aligned, financial incentives through innovative or flexible tariffs
- Enable settlement for all existing customer profile classes to support flexible tariffs
- Leverage next generation mobile communications
- Identify available other dispatchable energy resources, restrictions in real time

**2019 to 2022**

### Whole System

- Increase use of artificial intelligence to make decisions on a more dynamic network
- Collaborate with other energy sectors to optimise across multiple sites and vectors

**2022 onwards**

## What our stakeholders said

**"Cyber security is the most pressing issue; and we need significant innovation in the area of maximising the benefits provided by new technologies."**

**"More inflexible, distributed and micro-generative sources, electric vehicles and localised storage will exert greater pressures on the networks, and also create more opportunities."**

# Theme 4
# Customer and stakeholder focus

**Providing outstanding customer experience is a focal point for all of our businesses. This also extends to our relationships with stakeholders. Our goal is to deliver the strategy in the most economic and efficient manner whilst operating the network in a safe and reliable way.**

Innovation allows us to explore ways to provide services at a lower cost, improving customer experience as well as enabling choice by offering new services. Development of various online services such as open data sources and social interactions increase the transparency of operations and facilitates customer engagement.

One of the key enablers to building an interface between customers and us is smart meters. They have a large potential to provide communities with information and incentives to understand and influence their energy consumption behaviour and to benefit the networks we operate. They can also provide improved network visibility, enabling us to maintain and improve on our historic efficiency levels, thereby improving service and reliability to stakeholders.

## What our stakeholders said

**"Transparency of information and quality of accessible data should have the highest priority, followed by stimulating behavioural change initiatives to promote conservation and sustainability."**

## Innovation potential

| | Current level of innovation | Future innovation opportunity | Timeline (Short / Med / Long) |
|---|---|---|---|
| 4.1 Improve involvement of customers in the delivery of the innovation work | Medium | | |
| 4.2 Continuously improve customer experience and affordability, and support the fuel-poor | Medium | | |
| 4.3 Improve the understanding of future employee skill and resource requirements | Medium | | |
| 4.4 Improve the understanding of changing customer needs, particularly in regard to the electrification of heat and transport | Low | | |
| 4.5 Enable customer choice | Low | | |
| 4.6 Actively seek collaboration with stakeholders and partners | Medium | | |
| 4.7 Maximise the transparency of information and the quality of accessible data | Medium | | |
| 4.8 Facilitate community energy | Medium | | |
| 4.9 Facilitate behavioural change initiatives to promote energy conservation and sustainability | Medium | | |

Case study
**Customer Lead Network Revolution**

Northern Powergrid

CLNR was a major smart grid demonstration that brought together key stakeholders in the electricity industry – customers, suppliers and distributors – for the first time, to develop innovative solutions and commercial arrangements together.

Case study
**EnergyWise**

UK Power Networks

EnergyWise is a partnership between ten organisations, led by UK Power Networks, and with funding from Ofgem. The aim of EnergyWise is to investigate how to plan for our future energy needs. It's one of the first research projects of its kind and it's happening in Tower Hamlets.

## Examples of planned innovation projects and ideas

- Improve service delivery
- New solutions for vulnerable customers
- Improve customer service
- Minimise network operating costs to reduce customers' bills
- Manage-before-build solutions
- Faster, easier, more efficient connections
- Coordinate transmission/distribution service/revenue opportunities
- DSO/TSO shared services
- Improve data visibility
- Enhance energy efficiency
- Enable more LCT connections – domestic, EVs, heat pumps etc

## Innovation strategy outcomes

### Facilitate change

- Develop methodologies to measure and track customer requirements
- Make network information more readily available
- Improve communication on outages and interruptions
- Ensure availability of skilled workforce during emergency events
- Facilitate new customer-focused products and services from suppliers

**Now until 2019**

### Smarter networks

- Enhance sharing of network information via customer portals
- Digitisation of the workforce
- Facilitate new customer-focused products and services from suppliers

**2019 to 2022**

### Whole System

- Leverage smart home data without compromising comfort, security and privacy of customers
- Ensure successful innovation is automatically embedded as BAU

**2022 onwards**

# Theme 5
# Safety, health and environment

**Sensible and proportionate risk management is integral to delivering growth, innovation and protecting people. Safety, health and environment are areas that require constant efforts to maintain and improve conditions for the elements of society affected by our operations. Activities in this category revolve around the delivery of environmental and social obligations; protecting public and workers; reducing carbon emissions; reducing the visual and noise impacts of the assets; and ensuring the workforce of the future is equipped with appropriate knowledge and skills.**

Many of the activities in this area are considered BAU, however innovation will accelerate improvements in more unconventional areas. Those include alternative conductor or insulation materials to reduce the amount of oil in the equipment, as well as new approaches to combating theft through novel methods for detection.

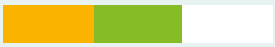
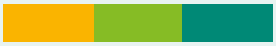
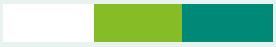
The Health and Safety Executive (HSE) has identified that "ensuring new large infrastructure projects, and ageing plant and assets, do not lead to an increase in injuries or ill health" is a strategic priority for the utilities sector over the next 3-5 years[18]. Through the electricity industry health and safety initiative, 'Powering Improvement'[19], ENA has been addressing the impact of innovation on the health and safety dimension of asset management.

## What our stakeholders said

**"Continuous improvements to the network will require continuous work in this area."**

**"Protecting the safety of public and staff will revolve around automation and physically separating humans from assets."**

## Innovation potential

| | Current level of innovation | Future innovation opportunity | Timeline (Short / Med / Long) |
|---|---|---|---|
| 5.1 Improve the safety and health of the public and workers | Low |  |  |
| 5.2 Further improve safety and health and reduce impact on the environment | High |  |  |
| 5.3 Reduce the visual and noise impacts of assets | Medium |  |  |

[18]http://www.hse.gov.uk/aboutus/strategiesandplans/sector-plans/utilities.htm
[19]http://www.poweringimprovement.org/2015-2020/2017-2/

| | |
|---|---|
| Case study<br>**FITNESS**<br><br>SP Energy Networks Transmission | Future Intelligent Transmission Network Substation (FITNESS) proposes a reduced outage and low risk approach to future substation monitoring, protection, automation, and control, by enabling faster deployment, greater availability, improved safety and greater controllability with a reduced footprint and lower cost than conventional design. |
| Case study<br>**Low Energy Automated Networks (LEAN)**<br><br>Scottish & Southern Electricity Networks | This project will demonstrate and deploy the Low Energy Automated Networks (LEAN) solution. This consists of two methods to reduce electrical losses on the 33kV/11kV networks. These methods could save over 31,000MWh of electricity over 45 years, worth over £40m to GB customers. This equates to savings of 6,421 tonnes of $CO_2$. |

## Examples of planned innovation projects and ideas

- Improve vegetation management
- Improve efficiency in building and construction
- Improve local community engagement/impact
- Identifying new safety solutions
- Develop new Personal Protective Equipment (PPE)
- Minimise environmental impacts of assets and activities
- Advances in asset management and inspections
- Quicker/cheaper/safer methods of providing adequate earthing for mobile generators in urban areas

## Innovation strategy outcomes

### Facilitate change

- Develop techniques to extract more value from disposed assets
- Identify new safety solutions
- Reduce risks from fire suppression systems
- Develop safer and more efficient working practices

**Now until 2019**

### Smarter networks

- Develop new techniques to reduce the need for humans to work on live lines
- Minimise on-site construction work
- Develop new techniques to reduce need for excavation
- Develop new techniques to reduce space and time required during construction

**2019 to 2022**

### Whole System

- Develop techniques to reduce noise levels from network equipment

**2022 onwards**

# Delivering benefits from innovation

**We firmly believe that innovation is key to delivering the best service and best value for our customers. Benefits resulting from our innovation projects delivered savings to customers of £1.1bn to £1.7bn[20] from the LNCF projects alone.**

Our customers and stakeholders benefit from innovation in the following ways:

- Reduced Use of System (UoS) charges
- Safer, more reliable and cost-efficient electricity networks, through modern monitoring and control techniques
- Improved service to our customers by investing in interaction platforms for new service offerings
- Lower costs to connect to our networks
- Faster connections through innovative and flexible service offerings
- More power to our customers by providing data and enabling them to make informed choices.

The following five sections detail how we will ensure that benefits of innovation are maximised across our businesses.

## Improving the transfer of innovation into BAU

We ensure adoption of new innovations to BAU. This includes involving key staff in the innovation process before transitioning to BAU to lead the adoption of new approaches. In addition, we have created new roles and functions to ensure that we are as well prepared as possible for future change – for example, some of our businesses have created DSO Transition Managers and established Smart Grid Development Teams in some of their major business functions. Such roles are focused on making sure that our businesses are prepared for future change by supporting the transfer of innovation into BAU by defining business change processes, setting clear development strategies, and agreeing the new business capabilities and skills from within. As a part of ENA, we ensure that our engineering standards are updated (or created) as a result of innovation projects.

Transitioning new solutions into BAU requires close intra-company collaboration. Innovation activities are therefore promoted across all teams. This helps us to adapt our knowledge and skills to deliver the outcomes of innovation projects, which facilitates the deployment of innovative solutions at scale.

Tracking and reporting of the volumes, costs, and benefits of the solutions deployed within our businesses also supports the transfer of innovation to BAU by encouraging internal stakeholder buy-in.

## Realising the full value of previous innovation

To ensure that we are delivering value for money to our customers and wider stakeholders, we continuously iterate and evolve our processes to make sure that we derive maximum value from innovation deployment. For example, there have been numerous occasions where systems trialled on innovation projects have undergone a series of upgrades and changes to improve reliability, reduce cost and expand access etc. This learning has been critical in subsequent deployments as we have moved this technology to BAU.

In addition, we look to adopt learning from each other's innovation projects to ensure the full value of innovation projects are realised. Figure 17 in Appendix E shows examples of how we deliver benefits by building on each other's work.

We also regularly seek feedback from our stakeholders to quantify levels of engagement and satisfaction resulting from innovation projects. We seek informal feedback, formal recognition and awards as well as using quantified survey results to understand the value provided by our innovation work.

[20]Ofgem/Poyry report on the Evaluation of the Low Carbon Networks Fund, October 2016.

## Improving methods of managing risk

Only high Technology Readiness Level (TRL) innovative technologies can be deployed to BAU directly from an innovation project. Most successful BAU deployments rely on learning from across several projects to ensure that as many risks are addressed as possible.

All innovation projects inherently carry a level of risk of failure. We efficiently manage spending on innovation projects, and we have implemented a series of checks and monitoring activities across our businesses. We perform thorough initial investigations, justify investment/deployment at scale once trialled; and where benefits are not or will not be realised, we may decide to stop a project prematurely.

## Ensuring early identification of useful innovations

We have created structured approaches to ensure a constant stream of internal and external innovation ideas and robust methodologies to consider which ideas to pursue. We believe that innovation is best facilitated when we have the support of a network of ideas, influences, challenges and transparency from both internal and external sources.

We also publish our challenges and opportunities as we see them, to engage with external stakeholders when creating and developing innovative solutions. We are active contributors to The Institution of Engineering and Technology (IET), industry events, industry working groups, and industry publications.

We frequently develop innovation ideas and projects with each other, partners, academics, and customers, taking into account their ideas and experience. Throughout the process we maintain focus on ensuring that the ideas we pursue are of benefit and resolve key innovation challenges.

## Increasing access for non-regulated businesses

We constantly undertake “calls for innovation” either directly or via third party organisations. The ENA hosts the Networks Innovation Collaboration Portal, which is described in the next section, and we also work with third party organisations, such as EIC and Innovate UK, to source new innovation projects. These organisations help us to facilitate collaboration with small-to-medium sized enterprises (SMEs), suppliers, academia, consultants, the gas industry, and other sectors (for example, transportation and heat).

In addition, we welcome stakeholders to contact us directly via our innovation websites, or to speak with us at stakeholder engagement events and panel sessions.

# Collaborative Innovation

**While each of us have our own strategy for innovation that captures the challenges unique to our licence area geographies and customers' needs, we strongly believe that electricity networks and wider industry collaboration is absolutely key to ensuring we deliver benefits to customers and helping the UK achieve its energy goals.**

As electricity network licensees, we already work together to effectively coordinate innovation activity, share project learning and implement critical innovation initiatives. We are not only collaborating between transmission and distribution, but working with the gas networks and third party providers; this joined-up approach across the wider industry promotes GB business and GB investment, delivers whole system innovation, and provides better value for energy consumers and network customers.

## Collaboration through ENA

Under ENA, there are a wide range of initiatives that facilitate collaboration between us as network and system operators. These activities include project partnerships, coordination of innovation strategies, sharing and dissemination of learnings, joint problem solving, maintaining innovation databases and promoting third party involvement in network innovation. The activities and groups described in this section support and strengthen the professional relationships between network operators and demonstrate how innovation collaboration is considered at every possible opportunity.

### Smarter Networks Portal

The Smarter Networks Portal acts as a repository for Ofgem-funded gas and electricity innovation projects and makes the learning accessible to us as well as third parties and the general public.

It includes an overview of the technical and commercial coverage of current and completed GB electricity and gas innovation projects and details of all current and past NIA and NIC projects. Progress and Closedown Reports are published for NIA and NIC projects, which include project outcomes and lessons learned.

By sharing this information on a common portal, we drive ongoing value from projects and their learnings. Automatic notification of new projects into ENA Smarter Networks Portals gives us, and interested parties, oversight of what projects are being undertaken, progress, and the key learning from those projects. This enables users to identify opportunities for further innovation and plan projects that complement and utilise work already done, hence minimising unnecessary duplication and driving better value for customers' money. This information is used by other networks to better understand business cases of emerging technologies and establish whether high TRL projects can be deployed in other network areas.

Another function of the Smarter Networks Portal is that it circulates NIA Project Registration Documents to innovation representatives from each network licensee ten days prior to publication on the Smarter Networks Portal. This review period gives us the opportunity to partner prior to project initiation where projects are pertinent to more than one licence area. This promotes collaboration and enables members to review, indicate interest in running a joint project and identify and prevent project overlaps prior to kick-off.

**The Smarter Networks Portal is hosted by ENA and can be found at http://www.smarternetworks.org**

ena energynetworks association | smarter networks portal

## Collaboration with the wider energy industry

The energy industry is becoming more and more integrated, bringing greater opportunity for wider industry collaboration. We are doing a lot of work to collaborate with third party innovators and we are strengthening our association with the gas networks, as we all move to embrace whole system thinking.

We already work and partner with third party consultants, manufacturers, innovators, solutions providers and developers through the NIA and NIC projects. By working with these parties, we are helping to promote GB businesses and get more of the wider energy industry involved in network innovation.

Working with third parties also enables us to assist in the development of lower TRL technologies; we want to work with experts to bring these technologies closer to deployment, so that their true value can be realised and the subsequent benefits shared with the UK customer. With the pace at which the role of networks is changing, awareness of novel ideas and emerging technologies is more important than ever.

The following sections highlight some of the key initiatives that we are currently undertaking to engage with third parties and the wider energy industry. We are aware that there are other initiatives and organisations in the energy industry also undertaking critical innovation work, and we want to engage with them further to align our strategy with their work. Hence, we have created links with, and want to increase collaboration with, groups such as Energy Systems Catapult, Energy Innovation Centre[21] (EIC), Engineering and Physical Sciences Research Council (EPSRC), Knowledge Transfer Network (KTN), Innovate UK, Collaborative Energy Portfolio[22] (CEP), academia, and doctoral training etc.

We want to deliver a Smart, Flexible Energy System and we want further engagement with third parties to implement innovation projects that can help deliver this. At the end of this section, we highlight ways in which you can be further involved, as we recognise that we need to do more.

### Network Innovation Collaboration Portal

ENA hosts the Network Innovation Collaboration Portal, which facilitates contact between network licensees and potential innovation project partners, to encourage collaboration on innovation projects eligible for the NIC or NIA funding. These project partners include manufacturers, LCT innovators, disruptors, service providers, researchers, consultants and other innovative solution providers. The portal was built to assist with this via two primary functions:

1. Allowing network licensees to post 'Invitations to Expressions of Interest' in relation to particular topics, inviting third parties to make contact with them with a view to partnering on NIA or NIC-funded projects.
2. Allowing third parties to propose new and innovative projects ideas, which will allow the development of their novel idea or technology in collaboration with the gas and electricity networks.

The portal was re-released in late 2017, and we want more third parties to use it to demonstrate their innovative solutions to the networks.

**The Network Innovation Collaboration Portal is hosted by ENA and can be found at: http://www.nicollaborationportal.org**

ena energynetworks association | network innovation collaboration portal

[21] Seven of our network companies are stakeholders in the EIC, so it is not a wholly independent organisation.
[22] The CEP is a collaborative project delivery mechanism, managed by ENA.

Case study
**FREEDOM**

Western Power Distribution & Wales and West Utilities

The research objectives of this project are to better understand if hybrid heating systems are technically capable, affordable and attractive to customers as a way of heating homes. This project aims to investigate the feasibility of the use of heat pumps on both WPD's & WWU's network.

Case study
**InTEGReL**

Northern Powergrid & Northern Gas Networks

Development of the UK's first fully integrated energy systems research, development and demonstration site as part of its work to develop a fully integrated, zero carbon energy network moving from cleaner to clean, greener to green.

## Cross-vector collaboration

Cross-vector collaboration is a critical part of whole energy systems thinking, which will help us to maximise the benefits for customers as we move to a Smart, Flexible Energy System.

We already undertake a range of initiatives in this space, including joint innovation projects between ENA's gas and electricity networks members. Under ENA, we are also increasing this collaboration by holding joint working groups and events. The theme for the 2017 LCNI conference was "Whole Systems", which we believe not only showcased what is being undertaken now, but also helped the networks and stakeholders build further cross-sector collaboration.

This space is relatively new to the networks, and we want to work with other vectors, including gas, heat and transport, to further develop innovation and create new cross-vector projects that can contribute towards optimising the whole energy system.

## Open Networks Project

The Open Networks Project was setup to help us to work together closely to transition the electricity networks to a smart grid. This will address short term issues, develop medium and long term enduring approaches to delivering a Smart, Flexible Energy System, as well as manage whole system issues.

The objectives of the Open Networks Project are to:

1. Develop improved transmission and distribution processes around connections, planning, shared services and operation.
2. Assess the gaps between the experience our customers currently receive and what they would like and identify any further changes to close the gaps within the context of 'level playing field' and common transmission and distribution approach.
3. Develop a more detailed view of the required transition to DSO, including the impacts on existing organisation capability.
4. Consider the charging requirements of enduring electricity transmission/ distribution systems.

To support this project, we have created a representative Advisory Group for the project comprising a range of industry experts from across the energy industry, including suppliers, aggregators, Independent Distribution Network Operators (IDNOs), industry groups, academia, generators, consumer groups, the gas industry, Government, Ofgem and other industry parties. We have used the Advisory Group to inform stakeholders of project progress, and more importantly to allow contribution and input into the workstream products at a very early stage. A wider stakeholder distribution list for the project has also been formed and used to gather further input. All of this input and feedback has heavily shaped the outcome of products, and we encourage stakeholders to continue with their feedback into 2018 and beyond.

The general shift towards a Smart, Flexible Energy System, including the shift in the networks towards the DSO, will result in a large amount of innovation being required to trial different commercial and technical models. This is an unparalleled time for change, and the best way to move forward is to test new technologies and systems and determine which are best for the future energy system. From 2018, we will trial a series of DSO configurations and techniques, and associated future energy system technologies. These include the following 2017 NIC DSO-related projects:

- Transition (Scottish & Southern Energy Networks and Electricity North West Limited)
- Electricity Flexibility and Forecasting System (Western Power Distribution)
- Fusion (SP Energy Networks)

There is a need to collaborate closely on DSO-related trials, and we will coordinate these projects, as well as further DSO-related trials, under the Open Networks Projects and more generally ENA. Given the strategic nature of transitioning to the future energy grid, innovation collaboration is key to ensuring the most beneficial solution for UK customers. We also note that separating the Transmission Operator and System Operator will generate new commercial models.

## Getting involved

As discussed, we are already undertaking a range of collaboration activities between electricity and gas networks and third party innovators. However, there is always room for improvement, and we want to increase this collaboration across the energy industry to encourage investment in innovation and hence deliver better value to energy consumers and network customers. We want you to get involved in the initiatives described in this strategy, but we also want to hear how you want to be involved going forward. **We welcome your input and we look forward to working with you.**

**To get involved, please contact innovation@energynetworks.org**

# Conclusions

In this Electricity Network Innovation Strategy, we have considered the transformation trends impacting the sector, the innovation challenges of most relevance and importance to stakeholders and the strong track record to date of network innovation in the UK. This has enabled us to group the many key innovation opportunities into themes and to recognise their respective future innovation opportunities. Stakeholder input has been a critical component of this, to encourage a focus on innovation that clearly benefits customers and provides future value.

**Innovation is a significant priority for our electricity networks, focused on achieving important long term objectives:**

1. **Identify opportunities for the continuous improvement of our networks and deliver improved value to our customers.**
2. **Find new ways to make our service more reliable, more affordable, more accessible, cleaner and safer.**
3. **Provide us the flexibility to better respond to the changing requirements of our customers, both today and tomorrow.**

As always, it is vital to consider the "so what" aspects from this work. What do we do differently? This has led us to propose three Strategic Focus Areas, which we believe encapsulate how we will best achieve our longer term objectives for innovation.

## Strategic Focus #1
## INNOVATE

**Focus in the short to mid term on innovation areas of high priority and with high innovation opportunity.**

As highlighted in our roadmaps, areas of high priority are:

- improving network visibility and controllability
- efficiently facilitating the adoption of low carbon technologies supporting the electrification of heat and transport
- enabling flexibility in the low carbon transition
- maximising cyber security and data protection
- maximising benefits provided by new technologies, with particular focus on network services provided by electric vehicles and energy storage
- facilitating the adoption of commercial business models that leverage low carbon technologies
- improving the understanding of changing customer needs, particularly in regard to the electrification of heat and transport
- enabling customer choice
- facilitating behavioural change initiatives to promote energy conservation and sustainability.

Strategic Focus #2

## IMPLEMENT

**Emphasise transition of proven innovation to BAU to realise the full benefit potential for customers.**

Beyond the importance of having a clear focus and collective set of innovation priorities, it is equally critical that we continue to make progress in delivering benefits from innovation within our businesses for our customers. Examples of this being achieved include improvements in the transfer of innovation into BAU, a commitment to realising the full value of previous innovation as innovation initiatives build on each other, and improvements in methods of managing risk.

We have also introduced novel ways of identifying an optimal innovation pipeline, so we start with a well-informed view. Going forward, noting the nature of the challenges identified, effective delivery of benefits from innovation will require a combination of investment, new capability development and cultural change, as well as ongoing measurement to track benefit delivery.

Strategic Focus #3

## COLLABORATE

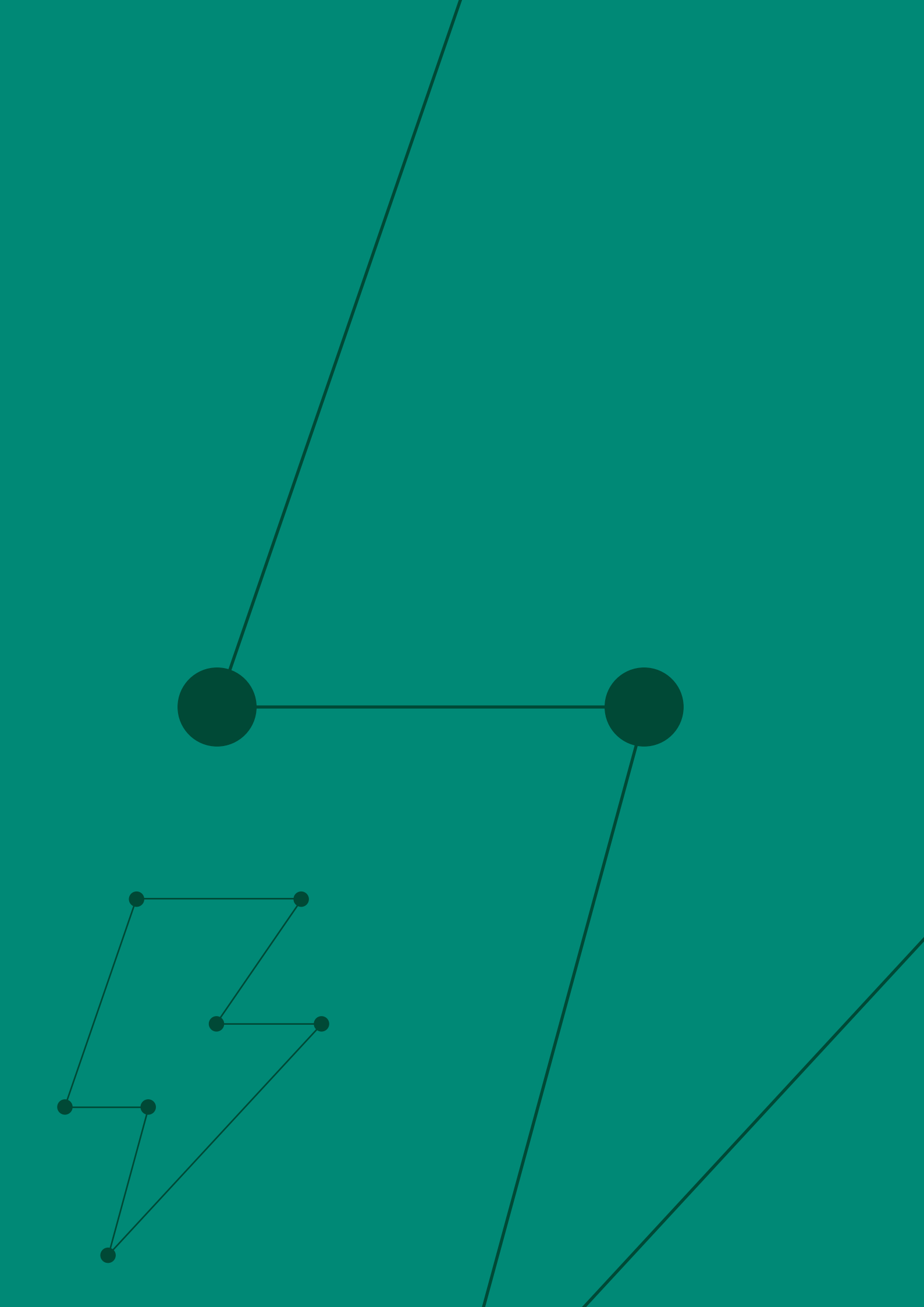
**Enhance strategic collaboration by increasing project partnerships, improving the dissemination of knowledge, and using industry forums more effectively.**

There will be renewed emphasis on the need for and benefits of collaboration in developing and deploying innovation. This is not just across the electricity network companies, but also cross-sector with gas networks and with third parties who have innovation as their raison d'être.

The optimisation of the five innovation areas on a whole system level, whether at community, municipality or national level, will require significant innovation. We are actively promoting whole system innovation through the Open Networks Portal and cross-industry events such as the LCNI conference.

# Glossary of terms

| Acronym | Description |
|---|---|
| **ANM** | Active Network Management |
| **BAU** | Business as Usual |
| **BEIS** | Department for Business, Energy and Industrial Strategy |
| **CBA** | Cost Benefit Assessment |
| **CCS** | Carbon Capture and Storage |
| **CEP** | Collaborative Energy Portfolio |
| **DER** | Distributed Energy Resources |
| **DNO** | Distribution Network Operator |
| **DSO** | Distribution System Operator |
| **ED1** | RIIO – Electricity Distribution Price Control 1 |
| **ED2** | RIIO – Electricity Distribution Price Control 2 |
| **EIC** | Energy Innovation Centre |
| **ENA** | Energy Networks Association |
| **ENW** | Electricity North West |
| **EPSRC** | Engineering & Physical Science Research Council |
| **EU** | European Union |
| **EV** | Electric Vehicle |
| **GB** | Great Britain |
| **HV** | High Voltage |
| **HVDC** | High Voltage Direct Current |
| **IDNO** | Independent Distribution Network Operator |
| **KTN** | Knowledge Transfer Networks |
| **LCNF** | Low Carbon Networks Fund |
| **LCT** | Low Carbon Technology |
| **LNO** | Licensed Network Operator |
| **LV** | Low Voltage |
| **NG** | National Grid |
| **NIA** | Network Innovation Allowance |
| **NIC** | Network Innovation Competition |
| **NPG** | Northern Powergrid |
| **PV** | Photovoltaics |
| **R&D** | Research & Development |
| **RIIO** | Revenue = Incentives + Innovation + Outputs |
| **SO** | System Operator |
| **SPEN** | SP Energy Networks |
| **SSEN** | Scottish & Southern Electricity Networks |
| **TO** | Transmission Owner |
| **TRL** | Technology Readiness Level |
| **UK** | United Kingdom |
| **UKERC** | UK Energy Research Centre |
| **UKPN** | UK Power Networks |
| **WPD** | Western Power Distribution |



Energy Networks Association
6th Floor, Dean Bradley House
52 Horseferry Road, London SW1P 2AF

Tel +44 (0)20 7706 5100
www.energynetworks.org
@EnergyNetworks