Our RIIO-2 ambition

April 2019

nationalgridESO

Help shape our RIIO-2 business plan

Why we are consulting

Our business planning takes place within the context of Ofgem's regulatory framework, known as RIIO (Revenue = Incentives + Innovation + Outputs). The framework sets price controls to determine the amount we can earn from the services we provide.

The current regulatory price control period is known as RIIO-T1 and runs from 2013 to 2021. The next regulatory period, RIIO-2, runs from April 2021 for five years.

We are currently preparing our business plan for RIIO-2. The plan will set out the activities that we will undertake, the investments we will make, how we will innovate for the future and the performance outcomes upon which we'll be measured.

Our stakeholders' views are vital in shaping our direction and role as we enter our first price control as a legally-separate Electricity System Operator (ESO). This consultation sets out our ambition for the next regulatory period and beyond. We will use this ambition to lay the foundations for our business plan. We want to share what we have learned from our stakeholders to date. This is an opportunity to play back this information, show how it has informed our ambition, and invite further views.

We are continuing to work together with stakeholders to develop this ambition into detailed proposed outputs and activities for our business plan. Sharing our ambition and our work to date will help us prepare an informed and robust first draft of this plan later in 2019.

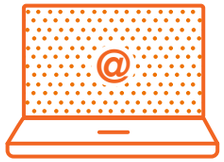
Tell us what you think

- Do we have the right level of ambition?
- Do you agree with the activities we have highlighted to deliver this ambition?
- Are our initial estimates of the potential cost of delivering this ambition reasonable?
- Do you agree with our articulation of the consumer benefit from our activities?
- Is it sufficiently clear how we have taken stakeholder input into account in developing our ambition?
- How would you like to be involved in the ongoing development of our RIIO-2 business plan?
- Are there any further comments you would like to make as we develop our RIIO-2 business plan?

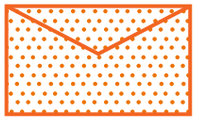
Who are our stakeholders
Throughout this document we refer to our stakeholders. This includes our customers, industry bodies, trade associations and anyone else with an interest in the ESO.

This consultation is open until 3 May 2019.

You can give us your views:



via email to box.eso.riio2@nationalgrideso.com



or in writing to ESO RIIO-2 team, National Grid ESO, Faraday House, Gallows Hill, Warwick CV34 6DA.

Our RIIO-2 ambition

1. Introduction

Our Mission is to enable the transformation to a sustainable energy system and ensure delivery of reliable affordable energy for all consumers.

Success in 2025 looks like:
- An electricity system that can operate carbon free
- A strategy for clean heat, and progress against that plan
- Competition everywhere
- The System Operator is a trusted partner

Energy is the lifeblood of our economy and society. As we head towards RIIO-2, our energy system is undergoing a revolution. Driven by developments in technology and policy, trends towards decarbonisation, decentralisation and digitisation are accelerating. Since 2013, the start of the RIIO-T1 price control, the system has already radically changed.

As the Electricity System Operator (ESO) for Great Britain, we hold a privileged position at the heart of the nation's energy system. As the landscape around us evolves, so too does our role. We continually manage the risks of this uncertainty on behalf of consumers. Looking ahead to RIIO-2, there is a huge amount for us to do as we continue to deliver energy safely and reliably and play our part in driving decarbonisation – the challenge of a generation.

In our new, legally-separate role, we are excited to step up and be the ambitious ESO that our stakeholders want us to be.

Our ambition for RIIO-2 is dominated by four themes – though many of our activities and aspirations are linked across more than one. These themes build on our current roles, and reflect the feedback we have heard from stakeholders through over 18 months of extensive engagement.

1. Reliable and secure system operation to deliver energy when consumers need it
2. Transforming participation in smart and sustainable markets
3. Unlocking consumer value through competition in networks
4. Driving towards a sustainable whole energy future

Alongside these themes, we need to **transform our capability for the future** through our investment in information technology (IT), innovation and people. There is more information on this in chapter 8. We recognise that we need to be a customer and stakeholder-focused organisation in delivering our core objective of maximising value for consumers. In this context, we will look to drive increasing customer satisfaction, measuring progress through our satisfaction surveys and Net Promoter Score.

Our goal is to be a trusted partner in the energy industry. We know that to deliver our ambition will require the continued confidence and support of Ofgem, government, and our customers and stakeholders – through a shared ambition and commitment to work together.

1. Our ambition

Reliable and secure system operation to deliver energy when consumers need it

As we transition to a low-carbon energy system, our operating environment is changing dramatically. The number and diversity of market participants is increasing rapidly. We are seeing ever greater participation by demand-side participants, volumes of variable renewable and distributed sources of power are increasing, flows on the power network are less predictable and system inertia is declining dramatically. We are committed to embracing and enabling this transition and the benefits it brings to our economy and society.

All of this has a significant impact on how we operate a reliable and secure system.

1. We will transform the operation of the electricity system so that, by 2025, it can operate carbon free.

2. Our selection and utilisation of resources will be transparent and based on driving consumer value – optimising across generation, storage, demand and other technologies (be they large scale, distributed or embedded) on an equal basis.

Operating a low-carbon electricity system will require a transformation in the markets that underpin the provision of generation, capacity, and the products that enable us to balance the system on a day-to-day, second-by-second basis.

Transforming participation in smart and sustainable markets

Markets will be key to the pace and overall effectiveness of the energy transformation. Unlocking consumer value requires that appropriate markets are in place and accessible to all. The barriers to entry that exist in the complexity of today's systems must be removed. We will provide a simpler, more customer-focused, platform into all our markets and improve and expand access to these markets.

We recognise that strategic change cannot be delivered efficiently under the current codes and code governance. We propose a transformed approach for the codes that we manage, one which can deliver for hundreds of market participants rather than the tens of participants for which the current process was devised. This will allow strategic code change to be prioritised, simplified and delivered quickly and efficiently to further accelerate and increase competition.

3. By 2023, all market participants 1 MW and above will be able to participate directly in our balancing service markets and the Capacity Market through a single platform. Participation of smaller assets, such as household storage and electric vehicles, will also be enabled through, for example, aggregation.

4. By 2025, we will deliver security of supply against a clear standard agreed with the Government. We will be responsible for all elements of the Capacity Market, manage the rule change process, and deliver a new platform to improve the experience of participants.

5. A sandbox experimental market environment will sit alongside our established markets to enable co-development of solutions to emerging operability issues, such as system inertia and stability.

6. We will work with all stakeholders to create a fully digitalised Grid Code which is principles-based, simple to understand and navigate, and enables the flexibility required to support the energy transition.

Transparent, accurate information and insight is essential given the increasing challenge of system operability and the fundamental role of markets in delivering secure and efficient system operation. The data and insight we provide will inform decision-making and grow industry and market confidence.

7. We will transform the data we make available – providing a clear interface for all ESO data, including core market and operational information, that can be easily accessed and interrogated with industry standard application programming interfaces for ease of access and use.

1. Our ambition

Unlocking consumer value through competition in networks

We will enable a step change in the role of competition in delivering optimal outcomes for consumers. Our network planning approach makes recommendations on the best solutions to problems identified on the transmission network. We will build on the successful *Network Options Assessment (NOA)* process. This will enable competition to be accelerated and delivered within and across network boundaries, and allow both asset (network and non-network) and market options to be explored.

8. We will facilitate competition across all dimensions, enabling all viable options to compete for delivery of solutions to network challenges. We will remain technology-agnostic, selecting solutions based on the consumer value they can deliver.

Specifically, in respect of competition in delivery of onshore transmission infrastructure, we fully support the introduction of competition in a way that maximises value for consumers. We think this is best achieved through a model which allows competition at the early stages of project development.

9. We will actively support Ofgem and industry to deliver a model for onshore competition that maximises consumer value, playing our part in setting up, and then operating within, the framework.

Driving towards a sustainable whole energy future

As the themes of decarbonisation, decentralisation and digitisation continue to dominate the changing energy landscape, there is a clear and unequivocal need to think and plan across the boundaries of transmission and distribution, and across the closely interlinked power, heat and transportation sectors.

We will need to take a whole system view of all our activities in the changing energy landscape, working with others to drive consumer value.

10. We will work with all stakeholders to ensure a whole system approach is taken to optimise planning, development, investment and operation of Great Britain's energy networks. We will bring our expertise to complement that of others and drive industry as it navigates a complex energy transition. We will facilitate informed decision-making that accounts for whole system impacts and minimises unintended costs or consequences.

11. We will reduce friction for participants in their interactions anywhere on the electricity network, for example whether connecting to the transmission or distribution network, accelerating the efficiency and effectiveness of the energy transformation.

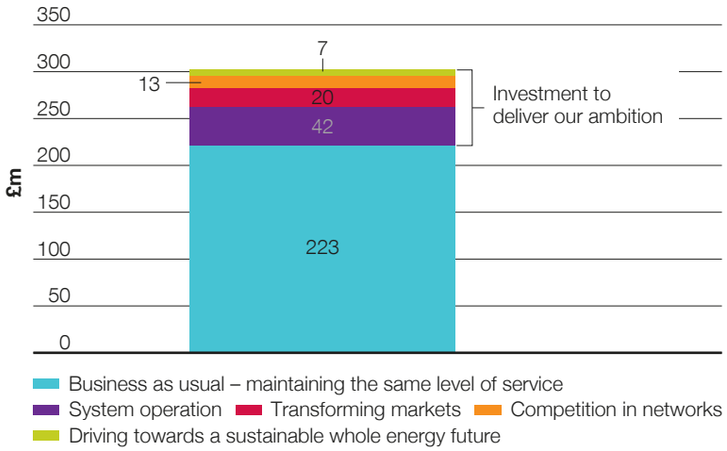
1. Size and scope of an ambitious ESO

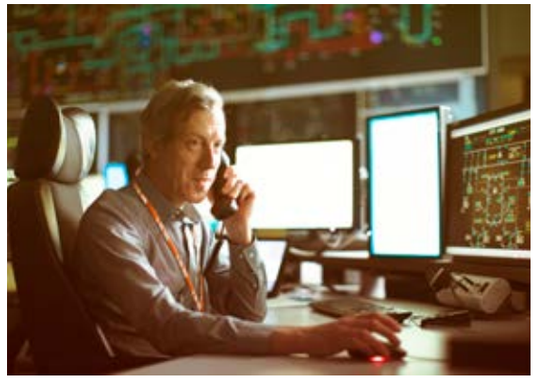
It costs around £200 million per year[1] to undertake our role today – equivalent to around £1 on a consumer's annual energy bill. This incorporates the efficiencies and innovations we have invested in over the RIIO-T1 period. However, the dramatically changing landscape has raised new challenges for operating the system. We have managed these without significant additional cost to the consumer in RIIO-T1, but we must now take the opportunity to invest in our systems and capability to continue operating at the same standard of security and reliability. We must also invest in our market platforms to provide access to a vastly increased number of diverse participants. We estimate that it will cost around £223 million per year to maintain the same level of service, including replacing and enhancing existing systems and making mandatory changes to implement new regulations.

We want to give stakeholders visibility of our initial thoughts on the range of costs that underpin our additional proposed activities and outputs for RIIO-2. These represent the upper end of what an ambitious ESO could cost. As we develop our business plan throughout 2019, we will complete more detailed cost-benefit analysis for the activities we propose to undertake during RIIO-2. We will share the outputs of this analysis with stakeholders through our engagement programme and in our draft business plan, published later in 2019, to seek feedback and refine our proposals

To deliver all of the proposals set out in this document could cost a further £82 million per year. This includes investment in new market platforms that will drive transparency and increased participation, transforming our Black Start capability, and systems to enable advanced system modelling and simulation using artificial intelligence and machine learning. This investment will unlock additional benefit for consumers and ensure delivery of reliable affordable energy. At the end of each chapter, we provide more details on the benefits that our roles and activities could deliver and our initial views of the items that make up these costs.

Potential scope of ESO RIIO-2 costs
£m per year





The ESO costs around £1 on a consumer's annual energy bill.

[1] The total costs per activity given throughout this document do not sum exactly to £200 million due to rounding.

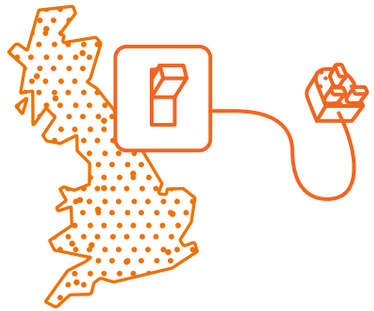
1. Delivering consumer benefit

The ESO is a small organisation but we influence huge consumer value across the energy system and are critical in enabling the transition to a sustainable, low-carbon economy. We facilitate markets worth over £35 billion a year and manage around £1 billion of electricity balancing decisions each year[2]. In 2018/19, we made network development recommendations that could save consumers between £1.85 billion and £2.67 billion over the next 11 years[3]. The market reforms we are driving could save consumers hundreds of millions of pounds and avoid significant future costs[4].

We want to make sure that our business plan drives benefit for consumers, both now and in the future. Throughout this document we have highlighted the benefits that our roles and activities could deliver using the categories described here.

1 Improved safety and reliability

Electricity at the flick of a switch, something we take for granted, is fundamental to our economy and society. As the energy landscape continues to decarbonise and transform, we operate a system with much more complex flows of energy and invest to make sure it remains safe and secure in the future. Investment in cyber security protects our system from cyber threats, ensuring the continued safe and reliable operation of the system. The distributed and decarbonised future of the electricity grid presents a wider threat landscape with opportunities for increasing frequency and sophistication of attack. We will invest further in cyber security to identify, prevent and manage these increased threats.



2 Improved quality of service

Over recent years we have transformed our approach to engaging with our customers and stakeholders, listening harder to what they want from us, and delivering on that. Where we can't act on this feedback, we explain why. Improvements in our quality of service ultimately benefit the consumer as interactions in the value chain across the industry become seamless, more efficient and effective.

3 Lower bills than would otherwise be the case

We lower consumers' bills by balancing the electricity system as efficiently and effectively as possible, managing around £1 billion of electricity balancing decisions every year and facilitating markets worth over £35 billion per year. We make decisions that influence network development costs, customer and wider wholesale market costs, and generation capacity, which all form part of the consumer bill today. We lower future bills by facilitating a rapid and efficient transition to a low-carbon electricity system which could save consumers up to £7.8 billion per year[5].

[2] Market value of traded electricity for inland consumption, not including VAT and duties. *Digest of UK energy statistics*, page 33 (July 2018). https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/736148/DUKES_2018.pdf

[3] This is the suggested saving against a counterfactual where the Transmission Owners do not build according to our recommendations. https://www.nationalgrideso.com/insights/network-options-assessment-noa For more information, see chapter 5.

[4] For more information, see chapter 4.

[5] This benefit is achieved in a 2030 system, meeting a target of 50gCO_2/kWh. £3.2 billion to £4.7 billion of annual consumer benefits could be achieved in a 2030 system meeting a carbon emissions target of 100gCO_2/kWh. This is taken from a report for the Committee on Climate Change (*Roadmap for Flexibility Services to 2030*, May 2017) https://www.theccc.org.uk/wp-content/uploads/2017/06/Roadmap-for-flexibility-services-to-2030-Poyry-and-Imperial-College-London.pdf

1. Delivering consumer benefit

4 Reduced environmental damage

Delivering the UK's 2050 carbon reduction target and ensuring a sustainable future for our planet is the challenge of a generation. As the ESO, we are at the centre of the transition to a low-carbon electricity system that is crucial if we are to meet this challenge. We design markets that support new, low-carbon technologies and disruptive solutions to today's environmental challenges. We work innovatively to enable low-carbon generation to quickly connect to the electricity transmission network.

5 Benefits for society as a whole

By 2050, energy system decarbonisation efforts could add 19 million jobs and $52 trillion of gross domestic product (GDP) to the global economy, increasing the GDP of Northern and Western Europe by 1.25 per cent and 2.5 per cent respectively. It could also generate a 15 per cent increase in global welfare and reduce negative health effects caused by local air pollution by 60 per cent[6].

[6] *Global Energy Transformation: A Roadmap to 2050*, International Renewable Energy Agency, https://irena.org/publications/2018/Apr/Global-Energy-Transition-A-Roadmap-to-2050

1. A plan shaped by our stakeholders

As we embark on this unprecedented opportunity to develop a new business plan for the ESO, we need the insight and support of our customers and stakeholders. It is critical that we produce a plan that reflects stakeholders' needs and ultimately drives value for consumers. Our stakeholders have played a vital role in shaping the proposals in this document and will continue to do so as we develop our final plan throughout 2019.

Where possible, we have built upon existing engagement opportunities, such as our customer connections seminars, charging forums, *Future Energy Scenarios* workshops and operational forums. We have also developed a programme of targeted RIIO-2 engagement activities to make sure we reach a broad range of stakeholders and discuss overarching topics, such as the whole energy system.

We have summarised how we have engaged with you so far, over and above our existing business as usual engagement channels. Throughout this document we show how your feedback has been used to develop our thinking. We will provide more detailed stakeholder feedback in our draft business plan published later this year.

Summary of our targeted RIIO-2 engagement

Interactive communication, including: • Bilateral meetings • Workshops • Webinars	**To date we have held:** • 84 bilaterals • 4 workshops • 6 webinars	**Which has resulted in engagement with:** • 273 individuals • 169 organisations
ESO RIIO-2 Stakeholder Group	**To date we have held:** • 3 meetings • 1 workshop • 1 electricity control room visit	**This has involved:** • 19 of our key stakeholders
Published communications, including: • Bi-monthly bulletins • Website • Thought pieces • Podcasts	**To date we have published:** • 4 bulletins • 2 stakeholder reports • 3 thought pieces • 1 podcast	**These have reached:** • Average of 900 individuals through our bulletins • 198 plays of the podcast

What we have heard

You have told us:

- We need to be ambitious when thinking about how our role can evolve to drive value for consumers.
- You want an ESO who advises and makes recommendations.
- You see value in a better service, and may be willing to pay for it.
- The funding model and regulation should drive us to be ambitious and allow us to respond flexibly to new challenges as they arise.
- We should be strongly incentivised to deliver benefits for consumers over and above our day-to-day role.
- We should be transparent and provide data to help facilitate the markets.

In each chapter of this document we set out the specific stakeholder feedback that has driven our ambition in that area. We hope that our proposals in this document show we are listening.

1. Consumer and stakeholder priorities

Consumers and stakeholders are at the heart of our preparations for RIIO-2. As a service business managing and influencing up to £4 billion of consumer spend per year[7], our overriding objective is to deliver consumer benefit. We have undertaken significant work to better understand the priorities of our consumers and stakeholders, and therefore what we should deliver, as the ESO. We have used a wide range of existing and targeted engagement events to help us develop, test and refine these priorities. You can find out more about how they were created on our website[8].

The priorities are used throughout this document to assess in which ways our activities will deliver value. We have indicated in each chapter how our ambition and transformational activities contribute to meeting them.

Consumer priorities

- We want an affordable energy bill
- We want a decarbonised energy system, fit for the future
- We want energy to be available when we need it
- We want a safe and secure energy system

Stakeholder priorities

- I want transparent and forecastable charges
- I want to provide more balancing and ancillary services
- I want efficient whole energy system operation
- I want to connect to the electricity network in a timely manner
- I want you to enable the smart, flexible and low-carbon energy system of the future
- I want you to facilitate active markets for a wide range of products and services
- I want you to protect the system from cyber and external threats
- I want you to be open, engaging and easy to work with
- I want you to be adaptable and innovative
- I want access to comprehensive, accurate and user-friendly information

[7] Network and balancing charges recovered from consumers.

[8] www.nationalgrideso.com/about-us/business-plans/future-planning-2021-onwards/have-your-say-on-our-future-plans

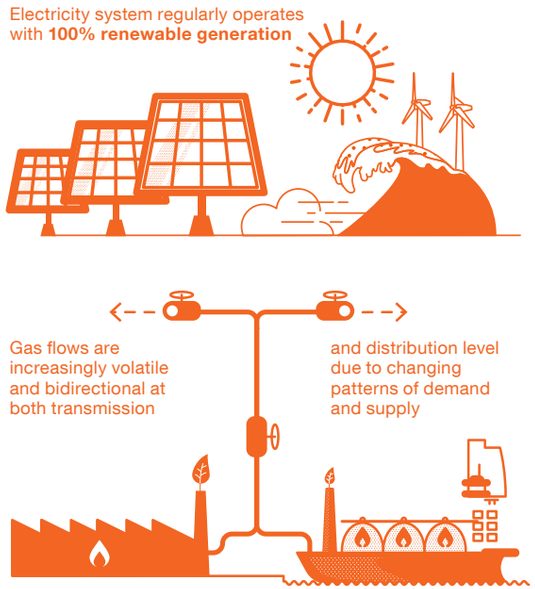
The changing energy landscape

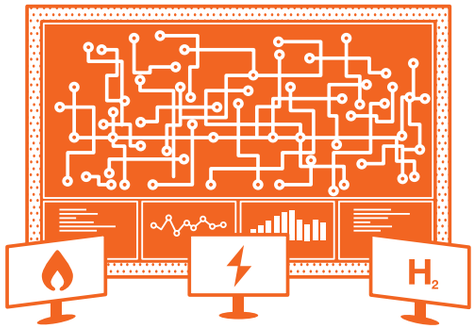
2. The changing energy landscape

The trends of decarbonisation, decentralisation and digitisation are driving unprecedented change across the energy system. As an industry, we often focus on the exciting potential and uncertainty of the energy future. However, when viewed through the lens of the whole energy system, and through the eyes of the consumers who our system serves, we can identify elements of our future with more confidence.

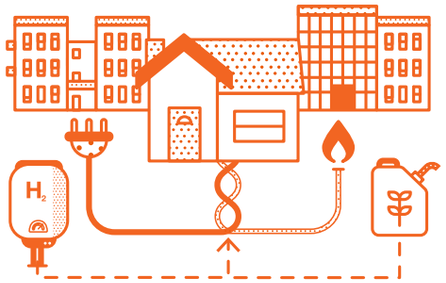
RIIO-2: the pathway to 2030

As the energy landscape transforms, so must our approach to continue to supply the energy Great Britain's homes and businesses rely on every day. The 2030 energy system will operate very differently to how it does today as we drive towards a decarbonised future.





All networks are actively managed
Distribution system operation is the norm and all networks are actively managed in real time



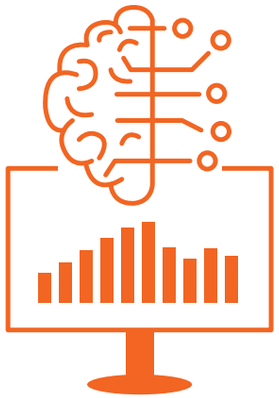
Network operations, planning and investment
Smart flexible networks, intelligent monitoring and commercial solutions enable optimisation of planning and investment across the whole energy system

2. The changing energy landscape

Competitive markets are designed and operated to ensure efficient and reliable operability, balancing supply and demand across gas and electricity systems

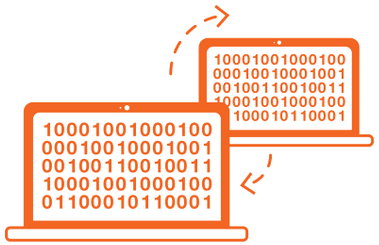
Risk and resilience is managed across the whole energy system. System event readiness, management and recovery is integrated across transmission and distribution networks for gas and electricity

Large volumes of **long-term energy storage**

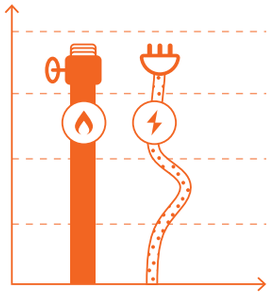


Artificial intelligence and machine learning are commonplace across all players in the industry, including vehicle charging, appliances, market participation and system operation. Critical functions such as system balancing always have human involvement

New commercial frameworks and markets will support whole system flexibility and operability, as well as potential new vectors (hydrogen, CO_2)



Data is shared openly wherever possible to inform competitive and efficient markets, enable innovation and inform change across industry



Consistency across networks for customers
Consistent and coordinated customer connection process across transmission, distribution, gas and electricity networks

Connection requirements are aligned across transmission and distribution networks

Policy direction on the decarbonisation of heat has been set and the first commercial deployments of new technology will be rolling out

Codes, frameworks and governance that facilitate competitive and efficient markets as the pace of change increases and the number of market participants grows

Scenarios and managing uncertainty

Uncertainty in the energy landscape translates into uncertainty in our roles and investments, and highlights the challenge of creating a business plan that will deliver for consumers now and in the future. We make decisions under uncertainty every day, managing the risk of this uncertainty for consumers.

A single 'best view' of what the energy landscape might look like in 2030 is unlikely to be accurate and could lead to over or under investment. Scenarios present a way of understanding and managing this uncertainty by outlining plausible future energy landscapes. Good scenarios should consider the whole energy system, be developed with stakeholders, use robust evidence and modelling, and be flexible enough to be used across the industry.

Our business plan will be based on National Grid System Operator's 2018 *Future Energy Scenarios*[9], which meets the above criteria through its large stakeholder development process, a view across fuels, networks and sectors, and its use internally and externally.

[9] http://fes.nationalgrid.com/

Reliable and secure system operation to deliver energy when consumers need it

3. Introduction to our ambitions

Our ambitions:

1. We will transform the operation of the electricity system so that, by 2025, it can operate carbon free.
2. Our selection and utilisation of resources will be transparent and based on driving consumer value – optimising across generation, storage, demand and other technologies (be they large scale, distributed or embedded) on an equal basis.

As we transition to a low-carbon energy system, our operating environment is changing dramatically and at pace. The number and diversity of market participants is increasing rapidly and information on market positions and system conditions is moving closer to real time. We are seeing ever greater volumes of less predictable renewable and distributed sources of electricity generation. Through our system operation and balancing role, we manage around £1 billion of cost per year and have held this broadly steady, despite the increasingly challenging environment.

Since the start of the previous price control, we have seen unprecedented change in the energy landscape. For example, at the start of RIIO-T1, we forecast that in 2019 we would have around 1 gigawatt (GW) of solar power capacity in the UK; we now have over 13 GW. Wind levels have similarly risen from 3 GW to 15 GW in the last 10 years as we transition to an increasingly decarbonised generation mix. Managing this uncertainty, together with declining system inertia, has a significant impact on how we operate the system.

The adoption of new technologies, such as electricity storage, and the increasing need for distribution system operation, will require new engineering and operational processes across the transmission-distribution boundary. The continued expansion in the number of market participants will increase the volume of technical and commercial data to be analysed and exchanged with other system users.

This is a huge challenge but these changes present an opportunity to transform our system balancing and operational processes. The changes we propose in this chapter will enable us to operate the zero-carbon network of the future.

At the same time, we must ensure our internal training and engineering capabilities keep up with the fast-changing energy landscape, and that our proposals for restarting the system from a total loss of power are robust.

Consumer priorities

- We want an affordable energy bill
- We want energy to be available when we need it
- We want a decarbonised energy system, fit for the future
- We want a safe and secure energy system

Stakeholder priorities

- I want efficient whole energy system operation
- I want you to enable the smart, flexible and low-carbon energy system of the future
- I want you to be open, engaging and easy to work with
- I want you to be adaptable and innovative
- I want to provide more balancing and ancillary services

3. Stakeholders have told us

We have started to talk to our stakeholders about future operation of the system and how our role should evolve for RIIO-2, and we know we have more engagement to do. We held workshops in September and December 2018 which have helped to shape our ambition in this area so far.

Our stakeholders expect to see the cost of operating the system remaining stable or reducing but tell us they have limited knowledge of how costs are managed today. This is something that we want to address. We have heard from stakeholders that more transparency behind the process for procuring services and decisions made in the electricity control room would drive more effective provision of services. Stakeholders want transparency in contract costs and for the market to do more so that the ESO, as residual balancer, has to intervene less. When the ESO does intervene, stakeholders would like greater transparency as to why, to provide a stronger feedback loop to the market. The market wants to know why the ESO uses the services and providers it does.

Stakeholders also want better delivery of large information technology programmes and need to feel confident that we can deliver them efficiently. We know stakeholders expect to see an improvement in our engagement in the delivery of market systems and platforms they need to interface with. We have learnt the importance of open and regular communications, of agile development, and where possible, engaging market users in the development and testing as programmes progress. We will apply this learning to future system development and implementation to ensure that stakeholders are part of that process, highlighting risks and issues as they arise.

We have consistently heard that roles and responsibilities, for example between the ESO and Distribution Network Operators (DNOs), need to be clarified. Market design and control may need different balancing timescales, but the interaction of local, national and international control rooms and markets is key. Clarity is required on accountabilities and what action should take precedence over another if a player can act in more than one market.

We further discuss how we will use a whole system approach to transforming the energy system in chapter 6.

To deliver our ambition and meet the needs of our stakeholders, we must:

- Transform our balancing capabilities
- Develop intelligent control and network analysis for a zero-carbon power system
- Go beyond Black Start to be able to restart the zero-carbon system of the future
- Enhance our resourcing, talent acquisition, training and simulation capabilities.

The ESO needs improved transparency around balancing service procurement and should publish its procurement strategy for each service.
ESO customer

The ESO should focus on a real step change in transparency and the establishment of competitive markets across balancing services. Customers should be able to build revenue streams and stack contracts.
ESO stakeholder

3. Activities to deliver our ambition

Transform our balancing capabilities

As we move to a lower carbon system with more and different market participants, energy balancing becomes more challenging. We will embrace this challenge and continue to operate a reliable system.

During RIIO-2, we propose to:

- Refresh existing systems to balance the network as they come to end-of-life and upgrade architecture to modern systems and capabilities that provide quicker and greater agility to react to the evolving markets.
- Make better use of the data available to us and apply artificial intelligence and automated control to transform how we balance the system.

Intelligent control and network analysis for a zero-carbon power system

The electricity control room of the future is very different to the control room we have today. We have different system challenges and different market participants. We therefore need to monitor different things and solve different problems using a different set of tools. We will build a pipeline of systems and tools to make sure the electricity control room has the right toolkit to operate the network. This will ensure that, as the technologies connecting to and those making up the network change, we can identify the key drivers of change to system operation.

During RIIO-2, we propose to:

- Introduce system inertia monitoring to understand the technical impact of the changing energy landscape, leading to more efficient management of constraints on the system, building on our preliminary work in RIIO-T1.
- Build new control systems and capabilities to improve look-ahead planning capability.
- Support DNOs as they develop their system operation capabilities, ensuring clarity for all parties on roles and responsibilities across the transmission-distribution interface.
- Develop intelligent situational awareness tools to replace the existing Integrated Energy Management System to ensure real-time operation remains well-managed, despite increasing complexity.
- Bring artificial intelligence into forecasting and scaling the ESO Lab, our internal applied research, to apply machine learning to a range of tools and systems.
- Develop and deploy detailed, real-time network simulation and modelling capabilities, with the accuracy to unlock system optimisation options.

Go beyond Black Start to be able to restart the zero-carbon system of the future

We must maintain the capability to coordinate restarting the power system in acceptable timescales as it transitions to a new model with less large, thermal generation plant. We will need to be able to re-energise a system where significant volumes of heat and transport infrastructure are also dependent on the electricity system, known respectively as cold and stationary start.

During RIIO-2, we propose to:

- Deliver the expected standard of the future for Black Start set by the Government.
- Build on our innovation project on Black Start from Distributed Energy Resources Project[10] to enhance our Black Start capabilities.
- Deliver the requirements for a future cold and stationary start.

Enhance our resourcing, talent acquisition, training and simulation capability

We must attract, develop, and retain the talent we need to operate the next-generation power system. Leading the way across the industry, we will enhance expertise and talent across the ESO and the energy sector. We will ensure real-time experiences are shared effectively with DNOs, to manage the whole electricity system better and enhance our reputation and service delivery. This will be underpinned by technology to support fast, efficient, forward-thinking training.

During RIIO-2, we propose to:

- Build new training simulators to provide better quality, lower cost and more scalable training for our power system engineers.
- Improve training, resourcing and understanding of system operation in a changing energy landscape.
- Better understand human factors, for example resilience, to make sure our power system engineers continue to make the right decisions in a highly complex energy environment.

[10] https://www.ofgem.gov.uk/publications-and-updates/electricity-nic-2018-national-grid-electricity-system-operator-eso-black-start-distributed-energy-resources

3. How do our proposals provide consumer benefit?

Improved safety and reliability	Refreshing our systems will facilitate new markets and provide greater accessibility, and protect from cyber threats, while enhancing our capability to efficiently balance the power system in real time. We will make sure a more complex and changing electricity system can still recover safely and quickly from a total loss of power and take steps to limit the risk of this occurring.
Improved quality of service	With a greater understanding of the state of the system, we will be able to better manage the interface between different parties and respond to their needs.
Lower bills than would otherwise be the case	We manage balancing costs of around £1 billion per year, and continue to keep these steady despite a more challenging operating environment. Facilitating accessibility for all participants will drive greater efficiency and competition in markets, ultimately reducing overall costs to energy consumers. By developing a greater understanding of the system, we can plan and operate it more efficiently, and therefore reduce the number and costs of the balancing actions we need to take.
Reduced environmental damage	Our commitments will enable us to balance a future network with new, low-carbon generation and demand sources. Transforming the capability of the electricity control room will create a level playing field where the full breadth of available technology can be dispatched.

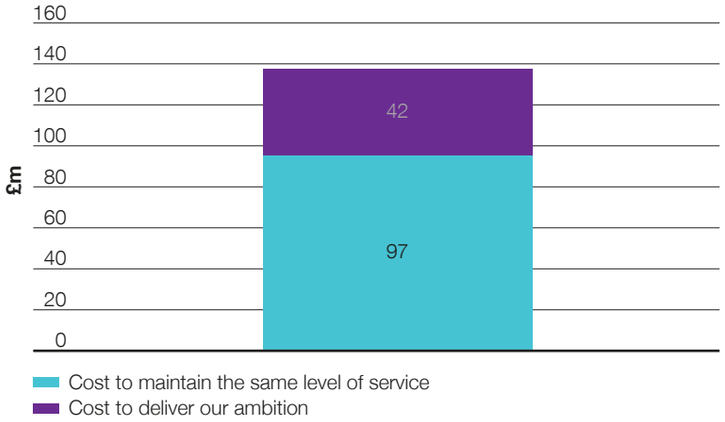
3. What could this cost?

Managing system balance and operability is a core role and takes up a significant portion of our budget. At present, this role costs around £97 million per year and we think that we can continue to provide a similar level of service for the same cost, taking into account planned efficiencies in this area.

Our investment in systems that underpin our other objectives – and are therefore accounted for in other chapters – will also contribute to some of the outputs in this chapter, for example, a new market platform for balancing services which is described in chapter 4. To deliver our proposals in this area, we may need to invest up to an additional £42 million per year. Of this, £11 million relates to potential investment in implementing reforms to Black Start, with investments in artificial intelligence, advanced modelling and simulation for the electricity control room, and system inertia monitoring accounting for approximately £22 million. Additional capability, including data scientists, could cost up to £6 million.

These are our initial views on costs and we will continue to refine them, in consultation with stakeholders, as we develop our business plan in 2019.

Reliable and secure system operation: potential RIIO-2 costs
£m per year



Transforming participation in smart and sustainable markets

4. Introduction to our ambitions

Our ambitions:

3. By 2023, all market participants 1 MW and above will be able to participate directly in our balancing service markets and the Capacity Market through a single platform. Participation of smaller assets, such as household storage and electric vehicles, will also be enabled through, for example, aggregation.
4. By 2025, we will deliver security of supply against a clear standard agreed with the Government. We will be responsible for all elements of the Capacity Market, manage the rule change process, and deliver a new platform to improve the experience of our participants.
5. A sandbox experimental market environment will sit alongside our established markets to enable co-development of solutions to emerging operability issues, such as system inertia and stability.
6. We will work with all stakeholders to create a fully digitalised Grid Code which is principles-based, simple to understand and navigate, and enables the flexibility required to support the energy transition.

Smart and sustainable markets will be essential for operating a carbon-free electricity system. We will need to maintain security of supply with much higher volumes of low-carbon generation and a significant increase in flexible sources of energy, such as demand-side response and storage. We have a vital role in delivering this complex task through development of the balancing service markets and promoting competition in wholesale and capacity markets.

The benefits for consumers, if we as an industry are successful, are high. Consumers currently spend over £35 billion annually across these markets, so a 1 per cent improvement in market efficiency would equate to an annual consumer benefit of £350 million[11]. More importantly, a report for the Committee on Climate Change has indicated that system costs to consumers could increase by £3.2 to £4.7 billion per annum by 2030 unless significant new sources of flexibility are attracted onto the system[12].

In developing a vision for markets, it is important that they all work together so that participants can make efficient business decisions. This is central to all our work.

Consumer priorities

- We want an affordable energy bill
- We want a decarbonised energy system, fit for the future
- We want energy to be available when we need it
- We want a safe and secure energy system

Stakeholder priorities

- I want transparent and forecastable charges
- I want to provide more balancing and ancillary services
- I want efficient whole energy system operation
- I want you to facilitate active markets for a wide range of products and services
- I want you to enable the smart, flexible and low-carbon energy system of the future
- I want you to be open, engaging and easy to work with
- I want you to be adaptable and innovative
- I want access to comprehensive, accurate and user-friendly information

[11] Market value of traded electricity for inland consumption, *Digest of UK Energy Statistics*, page 33 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/736148/DUKES_2018.pdf

[12] This benefit is achieved in a 2030 system meeting a target of 100gCO_2/kWh. In a 2030 system meeting a target of 50gCO_2/kWh, up to £7.8 billion of consumer benefit could be achieved. This is taken from a report for the Committee on Climate Change (*Roadmap for Flexibility Services to 2030*, May 2017) https://www.theccc.org.uk/wp-content/uploads/2017/06/Roadmap-for-flexibility-services-to-2030-Poyry-and-Imperial-College-London.pdf

4. Stakeholders have told us

We have received clear guidance to inform our ambition and proposals for balancing service markets through multiple channels, including electricity operational forums and Power Responsive events. We also held targeted workshops on our future strategy in September and December 2018. At these events, stakeholders told us that the ESO is well placed to take a leading role in defining future markets and that they want us to do this.

Written responses to our consultations, including over 100 responses to our *System Needs and Product Strategy (SNAPS)*[13], as well as our *Forward Plan*[14], also provide clear guidance from stakeholders to inform our plans for balancing market reform.

A wide variety of stakeholders have told us that we need to reduce barriers for market entrants. Our stakeholders have also identified transparency as the key principle both to stimulate markets and provide foresight on future balancing service requirements. Participants need better information on market structure and liquidity to decide which markets they should be investing in.

Stakeholders broadly agree that market arrangements need to be flexible and delivery of change should be agile. While change should be delivered incrementally, it is important to set out a clear strategic direction of intent. We intend to follow this approach.

When thinking about the future of codes, we have undertaken engagement through bilateral meetings, RIIO-2 webinars, our 2030 ambition workshop and two code panel meetings. We have heard that the current regulatory regime is too fragmented and needs to be aligned across assets, services and markets. Stakeholders said that code management and change need to be more accessible, including adoption of plain English and a move to web-based processes. There needs to be more signposting and better provision of information to allow market participants to access the codes and make changes in a more agile way. It was also generally agreed that the ESO and Ofgem are best placed to lead the required change to the governance framework, with Ofgem driving and coordinating this.

More specifically on code governance and administration, we have received detailed views on current service provision and how we can improve through our codes customer journey work. Stakeholders have told us that the current governance framework is not fit for purpose, that the pace of change is too slow and that there is a need to have a 'critical friend' throughout the code change process. Our engagement has told us that there is some support for us becoming a code manager for the codes that we currently administer. We want to seek further views on what this role should look like.

On our charging administration role, customers are looking for improvement around guidance and training on charges, clearer information and explanations of changes, and the formats in which data is provided.

Customers have informed us that the Capacity Market process is unnecessarily complicated which can be a barrier to entry. They have also expressed frustration with how long change takes to be implemented and the transparency in which policy and system changes are taken forward.

To deliver our ambition and meet the needs of our stakeholders, we must:

- Build the future balancing service and wholesale markets
- Transform access to the Capacity Market
- Develop codes and charging arrangements that are fit for the future.

Web-based platforms should be developed so that all types of assets can access these markets.
ESO customer

[13] https://www.nationalgrideso.com/insights/future-balancing-services

[14] https://www.nationalgrideso.com/about-us/business-plans/forward-plans-2021

4. Activities to deliver our ambition

Build the future balancing service and wholesale markets

By 2023, all market participants 1 megawatt (MW) and above will have equal access to all our balancing service markets through a single integrated ESO markets platform. They will know that they are treated fairly, both in the purchase of services and in the way they are dispatched, as we are transparent in all that we do. The ESO will continue to work actively to reduce the minimum size of market participants as we transform our electricity control room systems and processes.

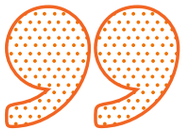
As new markets develop, for example at a distribution or community level, it is essential that participants can stack value by participating across these markets, regardless of who owns or operates them. This principle will be core to how we design our markets and the integrated market platform, which will expand to allow participants to access the full range of markets in a coordinated way.

By 2023, the wholesale electricity market will have hundreds of participants. There will be a liquid day-ahead auction which provides a strong reference price for short-term power. This increased market liquidity will drive increased wholesale market efficiency.

During RIIO-2, we propose to:

- Create a single, integrated platform for ESO markets. This one-stop-shop will provide a platform to participate in all our balancing service markets and the Capacity Market, and give access to both historical and forecast data to support investment cases and decision-making. It will be expanded as other markets develop to allow the integration and data sharing required to enable efficient decisions to be made across markets.
- Develop and implement a single day-ahead auction for response and reserve products. This will take into account the impact on distribution system operation when this information becomes available.
- Work collaboratively with the Distribution Network Operators (DNOs), sharing necessary data and bringing our expertise to bear alongside theirs, to accelerate development of markets at distribution level. We will design our systems to integrate this data into our electricity control room processes, and the cost signals that these markets provide will allow the ESO to take a whole system view when making decisions.
- Develop and run a sandbox experimental market environment, alongside our established markets, to test ideas such as a system inertia market, promote new entrants and ultimately drive down costs to consumers.
- Design the markets of the future; step up to lead a review of wholesale and balancing markets, delivering a new design by 2023, working closely with all stakeholders. Key considerations will include gate closure period, length of balancing period and the impact of large volumes of zero marginal cost generation on efficient market design.

Our stakeholders have told us that they want to be able to stack contracts to build their revenue streams. This might mean being able to offer multiple services to both the ESO and other industry players. In response to our *SNAPS* consultation, stacking of services was seen as important or very important by 96 per cent of respondents.



We need a better understanding of the process behind how you procure balancing services so we can provide services more effectively.
ESO stakeholder

4. Activities to deliver our ambition

Transform access to the Capacity Market

By 2025, the ESO will deliver security of supply against a clear standard agreed with the Government. We will be responsible for all elements of the Capacity Market; advising the Government on the volume to purchase, managing the rules change process, running the auction and managing the contracts. By transforming how we facilitate these activities, security of supply will be delivered with a technology mix that supports the UK's 2050 carbon reduction target at the lowest possible cost to consumers. All technologies, demand and supply side, will be able to participate in the Capacity Market in an equitable manner and participants will feel that they are fairly rewarded for their contribution to security of supply.

During RIIO-2, we propose to:

- Deliver a new platform for the Capacity Market within the single, integrated ESO markets platform. This platform will improve the experience for participants. Artificial intelligence will be used to help participants understand how they can participate in the Capacity Market and will guide them through the process.
- Take on responsibility for the development and management of the Capacity Market Rules. The principles of the code governance review will be used to make the rules clear, proportionate and equitable. There will be a clear roadmap for change, which will be developed through industry engagement.
- Improve our modelling capability to provide world-leading security of supply modelling for a system with significant levels of intermittent renewables, distributed flexible generation and demand-side response. This will be used together with detailed, granular data to determine the optimal volume of capacity to purchase.

We are mindful of our stakeholders' current priorities regarding the Capacity Market. Since its suspension on 15 November 2018[15], the ESO has been working with the Department for Business, Energy and Industrial Strategy (BEIS), Ofgem and the industry toward restoration of the Capacity Market. Despite this ruling, we still believe that the Capacity Market is the right answer for affordable security of supply and we would like to explore our proposed activities in more detail with stakeholders over the next few months.

Develop codes and charging arrangements that are fit for the future

We want our codes to facilitate the rapid change required to deliver the UK's 2050 carbon reduction target. By 2025, our codes and code governance will no longer be perceived as a barrier to change. Code modification will work for hundreds of market participants, rather than the tens of participants for which the current process was devised.

We have discussed with stakeholders the possibility of aligning commercial, technical and regulatory arrangements across transmission and distribution. There was a call from stakeholders to simplify and unify governance, while driving alignment across transmission and distribution and pulling it all together under one governance structure.

During RIIO-2, we propose to:

- Transform the process to amend our codes, allowing strategic change to be prioritised and implemented efficiently, while ensuring that it is much simpler and less time consuming to make incremental improvements.
- Work with all stakeholders to create a fully digitalised whole system Grid Code by 2025. This will be a single code for distribution and transmission, with a focus on providing minimum standards to allow safe and secure operation of the electricity systems. Artificial intelligence will be used to support navigation of the codes (i.e. being tailored to each code user) and supporting documents will provide examples of how the requirements might be met. There is more detail in chapter 5.
- Look at fully or partially fixing one or more components of the Balancing Services Use of System charges (BSUoS) to provide more stability for our customers, if this is in the best interests of consumers. A BSUoS taskforce has been set up to consider these types of issues.

[15] https://curia.europa.eu/jcms/upload/docs/application/pdf/2018-11/cp180178en.pdf

4. How do our proposals provide consumer benefit?

Improved safety and reliability	System needs will be better met by markets, giving the electricity control room the tools they need to safely and reliably operate the system. Facilitating a Capacity Market that is open to a broader mix of participants, including generators, storage and demand-side resources, supports greater reliability.
Improved quality of service	A single, integrated platform for balancing service markets will improve access to information and enable market participants to make more informed decisions. Fully digitalised codes, supported by artificial intelligence, will allow users to navigate and find the requirements that apply to them quickly and easily.
Lower bills than would otherwise be the case	With market participants better able to meet system needs, we will need to spend less on balancing actions closer to real time. In addition, by providing more certainty on balancing charges, suppliers will be able to hold less risk and pass these savings on to consumers. Enabling greater access to the Capacity Market will facilitate competition and lower auction costs. A report for the Committee on Climate Change has indicated that system costs to consumers could increase by £3.2 to £4.7 billion per annum by 2030 unless significant new sources of flexibility are attracted onto the system[16]. Our work on future markets is undertaken with these savings in mind. We are focusing on understanding and removing barriers to entry to attract new sources of flexibility. This increases competition in the short term which delivers consumer value in the form of lower bills today. More importantly, it creates the pipeline of new flexibility sources needed to balance the system in the future and deliver savings by 2030.
Reduced environmental damage	With markets able to deliver more of the services needed to operate the system, less curtailment of low-carbon generation will be required and there will be less part-load running of thermal plant for response and reserve. An open and accessible Capacity Market, with a diverse mix of participants, supports meeting the UK's 2050 carbon reduction target at the lowest possible cost to consumers.
Benefits for society as a whole	A level playing field for markets with reduced barriers to entry enables new and small parties to participate, supporting the wider economy.

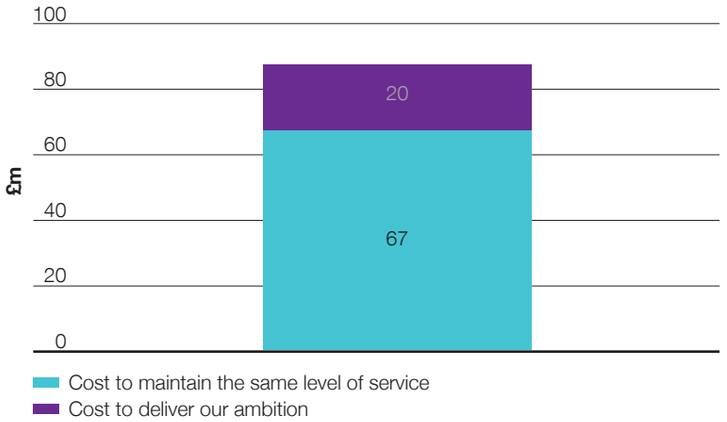
[16] This benefit is achieved in a 2030 system meeting a target of 100gCO_2/kWh. In a 2030 system meeting a target of 50gCO_2/kWh, up to £7.8 billion of consumer benefit could be achieved. This is taken from a report for the Committee on Climate Change (*Roadmap for Flexibility Services to 2030*, May 2017) https://www.theccc.org.uk/wp-content/uploads/2017/06/Roadmap-for-flexibility-services-to-2030-Poyry-and-Imperial-College-London.pdf

4. What could this cost?

We currently spend around £39 million per year in this role. In RIIO-2, we need to invest up to £28 million more per year in meeting new regulatory, cyber security and Electricity Market Reform requirements, as well as refreshing our charging and settlement systems. This investment will also contribute to our work to provide reliable and secure system operation.

Delivering our new RIIO-2 proposals could cost a further £20 million per year. This includes new people to deliver these outputs, as well as designing future markets, leading reforms to code governance and running the sandbox experimental market environment, which could cost around £8.5 million per year. Our proposed investment in new market portals – for example, a single platform for all ESO markets, supported by artificial intelligence – and systems to facilitate peer-to-peer trading could cost around £10 million per year. We will continue to refine these costs, together with the potential benefits, and will provide an update later in 2019.

Transforming participation in smart and sustainable markets: potential RIIO-2 costs
£m per year



Smart data driving zero-carbon system operation and markets

Our ambitions:

7. We will transform the data we make available – providing a clear interface for all ESO data, including core market and operational information, that can be easily accessed and interrogated with industry standard application programming interfaces for ease of access and use.

Transforming our approach to data and information will be critical to achieving our ambitions in system operation and markets.

We will be a transparent ESO, providing accurate information to help market participants make investment decisions. Alongside this, we want to improve confidence in our forecasts, increase transparency of our balancing actions and provide more comprehensive information which is accessible to all.

We will make our data publicly accessible and available wherever possible to facilitate competition and innovation across the sector, increasing transparency and enabling market participants to operate efficiently. We will need to use an increasing volume and range of data sources to operate the electricity system and markets. To enable the co-creation of a smart, flexible, sustainable energy system we will share as much of the data that we hold as possible. We will be a champion for data security and data privacy, vigilant to potential misuse of data which could threaten the system or distort markets.

We are committed to improving the user experience in everything we do and will use technology to enhance the accessibility and usability of our data and insights.

These activities support our ambitions in system operation and markets. Any associated costs are incorporated within chapters 3 and 4.

Stakeholders have told us

We have engaged stakeholders on this topic through many forums, including the electricity operational forum, strategy workshops and customer panels. Data and transparency are consistently very high priority issues for our stakeholders, with a strong consensus for how we should proceed.

We have heard a clear call for the ESO to share all its data and to play a proactive role in this space. Stakeholders have also told us that they want greater transparency of our processes, including how the electricity control room makes decisions.

We have held workshops with a representative sample of balancing service providers to define the functionality for a pilot data portal that we will be progressing in the next year. In advance of publishing our RIIO-2 business plan, we will consult stakeholders on options for delivering a massively expanded range of data and insight. This consultation will include questions on the scope of what we will publish, and how this should be shared.

Finally, our stakeholders have consistently told us that we need to be mindful of risks and unintended consequences of sharing more data. This includes considering cyber security, data privacy and the potential for market gaming. There is more information about our approach to cyber security in chapter 8.

To deliver our ambition and meet the needs of our stakeholders, we must:

- Publish data and increase transparency
- Transform our energy forecasting capability.

Smart data driving zero-carbon system operation and markets

Publish data and increase transparency

We currently publish a range of operational and market information, including cost summaries, trades information and market information reports, as well as demand and wind forecasts. This data is published in a number of formats on our website.

Stakeholders have consistently told us they want us to publish all our available operational and market data, both historical and forward-looking. This includes market dynamics such as real-time market data, and a strong emphasis on problem statements, such as locations of constraints.

Many stakeholders have called for all possible market and operational data to be made available in its rawest form. For some, this raw data can be difficult to use and so analysis and insight may be required to facilitate a level playing field for all parties to participate. This has been identified as particularly important by stakeholders who do not have the resources to analyse the raw data within their organisations.

Stakeholders have told us that they would like one source of the truth: a one-stop-shop to access all the data that we publish.

During RIIO-2, we propose to:

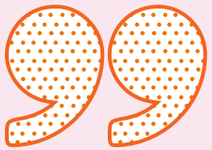
- Develop an ESO portal to share the data that we hold. The portal will use automated raw data feeds which are created with and for both regulated and non-regulated industry players. The ESO will operate this data portal and lead the industry effort in governing the data that is shared.

Transform our energy forecasting capability

Robust, accurate forecasts remain essential for us to continue balancing the electricity system efficiently and effectively in the context of a rapidly-changing operational environment. Service providers who use our forecasts have told us that we need to improve our forecasting capability and work hard to reduce errors.

During RIIO-2, we propose to:

- Apply machine learning and artificial intelligence to transform our energy forecasting capability. These tools will allow us to manipulate and develop insight from the ever larger and more diverse sources of data that we will need to forecast supply and demand as we transition to a low-carbon and more decentralised energy system.



Data is about quality, not quantity. We want the right data in the right way… In its raw form, data can be inconsistent and require us to do work that the ESO is probably already doing… We need insights as well as data.

ESO stakeholder

Unlocking consumer value through competition in networks

5. Introduction to our ambitions

Our ambitions:

8. We will facilitate competition across all dimensions, enabling all viable options to compete for delivery of solutions to network challenges. We will remain technology-agnostic, selecting solutions based on the consumer value they can deliver.

9. We will actively support Ofgem and industry to deliver a model for onshore competition that maximises consumer value, playing our part in setting up, and then operating within, the framework.

We are enabling a transformation in the role of network competition in delivering optimal outcomes for consumers. Our network planning process makes recommendations on whether and when to invest billions of pounds in the transmission network. This year's *Network Options Assessment (NOA)*[17] recommended that Transmission Owners (TOs) should invest £59.8 million in 2019/20 to progress 25 projects worth a combined value of £5.4 billion. Our operational and analytical expertise allows us to recommend the best time to invest. This saves billions of pounds for consumers through reduced system balancing costs and avoided network investment.

For example, our 2018/19 *NOA* recommends a set of investment options that could save consumers between £1.85 billion and £2.67 billion over the next 11 years[18].

We will continue to unlock further consumer benefits by building on our successful *NOA* approach. Our unique position means we can also consider alternatives to transmission asset investment, such as commercial or distribution network solutions. We will drive innovation and increased participation across the energy landscape. Through our pathfinder projects, we are introducing competition to identify the best value options. Our analysis this year suggests that using commercial solutions, such as intertrip schemes, for network issues could save consumers between £0.77 billion and £1.1 billion over the next 10 years. In addition to this, we're expanding our analysis to a wider range of network challenges, such as voltage and stability, and will also seek competitive solutions to these needs.

We fully support the introduction of competition in delivery of onshore transmission infrastructure and work with Ofgem to deliver this. Onshore competition should be implemented in a way that maximises value for consumers. We think that this is best achieved through a model which can facilitate innovation through competition at the early stages of project development.

Consumer priorities

- We want an affordable energy bill
- We want energy to be available when we need it

Stakeholder priorities

- I want efficient whole energy system operation
- I want you to enable the smart, flexible and low-carbon energy system of the future
- I want you to be open, engaging and easy to work with
- I want you to be adaptable and innovative
- I want to provide more balancing and ancillary services

[17] *Network Options Assessment 2018/19* (January 2019) https://www.nationalgrideso.com/document/137321/download

[18] This is the suggested saving against a counterfactual where the TOs do not build according to our recommendations. You can find out more on our website at https://www.nationalgrideso.com/insights/network-options-assessment-noa

5. Stakeholders have told us

Our stakeholders have already told us they want us to introduce competition for transmission solutions. In response to last year's consultation on our *Network Development Roadmap*, three quarters of respondents supported our proposals to expand our approach to seek both network and non-network solutions. Feedback so far has indicated there is potential value to be gained from further expanding *NOA* processes in RIIO-2. We have had initial discussions with a wide range of industry participants through customer seminars, webinars and targeted bilaterals.

The majority of TOs supported our proposals to explore how we could expand our network assessment processes to evaluate more elements of connection, the wider works and end-of-life asset replacement for larger projects. However, some did not think the drivers for either of these options materialised in their region.

At a workshop we held in December 2018, stakeholders emphasised the important role the ESO can play in coordinating information flows across network boundaries to support efficient network investment and applying a consistent methodology. Some of our stakeholders have encouraged us to consider expanding the *NOA* approach to lower voltage levels, though some have highlighted that other parties may be better placed to undertake assessments at this level. Stakeholders at the workshop had mixed views on how to ensure the Security and Quality of Supply Standards (SQSS) can best support the evolving industry. Some stakeholders felt that a fundamental review would be the best approach, while others felt that incremental changes would be better.

Parties who expect to be involved in future competitive processes for transmission assets have also told us that they would like to see more clarity on the role we intend to play in facilitating onshore network competition.

To deliver our ambition and meet the needs of our stakeholders, we must:

- Continue to expand and enhance our network planning approach to facilitate effective competition across a broader range of investment decisions
- Support competition in the delivery of onshore transmission infrastructure.

5. Activities to deliver our ambition

Expand and enhance network planning to facilitate effective competition

The continuing growth of distributed generation and new technologies is driving an increase in the volume and complexity of network modelling requirements we undertake. Following consultation with stakeholders, we have already begun to address this by extending our current processes to a wider set of system needs and solutions such as stability, voltage and system inertia.

In RIIO-2, we will continue to use the *NOA* process to compare the economic cases for meeting transmission needs with network assets (e.g. transformers) on either transmission or distribution networks, non-network assets (e.g. battery storage) or market-based solutions (e.g. flexibility contracts or approaches to make the current network assets work harder). Identifying the best solutions could save billions of pounds for consumers through reduced system balancing costs and ensuring that network investment happens at the right time.

We are also exploring whether there is value in expanding our approach to consider the end-of-life replacement of assets, and further elements of network reinforcement as part of connection agreements. Our additional insight into network needs and our *NOA* assessment processes could help add value beyond the TOs' own assessments.

There could be value from the ESO taking on a role to facilitate consistency (where appropriate) and best practice across planning in transmission and distribution networks, though the value of investment at this level is lower. Analysis of RIIO-T1 and RIIO-ED1 business plans suggests that load-related[19] investment at the 132 kV level is around £40 million per year on average, compared with around £1 billion per year at the transmission level in England and Wales.

During RIIO-2, we propose to:

- Embed the extensions we are making to the *NOA* to enable competition between and across technologies.
- Continue to invest in other *Network Development Roadmap* enhancements, such as probabilistic modelling and voltage optimisation.
- Extend the *NOA* approach to planning currently covered by TOs in connection agreements and end-of-life asset replacement, if the case exists to do so.
- Improve coordination across transmission and distribution network boundaries, through facilitating consistency across lower voltage levels.
- Explore, with industry, a review of the SQSS.

Support competition in delivery of onshore transmission infrastructure

Ofgem has confirmed its ongoing intention to introduce the Competitively Appointed Transmission Owner (CATO) regime for onshore transmission networks. Ahead of legislation being introduced, the ESO will continue to help Ofgem develop its thinking and any interim approaches to achieve the best outcomes for consumers. We believe the best outcome would be achieved through early models of competition, whereby competition can be used to drive innovation in the options proposed to meet a transmission network need, and the solution being put forward.

During RIIO-2, we propose to:

- Continue to play our part in identifying the need for transmission investment.
- Support Ofgem to establish the most cost-effective approaches to run their preferred model, expanding the role of the ESO where required.
- Support Ofgem with running the tender once the regime is introduced (for example, articulating the need, assisting with technical assessment of bid).

Expanding the *NOA* approach to lower voltage levels should be done but not necessarily by the ESO. The ESO should collaborate and facilitate this approach, not necessarily lead or tell.
ESO customer

[19] Load-related investment is made to accommodate changes in the level or pattern of electricity generation or demand.

5. How do our proposals provide consumer benefit?

Improved safety and reliability	Timely, effective and competitive network development will ensure we have a network that is always ready for the demands placed upon it and can operate securely as we transition to a zero-carbon electricity system.
Improved quality of service	Learning from our current pathfinders will allow us to embed efficient competitive processes that best meet the needs of potential providers. We will continue to improve how we communicate network needs in a way that supports different provider types participating. As these are new processes, we will continually seek feedback to refine and improve the quality of the service we provide.
Lower bills than would otherwise be the case	In addition to recommending when is the most efficient point to build transmission assets, increasing competition between and within technologies will deliver the network capacity the energy system needs at a lower cost to consumers. Our analysis suggests that non-build solutions to network issues, such as intertrip schemes, could deliver consumer benefits of between £0.77 billion and £1.1 billion over the next 10 years. Our *2018/19 NOA* recommends a set of investment options that could save consumers between £1.85 billion and £2.67 billion over the next 11 years[20]. Competition in offshore transmission infrastructure is estimated to have saved consumers between £0.6 billion and £1.2 billion since 2009[21]. We can help unlock further value through introducing competition as early as possible, before the solution is decided, to help stimulate innovation and find better solutions.
Reduced environmental damage	Securing sufficient investment in network capacity will ensure that new, low-carbon sources of electricity are able to connect and continue to decarbonise the energy system. Allowing parties to compete to provide the best solutions could stimulate innovation in less damaging infrastructure, or solutions that do not require additional infrastructure to be built at all.

[20] This is the suggested saving against a counterfactual where the TOs do not build according to our recommendations. You can find out more on our website at https://www.nationalgrideso.com/insights/network-options-assessment-noa

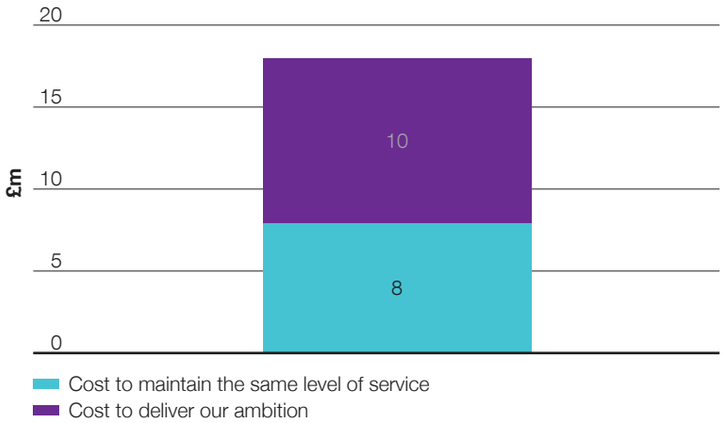
[21] https://www.ofgem.gov.uk/electricity/transmission-networks/competition-onshore-transmission

5. What could this cost?

Accelerating and extending competition in networks incorporates many new activities for us. Our current work in this area costs around £6 million per year. Incrementally improving this valued service in RIIO-2, for example improving our analysis techniques to enhance our ability to inform investment decisions, could require further investment of up to £2 million per year for additional people and a refresh of information technology (IT) systems.

Embedding and extending competition in network development will require additional resources and further IT system investment. We estimate that we could deliver our ambition for under £10 million per year. This includes supporting Ofgem to progress development of its approach for onshore competition for transmission assets. However, it does not include the cost to deliver that activity, which would need to be agreed once Ofgem confirm our role in the process. All of these costs represent the upper range, and we will continue to refine these, with stakeholder input, throughout 2019.

Competition in networks: potential RIIO-2 cost
£m per year



Driving towards a sustainable whole energy future

6. Introduction to our ambitions

Our ambitions:

10. We will work with all stakeholders to ensure a whole system approach is taken to optimise planning, development, investment and operation of Great Britain's energy networks. We will bring our expertise to complement that of others and drive industry as it navigates a complex energy transition. We will facilitate informed decision-making that accounts for whole system impacts and minimises unintended costs or consequences.
11. We will reduce friction for participants in their interactions anywhere on the electricity network, for example whether connecting to the transmission or distribution network, accelerating the efficiency and effectiveness of the energy transformation.

As decarbonisation, decentralisation and digitisation continue to dominate the changing energy landscape, there is a deeper need to think and plan across the boundaries of transmission and distribution, and across the closely interlinked power, heat and transportation sectors. As a key organisation in delivering the energy transition, we will facilitate the debate on how to best meet the UK's 2050 carbon reduction target across the whole energy sector. We will work with others to achieve this through facilitating whole system outcomes that deliver value for consumers. Our aim is that planning, development, investment and operation of Great Britain's networks will be optimised on a whole electricity system basis, irrespective of ownership boundaries.

We use the term 'whole energy system' to encompass the interactions between electricity, gas and other factors such as heat and transport, and 'whole electricity system' to consider electricity transmission and distribution interactions. While system operation activities are increasing at the distribution level, we will maintain a Great Britain-wide view, entrusting system operation of distribution networks to those with appropriate expertise.

We recognise that achieving the whole energy transition will require a whole system philosophy across the ESO's roles and activities. Elsewhere, in chapters 3, 4, and 5, we describe how we intend to take a whole system view in RIIO-2. For example:

- To achieve reliable and secure system operation, we will need to work more closely with operators of distribution networks to take a consistent whole system view.
- To transform participation in markets, we will need to make sure that consistent arrangements develop that allow services providers to appropriately stack revenue streams and that frameworks evolve to support whole system ways of working.
- To unlock consumer value through network competition, we will need to make sure aligned and coordinated processes are developed across transmission and distribution systems.

Consumer priorities

- We want an affordable energy bill
- We want energy to be available when we need it
- We want a decarbonised energy system, fit for the future

Stakeholder priorities

- I want efficient whole energy system operation
- I want you to enable the smart, flexible and low-carbon energy system of the future
- I want you to be open, engaging and easy to work with
- I want you to be adaptable and innovative
- I want to connect to the electricity network in a timely manner

6. Stakeholders have told us

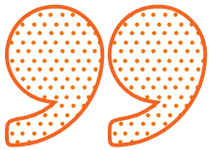
Whole energy system considerations are consistently highlighted by our stakeholders as a significant factor in our work to enable the transition to the energy system of the future. As the System Operator, we already carry out horizon-scanning activities that look across gas, electricity, heat and transport, most notably through the development of our *Future Energy Scenarios (FES)*. In developing *FES* for 2019, we have engaged with over 630 individual stakeholders from 415 unique organisations. As a result of their feedback, we will again publish four 'whole energy system' scenarios in 2019, including two that meet the UK's 2050 carbon reduction target, with security of supply for both gas and electricity achieved across all scenarios.

We have explored whole electricity system questions in more detail through our own events and the Energy Networks Association (ENA) 'Open Networks' group. Stakeholders recognise that a whole electricity system perspective needs to be taken across all the ESO roles and we have adopted this ethos throughout the ambition document. Stakeholders also recognise that the benefits of a whole electricity system are most deeply realised through common ways of working across all network organisations. They have highlighted the importance of working with other network companies to ensure consistent processes, efficient and appropriate exchange of data and information, and coordinated standardised experiences that work for customers. There has also been an emphasis on the need for robust cost-benefit analysis to inform decisions on outage planning in the short, medium and long term, with stakeholders having mixed views about the benefits of different approaches. Transmission and distribution connected generators have emphasised the need for a smooth and efficient connection process, whether on the transmission or the distribution network. This is particularly important for new, small parties connecting at distribution level.

Finally, stakeholders have highlighted that the ESO should continue to play a role in overall management of the national electricity system, including in times of system stress and emergencies.

To deliver our ambition and meet the needs of our stakeholders, we must:

- Lead the debate on decarbonisation of the UK energy industry
- Work closely with other network organisations and the broader stakeholder base to:
  - Take a whole system view of network operability
  - Transform the connections process
  - Drive consumer benefits from improved system access planning.



The codes system is a maze. It needs better alignment to allow people at different levels to participate and become more efficient.

ESO stakeholder

6. Activities to deliver our ambitions

Lead the debate on decarbonisation of the UK energy industry

Climate change is the challenge of a generation, and we will support the delivery of a credible and operable industry pathway that delivers the UK's 2050 carbon reduction target. We bring our expertise and analysis to help drive industry as it navigates a complex energy transition, supporting informed debate around energy system issues. This means we will step up from simply providing insight to advising on how to meet the UK's 2050 carbon reduction target.

During RIIO-2, we propose to:

- Apply our long-term modelling and analysis tools, capabilities and processes to develop energy policy recommendations across different markets and sectors, building on our deep understanding of system operability.
- Lead the industry engagement process to develop policy recommendations designed to deliver the maximum benefit for existing and future consumers.
- Support key decisions-makers to deliver a credible and operable whole energy pathway for industry, including a strategy for clean heat.
- Facilitate an ongoing and structured conversation through which a broad and interested community will be able to review and challenge our data, analysis and recommendations.
- Develop our policy recommendations transparently through publication of data, analysis and thought pieces tailored to meet the needs of different audiences.

Take a whole system view of network operability

As the range and diversity of parties connected to the electricity transmission and distribution systems increases, we need to work with transmission and distribution network owners to transform our approach to network operability issues. Along with new and transformed markets, this will enable our electricity control room to operate a zero-carbon electricity system. This includes assessing the impact of volatile and unpredictable gas and electricity supply and demand patterns using a common set of assumptions.

Electricity distribution networks are becoming increasingly active, using the flexibility of both new forms of distributed energy resource as well as consumers taking advantage of smart meter technology. We need to ensure that the greater volumes of data transferred between network parties remains fit for efficient planning and development purposes. We will also improve network modelling, working closely with Distribution Network Operators (DNOs) to develop a revised process that provides frequent updates and clear visibility of network information to optimise system operation activities across the transmission-distribution interface.

With increasing interaction between transmission and distribution systems, the driver for aligned or combined industry frameworks increases. This includes security standards, currently set by the Security and Quality of Supply Standard (SQSS) and Grid Code at a transmission level, and P2/7 and the Distribution Code at the distribution level. We need to ensure that these standards deliver the required outcomes efficiently and that sufficient consideration is given to these risks to ensure the lights stay on. This also provides opportunities to reduce complexity in codes facilitating more agile governance arrangements.

Through the current price control period, we have been working with other network organisations to develop new, innovative ways to connect parties to the system supporting this low-carbon transition, including the Regional Development Programmes. In RIIO-2 we would also like to develop the *System Operability Framework* pathfinders and product roadmaps into distribution networks[22].

During RIIO-2, we propose to:

- Create a common portal to share network data, and develop detailed regional models to improve network modelling across system boundaries.
- Lead work to develop accessible and aligned industry codes and standards, including reviewing the SQSS and Grid Code to ensure that security and technical standards are consistent across the whole electricity system. We have also highlighted our aspiration for a whole system Grid Code in chapter 4.
- Incorporate whole electricity system thinking into the network design and development process. This includes through extending and embedding whole electricity system approaches to operability solutions, rolling out our Regional Development Programmes and extending our *System Operability Framework* pathfinders into RIIO-2.
- Develop and deliver arrangements that optimise network operation across the whole electricity system and ensure the system remains operable in a zero-carbon future.
- Work with DNOs to develop clear roles and responsibilities ahead of the next distribution price control period starting in 2023.

[22] More details on these are in our *System Operability Framework* https://www.nationalgrideso.com/insights/system-operability-framework-sof

6. Activities to deliver our ambitions

Transform the connection process

Stakeholders have told us they value consistent approaches and data sources regarding the timing and location of potential connections to the transmission network. As a national entity, we are well-positioned to provide a central repository of information for parties wishing to get an electricity connection anywhere in Great Britain. We propose to develop this through working with other network organisations to create a central connections hub. This hub will be the first port of call for electricity connections linking with other network organisation websites and tools. As an impartial coordinator, the ESO could also include guidance on the appropriate efficient connection level for a generator.

While we have made significant improvements to the connections process, we know that there is more to be done. We want the connections process to be as simple as online banking. In addition, we will take a whole electricity system view of connections, including extending our successful customer seminars to be 'whole system' connections seminars and the establishment of a dedicated account manager for distributed energy resources.

During RIIO-2, we propose to:

- Create a central information hub for parties wishing to connect to electricity networks across Great Britain.
- Establish dedicated connections account managers for distributed energy resources, and work with DNOs to take a whole electricity system view of connections.
- Modernise customer connections account management through investing in new systems to allow customers to instantly access up-to-date information about their existing connection agreements and any applications they have submitted, along with other information such as service contracts and outages.

Drive consumer benefits from improved system access planning

Traditionally, network access planning has been one of the deepest areas of cooperation between distribution and transmission network companies. Network outages are essential for the safe and reliable development of the network, but they can increase costs to consumers as the ESO takes action to ensure overall system security and operability. As the ESO, we work hard to maximise system access for the Transmission Owners (TOs) whilst managing the balancing costs for the consumer.

In 2017/18, the ESO received requests for over 5,000 new outages on the transmission system after the outage plan had been agreed at year ahead. We work with all relevant stakeholders to ensure as many as possible of these requests can be accommodated. We do this through system optimisation and, where there is time, we will competitively procure constraint management services. Such cost implications are beginning to be experienced at a distribution level and the potential interactions between distribution and transmission systems needs to be considered to ensure efficient outcomes. Parties connected to the network have told us that short-notice change to outages can result in additional costs for them, as well as operational costs for the ESO. Conversely, short-notice outages can sometimes reduce costs for consumers, if they enable essential works to be undertaken. In RIIO-2, we will implement mechanisms to ensure the overall impact of system access on consumers is taken into account in the decisions parties take.

During RIIO-2, we propose to:

- Strengthen outage coordination across the transmission and distribution interface, including developing a whole electricity system cost view and appropriate mechanisms to facilitate its efficient management with other network organisations.
- Provide whole system outage notifications through extending our outage planning system to incorporate larger parties connected to distribution networks, and modernise our approach to notification using mobile technology and apps.
- Implement a mechanism to ensure that consumer costs and benefits are fully taken into account by parties considering short-notice changes to their network access plans.

6. How do our proposals provide consumer benefit?

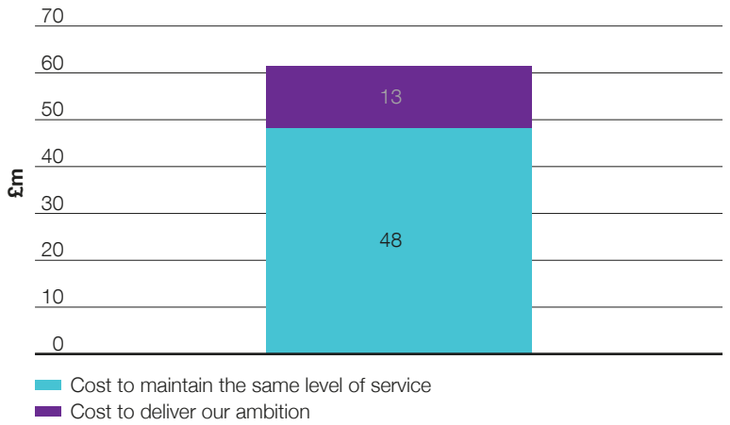
Improved safety and reliability	Taking a whole system view of risk and resilience, including developing accessible aligned frameworks, will ensure that the roles and responsibilities of all parties are clearly understood, including the responsibilities for operating the whole electricity system safely and securely.
Improved quality of service	Increasing consistency of codes and processes between transmission and distribution will improve the experience of network users, making markets more accessible and open for new participants. Improving the way we provide information to third parties will help them better manage their connections and be aware of transmission outages that may affect them.
Lower bills than would otherwise be the case	Coordination of system operation will enable more efficient use of distributed flexibility, allowing providers to stack services and revenue streams, improving the business case for new sources of flexibility as they take an increasing role in the energy system.
Reduced environmental damage	Assessing operability across the transmission-distribution interface can release additional network capacity, allowing faster connection of low-carbon generation, accelerating the shift to a zero-carbon energy system.

6. What could this cost?

Our current activities, including system access planning and managing the connections process, cost around £40 million per year. Investment of another £8 million per year will be required in RIIO-2 to refresh and replace existing systems, for example, to improve the connections process.

To build our role in driving whole system outcomes, up to £13 million of investment could be required. This includes investment to roll out the Regional Development Programmes, develop a data system, a data portal, and modelling tools, as well as capabilities to coordinate more effectively with TOs and DNOs. We will continue to refine these costs, together with the potential benefits, and will provide an update later in 2019.

Driving the whole energy transition: potential RIIO-2 costs
£m per year



How stakeholders have informed our ambition

7. How stakeholders have informed our ambition

Here we set out how we have structured our stakeholder engagement programme. So far, 273 individuals from 169 organisations across a range of sectors have worked with us to shape our ambition and proposed activities.

Our independently-chaired ESO RIIO-2 Stakeholder Group comprises members from across the industry. Its role is to scrutinise the production of our plan and how effective we have been at engaging with stakeholders. The group will submit a report to Ofgem outlining their views to coincide with our final business plan submission.

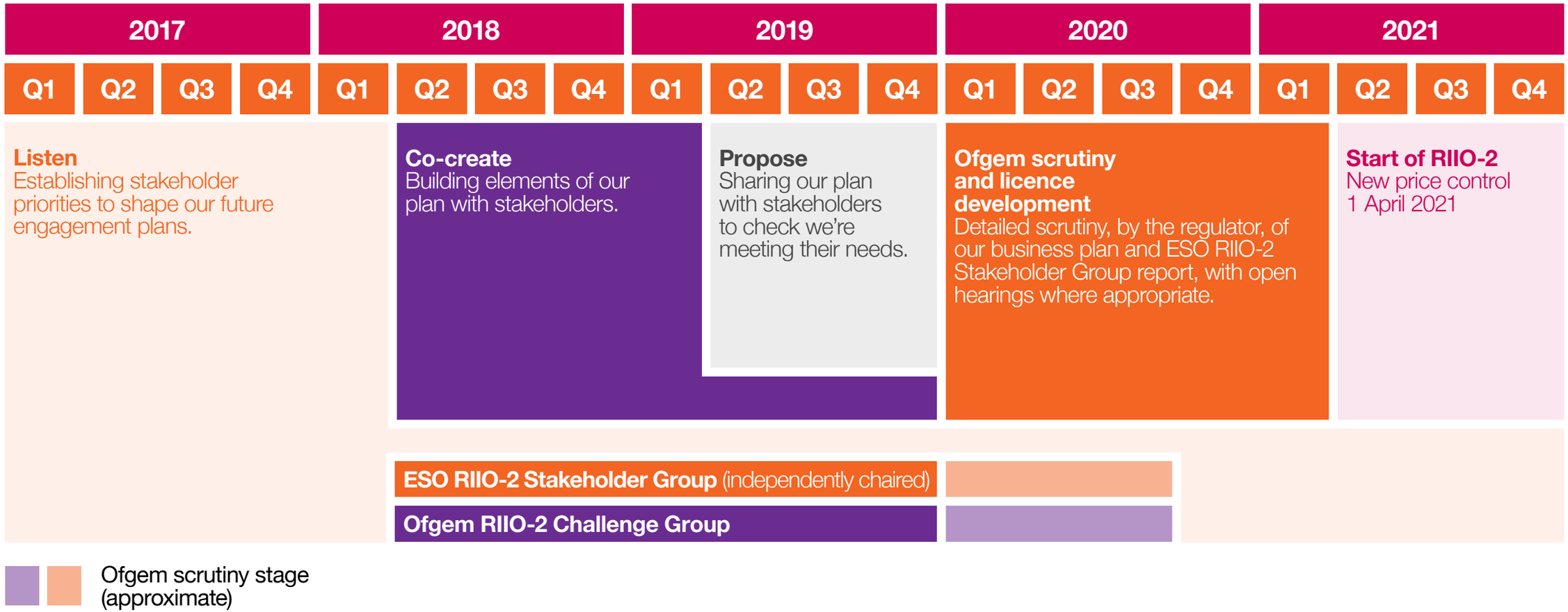
Engagement across three phases

We have mapped our stakeholders according to their interest in our activities and the level of impact that changes to our role may have on their businesses. This has enabled us to plan the most effective engagement channels for individual stakeholders across a range of sectors. We have structured our engagement programme around three overlapping phases, shown on the next page.

Our engagement objective

We are committed to working with our stakeholders to help shape the future of the energy market and understand how best the ESO can deliver benefits for our customers and consumers. Enhanced stakeholder engagement will enable us to create a plan that reflects your needs. It means that we plan, prepare, implement and improve engagement activity to make sure that we maximise the value of our engagement and are respectful of stakeholders' time.

7. Three phases of engagement to develop our business plan



7. Let's keep talking

Listen

Listening to our stakeholders is something we do as part of our day-to-day activities. During this phase, we brought together the outputs of all our engagement from across the ESO business and created additional activities as part of a coordinated programme of targeted engagement for RIIO-2. The stakeholder and consumer priorities, introduced on page 11, were a key output from this phase. These priorities form the fundamental cornerstone of our plan.

Co-create

The co-create phase is where we are now. We are building upon the consumer and stakeholder priorities, and developing the detail around what will become our business plan proposals. We are using a variety of engagement channels to maximise the range of stakeholders that we reach and make sure we have effective conversations.

Propose

This phase gives us the opportunity to share with you more holistically how your views have shaped our proposals and to seek your feedback. This document brings together the feedback we have heard in the listen and co-create phases and starts to evolve into the propose phase. We will continue to work with you to develop our business plan proposals ahead of our final submission to Ofgem at the end of 2019.

Independent scrutiny of our approach

The role of our ESO RIIO-2 Stakeholder Group is to challenge and test our approach to developing our proposals, and the way that we have engaged with stakeholders to reach our views.

Members of the group reflect the wider energy sector across Great Britain. They are drawn from a cross-section of current and future customers and service providers, key stakeholders and wider public interest organisations. You can find more information about the group and their discussions so far on our website[23].

Recognising the critical role that the chair of the group would play, we followed a rigorous scoping and shortlisting process of possible candidates. Charlotte Morgan, a partner in the Global Energy and Infrastructure Group at Linklaters, was appointed the chair of the group in July 2018.

Separately, Ofgem has created the RIIO-2 Challenge Group[24] to consider the affordability and sustainability of our business plan. There is also a Forward Plan Performance Panel which has been set up to assess our mid-year and end of year performance against our deliverables up to March 2021[25].

Let's keep talking

We know that we have more to do and are very much still listening to what you, our stakeholders and customers, want from the ESO in RIIO-2. We will keep reviewing our approach to ensure that we are employing best practice in this area. Please let us know how we can do better and if you would like to be involved.

I believe the ESO RIIO-2 Stakeholder Group has such an important role to play in delivering the RIIO-2 framework and, ultimately, driving value for end consumers.

Charlotte Morgan, Independent Chair

[23] https://www.nationalgrideso.com/about-us/business-plans/future-planning-2021-onwards/have-your-say-on-our-future-plans/eso-riio2-stakeholder-group

[24] https://www.ofgem.gov.uk/publications-and-updates/riio-2-challenge-group-terms-reference

[25] https://www.nationalgrideso.com/about-us/business-plans/forward-plans-2021

Transforming our capability for the future

- > IT strategy
- > Innovation
- > People and capability
- > Engagement during RIIO-2
- > A regulatory framework to support our ambition

8. IT strategy

We cannot deliver our ambitions without the right information technology (IT) infrastructure. As a technology and service-delivery company at the heart of the energy industry, we invest in, and maintain, critical IT infrastructure for Great Britain's economy. The proposals and costs in this document reflect our approach to IT, as detailed below.

Our core architecture and systems provide security ringfenced, highly available and reliable services in support of energy transmission and competitive open markets.

Critical national infrastructure systems are designed to provide dual redundant high availability services across multiple data centres, and control rooms with contingency solutions to maintain real-time operation. These systems analyse up to 40 million data points per day across Great Britain's transmission grid, with significant complexity expected as decentralisation and decarbonisation accelerate.

Our technologies support registration, forecasting and modelling capabilities for scheduling of supply, hours ahead of real time. This enables our real-time systems to dynamically meet demand by instructing balancing services for energy provision which utilise our highly-resilient, Black Start-compliant communication networks. Post-event services provide market transparency, settlements and regulatory reporting to stakeholders across Great Britain and continental Europe.

In addition to this comprehensive foundation, the UK energy landscape is undergoing a significant transformation driven by decarbonisation, decentralisation and digitisation. With these trends comes greater system complexity, an increased pace of change, and vast growth in the volume of data, with an expectation from internal and external stakeholders for sharing of data and insights.

Cyber threats associated with the energy sector have been growing in terms of both their sophistication and frequency, with the threat of an attack on critical infrastructure becoming an ever-increasing reality.

As we introduce new technologies into our environment, our exposure to cyber attack, through the increased connection to external systems, is expanding. Previously, our energy networks operated as a primarily closed system where concern would be placed on internal devices, systems and infrastructure. This is now transforming into a decentralised and interconnected mesh of systems, devices and partners that play an integral role in the operations of the energy network across the industry. Our solutions and capabilities to tackle threats need to grow and adapt to tackle this complexity.

Digital transformation

We will be a digitally-enabled organisation that will provide automated and integrated services, predictive analytics and forecasting, and will use robotics and other forms of automation to minimise manual intervention and optimise effectiveness. Digital transformation will result in faster, more efficient ways of performing the tasks we do today.

8. IT strategy

Information and data

The availability of comprehensive, timely and reliable data will be at the heart of everything we do. To meet this need we will invest in transforming our data management capability to create a flexible and scalable platform that will underpin the ambition to share insight widely, while ensuring that access can be controlled reliably. This will be accompanied by a portal that allows this data to be accessed through a range of channels as needed to support the requirements of both our external and internal stakeholders. More detail can be found on page 28.

To maximise the business and consumer value returned from this, data will invest in advanced analytics and visualisation tools, artificial intelligence and machine learning capabilities to enhance business operations and to enable the provision of insights to stakeholders and customers.

We will additionally invest in knowledge management and intelligent search tools to improve the ability to access and manage unstructured information, such as business documents.

We will enhance the user experience by enabling more interactive means of engaging with customers, stakeholders and the market, including new digital channels.

Cyber security

We will continue to develop our cyber security at a faster pace than the emerging threats. This is becoming increasingly critical as the energy sector evolves and accelerates the digitisation of energy infrastructure.

We are widening our focus to not only address cyber security within our enterprise and critical national infrastructure environments, but also ensuring cyber security is considered to address emerging risks within our operational environments. We will focus on defence-in-depth architectures and security controls to prevent unauthorised access or compromise to our critical environments. Embedded use of threat intelligence, and the adoption of the National Institute of Standards and Technology Cyber Security Framework, will address key risk areas across the organisation. This includes continuously monitoring our threat landscape, routinely testing our defences and delivery of new cyber capability to identify, detect, protect, respond, and recover from emerging threats. Threat intelligence, gathered through government and private interactions, and enriched with internal threat data, will also play a pivotal role in ensuring the generation of actionable information which can be leveraged to improve the security of our infrastructure and assets.

Reliability

We have a range of business processes, many of which require high integrity and high levels of availability. A key consumer priority is the safe and secure supply of electricity. We will therefore continue to invest in the asset health of our critical national infrastructure and operationally critical systems and data centres to ensure they are secure, reliable and well supported.

Business operations

Investments are required in a range of business service areas, including human resources, legal, digital communications and finance, to improve functionality, drive efficiency and enhance capability. We will embrace new technologies to enable process efficiencies and new ways for services to be delivered, while maintaining high levels of security.

8. Innovation

Decarbonisation, decentralisation and digitisation are creating an energy landscape that presents unique challenges. Given our privileged position at the heart of Great Britain's energy system, we have a role to lead efforts to scope and trial the tools and solutions needed for the energy system of the future. The System Operator (SO) must continue to prioritise and invest in innovation, facilitating the transformation of the energy system for the benefit of consumers and building on our successes so far as we move into RIIO-2.

Innovation, as one of the pillars of RIIO, is about using targeted projects conducted in a safe, collaborative environment to explore new, higher-risk technologies and ways of working. Today, we take full advantage of the innovation funding made available by Ofgem. In 2018/19, thanks to our well-defined strategy, we concentrated our efforts more effectively and invested all of our allowance to explore non-traditional solutions to our high priority strategic challenges. We expect to be in the same position in 2019/20, with significant spend already committed and a robust pipeline of projects in development. We recently won a £11.7 million Network Innovation Competition (NIC) project to explore Black Start capabilities from distributed energy resources, which will help us to operate the zero-carbon energy system of the future.

We recognise that we can, and must, do more to unlock the value of innovation. Our ambition is to explore more system-wide priorities, stepping up our engagement to ensure all relevant stakeholders can support us and help identify, then focus our efforts on, the most pressing challenges facing the whole energy system.

We proudly champion an open and collaborative approach to innovation, drawing on the expertise and skills from a wide range of partners. Each of our Network Innovation Allowance (NIA) funded projects has spent at least 75 per cent of funds externally through a third party. Our external calls for NIC project bids and Open Innovation Day events offer suppliers a chance to propose new solutions to our priority challenges. We continue to increase and balance our portfolio of partners, ensuring this reflects an appropriate diversity of industry colleagues, academia, consultants, startups and manufacturers.

We want to improve how we track and monitor the benefits of innovation, relative to no-innovation counterfactual scenarios. As the ESO, we are different from all other licenced network operators as we are asset light. This means we need to be more creative in our approach to tracking the benefits of our projects and ensuring their value is realised. Our projects are evaluated on their benefits for the whole system, and although we are fully committed to creating savings for our end consumers, financial benefits are only one piece of the puzzle. We aim to deliver projects that not only lower bills but also reduce environmental damage, improve safety and reliability, improve the quality of our service, benefit our society and improve our know-how so we can better understand and mitigate future energy system challenges. We plan to strengthen our framework for estimating project benefits against these categories during the project development stage and ensure we can monitor benefits once solutions have been implemented.

In 2018, we published our first dual-fuel SO Innovation Strategy, outlining our approach to innovation, our priorities and our process. We will continue to refresh and enhance this strategy as our project portfolio develops and we adapt to changing conditions in the energy landscape. Our ambition is to create a whole energy innovation strategy, to be used as a reference across both energy systems, and as a tool to direct academia and the industry's efforts towards tackling future energy challenges.

8. People and capability, and engagement during RIIO-2

People and capability

As we move into RIIO-2 and step up to meet the challenges of the energy transformation, our people and capabilities need to evolve.

The Energy and Utilities Skills Partnership[26] estimates that the sector will see the retirement of 20 per cent of its workforce in the next 10 years and that 221,000 new recruits will be required. This highlights the importance of inspiring and attracting new and diverse talent that is reflective of our sector. Today, only around one per cent of higher education leavers choose to enter the energy and utilities sector, with fewer than five per cent of engineering graduates employed within it. Within the ESO, advanced analytics and data management capabilities will be increasingly important, including in the fields of artificial intelligence, smart grids, power storage, electric vehicles, robotics and automation. Alongside these, our core skills of customer service, stakeholder and contract management remain crucial. In chapter 3, we set out our proposals for enhancing our capability to deliver the electricity control room of the future. We are developing a strategic workforce plan and we will share more details on the implications of this for our RIIO-2 business plan later in the year.

To help address national skills shortages, the ESO is part of National Grid's graduate and higher apprenticeship programmes, offering holistic skills training to school leavers and graduates. The intent of these schemes is to offer higher apprentices the opportunity to acquire the skills for a career, not just a job. We enjoy a high retention rate, which is close to 90 per cent after 5 years. We also participate in National Grid's EmployAbility internship programme, which helps students with special educational needs take the first steps to full-time employment. About 60 per cent of our 40 interns so far have found paid jobs, far above the national average of 6 per cent for students with learning disabilities.

Engagement during RIIO-2

This document is the first formal channel for us to test our ambition and proposed activities with stakeholders in the process of developing a RIIO-2 price control for the ESO. Our proposals take account of what we have heard from our stakeholders to date and aim to enhance the experience of customers and stakeholders when dealing with the ESO during the RIIO-2 period and beyond. Following the agreement of the price control, as we move through the RIIO-2 period, we will continue to listen to feedback so that we can be adaptable to changing stakeholder needs. We will also continuously check and report on whether our activities realise the consumer benefits that we predicted.

We will do this by continuing to improve how we engage, acting on your feedback to enhance our existing forums and channels, and creating new channels as required. We think that it will become increasingly important to make sure we have 'the right people in the room' in particular to facilitate whole system outcomes. We will also look at how we will measure customer satisfaction as we move forward, asking not just about what we are delivering but also how we are delivering it.

We will continue to report on our performance and to effectively use the enhanced engagement structure that we have put in place to facilitate development of our RIIO-2 proposals. We are finding input from our ESO RIIO-2 Stakeholder Group very valuable, and could see benefit in continuing with this group to challenge the development of our plans, review our performance and challenge our level and breadth of stakeholder and consumer engagement on an ongoing basis (subject to members' agreement).

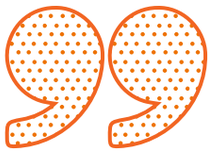
As we work towards our goal of becoming a trusted partner to our stakeholders in the energy industry, we are considering whether there is value in us taking a more direct role in engaging with consumers to help shape the debate and our role in decarbonising the industry. We will work with consumer representation organisations on how we bring, most effectively, the voice of consumers into what we do.

[26] https://www.euskills.co.uk/sites/default/files/Workforce%20Renewal%20and%20Skills%20Strategy%20FINAL.pdf

8. A regulatory framework to support our ambition

RIIO-2, and the introduction of a new regulatory framework for the ESO, is a unique opportunity to put in place a funding model and incentive scheme that supports the ESO to achieve its ambition. In parallel with developing our RIIO-2 business plan, we are working with Ofgem as it designs this new framework. We have engaged a wide range of stakeholders to develop and test ideas. We ran an initial workshop in June 2018 and since then have used webinars, bilaterals and the publication of a thought piece and podcast to share our thinking and seek feedback.

Ofgem consulted on its proposed regulatory framework for the ESO in December 2018. We have published our full response, including our detailed view on the regulatory framework, on our website[27].



It makes sense to ensure a baseline of service delivery whilst incentivising improved performance.
ESO customer

Objectives for the ESO's RIIO-2 price control

Transparency and enhanced engagement with stakeholders

An emphasis on the benefits the ESO can deliver across the energy system, as opposed to an emphasis on internal costs

Enabling an ESO that is agile, within a framework that provides clarity and stability

Ensuring the ESO is financeable as a standalone business and can mitigate against risk

An agile funding model that provides clarity and stability

Our funding model should allow flexibility within the price control framework to enable the ESO to be responsive to stakeholders and to invest to meet new requirements within the price control period. At the same time, providing longer-term (beyond two years) certainty for core elements of the price control that are well understood, scrutinised and agreed ex ante – such as baseline budgets to deliver baseline outputs and multi-year capex investments – will enable us to innovate and invest with confidence. We propose that the price control should be five years, with proportionate reviews undertaken on a more frequent basis under pre-specified circumstances. A cost trigger mechanism could be used to enable smaller, agile investments to be undertaken within the control period and reviewed on this, more frequent, basis.

Our budget for RIIO-2 will be set through agreement of our business plan. As part of this, an appropriate level of return will be agreed, to reflect the risk we manage on behalf of industry and consumers. This return may be different depending on the activity that is being funded, and could be applied on either cost or revenue. For example, we play a role collecting up to £4 billion of revenue each year on behalf of the industry; it would be appropriate to have a margin on the revenues we transact to reflect the significant cashflow risk we bear.

Robust incentives to drive consumer benefits

Incentives should continue to be used to encourage the ESO to take risks, innovate and experiment to deliver benefits beyond baseline expectations.

To be most effective, the incentives designed for the ESO in RIIO-2 should have clear success criteria, predictable financial outcomes, and be focused on the areas where we can deliver the most additional benefits for consumers.

The framework needs to work as a coherent, holistic package to ensure the ESO is financeable, incentivised to innovate and invest on behalf of consumers, and can earn a fair return for the risks we hold.

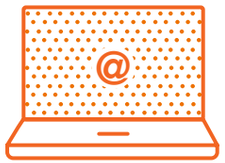
[27] https://www.nationalgrideso.com/document/139766/download

How to respond to this consultation

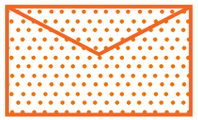
9. How to respond to this consultation

This consultation is open until 3 May 2019.

You can give us your views:



via email to box.eso.riio2@nationalgrideso.com



or in writing to ESO RIIO-2 team, National Grid ESO, Faraday House, Gallows Hill, Warwick CV34 6DA.

Tell us what you think

- Do we have the right level of ambition?
- Do you agree with the activities we have highlighted to deliver this ambition?
- Are our initial estimates of the potential cost of delivering this ambition reasonable?
- Do you agree with our articulation of the consumer benefit from our activities?
- Is it sufficiently clear how we have taken stakeholder input into account in developing our ambition?
- How would you like to be involved in the ongoing development of our RIIO-2 business plan?
- Are there any further comments you would like to make as we develop our RIIO-2 business plan?

Glossary

Word	Acronym	Description
2050 carbon reduction target		A target to reduce carbon emissions by at least 80 per cent of 1990 levels by 2050. This is taken from the UK's 2008 Climate Change Act.
Balancing Mechanism	**BM**	A platform used to make sure electricity supply and demand is balanced. From one hour prior to real time until the end of a settlement period, the ESO can instruct (or dispatch) parties to increase or decrease their generation or consumption.
Balancing services		Services procured by a system operator to balance demand and supply, and to ensure the security and quality of electricity supply across the transmission system. These services include reserve, frequency control and voltage control. Each service has different parameters that a provider must meet.
Balancing Services Use of System charges	**BSUoS**	This charge recovers the cost of day-to-day operation of the transmission system from generators and suppliers. BSUoS charges are calculated daily, depending on the balancing actions that the ESO takes. We also provide a monthly forecast of expected BSUoS charges.
Capacity Market	**CM**	Introduced by the UK Government as part of the Electricity Market Reform Programme to ensure the future security of our electricity supply. This is achieved by providing a payment for reliable sources of capacity, alongside their electricity revenues, ensuring they deliver energy when needed.
Competitively Appointed Transmission Owner regime	**CATO**	A process that grants licences on the basis of competitive tendering. In January 2018, Ofgem announced its intention to introduce competition into onshore electricity transmission build.
Critical national infrastructure	**CNI**	Assets that are considered vitally important to daily life and the economy. This includes infrastructure associated with the generation and transportation of electricity.

Word	Acronym	Description
Data centre		A data centre is a location used to house computer systems and associated components, for the purpose of collecting, storing, processing, distributing and managing large amounts of data, and running software applications.
Demand-side response	**DSR**	A deliberate change to an energy user's natural pattern of metered electricity or gas consumption, brought about by a signal from another party.
Department for Business, Energy and Industrial Strategy	**BEIS**	A UK Government department with responsibilities for business, industrial strategy, science, innovation, energy and climate change.
Distributed energy resource	**DER**	Resources connected to electricity distribution networks, which system operators can use to efficiently manage energy grids. These resources include flexible generation, flexible demand and storage.
Distributed generation	**DG**	Any generation that is connected directly to the electricity distribution networks, as opposed to the high voltage transmission network.
Distribution Network Operator	**DNO**	DNOs own and operate networks for the distribution of electricity.
Distribution System Operator	**DSO**	A DSO is the entity which monitors, controls and actively manages the electricity flow on the lower voltage distribution network to maintain a safe, secure and reliable electricity supply.
Electric vehicle	**EV**	A vehicle driven by an electric motor. It can either be driven solely off a battery, as part of a hybrid system, or have a generator that can recharge the battery but does not drive the wheels.

Glossary

Word	Acronym	Description
Electricity Balancing System	**EBS**	The EBS was implemented to replace the suite of systems used to execute the Balancing Mechanism.
Electricity Market Reform	**EMR**	A government policy to incentivise investment in secure, low-carbon electricity, improve the security of Great Britain's electricity supply, and improve affordability for consumers.
Electricity System Operator	**ESO**	An entity entrusted with transporting electric energy on a regional or national level, using fixed infrastructure. The ESO may not necessarily own the assets concerned. For example, National Grid ESO operates the electricity transmission system in Scotland, which is owned by Scottish Hydro Electricity Transmission and Scottish Power Transmission.
ESO RIIO-2 Stakeholder Group	**ERSG**	An independently chaired group set up to scrutinise and challenge our business plan, making sure it reflects our stakeholders' priorities, as well as driving value for consumers. Its members are drawn from a cross-section of customers, service providers and public interest groups.
Flexible generation		Types of generation that can respond quickly to requests to change their output.
Forward Plan		Published each financial year, our *Forward Plan* describes what we're planning to do to deliver benefits for our customers and stakeholders. It includes a set of criteria for our performance to be measured against.
Future Energy Scenarios	**FES**	The *FES* is a range of credible pathways for the future of energy out to 2050. They form the starting point for our transmission network and investment planning, and are used to identify future operability challenges and potential solutions.
Gigawatt	**GW**	A unit of power. 1 GW = 1,000,000,000 watts.

Word	Acronym	Description
Great Britain	**GB**	A geographical, social and economic grouping of countries that contains England, Scotland and Wales.
Grid Code		Specifies the technical requirements for connection to, and use of, the national electricity transmission system.
Inflexible generation		Types of generation that require long notice periods to change their output or have obligations that influence when they can generate.
Integrated Energy Management System	**iEMS**	The core control system which enables the real-time operation and monitoring of the transmission system. It is categorised as critical national infrastructure.
Intermittent generation		Types of generation that can only produce electricity when their primary energy source is available. For example, wind turbines can only generate when the wind is blowing.
Intertrip		Automatic control arrangements where generation may be reduced or disconnected following a system fault.
Machine learning		An application of artificial intelligence that enables software solutions to automatically learn and improve.
Megawatt	**MW**	A unit of power. 1 MW = 1,000,000 watts.
Network Options Assessment	**NOA**	A process for assessing the options for reinforcing the national electricity transmission system.
Office of Gas and Electricity Markets	**Ofgem**	The UK's independent National Regulatory Authority, a non-ministerial government department. Their principal objective is to protect the interests of existing and future electricity and gas consumers.
Peer-to-peer trading		Where individuals can buy and sell energy with each other.

Glossary

Word	Acronym	Description
Power Responsive		A stakeholder-led programme, facilitated by National Grid, to stimulate increased participation in different forms of flexible technology, such as demand-side response and storage.
Regional Development Programmes	**RDPs**	A programme set up to provide detailed analysis of areas of the network with large amounts of distributed generation and known network issues in accommodating this. RDPs adopt a whole system approach to push the boundaries of current thinking and optimise operations and investment across distribution and transmission networks.
Renewable generation		Renewable generation creates electricity from natural resources that are quickly replaced. For example wind, solar or biomass generation.
Residual balancer		An entity with overall responsibility for ensuring that electricity supply and demand match on a second-by-second basis.
RIIO		Ofgem's regulatory framework that sets price controls. These determine the amount network companies can earn from the services they provide. Revenue = Incentives + Innovation + Outputs.
RIIO-2		The next regulatory price control period, which starts in April 2021.
RIIO-T1		The current regulatory price control period, which runs from 2013 to 2021.
Sandbox		The ability to rapidly trial new products. We know that from previously introduced products, integration with our core systems needs bespoke development and takes a long time. A sandbox environment provides a scalable means of doing this, making trialling of new products quicker and cheaper.

Word	Acronym	Description
Security and Quality of Supply Standard	**SQSS**	A set of standards used in the planning and operation of Great Britain's national electricity transmission system, including both onshore and offshore.
System inertia		The property of the system that resists changes. This is provided largely by the rotating synchronous generator inertia, which is a function of the rotor mass, diameter and speed of rotation. Low system inertia increases the risk of rapid system changes.
System operability		The ability to maintain system stability and all of the asset ratings and operational parameters within pre-defined limits, safely, economically and sustainably.
System Operator	**SO**	An entity entrusted with transporting energy in the form of natural gas or electricity on a regional or national level, using fixed infrastructure. The SO may not necessarily own the assets concerned. For example, National Grid ESO operates the electricity transmission system in Scotland, which is owned by Scottish Hydro Electricity Transmission and Scottish Power.
Transmission Owner	**TO**	A collective term used to describe the three transmission asset owners within Great Britain, namely National Grid Electricity Transmission, Scottish Hydro Electric Transmission Limited and Scottish Power Transmission Limited.
United Kingdom of Great Britain and Northern Ireland	**UK**	A geographical, social and economic grouping of countries that contains England, Scotland, Wales and Northern Ireland.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