Facilitating the transition to a flexible, low carbon energy system

The Electricity System Operator RIIO-2 Business Plan 2021-23

nationalgridESO

Contents

How to use this document

Our Business Plan is divided into three main parts:

Part 1 (page 3)

outlines our business background, the context for our plan including the assumptions underpinning our proposals, and how stakeholders have helped develop them.

Part 2 (page 33)

sets out our planned outputs against our four Themes. In each Theme section, you will find information about the benefits, costs and net present value of our proposed new activities, as well as the stakeholder views on our proposals. We have also included in each of the Theme sections, our five-year strategy and delivery roadmaps for the proposed activities.

Part 3 (page 132)

provides more details about the parts of our business that underpin everything we deliver, including our IT strategy, our approach to innovation, how we will invest in people and capability, and the cross-cutting teams and shared services that support us to deliver value for consumers..

To help explain our thinking clearly, for each of the activities listed in Part 2, we have segmented our information under the following headings:

- Costs
- Ongoing activities and enhancements
- Transformational activities
- Investment roadmap
- Stakeholder views
- Cost benefit analysis
- Proposed performance metrics

Supporting this Business Plan is additional information which you can review alongside the various sections.

These include the:

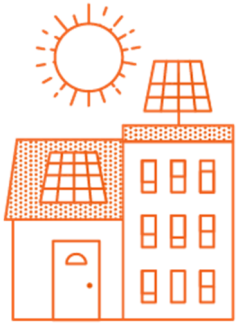
- **Annex 1** which includes summary investment tables, more information on our performance in RIIO-1, benchmarking, metrics, and assumptions underpinning our Business Plan. Also includes larger delivery roadmaps
- **Annex 2 - Cost-benefit analysis (CBA) report** which outlines more on how we calculated the net present values. This report includes our cost summary tables which you can review as you read through the various chapters.
- **Annex 3 - Stakeholder report** which highlights the feedback we have received through our extensive stakeholder engagement and how we have used it to develop our plan.
- **Annex 4 - Technology investment report** which supplements the IT chapter, sets out the IT investment refernces and includes benchmarking information.
- **Annex 5 - Finance report** which covers the supplementary information on the ESO's financeability, pensions, revenue and other costs. (Confidential)
- **Annex 6 – How our plan meets the Challenge Group's requirements** which looks at the feedback received by the Challenge Group and how we have responded to it in our suite of documents.
- **Annex 7 - Glossary** which has definitions of the terms used within this Business Plan.
- **Annex 8 –** Business plan data template commentary document. (Confidential)

Other things to note are that:

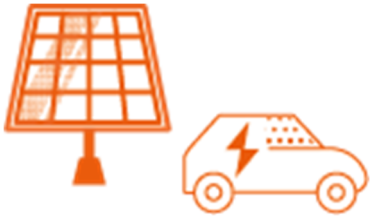
- The benefits and costs in this document are all in 2018/19 prices.
- We have calculated the benefits presented using Ofgem's net present value (NPV) model. More detail is in Annex 2.
- The RIIO-1 costs presented in this document are calculated as follows:
- Opex and FTE numbers are the average for the ESO since legal separation (years 2019/20 and 2020/21) which reflects the current ESO business structure.
- Capex numbers are the average over the eight years of RIIO-1. As capex programmes tend to span many financial years, this gives a more typical spend profile.
- The costs presented in this document represent our proposed spending.

Facilitating the transition to a net zero energy system

May 2019: Britain had its first fortnight without using electricity from coal since the 1880s.**1000 coal free hours in total this year.**

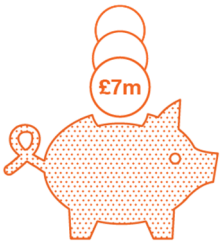


New peak solar generation record. **9.55 GW power generated from solar.**



Embedded generation: **in 2012 the industry predicted 12% in 2020, levels hit 27% in 2017.**

60% increase in active Balancing Mechanism Units in the system and a **42% increase in balancing service providers.**



£7 million annual efficiency savings in RIIO-2.

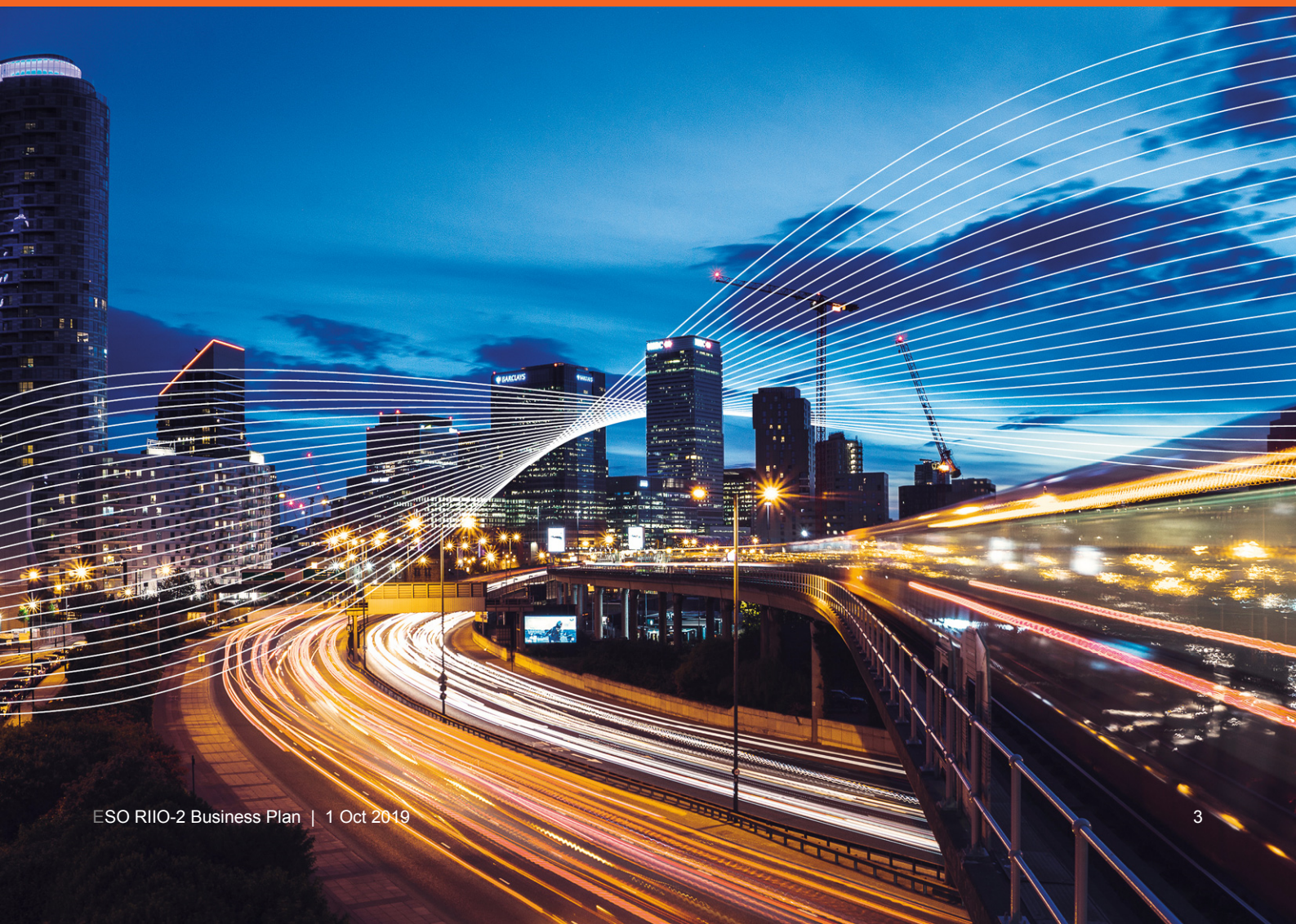
2025 when we will be able to operate a carbon free electricity system.

£250 million annual cost of the ESO.

Consumer bills £3 lower.

£2 billion net present value of consumer benefits to be delivered in RIIO-2.

Part 1
Context



1. Introduction and context

Energy is the lifeblood of our economy and society. As the Electricity System Operator (ESO) for Great Britain, we hold a unique position at the heart of the nation's energy system. Our actions influence investment decisions and markets worth billions of pounds and our role is critical for the transformation of the energy system. **In RIIO-2 we will deliver around £2 billion net benefits for consumers, reducing annual consumer bills by around £3.**

Our mission, as System Operator, 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:

1. an electricity system that can operate carbon free
2. a strategy for clean heat, and progress against that plan
3. competition everywhere
4. the System Operator is a trusted partner.

Our System Operator (SO) mission applies to both our Electricity System Operator and Gas System Operator businesses. This Business Plan focuses on how the ESO will contribute to this overall mission[1].

For our full ESO RIIO-2 ambition, please see our website[2].

"An effective ESO can play a crucial and positive role in ensuring that the UK has the ultra-low carbon, affordable, reliable and efficient power system it needs in the near future."
Wider Interest Group

The energy landscape has undergone a revolution – and change will continue at an even greater pace. The ESO sits at the heart of a complex, multi-directional system of electricity flows, where small-scale renewables, storage and demand-side participation make operating the system more challenging than ever before. We are rising to this challenge and have a clear vision for how we must change, including developing new capability and culture within our business. Supported by a new, bespoke regulatory model, we will facilitate the transition to a zero carbon power system, helping to achieve the UK's recent commitment to net zero emissions by 2050. Alongside this, we will continue to deliver energy safely and reliably and provide value for consumers in everything we do.

Our RIIO-2 Business Plan identifies the necessary investments in the ESO to transform our business and achieve these goals.

1.1. A Business Plan developed in partnership with stakeholders

In April 2019, we published *Towards 2030: a system operator for GB's energy future*[3] which set out our longer-term vision of the future of energy. Alongside this, we published *Our RIIO-2 Ambition*[4] – our view of the outputs and activities we propose to deliver in the crucial RIIO-2 period, as part of our journey to 2030. This was based on almost two years of extensive business and stakeholder engagement that we carried out both through our usual engagement channels and via RIIO-2-specific engagement. Stakeholders were universally supportive of the level of ambition set out in the document and the business is committed to delivering it.

We published a draft Business Plan in July. This provided the next level of detail on the new, transformational activities and set out how they benefit consumers. In this, our October draft plan, we explain our near-final proposals. The net benefits of our proposed new outputs in RIIO-2 is £2 billion. In RIIO-2 the ESO will deliver a net saving of around £3 on every consumer's annual bill.

For more information on how stakeholder feedback has informed our plan, please see chapter 2.

In RIIO-2 the ESO will deliver a net saving of around £3 on every consumer's annual bill.

1.2. Business plan Themes

To be consistent with the approach taken in *Our RIIO-2 Ambition* and our draft July Business Plan, we set out our proposals under the following four Themes:

1. reliable, secure system operation, to deliver electricity when consumers need it
2. transforming participation in smart and sustainable markets

[1] National Grid's gas system operator business is included in the RIIO-2 business plan for National Grid Gas Transmission.
[2] https://www.nationalgrideso.com/about-us/business-planning-riio/future-planning-2021-onwards
[3] https://www.nationalgrideso.com/document/141141/download
[4] https://www.nationalgrideso.com/about-us/business-planning-riio/future-planning-2021-onwards

3. unlocking consumer value through competition
4. driving towards a sustainable, whole energy future

We also highlight the role of open data in unlocking markets and zero carbon system operation.

We recognise that to deliver the ambitious outputs that stakeholders want, the ESO will need to change significantly. Our capabilities and culture must evolve. We describe towards the end of the Business Plan how we will transform in these areas as we become an organisation at the cutting-edge of technology - one that's trusted by the industry, consumers and citizens to facilitate the energy transition.

Key Outputs

In RIIO-2 we will collaborate with stakeholders to deliver:

- New control centre architecture and systems to operate a zero carbon network by 2025
- New area monitoring and control systems, to ensure power system stability in a low carbon world
- New market and auction platforms to promote competition and enable participants as small as 1 MW to participate
- An open data portal to provide a single point of contact for all ESO data and services, enabling a step change in data use and sharing across the industry.

We will also continue to:

- operate the electricity system so there is a minute-by-minute balance of supply and demand of electricity
- manage balancing and constraints to minimise costs to consumers
- manage existing balancing service markets, developing future markets and making improvements to facilitate greater transparency, participation and competition
- manage industry revenue flows through playing a leading role in setting charging methodologies
- collect charges for use of the transmission network and balancing services
- continue our electricity market reform (EMR) delivery body role
- manage connection applications for the transmission network, and acting as the contractual counter-party for these connections
- plan for the future of the electricity system, including network planning and the Network Options Assessment process, as well as how this interacts with the whole energy system.
- publish a variety of insights and data, including our annual *Future Energy Scenarios*
- deliver IT system changes required by our customers, and those mandated by GB and EU regulations.

Consumer bills £3 lower

Net benefits to consumers: £2 billion

1.3. Maximising benefits for consumers through new transformational activities

Our Business Plan includes a set of ambitious new outputs. We estimate that these will generate **net benefits[5] of around[6] £2 billion for consumers over the five-year RIIO-2 period**.

Some of the major components of these benefits are:

- Investment in our control centre architecture and systems, so we can operate a zero carbon system by 2025. Direct benefits come from reduced emissions and lower consumer bills through better access to lower-cost interconnection and reduced balancing costs – delivering consumers a **net benefit of £242 million**
- Working more closely across transmission and distribution networks to take a whole system view of zero carbon operability. This will reduce consumer bills through avoided network costs and constraint cost savings – delivering consumers a **net benefit of £469 million**
- Transforming network planning by introducing competition between network and commercial solutions. This will promote innovation in 'non-build' solutions and reduce bills through avoided asset investment and lower constraint costs – delivering consumers a **net benefit of £663 million.**

Our actions mean that industry costs are lower than would otherwise be the case through lower balancing costs, avoided network investment, and industry efficiencies. This generates savings that will be passed to consumers through lower bills. **In RIIO-2 the ESO will deliver a net annual saving to consumers of around £3 per bill**[7].

Figure 1: Types of benefit we deliver

[5] Net benefits in the document refers the Net Present Value (NPV) of an activity or group of activities. See the CBA report of more details on how we have calculated NPV

[6] This is a central estimate. Our analysis suggested that accounting for market, delivery and third-party uncertainty the net benefits could be between £3.1 and £1.2 billion. Additional risk and financing costs from fixing Balancing Use of System (BSUoS) charges would also be needed to be taken into account in the ESO's overall financing requirements

[7] This saving is as a result of our new and transformational proposals only which will save around £4.80 on each bill. The cost of the ESO in RIIO-2 is around £1.65. The ESO's core ongoing role also delivers consumer savings that have not been quantified, so the £3 is likely to be an underestimate

For our transformational activities, where appropriate, we have undertaken a Cost Benefit Analysis (CBA) to determine the value of each activity for consumers. There are natural dependencies between our transformational activities, where one activity's benefits cannot be fully realised without other activities being undertaken. We only consider the direct benefits of an activity, without assuming the other activities outputs, which reduces the chance of double counting benefits. We have therefore also shown the dependencies between benefits to highlight how our benefits cannot be realised without consideration of these dependencies. Indeed, the relationship between our activities and benefits is not linear. If we do not undertake an activity on which another is dependent, the benefits of both activities will be reduced. The chart below illustrates these relationships. For more detail see the Annex 2 - CBA report

The financial benefit figure we have estimated for consumers is likely to significantly understate the total benefits that the ESO will drive. This is because it only includes the direct benefits that are able to be quantified and does not consider wider environmental improvements or the wider benefits of our core role – providing a safe and reliable supply of electricity to underpin an economy worth over £2 trillion.

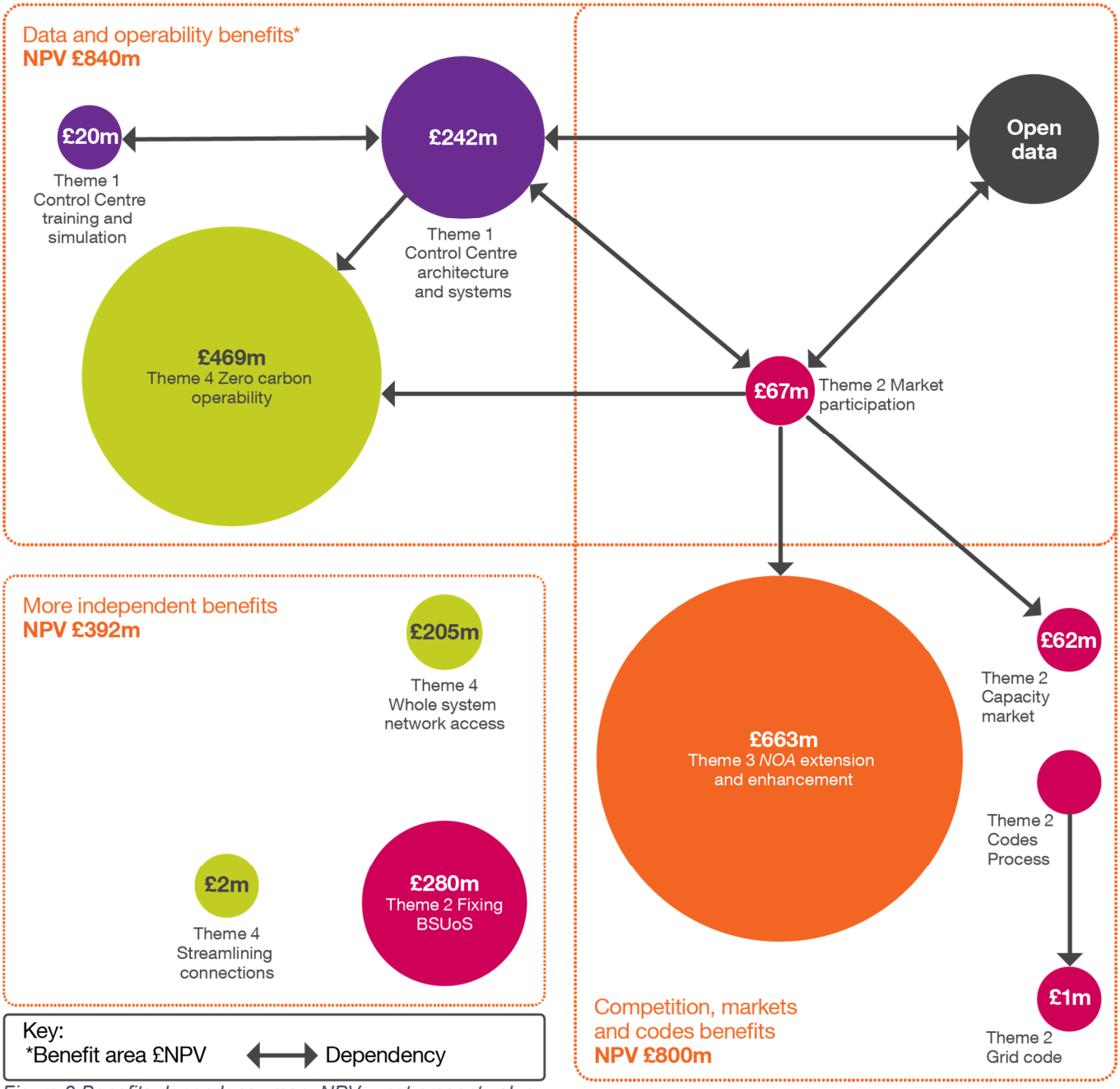


Figure 2 Benefits dependency map. NPV = net present value.

1.4. A flexible Business Plan for a changing energy landscape

Since the start of the RIIO-1 price control we have seen unprecedented change in the energy system:

- In May 2019, Britain had its first fortnight without using electricity from coal since the 1880s, with over 1,000 coal-free hours in total this year.
- A new peak solar power generation record was set on 14 May 2019 with 9.55 gigawatt (GW) of power generated from solar.
- In our 2011 Future Energy Scenarios, we anticipated that in 2019 we would have around 1 GW of solar power capacity in GB; we now have over 12 GW.
- In 2012 industry predicted 12 per cent embedded generation in 2020; levels hit 27 per cent in 2017.
- There has been an increase of 60 per cent in active Balancing Mechanism Units in the system and a 42 per cent increase in ancillary service providers.

1.4.1. The future is already here

The 'three Ds' of the energy transition – decentralisation, decarbonisation and digitisation – are well known. We are now operating in this future. It is an energy system where:

- **Renewable and low carbon technology** dominates how we generate electricity, the way we travel and how we heat our homes.
- This technology will be more **decentralised,** with significant distributed and local generation, supported by energy storage and demand-side solutions
- Consumers **produce, store and sell energy** in response to market signals, based on cost and carbon-intensity, through peer-to-peer trading, smart homes, and participation in our balancing and ancillary service markets
- **Advanced data and analytics** change the way market participants interact with us and each other, enabling them to make informed choices.

The ESO of 2025 will be an organisation that operates the system using new technologies. These will harness the power of **automation, artificial intelligence and machine learning** to efficiently manage the complex energy system of the future. We will **lead changes to markets** so new sources of flexibility, including innovative providers and disruptive technologies, can participate in the low carbon energy mix of the future. We will pave the way in **sharing data** across the industry, which will influence better decision-making and increased transparency. It will be essential for us to work across **transmission and distribution boundaries**, collaborating with network and market companies to solve local and national balancing challenges together. Our RIIO 2 Business Plan describes how we will meet these challenges to become the ESO of 2025 that the energy transition needs.

The ESO will publish two-year Business Plans in the context of a five-year strategy

Recognising the changing energy landscape, during the RIIO-2 period the ESO will publish two-year Business Plans in the context of a five-year strategy for each of the four delivery Themes.

1.5. The ESO business

The ESO is part of the National Grid System Operator business, which covers both electricity and gas system operation.

We operate the National Electricity Transmission System for Great Britain. We balance supply and demand in real time, making sure consumers have safe and reliable energy at their fingertips at a fraction of the cost they'd be willing to pay[8].

The ESO plays a unique role within the energy system. Although we are relatively small in terms of internal costs, we influence industry costs that are many times higher.

We do not have a large asset base, with an expected regulatory asset value (RAV) of around £220 million at 31 March 2021. This results in a very small balance sheet compared with the more than £4 billion cash we transact in our industry revenue management collection role.

While we are an asset-light business, we run IT systems that enable core energy industry activities, such as real-time system operation by our control room, and maintain IT infrastructure necessary to enable the energy transition. Our IT systems have an asset life of five to ten years. We invest heavily in people and have a directly employed workforce of around 600, many of whom have specialist skills.

The ESO became a legally separate entity within the National Grid Group on 1 April 2019. Separating the ESO business from National Grid Electricity Transmission (NGET) allows for increased independence and transparency in our decision-making.

Board assurance of our Business Plan

The ESO has a separate Board of Directors[9], including three independent non-executive directors, which is overseeing the development of our RIIO-2 Business Plan and assuring our proposals for accuracy, ambition and efficiency.

1.5.1. How we will be regulated in RIIO-2

RIIO is an opportunity to design a bespoke regulatory framework for the legally separate ESO, so we can deliver this ambitious plan.

This process is still ongoing – Ofgem closed a consultation on our financial methodology on 25 September and is currently consulting on the design of our incentives scheme, which closes on 9 October. We expect the decision on both consultations in late October.

In May and August 2019, Ofgem set out part of its decision on how the ESO will be regulated in RIIO-2. We know that the ESO will have:

- A two-year business planning cycle, within the five-year RIIO-2 period. This will require us to set out a long-term vision to 2030 or beyond. We will also produce a medium-term strategy over five years and detail our costs, activities, deliverables and performance metrics in a Business Plan every two years
- A regulatory asset value (RAV)-based, slow money approach for capex, and a fast money approach for opex[10]. All efficient costs will be passed through to consumers.
- No sharing factor, and a cost disallowance approach aligned to the other RIIO companies.
- Continuation of an ex post, evaluative incentive scheme[11].

Our assessment of the working assumptions provided by Ofgem is that they risk the ESO being unable to raise sufficient investment to deliver our Business Plan. An important aspect of our financeability is the provision of fair remuneration to reflect the services we provide and the risks we hold. Any additional remuneration for the ESO will be consulted on during the Draft Determinations stage in quarter two next year, alongside our financial parameters and value of incentives.

We have prepared this Business Plan on the assumption that the ESO will have a sustainable funding model that ensures the financeability of the ESO as a standalone business.

[8] Including the Estimating Electricity and Gas Transmission Consumers' Willingness to Pay for Changes in Service during RIIO2 report

[9] https://www.nationalgrideso.com/about-us/meet-ngeso-board

[10] Slow money is where costs are added to the RAV, and therefore revenues are recovered over time from both current and future consumers. Fast money allows companies to recover a percentage of total expenditure within a one-year period. For example, 15% fast money would allow companies to recover 15% of total expenditure within year, with the rest being capitalised in the RAV (slow money)

[11] Further details are still being consulted on by Ofgem

1.5.2. Investment in the ESO in RIIO-2

Our proposed investment[12] in the ESO in RIIO-2, including our core, ongoing outputs, is an average of £250 million per year. This incorporates efficiencies worth £7 million per year. Please see chapter 3 for more information on the efficiencies we have incorporated in our plan. The ESO's spending in RIIO-2 includes £60 million of proposed new investment as well as continued delivery, and enhancements to, the processes and systems we use to carry out our core role. The increase on our RIIO-1 annual average spending of £180 million per year is mainly due to this £60 million new proposed investment. Other cost increases have been offset by efficiency gains, so the rest of the net increase reflects increased investment in our core IT services, including additional investment in digital and cyber security measures. For more information, please see chapter 9.

We have set out our proposed spending for a five-year period, reflecting the longer-term nature of many of the transformational outputs we propose. Our cost-benefit analysis and data tables also look at a five-year period, as required by Ofgem.

The proposed spending set out for the first two years of this period should be read as part of this longer-term investment proposal. The spending for 2023/24 and beyond will be updated when we publish our next two-year Business Plan.

The cost of our role in RIIO-2 is around £1.65[13] on a consumer's annual energy bill, however our proposed new and transformational outputs will save consumers around £4.80 per year, resulting in a net reduction of more than £3. **The ESO therefore delivers a net saving to consumer bills.**

ESO annual investment, staff numbers (full time equivalent (FTE)) and benefits in RIIO-2

Figure 3

Investment

The ESO's Business Plan spending will be reported on a two-year cycle. In this Business Plan we focus on the first two years of RIIO-2 but have also set out our view of what spending will be over the full five-year period.

[12] Excluding items not classified as totex, for regulatory accounting purposes. The average of £250m is for 2021-22 and 2022-23. In line with Ofgem's requirements, this business plan focuses on the first two years of RIIO-2

[13] First two years of RIIO-2, 2018-19 prices

2. A plan informed by our stakeholders

2.1. The importance of stakeholder views

As we embark on this unprecedented opportunity to develop a new regulatory framework and Business Plan for the ESO, we need the insight and support of our customers and stakeholders so we can make sure that we focus on the right areas. It is critical that we produce a plan that reflects stakeholders' needs and maximises benefits for consumers and society as a whole. This document has been produced in collaboration with stakeholders, with proposals constantly tested and refined. We will continue to work collaboratively with our stakeholders as we produce our final plan in quarter four 2019.

Our engagement objective

We are committed to working with our customers and stakeholders to help shape the future of the energy market and understand how best the ESO can deliver value for our customers and consumers. Through enhanced stakeholder engagement we will be able to create a plan that reflects their needs.

In this chapter, we set out what we have learnt from our engagement and how we have structured our stakeholder engagement programme. The ESO continuously engages stakeholders and our RIIO-2 specific engagement is a natural extension of this. Details about how stakeholders' views have shaped our proposals can be found in the Theme chapters and are described in more detail by Theme and by topic in the supporting Stakeholder report.

We have also embraced an enhanced engagement approach through the introduction of our ESO RIIO-2 Stakeholder Group (ERSG). Comprising 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 publish a report that sets out their views on our engagement activity and the development of our Business Plan on 22 December 2019.

2.1.1. Engagement key themes

Feedback from stakeholders has encouraged, supported, challenged and guided us towards the ambitious Business Plan presented here. Similarly, the broad knowledge and experience of our Stakeholder Group – ERSG – has created an environment of robust challenge and strong support to elevate the level of ambition in our plan. This builds on our current role and capabilities now to reflect the evolving role we can play as system operator in the future. The main points we have learnt are that we need to:

- be ambitious and proactive - creating value for consumers and delivering a high-quality service in all that we do.
- set ourselves up strongly to deliver against the plan, including establishing the culture needed to deliver the proposals through all levels of the organisation.
- adopt a principle of open data to help facilitate open and efficient markets
- transform our engagement approach to involve stakeholders throughout RIIO-2 in the development and execution of our major deliverables
- be mindful of how our proposals are dependent on wider industry change initiatives
- work closely with DNOs to ensure a joined-up experience for market participants and connection customers across transmission and distribution
- make sure our funding model drives us to be ambitious and enables us to respond flexibly to new challenges as they arise, with strong incentives to provide benefits for consumers over and above our day-to-day role.

As a result of stakeholder feedback, we have developed our Business Plan to:

- talk more holistically about our ongoing activities, enhancements to them during the RIIO-2 period and transformational activities to help readers understand our Business Plan
- refine and expand the cost benefit analysis and how we explain both the costs and benefits in the Business Plan
- provide clarity on the intention of our ambition on operating a carbon free electricity system and which activities contribute to its delivery
- include investment roadmaps to achieve our ambitions, including setting out those actions that will be taken forward during the remainder of the RIIO-1 period
- take an agile, modular approach to developing our new balancing and control capabilities, including building them offline
- transform engagement in delivering all our IT capabilities through fully involving stakeholders in their development through a design authority
- clarify how we will work with universities to secure an increased pool of appropriate resources

- remove our proposal to take on responsibility for the Capacity Market rules
- make participation in our markets easier through establishing a single integrated platform for both balancing service markets and the Capacity Market
- clarify our proposed role in relation to leading the debate in Theme 4
- adopt a principle of open data – committing to sharing our data (in machine readable format) while making sure we are protecting data confidentiality and security
- better understand consumer views in the regards to the future energy system and show how are plan aligns to their priorities
- understand how our people, capability and culture need to change and identify what we are going to do to manage this transition.

We also set out more detailed changes throughout the Business Plan and the feedback that has informed this in our Stakeholder report.

2.2. Our stakeholder engagement strategy

Our stakeholder engagement strategy takes a dynamic approach. It includes continuous feedback, which enables us to develop and refine our thinking into the prioritised activities that feature in this and subsequent business plans. We are inclusive in our engagement approach and work with a broad range of stakeholders of different sizes and across a number of sectors. We have evolved our engagement strategy to an 'always on' approach that adopts a permanent invitation to engage.

As some of our key stakeholders, we have sought to engage specifically and regularly, both bilaterally and as a group, with network companies. With TOs we have discussed our respective proposals to determine where our plans may overlap and interact such that we can work collaboratively to move forward and deliver collective value for customers and consumers. We have engaged with DNOs through the ENA, our own engagement events and have had an open invite to engage bilaterally on how our proposals could interact with their future role and activities and how we can work more closely together.

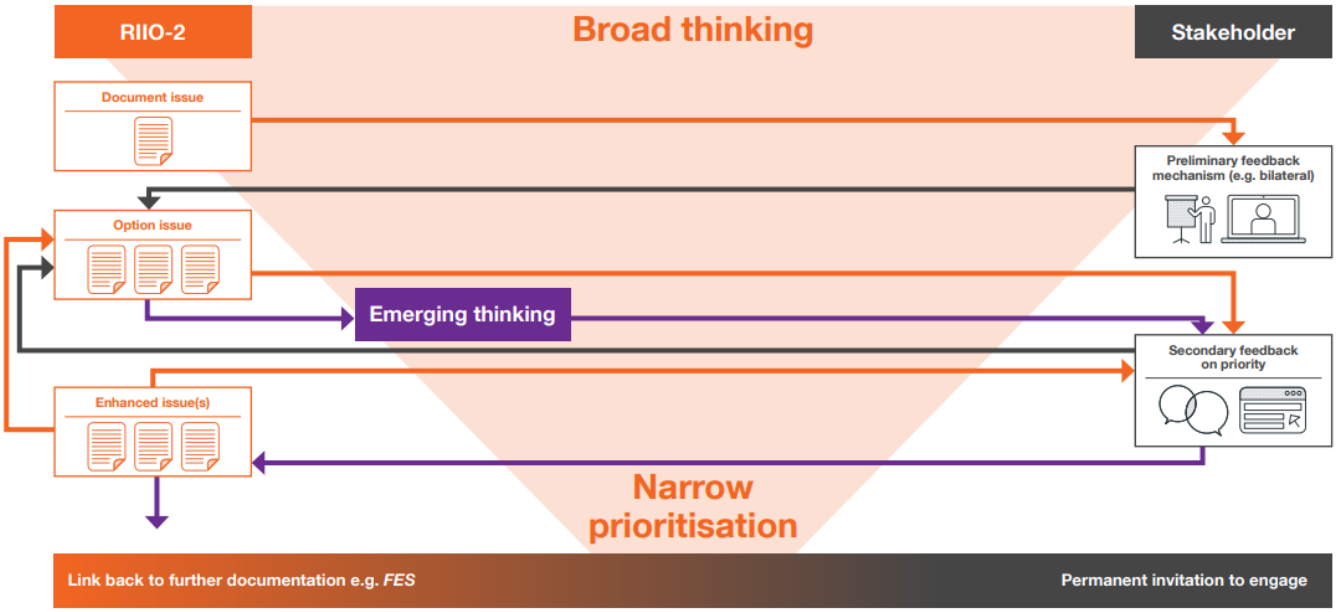


Figure 4: RIIO-2 stakeholder engagement strategy

We seek to use the principles of the AA1000 Stakeholder Engagement Standard in our engagement approach to establish a benchmark. It means that we plan, prepare, implement and improve engagement activity, so we maximise the value of our engagement and are respectful of stakeholders' time. We are not accredited to the standard, so have not assessed our performance against it. Instead, we commissioned an independent review of our stakeholder engagement approach earlier in the year to make sure we are taking a best practice approach in developing the Business Plan. The review was largely positive, based on stakeholder feedback and comparison with best practice organisations. Some enhancements to evolve our approach were recommended, many of which we have taken forward as we've developed the Business Plan.

2.3. Dynamic engagement through the Business Plan process

We have taken an approach of continuous story creation which fall into 3 broad areas – broad thinking, developing our proposals and testing our proposals. These are described in more detail below and are reflected in the structure of our Stakeholder Report. We began by understanding our consumer and stakeholder priorities to steer what we should deliver. These form the fundamental cornerstone of our plan.

"[ESO] RIIO-2 is leading the pack in terms of proactive engagement. Process isn't finished but so far, so good."
Generator / supplier

2.3.1. Broad thinking

To create our consumer and stakeholder priorities we commissioned an independent research study, reaching stakeholders, Members of Parliament and 2,000 members of the public. We also brought together the outputs of our day-to-day engagement activities from across the ESO and created additional activities as part of a coordinated programme of engagement for RIIO-2 to test and refine the priorities.

This included regular direct conversations, and an online stakeholder webinar with 88 attendees from 68 organisations. We made additional changes to these after they were presented to our ESO RIIO-2 Stakeholder Group (ERSG).

You can find out more about how they were created on our website[14].

Our Consumer and Stakeholder priorities are used throughout the Business Plan to assess how our activities will deliver value. In our proposal chapters (chapters 4-8) we have highlighted which consumer and stakeholder priorities are supported by our activities.

Figure 5: Our consumer and stakeholder priorities

2.3.2. Developing our proposals

In developing the proposals in the Business Plan, we built on the priorities of consumers and stakeholders. We carried out a consultation on our high-level proposals through *Our RIIO-2 Ambition* in April, inviting written views. We also used a variety of engagement channels to maximise the range of stakeholders we reach and have effective conversations with, such as stakeholder workshops with roundtables, direct engagement, webinars and email bulletins.

[14]https://www.nationalgrideso.com/about-us/business-planning-riio/have-your-say-our-future-plan

2.3.3. Testing our proposals

"Whenever there are changes they listen – they will set up a meeting quickly, they are easy to engage. Set up is perfect."
Consumer interest organisation

In our July draft Business Plan, we shared how stakeholder views have shaped our proposals, to help us seek further feedback. Stakeholders were supportive of many of our proposals up to that point so our engagement since then has focused on:

- testing those proposals where we had not heard stakeholder consensus;
- working with stakeholders to develop performance metrics;
- understanding their views on our more detailed costs and benefits; and
- engaging further with TOs (bilaterally and as a group) on our respective RIIO-2 proposals and with DNOs on aspects of our proposals where we would like to work more closely.

We will continue to work with our stakeholders to refine our proposals ahead of our final submission to Ofgem in December 2019, and also to understand their views on the plan as a whole.

The engagement channels we have used between the July draft Business Plan and this one have been similar to those we have used up to now. We ran three engagement events at the Electricity National Control Centre, focusing on understanding stakeholders' views on the areas highlighted in the bullet points above. We have supplemented these engagement events by attending existing trade association and Power Responsive events; the details of which are included in the stakeholder report. We are planning further engagement so we can test this Business Plan as a whole fully and our proposed metrics, before its final submission to Ofgem in December.

2.3.4. Our engagement activity

ERSG supports our stakeholder engagement to develop the Business Plan.

"The quality of information provided on feedback from customers and stakeholders and how this has been reacted to is high."

Engaging with a representative group of stakeholders gives us confidence we have created the Business Plan proposals with an appropriate breadth of stakeholder views. We have mapped our stakeholders according to their interest in our Themes and activities, and the level of impact that changes to our role may have on their businesses. This remains under continuous review as we develop the Business Plan. We used this approach to plan the most effective engagement channels for individual stakeholders across a range of sectors.

"Strongly welcome the ESO's efforts to put forward an ambitious plan that sets clear goals and reflects stakeholder feedback."
Trade association

We aim to be accessible in our engagement and, where possible, use and build upon the existing engagement opportunities that we have in place, such as our customer connections seminars, charging forums, *FES* workshops and electricity operational forums. This approach makes sure we use every opportunity to engage. Additionally, collaboration with other bodies gives us access to wider and more specialist views in a way that is more efficient for the ESO and our stakeholders. We've also created further channels to make sure we reach a broad range of stakeholders for each Theme and over-arching topics such as whole electricity system.

Below is a summary of how we have engaged over and above our existing engagement channels.

"ESO are giving a good level of access to people and events. It's all positive in terms of ability to contact and engage."
Distribution Network Operator

Face to face engagement, including: • Bilateral meetings • Workshops • Webinars	**To date we have held:** • 105 bilateral meetings • 9 Workshops • 9 Webinars	**Which has resulted in engagement with:** • Over 700 individuals from • Around 300 organisations
ESO RIIO-2 Stakeholder Group	**To date we have held:** • 7 meetings • 1 workshop • 1 control room visit	**This has involved:** • 19 of our key stakeholders
Written communications, including: • Bi-Monthly bulletins • Website • Thought pieces • Podcasts	**To date we have published:** • 7 bulletins • 4 stakeholder reports • 3 thought pieces • 1 podcast	**These have reached:** • Average of 900 individuals through our bulletins • 211 plays of the podcast

Figure 6: Summary of our RIIO-2 engagements

Stakeholder engagement numbers by segment

We have met more than 700 individuals from around 300 organisations through some 1,100 interactions. Generators, service providers and suppliers were the groups most commonly represented. In the figures below many stakeholders have been assumed to be representing more than one stakeholder segment. For example, one person may be classed as both a generator and a supplier, which will appear to inflate the numbers for these groups. The 'other' category includes non-domestic consumers, construction companies, automotive companies and charities.

Figure 7: Stakeholders engaged with in RIIO-2 by sector

Accessible ESO RIIO-2 engagement

This range of engagement channels and our 'always on' approach to engagement have resulted in stakeholders telling us that they find the ESO RIIO-2 programme to be very accessible, and feel well engaged and consulted. All of the stakeholders we asked find it easy or very easy to engage with the ESO and 93 per cent were satisfied or very satisfied with the process. We will continue to use the broad range of engagement channels set out above and to look for additional appropriate channels / engagement opportunities to ensure we remain open to new approaches.

Stakeholders have also given us some useful pointers on how we can improve our engagement. We hope the Business Plan and the CBA and Stakeholder reports will address the desire to see more detail on costs and benefits, and also for us to play back the range of views we've received and how we've responded to them. Over the last few months we have refined and further improved our engagement. For example, in response to stakeholder feedback we're engaging as much as possible through trade associations. We've also investigated improvements that will make the RIIO-2 parts of our website more accessible.

"All the transmission companies are going through the price control so prompts [in emails] are useful and an importance level indicator would be useful too."
Network company

2.4. Enhanced stakeholder engagement

"I believe the ERSG has such an important role to play in delivering the RIIO-2 framework and, ultimately, driving value for end consumers."
Charlotte Morgan, ERSG Chair[15]

The RIIO-2 enhanced engagement approach involves the establishment of an independent stakeholder group to provide challenge on and input to our Business Plan proposals. In addition, Ofgem has formed a RIIO-2 Challenge Group to independently assess Business Plan proposals across sectors and to provide challenge on Ofgem's regulatory approach.

2.4.1. Our independent Stakeholder Group

The role of our 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.

We wanted to make sure the members of our ERSG were representative of our role in the industry and reflective of the wider industry across Great Britain. Therefore, members include current and future customers and service providers, key stakeholders and wider public interest organisations. The challenge provided by the group has proved invaluable in developing the Business Plan, pushing us to go further in our ambition, be more coherent about our approach to stakeholder engagement, and change how IT is developed in the company.

We also recognised the critical role that the independent chair of the group would play, so 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 independent chair of our stakeholder group in July 2018. You can find more information about our group and their discussions so far on our website[16] and in the Stakeholder report.

We anticipate continuing with an evolved version of the ESO RIIO-2 stakeholder group beyond development of this RIIO-2 Business Plan. It would have an ongoing role in challenging the development of our business plans, potentially reviewing our performance and challenging our level and breadth of stakeholder and consumer engagement on an ongoing basis. We will include a firmer proposal on the ongoing role of our stakeholder group in the December version of our Business Plan. Ofgem's RIIO-2 Challenge Group provides another welcome level of scrutiny and challenge to make sure we deliver a robust plan that will provide benefits for consumers. You can find more information about these groups, our engagement with them and how we have responded to their feedback in the Stakeholder report.

"ESO is very committed to ERSG, which is to their credit. It's a diverse group which is good, and it's well constructed."
ERSG member

As per a Challenge Group request, throughout the Business Plan we have stipulated in call out boxes where ERSG have agreed or disagreed with our proposals.

[15] https://www.nationalgrideso.com/news/eso-prepares-first-legally-separate-price-control

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

2.5. Understanding consumer views

Understanding consumer views has been important to the development of our ESO Business Plan. As our engagement programme has progressed, we have further improved our approach to incorporating consumers' views. We have strengthened our understanding of their needs by undertaking additional research and engaging with a broader sector of stakeholders. This is alongside our direct engagement with consumer representative groups of domestic and non-domestic consumers and including such organisations on our ERSG. In our review of consumer research, we have learnt the following.

The *UKERC Synthesis Report*[17] found that the British public wants and expects change in how energy is supplied, used and governed. They are positive about the need for energy system change and do not prioritise demand over supply or vice versa. It also stated that affordability is more important than the lowest cost possible in terms of energy system change. The cost related to a number of factors, such as long-term stability versus fluctuation in cost, existing market structures, getting a 'fair deal' and trust in energy companies.

A second report by *UKERC 'Paying for energy transitions*[18]*'* surveyed 3,150 consumers, followed by five focus groups across the UK. The study found that generally the public are willing to pay towards the transition to a low carbon, reliable and affordable energy system but believe this is alongside both government and energy companies making a more significant investment.

The group was presented with four goals the energy transition may address. They found that all four were important and "one did not necessarily emerge as an overriding priority". The four goals were:

- ensuring energy is affordable for all households
- increasing the use of low carbon energy sources
- reducing overall energy use in the UK; and
- ensuring a reliable energy supply is continuously available.

These four goals very closely align with our original consumer priorities and also with four of the six long-term outcomes identified by Sustainability First as part of their New Pin[19] research findings. This verifies that our thoughts are robust when understating what consumers expect in the future of energy and our plans are developed with this in mind.

[17] http://www.ukerc.ac.uk/publications/energy-2050-synthesis-report.html
[18] http://www.ukerc.ac.uk/publications/paying-for-energy-transitions.html
[19] https://www.sustainabilityfirst.org.uk/new-pin/new-pin-pubs-sub

How they fit together

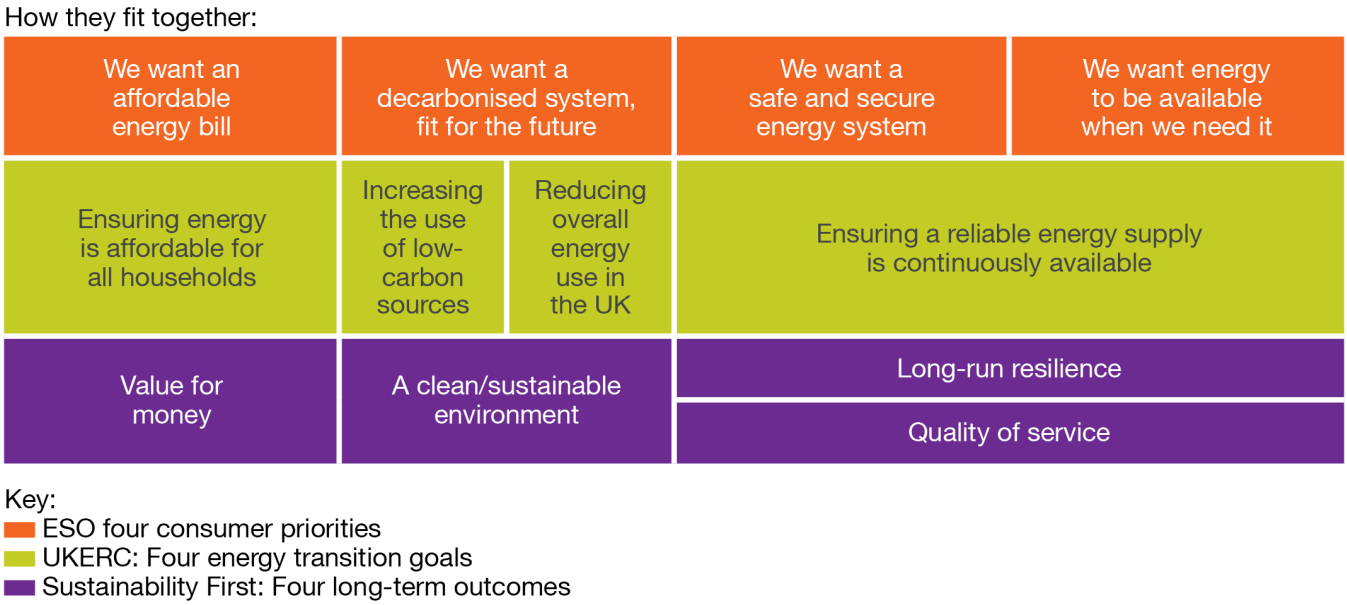


Figure 8

We do know, despite the findings shown above, that a significant proportion of people already struggle to pay their energy and water bills. The New Pin research found in 2015 10 per cent of households in England, 30 per cent in Wales and 39 per cent in Scotland were estimated to be in fuel poverty. In March 2019, as detailed by the BEIS Attitude tracker[20], 30 per cent of a population surveyed across the UK was worried about paying their energy bills.

The report also found the public was most likely to be concerned about steep rises in energy prices in the future (75 per cent), the UK not investing fast enough in alternative sources of energy (69 per cent), and the UK becoming too dependent on energy from other countries (65 per cent). 84 per cent support the use of renewable energy.

For non-domestic consumers, we identified:

- new routes to market should be developed for community energy schemes. System operators should include community energy projects in their flexibility and capacity procurement strategies.
- community energy groups should be invited and supported to participate in local trials for flexibility, demand management, peer-peer trading and other specific services to the grid, like network cost avoidance.
- data from heat maps and grid data is intimidating for communities to use - is it possible to make data more accessible and easier to navigate?
- local authorities and community energy groups were supportive of our ambition to operate a carbon free system as many of their members and customers were concerned about climate change and wanted to see more renewable energy available.
- stakeholders welcomed our proposals to remove barriers from entry to markets and their ability to aggregate their projects up to 1 MW.
- providing further insight to policy recommendations and our data analysis was welcomed with *FES* being mentioned as a useful document they used to enable their business strategy and when engaging with BEIS.

2.5.1. Consumers' willingness to pay

Through our independent survey of consumers, we got a very clear message that reliability and resilience are the highest priority for consumers, both now and in the future. We have drawn on other publicly available information to help us understand further consumers' willingness to pay for their different priorities[21]. The willingness to pay study commissioned by the four GB electricity and gas transmission owners confirmed the relative priorities of the other consumer work as well as placing some values around the priorities. In terms of reducing the risk of power cuts, the analysis suggests that consumers are willing to pay more to reduce the length of an interruption to power supply, which occurs with a 1.5 per cent probability, by one hour and to reduce by a day the duration of a prolonged interruption causing widespread disruption.

[20]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/800429/BEIS_Public_Attitudes_Tracker_-_Wave_29_-_key_findings.pdf

[21]Including the *Estimating Electricity and Gas Transmission Consumers' Willingness to Pay for Changes in Service during RIIO2* report https://www.nationalgridet.com/document/131211/download and UKERC's *Paying for energy transitions* report http://www.ukerc.ac.uk/publications/paying-for-energy-transitions.html

From UKERC's *Paying for energy transitions report,* generally domestic consumers are willing to pay towards the transition to a low carbon, reliable and affordable energy system but believe this is alongside both government and energy companies making a more significant investment.

The report looked at public views on paying for the energy change; and previous UKERC research showed that the assumption people only care about the cheapest possible option was not necessarily correct. The work shows "public understandings of the acceptability of a sustainable system change are affected by a range of personal and social values over and above the cost appearing on their bills."

2.5.2. How are we minimising cost to consumer bills?

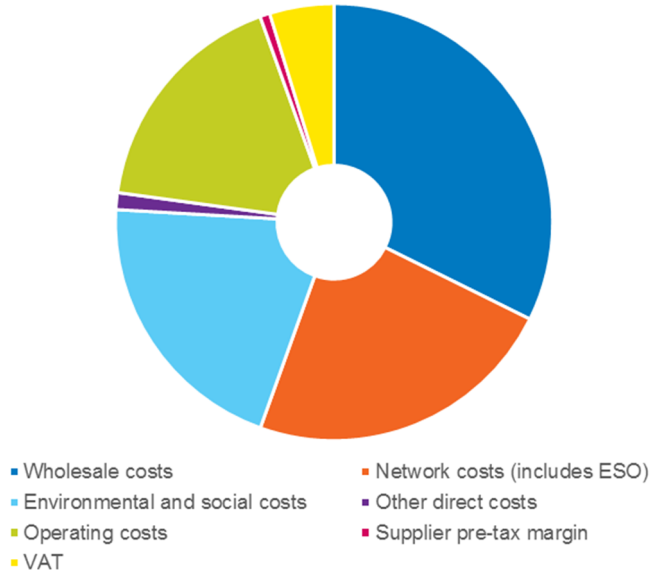


Figure 9

The average GB customer's annual electricity bill is £612 based on Ofgem's latest analysis in August 2019. We estimate that the average UK household will be paying £1.65 on average for the ESO's internal activities during the first two years of RIIO-2 (2018/19 prices). This equates to around 0.3 per cent of the total electricity bill and less than 0.2 per cent of the dual fuel bill. Although this is a slight increase in what consumers currently pay, it is in line with their priorities from a future energy system and our plans will generate around £2 billion worth of benefits over the next five years. In each of the Theme chapters we detail how benefits are realised through our transformational activities. Full details can be found in Annex 2 - CBA report.

2.5.3. How has this influenced our plan?

Within this Business Plan, we have highlighted what consumer and stakeholder priorities have been taken into consideration in the development of our proposals where relevant. Most of our transformational activities provide end consumer benefits and are the main factor of our cost-benefit analysis process.

2.6. Let's keep talking

We need to make sure we understand stakeholders' views on the Business Plan as a whole, as well as parts that stakeholders are seeing for the first time in this version, such as our proposed performance metrics. We will be testing these through an engagement event at the beginning of October and through some existing meetings. Please get in contact via box.RIIO2@nationalgrideso.com if you'd like to talk to us about this directly.

2.6.1. How we will engage going forward

Stakeholder input and feedback has been incredibly important in helping us to develop our RIIO-2 Business Plan to this point. Engagement will continue to be important after we submit the final plan in December and move onto agreeing and then implementing the activities and changes the ESO will take forward in the RIIO-2 period.

2.6.2. Engagement in advance of the RIIO-2 period

After submission of our Business Plan to Ofgem in December we will continue to work with stakeholders as the RIIO-2 process progresses and in preparing to deliver some of the transformational activities set out in this plan. This will include:

1. **Open public hearings** – understanding stakeholders' views on areas of disagreement or contention that are being discussed at Ofgem's open hearings.
2. **Scoping of new activities** – to prepare delivery of many of the new activities at the beginning of the RIIO-2 period we will need to scope them further, with the help of stakeholders. In addition, some of our proposals, such as the Design Authority will be implemented before the RIIO-2 period.

3. Assumptions underpinning our plan

3.1. Efficiency

We are committed to making sure we run our business at an efficient cost to consumers. In RIIO-2 we will deliver a net saving to consumers equivalent to around £3 on each annual bill. Our proposed investment to achieve this saving represents around £1.65 on an annual consumer bill. This equates to around 0.3 per cent of the total electricity bill and less than 0.2 per cent of the dual fuel bill.

In developing this Business Plan, an important component of our efficiency considerations is satisfying ourselves, and stakeholders, that our planned investments will deliver consumer value, and that our choice of solution and delivery approach is efficient. Section 2 of this document, together with Annex 2 – CBA report and Annex 4 – Technology investment report, provide detailed explanation and justification for these aspects.

Our regulatory framework for RIIO-2 is intended to promote efficiency through:

- ex ante Business Plan scrutiny and strong stakeholder input at all stages of plan development, ensuring that our proposals are robust and will deliver the outputs that stakeholder want.
- a two-year budget cycle. This will give us the opportunity to incorporate any further efficiency opportunities gained in the first two years of RIIO-1 into our Business Plan for the period starting in 2023/24.
- pass-through funding, which will enable any reductions in spending, compared with Business Plan forecasts, to be fully passed on to consumers.
- our incentive scheme, which should recognise and reward efficiencies in delivering Business Plan outputs, or indeed where further outputs or benefits have been delivered for no extra cost.

For more information on our regulatory framework, please see chapter 10.

In this section, we focus on unit cost efficiency. We explain how we have challenged every element of our proposed RIIO-2 spending to ensure they are efficient and will remain so over the period. This includes cross-industry and international benchmarking, and quantifying efficiencies made in RIIO-11 that will continue to deliver benefits in RIIO-2.

3.1.1. What does efficiency look like for the ESO?

Efficiency is measured through the quantity of input resources (people, time, materials) needed to achieve an outcome. The relative efficiency of similar companies can be assessed by looking at the ratio of outputs to inputs for each company being assessed. A company is at the efficiency frontier when it is using optimal levels of input resources to achieve a defined outcome.

3.1.2. Whole company benchmarking

We conducted an international benchmarking exercise to examine the ESO's overall costs compared to other system operators. We looked at costs in relation to:

- population served – accounting for population differences, the results are presented in per capita units.
- network service – adjusting for the kilometres of networks the organisation oversees.

We identified a short list of comparator organisations and extracted cost information from financial reports to generate high-level cost benchmarks. We excluded some ESO-specific costs to improve comparability. We then applied various adjustments to ensure consistent comparisons between geographies and different years. Finally, we adjusted and normalised the metrics to benchmark against ESO cost information.

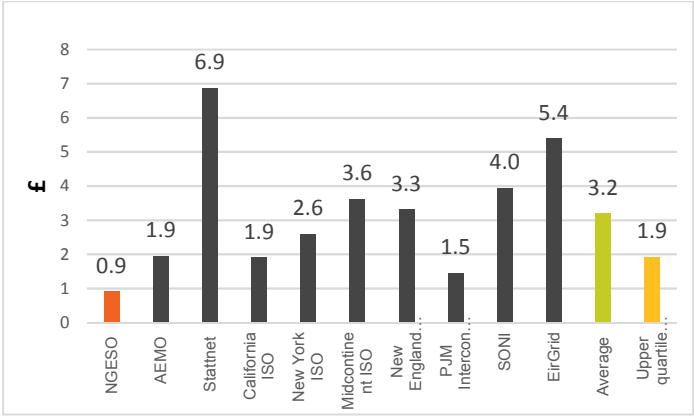


Figure 10: High-level benchmarking – direct operating costs per capita (£ 2018 prices)

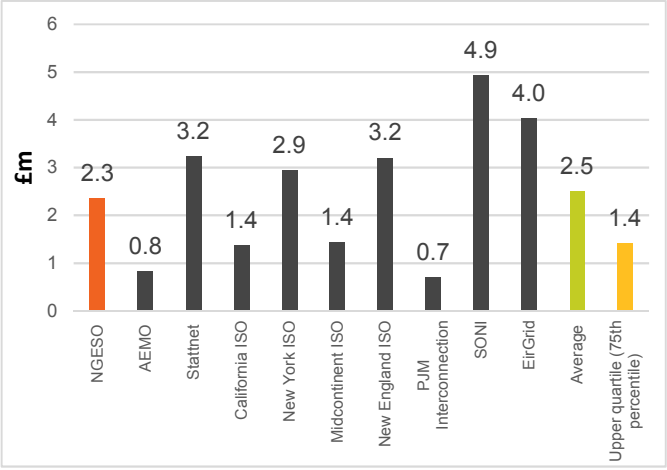


Figure 11: High-level benchmarking – direct operating costs per 1000 km of network (£ million, 2018 prices)

The initial results show the ESO's costs are below the average against both measures.

We also conducted some high-level benchmarking of cost trends, using historical adjusted (but not normalised) cost trends versus the comparator companies. The costs are expressed in 2018 prices, using the retail price index (RPI).

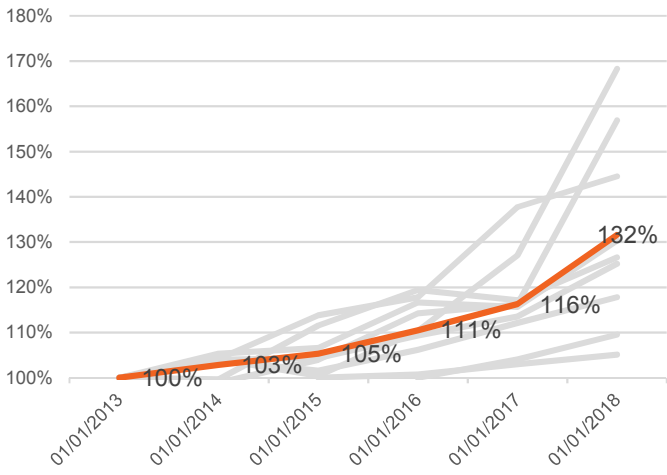


Figure 12: Historic real costs index (RPI inflation adjusted)[22]

The bold line on the graph shows average increasing real costs through the period 2015 to 2018, with the grey lines showing individual organisations.

Reviews of the commentary in the accounts and financial statements of the companies we surveyed suggest the main reason for the rise is that organisations are seeing a transformation in the energy market – and an associated increase in complexity in managing the electricity systems. We have reviewed these trends and how they are accounted for in our Business Plan in section 5.1-5.3.

The challenges are also recognised by other system operators. For example, the Australian energy market operator AEMO[23], in its final budget and fees report, notes "the changing energy environment is resulting in additional resources and investment being needed to manage: increased complexities of managing the grid day by day".

The AEMO also states that "labour increase includes increases in resources along with a provision for ongoing resources to manage the increasing complexity of our work. Consulting costs are higher in 2018/19 … and include specialist advice and support relating to modernising our markets and managing the complexities of the grid".[24]

Please see Annex 1D for more details of the methodology and assumptions behind this benchmarking.

3.1.3. Activity benchmarking and incorporation of RIIO-1 efficiencies

Organisation-level benchmarking cannot provide a perfect assessment of cost efficiency. The direct comparability of costs and factors driving those costs is often limited.

We have conducted international and cross-sector benchmarking to ensure that our proposed spending is efficient.

As well as the high-level review of our overall costs in relation to other system operators, we have therefore conducted a more detailed challenge of our proposed £250 million annual costs and activities.

We have broken them down into different categories depending on the most appropriate way to challenge these costs for efficiency. This allows us to identify costs that lend themselves more easily to benchmarking because equivalent activities and functions exist in other companies or sectors.

We have also identified areas where the efficiency improvements we made in RIIO-1 have reduced our proposed spending in RIIO-2. Through our benchmarking and the efficiencies that we have embedded from RIIO-1, we believe that this Business Plan represents an efficient level of costs.

The categories are:

1. **Ongoing activities delivered more efficiently**.
   a. **£69 million direct operating costs for ongoing activities.** These are subject to £7 million

[22] Note: the analysis presented above does not control for any normalisation factors such as the varying levels of complexity across various networks.

[23] AEMO Electricity Final Budget and Fees 2018/19, https://www.aemo.com.au/-/media/Files/Electricity/NEM/Participant_Information/Fees/2018/Final-AEMO-Electricity-Final-Budget-and-Fees-2018-19.pdf page 2

[24] AEMO Electricity Final Budget and Fees 2018/19, page 6

embedded efficiency savings in our proposed costs for the ongoing services we have delivered in RIIO-1 and will continue to deliver in RIIO-2. These reflect the efficiency gains from process streamlining, automation and offshoring that we invested in over RIIO-1 (see case study). Where activity costs have gone up, we have set out the external drivers that have led to this increase. In RIIO-2 we commit to a further **1 per cent efficiency stretch target** on these costs to ensure we remain at the efficiency frontier. More details about the frontier are below.

b. **£18 million shared service costs.** These have been benchmarked for efficiency using cross-sector data. This benchmarking showed that our forecast costs for RIIO-2 are equivalent to the most efficient companies, after adjusting for costs of being a regulated network and the additional security measures we take to protect our operations from threat. For more details please see chapter 13. In RIIO-2 we commit to a further **1 per cent efficiency stretch target** on these costs to ensure we remain at the efficiency frontier.

c. **£103 million ongoing IT costs** to run and grow our core services and ensure appropriate levels of cyber security. These were subject to a detailed, cross-sector benchmarking study by Gartner. We conducted a further review of these costs with our Application Development and Maintenance Partners. As a result, we are confident that our proposed IT costs are efficient. For more details please see chapter 11.

2. Efficient levels of new and transformational investment.

a. **£60 million proposed investment in new and transformational outputs** has been subject to cost-benefit analysis to assess the consumer benefit case for this investment, and which options should be taken forward. All proposed new capital expenditure has been benchmarked for efficiency by Gartner and our Application Development partners, as above.

We have also benchmarked the staff costs that underpin most of our operational costs, to show they are efficient. Our aim is to be at the market median position in relation to our comparator group. The last review, conducted in 2018, showed that total cash remuneration is in line with median pay for a comparator of 130 entities in the utilities, oil and gas, and chemical sectors, with an average comparison ratio of 101 per cent. For more information, see chapter 15.

All of the proposed investment in this Business Plan have been benchmarked and/or subject to efficiency savings and an efficiency stretch target.

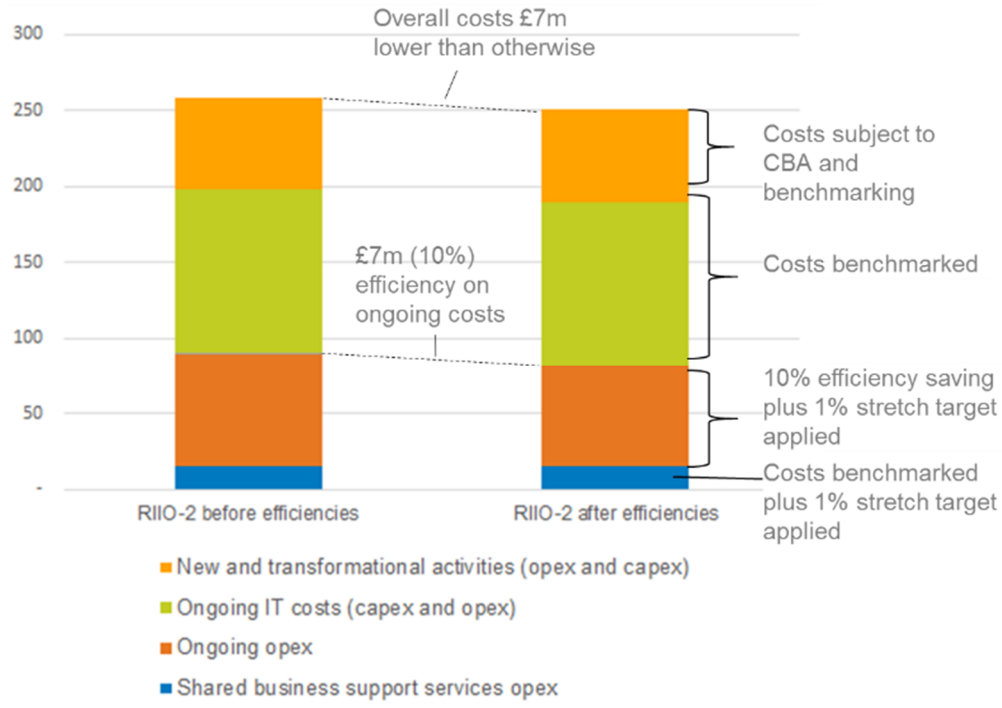


Figure 13 Average annual proposed investment, before and after efficiencies

Case study: system modelling and customer data transformation

In RIIO-1 we explored efficiency through assessing the benefits of outsourcing processes the ESO undertakes to create electricity system models to an offshore supplier.

We identified two key processes in data collection, manipulation and technical analysis that could be undertaken by a specialist offshore team. These were then moved offshore.

The benefits that can be achieved through this approach include cost savings, or an uplift in capacity, capability and effectiveness, depending on the needs of the process. The modelled cost savings from this approach are reflected in our proposed costs for RIIO-2.

We have also identified improvements in effectiveness. These include automating the validation of TO data submissions, reducing the turn-around time from days to minutes, enabling quicker problem resolution, increased confidence in the quality of the output. As a result, the onshore team is able to focus on higher-value, transformational activities. These benefits are embedded in our proposals for RIIO-2 and will help to improve the capability of our business to deliver the ambitious outputs that stakeholders want.

3.1.4. Frontier shift and efficiency stretch target

Frontier shift happens where the unit costs of an efficient company change over time – the frontier of possible outputs from a given set of inputs changes. If a company has become more efficient, the frontier will move outwards showing that more outputs can be produced for the same level of inputs.

Through our benchmarking and the efficiencies, we have embedded from RIIO-1, we believe that this Business Plan represents an efficient level of costs. To ensure we remain at the frontier throughout RIIO-2, we are investing in innovation and process improvement to achieve a step change in our ability to deliver value for consumers.

- Building on our system modelling and customer data transformation project (see case study), we are increasing capability via offshoring, enabling us to access larger pools of engineering services capability through a supply-chain contract with Accenture.
- To achieve the ambitious outputs in our Business Plan we will use this approach to deliver more robust process control and monitoring of supplier performance for the processes that are offshored. This will contribute to improved reliability of our system and a more agile response to changing demand. As this partnership matures Accenture will be incentivised to challenge our thinking on how we deliver services and provide us with access to market-leading digital solutions at scale. This will deliver more value and performance enhancements.
- We have invested in innovation projects that will enhance performance and may have potential to reduce operating costs. Many of the benefits from our innovation activity are positive for the wider industry or consumers in the form of reduced balancing costs, rather than reductions in the ESO's internal costs. For example, our RIIO-1 Samuel Inertia Element project, which aimed to reduce balancing costs associated with inaccuracies in estimating inertia, will deliver £6 to 10 million of savings for consumers per year.[25] Where innovation has contributed to the proposals in this plan, we provide detail in section 2 of this document.
- Our 1 per cent efficiency stretch target compares well with the EU Capital (K), Labour (L), Energy (E), Materials (M) and Services (S) (EU KLEMS) productivity data[26] for the UK. This data shows that industries in a broadly comparable range of sectors[27] from 1999 to 2016 delivered an average of 0.87 per cent productivity growth over the period. We have applied this stretch target to our ongoing and shared services operational costs as these are more likely to consist of repeatable, known processes that can benefit from more efficient ways of working.

[25] Please see chapter 13 for more details, and https://www.smarternetworks.org/project/NIA_NGET0052

[26] http://www.euklems.net/. This database has been used previously in other regulatory reviews and it includes data for a number of industry sectors including electricity, gas and water supply.

[27] manufacturing, machinery & equipment, electricity gas & water supply, construction, chemicals, transportation & storage, maintenance of motor vehicles and professional, scientific, technical administrative and support service activities

3.2. Scenarios

The energy landscape in 2030 will be significantly different to today. The scale and pace of this transition is accelerating, notwithstanding that policy, technology and society are challenging to predict.

While a single, 'best view' of the energy landscape 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 credible 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 ESO Business Plan is based on our *Future Energy Scenarios (FES) 2019*[28], which meets these criteria through its large and collaborative stakeholder development process, and by providing a view across fuels, networks and sectors. It is also used widely by the ESO and stakeholders for a range of purposes. The key messages from *FES 2019* are:

- Reaching net zero carbon emissions by 2050 is achievable. However, this requires immediate action across all key technologies and policy areas. Over the RIIO-2 period, our work in upgrading our control centre systems (Theme 1) and opening markets for all technologies to participate (Theme 2) will be crucial for achieving this.
- Heat decarbonisation pathways are uncertain and vary by region. However, there are clear, urgent, no-regrets actions that can remove barriers to deploying solutions at scale. Over the RIIO-2 period, our proposals enable us to facilitate whole system and cross-vector solutions, for example through leading the debate (Theme 4).
- Electric vehicles (EVs) can help decarbonise both transport and electricity supply for Great Britain. The market needs to align vehicle charging behaviour to complement renewable generation and system needs. Our proposals in Theme 1 and Theme 2 will help to enable the smart, flexible system with new business models and charging requirements.
- A whole system view across electricity, gas, heat and transport underpins a sustainable energy transformation. Widespread digitisation and sharing of data is fundamental to harnessing the interactions between these changing systems. By enhancing competition in the provision of services (Theme 3) and thinking in a whole system way (Theme 4), we will drive a sustainable energy future. Our work on open data will mean information is presumed shared and free for all.

We have used the scenarios in *FES 2019*:

- to inform our understanding of the changing energy landscape that we need to address in developing our proposals; identifying the key drivers of change over the RIIO-2 period and testing these with stakeholders.
- to develop a 10-year vision of the key impacts that change will have on the energy system and how we are preparing to manage them.
- to provide data for use in the cost-benefit analysis – for example, on carbon intensity when calculating the benefit of our activities in reducing environmental damage.

Key drivers of change

- Decarbonisation of electricity supply
- Decentralisation
- Digitisation and 'big data'
- Policy and governance
- Electric vehicles (EVs) and the decarbonisation of transport
- Storage
- Consumer behaviour
- Decarbonisation of heat
- Demand-side response

[28] http://fes.nationalgrid.com/fes-document/

3.2.1. ENA common view

In September 2018, Ofgem's RIIO-2 Challenge Group requested a consistent view of the future across the RIIO-regulated companies. In response, all of these businesses, including the ESO, came together at a new Scenarios and Forecasting Working Group, coordinated by the Energy Networks Association (ENA), in October 2018. The group has produced a report, with an annex of detailed assumptions, which addresses this request from Ofgem. An independent review accompanies the report from the ESO's Energy Analysis team. The main element of the work is a set of consistent assumptions across the RIIO-regulated companies, for use in their business plans. We refer to this work as the *ENA common view*[29].

To further ensure consistency across RIIO-2 business plans, Ofgem issued guidance to the other RIIO-regulated companies. It stated that they should "design their baseline revenues around parameters which are no greater than the lowest point of the ranges provided in the ENA Scenario and Forecasting Working Group report, and ensure that their plans can flex."

While this guidance was not specifically for the ESO, we believe that consistency across networks and fuels is essential to fully understand the whole energy system. As such, we will consider the view from *FES 2019* that is no greater than the lowest ENA common view range to enable our plan to flex. We will also consider scenarios that support our ambitions, in particular around carbon free system operation.

3.3. How we will manage uncertainty

As the energy landscape is constantly evolving, we need a robust process to manage changes and update our activities as appropriate. Our regulatory framework has been designed to enable this in two ways:

- our Business Plan focuses on our activities for the first two years of RIIO-2, in the context of the five-year strategy and 10-year vision. In subsequent two-year cycles, we will review the energy landscape as we update our proposed costs and activities.
- pass-through funding for our costs gives us the flexibility to adjust our spending within two-year Business Plan cycles, as we respond to changes in the energy landscape and/or stakeholder needs.

We therefore do not have formal uncertainty mechanisms as part of our regulatory framework. However, the ESO may use reopeners for cyber and physical security investments, in line with the other RIIO-regulated companies.

In addition to the above, we consider uncertainty in our plan as follows:

- the energy landscape assumptions, which underpin our plan, can be found in Annex 1 Section D. These also show, at a high-level, how the activity, timeline, cost and benefit could potentially change if the assumption does not bear out.
- the delivery confidence section, below, highlights the main risks to delivery of the whole Business Plan and their mitigations.
- we have included risks and mitigations for the specific activities in Annex 2 - CBA report.
- our CBA includes market, delivery and third-party sensitivities to give a range of potential benefits. The CBA will be updated with each two-year forecast of costs and activities.
- the Annex 2 - CBA report also explains where we have explicitly or implicitly used a range of *FES* scenarios. For example, in forecasts of constraint costs.

3.4. Our ten-year vision

The *FES* sets out four potential futures to 2050. No one pathway is expected to dominate necessarily, but they are designed to capture a credible range of outcomes that will impact the energy system. Looking out over 10 years to 2030, the scenarios tell us a number of things.

[29] http://www.energynetworks.org/assets/files/ENA%20Common%20RIIO2%20Scenario%20report%20-%20March%202019%20FINAL.pdf

3.4.1. Key changes and uncertainties to 2030

There will be a significant change in the types of demand and generation using the energy system. *FES 19* indicates that the biggest impacts are likely to come from the following:

Technology	Change from now to 2030 (*FES* assumptions)	ENA common view	Commentary
Electric Vehicles	Large increase from 150k today to between 2.3 million and 12 million	10.1 million -10.6 million	Large range, indicating uncertainty, but technology and policy direction suggests high end of range
Interconnectors	Large increase from 4 GW today to between 12 GW and 20 GW	15 GW-16.5 GW	Large range reflecting project risk, but minimum backed by cap and floor, and projects under construction
Transmission-connected gas generation	No change to large decrease. From 31.1 GW today to between 9.7 GW and 33.3 GW	20 GW-33 GW	Economic pressure suggests reduction most likely, as other sources of supply, such as wind and interconnectors, take market share
Offshore wind	Large increase from 8.5 GW today to between 20.9 GW and 33.6 GW	25.1 GW- 29.1 GW	High growth expected due to sector deal of 30 GW by 2030 and falling costs – Sept 2019 Contract for difference (CfD) results of <£40/MWh
Distributed generation – contribution to peak demand	Large increase from 9.4 GW today to between 12.9 GW and 26.2 GW	n/a	Charging Reviews likely to have an impact in the shorter term, but growth likely due to falling costs of solar and onshore wind and gas peaking plant displacing combined cycle gas turbine (CCGT)
Distributed generation – installed capacity	Large increase from 30.9 GW today to between 38 GW and 70.3 GW	42.9 GW-53.7 GW (est)	Charging Reviews likely to have an impact in the shorter term, but growth likely due to falling costs of solar and onshore wind and gas peaking plant displacing CCGT
Electricity storage	Large increase from 4 GW today to between 7 GW and 13 GW	5.9 GW-9 GW	Increasing levels of intermittency from renewables, tightening environmental restrictions on gas peakers and falling costs expected to strengthen storage business cases
Carbon intensity of electricity (gCO_2/kWh)	Large decrease from 248 gCO2/KWh to between 112.7 gCO2/KWh and 24.9 gCO2/KWh	n/a	High uncertainty dependent on delivery of low carbon supply above.

Figure 14 Key changes and uncertainties to 2030

3.4.2. Net zero

Two of the scenarios (Two Degrees and Community Renewables) meet an eighty per cent reduction in carbon dioxide (CO2) emissions target by 2050 and two (Consumer Evolution and Steady Progression) fail to meet that target. The UK government has since tightened the 2050 target to net zero CO2 emissions. It is likely that new policy and support will be put in place to achieve this aim, therefore we would expect that by 2030 the electricity system would be closer to Two Degrees and Community Renewables than the other two scenarios.

3.4.3. An example of how the scenarios reflect uncertainty – focus on offshore wind

There are 40 GW of known projects under development, with varying degrees of certainty. The September 2019 CfD round means that 18.7GW is either built, under construction or has a CfD. The FES19 range reflects the uncertainty with the lower end including those plus some consented projects and the upper end over shooting the sector deal target assuming costs continue to fall and some projects will get built without CfD

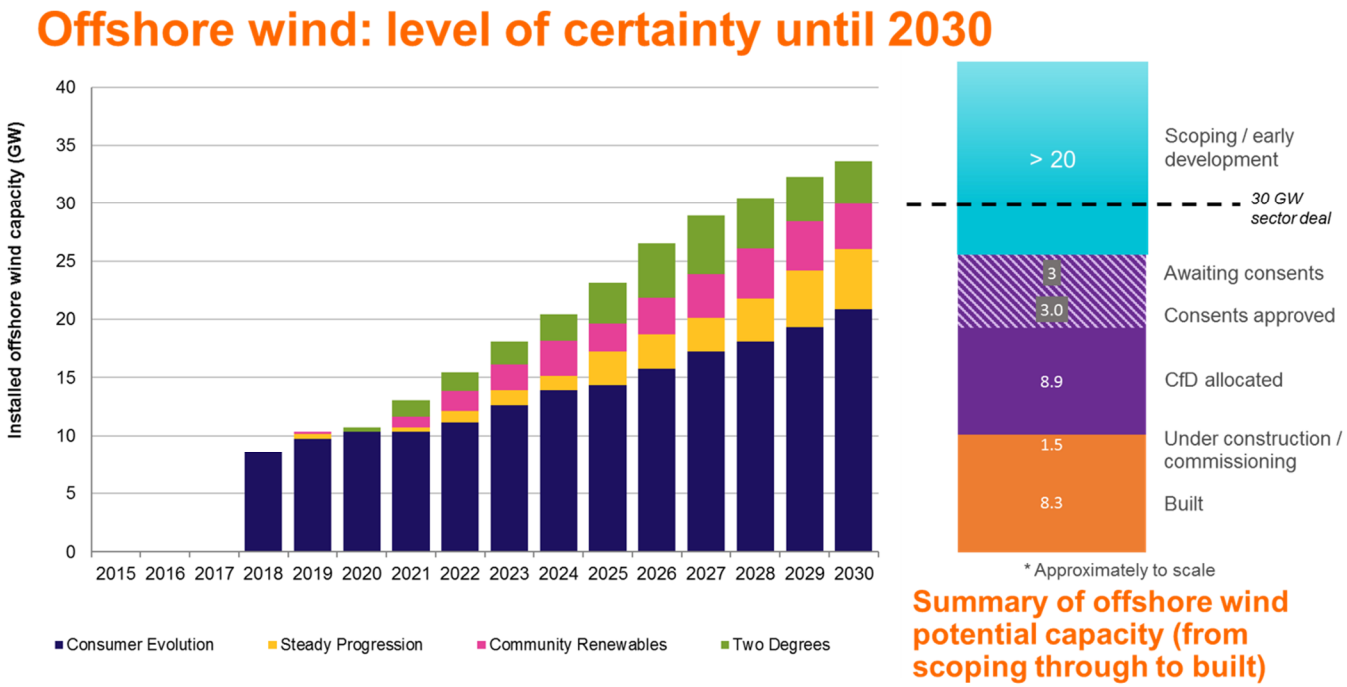


Figure 15 Offshore wind: level of certainty until 2030 per FES 19

3.4.4. How does this change the energy system?

From these changing supply and demand patterns, a number of issues emerge that the ESO and the energy system needs to respond to.

Correlated behaviour by technology

- Wind and solar will correlate (separately) with different types of weather. For example, there will be greater variability of generation as large volumes of wind or solar assets change output in line with the weather.
- interconnectors are mostly connected to the same continental market, so prices, flows and issues will be correlated.
- EVs and other smart technology may all move at the same time, as they respond to the same price signal.

Geographical clustering of generation types

The same technologies tend to establish themselves in similar locations due to the natural resources that exist there. For example:

offshore wind	predominantly north and east coast
solar	south and south-west
interconnectors	predominantly south-east coast

The clustering and correlated behaviour will also compound each other. As the impact of weather patterns drives more variability in renewable output – which are all concentrated in one area of the network – this will impact the energy balance and requirements for system services in that location.

Shifting types of electricity resource

The type of supply source will also change dramatically. This will impact how the energy system is managed and secured.

Historic electricity resources	Future electricity resources
Large supply sources fairly spread over the middle of the country	Large supply sources at the edges of the country and millions of very small sources at distribution level and below
Synchronous (well-understood performance)	Asynchronous (performance is specific to the manufacturer and lacks the inherent capability to provide system inertia)
Dispatchable (high volumes of flexibility)	Intermittent (the need for flexibility increases as traditional sources shrink)

New Operability challenges

The chart below (figure 16) is an example of how the shape of demand may change in 2030 and how it affects operability. It shows the impact of solar generation on the demand curve on a summers day. There are three challenges shown here and reflected in the chart:

a) when transmission demand falls below 10 GW -15 GW it becomes increasingly difficult to manage the system with current tools.

b) 3.5 GW is the minimum output expected from inflexible generation, below that it would have to be constrained or stored.

c) the rate of change of demand between 14:30hrs and 20:30hrs would require more and new flexibility tools to manage.

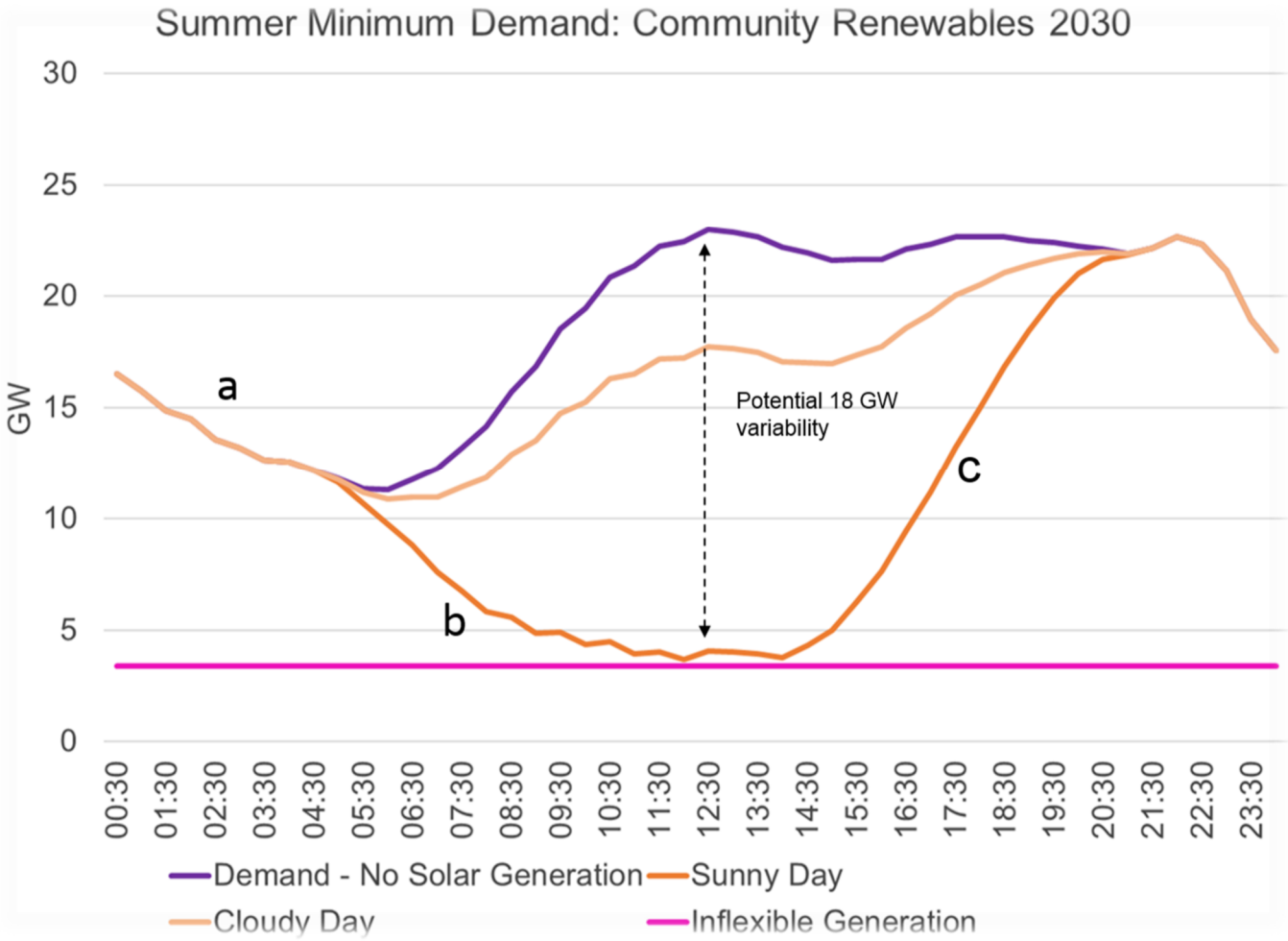


Figure 16 Summer minimum demand: Community Renewables 2030

3.4.5. What does this mean for the ESO?

Operational and market challenges will increase as the energy system evolves. These are likely to include greater variability in where the power – both active and reactive – is coming from. For example:

- large supply sources are at the edges of the country and driven by the weather or the behaviour of continental markets.
- large volumes of supply could swing from the north-east, to the south-east, to the south-west across the day.
- there will be large transmission capacity requirements and fast ramp rates.
- more local constraints, due to clustering and more active distribution networks.
- changing market dynamics due to local energy and peer to peer trading.
- changing market dynamics due to greater interconnection with other markets.
- challenging outage management because seasonal patterns and smart networks mean there is now no quiet summer window.
- lower system inertia will require more tools to cope with supply losses
- system restoration would need new services from different providers – and greater resilience – as we rely less on existing providers.

From today – and over the next 10 years – the ESO is experiencing a paradigm shift:

- **from** designing a network to meet the peak
- **to** peak being just one of a set of challenging periods that the system needs to be designed and operated for.

3.5. Delivery confidence

Through the development of our Business Plan for RIIO-2 we have identified a set of key risks to its successful delivery. Within the plan, we have addressed our approach to managing and mitigating these risks. The risks identified are at a high level to cover delivery of the whole Business Plan. Specific delivery risks are identified in Annex 2 CBA report.

We recognise the complexity and volume of change that we are proposing to deliver in our Business Plan and we want to ensure that we deliver a high quality and co-ordinated output that is owned and led by the ESO. We will bring together the elements required to deliver a sustainable programme of change covering IT, process, people and culture and organisational design. Following stakeholder feedback we are refining our proposals to ensure the most effective method of delivery. Further details will be included in our final Business Plan in December.

3.5.1. Ability to source the right level of capability to deliver our Business Plan

Our Business Plan is ambitious and with that ambition we require both an increased number of people in the business and a more diverse, specialist range of capabilities.

Our employee numbers increase between RIIO-1 and RIIO-2 to enable the delivery of our ambitions and will require a recruitment drive. We will create a compelling value proposition to attract the best talent available, focusing on creating an inclusive and diverse workforce with fair and benchmarked pay and reward. We will source talent through a blended mix of 'growing our own', recruiting specialists and hiring contractors so we have the right capability mix during RIIO. Our people and capability chapter describes this in more detail.

3.5.2. Investing in our IT portfolio

We need to invest in our IT systems to achieve our ambitions and deliver what stakeholders want from us. Several key IT systems will reach the end of their usable life during RIIO-2. The investment required to meet our ambitions and the value of our IT investment has grown from RIIO-1.

This investment is significant. To make sure we are can increase the IT portfolio effectively, we will take a modular approach to our IT solutions, deploying modules incrementally throughout RIIO-2. This will ensure that solutions are fit for purpose and flexible to energy industry needs.

We will also use a range of delivery models to remain cost efficient. We will create an internal delivery body, led by a business programme director, to augment the key skills across the ESO, IT and those of our framework partners and vendors.

To achieve the right outcomes at the right time, we are introducing the Design Authority at the heart of ESO business. For more information, please see chapter 4.

We are also working with the support of our major IT partners and using external sector case studies to plan a successful delivery strategy. We're adopting lessons learnt from other business that have transformed, including Transport for London and Red Bull Racing.

More detail on our delivery approach for RIIO-2 can be found in our Annex 4 – Technology investment report.

3.5.3. How we finance the increased size and scope of our future ESO business

We are continuing to review the delivery of our plan following Ofgem's August funding model decision and financial methodology consultation for the ESO. To finance the growth in investment in this Business Plan, we will need to rely more heavily on support from equity investors. We will continue to consider the effects of this as we develop our plan for December.

3.5.4. Ensuring our activities deliver the ambitions that stakeholders have for us

We have approached the development of our Business Plan from both a top-down and bottom-up perspective. Throughout 2018 we engaged extensively to understand the priorities of our stakeholders, customers and consumers. In early 2019 we used those priorities to shape our ambitions for 2030 that set out our strategic direction. This was published in April. Working with our leaders and teams across the ESO, we then mapped out our requirements to be delivered during RIIO-2 period and build a robust set of proposals. We then tested and refined these proposals with our external stakeholders through formal events and bilateral meetings, so our proposals were fit for purpose and aligned to the future needs of the energy industry.

3.5.5. Aligning with industry and collaboration

We have acted upon the feedback of our stakeholders, refining and improving our proposals. Where we have made proposals that also require the active participation of wider industry for delivery, we have held specific stakeholder engagement events to gauge the warmth of stakeholders to our proposals. We have set out in Annex 3 -Stakeholder report how we have approached co-creation and the feedback that we have received.

3.5.6. Identifying our future IT requirements and scoping the right solutions

We have built our IT proposals based upon the ESO ambitions that we have targeted by 2030, the changes and trends that we have observed in the energy industry and how fit for the future our current architecture is. These factors plus additional external drivers and technology availability have led us to identify and propose the suite of IT solutions in our Business Plan. Where possible we have identified a range of options and tested our proposals with both industry stakeholders and external IT delivery providers.

Part 2
Our proposals

Theme 1

Ensure reliable, secure system operation to deliver electricity when customers need it

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

What this Theme covers

What we need to do to be able to operate a carbon free system in 2025 and beyond while continuing to ensure a safe and reliable supply of electricity that underpins the UK economy.

What we propose to do

Developing new control centre balancing and network control capabilities in an agile and modular fashion using digital twin technology and a stakeholder design authority to inform the development of these. In parallel, we will ensure we have the right training, simulation and restoration procedures for operating a carbon free system.

What our Stakeholders have told us

Stakeholders have welcomed our ambition but want to know what steps we will take to achieve it. They want us to deliver new system capability in an agile, transparent manner with cross industry representation on our design authority. They would like further information on our digital twin proposal.

What are the key benefits?

New balancing and control tools will enable the ESO to unlock the benefits of new markets and technologies in providing flexibility services, minimising bills for consumers. It will ensure system safety and reliability by ensuring we have the right tools to handle an increasingly complex operating environment.

4. Theme 1: Ensure reliable, secure system operation to deliver electricity when consumers need it

Theme 1 delivers £254 million of consumer benefits[30] Investment[31] for this Theme (2 year): £131.6 million

4.1. Five-year strategy

We aim to be able to operate a carbon free system in 2025 and beyond. Our five-year strategy focuses on what we need to do to deliver this goal, while continuing to ensure a safe and reliable supply of electricity that underpins the UK economy, which is worth over £2.3 trillion[32].

Achieving the UK's net zero target is likely to require significant periods of carbon free operation. Our plan enables this by:

- building the tools and systems we need to operate a carbon free system
- training our control centre engineers to operate a carbon free system
- ensuring we can restore a carbon free system, should the need ever arise.

This is a foundation of enabling the UK to achieve net zero emissions by 2050, as well as unlocking the significant economic and environmental benefits that a decarbonised economy brings[33]. This strategy will also reduce the costs of operating the system all year round.

The changes in the energy landscape over RIIO-1 have increased the operational challenges our control centre faces every day.

In spring 2019 we operated the system for a fortnight with no coal generation for the first time and managed a new peak solar generation record of 9.55 GW. We have also dealt with new operability challenges such as the impact of decreasing system inertia and reduced levels of synchronous generation.

"This is where we would want you to be" [on our ability to operate a zero carbon system ambition]
Trade Association body

Operating the system will become even more complex over the RIIO-2 period. Significant investment is required to manage a system with more intermittent generation from a range of new low carbon technologies and services, much connected at the distribution level where it is less visible to us. Distribution-connected generation capacity has increased by 80 per cent since 2013.[34]

"We commend the ESO on their zero carbon ambition"
House of Commons Science and Technology Committee

Our control centre engineers will need to make more decisions in an increasingly unpredictable environment. Meanwhile, society will be increasingly reliant on electricity, with heat, transport, lighting, communication and medical systems all needing a reliable supply, changing expectations of system restoration.

Our proposals in Theme 1 are the foundation for all our other proposals. Many of the benefits articulated in the other Theme chapters can only be realised if we

[30] Consumer benefits are the net present value (NPV) of Theme 1's transformational activities over the RIIO-2 period. Our analysis suggested that accounting for market, delivery and third-party uncertainty the net present value could credibly be between £58 million and £500 million
[31] The ESO will generate a net saving for consumers in RIIO-2. The proposed investment in this chapter will help to deliver this net saving
[32] World Bank: https://data.worldbank.org/country/united-kingdom. Based on exchange rates as of 22 August 2019.
[33] Committee on Climate Change: Net-zero – the UK's contribution to stopping global warming https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-The-UKs-contribution-to-stopping-global-warming.pdf
[34] BEIS: Digest of UK Energy Statistics – Table 5.12 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/826562/DUKES_5.12.xls
[35] House of Commons Science and Technology Committee: Clean Growth: Technologies for meeting the UK's emissions reduction targets https://publications.parliament.uk/pa/cm201719/cmselect/cmsctech/1454/145412.htm

significantly upgrade our control centre systems and environment.

By improving our balancing and control tools, we unlock the benefits of new markets delivered in Theme 2, of competition in Theme 3 and whole system thinking in Theme 4.

To meet these challenges and realise our ambition, transformation is needed. Supported by stakeholders, our five-year strategy involves:

- transforming our **control centre architecture and systems**, developing **enhanced balancing** capability and **transforming network control**. We will do this in an agile and modular way by reengineering our **control centre architecture**.
- upgrading our **control centre training and simulation** capabilities, by **enhancing training material**, upgrading our **training simulation and technology** and through updated **workforce and change management tools.**
- evolving our **restoration** procedures to ensure they meet the expectations of consumers in a highly-electrified world, by ensuring we are compliant with the **new restoration standard**, building on our **Distributed Energy NIC project**[36].

As a result, of our proposals, market participants will have increased confidence and transparency of our decision-making and will be able to provide services to us regardless of their size or connection type. We will be able to operate the system carbon free, in a safe and reliable way, minimising bills for consumers.

The graph below shows our proposed capex, opex and FTE[37] numbers. The proposed investment is profiled in line with the capabilities we will be developing and delivering in a modular fashion, and thus is largest towards the middle of the RIIO-2 period. Details on how we have incorporated efficiency assumptions and benchmarked these costs are in chapter 4.

The ERSG supports Theme 1.

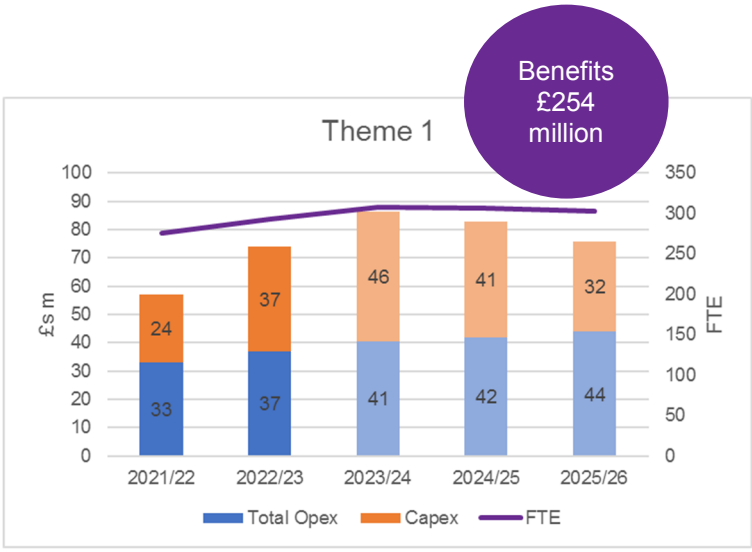


Figure 17

The main benefits for the RIIO-2 period under this Theme are:

- £158 million of benefits from a 5 per cent improvement in managing constraints and a 2 per cent improvement in managing response and reserve through a combination of improved situational awareness tools and improved training capabilities
- Unlocking additional benefits through our residual balancer role:
  - £52 million from our control centre architecture and systems investments and resulting reduced carbon intensity (impact of the difference between our Steady Progression scenario and Two Degrees scenario)
  - £35 million from unlocking 2 per cent of estimated benefits from greater interconnection by upgrading our tools to better handle greater levels of interconnection[38]
  - £104 million from unlocking 1 per cent of flexibility benefits, through the ability to dispatch large amounts of DER, resulting in lower consumer bills than would have otherwise been the case.[39]
  - £5 million in efficiencies realised through updating our shift patterns and working arrangements in our control centres

[36] *Black Start from DER* is a project we are undertaking in conjunction with Scottish Power Energy Networks and TNEI, and is funded through the Network Innovation Competition. The project aims to demonstrate a world first – coordinating a number of DER to provide a safe and effective restoration service. More details are available at: https://www.ofgem.gov.uk/system/files/docs/2018/11/redacted_electricity_nic_submission_2018_esoen01_v03.pdf

[37] FTE= full time equivalent

[38] Analysis from National Grid Ventures demonstrates there is £11bn in consumer benefit over 25 years from greater interconnection https://www.nationalgrid.com/sites/default/files/documents/P2270%20Connecting%20for%20a%20smarter%20future%20final%20med%20res.pdf

[39] Proprietary analysis based on the Committee on Climate Change: Roadmap for Flexibility Services to 2030 report https://www.theccc.org.uk/wp-content/uploads/2017/06/Roadmap-for-flexibility-services-to-2030-Poyry-and-Imperial-College-London.pdf. For more details, please refer to the Cost-benefit analysis report

For more details, refer to the Cost-benefit Analysis report.

We will focus on consumer priorities:

- An affordable energy bill:
  - Unlocking the benefits of increased participation and competition in balancing and ancillary markets, delivered in Theme 2, by being able to monitor, schedule and dispatch a greater number of market participants
  - Improving our real time balancing and control tools, meaning we will better understand the operational situation and run the system more efficiently.
- Energy available when needed:
  - developing a better understanding of the operational limits of the system
  - quicker restoration, in line with acceptable stakeholder timescales, will follow from implementing our restoration decision-making tool
- A decarbonised energy system, fit for the future through:
  - being able to schedule and dispatch the new low carbon technologies and services of the future
  - control centre engineers being able to better operate the decarbonised and decentralised energy system of the future, through enhanced training and simulation
  - wider service diversity resulting in less need to maintain readiness (warmth) of thermal plants
- Safe and secure energy system through:
  - better trained control centre engineers, leading to improved operational decision-making from enhanced training and simulators
  - a level playing field with new parties able to participate in restoration, leading to more diversity in restoration providers, giving the ESO more options for system restoration
  - growing a resilient workforce, promoting STEM and developing talent across the whole electricity system, by partnering with universities and industry.

Stakeholder feedback on our 2025 carbon free ambition

Stakeholders were universally supportive of our 2025 carbon free ambition although many asked us to clarify the exact intention.

Our ambition is to be able to run a carbon free system if that is what the market provides. We will continue to remain technology-neutral and operate the system in an economical and efficient way, consistent with our licence conditions, but we must prepare for a net zero future. The definition and scope of our ambition will remain flexible to changes in generation technology and government policy.

Stakeholders have commented that this could be very challenging and that we shouldn't underplay system issues such as voltage and inertia management. Some stakeholders, particularly service providers, said they would like to see a roadmap to 2025, outlining the milestones and deliverables needed to meet this ambition. Service providers said that this was important to ensure they could adapt their own systems and interfaces efficiently in response to our new systems as required. This document, including the investment roadmap shown later in this section, provides stakeholders with more detail on the individual capabilities needed.

Some stakeholders reflected that, while they were supportive of our 2025 zero carbon system operation target, we should not hold ourselves to it if it turns out to be too expensive. A consumer interest organisation thought it was better for consumers in the long term to let the target slip rather than bake in some very expensive sub-optimal solutions. They suggested we should think about short and long-term consumer benefit and remain agile around our plan as we move closer to 2025.

4.2. Control centre architecture and systems

Our control centre operates the power system to deliver a safe and reliable electricity supply. We will continue to ensure we can do this in a manner consistent with our licence obligations, through the activities below.

4.2.1. Costs

Control Centre Architecture and Systems	Five-Year Strategy					
	Two-Year BP					
	RIIO-1	2021/22	2022/23	2023/24	2024/25	2025/26
Capex (£m)	22.6	23.2	34.6	37.0	30.5	23.2
Opex (£m)	19.6	26.0	28.5	30.2	29.3	30.3
FTE[40]	179	197	208	214	211	207

Highlights

We propose start to design new control centre tools and systems in conjunction with stakeholders. This will enable us to manage more low carbon market participants, minimise consumer bills and ensure continued safe and reliable system operation

We will make improvements to our ongoing forecasting activities and the structuring and optimisation of the services we use to manage the system. This will ensure we have the appropriate plans in place to manage current and future operability challenges.

Complementing changes to existing processes will be the deployment of artificial intelligence (AI) and machine learning to assess large volumes of data in new ways.

Commercial Operations & Strategy	Five-Year Strategy					
	Two-Year BP					
	RIIO-1	2021/22	2022/23	2023/24	2024/25	2025/26
Capex (£m)	0	0	0	0	0	0
Opex (£m)	4.4	4.9	4.9	4.9	4.9	4.9
FTE	48	51	51	51	51	51

Highlights

We propose to perform extra analysis in developing operability plans, support more regional development programmes (RDPs) and undertake more trading activities. These will help ensure we deliver an operable system in an economical way.

[40] Opex and FTE numbers are the average for the ESO since legal separation (years 2020 & 2021) which reflects the current ESO business structure. Capex figures are the average over the 8 years of RIIO-1.

4.2.2. Ongoing activities and enhancements in RIIO-2

Our ongoing activities in this area cover the control centre and supporting teams. Further details are available in our *Future of the ENCC report*[41]. These teams will continue to:

- balance GB's demand for energy with supply from generators around the clock
- maintain security of supply in real-time, and the ability to restart the system in the event of a partial or total loss of power
- maintain the integrity of the transmission network, while managing the economical operation of the system
- support the ESO's European operations, including with the European Network of Transmission System Operators for Electricity (ENTSOE) and Coreso, the coordination body for security of supply in Europe.
- perform ongoing maintenance and incremental upgrades to our legacy balancing and situational awareness tools
- assess future operability challenges, communicate these through the *Operability Strategy Report* and ensure the control room has appropriate management plans
- produce detailed forecasts and analysis, for both demand and generation
- provide trading solutions to deliver a safe, secure and economical strategy into the control centre.

Further enhancements to our ongoing activities during RIIO-2 include:

- maintaining our legacy balancing and situational awareness tools while we develop new ones (IT investment references 210 Balancing Asset Health and 240 ENCC Asset Health)
- enhancing our published forecasts using detailed statistical and machine learning (IT investment reference 260 Forecasting enhancements)
- evolving our operability strategy work to ensure the system remains operable.

Most of our investment and FTEs increase is from our transformational activities. Here we demonstrate that the costs of our ongoing activities are efficient.

Our control centre currently comprises 129 FTEs. This will increase slightly to 133 FTEs to support an increased volume of decision-making, from around 200 per hour today to around double this at the end of the RIIO-2 period.

Our ongoing control centre process review will enable us to operate the system more efficiently while the transformational activities are delivered in a modular way over RIIO-2.

Our control support teams will need to make changes to systems resulting from the Clean Energy Package, Project TERRE, Project MARI and other regulatory changes. Our ongoing teams will manage these on current FTE profiles by realising efficiencies from current processes.

"[The Operability Strategy Report] is a very useful overview. There is a lot of work being taken forward here, which chimes with the need to commoditise flexibility services."
Cornwall Energy

The Commercial Operations Strategy team headcount will increase by two FTEs, reflecting the greater levels of analysis needed as operability becomes more challenging, demonstrating efficiency, against a backdrop of greater workload.

The Commercial Operations team headcount will increase by one FTE. The extra work expected includes supporting three to five RDPs per year, compared with the two in total there has been so far and a potential 100 per cent increase in interconnector trading volumes.

The energy forecasting team headcount will remain flat by implementing advanced machine learning tools and automation so we can deliver an increased number of forecasts to the market during 2019 to 2021 and into RIIO-2. This will include four additional wind forecasts and an extra day-ahead demand update. This will also mitigate the increased challenge of forecasting from growing embedded generation, an area where we currently have limited visibility. Its share of generation could increase to 40 per cent of installed generation capacity, representing negative demand the ESO must accurately forecast, up from 27 per cent today.

The cost of Coreso membership has increased by around £2 million per year on RIIO-1 average levels.

4.2.3. Transformational activities

The net present value of our control centre architecture and systems proposals are estimated at £242 million and deliver £2.21 of benefits for every £1 spent over RIIO-2. The net benefits are positive from 2021/22 onwards

[41] National Grid Electricity System Operator: Future of the Electricity National Control Centre https://www.nationalgrideso.com/document/149711/download

Our control centre architecture and systems play a critical role in enabling us to keep the network secure and balance the system.

We need to make significant improvements to our control centre tools and IT systems to be able to realise our ambition, unlock the benefits mentioned in other Themes and meet the expectations of industry.

"System operators and networks must make significant improvements to the informational and operational technology, digital and communications infrastructure."
BEIS and Ofgem open letter to the ENA

Ongoing maintenance and incremental improvements alone will not achieve this, even if we were to significantly increase the number of control centre engineers to unsustainable levels.

For clarity, within this Business Plan we have separated out the control centre architecture and systems into three key areas: **enhanced balancing capabilities**, **transforming network control, and control centre architecture**. More detail on the specific IT investments can be found in Annex 4 - Technology investment report.

Evolution of FTE

Most of the increases in FTEs are from our transformational activities. An increase is needed due to the volume of work required to transform the ESO's digital capabilities, while maintaining current system security and efficient balancing costs.

The control centre architecture and enhanced balancing activities will result in an FTE increase from today of 10 FTEs in 2021/22 and 15 in 2022/23, with the profile tailored throughout the remaining RIIO-2 period to the new tools being developed in a modular way.

A new leadership position will be created to oversee the ESO transformation at a senior level. This will allow existing senior management to concentrate on delivering the consumer benefits outlined in the other Theme chapters. During the first two years of RIIO-2, the additional FTEs will be needed for two main activities:

- implementing the design authority, including onboarding external stakeholders, scoping requirements and considering development and procurement methods
- designing and delivering new capabilities, including providing expertise from a technology, operational and academic perspective into the new market balancing algorithms our systems will use.

Transforming network control will need four FTEs in 2021/22 and 11 FTEs in 2022/23, with the profile tailored to the delivery of new systems in the remainder of RIIO-2. The additional FTE are needed to develop our new situational awareness and visualisation tools, whilst continuing to offer the same levels of control centre support that they currently do. Some of this resource will be internal, seconding people onto the delivery of new systems, where they can use their existing knowledge to drive a clearly defined project scope while reducing the number of extra FTEs that must be sourced. At the end of RIIO-2, these FTEs would return to their teams.

We have considered industry standards and our historical performance to set an efficient level of FTEs in proportion to proposed investment. As outlined in chapter 15 – people, culture and capability, a focus on sourcing high-quality talent, with skills in data science and advanced analytics, will help ensure the capex FTE profile remains efficient.

Evolution of capex

Our transformational control centre architecture and systems proposals include a significant capex investment of £120 million over the RIIO-2 period. This spend is necessary because we cannot continue with our existing tools to reach our 2025 carbon free ambition. This is because they were not designed to handle a decentralised system with potentially thousands of market participants. The main components of this investment are:

- the new network control tool (IT investment reference 110 Network Control) - £27 million over RIIO-2
- the new enhanced balancing capability tool (IT investment reference 180 Enhanced balancing capability) - £41 million over RIIO-2
- the data and analytics platform (IT investment reference 220 Data and analytics platform) - £20 million over RIIO-2.

Due to the time it takes to develop new balancing and control systems, it is necessary that work starts as soon as possible, hence our proposed capex investment of £46 million in the first two-years of RIIO-2. The main drivers of this cost are preparatory design and development work of £8 million for new network control tool, £18 million for the enhanced balancing tool and £9 million for new data and analytics platform.

The capex profile over the remainder of RIIO-2 is profiled with the delivery of new systems. We propose to spend £12 million in 2023/24 on the enhanced balancing tool ahead of delivery in that year, and £14 million over 2023 to 2025 on the network control tool ready for delivery in 2024/25. Investment in the data platform will reduce over the period, with additional investment required for adding new components in a modular fashion.

The transformational capex spend has been benchmarked by a range of external providers, including Gartner, Hackett and our application development and maintenance partners (ADAM), to ensure it is efficient. More detail is in chapter 11.

4.2.3.1. Enhanced balancing capability

Our core balancing systems allow generation and demand to be balanced in real time by scheduling and dispatching market participants in a cost-effective way. Significant investment will be needed to deal with greater decentralisation of providers and to accommodate closer-to-real-time GB and European markets.

Greater automation, machine learning and use of artificial intelligence will be required to handle increases in the amount of incoming data and the number of expected actions. We will consider how ringfenced innovation funding could support this (IT investment reference 450 Future innovation productionisation).

We will:

- refresh and enhance our core balancing capabilities in a modular way during the RIIO-2 period. This will involve modifying and upgrading our scheduling and dispatch systems, building on the strategic design work that will be completed during RIIO-1. During the first two years of RIIO-2 our work will focus on building and testing these new capabilities ahead of planned go-live in 2023/24. (IT investment references 180 Enhanced balancing capability and 480 Ancillary services dispatch).
- deliver inertia modelling capabilities, building on the inertia monitoring and forecasting work outlined in the *2019-21 Forward Plan*. This will be delivered in 2021/22 and will link with our enhanced balancing capabilities in 2023/24. We will develop other tools during RIIO-2 to address emerging technology and system management issues, as highlighted in future *Operability Strategy Reports*. (IT investment reference 130 Emergent technology and system management).

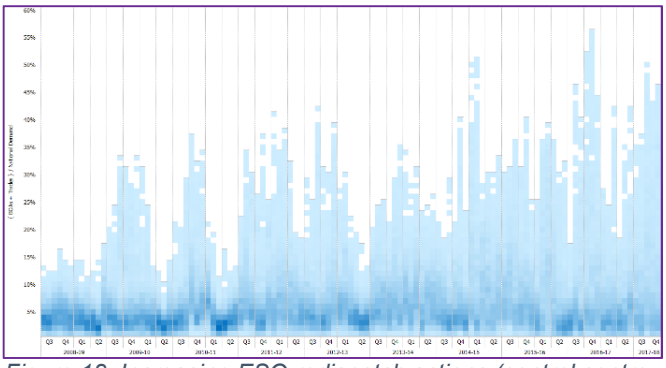


Figure 18: Increasing ESO redispatch actions (control centre and trading activity) as a proportion of national demand

The benefit of enhanced balancing capability is that it will ensure we schedule and dispatch a far greater number of market participants at once than we can today, using automation. As shown by Figure 18 we are having to re-dispatch an increasing proportion of the market, up to 55 per cent in some half-hourly settlement periods. Increased automation will also mean that market participants will have greater confidence in our decision-making.

4.2.3.2. Transform network control

To operate the electricity system economically and efficiently, our control centre engineers need a high degree of situational awareness – the ability to monitor and understand the status of the network and evolving operational limits.

Our control centre engineers currently manage around 1 billion data points per day, and we expect this number to increase. The better we understand the real-time 'operational envelope'[42] the more efficiently balancing costs can be managed without increasing system security risks.

We will:

- replace our current real-time situational awareness tool, the Integrated Energy Management System (IEMS). The new tool will go live in 2025/26. During the first two years of RIIO-2, we will focus on defining the requirements of the new tool, working with network parties through the design authority. It will build on two of our recent innovation projects: Project RecorDER[43] and Project SIM[44]. (IT investment reference 110 Network control)
- develop new online and offline modelling capabilities, including whole electricity system simulation and modelling aided by machine learning and probabilistic analysis. This enhanced look-ahead capability will allow us to predict transmission problems in a more volatile operating environment. We will also understand more clearly the impact of distribution network capability, so that we can make better decisions. Our work in the first two years of RIIO-2 will mainly be preparatory, ahead of development and testing in subsequent years (IT investment reference 150 Operational awareness and decision support)
- enhance our control centre video walls and operator consoles to ensure we can visualise the real-time state of the network. Upgrades are needed given the increased data coming into the control centre that our engineers must be able to understand and analyse to make optimal decisions. Our work will start in 2022/23 focusing on project set-up, with delivery in later years
- increase our operational liaison with DNOs and offshore transmission owners, allowing us to implement in real-time the enhanced whole electricity system coordination proposed under Theme 4.

[42] The operational envelope refers to the tolerance we need to allow for to handle system events. The better we can analyse incoming data, the clearer the operating envelope is to us, meaning we can more efficiently and economically operate the system by, for example, holding appropriate levels of reserve. A poor understanding of the operational envelope could lead to us being unnecessarily risk-averse.

[43] Energy Networks Association Smarter Networks Portal: RecorDER https://www.smarternetworks.org/project/nia_ngso0018/

[44] Energy Networks Association Smarter Networks Portal: SIM – Samuel Inertia Element https://www.smarternetworks.org/project/NIA_NGET0192

The benefit of transforming our network control capability is that we will be able to manage and visualise far greater volumes of data currently. We use this information to better understand the operating envelope, allowing us to run a more efficient system safely and at lower cost to consumers.

4.2.3.3. Control centre architecture

We must make changes to our control centre systems in smarter and quicker ways than we have previously. We will use a digital twin, sandbox and shadow control room to test and inform the development of our new balancing and control capabilities. We will also host them on a central data platform.

Digital twin

A digital twin is an offline replica of our digital control centre IT estate with live data feeds that we can use to simulate both markets and the operation of the GB transmission system. It can be used as a testing and/or pre-production environment to validate the benefits and impacts of changes to the market and physical network. It will use AI to run multiple, complex scenarios in a parallel timeline (i.e. we can run scenarios faster than real time to model outcomes).

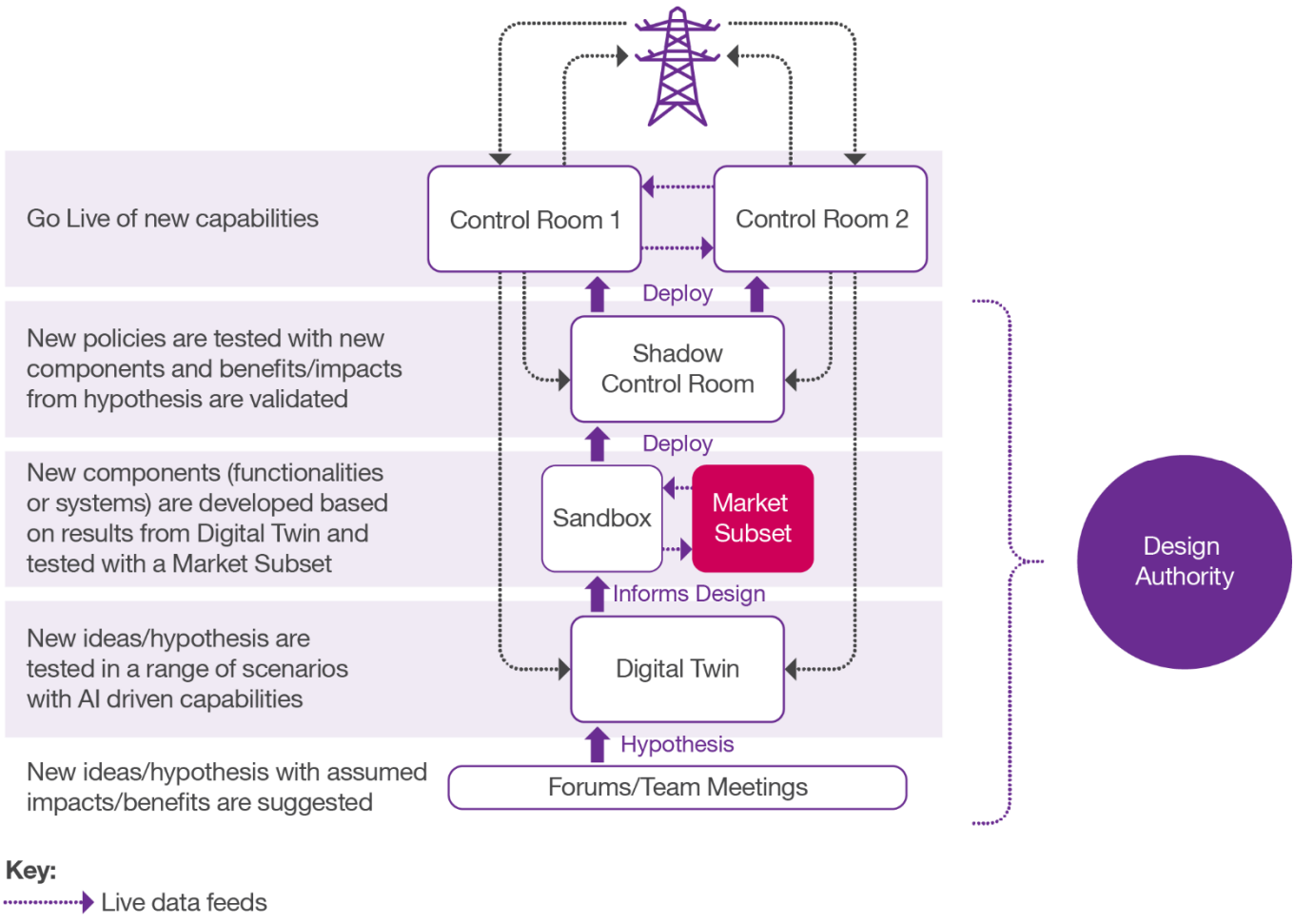


Figure 19:
Development process for Control Centre capabilities

Digital twin, sandbox and shadow control room

The digital twin will replicate our digital control room systems using real-time data. This approach is in line with the recommendations of the National Infrastructure Commission (NIC)[45] and the Energy Data Taskforce[46] on the use of digital twin concepts to manage infrastructure more effectively. A digital twin will mean we can run simulation and hypothesis testing to inform and enhance the way we develop our new balancing and control tools which will then be built offline in an agile and modular way. A sandbox environment with live data feeds will allow us to test these tools with a small group of market participants.

In parallel, we will use a shadow control room to assess how these capabilities work in a 'real-life' control centre environment. This will include visualisation, end-to-end processes, team dynamics and human reaction times. This opportunity will be extremely important as the control centre needs to manage and understand increasing volumes of interrelated data.

We do not envisage creating a separate shadow control room team, but instead will explore how whether an existing space could be used to create a shadow control room environment.

Shadow Control Room

A shadow control room is a physical space that mirrors the control centre environment. It allows us to test current and future processes with our new balancing and control capability in a 'real-life' environment with live data feeds.

The digital twin and shadow control room will be developed in parallel to our capabilities and will evolve as these new capabilities are delivered.

The benefit of this approach is that it allows for extensive 'real-world' development and testing using live data feeds and the ability to run multiple complex scenarios to refine the new tools. We can also test impacts and benefits of the changes in a control centre environment. We can test the interactions between system and market changes much earlier to ensure their development is aligned.

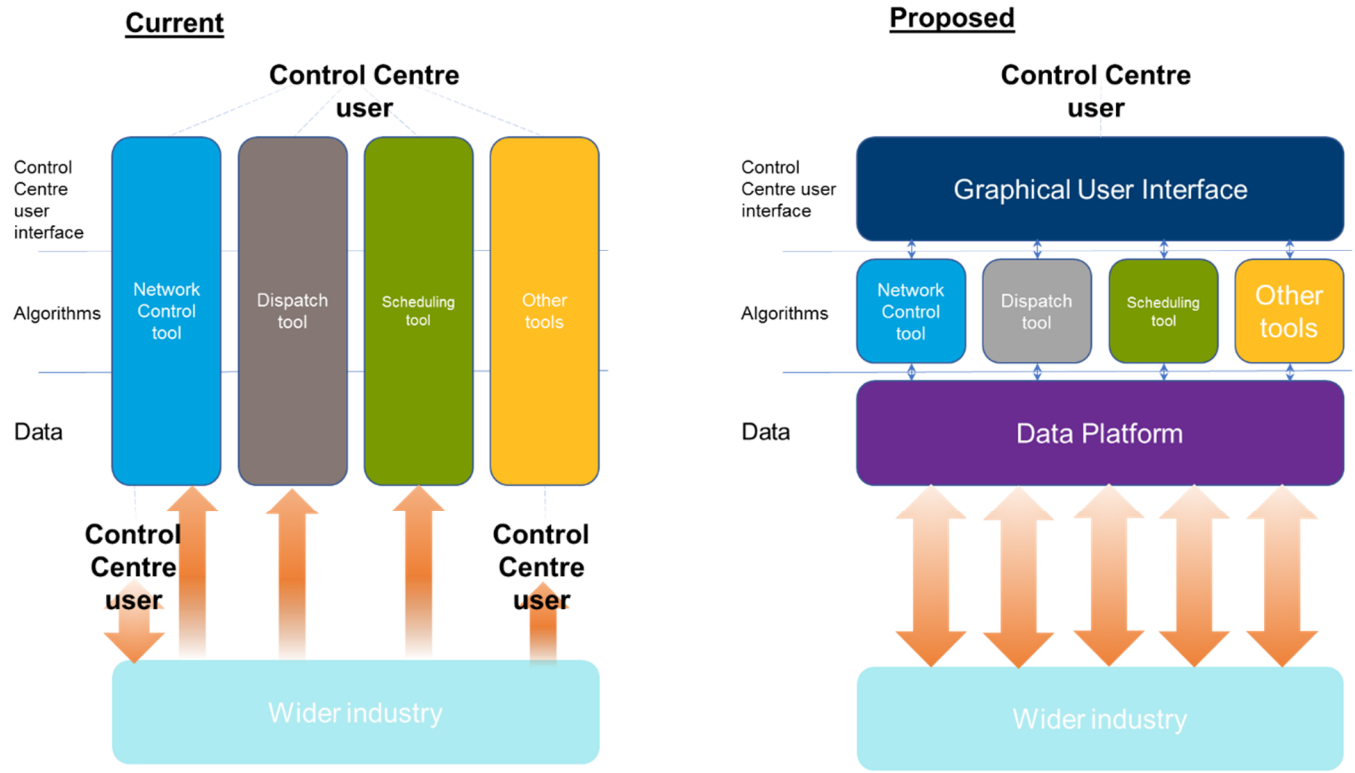


Figure 20: Comparison of current and proposed control centre architecture

[45] National Infrastructure Commission: Data for the Public Good https://www.nic.org.uk/wp-content/uploads/Data-for-the-Public-Good-NIC-Report.pdf

[46] Energy Data Taskforce: A strategy for a Modern Digitalised Energy System https://es.catapult.org.uk/news/energy-data-taskforce-report/

The development of markets and systems are two sides of the same coin".
IT service provider

Sandbox

A sandbox is an environment with live data feeds that we can use to test new tools with just a pre-agreed subset of the market. This market subset will vary depending on the changes being tested.

Data and analytics platform

To develop the new capabilities in an agile and modular way, the first step will be to create a data and analytics platform. (IT investment reference 220 Data and analytics platform).

The new systems will then connect to this platform (see figure 20), meaning it will receive live operational data, make it available to all systems that require it and log any system actions.

The data held on the system will be available to all external parties through the data portal. We will begin work on the data platform towards the end of RIIO-1, with delivery in 2021/22, and integrate our new tools when they are ready.

The benefits of this approach are two-fold. Firstly, it creates a new communications architecture that allows new systems to be integrated seamlessly in a 'plug-and-play' or 'app-like' way. Secondly, the data platform will act as a single version of the truth for all data, providing accessibility and transparency for stakeholders.

4.2.4. Investment roadmap

The roadmap below shows the deliverables and activities that we propose across the RIIO-2 period.

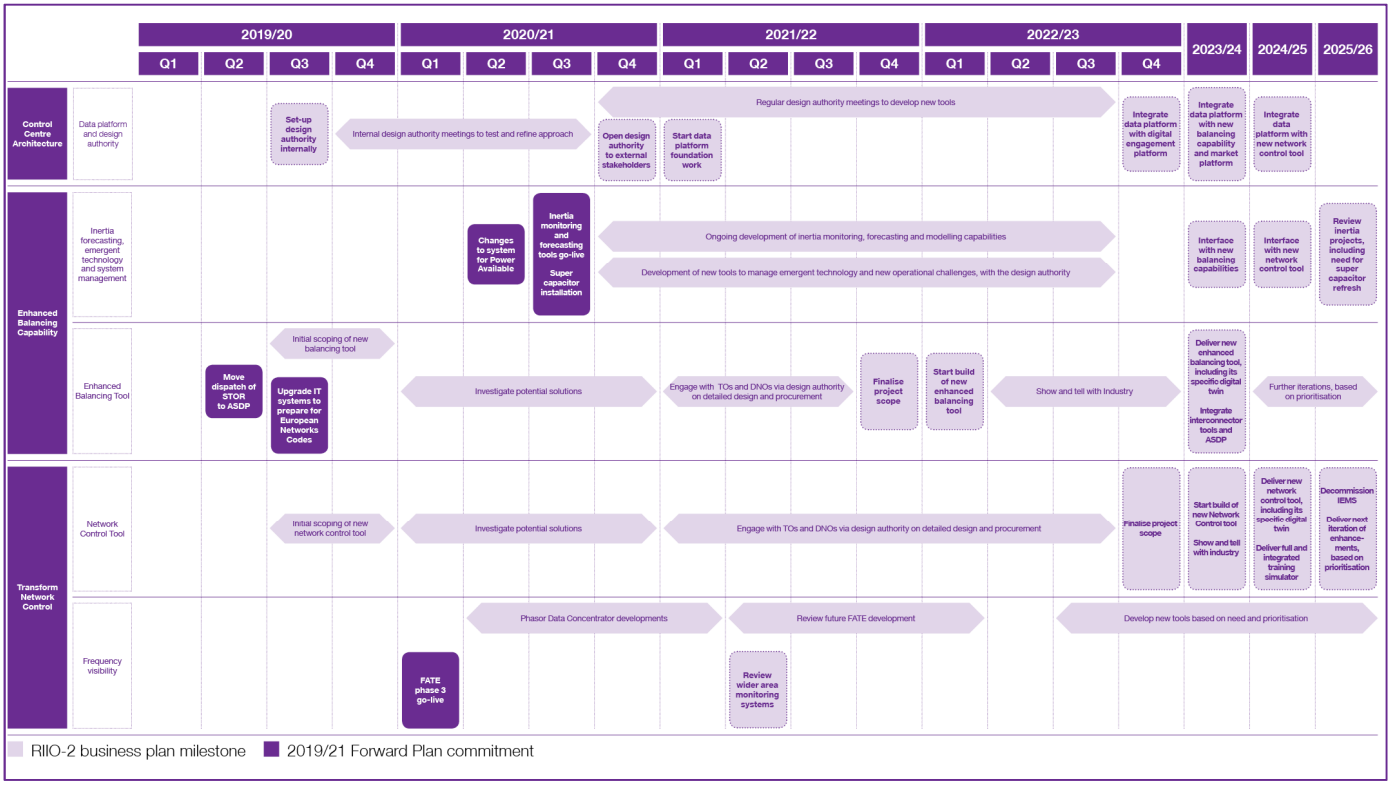


Figure 21

Design authority

We will continue to collaborate with our stakeholders to ensure the success of future developments. To develop the new systems, we will work with industry under a cross-sector design authority for ESO transformation. This will give stakeholders a say in the design of new systems, ensuring they reflect future market needs, delivering a step change in levels of transparency and accountability.

We expect to open the design authority to external stakeholders in 2020/21. It will meet regularly throughout the RIIO-2 period. We envisage the design authority could involve the ESO, network and market participants, technology companies and academics. It would be advisory, with the ESO retaining decision-making responsibility.

4.2.5. Confidence we can deliver

The ESO is in transition. Following the recent legal separation, we are moving away from being an asset business to becoming a technology company operating in an environment that changes in real-time. We will need to change our organisation, operations and culture along the way, and we understand that managing a transition of this scale is difficult.

We will create an internal delivery body, led by a business programme director, to augment the key skills across the ESO, IT and those of our framework partners and vendors. To ensure the programme delivers the right outcomes at the right time, we are introducing the Design Authority at the heart of ESO business.

We are currently working with the support of our major IT partners and using external sector case studies to plan a successful deliver strategy and embed the lessons learnt from other business that have completed transformations, including Transport for London[47] and Red Bull Racing[48].

4.2.6. Stakeholder views

Rationale and approach to delivering new control capability

We asked stakeholders if they agreed with our rationale to update control centre architecture and systems at the Operational Forum, at our IS Change Forum and at our RIIO-2 engagement events.

Parties such as generators, networks and trade associations welcomed our proposals and agreed that they need to be upgraded to be fit for the future. We also heard, particularly from generators and service providers, that we need to learn from our experience of previous projects (for example EBS) to take a more agile, modular approach to new capability development.

Stakeholders thought that this approach would help to mitigate costly delays, maintain transparency and keep their own costs down. Some service providers said that the approach we took in developing the Platform for Ancillary Services (PAS), which is similar to our proposals for RIIO-2, worked well.

We heard from some smaller service providers that a key requirement is transparency around the algorithms and back-end decision-making for any new system development. We aim to address this using the design authority approach.

It was also recommended that we benchmark our proposals against other system operators and comparable sectors. As mentioned in the section above, we have worked with our IT partners and learnt lessons from comparable external organisations

Stakeholders from renewable generation companies stressed the future challenges of managing a low-inertia system. As a result, they supported our proposals to introduce enhanced network monitoring such as inertia monitoring. This will help to improve our visibility of the system and therefore control.

"Your proposals for a digital twin, design authority and sandbox are enormously ambitious"
Trade Association body

The ERSG commented that it may be challenging to deliver new systems that are suited to as many stakeholders as possible given the number of participants and preferences. The remit and scope of the design authority will help to tackle this challenge by providing key input into the design, development and testing of our proposed solutions.

The ERSG also enquired about the cost impact on users of integrating our new capabilities with their systems. While there may be a cost to some legacy generators to update their systems, we believe that new parties would not face these costs, or the costs would be commensurate with the cost they would incur otherwise in integrating their systems.

In addition, the input of the design authority will also ensure we develop systems that meet the needs of users who interface with the control room and wish to make use of the data we provide.

Digital twin and shadow control room

On the digital twin and the shadow control room, we heard at an industry roundtable for decentralised market participants that our proposals for the digital twin, design authority and sandbox testing environment were enormously ambitious.

The ERSG said that it supported the digital twin initiative and could see great benefits in this approach to allow greater flexibility for innovation, particularly in future market architecture. The Challenge Group, did, however, comment that more clarity was needed on the roles of the digital twin and shadow control room, and interaction between them. In the section above we have explained the role of each and provided a diagram in the *control centre architecture* section above (figure 20) to show how they interact.

[47] www.tfl.gov.uk/
[48] www.redbullracing.redbull.com/

Role and membership of the design authority

The ERSG asked how we intend to involve stakeholders in the development of systems to involve stakeholders in the development of systems. This will be primarily through the design authority, but we are also working with other organisations that use data heavily to adopt best practice.

The ERSG challenged us on the level of the design authority (e.g. working level or decision-making). We envisage that it would be a working level group. A generator at our control centre round table event thought that it could take a project management approach to discussion, for example tracking milestones and risks.

Also at our August control centre round table, we asked stakeholders how we could ensure that the design authority had strong industry representation. Stakeholders from the renewable energy, consumer interest and generation sectors highlighted that smaller parties do not have the resource to participate in a lot of industry groups.

One suggestion was to involve trade associations so they could represent the needs of several organisations. A trade association told us that we must ensure that the design authority includes perspectives from small, innovative market participants.

DNOs felt that they should each have a seat at the table, given the different network configurations and interactions with the ESO. A consumer group noted that consumers were not represented in some of our initial proposals for the design authority even though they would ultimately pay for it.

We also heard that it was important that the design authority did not become a 'talking shop'. Stakeholders across the board agreed that the design authority should be advisory, with the ESO having the decision-making power, but that the ESO needs to justify its actions. We have used this feedback to inform our proposals and will consider them when we open the design authority for external representation.

4.2.7. Cost-benefit analysis

We estimate the benefits to be £338 million over RIIO-2. This gives an NPV of £242 million over RIIO-2.

The main areas of the quantitative benefit above are the following:

- Estimating a 5 per cent improvement in managing constraints and a 2 per cent improvement in managing response and reserve, from a combination of improved situational awareness tools and improved training capabilities (see Control Centre Training and Simulation section below), delivering £158 million of benefit.
- Reduced environmental damage from our control centre residual balancing actions, delivering a benefit of £52 million.
- Upgrading our tools to better handle greater levels of interconnection, delivering £35 million of consumer benefit.
- Lowering consumer bills through unlocking the benefits of greater flexibility, delivering £104 million of benefit.

This is against a baseline assumption of performing the ongoing maintenance to our legacy systems to remain compliant with our licence obligations, as detailed in the ongoing activities section above.

This activity is dependent on the following transformational activities:

1. *Control centre training and simulation (Theme 1)* – Ensuing the control centre has fully trained staff to operate in a zero carbon world
2. *Open Data* – Ensuring that the data flow between the ESO and participants is open allowing participants to understand system operability

This also enables, though economically optimal operation of a complex decentralised and decarbonised electricity system, the following transformational activities:

1. Taking a whole electricity system approach to promote zero carbon operability (Theme 4)
2. Build the future balancing service and wholesale markets (Theme 2)
3. Control centre training and simulation (Theme 1) - Providing real world experience for training and simulations
4. Open Data - Providing additional data from real world system operation

Delivery of this activity will pass on benefits and costs to other parties. There may be a cost to DNOs, TOs and market participants integrating their systems and data to our new tools. However, for new market participants we believe that such a cost would be commensurate with any costs they would incur anyway. In all cases, the benefit of moving towards standardised technology and data should outweigh any additional cost.

Our analysis suggested that accounting for market, delivery and third-party uncertainty the net present value could credibly be between £476 million and £69 million.

See the Annex 2 - CBA report section 2.1 for more details.

4.2.8. Proposed performance metrics

There are two metrics that could be used to evaluate the performance of our ongoing activities.

- **A balancing cost metric**

We recognise the impact that the cost of balancing the network has on end consumers, during our RIIO-2 engagement events stakeholders have mentioned that is important we work to minimise balancing costs. We propose to measure and report the total balancing costs monthly in line with feedback from stakeholders. However as there are areas of balancing costs that have external and environmental factors which can strongly influence the total cost of balancing the network we would like to work with both the industry and Ofgem to develop a metric that provides the confidence and visibility that stakeholders require while also reflects the leverage that the ESO has over balancing spend.

- **A demand and wind generation forecast metric.**

We would also propose to measure demand and wind generation forecast accuracy. An improved accuracy of forecast can directly deliver value to the end consumer through the market self-balancing and allowing the control room to make more optimal decisions. We understand from stakeholder feedback on the forward plan that this is an important area for stakeholders and one which they would like to see more progress for us in. We would look to understand stakeholder and Ofgem views further in this area to agree the most effective measurement method and ensure that we are providing the appropriate level of visibility to give confidence in our performance.

Like the approach taken in the *2019-21 Forward Plan*, we could be measured against a target set in advance. Such a metric would clearly demonstrate consumer benefit with historic data available that could be updated each year to set a benchmark.

- **A metric on the percentage of times we have dispatched in merit order**. This would provide confidence and transparency to market participants on our control centre actions. Such a metric would be measurable and auditable, and benchmark and historic performance data is available. We have heard positive feedback from some stakeholders on the principle of this, although some commented that ESO actions are often taken in real-time for operability or economic reasons, and that such factors would need to be considered.
- **A metric on system health**. This would allow us to demonstrate the benefits of our transformational activities outlined above. Historical and baseline data is available, and it would be auditable. During our engagement, some stakeholders mentioned that transparency of system health was important and something they currently had limited visibility of.
- **A stakeholder satisfaction survey of the design authority**. This would allow stakeholders to evaluate the delivery of our transformational activity, given the need to do so in new ways. It would be clearly measurable, and a benchmark could be reset in subsequent years. A historical benchmark, such as from previous customer satisfaction (CSAT) or stakeholder satisfaction (SSAT) surveys could be used for the first year.

4.3. Control centre training and simulation

Our control centre engineers play a vital role managing the electricity network. We must ensure they have the right training and simulation capabilities to operate the energy system of the future.

4.3.1. Costs

Control Training and Simulation	Five-Year Strategy					
		Two-Year BP				
	RIIO-1	2021/22	2022/23	2023/24	2024/25	2025/26
Capex (£m)	0	0	0	1.2	2.3	2.3
Opex (£m)	2.0	1.8	2.3	3.2	4.0	4.7
FTE	18	20	21	25	27	28

Highlights

We propose to expand our training activities and start to design new simulators. This will ensure our control centre engineers can operate a carbon free system.

We will need extra resource to deliver our transformational activity, including designing and delivering new courses to train students, ESO colleagues and possibly distribution system operation control engineers. The latter would lead to a significant increase in training requirement, from around 30-40 FTE per year currently to approximately 120 FTE.[49] In line with our carbon free ambition, we need new scenario writers to develop 'what-if' exercises.

Without increasing headcount to deliver enhanced training, we would need extra control centre staff due to the inefficiencies of training live in the control centre. Our Technical Operations team will see a slight increase in headcount to serve customers better as the number of queries from market providers increases. This is driven by the increase in BMUs we interact with. From 2014 to 2017 we saw a 60 per cent increase in BMUs and we expect this trend to continue during RIIO-2.

4.3.2. Ongoing activities and enhancements in RIIO-2

We will continue to:

- develop and drive control centre strategic resource planning, scheduling and training
- lead on incident analysis and investigations of abnormal events, implementing improvements where needed
- monitor and report on system performance to regulatory bodies and ENTSOE
- provide guidance on operational policies for use in the control centre.

4.3.3. Transformational activity

The net present value of our control centre training and simulation proposals are estimated at £20 million and deliver £1.73 of benefits for every £1 spent over RIIO-2. The net benefits are positive from 2021/22 onwards.

Our current training and simulation capabilities cannot continue in their current form. We will need to train control centre engineers on new tools, in new areas such as data science, and against a backdrop of an increasingly complex and unpredictable system.

We must also ensure we attract and retain talent. There will be competition for the skills we need as DNOs transition to distribution system operation, as well as externally in sectors such as banking and video game development.

We will focus on three areas; partnering with academia and industry to develop enhanced training material and attract talent; upgrading our training simulators and; enhancing our workforce and change management tools.

4.3.3.1. Enhanced training material

Academia

We will partner with academic institutions to enhance and accredit existing qualifications and courses. We will also look to develop new ones if necessary.

We will focus on institutions that already offer courses in relevant subjects such as power system engineering, data science and energy systems. Universities tell us that demand for such courses continues to grow. Our discussions have given us an overview of how we can partner with institutions to deliver more effective training and appeal to students as a future employer.

During the first two years of RIIO-2 we will consider how we can:

[49] Assuming 100 FTE in the ESO control room, 50 FTE in each of the 14 DSO control rooms and a 15% attrition rate due to retirement and career progression. This does not include other staff who may benefits from such training.

- sponsor the dissertation process of existing university courses, allowing candidates to work on an ESO-relevant project and gain experience of the ESO as part of the development of their project
- design and deliver optional electricity system operation modules for existing university courses. These would give an overview of all elements of system operation, including power system engineering, market operation and commercial and regulatory frameworks. We would look to include 'hands-on' training through experience days at our control centres, including use of our training simulators
- offer candidates on these courses employment opportunities. This could be in the form of summer placements and / or post-qualification permanent positions.

Longer term, we will analyse the feedback from and continuing appetite for the modules. If there is demand and clear benefit, we would aim to run further modules or develop a new qualification or degree in electricity system operation.

Our proposal will benefit candidates by ensuring that existing qualifications remain relevant and providing potential post-qualification employment opportunities. It will also benefit our the ESO by creating a pool of talented people with the skills for the future.

DNOs and wider industry

As distribution network operations evolve towards distribution system operation, there will be increasing demand for energy system operation skillsets across the industry.

We see the potential value of developing operating engineers in partnership to meet overall industry demand. A full DNO to distribution system operation transition could mean that 120 FTEs would need training each year, meaning there are likely to be efficiencies in combined training and benefits from greater collaboration and understanding of our networks, roles and interactions.

Regardless of our actual training relationship with DNOs, we will need to perform modelling and training on whole system solutions and interfaces.

During RIIO-2, we will engage with DNOs to understand how we can provide the initial training for distribution system operation control room engineers. In the first two years of RIIO-2, we will explore how to open our training to DNOs to support this transition, including:

- exploring the potential of joint simulator training sessions to develop best practice and incident management techniques
- providing and participating in cross-sector secondment opportunities to improve whole system decision-making, by better understanding the needs of other parties.

4.3.3.2. Training simulators and technology

We plan to develop new training simulators to accurately reflect the changing energy landscape. This will allow us to train control centre engineers on a range of past and future scenarios, including using real-time data as opposed to the current snapshots we use today.

We will build our simulation capabilities together with the new balancing and control tools. The simulators are a separate concept from the shadow control room. They provide an environment for training on new systems in real time and can capture post-event training scenarios. The shadow control room will allow new control centre processes and interfaces to be tested.

In the first two years of RIIO-2 we will:

- make upgrades to our current simulators to ensure they remain fit for purpose, ahead of new simulation capability, facilitated by the digital twin (IT investment reference 200 Future simulator and tools)
- implement appropriate additional training options, including online and e-learning.

This approach will benefit consumers by helping control centre engineers make better operational decisions, ensuring that the system continues to run safely and reliably on behalf of consumers, while minimising bills.

4.3.3.3. Workforce and change management tools

Given the impacts of shift work in a complex and stressful environment, we must ensure that we provide an environment that supports the wellbeing and at the same time continued development of our control centre engineers. During RIIO-2, we want to use greater automation in producing rotas and personalised training packages. Many of our current workforce and change management tools are undertaken using legacy tools or manually; we will update these. They will require investment to create an enhanced user experience to provide flexibility to both the trainee and the trainers through their authorisations and training needs (IT investment reference 190 workflow and change management tools).

During the first two years of RIIO-2 we will:

- develop personalised updates and automated shift logins, ahead of delivery in subsequent years of RIIO-2
- design and develop content and infrastructure for personalised training plans, which we will fully deploy in later years.

4.3.4. Investment roadmap

- The roadmap below shows the deliverables and activities that we propose across the RIIO-2 period.

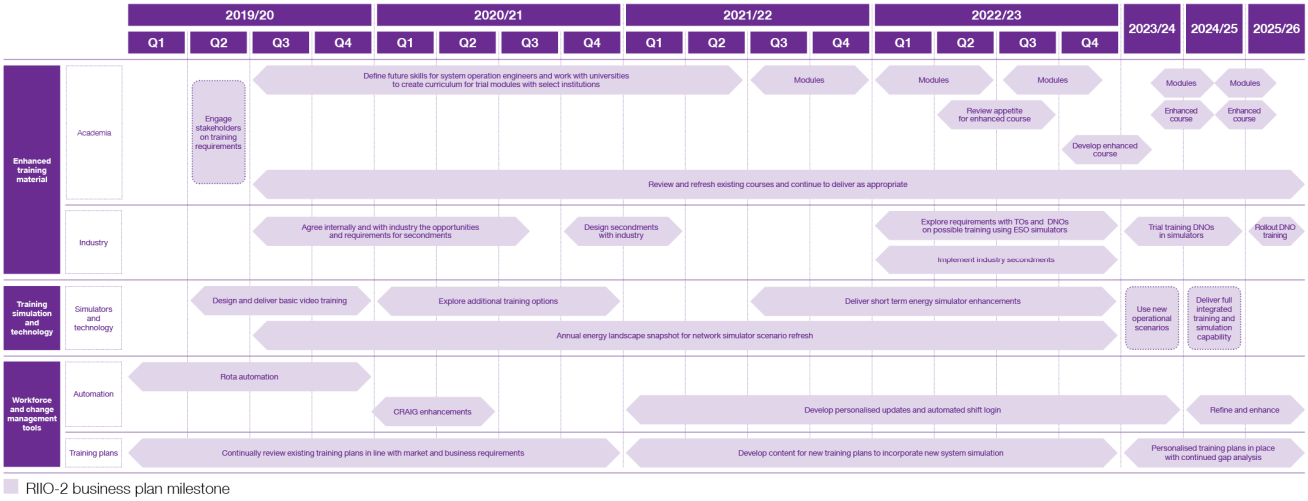


Figure 22

4.3.5. Stakeholder views

We sought stakeholders' views on how we plan to develop our people at the ESO RIIO-2 events in April and August 2019 and through our *RIIO-2 Ambition* consultation document. We engaged in more detail on our training proposals at our control centre events in July / August 2019 and we spoke to universities about how we could partner in future.

Stakeholders generally agreed that our training simulators should match our balancing and control capabilities and that updated simulators would be a useful resource to share across industry. On resourcing, a supplier said that it was important for people capability, health and well-being to be 'upgraded' as well as systems.

More specifically on control centre skillsets, stakeholders agreed that the ESO will increasingly need data and computer science skills to complement our power system engineering capabilities. They also felt that developing distribution system operation capabilities will only increase demand.

There were some differing views on how to solve the skills gap issue, and whether it was the responsibility of the ESO to solve wider industry resourcing issues.

Some stakeholders (from supplier and service provider sectors) felt it should be left to the market to solve. Other stakeholders (from generation, government and consultancy sectors) thought we should partner with the ENA, universities, government initiatives and technology companies to train talent, building on our existing programmes.

One stakeholder said that the ESO had lots of energy trading experience where DNOs may want to get involved and participate in training. Another comment was that we could tailor our training approach with different companies depending on their needs.

In response to *Our RIIO-2 Ambition* consultation, a consumer interest body pointed out that we discussed training and developing our people but didn't mention retaining employees.

We agree that this is key to a resourcing strategy and have provided more details in the people, culture and capability section. We know that talent retention is important, but we are also conscious that we need to future-proof against our current age profile in critical operational roles.

The ERSG commented that to keep high calibre people we need to offer a good work-life balance. This includes more flexible working practices in the control room and ensuring control room engineers remain 'in practice' while on maternity, paternity or adoption leave. It also encompasses more part-time working.

We already have well-being support in place and conduct regular health checks. We have an on-site gym and look carefully at rota patterns to ensure staff well-being. We are committed to being at the leading edge in this area, especially in relation to the shift working needed for our round-the-clock operation. We will look to increase the amount of flexible working available, balancing this against the requirements of operational and shift work.

The ERSG also said that in an international market, recruiting and retaining talent was difficult. They recommended we worked with universities and the Energy Networks Association to build university capability and to ensure careers appeal to young people.

Following publication of our draft Business Plan, we have spoken to three universities (UCL, Manchester and Strathclyde) about the resourcing challenge that we and the wider industry may face in future.

We discussed how we could work together to attract and train our future control engineers. The universities were all positive about potential collaboration, with one academic saying that a partnership looking at system operation of the future could be 'world-leading'.

The universities agreed that a slightly different emphasis for system operation in terms of topics being taught was required (versus a more technically focussed qualification). There are several options for bespoke system operation qualifications, for example, through the dissertation process, through guest lecturing or setting up a module within an existing course.

One university also thought that we could work in partnership using our simulation facility to enhance teaching for an existing course. Whilst we already do some work in this area, for example through the IET Power Academy, we believe there is scope to go further, and these discussions have directly informed our proposals.

4.3.6. Cost-benefit analysis

We estimate the benefits here to be £38 million over RIIO-2. This gives an NPV of £20 million over RIIO-2.

The quantitative benefits stated above have been calculated by:

- Estimating a 5 per cent improvement in managing constraints and a 2 per cent improvement in managing response and reserve, from a combination of improved situational awareness tools and improved training capabilities (see Control Centre Architecture and Systems section above). We assign the reserve & response benefit in this section, resulting in £31 million of benefit.
- Updating our shift patterns, working arrangements and training delivers benefit of £8 million over RIIO-2.

This is against a baseline assumption of continuing with the as is state of limited training and simulation capability.

This activity is dependent on the following transformational activity:

1. Control centre architecture and systems (Theme 1) – Allowing high skilled engineers to use their training for zero carbon system operation

This also enables, though high a highly skilled workforce which can operate a complex decentralised and decarbonised electricity system, the following transformational activity:

1. Control centre architecture and systems (Theme 1) - Providing real world experience for training and simulations

Delivery of this activity could pass on benefits and costs to third parties. There may be a cost to DNOs and TOs for training their staff using our facilities. However, this would likely be offset by savings from not having to run some or all of their own training programmes. They will benefit from having a greater pipeline of resource due to our enhanced academic partnerships attracting talent to the industry. Greater co-ordination and collaboration of training will help the industry make better whole system decision, particularly in areas such as restoration and disaster recovery.

Our analysis suggested that accounting for market, delivery and third-party uncertainty the net present value could credibly be between £0 million and £35 million.

See the Annex 2 - CBA report section 2.2 for more details.

4.4. Restoration

A safe, secure and reliable supply of electricity is vital to our economy and way of life. While extremely unlikely, a total loss of power could cost the UK £5.6 billion to £9.6 billion per day[50]. It is vital we have the right procedures to economically restore the system within acceptable timescales.

4.4.1. Costs

Restoration		Five-Year Strategy				
		Two-Year BP				
	RIIO-1	2021/22	2022/23	2023/24	2024/25	2025/26
Capex (£m)	0	0.9	2.3	7.7	8.1	6.3
Opex (£m)	0.7	0.7	1.4	2.3	3.3	4.1
FTE	7	8	13	18	18	17

Highlights

We propose to open restoration services to more technologies and implement the new standard. This will allow quicker restoration, should the need ever arise.

Our ongoing restoration activities will not increase FTEs despite the number of restoration providers increasing as we open restoration services to wind and solar. This is due to efficiencies resulting from tenders replacing bilateral contracts for procurement and improvements to our Black Start testing methods.

Our transformation work is driving the need for more FTEs in future. In the first two years of RIIO-2, this includes extra resource to deliver the restoration standard and the restoration decision-making support tool. The increase from 2023/4 onwards covers the resource required to implement the proof of concept from the Distributed Restoration NIC project. The proposed transformational capex spend has been benchmarked to ensure it is efficient.

[50] Calculated using a value of lost load of £7,000 to £12,000 per MWh and 0.8TWh daily demand https://www.ofgem.gov.uk/ofgem-publications/82293/london-economics-value-lost-load-electricity-gbpdf

4.4.2. Ongoing activities and enhancements

Our restoration and resilience teams will continue to:

- provide the control centre with fully-tested skills, processes, plans and tools to support incident management and disaster recovery.
- develop and maintain restoration plans for GB with the necessary stakeholders, ensuring these are validated and supported.
- ensure that ESO can maintain its licence and code obligations to meet the GB Restoration Standard, including facilitating the annual validation of a standard via the Assurance Framework.
- provide advice and oversight of Black Start and restoration strategy for the future.
- run a fully-competitive Black Start procurement process with submissions from a wide range of technologies connected at different voltage levels on the network, with DNOs playing a more active role in the restoration approach.

Enhancements made during RIIO-1

In response to stakeholder feedback on the future of balancing services, we published our *Product Roadmap for Restoration*[51] in May 2018. This outlined our commitments to improve the transparency of requirements, remove barriers to entry and explore alternative methods to procuring services. A core output of this is that we will trial a market approach for Black Start procurement from 2020/21 onwards.

To explore the provision of new technologies and services in restoration, we launched our Distributed Energy Resources (DER) Network Innovation Competition (NIC) Project, together with Scottish Power Energy Networks and TNEI, an energy consultancy. We released our initial findings from this in July 2019[52]. More details of how we would take the resulting proof of concept and implement it are below.

4.4.3. Transformational activity

The net present value of our proposal is estimated at negative £8 million.

System restoration is the ultimate backstop on which the country's economy relies. However, maintaining the ability to restore cannot be a blocker to achieving our ambition of being able to operate a carbon free network by 2025 if we rely on old methods, processes and technologies.

We expect a significant increase in the number of restoration providers. As society shifts to a potentially more electrified future, we will likely see changing expectations for restoration too.

System restoration will need to become a much more 'self-healing' process. This would feature automated power supply recovery and a whole system process with the appropriate system control, simulation and training tools in place. It would also see highly-trained power system engineers across all networks. Our transformational activities focus on implementing the new restoration standard and our DER NIC project.

4.4.3.1. Restoration standard

The Black Start Task Group, a cross-industry government-led group, is currently developing a national standard (with a potential regional requirement) for restoration. It uses an evidence-based methodology that includes socio-economic impacts and likelihood of a shutdown event.

This is due to become a licence obligation on the ESO in April 2020 and will be implemented in the following 12 months. The expected standard is likely to drive much shorter restoration timelines, and therefore more work and cost to achieve this (IT investment reference 460 Restoration). Annually, throughout RIIO-2 this will include:

- facilitating and compiling, on behalf of the GB industry, an annual assurance process for GB Black Start readiness
- validating restoration timelines for GB using the assurance data
- maintaining our obligations and requirements against the new standard for Black Start capability provision.

The decisions and instructions we make during a restoration event are vital to restoring the system quickly. To support our role, we will develop a decision-making support tool to advise our control room engineers on the best route for restoration at any point. This will also enable them to manage potentially hundreds of restoration providers.

[51] National Grid: Product Roadmap – Restoration https://www.nationalgrideso.com/sites/eso/files/documents/National%20Grid%20SO%20Product%20Roadmap%20for%20Restoration.pdf

[52] National Grid ESO: Power engineering and trials – report on the viability of restoration from DERs (Redacted) https://www.nationalgrideso.com/document/149961/download

The tool would continually update and adjust if the first restoration plan produced by the system was not followed, for example if it were overridden on either social or political grounds, for example the instruction of the Secretary of State consistent with their powers, or technological grounds. During the first two years of RIIO-2 we will begin developing the tool, ahead of go-live in 2024/25 (IT investment reference 510 Restoration decision support).

4.4.3.2. Innovation project in restoration

Creating a collaborative and comprehensive solution developed jointly by the ESO and DNOs to allow DER to participate in the restoration market will bring significant financial benefits to consumers through increased competition, lower costs and quicker restoration.

We have secured funding through the NIC to explore how to provide restoration services via DER. This project, which ends in 2022, will produce a whole system project output including the technology needed to support and dispatch DER. This will include tools and communications, and any regulatory and commercial framework changes needed.

We plan to trial case studies based on different technology types during 2020 and 2021 to look at feasibility and confirm costs. Subject to the outcome of the project, we estimate that full implementation of the proof of concept findings will be completed by 2025/26. As restoration requirements evolve, we see the NIC project as an important way to improve our toolkit in line with the changing system.

4.4.4. Investment roadmap

The roadmap below shows the deliverables and activities that we propose across the RIIO-2 period.

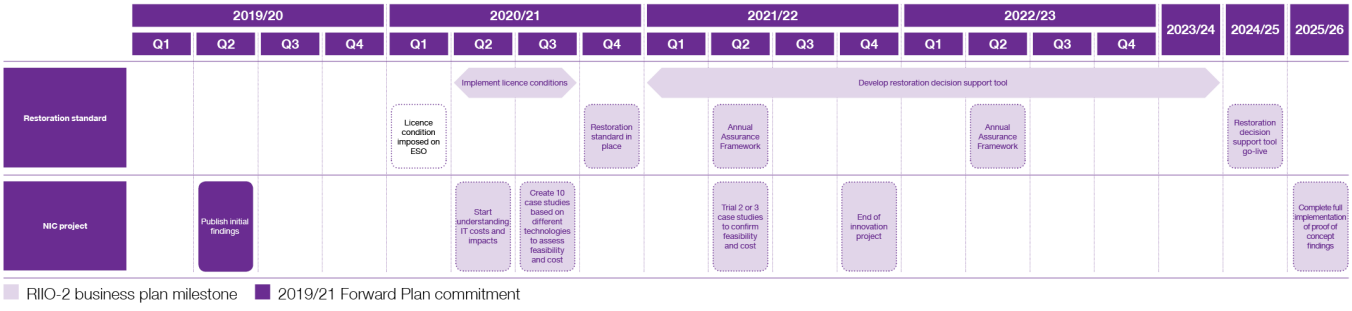


Figure 23

4.4.5. Stakeholder views

We have discussed the future system restoration standard at various industry forums. These include the Black Start Task Group, the Electricity Task Group, and the Energy Networks Association-led Emergency Planning Managers Forum and Electricity Networks and Futures Group.

In general, stakeholders support faster restoration timescales, committing to a standard, and allowing new products and technologies to provide restoration services.

We discussed our RIIO-2 proposals at our ESO RIIO-2 event in April 2019 and received comments via our *RIIO-2 Ambition* consultation. At the event, there was some support expressed for our proposals, particularly from service providers, and a call for the ESO to be more creative in finding Black Start solutions to bring down the cost.

Ultimately it was determined that the physics of being able to restore the system are critical and that this could be tested using the proposed simulator. There were some conflicting views across generation companies about the role of different technologies, including renewables, in providing restoration services.

A renewable developer commented that we talked a lot in our ambition about use of DER for Black Start but that there was a role to play for large-scale transmission connection renewables too. We agree, and through our competitive Black Start procurement events, any technology that meets the technical requirements can participate.

Also, in responding to our ambition consultation document, a supplier said it was vital that learnings from innovation projects (such as the Distributed Energy NIC project) became business as usual. These lessons should be extended into future scenarios such as ‘stationary’ and ‘cold’ starts where there could be a high dependency on electricity for transport and heat respectively. A stakeholder trade association also said that it welcomed our proposal to build on the findings from the innovation project.

4.4.6. Cost-benefit analysis

We estimate the benefits to be £5 million over RIIO-2. This gives an NPV of negative £8 million over RIIO-2. Despite our proposals having a negative NPV, it is important we open our restoration services to more providers including DER. We must also comply with the new restoration standard and build tools that can minimise restoration times.

Given the £115 million net benefit from 2025 to 2050 of our DER NIC project, we expect our proposals to deliver net benefits over the period to 2050. This is against a baseline assumption of continuing with current Black Start procurement activities.

This activity is not a strong enabler or dependency on any of our other activities. Our Distributed Energy NIC project does complement our work in Theme 2 to transform participation in balancing markets. The restoration decision support tool will complement the other tools delivered by our control centre architecture and systems activities.

Our proposals may pass some costs onto third parties. DNOs, TOs and restoration service providers will need to make investment to comply with the restoration standard that we will be conducting the assurance process for. DNOs and service providers may need to implement communication systems, depending on the proof of concept findings from the Distributed Energy NIC project, to participate in restoration services. We are confident that the benefits, including assurance of reduced restoration timelines, the ability for new technologies to provide restoration services and, for DNOs, the potential to be able to control restoration in their own area, outweigh these costs

See Annex 2 - CBA report section 2.3 for more details.

4.4.7. Proposed performance metrics

A potential metric to evaluate our performance would measure the number of parties providing restoration services. This is aligned to our ambition for carbon free operation, because many of these providers have traditionally been large thermal generation units. This metric could be audited and measures, and we have historical data to set an initial benchmark which would then be updated.

Theme 2
Transforming participation in smart and sustainable markets

Consumer priorities

- We want an affordable energy bill
- We want a decarbonised energy system, fit for the future
- We want a safe and secure energy system

Stakeholder priorities

- I want transparent and forecastable charges
- 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 you to facilitate active markets for a wide range of products and services
- I want access to comprehensive accurate and user-friendly information.

What this Theme covers

Transforming the markets and the frameworks that govern them to ensure maximum participation and efficient costs of managing the system

What we propose to do

Deliver closer to real time markets for balancing services to which all market participants 1 MW and above will have equal access. The markets will be accessed through a single integrated ESO markets platform transforming the process for market participation.
We will transform the process to amend our codes. We will also make the codes we administer more accessible and aligned across the whole electricity system.

What our Stakeholders have told us

Stakeholders have enthusiastically welcomed our proposals as they will transform the experience of participation in balancing markets, addressing many of their concerns with the burdensome nature of current arrangements. They have also welcomed our proposals that will enable them to more effectively drive and participate in code change.

What are the key benefits

In order to operate a carbon free electricity system we will need to attract significant volumes of additional flexibility services. Closer to real time markets accessed through a user-friendly platform will enable us to procure that flexibility at the lowest cost to the consumer. Codes that are more accessible to a wider group of stakeholders will facilitate greater overall market participation and more efficient outcomes for consumers.

5. Theme 2: Transforming participation in smart and sustainable markets

Theme 2 delivers £411 million of consumer benefits[53] Investment[54] for this Theme (2 year) £93.5 million

5.1. Five-year strategy

Efficient, well-functioning markets are essential if we are to operate a carbon free system by 2025.

Market arrangements supporting net zero

Our proposals support delivery of the UK's commitment to net zero by 2050 by:

- ensuring we can procure the flexibility and capacity required to operate a zero carbon system at least cost to consumers
- delivering close to real-time markets for balancing services that promote participation of all technologies including renewable generators and demand side flexibility
- providing open and accessible tools and processes for balancing services and the Capacity Market to remove barriers to entry for renewable and distributed resources, promoting participation of a wide technology base
- delivering industry frameworks and associated change processes that are accessible and usable for all market participants

We must run the system and deliver economical 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 by working with a wide range of stakeholders to develop the balancing service markets, ensuring our codes and charging arrangements are fit for the future and promoting competition in wholesale and capacity markets.

5.1.1. Build the future balancing service and wholesale markets

We know through extensive engagement that to deliver the required flexibility at the lowest sustainable cost to consumers, we will need to transform the markets that we operate. Changes will also be needed in how existing and potential service providers interact with those markets.

Service providers have told us it is time-consuming to participate in the markets we operate and that there are too many barriers, particularly for smaller players.

By 2023, all market participants of 1 MW and above will have equal access to all our balancing service markets. These balancing markets as well as the Capacity Market will be accessed by a single integrated ESO markets platform.

Closer to real-time markets will allow us to procure more efficient volumes of balancing services and help more providers to participate, for example those with demand-side response, storage and renewable sources of energy. An integrated markets platform will expand to allow participants to access the full range of ESO markets in a co-ordinated way.

We will be transparent in everything we do, ensuring market participants are treated fairly, both in purchasing services and how they are dispatched.

Existing and prospective service providers have told us that as new markets develop, for example at a distribution or community level, participants must be able to stack value by participating across these markets, regardless of who owns or operates them.

Common standards, data models and interoperable systems will be central in how we design our markets and their interaction with other markets.

As we transform the markets we operate, we also need to consider wider markets and how they interact to ensure they are individually and collectively fit for purpose.

As part of our longer-term strategy, we propose to lead a review of wholesale, balancing and capacity markets. By 2026, there will be a clear view across industry of how these markets need to evolve to deliver price signals in a world of high volumes of zero marginal cost plant. For more details see Annex 2 - CBA report section 3.2.

5.1.2. Transform access to the Capacity Market

By 2025, we will be trusted to deliver security of supply against a clear standard agreed with Government. We

[53] Consumer benefits are the net present value (NPV) of Theme 2's transformational activities over the RIIO-2 period. Our analysis suggested that accounting for market, delivery and third-party uncertainty the net present value could credibly be between £903 million and £228 million

[54] The ESO will generate a net saving for consumers in RIIO-2. The proposed investment in this chapter will help to deliver this net saving

will be responsible for key elements of the auction, advising the Government on the volume to procure, running auctions and managing contracts.

By transforming how we facilitate these activities, we will achieve security of supply through a technology mix that supports the UK's net zero ambition at the lowest possible cost to consumers.

All technologies will be able to participate in the Capacity Market equally and participants will feel that they are fairly rewarded for their contribution to security of supply.

5.1.3. Develop codes and charging arrangements that are fit for the future

We want our codes to facilitate the rapid change needed to meet the UK's net zero ambition. A wide range of stakeholders have told us, via the Code Administrators' Code of Practice Survey, that the process to change a code is too cumbersome and slow.

By 2025, our codes and code governance will be seen as an enabler of change, not a barrier. The codes we administer will be accessible and relevant to all users. Code modification will work for hundreds of market participants, rather than the tens of participants for which the current process was devised.

We will work with others to ensure that commercial, technical and regulatory arrangements across transmission and distribution will be far more joined up; for example, through a whole system Grid Code.

5.1.4. Costs and benefits

The graph below shows our proposed capex, opex and FTE numbers. The increased spend in 2021/22 reflects the outputs and activities that are due to be delivered at the start of RIIO-2, in line with stakeholder requirements. Details on how we have incorporated efficiency assumptions and benchmarked these costs are in chapter 3.

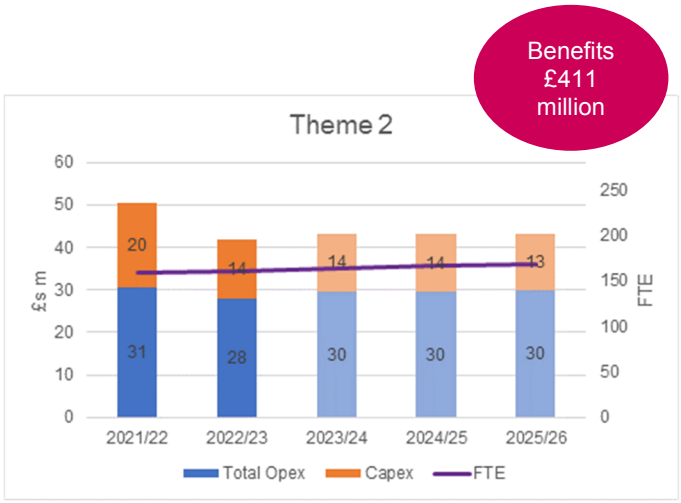


Figure 24

Our main benefit ambitions for the RIIO-2 period under this Theme are:

- Further 5 per cent reduction in the response and reserve prices, in combination with procuring optimised volumes, resulting in over £100 million in consumer benefits.
- Further two per cent improvements in Capacity market modelling accuracy which could unlock approx. £74 million in benefits.
- Over £300 million in reduced risk premia through working with industry to reduce BSUoS volatility and unpredictability.
- Realisation of FTE efficiencies across the energy industry for:
  - Capacity Market customers resulting from reduced barriers to entry for around 400 customers.
  - Grid Code users, around 500, total £6 million over RIIO-2.

We will maintain a focus on consumer priorities:

- An affordable energy bill through closer to real time markets operated through a single market platform enabling optimised cost and volume procurement.
- Energy available when needed through:
  - opening up markets to new providers 1 MW and above.
  - an enhanced platform for the Capacity Market, integrated in the ESO markets platform and optimised using the latest data technologies.
- A decarbonised energy system, fit for the future through:
  - facilitating activities enabling a Capacity Market operating with a technology mix that economically drivers towards net zero.
  - breaking down barriers to entry for participants crucial to meeting net zero targets such as renewable generation and providers of demand side flexibility.
- Safe and secure energy system through:
  - procurement of flexibility required to securely operate a carbon free electricity system at lowest cost to consumers.
  - a fully digitalised whole system Grid Code by 2025 and code governance that enables change, fit for all market participants.

We will measure our success by tracking:

- proportion of balancing services procured through competitive markets
- market liquidity and concentration
- customer satisfaction surveys.

5.2. Build the future balancing service and wholesale markets

More flexible energy will need to be purchased in future to manage a low carbon system. There is also lower availability of flexible generation such as combined cycle gas turbines (CCGTs) and coal plant traditionally used to manage the system. It is clear that we need to attract significant sources of new flexibility onto the system such as demand side response and storage.

Our stakeholders involved in providing balancing services have told us that our balancing products, markets, processes and IT infrastructure need to change. We have made significant progress and this will continue through our *Forward Plan 2019-21* over the next two years.

Much of the work to date has focused on simplifying and standardising products and this has led to significantly more competitive markets.

However, a step change is required to attract the volume of flexibility we will need in future and to manage the daily variation of this volume which depends on the generation mix on the system.

5.2.1. Costs

Build the future balancing service and wholesale markets	**Five-Year Strategy**					
	Two-Year BP					
	RIIO-1	**2021/22**	**2022/23**	**2023/24**	**2024/25**	**2025/26**
Capex (£m)	1.1	5.3	3.3	2.3	1.4	1.5
Opex (£m)	3.0	11.8	9.7	11.1	10.4	8.5
FTE[55]	34	55	52	54	56	55

Highlights

We will develop a single, integrated platform to transform access to ESO balancing markets and the Capacity Market. We will enhance participation and market efficiency through delivering a day ahead market for response and reserve.

Capex and opex in this area are driven by three major IT investments: Single markets platform, Auction capability and Ancillary services settlement refresh. Each investment consists of both a capex and an opex element. Where an investment is anticipated to be met either partially or fully by a cloud solution, this is treated as opex. The fall in opex in year 2 is a result of a drop in the project opex for the Auction capability and Ancillary Services settlement refresh investments. Further information on the IT investments referenced in this chapter (IT investment reference 400 - Single markets platform, IT investment reference 420 - Auction capability; and IT investment reference 410 - Ancillary services settlement refresh) can be found in Annex 4 - Technology investment report.

The remaining opex increases are a result of the additional people required to deliver enhanced capabilities to meet market requirements and the transformational activities in this section. More details are given below.

5.2.2. Ongoing activities and enhancements: Manage existing balancing services markets

We manage an end-to-end process to ensure that balancing and ancillary services are procured to deliver security of supply at lowest cost to consumers. Our work to reduce barriers to entry has helped to facilitate an increase from around 75 service providers in 2017 to over 250 today, including:

- rationalising our product suite to make it clearer to the market, and simplifying and standardising Response and Reserve contracts
- enabling wider access to the Balancing Mechanism (BM) programme with updated procurement processes so new aggregators and battery providers can participate alongside traditional large generators.

We have consistently evolved our approach to managing existing balancing and ancillary service markets in the RIIO-1 period as well as providing enhanced support to providers, including:

- streamlining the induction process for new service providers, including interactive guidance documents and webinars. We published an improved testing process for participation in our services
- publishing a detailed guide to contracting, tendering, and providing response and reserve services.

We will continue to evolve our markets and support to ensure as many providers as possible participate. Further improvements will include:

- delivering Power Available[56] to facilitate the participation of renewable resources in providing frequency response
- enhancing provider support with interactive guidance for each balancing service
- completing the replacement of our ancillary services settlement system.

Of the 34 people in the cost table for RIIO-1 above, 26 are delivering the Manage Existing Balancing Services

[55] Opex and FTE numbers are the average for the ESO since legal separation (years 2020 & 2021) which reflects the current ESO business. Capex figures are the average over the 8 years of RIIO-1.

[56] https://www.nationalgrideso.com/codes/grid-code/modifications/gc0063-power-available

Markets activity. For RIIO-2 we propose to increase the size of this team from 26 to 31 FTEs. We need more people to manage relationships and contracts with the growing volume and diversity of service providers. An additional three people will be required in 2022 to support delivery of the Ancillary service refresh IT investment (IT investment reference 410).

In April 2017, we had 75 service providers. Work to remove barriers to market entry, such as reducing minimum participation size for Fast Frequency Response (FFR) from 10 MW to 1 MW, has led to a significant growth in service providers to over 250 in 2019. More efficient processes and systems have enabled us to serve more service providers with less resource, with the ratio of service providers to employees in this area from around 3 providers per FTE in 2017 estimated to rise to more than 8 service providers per FTE in RIIO-2.

Our RIIO-2 proposals create new markets with lower barriers, such as procurement closer to real-time and reducing the minimum size of participation in all markets to 1 MW. We expect this approach to lead to significant growth and diversity of service providers during RIIO-2.

- One additional resource is required to support how we manage the increased volume of contracts as service provider numbers rise.
- One of the additional FTEs will manage the onboarding of new providers. This will include initial contact and query response as well as supporting providers through early testing and framework agreements.

Based on current TEC register numbers, 11 new interconnectors (~13 GW) are due to connect in the period 2021 to 2026. Work will be needed so that agreements are in place in time for these connections.

Significant efforts are also required to better integrate interconnectors into markets. Three FTEs will manage commercial relationships with interconnectors. If we assume 0.5 FTEs per new connection, efficiency has already been built into this FTE number, assuming not all projects will connect.

In RIIO-2, five people will continue with our current work to reform ancillary services markets. We are delivering much of the current change using virtual teams that heavily pull on colleagues who have demanding jobs delivering ongoing activities.

Competing priorities mean we face a bottleneck in being able to deliver multiple projects simultaneously. We have also been told by stakeholders that we need to deliver tangible change faster than our current capability allows.

Power Responsive

Power Responsive[57] is a stakeholder-led programme, facilitated by the ESO, to encourage more participation in balancing and ancillary services markets for the different forms of demand side flexibility (DSF) such as demand side response (DSR) and storage.

Power Responsive has played a significant role in transitioning demand side flexibility and provision of balancing services to become a mainstream proposition:

- We have moved from 20 to 30 participants in our original DSR provider group to regularly hosting over 200 attendees at our flexibility forums and summer events.
- Between 30 and 50 per cent of balancing services tenders in 2018/19 were received from demand side providers.

We will continue to evolve the work of the programme by introducing more regular and specific metrics and publications across:

- Distribution System Operator development and co-development of local flexibility markets through a variety of innovation projects
- Multi sector approaches focusing on opportunities for household, community energy, small business participation, zero carbon technologies, and electrification of heat in DSF.

Three of the 34 RIIO-1 FTEs in the cost table are delivering our Power Responsive programme. The size of this team will remain unchanged in the RIIO-2 period. This reflects our increasing maturity in performing our role with greater numbers of stakeholders and how we are expanding our engagement to new stakeholder groups.

[57] http://powerresponsive.com/

5.2.3. Transformational activities

The net present value of our Build the future balancing service and wholesale markets is estimated at £67 million, and to deliver £2.89 of benefits for every £1 spent over RIIO-2. The net benefits are positive from 2023/24 onwards.

We have made substantial progress in reforming balancing services markets in the RIIO-1 period. To be able to operate a zero carbon system by 2025 and meet stakeholders' needs we will need to transform both the markets where we procure balancing services and how service providers participate in those markets.

Procurement approaches for balancing services

Some system services, such as Frequency Response and Reserve, are procured as commodities through relatively mature liquid markets with large numbers of participants. We will transform these markets through removing barriers to entry and procuring them closer to real time.

As the market and system dynamics change we will increasingly need to procure other services such as stability (including inertia), voltage (reactive power) and thermal (to manage thermal constraints). For these less mature markets we are adopting a "learning by doing" approach. Pathfinder projects are allowing us to work with others to test different approaches to meeting these operability needs. Theme 3 sets out more detail on how we are introducing competition in to network development to identify the most efficient solution to longer term network needs. This could be a Transmission or Distribution network asset solution, a long-term contract with a service provider or a short-term market such as those for Response and Reserve. In this Business Plan our intention is to provide clarity on the key milestones in that process, signposting when key activities are happening and when learnings and next steps will be shared with the market.

Additionally, to fully realise the benefits of this work, we require the transformational investments in the control room from Theme 1. These investments will allow us to assess, optimise and dispatch the diverse players in these new markets.

To deliver the transformational activities detailed below in RIIO-2 we have budgeted for an additional six full time FTEs starting in 2021-2022.

To achieve our 2025 ambition, we need to progress on multiple, interlinked operability and market challenges.

The additional resources give us the core capability and capacity to do this while lessening the burden on teams delivering the Manage Existing Balancing Services markets activity. A further maximum of seven FTEs in year one will be needed to support three IT projects. This number will reduce in year two as projects develop.

5.2.3.1. A single day-ahead response and reserve market

Responding to stakeholder feedback received through our *System Needs and Product Strategy* consultation, in this price control period, we have launched an innovation project to trial a weekly auction for frequency response. We will use the lessons from this to build the foundations for a move to day-ahead markets. This has received strong support and we have been pushed to go further and faster.

In RIIO-2 we will respond to the requirement for efficient, safe and secure system operation and stakeholder needs by delivering a single day-ahead response and reserve market.

This will provide a transparent, open and regular procurement opportunity for all market participants. It will also give a robust market signal to support business cases and investment decisions for new flexible assets. Day-ahead markets are an important step towards our goal of ever closer to real-time markets.

At present, we tender separately for response and reserve through competitive monthly and quarterly markets. This far ahead of real time, we cannot forecast the generation mix on the system on any single day. We buy access to minimum volumes of response and reserve which are towards the lower end of our daily requirement.

For frequency response, the daily variation above this level is managed using mandatory response capability on CCGTs and coal plant. This plant will run less frequently in the future and so a new approach is needed.

In future, we could simply buy enough volume at the month or quarter-ahead stage to meet our view of the maximum we would need to buy on any single day. However, this would result in purchasing significantly more volume than we would require in practice. It would dramatically increase costs to consumers.

A much more cost-effective way of managing the volume variation in the future is to move our response and reserve markets closer to real time. At the day-ahead stage there is more certainty about the plant mix that will be on the system.

By moving our markets to day-ahead, or even within-day, we can optimise the volume of response and reserve that we buy through competitive markets against the volume of response provided by mandatory products. This minimises the risk that market signals are distorted. These two factors will result in a liquid, transparent market that provides a clear and consistent price signal for investors and drives down costs to consumers.

In addition, these changes would also remove a barrier to entry for sources of flexibility such as wind, solar and DSR and they are strongly supported by these market participants. Such providers have told us they find it difficult to participate in the current monthly tenders. Their availability to provide services is highly uncertain

at the month-ahead stage. There is greater certainty of their available volume at the day-ahead stage and so they can optimise their bidding into the markets much more effectively.

To maximise market participation and liquidity it is vital that providers can make informed decisions about participation in local and national markets. Consistency and alignment of local and national markets will also be important for maximising participation and consumer value. We will work with stakeholders, including DNOs, to ensure that ESO markets are consistent and coordinated with other markets.

In early 2021/22, we will start by procuring frequency response in day-ahead timescales. At the end of 2021/22 we will begin procuring reserve through new products.

We will build on these steps to deliver the full co-optimised auction for Response and Reserve at day ahead or even closer to real time in 2022/23.

Our proposed headcount to deliver these activities is as follows:

- An extra two people are required in 2021/22 for balancing services development, with a further one person in 2022/23. This requirement drops later in the period back to two additional people in 2024/25 and one in 2025/26. These people will be delivering 'first of kind' commercial solutions solving long-term operability challenges. This represents a fundamental change from our current work to improve balancing services markets through standardisation and simplification.
- The increase in 2021/22 and 2022/23 reflects the level of upfront work in the first few years of RIIO-2 ahead of getting contracts in place to support zero carbon system operation in 2025. We assume efficiencies towards the end of the period, as markets and processes mature, allowing us to scale down resource
- In order to deliver a whole system approach to ESO markets, starting in 2022/23, one FTE will primarily engage with DSOs and other stakeholders. This will involve defining new ways of working to ensure that local and national markets are consistent and aligned.
- We currently have less than one full time resource available to cover the current level of activity is this area. With the anticipated increase in distributed generation and advent of flexibility procurement at the distribution level, in the RIIO-2 period we expect this activity to ramp up significantly. It is likely to require at least double the existing resource in this area from 2022/23. The number of people working on whole system markets is expected to rise to three in the last years of the period. This reflects the developments of the electricity distribution price control and the expected increase in market development at the distribution level. In 2021/22 an additional 3 people will be supporting delivery of the whole system aspects of the IT investments in this area including the single market platform, ensuring interoperability with other markets. This will drop to two people and then zero in 2025 as the projects mature.

A sandbox, experimental market environment

We will adopt a 'learning by doing' approach as we transform balancing services markets and enhance procurement through the Single markets platform. This will include trialling potential solutions through an experimental market sandbox environment.

Alongside our established markets, we will use the sandbox to test ideas such as markets for new services with the industry in a dynamic way. The sandbox will open doors to more innovation, enabling us to work with third parties to find new market solutions that can be tested out in a similar way. The sandbox means we can support new market entrants and technologies, while increasing speed to market.

We currently trial new approaches through integration and testing with operational systems. This can be slow because we need to protect operational processes. The market sandbox is an offline environment allowing us to test new balancing services products and markets with a subset of market participants.

We will be able to see if the approaches tested provide the outcomes required to operate the system securely at least cost. It will also tell us if the new approaches meet the needs of service providers. With the insight from the sandbox we can better target investments in operational systems with higher confidence that they will deliver the desired outcomes. Using this approach, we will reduce the 'regret spend' in developing and testing new products and ultimately drive down costs to consumers.

The market sandbox environment will be able to use outputs from the digital twin virtual system operation environment too. This will inform us on which services we need to procure to operate a secure system.

5.2.3.2. Stakeholder feedback

We asked stakeholders if they agreed with our approach to transforming markets through industry association roundtables, the Power Responsive Steering Group, bilateral meetings and at our RIIO-2 engagement events.

Many stakeholders, particularly renewable and decentralised parties, endorsed our approach to markets because deep, liquid markets can provide a strong investment signal.

We have received some feedback from an ERSG member that we should go closer to real time than day-ahead i.e. within-day. Conversely, some stakeholders, including generators, have told us that long-term contracts are needed to incentivise investment in new assets to provide services.

ERSG supports Theme 2 with conditions.
"The group agrees that action should be taken on codes and Capacity Market arrangements but questions whether it is the ESO's place to do this, and whether these decisions will be taken elsewhere.

While we believe that close to real-time markets will be our standard for established balancing services markets, longer-term contracts may be appropriate for procuring services to meet long-term system needs (see box – procurement approaches for balancing services).

We have also heard from current and potential service providers that we need to be clearer on how our RIIO-2 proposals will build on work we have already started. Our investment roadmap now shows how the market platform will build on our ongoing work to reform markets in RIIO-1.

5.2.3.3. A single, integrated platform for ESO markets

The single markets platform is designed to remove the current pinch points identified by stakeholders and make participating in a range of markets easier.

This one-stop-shop will provide a portal as the focal point for parties of 1 MW and above to participate in all our ESO balancing service markets. It will also provide access to the Capacity Market and the Contracts for Difference (CfD) auctions.

The platform will provide both historical and forecast data to support market participants' investment cases and decision-making. We will expand the platform as other markets develop to allow the integration and data sharing required for efficient decisions across markets.

While our market platform will provide a route to participate in all ESO markets, service providers have impressed upon us the importance of common standards with other flexibility platforms, particularly at the distribution level. We will work with DNOs and others to ensure that common standards, including interoperable systems, a common data model and shared minimum specifications are central to the design and delivery of the single market platform. This interface will also allow the ESO and DSOs better visibility of what services are being provided to whom, as well as any network limitations on service provision.

The foundation of the platform will be an asset register identifying each unique asset on the transmission or distribution system that is participating in the markets.

Participants will be able to manage their portfolio by aggregating assets from these underlying components to participate in the markets. Extensive stakeholder engagement has told us that this will transform the experience and make participating much more efficient for service providers.

Many of the existing processes require service providers to use different methods and systems to register and take part in our balancing markets. This creates an administrative burden on both market participants and the ESO. Manual input also increases the risk of human error and associated rework.

The market platform will significantly reduce the time and effort required to participate in markets:

- Communications on processes including contracting, testing, procurement events, performance monitoring and reporting, payment and portfolio management will move from email to communication via the portal. This will put all the relevant information in one place.
- Data input and management for processes including procurement events and performance monitoring will move from offline spreadsheets to data management and communication via the single market platform.
- Messaging capabilities and validation rules will enable online decision support, for example by telling market participants which markets their assets are eligible for. The system will also notify them if they are submitting non-compliant information.

The market platform will significantly reduce the overhead of market participation by streamlining the number of process steps, manual input and checking. This will make market outcomes more efficient.

Delivery of the market platform will build on the Platform for Ancillary Services (PAS) project in RIIO-1. We will integrate the single markets platform with our control centre capabilities. More services and functionality will be added through the first two years of RIIO-2, starting with frequency response in day-ahead timescales early in 2021/22. New reserve products will be procured through the platform towards the end of 2021/22.

The market platform will also employ the user interface capabilities delivered through the Digital Engagement Platform investment. This will provide ESO stakeholders with a common experience across all our digital interfaces, including the data portal and the connections portal.

Two of our proposed six new resources will be focused on delivering auction functionality for closer to real-time markets as well as ensuring that access to new markets is integrated through the market platform. This is a new activity. An additional four people will be required to support the delivery of single market platform in 2022 and 2023, this will tail off in the later years as the project is delivered.

5.2.4. Investment roadmap

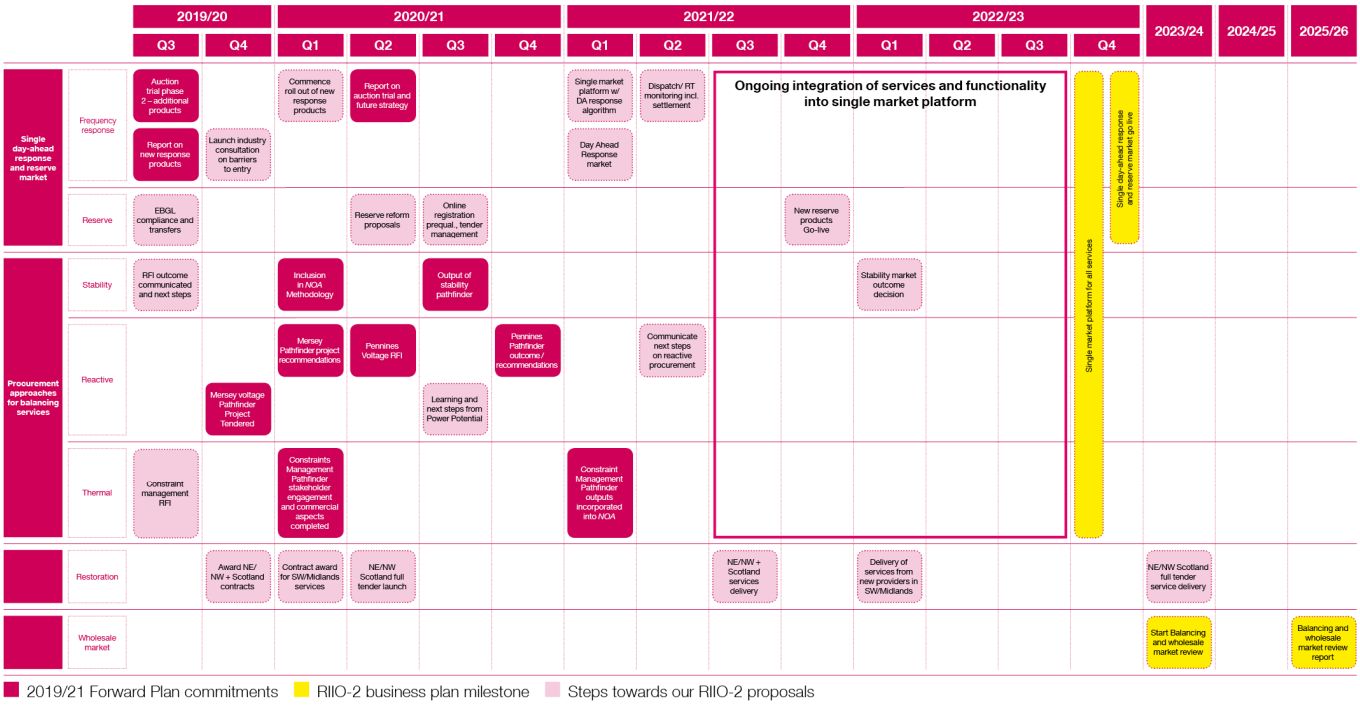


Figure 25

5.2.5. Stakeholder feedback

We asked stakeholders if they agreed with our approach to transforming access to our markets via the markets platform through industry association roundtables, the Power Responsive Steering Group, bilateral meetings and at our RIIO-2 engagement events.

A broad range of stakeholders including generators, suppliers and aggregators endorsed our proposal to streamline market participation through the markets platform. They find the current approach of managing assets, particularly aggregated assets, in the markets extremely cumbersome.

Smaller market participants have welcomed this proposal too because a significant amount of their time is spent participating across different markets. The markets platform is seen as important in making the process faster. A community energy group has told us that market entry down to 1 MW would encourage participation from community energy-scale generation sites.

Many parties participate in both the balancing services markets and the Capacity Market. Looking at their feedback on the separate markets, we recognised that they experience similar pain points in both. There is significant duplication of effort in managing their participation across both markets.

We have responded to stakeholder feedback by moving away from our original proposal of a new platform for balancing alongside an improved Capacity Market portal. Instead, we will create a single integrated platform. This approach will also be simpler to build and maintain than two separate systems.

Our proposal to register individual rather than aggregated assets was widely welcomed by a diverse range of service providers. Together, these changes allow participants to manage their portfolio of assets flexibly in a single location. It will significantly reduce the cost of participating in markets.

We have been told consistently by service providers that we need a joined-up approach to flexibility procurement with distribution markets. At the same time, we were cautioned not to over-extend ourselves by trying to procure flexibility services for both transmission and distribution system needs.

Therefore, in this Business Plan we have clarified that the ESO market platform will provide access to markets administered by the ESO. We have also heard from a number of service providers and a DNO that we should draw out more clearly the transmission-distribution aspects of our proposals and reflect the importance of aligning national and local flexibility markets.

We have made it clearer that the ESO market platform will interface with other market platforms, including those at the distribution level, and that we will work closely with DNOs when the distribution level is involved.

Service providers and an industry association have also emphasised the importance of a robust consultation process with industry throughout the design of the platform. They said that IT system development must be pursued in a way that avoids missed deadlines or delivery failures.

In order to achieve this objective, delivery of the market platform will align closely with the Design Authority described in Theme 1.

5.2.6. Cost-benefit analysis

We estimate the benefits here to be £106 million over RIIO-2. This gives an NPV of £67 million over RIIO-2.

The quantitative benefits were calculated firstly by considering the liquidity of the reserve and response market – about £500 million on a 12-year average. Based on our Power Responsive work we have seen prices drop and estimate that a further 5 percent reduction is credible for these activities.

Secondly, we have looked at buying optimal volumes of response – about £190 million on a 12-year average. Again, based on our previous experience of moving closer to real time we estimate a further 5 percent reduction is credible.

This is against a baseline assumption of the existing participation in balancing and capacity markets without a single platform or reduced participant size to 1 MW.

This activity is dependent on the following transformational activities:

1. Control centre architecture and systems (Theme 1) – Ensuing the control centre has the tools required to dispatch new players in the reserve and response markets
2. Open Data – Ensuring that the data flow between the ESO and participants is open allowing participants to understand the market requirements

This also enables, though competitive flexible markets, the following transformational activities:

1. Taking a whole electricity system approach to promote zero carbon operability (Theme 4)
2. Transform access to the Capacity Market (Theme 2)
3. *NOA* enhancements (Theme 3)
4. Open Data - Providing additional data from competitive markets

In order to deliver this activity, we require third parties to engage with the new system and markets, there may be small costs associated with adapting to these new arrangements, but we believe these are within the scope of third parties ongoing investments.

Our analysis suggested that accounting for market, delivery and third-party uncertainty the net present value could credibly be between £3 million and £115 million.

See the Annex 2 - CBA Report section 3.1 for more details.

5.2.7. Proposed performance metrics

We will measure the proportion of balancing services that are procured through competitive markets.

We will do this firstly by identifying all the services that we think should be procured through markets to deliver the best outcome for consumers. We will then measure the proportion of these services (by appropriate unit such as MW of service requirement provided) that are procured through competitive means such as auctions or tenders as opposed to bilateral contracts. We will be able to monitor our progress over time and track the impact of key actions.

This will promote consumer value by ensuring we are striving to buy the optimal volume of balancing services via the lowest cost approach. We believe this is a good measure because while many factors influencing the ultimate cost of balancing services are outside our control, the means of procurement are within our control.

Service providers and industry associations consulted have told us that this would be an appropriate measure.

5.3. Transform access to the Capacity Market

We manage an end-to-end process for all Capacity Market participants, supporting them through pre-qualification, multiple annual auctions through to the issuing and management of capacity agreements. We are also responsible for running the pre-qualification and auctions for Contracts for Difference (CfD).

The number of applications for participation in the capacity market: has risen fourfold since the start of EMR in 2014, and the number of units below 100 MW has increased by 200 per cent. In 2017/18 we received almost 2000 applications of which 91 per cent were below 100 MW.

By 2025, the ESO will deliver security of supply against a clear standard agreed with the Government. We will be responsible for key elements of the Capacity Market; advising the Government on the volume to purchase running auctions and managing agreements.

By transforming our approach to these activities, we will ensure security of supply through a technology mix that supports the UK's 2050 carbon reduction target at the lowest possible cost to consumers.

All technologies will be able to participate in the Capacity Market fairly and participants will feel that they are appropriately rewarded for their contribution to security of supply.

We will deliver an enhanced platform for the Capacity Market within the single, integrated ESO markets platform. This will build on the new EMR portal we are currently developing. It will also use the latest data technology to guide participants through the process.

We will also improve our security of supply modelling to keep pace with technological and market changes.

The EMR function is split into three areas: EMR Stakeholder and Compliance; Capacity Market & CfD Auctions; and EMR Modelling.

5.3.1. Costs

Transform access to the Capacity Market	Five-Year Strategy					
	Two-Year BP					
	RIIO-1	2021/22	2022/23	2023/24	2024/25	2025/26
Capex (£m)	4.6	1.2	0.9	0.9	0.9	0.9
Opex (£m)	3.0	5.2	4.7	4.7	4.4	4.4
FTE	32	35	34	34	31	31

Highlights

We propose to improve our security of supply modelling capability to account for greater interconnection, intermittent and distributed generation. We will continue to support the Capacity Market process though improving service to customers and making our online-based services more efficient and able to support our customers more effectively.

Further information on the IT investments referenced in this chapter (IT reference 320 - EMR and CfD Improvements) can be found in Annex 4 -Technology investment report

5.3.2. Ongoing activities and enhancements

In the changing energy landscape, we support new and existing participants that wish to compete in evolving capacity and CfD markets. We ensure that our processes and systems comply with all EMR rules and regulations, and we support stakeholders to ensure that they are compliant through the EMR processes. Our ongoing activities include:

- creating guidance documents, hosting workshops and surgeries and running a dedicated help desk to deal with customer queries
- working with BEIS, Ofgem and stakeholders to ensure rules, regulations and processes enable competitive capacity procurement and facilitate participation of new technologies and players
- working with BEIS and Ofgem to implement the longer-term solutions identified in their Five-Year Reviews. As part of this, we will support the development, and drive the implementation, of the Capacity Market and CfD rules.

We are starting a project to improve the EMR portal significantly during the RIIO-1 period. This will be done to facilitate the implementation of rule changes in a swift and efficient way. We are enhancing the portal in response to stakeholder feedback. Parties want a system that is easy to use and enables them to navigate the process painlessly.

Simpler rules and the latest data technologies will enable participants increasingly to use the portal for self-service. Together with greater automation of our processes, this will enable us to focus on dealing with more complex customer queries.

We provide modelling expertise to inform Government decisions on future capacity market auction parameters and electricity security of supply. We will continue to improve our modelling in RIIO-1 and we will engage with stakeholders to develop our analysis.

5.3.3. Transformational activities

The net present value of transform access to the Capacity Market is estimated at £62 million, and to deliver £8.16 of benefits for every £1 spent over RIIO-2. The net benefits are positive from 2022/23 onwards.

As shown above we continue to improve our approach to compliance and stakeholder engagement in RIIO-1. To achieve our ambition to be able to operate a zero carbon system by 2025 and meet stakeholders' needs, we will need to transform the processes to help facilitate market participation.

5.3.3.1. Deliver an enhanced platform for the Capacity Market within the single, integrated ESO markets platform

In future, we will need to maintain security of supply with much higher volumes of low carbon generation. There will also be a significant increase in flexible sources of energy, such as demand side response and storage.

We will work with stakeholders to improve customer experience and ensure our systems and processes do not act as a barrier to entry. Instead, they should facilitate wider market participation.

As described under the Single markets platform, participants have told us that this platform will improve their experience of market participation, improving decision making, reducing costs and ultimately will help to drive further market efficiencies by reducing barriers to entry for all Capacity Market participants. The latest data technologies will be used to help participants understand how they can participate in the Capacity Market and will guide them through the process.

Stakeholder feedback

Stakeholders have broadly welcomed the inclusion of the Capacity Market in the markets platform. It makes it easier for them to make decisions to optimise their participation across multiple markets and reduces administration.

5.3.3.2. Improve our security of supply modelling capability

In a world of rapidly evolving energy systems, we will need an increase of two highly skilled analysts capable of employing the latest modelling techniques so that we can keep pace with these changes.

We will need to develop new data sets, models and methods to correctly model the growing interactions of non-conventional plants. This will ensure their contributions to security of supply remain appropriate and help to ensure the GB Reliability Standard is met.

To facilitate this enhanced modelling, we need access to granular data for all demand and generation sites' output. We also require capacity data so that smaller flexible sources can be modelled correctly. Our models will need further development to model the contribution from new combinations of technologies e.g. co-located or hybrid sites where there is a network connection limitation.

With growing interconnection across Europe and between GB and other countries, our pan-European modelling needs to adapt to model different markets. For example, this would include participation of interconnectors and/or foreign generators in the Capacity Market.

This will require significant development of the model and data collection to correctly model the interactions of future plant mixes within Europe. It will have to factor in the different operating regimes and security of supply standards across the various European capacity markets.

We intend to continue to use the established prioritisation process with BEIS, Ofgem and the PTE to decide which modelling developments to undertake.

However, in 2021 and 2022 it is likely that these will focus on enhancing the modelling for distributed generation, duration-limited storage and demand response. We will maximise use of the data from the DCUSA modification, scheduled for approval in 2020.

In addition, we also expect to improve our pan-European modelling in 2021 and 2022 as this coincides with the connection of new interconnectors to Europe and implementation of the Clean Energy Package. This could lead to foreign generators participating in the Capacity Market.

5.3.4. Investment roadmap

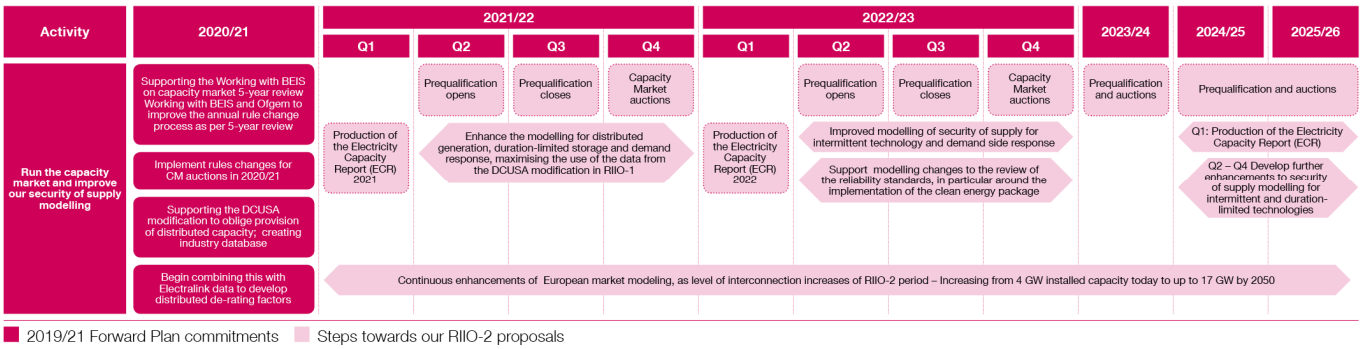


Figure 26

5.3.5. Stakeholder feedback

The EMR analysis role is seen as a core ESO activity. Capacity market participants recognised the need to enhance our modelling tools to correctly analyse the growing interactions of new technologies.

Many stakeholders agree that, to facilitate this enhanced modelling, the ESO requires access to more granular data for all demand and supply sources and that our analysis would need to be developed to be able to model the contribution from new combinations of technologies such as co-located or hybrid sites.

5.3.6. Cost-benefit analysis

We estimate the benefits here to be £74 million over RIIO-2. This gives an NPV of £62 million over RIIO-2.

We calculated the quantitative benefits stated above by firstly considering the enhanced modelling capability.

These enhancements will look to ensure the capacity auction purchases the most accurate volumes of capacity. The average capacity purchased over previous auctions was about 50 GW – based on reasonable estimate of forecast accuracy improvement of two per cent (see for example EMR forecasting incentive) or 1 GW.

Based on average auction prices of around £17.08/kW, this leads to a saving for consumers of around £17 million a year.

Secondly, by reducing barriers to entry, we will remove the need for unnecessary resource for the around 400 Capacity Market customers, and this saving will ultimately be passed through to consumers.

This is against a baseline assumption of the existing participation in capacity markets and only ongoing modelling capability.

This activity is dependent on the following transformational activity:

1. Transforming participation in balancing and capacity markets (Theme 2) – Sharing the Single markets platform

In order to deliver this activity, we require third parties to fully engage with the new system, there may be small costs associated with adapting to these new arrangements, but we believe these are within the scope of third parties ongoing investments.

Our analysis suggested that accounting for market, delivery and third-party uncertainty the net present value could credibly be between £94 million and £22 million.

See Annex 2 - CBA report section 3.3 for more details.

5.3.7. Proposed performance metrics

As proposed earlier in the Business Plan we will be aiming to increase the liquidity of the capacity market during RIIO-2, to measure this we propose to measure the amount of capacity that successfully pre-qualifies against the amount of capacity that is available in both the T-1 and T-4 auctions expressed as a ratio. This ratio between pre-qualified and available capacity can indicate the liquidity of the market, the greater the ratio the lower the cost to consumers through more competition in the marketplace. We would measure, target and report T-1 and T-4 auctions separately due to the separate nature of the processes here

Will are also proposing a metric on the accuracy of both the T-1 and T-4 peak demand forecasts where we would measure the percentage difference between our peak demand forecast vs outturn peak demand. The accuracy of our forecasts impacts on how much capacity is secured in the auction vs security of supply, and therefore how much consumers pay thus there is a direct benefit to consumers in the measurement and increased accuracy of the T-1 and T-4 forecast. We would measure target and report T-1 and T-4 separately for the same reasons above.

5.4. Develop code and charging arrangements that are fit for the future

Stakeholders have consistently told us that the current codes and code processes are not fit for purpose. There are currently 11 separate industry codes and over 10,000 pages of codes and other licence documentation which participants must follow.

We want our codes to facilitate the rapid change needed to deliver the UK's 2050 net zero requirement. By 2025, our codes and code governance will no longer be seen 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 engaged stakeholders on our roles in codes and charging arrangements. We have done this through our customer journey work, our RIIO-2 webinars, code panel meetings, bilateral meetings and with trade associations.

We also sought views on our ambitions and proposals at our RIIO-2 stakeholder events. We sought views on the proposals in the first draft of the Business Plan published in July at stakeholder events and meetings with industry associations.

The aim of this work is to transform the process to amend our codes. It will allow strategic change to be prioritised and implemented efficiently, while ensuring that it is much simpler and less time-consuming to make incremental improvements. This will improve access for all participants and give us the flexibility to deliver forward-looking change much more quickly.

Transforming the codes process will also deliver important consumer benefits in both the near term and in the longer term. Modifications will be delivered more efficiently, innovation encouraged and there will be greater harmonisation across systems. This all ultimately contributes to more efficient and competitive markets, reducing wholesale market costs and creating consumer benefits.

The ongoing Energy Codes Review could have the potential to change some of our plans in this section. As a result, our draft costs and deliverables will require further consideration. We continue to contribute to the Energy Codes Review and will provide further updates in our next iteration of our Business Plan.

5.4.1. Costs

Develop code and charging arrangements that are fit for the future	Five-Year Strategy					
	Two-Year BP					
	RIIO-1	2021/22	2022/23	2023/24	2024/25	2025/26
Capex (£m)	8.9	12.9	10.3	10.5	11.4	10.9
Opex (£m)	7.1	14.5	13.7	14.6	15.4	16.7
FTE	50	69	74	75	79	83

Highlights

We will step up our European engagement as code changes here will support zero carbon operation in GB and across Europe. We will also need to invest in IT to support these changes across the ESO. We will drive our ambition to transform the codes process, with an increasing focus on customer service, prioritisation of code modifications and strategic thinking. A one-off investment in 2021/22 is for our charging and billing asset health project.

Further information on the IT investments referenced in this chapter; (IT reference 270 - EU regulation; IT reference 280 - GB regulation, IT reference 290 - Charging and billing asset health; IT reference 300 - Charging regime and CUSC changes; IT ref 330 - Digitalised code management) can be found in Annex 4 - Technology investment report.

5.4.2. Ongoing activities and enhancements

Code management / market development and change

We facilitate changes to the Grid Code, Connection and Use of System Code (CUSC), System Operator Transmission Owner Code (STC) and Security and Quality of Supply Standards (SQSS); working with the principles of being open and transparent about the change process and enabling all parties to contribute their views. We also deliver and support regulatory change across key markets and codes to better facilitate competition and deliver strong consumer benefits. Our ongoing activities include:

- providing thought leadership and working with key stakeholders to enable the prioritisation and delivery of key future framework changes over a 10-year timescale.
- administering our codes as a Code Manager with enhanced legal capabilities to help drive strategic change. We will also increase our ambition to

deliver both strategic and incremental change to facilitate competition and deliver consumer value.

Transformational activities in this area will be covered by the transform the process to amend our codes activity described below. This also includes further details on our Code Manager activities.

EU code change and relationships

The GB electricity system is interconnected with our European counterparts. We therefore play an important role working with domestic and European institutions and stakeholders to support a well-functioning market that delivers in the interest of consumers.

Our activities range from advocacy and shaping emerging legislation, to implementing requirements in our processes, systems and frameworks, and delivering ongoing compliance and reporting obligations.

There are numerous ENTSOE working groups and expected consultations from ENTSOE and institutions such as the European Commission, ACER and Ofgem that will affect GB consumers over the RIIO-2 period.

This includes the continued implementation of changes related to the Third Energy Package, new changes as a result of the Clean Energy Package, and a potential new legislative package in future under the new European Commission. The scale of the energy transition has meant that ENTSOE's remit has been growing year on year, today there are more priorities and topic areas than ever before and as the ESO we provide resource around 50 working groups at any one time.

Over RIIO-2, we will increase the size of the team supporting this area to step up our presence in the key working groups and ensure we respond to consultations where we can influence on behalf of the GB consumer. We believe the current team is under resourced to deliver today's workload - this has been noted by stakeholders' in terms of attendance at meeting and contributions to EU consultations. The current team calls on resource across Future Markets, creating a "virtual team" of seven. Based on the increased workload a fulltime team of seven would be able to fully engage here. Thus, a fully resourced team to deliver EU obligations is 14, assuming the UK remains closely aligned to ENTSOE. This means seven additional FTE to support the increase in European engagement required and seven FTE to support the requirements to support European code change IT investments which are required to deliver this change into the ESO. This level is based on our previous experience in implementing European code changes, with an additional efficiency assumption.

Industry revenue management

We are responsible for managing, collecting and disbursing charges relating to the operation of the transmission system with an annual value of around £4 billion. We are committed to having charging and billing processes that meet the needs of our customers. As the market changes, and as transmission and balancing charges evolve, we recognise the need to ensure that arrangements for how parties pay their charges keep pace.

Over the RIIO-2 period the focus will continue to be on delivering the transformation of customer experience whilst also ensuring that we can deliver efficiencies in how we run the processes over time. This will include delivery of new charging tools and processes such as better digital interfaces for our customers and more flexible processes and systems to implement the pipeline of changes to network charges as they come into force over this period.

Ofgem's 28 August consultation asks whether it could be more efficient for the revenue collection risk that the ESO bears to be borne by another party. Ahead of further consideration of this issue, our Business Plan assumes that the revenue collection risk of this role remains with the ESO.

Enhancements made during RIIO-1

Code Management

We are facilitating significantly more modifications a year, from an average of 24 new modifications a year across 2013-15 to 42 being raised in 2018. In 2017 we launched Charging Futures to facilitate balanced industry-wide debate on future network charging reform and more recently we have undertaken a Customer Journey setting our forward improvement agenda to improve our service.

Market development and change

Throughout RIIO-1 we led and supported on significant changes to industry codes to better facilitate competition and to deliver significant consumer benefits. We continued to do so despite the increasing scale and complexity of change and the significant changes to markets we have seen over the RIIO-1 period. The breadth of these changes varied from targeted changes to more fundamental reforms such as in relation to Project Transmit or through revisions to the User Commitment Methodology. In recent years, due to the increasing challenges and expectations of others and ourselves, we have also become more ambitious in our change, such as with the launch of the Wider Access to the BM programme. We expect this ambition to continue to increase in future.

EU code change and relationships

We have implemented requirements from the Third Energy Package and European Network Codes, which include improvements to support to cross-border trading of electricity and approach to integrating renewable energy. To support our activities, we have introduced an annual prioritisation processes to ensure we are effectively participating in ENTSOE working groups and engaging with GB stakeholders. We have also re-structured and re-prioritisation of our internal operating model for European activities. More recently we have been conducting EU Exit preparatory activities internally

and externally, including engaging with government, Ofgem and stakeholders

Charging arrangements

Our focus is to transform the customer experience for network charging; helping our customers be successful ultimately driving down costs to end consumers. This is being achieved through delivery of a pipeline of improvements including the way we deal with charging queries, improved guidance and education materials and a licence change to allow us the option to roll the reconciliation of adjustment to ESO incentive outcome to future years. This will increase certainty around the BSUoS charges market participants face as a result of incentive payments incurred by the ESO.

Our *2019-21 Forward Plan* highlights the further enhancements we will undertake throughout the rest of the RIIO-1 period

5.4.3. Transformational activities

5.4.3.1. Transform the process to amend our codes

BEIS-Ofgem Energy Codes Review

The Government and Ofgem have launched the Energy Codes Review, which is a joint comprehensive review into the energy codes that govern our energy system. The aim of the review is to consider options for improving the existing arrangements, including scope for fundamental reform.
This suggests a range of options for improving code processes and governance, through the potential for merging some codes and enhancing the role of code bodies to radical change to the structure of code governance such as the introduction of a Strategic Body or an Integrated Rule Making Body.
We are taking a leadership position in this review and have recently published a thought piece on our views. We will advocate for changes aligned with our desire to transform the process to amend our codes and continue to review the scope of this transformational activity as our thoughts on the Energy Codes Review develop in future.

This activity will allow the strategic change that stakeholders are really pushing for to be prioritised and implemented efficiently, while ensuring that it is much simpler and less time consuming to make incremental improvements. We will develop a transparent prioritisation process and agreed criteria that are aligned to the strategic direction set by BEIS and Ofgem. Stakeholder-led change will continue to be important and will feed into this process.

The electricity system is currently transitioning from a world with large, transmission connected thermal plant to small, distribution-connected renewables. It is also changing from a static, passive consumer base to a dynamic, engaged one. The existing code system is not fit for purpose in this new world. Without action, it will continue to be an increasing barrier to innovation, competition and consumer value.

Effective involvement in the code system and the code change process requires technical expertise and significant resource. This means that engagement with the codes system is disproportionately low for newer and smaller parties due to resource constraints and the high costs of participation. In turn, this allows larger incumbents to dominate the code change process.

Overcoming these challenges requires greater accessibility for all participants and the flexibility to deliver forward-looking change at much greater pace. Codes and code governance processes need to transform from being viewed as a blocker to change, to becoming a key enabler to facilitate this transformation and the ability to operate a zero carbon system from 2025.

As Code Manager under a transformed process to amend our codes and building upon our Code Management foundations, we will look to:

- create and own a strategic and incremental industry change plan in respect of our codes.
- seek more explicit powers to assess and prioritise code change to ensure the delivery of more strategic change which is expected to be of benefit to consumers.
- seek more explicit powers for managing the change process. This will help ensure change is delivered at pace, relevant modelling is undertaken if not available, and we have more ownership of change development and delivery throughout the process.
- place more emphasis on engagement with wider stakeholders outside our standard working groups. For example, by continuing to embed and learn lessons from the approach taken through Charging Futures.
- make better use of technology through initiatives such as code digitalisation, a more customer-friendly and accessible website, and better information management and communication channels.
- provide better user guidance and supporting documents that support self-service, but also have a service-focused and well-resourced team available to be a great critical friend where stakeholders require. Support could include an allocated code account manager as well as industry training events on certain elements of the code.
- take on additional responsibilities for developing code modification and directing incremental improvements for our own codes. For example, analysing and modelling change proposals, engaging stakeholders on proposals and developing options.

Building on the foundations of market development and change, we will also look to:

- place extra emphasis on larger and more co-ordinated programmes of work for our codes, in line with wider industry strategy. For example, we would take a more active and leading role in strategic change, particularly in relation to ongoing charging and access reforms, and Charging Futures responsibilities.
- give more focus to other industry change, which is less directly relevant to ESO but where we feel we could add value to the process and. For example, for incremental and strategic change we could become more involved in other markets and codes, such as Balancing and Settlement Code (BSC[58]) or Distribution Connection and Use of System Agreement (DCUSA[59]) changes as and where we believe we could add value as ESO. In one example, Elexon[60] is currently leading a design working group for market-wide settlement reform. This is expected to have significant positive consumer impact, unlock flexibility and impact our own codes and processes, but we have had limited involvement to date. In our transformed position, we would aim to be much more involved in similar programmes in the future and bring an additional ESO perspective.

Therefore, in 2021 and 2022 under new regulatory and funding arrangements provided by RIIO-2, we will seek a licence change to support the code transformation process. We will look to enhance our code management powers and responsibilities and, in parallel, further drive the agenda for both strategic and incremental code change. We expect that an element of this change will be reform of the code change process itself. This will ensure it facilitates agile, consumer-focused change, and is not an obstacle to such change. This will initially require an additional five FTE who will, in collaboration with the wider industry, start to transform code processes to begin our transition into a Code Manager. Further details of the activities that will be undertaken by our Code Manager role are highlighted in this section, but key early focus of the team will be on process development to create and own a strategic and incremental industry change plan in respect of our codes.

In addition, we will also be seeking more explicit powers to assess and prioritise code change and seek necessary amendments to the management of the change process. We believe an incremental approach, rather than a one-step implementation, will best deliver this process transformation allowing the gradual build-up of skills and capabilities alongside the corresponding legislative changes required to fully fulfil our ambition.

An incremental transformational programme will also allow the current FTE to continue to focus on implementing important industry change. The increase has been developed by considering: benchmarking against other code administrators such as for the Smart Energy Code; the volume of potential code change driven by the low carbon transformation; as well as the volume of resource committed by Ofgem to support Significant Code Reviews which we believe is a large undertaking for a Code Manager which will require significant knowledge and expertise.

For this activity, we have undertaken a break-even analysis, for details see section 3.4 of Annex 2 - CBA report.

5.4.3.2. Stakeholder feedback

As previously noted, stakeholders including market participants and Ofgem have welcomed our proposal to take a more proactive role in driving industry change.

Throughout our engagements via industry association meetings, our RIIO-2 engagement events and code panel meetings we have consistently heard common concerns on the existing market frameworks in terms of too much complexity, the slow pace of change and limited opportunity for smaller or new players to participate in modifications.

We have also heard that parties require more support in the code modification process. In our RIIO-2 webinar we asked a poll question on the potential characteristics of a Code Manager. Most respondents agreed that the characteristics we had presented were appropriate.

The stretching level of ambition was also noted in code reform and a couple of stakeholders were concerned that we would not have the appropriate level of resource to deliver this activity effectively. We have planned to resource this activity appropriately to support delivery.

We have been asked to be clearer on our delivery plans for this activity and for more detail on what is involved – particularly on how and why certain code modifications would be prioritised. We have provided this in the section above.

5.4.3.3. Work with all stakeholders to create a fully-digitised, whole system Grid Code by 2025

The net present value of work with all stakeholders to create a fully-digitised, whole system Grid Code by 2025 is estimated at £1 million and deliver £1.03 of benefits for every £1 spent over RIIO-2. The net benefits are positive from 2025/26 onwards.

We will develop a single technical code for distribution and transmission. It will focus on providing minimum standards to allow safe and secure operation of the electricity systems. We will use the latest data technologies to support navigation of the codes, being tailored to each code user's individual needs. Supporting documents will provide examples of how the requirements might be met. While noting the complexity of this task, we believe we can achieve this by 2025.

[58] https://www.elexon.co.uk/bsc-and-codes/balancing-settlement-code/
[59] https://www.dcusa.co.uk/

[60] https://www.elexon.co.uk/

The benefits of a digitised, whole system Grid Code are a more user-friendly, inclusive and tailored experience that will meet the diverse needs of our customers.

A whole system Grid Code that is easier to understand will increase the pace at which important decisions are taken throughout the connection journey. Crucially, it will provide more targeted and customised information as and when customers need it.

Removing this barrier of complex to understand and navigate industry codes will also aid the support for new, smaller entrants and encourage innovation in the market.

The first step in delivering this activity will be to determine the scope, objectives and approach together with all stakeholders at the start of this activity in 2021/22. This will ensure that there is a consensus on the direction of this work from the beginning.

5.4.4. Stakeholder feedback

Consistent with the views above on the current state of industry codes and code governance, there is general support for our ambition to create a fully-digitised, whole system Grid Code by 2025. Many stakeholders noted this would increase the efficiency within their organisation, while reducing barriers to entry.

Some stakeholders felt this was extremely ambitious. At one of our stakeholder events in July, an industry association representative noted the need for both extensive stakeholder engagement and suitable resourcing. We recognise these challenges and have sought to resource the activity appropriately in this Business Plan.

There was support for the final product, but also general agreement on the need to make it clear that regulatory compliance is still the obligation for industry participants. This ambition does not remove the requirement for due diligence from the industry in terms of compliance.

Some stakeholders, including an industry association, have asked if this activity will look to change the content of the code or look only at the accessibility. A DNO advised they were comfortable with the proposal to bring the transmission and distribution grid codes together but would want to be comfortable with where the decision-making power sits. The proposal would also need to be developed with agile and inclusive governance.

5.4.5. Cost-benefit analysis

We estimate the benefits here to be £6 million over RIIO-2. This gives an NPV of £1 million over RIIO-2.

The quantitative benefits stated above have been calculated by considering how the reduced barriers to entry will save resource for Grid Code users, as it is less complicated, easier to navigate and find and use the relevant information. There are around 500 potential projects which would look to access the Gird Code per year, with each resource saving being passed through to consumers.

This is against a baseline assumption of the Grid Code not being digitised and access remaining as it is today. It would also not extend to consider the whole system.

This activity is dependent on the following transformational activity:

1. Transform the process to amend our codes (Theme 2) – Allowing the ESO to manage codes more efficiently, prioritising change and maximising synergies across all ESO managed codes

This activity will require third parties, in particular the distribution networks operators (DNO) to engage with the process to create the whole system element and for current and future Grid Code users to fully participate in the process, there may be small costs associated with adapting to these new arrangements, but we believe these are within the scope of third parties ongoing investments.

Our analysis suggests that accounting for market, delivery and third-party uncertainty the net present value could credibly be between £4 million and negative £3 million.

See Annex 2 - CBA report section 3.5 for more details.

5.4.5.1. Look at fully or partially fixing one or more components of Balancing Services Use of System (BSUoS) charges

The net present value of partially fixing one or more components of Balancing Services Use of System (BSUoS) charges is estimated at £280 million. The net benefits are positive from 2022/23 onwards.

Partially fixing BSUoS will provide the greater stability that our customers want, if this is demonstrated to be in the best interests of consumers.

BSUoS is one element of the existing code system that is scrutinised regularly by industry stakeholders. Due to the increasing volatility, complexity and difficulty in forecasting these charges, which are set on an ex post basis, there have been suggestions to move to an ex ante arrangement.

This, in effect, transfers forecasting risk from industry to ESO. It also fixes the charge in a given period, albeit with any under or over-recovery being accounted for in a subsequent chargeable period.

A modification to fix BSUoS was raised in August 2015 and rejected by Ofgem in October 2018. This was because Ofgem wanted to explore whether some elements of BSUoS could provide a stronger, forward-looking signal. There was also a concern that the analysis on risk premia was not sufficiently robust.

However, recent work by the Balancing Services Charges Task Force has concluded that BSUoS does not have a role in providing a forward signal that can influence the behaviour of market participants and drive down costs. If Ofgem agrees with this conclusion, as part of its Targeted Charging Review, this suggests that

BSUoS is focused purely on cost recovery. So, it would be appropriate to revisit the subject of fixing these charges.

If an updated CBA shows consumer benefits from fixing some or all elements of BSUoS, then there should be suitable arrangements for the ESO through RIIO-2 to facilitate these changes. This would consist of the costs of managing the increased cashflow risk for the ESO.

The ESO would commit to raising a Connection and Use of System Code (CUSC) modification in this incentive period to allow fixing to commence as close to the start of RIIO-2 as possible. We currently believe that a start date of 1 April 2022 would be possible.

5.4.5.2. Stakeholder feedback

Payers of BSUoS have consistently told us that the lack of predictability in the way it is currently charged exposes them to risk premia that are passed on to consumers. A majority expressed support for our proposal to look at fully or partially fixing one or more components of BSUoS charges in the RIIO-2 period. We have therefore taken this activity forward in our Business Plan. They also challenged us to better understand the risk premia that suppliers pass on to consumers to validate our assumptions on the consumer value of this work. We will continue to refine our views of the risk premia, and feed this into the next iterations of our Business Plan. As industry work is ongoing here, we will reflect the latest views as we get them. We have also included more detail in the Stakeholder report on this activity – see section 5.4.4 of the report.

We have also been asked to consider the implications of this activity on ESO funding and regulatory arrangements. In particular, the significant new cashflow costs for the ESO due to the challenge of forecasting BSUoS to a sufficient degree of accuracy. Again, in Annex 2 - CBA report section 3.6 – we have provided further information on the likely costs of financing this activity throughout RIIO-2.

5.4.5.3. Cost-benefit analysis

We estimate the benefits here to be £324 million over RIIO-2. This gives an NPV of £280 million over RIIO-2.

The quantitative benefits stated above have been calculated by considering the ongoing industry work that is focused on reducing BSUoS volatility and unpredictability[61]. As this work is continuing – and we will work with industry and Ofgem to further refine it – we have used the lower estimates of benefits from the scenarios considered. This amounts to around £81 million per year in reduced risk premia held by industry. We also considered the higher ESO financing costs required to manage any new BSUoS arrangements – again to reflect the uncertainty – of around £4.8 million per year. This is an early estimate and is not reflected in our analysis of overall ESO financing costs, which is detailed in chapter 10. The difference in ESO financing costs, and benefits savings from reduced industry risk premia, is due to the number of parties that hold risk premia for BSUoS – and this now being managed though a single party, the ESO.

This is against a baseline assumption of BSUoS arrangements remaining as they are today, with the price being set ex post.

In order to deliver this activity, we require the ongoing work to demonstrate that any changes to BSUoS demonstrate a positive benefit to consumers. We also require that BSUoS being confirmed to be cost recovery by Ofgem. Finally, that BSUoS payers pass any reduced operational costs onto consumers.

Our analysis suggested that accounting for market, delivery and third-party uncertainty the net present value could credibly be between £730 million and £206 million.

See the Annex 2 - CBA report section 3.6 for more details.

[61] https://www.nationalgrideso.com/document/106876/download

5.4.6. Investment roadmap

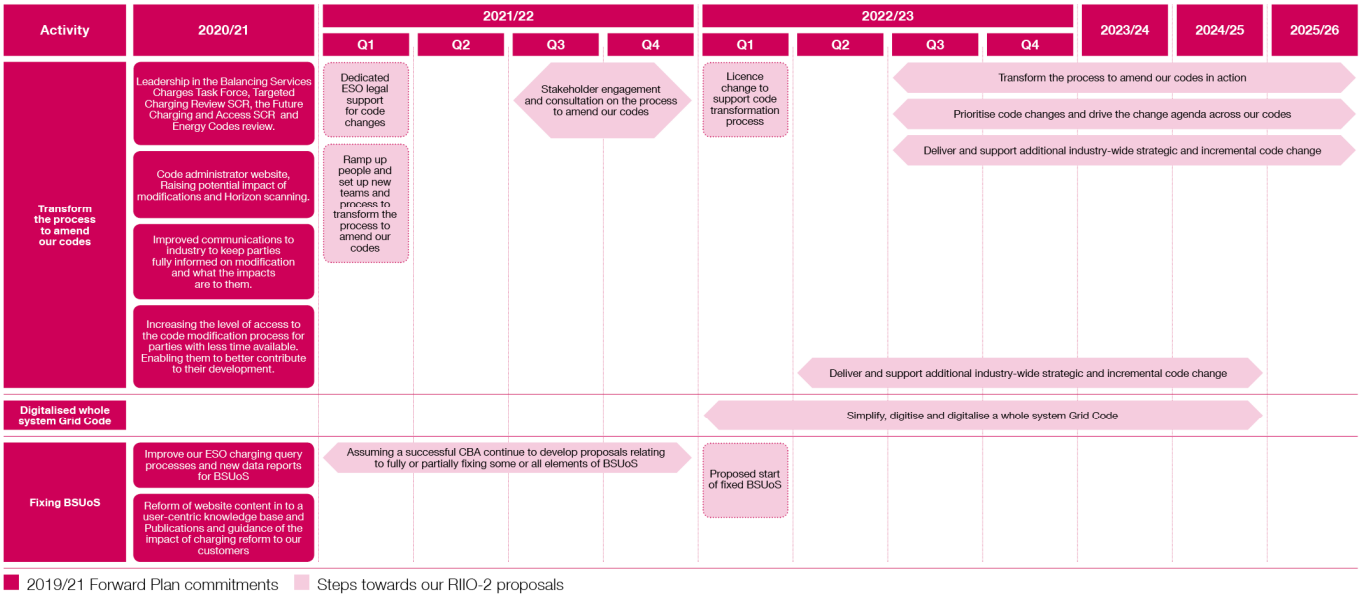


Figure 27

5.4.7. Proposed performance metrics

For administration of codes, we will continue to measure customer satisfaction (CSAT) scoring. In our role as code manager, there is the potential to evaluate the consumer benefit of modifications that are undertaken.

In terms of CSAT scoring, we will continue to survey our customers as part of the Code Administrator Code of Practice (CACoP) process. We will then be able to monitor our progress over time and track the impact of key actions. For our code manager role, we will investigate whether consumer benefits can be measured for modifications, with high-value consumer benefits being targeted.

All of this will mean greater benefits for consumers. By making sure we improve the quality of service for our customers, they will either directly or indirectly pass any savings onto consumers. We will also ensure we prioritise the code modifications which deliver the most benefits to consumers. The consumer benefit of modifications is a good thing to measure. While many of the factors that drive the ultimate costs of code administration and management are outside our control, the level of service provided and the prioritisation of code modifications are within our control.

Service providers and industry associations have told us that this would be an appropriate measure.

Theme 3
Unlocking consumer value through competition

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

What this Theme covers

Transforming network planning through competition and extending network operations assessment to other areas of network development.

What we propose to do

Enhance and expand the *NOA* process to look at more connections wider works and end-of-life asset replacement. Carry out a targeted review of the SQSS. Progress development of an Early Competition Plan proposal at Ofgem's request.

What our Stakeholders have told us

Stakeholders agree that we should be expanding the *NOA* approach to look at wider transmission system needs and support assessments for lower voltage networks. They agree that we should review the SQSS but have mixed views on the scale of such review.

What are the key benefits?

Wider investment options are identified on the distribution network and commercially. Improve the reliability of the system, embedding efficient competitive processes, enhancing communications with the network operators and improve service quality to help reduce consumer bills

6. Theme 3: Unlocking consumer value through competition

Theme 3 delivers £663 million of consumer benefits[62] Investment[63] for this Theme over the first two years: £14.3 million

6.1. Five-year strategy

Our five-year strategy is to use competition to support the development of a network that is always ready for the demands placed on it – and can operate securely as we transition to a zero carbon electricity system. Competition is also fundamental to our proposals to transform participation in smart and sustainable markets. We have focused on this in the previous chapter.

To achieve our network competition aims, we must:

- transform network planning by extending and enhancing competition across network development.
- invest in capabilities so we can operate a carbon free network in 2025.

Net zero by 2050
We will enable the UK to transition to net zero emissions by:
- increasing competition to drive innovation and better network solutions to unlock consumer value.
- enhancing our network modelling to help manage the increasing complexity of a carbon free network.
- leading work to ensure the standards that underpin the network are appropriate.

6.1.1. Extending and enhancing competition

Competition can unlock significant consumer benefits by finding solutions to network challenges. The ESO's unique, independent position means we are well placed to drive this process.

Currently, when there is a need on the transmission network, the relevant Transmission Owner (TO) will develop and implement the solution. However, when we take a whole system view, there may be better options available on distribution networks or through commercial arrangements that do not involve transmission investment. We have already begun to investigate these through our pathfinder projects (e.g. our stability pathfinder project[64]), but we intend to go much further. In the final two years of RIIO-1, we will run two or three pathfinding tenders each year; from early RIIO-2 we'll be running several tenders each year across a range of network needs, to ensure we unlock the broadest range of potential solutions that maximise consumer value.

We are fully committed to introduce competition everywhere, including supporting Ofgem to develop and implement competition for onshore transmission. We recognise the ESO has a key role both in supporting the introduction of Competitively Appointed Transmission Owners (CATO) and in supporting alternative approaches prior to the introduction of the legislative changes required for CATO.

In May 2019 Ofgem requested, in their Sector Specific Methodology and further consultation[65], that the ESO develop an 'Early Competition Plan' setting out how early forms of competition for onshore transmission could be introduced. They have since clarified their expectations in their open letter, dated the 24 September 2019[66].

Early competition has the potential to deliver significant consumer benefit through identifying the best value solutions for major transmission investment needs. Through the Early Competition plan the ESO will explore a range of options for how different forms of early competition could be introduced in order to unlock this value for consumers. This could include competitions for non-network solutions, design-only competitions and CATO competitions. The Early Competition Plan will also explore the roles and responsibilities of different industry parties, including what role the ESO should play in the process. In addition, the plan will set out how early competition could be implemented, including timeframes, costs and legislative or framework changes that would be required.

Following submission of the Early Competition Plan in February 2021, Ofgem will then determine how early competition should be progressed, including the ESO's role. Therefore, while we anticipate that there will be additional roles and resource requirements for the ESO

[62] Consumer benefits are the net present value (NPV) of Theme 3's transformational activities over the RIIO-2 period. Our analysis suggested that accounting for market, delivery and third-party uncertainty the net present value could credibly be between £462 million and £906 million

[63] The ESO will generate a net saving for consumers in RIIO-2. The proposed investment in this chapter will help to deliver this net saving

64 https://www.nationalgrideso.com/insights/network-options-assessment-noa/network-development-roadmap

[65] https://www.ofgem.gov.uk/system/files/docs/2019/05/riio-2_sector_specific_methodoloy_decision_-_eso.pdf

[66] https://www.ofgem.gov.uk/system/files/docs/2019/09/electricity_system_operators_early_competition_plan_letter_0.pdf

relating to this in RIIO-2, they cannot yet be determined and so are not included in this Business Plan. If Ofgem decide to proceed with proposals submitted, any new roles will be built into the ESO's wider performance and incentives framework. We are continuing to work iteratively with Ofgem to develop this proposal and engage widely with stakeholders to ensure proposals are practical and maximise consumer value. We are also exploring how the stakeholder governance arrangements developed for the RIIO-2 Business Plan could be best utilised to provide oversight, in addition to Ofgem's close involvement throughout the development of the plan.

Further details on how the ESO intends to progress the Early Competition Plan during RIIO-2 are available on our website[67] and although not a RIIO-2 proposed activity we have outlined our proposed development approach in section 6.4.

By the end of RIIO-2, competition will be the established approach for most new transmission investment. This will create fresh solutions, including commercial ones, for network issues. Our analysis this year suggests that using solutions, such as intertrip schemes, could save consumers between £0.77 billion and £1.1 billion over the next 10 years[68]. We expect that further savings can be unlocked by using competition to address other network needs, such as voltage and stability.

Our network planning already creates significant benefits for consumers; our 2018/19 *Network Options Assessment* (*NOA)*[69] recommends a set of investment options to increase the transfer capability of key transmission boundaries. This could save consumers between £1.85 billion and £2.67 billion over the next 11 years[70]. Our five-year strategy is therefore to expand the *NOA* and the evaluation techniques (such as network analysis and economic modelling) that support the process and consumer value creation to other areas of network investment. By the end of RIIO-2, we will therefore also use *NOA* to assess major end-of-asset-life decisions as well as all wider works on connections. We will also provide support to Distribution Network Operators (DNOs) to establish their own *NOA*-type processes.

By enabling more efficient decisions to be taken on what network assets to invest in and when, consumer bills will be lower than would otherwise be the case. Improving competition and securing sufficient investment in network capacity will reduce costs further as an increased number of players develop new network and non-network solutions. This increased participation can also help identify innovations that unlock more efficiencies and enable further decarbonisation of the energy system.

6.1.2. Investing in capabilities so we can operate a carbon free network in 2025

As well as introducing competition and expanding our *NOA* assessments, we will prepare to operate a carbon free network in 2025. The continuing growth of distributed generation and new technologies makes the network more difficult to operate. This is due to reduced system inertia and changing reactive demand[71], among numerous other challenges. The overall operability costs for these growing needs are forecast to be £596 million per year over the period 2021 to 2026.

Effective network planning will allow us to reduce these costs in the future. Across RIIO-2, we will therefore increase our network-modelling capabilities to respond to the increased volume and complexity of network challenges. During RIIO-2, there will be an increased focus on both the potential for an integrated offshore network, and on interactions between different energy sources, such as gas and electricity. We will need to provide expert input into early thinking around both these developments. By better understanding these interactions, we will be able to plan more effectively and tender for solutions that meet multiple needs.

During early RIIO-2 we also intend to embed and enhance the ongoing work we are doing to explore probabilistic modelling. The tools and techniques we are investigating will allow us to identify thermal constraints for year-round conditions, including looking at multiple generation and demand eventualities for each hour in a matter of minutes. This is compared to the one to two weeks manual process an engineer would follow to identify the boundary capability for a particular boundary looking at peak conditions in a single year and associated with a single snapshot (single generation and demand pattern). We will have a wider and more refined view of network needs across the year rather than focusing on a point in time, such as winter peak capacity.

The chart below summarises our proposed investment over the RIIO-2 period. This covers both our ongoing and transformational activities. Further justification for the costs associated with these activities is set out in the relevant sections that follow. Details on how we have incorporated efficiency assumptions and benchmarked these costs are in chapter 3.

[67] https://www.nationalgrideso.com/publications/network-options-assessment-noa/network-development-roadmap
[68] https://www.nationalgrideso.com/document/137321/download 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
[69] https://www.nationalgrideso.com/insights/network-options-assessment-noa
[70] 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 https://www.nationalgrideso.com/insights/network-options-assessment-noa Consumer priorities
[71] The glossary provides an explanation of these terms

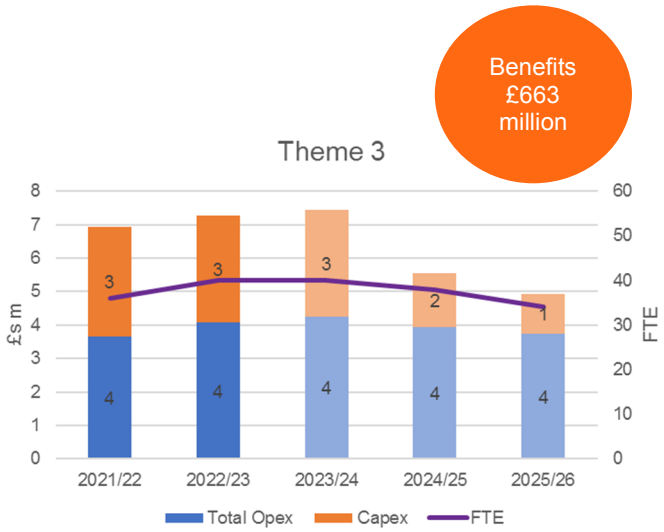


Figure 28

Our main benefit ambitions for the RIIO-2 period under this Theme are:

- Support at least twice as many participants in the *NOA* tender process, ensuring the service quality encourages more participants to offer and deliver competitive solutions, potentially delivering £429 million in benefits to consumers and enabling the path to net zero by 2050.
- Delivering £30 million in benefits through increasing engagement and coordination with distribution-level parties across network planning and the *NOA* methodology.

We will maintain a focus on consumer priorities:

- An affordable energy bill - realising savings through choosing the most economic option for solving network issues.
- Energy available when needed - enhancing the robustness of the *NOA* process using new analytical tools.
- A decarbonised energy system, fit for the future through - network planning to support ability to operate the network carbon free by 2025.
- Safe and secure energy system through - incorporating more probabilistic modelling capabilities, giving a more refined view of network needs, ensuring its resilience .

We will measure our success by tracking:

- Benefits/savings created for consumers
- Diversity of participants in the *NOA* process
- Stakeholder satisfaction survey

6.2. Network development

Our ongoing activities, and the improvements we propose to them, will underpin both elements of our five-year strategy.

6.2.1. Costs

Network development		Five-Year Strategy				
		Two-Year BP				
	RIIO-1	2021/22	2022/23	2023/24	2024/25	2025/26
Capex (£m)	0	3	3	3.2	1.6	1.2
Opex (£m)	1.7	3.3	3.7	3.9	3.7	3.5
FTE[72]	27	33	36	36	35	32

Highlights

We propose to invest in enhancing our analytical and modelling capabilities. This will enable us to analyse more than double the number of tenders and undertake network modelling across all solution types.

6.2.2. Ongoing activities

Through our planning processes, we advise which investments will deliver the greatest benefit for consumers – and at what point in time.

We analyse and communicate future network needs, published in our annual *Electricity Ten Year Statement (ETYS).* This information allows TOs to develop appropriate solutions. We are developing these processes so that a broader range of participants can engage with the information and potentially provide competitive solutions.

We use our unique position as ESO to advise on economically efficient ways to address network needs, published in our annual *NOA* report. For example, we consider whether TOs should build new transmission assets now, or whether investment should be delayed and the ESO manage the challenge in other ways.

We also analyse and publish (in *NOA*) the optimal level of interconnection for the Great Britain market, which helps to show developers what investments could be of value. In addition, we support the development of European regional investment plans and 10-year network development plan. Finally, we also undertake additional ad hoc analysis of:

- Strategic Wider Works projects (very large transmission investment projects).

[72] Opex and FTE numbers are the average for the ESO since legal separation (years 2020 & 2021), which reflects the current ESO business. Capex figures are the average over the eight years of RIIO-1.

- boundary studies for the Connections and Infrastructure Options Note (CION) process covering offshore connections.
- Cost-benefit Analysis (CBAs) for small schemes (ad hoc assessments for localised network issues).

Activity within our network development teams also helps support Theme 4; through the analysis of constraint costs which helps optimise outage planning.

The network development costs for our ongoing activities in RIIO-2, as set out above, will increase by one FTE and £0.7 million per year opex.

This will enable us to:

- analyse double the number of network solutions.
- manage a significant increase in the complexity of the network needs we will model. This complexity is driven by the continuing growth of distributed generation and new technologies, which create operability challenges such as system inertia and reactive demand[73].
- accommodate the potential for integrated offshore networks, and on interactions between different energy sources, such as gas and electricity.

We will keep our FTE and opex costs for ongoing activities at the same level through the RIIO-2 period. We will do this by continuing to review our processes and incorporating the results of the Performance Excellence efficiency programme carried out in RIIO-1[74].

Our baseline FTEs, covering our ongoing activities, increase from 27 to 28 in 2021/22 and then remain at 28 for the remainder of the RIIO-2 plan period. The further increase in FTEs, as illustrated above, reflect our transformational proposals as detailed in the following section.

Enhancements made in RIIO-1 and innovation into RIIO-2

During RIIO-1 we improved how we unlocked consumer value by introducing *NOA*. This saves billions for consumers by recommending which network investments provide the most value to consumers, and the most appropriate timing for them. We also expanded the *NOA* approach to cover Scotland, as well as England and Wales.

We have built on the independence of our investment recommendations through legal separation of the ESO from National Grid's Transmission Operator (TO). This underpins our transformational ambition to introduce competition across network development. We have already begun this transformation with our *Network Development Roadmap*[75] pathfinders. Through these, we are trialling competitive approaches to meet certain transmission needs, which have been welcomed by market participants.

We have also responded to the changing needs on our network – driven by the move towards zero carbon. The network needs have become more challenging and we are developing our analysis in order to improve our understanding and modelling of voltage and stability. We have also made big steps in moving towards a probabilistic analytical approach. This provides a more refined assessment of network needs across the year, rather than at a single point.

Through two innovation projects, we are exploring ways to improve our existing modelling techniques for use in our ongoing activities. The aim here is to be able to better identify the right level of investment needed on the networks. We will establish new and more efficient ways to undertake increasing and more complex analysis, while ensuring we reflect and assess the growing number of interactions between different network issues.

The projects are:

Application of Convex Optimisation to Enhance the *NOA* Process: We are launching a Network Innovation Allowance (NIA) funded project in collaboration with Strathclyde University. This will develop an algorithm and code to include in our existing voltage assessment tools, which will enable us to analyse voltage requirements and develop solutions faster. This work is in response to the following energy challenges: the forecast level of electricity decentralisation, a need to consider a whole system approach to network development, a need to support different energy vectors, and increased uncertainty across the year due to low carbon generation.

[73] The glossary provides an explanation of these terms
[74] For more information, see chapter 3
[75] https://www.nationalgrideso.com/insights/network-options-assessment-noa/network-development-roadmap

Study of Advanced Modelling for Network Planning Under Uncertainty: We are running an innovation project focused on decision-making. It specifically explores questions around the 'least worst regrets' process, such as whether this is still fit for purpose against the uncertainty of planning timescales, and whether deterministic planning is still applicable. The project will review state-of-the-art planning techniques, which include probabilistic or risk-based approaches in decision-making. It will also explore the benefits of integrating technical and economic assessments into a single platform.

6.2.3. *NOA* transformational activities

The net present value of our proposals is estimated at £663 million and delivers £45 of benefits for every £1 spent. The net benefits are positive from 2021/22 onwards.

To deliver the benefits from competition outlined in our five-year strategy, we propose four new areas of work. This section provides more detail on our proposals, the rationale, and the stakeholder feedback that underpins them.

Embedding competition and expanding the *NOA*

1. Implement and enhance competition to enable all solution types to compete to meet transmission needs.
2. Extend the *NOA* approach to end-of-life asset replacement decisions and connections wider works.
3. Support decision-making for investment at the distribution level.
4. Enhance our analytical capabilities to support these activities.

The following sections provide further details on these activities and their associated costs.

6.2.3.1. Implement and enhance competition to enable all solution types to compete to meet transmission needs

The benefit of this activity is £429 million.
From the start of RIIO-2, we want to at least double the number of competitive tenders for transmission needs from the four that we currently run each year. As a result, competition for alternatives to TO solutions to network investment needs will become the norm by the end of RIIO-2. Our *Network Development Roadmap,* which we previously consulted on, has started this transformation. Stakeholders, particularly potential service providers, are strongly supportive of these developments and keen for them to be delivered as soon as possible. While we expect the number of tenders to more than double, as competition grows, we will limit additional costs by improving our tendering approach. We expect to reduce associated costs by the end of RIIO-2 as we capitalise on process improvements.

Creating competition between asset solutions and non-network solutions, and regulated businesses with non-regulated businesses, is challenging due to different funding and regulatory regimes. Alongside this, the network needs for which we are assessing competing solutions is becoming more complex. Our pathfinder work in RIIO-1 will have given us a large amount of learning, which we can use to address the technical, commercial and regulatory challenges. However, much more will need to be done to maximise benefits from this transformation.

"We welcome proposals to build on the *NOA* process and facilitate competition in delivery of solutions to network challenges, including through market solutions and non-network assets."
Supplier, in response to the ESO RIIO-2 Ambition consultation

We have assumed that appropriate funding arrangements will be in place to support delivery of solutions, regardless of the provider type. This would include network companies having appropriate arrangements to support the necessary preparation of options to feed into tender assessments. It also includes appropriate funding routes for commercial solutions so costs are recovered from the appropriate customers. We have also assumed that the licence conditions on whole system working across TOs, distribution network operators (DNOs) and the ESO will be implemented, alongside appropriate funding mechanisms.

For this specific activity, two additional FTEs are required in 2021/22, representing an increase from 28 to 30 of the 33 FTEs in 2021/22. We plan to scale back this activity in 2023/24 to one FTE due to process efficiencies. We have estimated these resources based on historical levels of *NOA* activity and current team size. These FTEs will undertake the following:

- **Optimise the assessment and communication of future needs**

Stakeholders, particularly potential service providers and also one of the TOs, have told us that they want us to communicate future needs to them more clearly, so they can participate in those markets. As our modelling of network issues and potential solutions grows, we will need to continue to improve how we communicate these future needs.

- **Enhance tendering models**

To maximise participation in tenders, including from potential new technologies and new market entrants, we

will need to continue to develop and embed improved – or potentially new – tendering processes. We know stakeholders want to see better alignment across the tendering processes that we use to meet different network and service needs, so that they better support their business cases for new investments. We are beginning work on this now, but much of the implementation and ongoing enhancements will occur in RIIO-2.

- **Support and respond to changing regulatory frameworks**

Existing regulatory and funding frameworks were designed to support a regime where longer-term network needs were addressed by the relevant TO, with funding allocated through their price controls.

This landscape is now changing, so the supporting frameworks also need to change to make sure appropriate funding can be made available for all possible solutions. During the rest of RIIO-1, we will work with Ofgem to identify – and begin making – the framework and funding changes that are needed.

Some of these changes are expected to begin at the start of RIIO-2 and the ESO will need to support and respond to them. There will also be transitional arrangements to manage, such as bridging the gap between RIIO-2 and RIIO-ED2[76] – and legacy from RIIO-1.

[76] Price control for Electricity Distribution Network Owners, scheduled to commence in April 2023

Investment roadmap

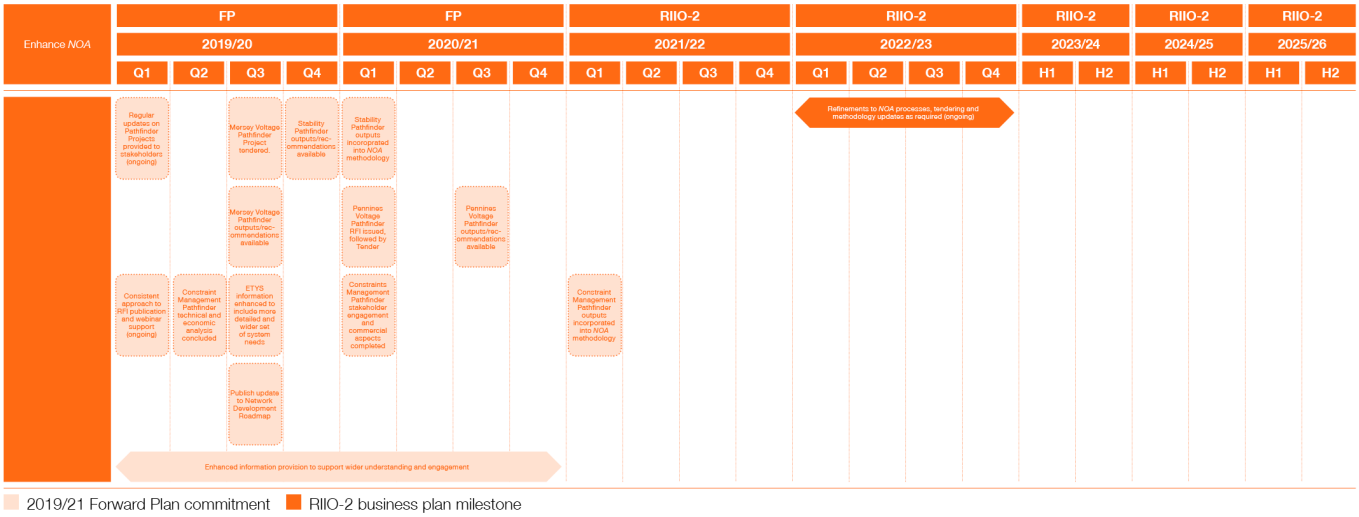


Figure 29

Stakeholder feedback

ERSG supports Theme 3 with conditions. "Important and worthwhile proposals which are heading in the right direction. The group feels that the ESO is not committed to delivering the CATO model and that this section is very weak. Also unsure whose role implementation of the SQSS should be (TOs or ESO), and whether it is the ESO or relevant TO who has the primary responsibility for standards being met."

We have engaged with stakeholders on this topic through our RIIO-2 engagement events (including a more technically focussed event in December 2018), RIIO-2 webinars, at our customer connections seminars and via dedicated network development channels. Given the possible impact on network companies of this activity, we have also engaged bilaterally with TOs and some DNOs.

Overall we have heard that stakeholders want us to introduce competition for transmission solutions in network planning. In response to last year's consultation on our *Network Development Roadmap*[77], three-quarters of respondents from networks and renewable generation sectors supported our proposals to expand our approach to seek both network and non-network solutions.

Most stakeholders at our RIIO-2 event in April confirmed this view. They expressed support for us to embed competition in network planning – and for expanding the *NOA* approach to a wider set of transmission network needs. However, two generator stakeholders said that we need to be careful of the impact this could have on energy markets, in terms of service provision through contracting with providers in particular locations, for example thermal, voltage or stability requirements.

At our Network Development event on 16 May 2019, several of the 21 stakeholders who attended (particularly service providers) felt that we could significantly help more providers enter the market by optimising the alignment of how we communicate and tender different needs. This, they said, would support the business case needed to invest in new assets.

Cost benefit analysis

Our proposed investment in extra resources will enable us to support at least twice as many participants in the tender process. It will ensure they receive a quality service that encourages them to participate, offer and deliver competitive solutions. Solutions that will ensure we have a network that is always ready for the demands placed on it – and can operate securely as we transition to a zero carbon electricity system.

The £429 million benefit has been calculated by comparing the outputs of the *NOA* process with and without commercial solutions added in. We have used historic costs of previous commercial solutions as the benchmark for our analysis.

This is against a baseline assumption of the current *NOA* process, without commercial solutions and only current network solutions considered, as per our licence conditions.

[77] This consultation can be found on our website here: https://www.nationalgrideso.com/publications/network-options-assessment-noa/network-development-roadmap

Note the following are relevant for the overall *NOA* transformational activity:

This activity is dependent on the following transformational activity:

1. Build the future balancing services and wholesale markets (Theme 2)

Delivery of this activity will pass on benefits and costs to other parties. There is likely to be increased analysis for TOs and DNOs in creating options and running new processes. However, we expect that the cost of this should be offset by the overall benefits realised and that there would be potential benefits for network companies to carry out this work because of their regulatory and incentive frameworks.

Our analysis suggested that accounting for market, delivery and third-party uncertainty the net present value could credibly be between £462 million and £906 million.

See Annex 2- CBA report section 4.1 for more details.

6.2.3.2. Extending *NOA* to end-of-life asset replacement decisions and connections wider works[78]

The benefit of this activity is £266 million (comprising £118 million end-of-life asset replacement and £148 million connections wider works).

We propose to expand our network-planning processes to look at end-of-life asset replacement decisions for large assets, with the first recommendations to come in *NOA* 2024. This will be informed by the significant data volumes and types we have access to, covering our *NOA* economic models, historic operational data and the insights derived from developing our Future Energy Scenarios.

We believe that by reviewing these decisions, the ESO may be able to recommend a different outcome. For example, there may be occasions when there is value in replacing or upgrading an asset earlier, to address a wider issue on the network.

We already deliver millions of pounds of savings for consumers by assessing many connections wider works through the *NOA*. However, not all wider works are included.

The transmission system is split by regional boundaries. These define important power-flow paths where there are limitations to capability or where we expect additional bulk-power transfer capability will be needed. These boundaries were set at the start of RIIO-1. The subsequent evolution of the network means that the originally defined boundaries no longer capture all areas of the network where significant enhancements in capability are required to be assessed. This means that while most connections wider works are subject to *NOA* assessments, some are not. We therefore propose to change our processes so that more connections wider works are assessed. We intend to assess a trial region in *NOA* 2022/23, expanding to all wider works by *NOA* 2025/26.

Our costs include both end-of-life assets and connections wider works. These activities are extensions of our ongoing work. To forecast our costs, we have applied the same resourcing assumptions as for our ongoing activities, including the embedded efficiencies resulting from our RIIO-1 Performance Excellence programme. To undertake these activities, we require two additional FTEs in 2022/23 and three over 2023/25, representing the increase in our FTEs from 32 in 2021/22 to 35 in 2022/23. We plan to reduce these additional required FTEs by one by the end of the RIIO-2 period due to process efficiency gains and improved tools. We have estimated these resources based on historical levels of *NOA* activity and current team size.

[78] See Glossary for definition of Connections Wider Works

Investment roadmap

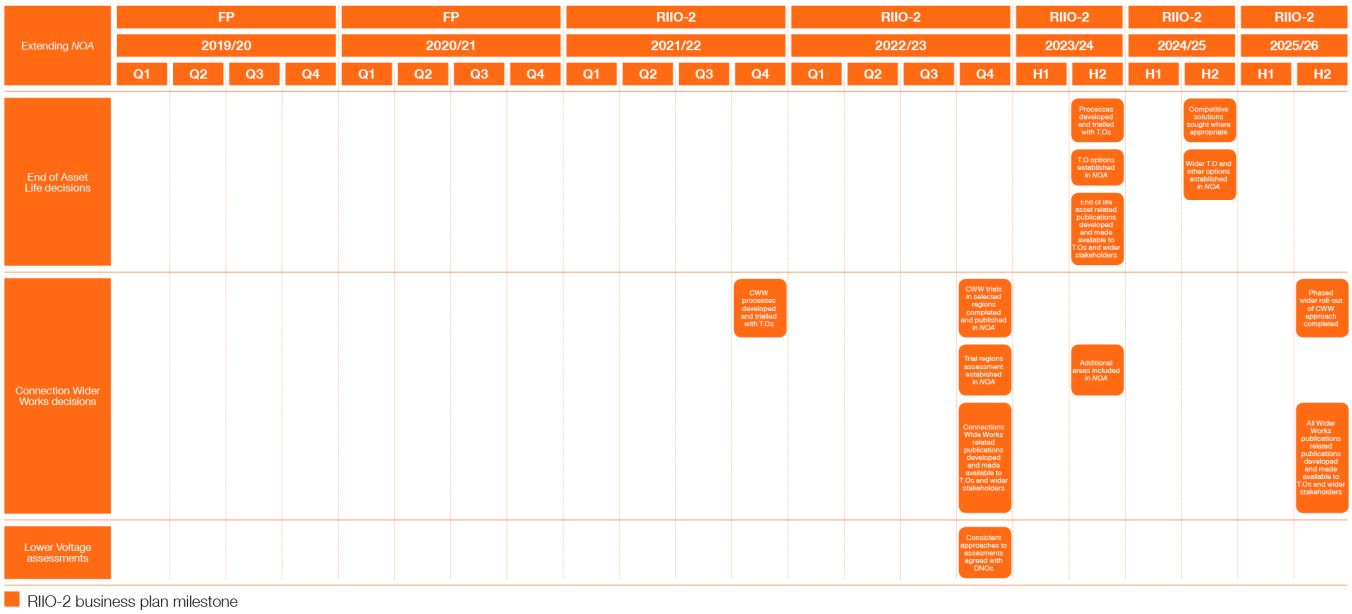


Figure 30

Cost-benefit analysis

Extending our *NOA* assessment to these additional areas will enable us to identify the most efficient investment options. This will help reduce costs to the consumer.

End-of-life assets

The £118 million benefit has been calculated by using historic data from *NOA* We have looked at assets whose end of life was due to be within five years. We profiled the cost of bringing forward an asset upgrade to negate the need for a like-for-like replacement. This delivers a benefit, because the asset-replacement saving is greater than the additional cost of upgrade resulting from bringing it forward. It is very difficult to forecast the exact benefit, because the ESO does not hold currently asset price data or long-term asset replacement information. In RIIO-2 we would request this information from TOs. Therefore, we have made our estimates from *NOA*, based on a similar profile.

This is against a baseline assumption of the current *NOA* process, without the addition of end-of-life asset considerations.

See Annex 2 - CBA report section 4.1.2.2 for more details.

Connections wider works

The £148 million benefit has been calculated by comparing the output of *NOA* with the materiality of existing wider works, which are not currently considered within the *NOA* document. This comparison has identified options that were in customer offers, but not in the *NOA*, suggesting boundaries could be added to *NOA* to cover these. We believe *NOA* could look at 10 per cent more boundaries, which equates to three to six boundaries where we suspect problems. We have made a conservative assumption is this would deliver two per cent more consumer benefit given the uncertain relationship between looking at more boundaries and consumer benefit. Two per cent equates to £37 million of consumer benefit each year.

This is against a baseline assumption of the current *NOA* process, without increasing the number of boundaries analysed.

See Annex 2 - CBA report section 4.1.2.3 for more details.

Stakeholder feedback

During our *Network Development Roadmap* consultation, respondents thought we could apply a *NOA*-type approach to end-of-life assets and connections wider works. At our December 2018 RIIO-2 event, stakeholders similarly supported this. Specific views about each of these areas were as follows.

End-of-life assets

We have spoken to all the TOs through our RIIO-2 engagement to explain our proposed activities in this area. Some TOs wanted to know how our end-of-life assets assessment proposal would complement the assessment they already carry out for their own assets and to the assumptions they are making in their RIIO-2 Business Plans. We responded that the ESO assessment would add to the TOs' own work, because we have access to additional operational data. TOs also wanted to better understand how the process and timing might work. We are holding further discussions with TOs to confirm the scope of this activity. We will work with them to establish the likely number of asset replacements over RIIO-2; determine the size or type of

assets that are appropriate to be assessed by the ESO, versus the TOs; and agree an efficient assessment process, including asset information sharing requirements between parties. Almost all stakeholders at our April event supported our proposal to expand our processes.

Connections wider works

Some stakeholders were interested to understand how this would affect timeframes in connections wider works. Most connections wider works are already assessed by the *NOA*, so our proposals would bring the remaining elements in line with that process. Almost all stakeholders at our April event supported our proposal to expand our processes at the transmission level, subject to more detail on the costs and benefits, which we provide here.

6.2.3.3. Support decision-making for investment at the distribution level

The benefit of our proposals is £30 million.

The ESO currently assesses investment decisions for transmission networks, which includes the 132 kV networks in Scotland. We considered whether there would be value in expanding our role further to also undertake a *NOA*-type process at the 132 kV networks in England and Wales.

Given the ESO's experience in delivering *NOA*-type assessments, we believe we could add value to network planning at the distribution level, by collaborating with DNOs to develop effective processes. We already work closely with DNOs through Open Networks to share learning – and we publish our *NOA* methodology. During our stakeholder engagement two DNOs agreed that we should not be undertaking lower voltage assessments and that it should be more of a co-ordination exercise. One DNO added that the ESO has a lot of knowledge in this area and can support DNOs to transition to DSOs.

In addition, we propose to take on a specific role to ensure consistency of methodologies, where appropriate, across the different networks. Consistency will help support cross-network planning. It will also help third parties to engage more easily with planning across the networks. This will be thanks to an overall, coordinated approach as both transmission and distribution system needs evolve.

We will also provide bespoke support to individual DNOs, on request, to help them develop their own processes. We expect DNOs would begin undertaking such assessments from the start of RIIO-ED2. Therefore, we believe our support would be required from the first quarter of 2022/23 to help DNOs prepare to implement this activity. This would run to the second half of 2025/26 in order to support all DNOs who may introduce this at different times.

The 132 kV networks in England and Wales are different in nature to the transmission networks, so we would need to gain a thorough understanding of these networks and develop relevant modelling and analytical tools. The amount of investment at this voltage level is expected to be relatively low (around £40 million a year, compared with around £1 billion a year at the transmission level). However, we do believe further consumer value can be generated by the DNOs adopting a *NOA*-type approach by ensuring optimum timing of their investment decisions. It could lead to enhancements in decision-making for distribution investment, potentially generating savings of £10 million for consumers. We believe our support will help DNOs maximise these savings and will help to provide consistency for consumers.

The additional FTE proposed for this activity has been included in the wider *NOA* enhancements. This represents the minimum resource we feel is needed to make this a meaningful proposition. Any less would make it a struggle to build the specialist knowledge of the challenges of lower voltage networks to be able to support in a significant way. The timeline for lower-voltage assessments is included in the delivery chart covering end-of-life assets and connections wider works decisions – in the previous section.

Stakeholder feedback

During our more technically focussed RIIO-2 engagement event in December 2018, a range of stakeholders told us they had limited appetite for the ESO to undertake assessments at lower-voltage networks – noting how different they were to the transmission networks. This view has been echoed by the Electricity Networks Association (ENA), which said it believed that at distribution level DNOs are better placed to make these decisions. The ENA added that expansion of the *NOA*'s current remit to distribution voltages could be inappropriate, particularly as work continues to establish the future 'world' and the transition to distribution system operators (DSOs).

We were, therefore, minded not to take the proposal forward, but were challenged by our RIIO-2 stakeholder group (ERSG) to explore the option with stakeholders further. So, at our April RIIO-2 event, we asked stakeholders if we should have a role looking at lower voltages. Most stakeholders agreed that the ESO was not best placed to undertake the assessments at lower voltages. But some, from networks, local government and generation sectors, were supportive of us having a role in providing support and a consistent analytical approach to network planning at lower voltage levels.

Conversely, one generator felt that we could undertake these assessments, depending on the respective future roles of DSOs and the ESO, which still need to be clarified. As a result of this feedback we have refined our proposal, as set out above, to provide support to DNOs to do their own assessments rather than undertake the assessments ourselves.

Cost-benefit analysis

Distribution-level organisations, including DNOs, will be able to engage more easily with the ESO thanks to a more coordinated approach to planning across the networks and a consistent *NOA* methodology. This will

include being able to access shared best practice in economic evaluations. We would expect DNOs to develop their processes and will share our experience of *NOA* assessment to help them ensure they are effective.

The £30 million benefit has been calculated using an estimate of DNO investment at this voltage level of £40m. At a transmission level, around 40 per cent of options do not make it onto the optimal path for any of the *FES* scenarios. Assuming the same is true at a distribution level, this would mean £16 million of investment would be recommended to not proceed each year. Given the uncertainty in this, we have assumed £10 million benefit a year would be realised.

This is against a baseline assumption of not supporting DNOs to deliver *NOA*-type benefits on the distribution networks.

See the Annex 2 - CBA report section 4.1.2.4 for more details.

6.2.3.4. Enhance our analytical capabilities to support these activities

Our modelling capabilities underpin most of what we intend to deliver in Theme 3 and many in Theme 4, enabling us to unlock significant benefits. We need to be able to manage the rising number of scenarios and increased modelling complexity that are driven by the growing interaction between different network needs, such as voltage and stability. The better we understand likely needs, the better we can identify where and when to efficiently invest.

Our current analytical tools focus on thermal needs[79] and some voltage issues. We need to expand our tools to cover all energy-related network issues. Work is already under way to develop our capabilities, but we are only at the beginning of this journey.

The innovative techniques currently being explored will need to be implemented in RIIO-2 and we expect further benefits can be gained as we build on these techniques. For example, greater integration between the different modelling tools will allow us to better understand the interactions between different network needs – and optimise our economic decision-making.

Specific tools we will develop are:

- **economic assessment**. This tool enables us to identify the most efficient time to invest in our networks, to address the future needs identified through our network modelling.

  Our current tool is scheduled to be refreshed before the end of RIIO-1. As part of this, we will transform our economic modelling capability to go beyond its current limited assessments to evaluate all energy-related network challenges, such as all voltage issues, stability and rate of change of frequency (RoCoF). We will refresh the tool every three years (fourth quarter 2022/23 and second half of 2025/26) to ensure it supports our evolving network development requirements.

  We will also integrate our economic-assessment tools with our power-system modelling tools, building in the processing power to solve ever more complicated network optimisations.

  These enhancements will allow us to further pinpoint the most economical time to invest in the networks – and the most efficient solution. Correctly identifying the best time to invest saves consumers many millions of pounds.

  In addition to our future network planning, this tool will support our year-ahead outage planning by providing a more refined understanding of the networks.

- probabilistic modelling. This approach allows detailed statistical analysis of network flows and other system conditions. It is a significant step forward, as the ESO will be able to not just understand that a circuit is overloaded, but also when, how often and under what prevailing conditions. This will support better decision-making to prevent over or under-investment.

  Proof of concept work is currently under way to develop these techniques for thermal issues. By the fourth quarter of 2021/22, we intend to have developed the modelling further to account for actions the ESO takes to optimise the capability of the network. For example, using network assets to direct and control the power flow across the network.

  We also intend to model potential alternatives to traditional transmission reinforcement. These include commercial options, flexible power-flow devices and energy storage, which will enhance our capability to compare multiple options in the *NOA* process.

  Also, by integrating this tool with our other network-planning tools, we will better optimise the decision-making process by combining the economic and technical studies within a single platform.

  Subject to the success of our probabilistic modelling and voltage optimisation (see below), from 2024 onwards we will provide an online portal that enables stakeholders to see a visual representation of network needs and to potentially test high-level solutions.

- **voltage optimisation**. As set out earlier, voltage issues on the network have grown significantly. The ESO's current tools for voltage assessment need to be developed to be able to manage the increased volume of analysis that needs to be done in a short space of time.

  We are currently investigating the possibility of a new voltage-assessment tool that can examine more scenarios, more quickly. If this proof of academic

[79] Thermal needs – Where the amount of power that would flow exceeds the design rating (or capacity) of any network components E.g. Overhead lines, cable circuits, transformers and circuit breakers.

concept is successful, a new voltage-optimisation tool will be developed by the second half of 2023/24.

During RIIO-2, we would look to enhance this tool further. Specifically, we are keen to integrate this with other tools to allow us to look across a range of system needs at the same time, such as thermal, dynamic and steady-state voltage requirements.

The voltage-optimisation tool will allow us to identify where and when this need occurs, which in turn helps us to identify the most efficient solution. We anticipate this could contribute to the savings across all of the operability constraints in RIIO-2 as detailed in Annex 2 - CBA report.

- **stability assessment**. Stability is the inherent ability of the system to quickly return to acceptable operation following a disturbance. The increasing contribution of non-synchronous generation technology[80], and the corresponding decline of synchronous generation, means that we have had to enhance our capabilities in monitoring, understanding and maintaining stability. This is essential to provide a reliable network.

  Investigation is currently under way into new algorithms that allow faster assessment for our control centre. We also need improved tools that allow us to identify and plan for future stability issues.

These requirements are even more complex than the algorithms being developed, as our ability to rely on established generation equipment for stability reduces. Investment is required in RIIO-2 to allow us to develop and implement new tools to assess future stability needs. New stability assessment tools will be in place in the first half of 2024/25 (See IT investment reference 390 *NOA* enhancements).

Investment roadmap

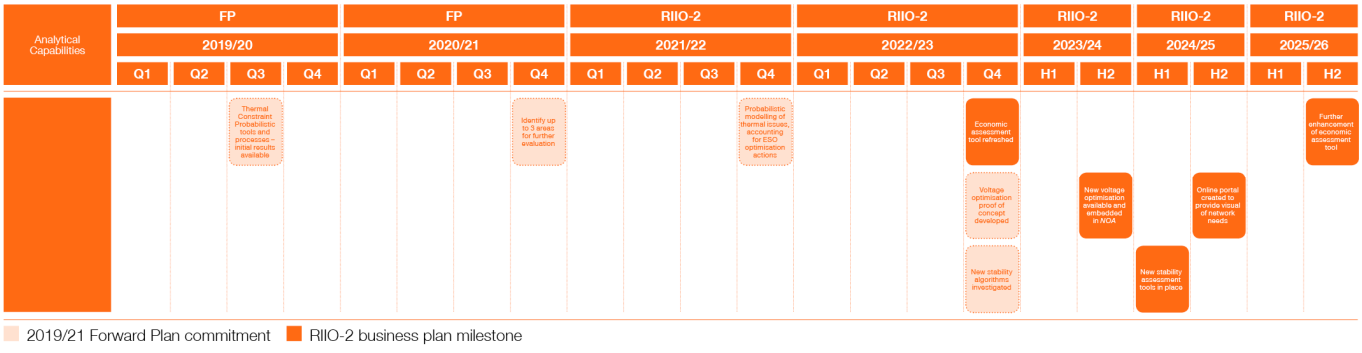


Figure 31

[80] Non-Synchronous Generation Technologies – NSG technologies are de-coupled from the grid and do not contribute to the system inertia. Examples include Wind Turbines, Solar PV, and HVDC Converters.

6.3. Review of the SQSS

Review of the SQSS		Five-Year Strategy				
		Two-Year BP				
	RIIO-1	2021/22	2022/23	2023/24	2024/25	2025/26
Capex (£m)	0	0	0	0	0	0
Opex (£m)	0	0.2	0.3	0.3	0.2	0.1
FTE	0	2	3	3	2	1

Highlights

We propose to invest in supporting a targeted review of the Security and Quality of Supply (SQSS) technical standard, to ensure it is designed to enable decarbonisation of the energy system. We will invest to scope and manage the technical developments, and then scale them back through implementation.

In order to make a review worthwhile, we will need sufficient resources to ensure we can effectively support and action the meaningful improvements identified. Two additional FTEs are required to scope and initiate the review, expected to start in 2021/22, and one additional required over 2022/23 to manage the content changes and technical developments. We anticipate a decreasing FTE profile to continue the implementation of any changes.

The SQSS sets the technical standards that TOs must meet. The energy industry has changed significantly since the SQSS was introduced. As we move towards a decarbonised energy system, it is important that industry codes and standards reflect this.

There are a number of areas where improvements could be made, including reviewing its approach to deterministic standards to ensure it reflects the *NOA*, and developing the offshore transmission section to reflect the growth of this sector.

In line with the majority of stakeholder views, we suggested in our July Business Plan draft that a focused review of the SQSS – addressing a targeted set of known concerns – would be an effective first step. Since then, the Department for Business, Energy and Industrial Strategy (BEIS) has announced that its review of engineering standards will include the SQSS within its scope. We expect that this review will outline key areas of change that are required, but not explore these in detail. We therefore continue to propose a targeted SQSS review, building on the recommendations from the BEIS work, and to drive forward the changes with the highest consumer benefit.

Given that BEIS's review starts imminently, and is due to finish in March 2020, we expect a targeted SQSS review would begin at the start of RIIO-2 and run for four years. Potentially, we would move to a larger-scale review if the BEIS work recommends this, or if the early stages of the targeted SQSS review indicated a need. Costs and timeframes for this are not accounted for here.

The review could potentially go beyond SQSS to include the distribution standard P2/6, and would need to be supported by TOs, DNOs and other affected stakeholders. We are mindful of the feedback we have received, particularly in Themes 2 and 4, of the need to take a broader, whole system view of technical codes and frameworks, along with the need to make these areas more accessible. We will therefore be considering how we can make timely changes in this area while a broader review is developed.

Cost-benefit analysis

We have conducted a break-even analysis of the SQSS review, rather than a full cost-benefit analysis. We have conducted a breakeven analysis because the SQSS review does not deliver consumer benefit by itself. It is the implementation of the review recommendations (if any) that provide consumer benefit, and we cannot say at this stage what these could to be. Given the stakeholder feedback (see below) we propose a targeted review.

For more details see Annex 2 - CBA report section 4.2.

Investment roadmap

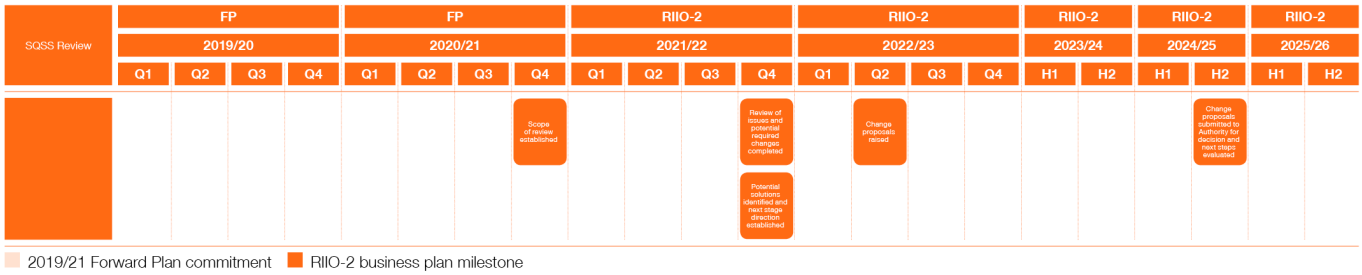


Figure 32

Stakeholder feedback

We engaged with stakeholders on our proposal to review the SQSS at our webinar in November 2018, our December 2018 RIIO-2 event, and our RIIO-2 workshop in April 2019.

"As SQSS sets the rules for the NOA it is very important that the SQSS is up to date with current technology and capability, so that it is a level playing field for all technologies."
Generator, in response to the Our RIIO-2 Ambition consultation

Stakeholder views were mixed on whether a fundamental review was necessary. In our November webinar, six out of eight participants supported a fundamental review of some form. However, at our December event, there was no clear agreement on whether a fundamental review was required.

Several stakeholders, particularly DNOs and TOs, felt that a fundamental review was unnecessary and potentially lengthy, whereas others felt that undertaking a review would benefit the industry. At our April event, of the seven stakeholders who gave an opinion, the majority supported some form of review. But there were no definitive thoughts on whether this should be a light-touch or fundamental. These stakeholders were from a range of sectors, including generation, networks, government and renewable energy. A generator company highlighted that changes to the SQSS would have an impact on system charges.

A service-provider stakeholder questioned the need for the SQSS at all, citing other countries that don't have a standard. Feedback from some offshore parties has suggested that the offshore section of the SQSS may benefit from a significant level of review.

We also explored different possible approaches with the TOs. All agreed that a more focused review would be more appropriate than a fundamental one. It was felt that a fundamental review could slow down the benefits that could be achieved by addressing known issues. It could also be bureaucratic, they said. And it was unclear what we would expect to be radically different at the end. It was noted that a fundamental review was started around 10 years ago and continued for around nine years. We agree that a more targeted review would be more efficient – and we will undertake further work to determine a possible approach.

6.4. Supporting the design and delivery of an early competition plan

Separate from and prior to the RIIO-2 Business Plan we propose to take a four-stage approach to develop an early competition model plan we can submit to Ofgem by February 2021. The development work will be completed in the RIIO-1 period and the models and roles established in RIIO-2. We have agreed the development scope with Ofgem, as per the request in their open letter dated 24 September 2019 and are currently agreeing how this work will be funded and sourcing the external support we need.

Stage 1 of the development phase will include identifying the preferred models and completing more detailed planning of stage 2 to 4. Stage 1 will run to December and result in the production and submission of an update to Ofgem covering existing development of ongoing work to tender for non-network solutions; justifications for two (or more) preferred models, project plan for stages 2 to 4 and a further funding request to February 2021.

Our model development and selection process will include broad stakeholder engagement, including webinars and workshops and an equivalent stakeholder governance approach to RIIO-2; model development, supported by external consultants to ensure effective stakeholder input to their development and evaluation; completion of external case studies; and development and application of evaluation criteria, to enable us to select the preferred models

6.5. Proposed performance metrics

Our *NOA* process drives economic and efficient outcomes from planning, developing and investing in the network. We have received positive feedback regarding our Forward plan metric of the value savings that are passed on to the customer. We propose to continue this metric in RIIO-2 as we continue to drive for optimal network solutions. To do this, we would propose using the calculation methodology set out in our Forward Plan. We propose to set targets for the areas in which the ESO has control (this being either ESO exclusive options or ESO collaborate options and excluding TO exclusive options).

The metric would be calculated where the percentage of the overall *NOA* value generated by the options we are involved in exceeds the percentage they represent of the overall number of options in the optimal path. This shows that as ESO we are driving value through creating and influencing options to best meet system needs.

For reference, to meet our baseline target in the Forward Plan, the percentage of ESO exclusive and ESO collaborative options would be between 10 and 12 per cent of the total number of options in the optimal paths. The value they represent is between 3 and 4 per cent of the overall consumer benefit delivered by that *NOA* process. Alongside our measure of customer benefit saved from *NOA*, we would also propose measuring the percentage of different participant types that are in the *NOA* process. The context here is that we intend to expand the *NOA* to a wider range of participants to increase competition, enable us to identify the most efficient and effective network solution possible, and increase the potential for consumer benefits.

We would also propose supporting the participant-mix metric with a routine Stakeholder Satisfaction (SSAT) measure, which would help to inform how the NOA methodology develops in the future. As the expected variety of participants involved in the *NOA* process becomes more diverse, a measure of satisfaction from our process stakeholders will give us a wider range of perspectives from which to drive further improvements in the methodology.

Stakeholders have been supportive of the expansion of the *NOA* to other areas of network development as well as enhancing competition. Our proposed metrics in this area align to that view and support our ambition to create competition everywhere.

Theme 4
Driving towards a sustainable, whole-energy future

Consumer priorities

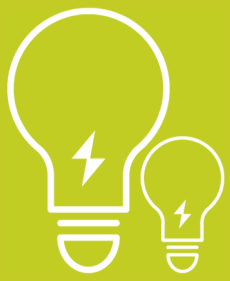
- We want an affordable energy bill
- We want energy to be available when we need it
- We want a decarbonised energy system, fit for the future

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 in a timely manner.

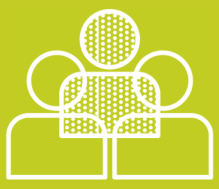
What this Theme covers

Adopting a whole system approach to drive the whole energy system transition of the industry and realise GBs carbon and net zero ambitions..



What we propose to do

Provide deeper insights to inform key policy areas. Work with other network organisations to develop consistent and co-ordinated processes for customers that facilitate efficient connection and access to the system, and ensure we have the tools to manage overall system operability .



What our Stakeholders have told us

Stakeholders have mixed views on the extent to which we should develop policy recommendations from our *FES* analysis on key industry topics. They think that whole energy system solutions are essential to the transformation of the energy landscape and that our connections and system access proposals can assist the transition.

What are the key benefits

Provide the industry with a clear and detailed view of the future energy system and pathways to inform their plans and investment decisions. Facilitating efficient whole system ways of working that drive consumer value and the connection of low carbon energy resource. Allowing customers to access a more supportive, co-ordinated connections experience.

7. Theme 4: Driving towards a sustainable, whole energy future

Theme 4 delivers £676 million of consumer benefits[81] Investment[82] for this Theme for the first two years: £57.0 million

7.1. Five-year strategy

Net-zero by 2050

We will enable the UK to transition to net zero emissions by:

- developing policy recommendations, pathways and strategies related to clean heat and zero carbon electricity grid operation.
- rolling out our Enhanced Frequency Control Capability system to our National Control Centre.
- build and enhance relationships with other network organisations to facilitate decarbonisation opportunities.

We will take a whole energy system view of the changing energy landscape to operate a zero carbon electricity system by 2025 that delivers maximum consumer value. We define a whole energy system as covering more than a single fuel source, while extending into transformational areas such as the decarbonisation of heat and transport.

The significant changes since the start of RIIO-1 have increased the challenges we face in planning and operating the system:

- **The number and mix of parties connecting to the system:** in the last 12 months applications from new market participants have increased by 60 per cent, driven by new small generation units for battery storage and solar connections, new interconnectors and new demand points for data centres and independent DNOs. We forecast that this trend will continue in RIIO-2, with an increasing number of applicants being small, new players that require more support
- **The generation mix:** Declining levels of traditional generation are bringing increased operability challenges, for example due to lower levels of system inertia. In the first quarter of 2019 renewable generation was the second highest on record and in line with the trend that has seen renewable generation rise 70 per cent since 2014[83] while fossil fuels have declined by 26 per cent.
- **Significant increases in distribution-connected generation:** this requires us to be able to model the operational characteristics of distribution networks with much higher volumes of data. Distribution-connected generation capacity has increased by 80 per cent since 2013 and in 2018, 77 per cent of this capacity was renewable[84].

To deliver our strategy for this Theme, our proposals therefore focus on enhancing the way we work across the transmission and distribution networks and providing using our whole energy system view to provide insight on policy issues and pathways to net zero by 2050. We will:

- Lead the debate – providing insights and policy pathways to achieve the UK's low carbon goals
- Take a whole electricity system approach to connections - to accommodate the growing numbers of parties seeking to connect to the network, and their more complex needs
- Use a whole electricity system approach for zero carbon operability – investing in our capability to undertake more complex system modelling including data exchange, sharing and analysis
- Deliver consumer benefits from improved network access planning - taking into account effects across the transmission and distribution networks

While longer term development will be around whole energy system approaches, our delivery focus for the early part of RIIO-2 will be on whole electricity system solutions. We define the whole electricity system as covering electricity transmission and distribution, including all parties involved in delivering for consumers.

The whole electricity system transition will affect all stakeholders within the sector, and this Theme primarily considers how our role will change in relation to other network organisations. Other impacts, such as the development of flexibility markets, are considered elsewhere in our proposals.

7.1.1. Interactions with other parties

Each of the actions proposed above aims to drive efficiency in areas where cross-business working

[81] Consumer benefits are the net present value (NPV) of Theme 4's transformational activities over the RIIO-2 period. Our analysis suggested that accounting for market, delivery and third-party uncertainty the net present value could credibly be between £921 million and £429 million

[82] The ESO will generate a net saving for consumers in RIIO-2. The proposed investment in this chapter will help to deliver this net saving

[83] Digest of UK energy statistics 2019 table 5.1

[84] Digest of UK energy statistics 2019 table 5.12

currently poses a risk to the efficient delivery of a low carbon power system. They should ensure the industry works better together, for the benefit of consumers, delivering lower bills than would otherwise be the case. They also support the other proposals in this Business Plan, including the development of distributed markets for flexibility as well as facilitating zero carbon operability.

In particular, we propose to deepen the way we coordinate with distribution network operators (DNOs), as a natural evolution of our existing role. This will enable us to take a whole electricity system view that will enhance consumer benefits. This approach is consistent with the ethos of the Energy Networks Association (ENA) *Future Worlds 'World B*[85]', which is supported by a wide stakeholder base and consistent with the least-regrets approach taken by Ofgem in their position paper on distribution system operation. The approach is also supported by our ESO RIIO-2 Stakeholder Group (ERSG) and forms the basis of our strategy. Our relationship with Transmission Owners (TOs) will remain similar to today. However, we will continue to enhance this relationship, looking for incremental opportunities to unlock consumer benefits in a changing energy landscape.

To ensure enhanced electricity system coordination and effective management of operational issues at the transmission-distribution interface, we expect DNOs and TOs to have access to funding and resources to establish new ways of working. This includes information technology (IT) system changes to appropriately interface with ESO systems, so the required data exchanges can take place. For example, in relation to system conditions and the use of flexibility services. We are working with network organisations, both bilaterally and through the ENA Open Networks project, to ensure that that the activities we are doing to enable distribution system operation are co-ordinated. To that end we are also engaging with TOs to ensure a coordinated approach to our RIIO-2 Business Plans. We will look to ensure similar engagement with DNOs as they develop their plans for RIIO-ED2.

7.1.2. Proposed investment

The chart below summarises our proposed investment over the RIIO-2 period. It covers both our ongoing and transformational activities. Further justification for the costs associated with these is set out in the relevant sections that follow. Details on how we have included efficiency assumptions and benchmarked these costs are in chapter four.

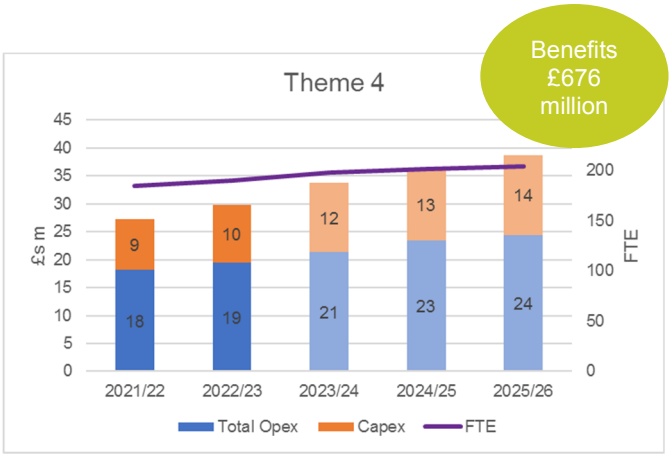


Figure 33

Our main benefit ambitions for the RIIO-2 period under this Theme are:

- Continued customer efficiency through easier access to front-line support and coordinated information, resulting in £8 million in consumer benefits
- Realising significant value through identifying and opening up potential new market opportunities to address network operability challenges, which could unlock around £500 million in benefits
- Continued deployment of Regional Development Plans (RDPs) saving consumers over £50 million and saving over half a million tonnes of carbon
- Transmission and distribution-connected parties will receive better notification of planned outages and their impacts on the networks, releasing £224 million in consumer benefits.

We will maintain a focus on consumer priorities:

- An affordable energy bill:
  - We will develop and share an understanding of the whole system cost of different heat decarbonisation pathways. This will allow Great Britain to avoid choices that would lead to overspending and stranded assets.
  - Increased sharing of network data and models, particularly between network organisations, will help us develop and operate the transmission system more efficiently. It will reduce the need to take expensive actions to manage congestion or build unnecessary assets.
  - We will roll out the enhanced SO-TO cost-recovery mechanism across Great Britain. This will optimise access to the network in the long and short term, while facilitating efficient recovery of costs by network organisations
- Energy available when needed
  - By providing a clear view of the future, we help steer the energy system away from pathways that

[85] http://www.energynetworks.org/electricity/futures/open-networks-project/future-worlds/future-worlds-consultation.html

could lead to safety and reliability problems before they become an issue.

- A decarbonised energy system, fit for the future through:
  - Providing better information on available transmission capacity will help low carbon developers understand where they can quickly connect to networks. This will speed up the decarbonisation of the energy sector.
  - Deepening our relationship with DNOs in the design and development process will embed the Regional Development Plan ethos and facilitate the faster connection of low carbon generation
  - Safe and secure energy system through:
  - Our proposal ensures future operability of the whole electricity system, with clearly defined roles and responsibilities for both the ESO and emerging DSOs.
  - Increased coordination and optimisation of network access will facilitate timely construction and maintenance of assets, improving safety and reliability.

We will measure our success by tracking:

- Cost of balancing
- Outage timeliness
- Outage value
- Customer satisfaction surveys

Stakeholder engagement on our approach to the whole electricity system and whole energy system.

We have engaged our stakeholders through a number of channels to establish their views. This included our December 2018 and April 2019 ESO RIIO-2 stakeholder events, and through thought pieces, bilateral meetings and webinars. Our Business Plan responds to their views, which include:

- Whole energy system solutions are essential to transforming the energy landscape. It is important to work 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 is widespread recognition that we could use our unique perspective – particularly on the system operability and network costs of different pathways – to provide more support to policy makers and help drive the energy system transition.
- Our proposal to create a connections portal, which guides customers through the process, is a positive development. There is merit in customers having access to connection and delay charges, user liabilities and construction progress through the portal.

7.2. Leading the debate: providing energy analysis and market insights to drive the energy transition

We have an important role to play in leading the debate on the energy revolution across the industry. We will inform and work with our stakeholders to make sure we have a safe, secure and reliable energy future. This includes our wide range of publications that provide energy insight and analysis that we are seeking to enhance over the RIIO-2 period.

We are uniquely positioned to use our expertise and share our analysis to lead the debate and help drive the whole energy transition that will support the UK's 2050 net zero commitment. We will deliver deep and targeted analysis and industry engagement, so we can facilitate and enable the development of specific energy policy recommendations. These will build on the valued insights we already produce through our *Future Energy Scenarios (FES)* and associated documents. As we stated in our 2019 *FES*, we believe that net zero is achievable. We will continue to support the Department for Business, Energy and Industrial Strategy (BEIS) to ensure the timely development of its clean heat strategy, providing key inputs from a whole energy system perspective. And, as indicated in our *Towards 2030* document, we will play an instrumental role – and work with the industry – in the delivery of a smart, flexible energy system. We will focus discussion on the many constituent areas of a whole energy system transition to net zero, including clean heat, Carbon Capture Use and Storage (CCUS), electric vehicles, and energy data. Delivering the best outcomes for consumers will be at the heart of our analysis. While the content of this activity analyses the uncertainty and impact of policy, the work itself has no specific policy dependencies.

The ESO operates within the wider Great Britain System Operator structure, which covers both gas and electricity system operation. While most roles and activities within the ESO consider the impact of change on the electricity sector, there are several dual-fuel roles. These allow us to take a broader view across gas and electricity, which informs our whole energy system view where appropriate. Examples include our analytical work to produce the *FES* and *Summer/Winter Outlooks*, as well as producing analysis and thought pieces that support the development and impact assessment energy policies.

In RIIO-2, our development of whole energy system thinking will be extended into 'design by doing'. We have successfully taken such an approach in the development of whole electricity system approaches such as regional development programmes (RDPs). Initially, we will do this through the targeted use of innovation projects. In later years, we will use what we learn to inform our core business activities. Work here will be driven by emerging policy-topic needs, including the decarbonisation of heat and transport.

7.2.1. Costs

Leading the debate		Five-Year Strategy				
		Two-Year BP				
	RIIO-1	2021/22	2022/23	2023/24	2024/25	2025/26
Capex (£m)	0	0	0	0	0	0
Opex (£m)	2.2	4.1	4.2	4.3	4.4	4.1
FTE[86]	17	33	35	36	37	34

Highlights

Our opex will ensure we can build on our *FES*, undertake deeper, targeted analysis and industry engagements, facilitate development of specific energy policy recommendations, support DNOs and TOs develop their regional *FES* and the end consumer through the energy transition

Capital investments associated with this activity include the need for a Data and Analytics platform. This is captured under Theme 1 investments as the platform will be developed and deployed to support wider ESO requirements. Our opex reflects our proposed increase in FTEs, which are further explained below.

7.2.2. Ongoing activities

We will continue to bring energy, customer and stakeholder insights together. This will underpin – and help inform – the development of the ESO strategy, as well as how we plan investments and how we operate to meet decarbonisation targets. Activities in this area include:

- providing expert advice and insights through publications including *FES*, *Winter Outlook* and *Review*, *Summer Outlook* and other thought-leadership pieces.
- conducting electricity and energy mathematical modelling and market research, such as analysis on pan-European models and geographical demand information, to understand how the landscape in which we operate could change.
- maintaining external engagement channels to capture and share insights from stakeholders, including consumers, on their future requirements and expectations.

[86] Opex and FTE numbers are the average for the ESO since legal separation (years 2020 & 2021), which reflects the current ESO business. Capex figures are the average over the 8 years of RIIO-1.

Enhancements to our ongoing work

We carry out significant stakeholder engagement to develop the *FES* and we publish the feedback we receive annually[87]. Stakeholders consistently tell us that whole energy system considerations are crucial to enabling the transition to the energy system of the future. In developing *FES* for 2019, we engaged more than 630 individual stakeholders from 415 organisations.

In RIIO-1, we made several improvements to our ongoing activities, without requiring additional resources. For example:

- we launched an annual *FES* stakeholder feedback document.
- we grew the number, and range of stakeholders we engaged with.
- we developed new data and techniques to model growing levels of distributed energy, renewable generation and interconnectors.
- we improved the visibility and transparency of our *FES* data. This included providing a regional breakdown of *FES* electricity data, including the impact of electric vehicle and heat pump penetrations by grid supply point for each of the four *FES* scenarios.
- we played an active role in the ENA Open Networks Project, including leading the whole energy system workstream.

Of the 33 FTEs in 2021/22 in the cost table above an additional three FTEs are required to deliver our ongoing activities and work enhancements in 2021/22. The increase, from our baseline 17 to 20 FTEs, includes two needed to deliver additional requirements from *FES*, ensure our analysis and modelling keeps up with the rapidly changing landscape and meets the increased analysis demands from other teams. These demands, against our current priorities, include probabilistic modelling, heat improvements and demand profiling. The remaining one additional FTE is required to deliver the strategic inputs needed to address the increased volume of work required from a more frequent ESO RIIO cycle and ensuring alignment to external changes.

Innovation funding during RIIO-1 has contributed to our proposals

Our ability to lead this debate is built on data-driven analysis, including data from our innovation projects. One example is our Network Innovation Allowance (NIA) project on electric vehicles (EVs) charging behaviour, which has brought a step change in our modelling of electricity demand from EVs. Another is our self-funded carbon intensity forecasting project. This used machine learning and automation to provide more accurate forecasts, which we publish continuously to enable consumers, academics and industry stakeholders to make more informed choices.

In RIIO-2, we will continue to enhance our ongoing work, including delivering modelling improvements such as a spatial heat model, while incorporating demand curve developments. This will enable a more regional approach to be employed to understand the locational impact of heat decarbonisation. Allowing better network planning outcomes and faster adoption of optimised decarbonisation solutions.

7.2.3. Transformational activities

We will respond to stakeholder feedback to carry out deeper analysis and broader industry engagement to, where appropriate, develop evidence-based recommendations to support the development and successful implementation and execution of energy policy. Our work in this space will build on the valued insights we already produce through our Future Energy Scenarios and associated documents. We will do this in partnership with key decision makers and stakeholders. Our focus will be on the delivery of a smart, flexible low carbon energy system, zero carbon electricity grid operation, and the development of a clean-heat strategy. These areas will focus discussions on how we can achieve the best outcomes for consumers across areas including clean heat, CCUS, electric vehicles and energy data.

"ESO's core role should move beyond keeping the lights on, to also include facilitating the energy transition."
Flexibility provider

[87] More information on our engagement approach for *FES* can be found here: http://fes.nationalgrid.com/stakeholder-feedback/

By developing and sharing our understanding of the whole system implications of different heat decarbonisation pathways, we can also inform investment choices in new network assets or other market solutions. We would expect this to translate into lower bills and reduced environmental impact.

We will provide broader and deeper insights, which will be underpinned by enhanced long-term modelling and improved analysis tools, capabilities and processes. Our capabilities and processes will need to change to make efficient use of a vast range of energy system data which will become increasingly open as the recommendations from the Energy Data Taskforce are implemented. We will use new techniques, such as artificial intelligence and machine learning, to derive new insights from it. The IT investments required to provide this are included in IT reference 220 Data & Analytics Platform (See Annex 4 - Technology investment report), which is covered in more detail in Theme 1. We plan to deliver new demand models and whole system model enhancements in the period to 2023, followed by further enhancements to demand models, heat models and probabilistic models in the period to 2026.

Thirteen of the thirty-three FTEs in 2021/22 of RIIO-2 are required to significantly step up our engagement and collaboration, both with DNOs and wider industry, as we seek to bring analysis and insight to explore the 'so what' of the changing energy landscape at a national and regional level – driving tangible action towards net zero.; Eleven will support opex and two will support *FES* capex investments. This will increase by two additional opex FTEs in 2022/23. We have estimated these resource needs based on historical activity levels and existing modelling team sizes. We expect to realise efficiencies in our modelling processes, which will enable us to reduce our FTE requirements later in the RIIO-2 period.

7.2.3.1. *FES*: Steps to Net Zero

Of the 33 FTEs for 2021/22, in the table above, four are additional FTEs required from 2021/22 to 2022/23 to enable us to build on the results of our *Future Energy Scenarios* and delve further into specific decisions facing policy makers and industry, both with our own analysis and with stakeholders across the energy system. We will require one further FTE in 2024/25 as our insights work broadens to encompass new insights from the increasing volumes of data we will see. See Annex 4 -Technology investment report, investment reference 220 - Data and Analytics Platform.

Through the *FES*: Steps to Net Zero work, we will work collaboratively across the energy industry, to look in more detail at areas of uncertainty in *FES* and support industry conversations that will progress the UK towards net zero. The additional FTEs will work with partners and stakeholders to explore the whole energy system challenges which are inherent to specific policy and industry decisions, and to build a shared understanding of these across industry through events and publications so that high quality decisions are made across industry for the benefit of the consumer. Additional opportunities created through this work will include highlighting the need for collaborative innovation projects, studies, and informing the scope of existing work across industry so that a whole system lens becomes the norm when considering energy challenges.

7.2.3.2. Distribution / Regional *FES*

Consistent with the Energy Data Task Force[88] recommendations we will publish our data, analysis and insight to further facilitate and progress debate across a range of different audiences. This will include deepening our relationships and co-ordination with DNOs and TOs as they embed their own regional future scenarios.

Of the 33 FTEs in 2021/22, seven are additional FTEs required from 2021/22 to support DNOs develop their regional FES by aligning our energy data capture, analysis and modelling processes, where appropriate. Five are opex, rising to seven FTEs in 2022/23 and two capex, supporting FES investment. This is the equivalent of half an FTE to support each DNO licence area. We will limit this to where it makes sense and is in the consumer interest for us to do so, as we recognise that a Regional *FES* will seek to answer different questions. There is however an opportunity and benefits to be gained from understanding different approaches and scenarios assumptions, and from independent analysis and outputs reporting.

In addition to supporting the DNOs the additional FTEs are required to enable us to build and develop more granular models, both geographical and temporal, and incorporate increasing volumes of data, such as from smart meters. The resources will also engage with DNOs and a wider range of stakeholders. This includes developing local models with DNOs and Gas Distribution Networks, such as Western Power Distribution or Wales and West Utilities covering energy future growth and over the year, not just at peak demand, modelling along the demand curve to better reflect how it may change due to increasing solar power demand and use of electric vehicles. Once we have built the new models and established the capability to manage the increased data volumes we will scale back our resources. See Annex 4 - Technology investment report, Investment reference 220 - Data and Analytics Platform.

7.2.3.3. Consumer Champion

We propose stepping up our role in relation to consumer engagement; developing our presence as a balanced and neutral partner to consumers, becoming a consumer champion across the energy markets and providing data and marketing to enable behaviour change around energy use. This work is likely to be a long-term journey, particularly as progress on

[88] https://es.catapult.org.uk/news/energy-data-taskforce-report/

decarbonisation of heat and transport begins to impact more directly upon greater numbers of consumers.

Of the 33 FTEs in 2021/22, two are additional FTEs (opex) required from 2021/22 to enable us to create a small consumer team to establish a consumer insights and experience led approach to external engagement, support and partner with the end consumer through the energy transition and build on our experience with campaigns such as Power Responsive We will retain this additional level of FTEs through the RIIO-2 period to sustain this work.

7.2.4. Investment roadmap

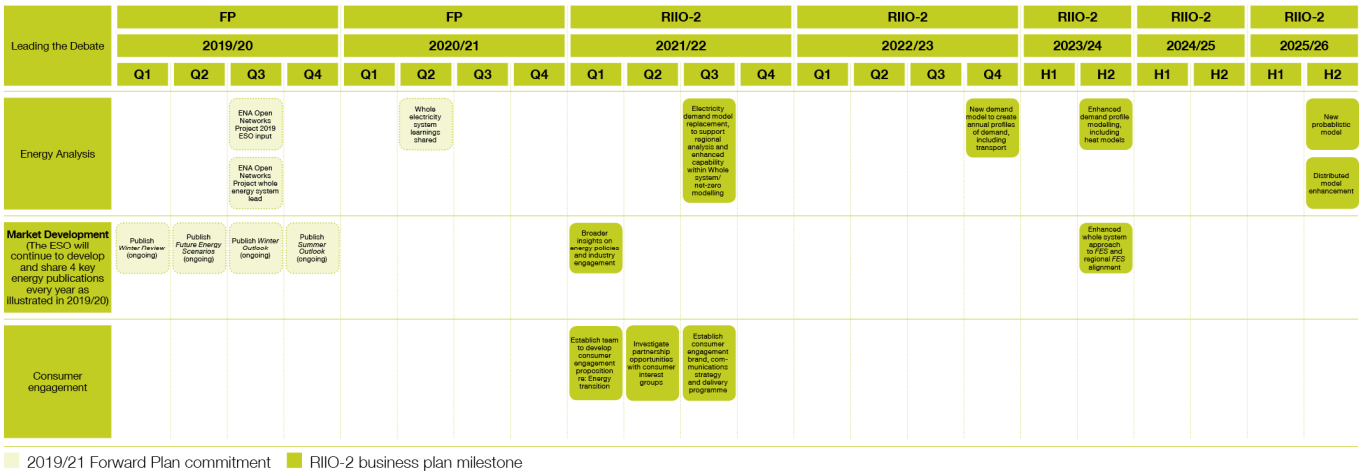


Figure 34

7.2.5. Stakeholder views

ERSG supports Theme 4.

We have engaged on this subject at our *FES* events, through our Ambition consultation, and more recently at our Control Centre workshops in July and August and trade association meetings. Through our annual *FES* engagement cycle, we have been challenged to provide greater insight and direction on how different pathways could be realised. In response to the *Our RIIO-2 Ambition* publication, stakeholders expressed a range of views on our role. All respondents were supportive of the ESO providing insight and analysis to support the government in the formation of energy policy. However, one large supplier felt that our proposals to make policy recommendations went beyond the boundary of our role. In contrast, a large renewable generator highlighted that the ESO has a unique position as the interface between multiple organisations in the energy market, so we should be offering guidance on how to address decarbonisation.

"We strongly support the need to decarbonise the energy system and the critical role the ESO has to play to support government with insight and advice on their areas of expertise."
Supplier, in response to the ESO Ambition consultation

Given the differing views we had received up to the publication of our draft plan, we sought to engage stakeholders further on this topic. We did this at our Control Centre round table events in July and August, at the *FES* 2019 launch event in July in Birmingham, and with trade associations. Following review of our draft plan, the ERSG also said that we should engage further on this topic and seek to clarify our role.

At the *FES* launch event, most people we spoke to about our proposals were supportive of the ESO

stepping into a role where we make policy recommendations from the *FES* analysis. These included stakeholders from the renewable energy, supplier, and gas DN sectors. Similarly, at our Control Centre events, two consultants, a generator, an energy technology company and a member of local government thought we should go further – and start to make recommendations from our analysis, saying that we are well placed to do so. They did, however, question what impact this would ultimately have.

"ESO being a second government is not as valuable as laying out all the information and analysis."

Consultant company, Control Centre engagement event

Conversely, two generation companies and a consultant thought that we should not be making value judgements from the *FES.* Instead, we should just provide our analysis and data (in raw, dissectible form) for others to scrutinise and draw their own conclusions. A consumer body also thought we should be facilitating debate, rather than leading, but that we could perhaps take more of a role on the subject of heat. Members of a trade association thought it could look like we were trying to position ourselves at the centre of the system. They questioned whether, instead, we could make our assumptions within the *FES* more explicit. Or set out what policies would need to be in place to achieve a particular scenario.

At our Control Centre events, we also discussed our role in the development of regional scenarios. On regional *FES* development, different views were expressed. Some stakeholders, including a DNO and supplier, thought that regional *FES* should build on each other and 'add up' to the national picture. Others, including a supplier, member of local government and renewables company, felt that regional differences should exist; and that we just need to understand how assumptions differ across them. A consultancy company thought that we should take a leading role in ensuring consistency across regional scenarios, which can very quickly become misleading for industry.

On being a consumer advocate, a consumer-interest body questioned how we might interact with consumer-advice organisations in this space, citing that other consumer organisations have different specialisms. A generator thought that we should consider direct engagement with consumers, but that it wasn't a priority. A consultant, meanwhile, wasn't sure whether we could be a consumer advocate without talking to consumers directly and building a level of trust.

7.2.6. Cost-benefit analysis.

For this activity we have undertaken a break-even analysis, for details see Annex 2 - CBA report section 5.1.

7.3. Taking a whole electricity system approach to connections

We deal with all aspects of contracts for connections to use the National Electricity Transmission System (NETS). We also manage the impact on the transmission network of connections at distribution level, through liaison with DNOs. We propose to enhance the way we carry out our connections activities, so that we can continue to meet the needs of customers through RIIO-2.

7.3.1. Costs

Whole system approach to connections		Five-Year Strategy				
		Two-Year BP				
	RIIO-1	2021/22	2022/23	2023/24	2024/25	2025/26
Capex (£m)	0	0.7	0.7	0.2	0.1	0.1
Opex (£m)	3.2	4.3	4.3	4.1	4.2	4.2
FTE	40	48	48	48	50	50

Highlights

Our opex will ensure we support the continuing increase and variety of market participants looking to connect to the network. This will be facilitated by capital investment in a connections hub to help generators engage through the connections process and improve customer service and contract management.

7.3.2. Ongoing activities

We provide a valued service to energy businesses wishing to connect to the transmission system. Our relationships extend across the whole asset lifecycle; from initial investment discussions, to the connections process and contract relationships, through the asset's operation and decommissioning.

We are seeing a wider range and number of customers wishing to connect. Many of these are smaller and new to the industry frameworks, so they require additional support. In the past 12 months, we have seen a 60 per cent increase in applications from new market participants from 210 to over 350. This is primarily driven by new, small generation units for battery storage

and solar connections, new interconnectors and new demand points for data centres and independent DNOs.

We expect this trend to continue into RIIO-2 as the increased activity and interest in developing distributed energy resource and the move away from centralised generation continues, as identified in *FES*. In RIIO-1 the activity in this area commenced in the south-east and south west of the UK, this has continued to increase and move through the country geographically. This is changing the nature and level of support we need to give to customers, so we need to increase our resources by two FTEs to maintain an appropriate level of dedicated service.

In addition we will continue to adapt this service to meet the requirements of a changing customer base and evolving customer expectations. The enhancements detailed below summarise the improvements we will deliver during RIIO-1 and propose for RIIO-2. These are in addition to the larger changes required to significantly enhance the customer connections experience, which are set out later in the section.

In RIIO-1, we made the following enhancements to our service:

- delivered efficiencies to the connection process for parties connecting to distribution networks, who may cause a need for transmission investment. The introduction of the Appendix G process allows DNO's to offer connections to embedded customers much more quickly and without the need to engage the ESO through the Statement of Works process. This reduces the connections application process by up to 6 months and reduces costs of the individual customer applicants and DNOs.
- provided more information to our customers to improve their experience.
- worked with network owners to develop new types of connection for energy storage. This has improved the speed at which certain embedded customers get connected.
- worked with TOs to develop faster connection application processes.

In RIIO-2, we will further enhance our service through:

- tailoring our contract management service to ensure appropriate assistance can be efficiently provided to less experienced customers.
- working with TOs to enhance the overall customer experience of connection, compliance and contract management processes.

7.3.3. Transformational proposals

The net present value of taking a whole electricity system approach to connections is estimated at £2 million, and to deliver £1.27 of benefits for every £1 spent over RIIO-2. The net benefits are positive from 2023/24 onwards.

We will step up the level of support provided to smaller parties, helping them to navigate the complex connection processes that exist across Great Britain. As part of this, we will develop, in co-ordination with other network organisations, a connections hub providing a seamless connections experience to electricity distribution and transmission networks across GB that will help guide customers through the connection process. The connections hub will enable participants to access specific information on available network capacity as well as on-line account management. It will allow them to facilitate and accelerate their decision-making around connections and establish an ongoing relationship with the ESO. Being able to quickly understand where network capacity exists should help low carbon developers more quickly navigate the connections process. This will help drive the decarbonisation of the energy sector. We will work with other network organisations to develop this hub and ensure it works efficiently. It will feature information provided by different parties as well as links to the appropriate network organisation for customers' needs whether a party wants to connect at the transmission or distribution level. Through facilitating customers having access to information across the whole electricity system we believe that this will allow informed efficient connection decisions to be made, whether to connect to the transmission system or a distribution network. We received support for this type of connections tool at our April engagement event, particularly from small generators and project developers who thought it would be useful for location-neutral projects.

Our capex investment is focused on the delivery of this connections hub. We derived these costs from our experience of similar work programmes and they have been benchmarked to ensure they represent value for money. For more detail on the benchmarking we have done, please see Annex 4 - Technology investment report investment reference 380 - Connections Platform. To deliver this project, resource its ongoing use and maintenance, and deliver associated customer service activities will require an increase in opex of £1.1 million in the first year of RIIO-2. Part of this increase will be through the recruitment of six additional FTEs to:

- enhance the customer connection experience. This will include dedicated account management for distributed energy resources (DER), and the provision of a broader, whole electricity system view at our customer seminars.
- facilitate the development of our customer connections hub.

We expect this to rise to eight FTEs towards the end of RIIO-2 as the number of new market participants and the volume of new connections continues to increase. A

proportion of the increasing resourcing requirement will be offset by the increasing volume of connection application fees from new connection customers to the network. Our analysis suggests the rate of connections applications will continue to grow, by 20 per cent at the start of the RIIO-2 period, and potentially reducing to eight per cent after five-years. We expect the customer base to evolve further, with a continuing move towards new and smaller customers that require more support through the connections process.

We have estimated that we will realise direct resource efficiencies of ten per cent by providing initial support through the proposed connections hub in development with the Transmission Owners; and a further 30 percent from the roll-out of account management. We expect these efficiencies to be offset by the ongoing increase in the number and variety of applications.

The Great Britain customer connections hub will be fully integrated with our external digital engagement and customer relationship management (CRM) tools to provide a seamless experience to customers and stakeholders (IT investment reference 380 - Connections Platform). This capability will build on our investments in open data and digital engagement. We propose to build this capability incrementally, working with other network organisations to minimise duplication while ensuring customers have a positive experience. As a result of this coordinated approach, we anticipate that the first phase will be delivered in 2023.

In addition, we will provide dedicated account management support to smaller parties who may have transmission-related issues to their connections.

We will work closely with both DNOs and TOs to ensure delivery of this hub and an efficient connections process. We have included some additional FTEs in our operability plans from 2021 to 2023 to support RIIO-ED2, including working with DNOs in establishing efficient processes with customers.

A new connections hub

The connections hub will enable customers to access their account information online. They will be able to view their connection agreements – and track the progress of their connections throughout the process. Through initial engagement, stakeholders have told us they also see merit in having access to connection and delay charges, user liabilities and construction progress from the hub. Through RIIO-2, we will engage stakeholders, through bilateral conversations and industry events such as our customer connection seminars, to further develop this tool. It could potentially include signed agreements, charges and operational notifications.

7.3.4. Investment roadmap

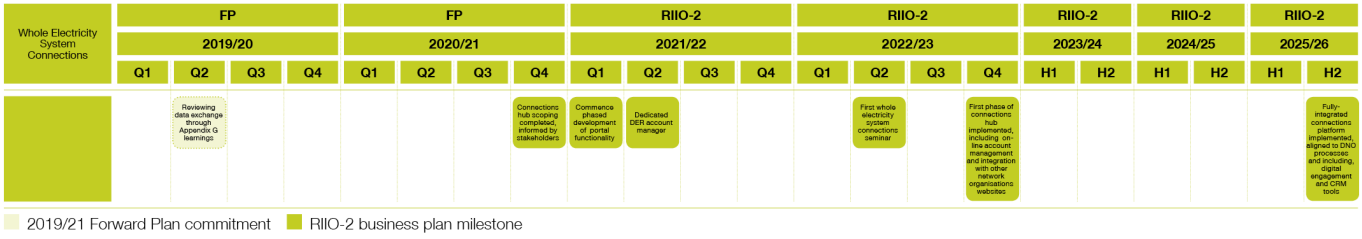


Figure 35

7.3.5. Stakeholder feedback

We have engaged on this subject with network companies, generators, suppliers, trade associations, a consumer interest body, and network users more widely. We undertook engagement at our RIIO-2 webinars, our Ambition consultation and workshop, and more specifically at our customer connections seminars. The need for consistent, whole system approaches and collaborative working was highlighted in our engagement on customer connections, particularly with DNOs. Smaller parties, such as those connected to distribution networks, talked about the value of receiving appropriate support to help facilitate their connection. Our connections proposals were welcomed by several stakeholders at our customer seminars in March 2019 (a TO, DNO and two renewable energy developers), at our RIIO-2 event in April 2019 (small and large generators and network companies), and in some of the responses to our RIIO-2 Ambition consultation document (a trade association and supplier). We have received stakeholder support for our connections hub proposal. In particular, from smaller connected parties and service providers, who could see benefit in having a single destination to find all connection-related information regardless of voltage level.

In response to *Our RIIO-2 Ambition* consultation document, we also received questions from a trade association and network companies. They wanted to know whether the support provided to smaller parties who have transmission-related issues to their connections should come from the ESO – or whether it potentially duplicates the work of other network companies. We think we have a coordination role to play, so we have maintained proposals to support new parties in navigating the connections processes. We believe that we can add value for customers when there are connection-related issues across the transmission-distribution interface.

"This ambition must not undermine the existing role of the TO or DNO in the connection process to avoid any duplication of effort."

Network company, in response to ESO RIIO-2 Ambition consultation

Following publication of our draft Business Plan in July, we have spoken further with the TOs – National Grid Electricity Transmission (NGET), Scottish Power Transmission (SPT) and Scottish and Southern Energy (SSE) – about our respective proposals for connections. We are aware that across all plans, there are proposals to develop online customer connection portals. These are designed to enhance the service that we collectively provide to customers for different aspects of the Great Britain connections process. In our discussions, we have recognised the need to be coordinated on our proposals. By doing so, we will ensure that all portals are developed in a consistent and customer-led way. We also all agreed that there could be a central, online access or landing point for the Great Britain connections process. From there, customers would be directed to the appropriate party to progress their connection query or application (for transmission or distribution, as appropriate). We will continue to work together to scope our respective proposals and engage with customers on the direction of their development.

7.3.6. Cost-benefit analysis

We estimate the benefits here to be £8 million over RIIO-2. This gives an NPV of £2 million over RIIO-2.

Our proposal enhances and extends our current connections processes. It establishes new online systems to provide more support in co-ordination with distribution network organisations – for parties wishing to connect to networks. They will benefit from easier access to front-line support and coordinated information, making it simpler to navigate around complex industry processes.

The quantitative benefits stated above have been calculated by considering the efficiency savings for customers who use the connections process (estimated at around 450 applications per year) and the resulting reduction in FTE requirements, with these savings being passed on to consumers.

This is against a baseline assumption of continuing with our ongoing connections process, with no additional online support or connections hub.

In order to deliver this activity, we require customers to engage with the new hub and systems and that connections customers pass any reduced operational costs onto consumers.

Our analysis suggested that accounting for market, delivery and third-party uncertainty the net present value could credibly be between £3 million and negative £2 million.

See Annex 2 - CBA report section 5.2 for more details.

7.3.7. Proposed performance metrics

The number of connection applications to the network that we manage through our customer connections team has been steadily rising through RIIO-1 due to the increased activity and interest in developing distributed energy resource and the move away from centralised generation to more embedded connections continues to increase in RIIO-2. As a result, we are focusing on creating an efficient and effective experience for our customers through further process improvements and the implementation of a customer connections portal, as highlighted earlier. We are proposing a periodic customer satisfaction (CSAT) measure for our customers, where they can rate and comment on their connections experience. This will provide us with an understanding of both our performance and how we can improve our service to our customers.

7.4. Taking a whole electricity system approach to promote zero carbon operability

7.4.1. Costs

The growth of low carbon and renewable generation, closures of conventional thermal power stations and changing interactions across the whole of the power system are just a few of the areas that will impact the operability of the power system through RIIO-2. Our proposals seek to enable us to address these, so we are able to operate a zero carbon power system by 2025.

Whole electricity system approach to promote zero carbon operability	Five-Year Strategy					
	Two-Year BP					
	RIIO-1	2021/22	2022/23	2023/24	2024/25	2025/26
Capex (£m)	2.9	8.1	9.1	11.0	11.3	13
Opex (£m)	3.4	4.9	6.0	7.6	9.5	10.7
FTE	36	43	46	49	54	55

Highlights

We will support zero carbon operability through the wider roll-out of our Regional Development Programmes and innovation projects, including Enhanced Frequency Control Capability and Power Potential.

7.4.2. Ongoing activities

We will continue to identify and quantify risks and opportunities for the operation of the electricity networks. And we will provide solutions in both long and short-term planning timescales. This may include the use of external innovation funding, such as NIA, to develop future operability solutions. We will maintain our data and modelling capabilities to underpin all the offline network analysis within the ESO. We will provide technical expertise into the development of codes and standards.

In RIIO-1, we enhanced our activities in this area through:

- introducing the RDPs, which look across the whole system landscape to identify key areas of development. This unlocks additional network capacity, reduces constraints, and opens up new revenue streams for market participants.
- developing an automated dispatch capability for generation in highly constrained areas.
- leading a national programme to change DER protection from Vector Shift to RoCoF. This will reduce the risk of inadvertent DER tripping and reduce system-balancing costs.

- completing the EFCC[89] project, the learnings from which will be taken forward as a transformational activity in RIIO-2.
- embedding efficiency through increased automation of certain data and modelling activities, with associated process reviews.

Our RDPs are already delivering significant value for the end consumer, with the first bringing a net saving of £13 million by eliminating the need to build new assets. Our second RDP provided network capacity for new low carbon energy resource, without the need for additional network infrastructure, thereby facilitating an extra 278 MW of renewable generation across four grid-supply points.

In RIIO-1 we set up a project to explore the potential benefits of transferring some of our modelling processes offshore. We will continue to explore the potential for this approach to improve our capability and deliver efficiency benefits in RIIO-2. For more details please see chapter 3 efficiency case study.

In RIIO-2, we will further enhance our activities through:

- continuing to work with other network organisations to roll out RDPs facilitating the connection of new low carbon energy sources in capacity constrained network areas.
- targeting areas, which will facilitate connection of DER and unlock consumer benefits.
- continuing to look for opportunities to further outsource and automate processes.
- making efficient use of the increased availability of data to enhance our ways of working and generate consumer benefit.

Through these enhancements, and synergies with the transformational activities described below, we anticipate a reduction in one FTE for BAU activities in this area in 2021/22.

BAU resource numbers are based on the efficient delivery of our ongoing activities including RDPs. On average, the overall programme will have three RDPs in progress at any time, which will be enabled by investment in IT (IT Investment Reference 340 - RDP Implementation & Extension) and our FTE numbers reflect this delivery profile (a team of three FTEs will be required within our core business activities). Our current RDP delivery costs are approximately £4 million in RIIO-1. We believe we can realise efficiencies and reduce this to around £2.4 million per RDP. We can achieve this by establishing a repeatable approach to delivering the required capabilities within our systems and processes. On this basis, we have assumed an RDP will take, on average, two-and-a-half years to deliver. With three RDPs in development at any time, we have budgeted £17.5 million for delivery of six RDPs during RIIO-2.

Innovation funding during RIIO-1 has contributed to these proposals

Our work to develop the capability to operate a zero carbon electricity system will use the learning from our EFCC and Power Potential[90] innovation projects – and potentially our recently funded Distributed Restoration[91] project.

7.4.3. Transformational proposals

The net present value of taking a whole electricity system approach to promote zero carbon operability is estimated at £469 million and deliver £7.34 of benefits for every £1 spent over RIIO-2. The net benefits are positive from 2021/22 onwards.

Our transformational proposals are to:

- Transform our capability in modelling and data management, enhancing data-sharing across transmission and distribution networks. This will require one additional FTE in 2021/22.
- Provide technical input into broader industry work to align and simplify industry codes and standards and development Distribution System Operation. This will require two additional FTEs in 2021/22.
- Deliver an operable zero carbon system by 2025. Our innovation project Enhanced Frequency Control Capability (EFCC) is providing us with a toolkit to support zero carbon operation. In RIIO-2 we will implement its functionality in our control room environment. (IT investment reference 500 - Zero Carbon Operability). This will require 3 additional FTEs in 2021/22.
- Identify future operability needs, looking beyond our need to operate a zero carbon system by 2025. We believe that, in the long term, consumer value will be realised through harnessing opportunities created from electrification of heat and transport and the increasing digitalisation of the energy sectors. Through development of a whole system operability framework and extending of RDP philosophy across energy vectors we will explore these opportunities. No additional FTEs will be required for this activity until 2023/24.

7.4.3.1. Transform our capability in modelling and data management

We recognise that, consistent with the Energy Data Task Force recommendations, in RIIO-2 we will have access to much more information and data relating to networks and parties across the whole electricity system. This data can help us work with other network organisations to efficiently manage an increasingly decentralised. grid. Consequentially modelling and data

[89] https://www.nationalgrideso.com/innovation/projects/enhanced-frequency-control-capability-efcc

[90] https://www.nationalgrideso.com/innovation/projects/power-potential

[91] https://www.nationalgrideso.com/innovation/projects/distributed-restart

enhancements will enable many related activities including;

- our zero carbon operability ambitions
- the development and delivery of new RDPs
- real-time optimisation of transmission and distribution assets.
- Deeper system access arrangements across the transmission – distribution interface

To achieve this added functionality, recognising the much higher volumes of data to be managed, we will take a probabilistic approach to modelling. This will see us develop the ability to undertake more complex modelling, where a greater number of scenarios are considered. We envisage that these changes will help to accelerate scenario planning, including closer-to-real-time planning. We will also consider the use of artificial intelligence and automation to enable improvements in modelling. See Annex 4 – Technology investment report, investment references 360 - Offline Network Modelling and 350 - Planning and Outage Data Exchange.

To achieve this, in the period 2021 to 2023, we plan to deliver a major upgrade to our offline modelling tools, which will allow us to model a more complex system. The IT investment for this is included in the table above. This upgrade will also facilitate compliance with the European Capacity Allocation and Congestion Management (CACM) regulations, which is covered under IT investment reference 270 EU Regulation and will be done in co-ordination with Transmission Owners. We will continue to invest in ongoing enhancements, with another major upgrade to follow in the period 2023-26 in-line with the additional drive to Distribution System Operation expected during RIIO-ED2. This will enable deeper outage planning with DNOs, and zero carbon operational readiness. See Annex 4 - Technology investment report, investment references 360 - Offline Network Modelling and 350 - Planning and Outage Data Exchange. This improved capability will build on our investments in open data and digital engagement. In total during RIIO-2, we propose to invest £7 million in IT developments to facilitate our modelling and data management proposals.

FTE requirements to deliver this work will increase from a single FTE in 2021/22 through to a total of six FTEs at the end of RIIO-2, when we will be considering broader whole energy system implications and data sets. To manage these costs we will continue to adopt an approach of right-sourcing capability to allow us to efficiently manage this increased scope of work. However given the breadth of change required, we expect these costs to have doubled by 2024/25.

7.4.3.2. Provide technical support to DSO and whole electricity system alignment

We are conscious of the need to support other network organisations and the wider industry in the transition to Distribution System Operation (DSO). We have budgeted a single FTE to support the delivery of DSO into RIIO-ED2.

The transition to DSO will need development of existing standards and frameworks on a whole electricity system basis. To that end stakeholder have told us that they want alignment of standards and frameworks. We have therefore budgeted one FTE in 2021/22 s to provide technical input into such a broader review. This will rise to two FTEs from 2023/24. This will ensure there is alignment of operational standards across the whole electricity system.

7.4.3.3. Deliver an operable zero carbon system by 2025

Our whole system innovation projects, Enhanced Frequency Control Capability (EFCC) and Power Potential, will be complete by the start of RIIO-2. We will use the learnings from these, as well as other insights from DNO innovation projects and the Open Networks project, to inform our operability system development in RIIO-2. We see EFCC as particularly critical in the development of our zero carbon operability ambition and will roll out its functionality in our control centre ahead of 2025. Through implementation of the project's monitoring and control system we will be able to monitor the electricity grid at a regional level and coordinate regional frequency response from a range of service providers as necessary[92].

The cost of our proposed roll-out of the EFCC project's monitoring and control system is budgeted to be £24.9 million. The majority of this spend will be to meet before the system is fully implemented in 2025 and will require a team of up to six FTEs to deliver. See Annex 4 - Technology investment report investment reference 500 - Zero Carbon Operability.

[92] When a variance in frequency occurs on the system, a response needs to be achieved within fractions of a second to be effective. Over the fast timeframes that this frequency response is being calculated and deployed, there is a difference between the frequencies that are seen at the points where these technologies connect. The MCS provides the bridge of information between the different technologies and the System Operator and can deploy the right response from these technologies at the right time to support the stability of the power system. This provides greater visibility of what is happening on the grid by using real time data.

7.4.3.4. Identify future operability needs across the whole energy system

We believe that, in the long term, consumer value will be realised through harnessing opportunities created from electrification of heat and transport and the increasing digitalisation of the energy sectors. In RIIO-2 we will begin looking at how we can take advantage of opportunities from related energy sectors to develop new operability tools to help us efficiently manage the electricity grid.

We will do this through working with others in forums like the ENA Open Networks programme to gain insights from experts in other sectors. This will allow us to develop;

- From 2022; new innovation projects to trial whole energy system operability tools. These will be funded from existing innovation routes.
- From 2024; a whole energy *System Operability Framework*. This will require five additional FTEs from 2024/25.
- From 2023; Regional programmes that make best use of opportunities to develop cross vector operability solutions to facilitate the UK's 2050 carbon reduction targets. These will build on the ethos and approach we have developed in the electricity sector's RDP programme. This will require an initial scoping resource in 2023/24 with four FTEs required in 2024/25 and eight in 2025/26. We have also accounted for IT spend on these broader whole energy system projects with £2.5 million in 2024/25 and £6.8 million in 2025/26. There is no additional spend in the first two years in RIIO-2 for this activity.

7.4.4. Investment roadmap

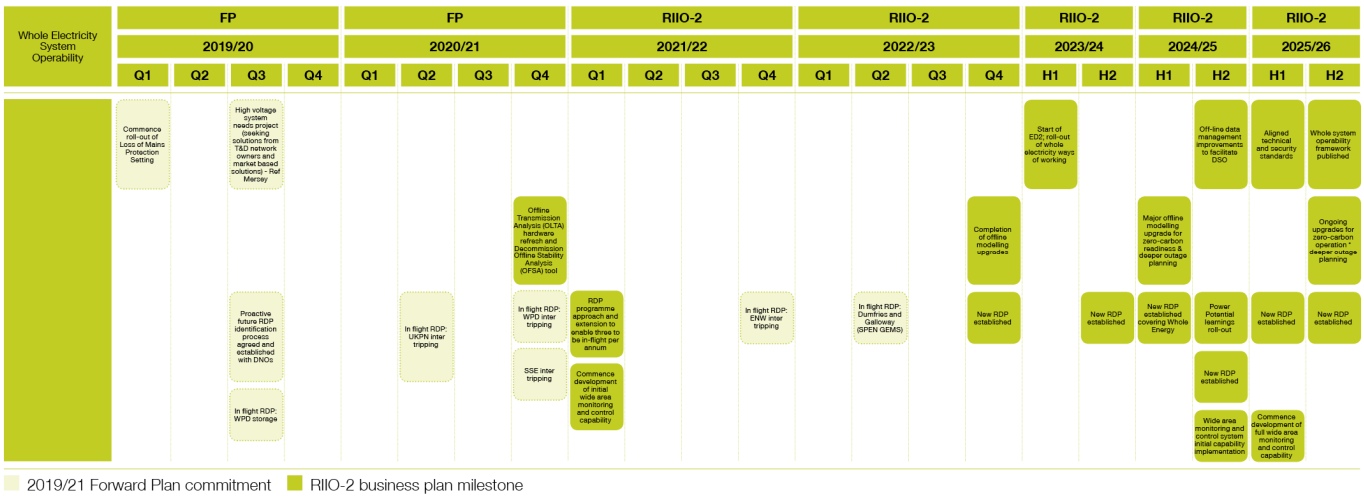


Figure 36

7.4.5. Stakeholder feedback

We have explored whole electricity system questions in more detail at our own events and through the ENA Open Networks Project. Both commercial entities and network organisations recognise the inherent value of a whole electricity system perspective – and the benefits of finding common ways of working across all network organisations. We have reviewed the 47 responses to the 2018 ENA Future Worlds consultation[93] and used this to develop our thinking on both the ESO's role in RIIO-2 and the transformational activities needed. While there has been support for all five future worlds developed, responses indicate that the strongest consensus – and particularly from commercial entities – is for the coordinated and collaborative future provided through 'World B'. This is consistent with our Business Plan approach to distribution system operation.

Ofgem, in its recently published position paper, *Distribution System Operation,* highlighted the need to focus on a 'least-regrets' development of this new landscape. We believe that, in RIIO-2 timescales, this is consistent with the direction we have taken, through consideration of World B and the ENA's approach. Our approach builds on the current industry ways of working, including developments in RIIO-1. It can be progressed with a minimum of industry reform, but also allows optionality for future arrangements.

Responses to the Future Worlds consultation also 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. This is something that many of our stakeholders in our RIIO-2 engagement have shown support for, in particular at our 2030 Ambition workshop in September 2018. They saw potential benefits for both the ESO's customers and DNOs as they head into their RIIO-ED2 price-control discussions. Stakeholders, such as renewable energy companies and a consumer interest body, indicated a need for aligned codes and frameworks to support the energy transition. They 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.

Stakeholders at our April 2019 workshop event, including DNOs, developers and a renewable energy company, similarly recognised that we need to work with emerging DSOs. They felt this would ensure efficient design and operation of the whole electricity system, with some seeing our existing skills as complementary, with potential benefits from closer working. There was also support for using the first two years of RIIO-2 to test and embed new ways of working, prior to the start of RIIO-ED2.

Stakeholders, including generators, DNOs and TOs, recognise the importance of closer working relationships across the transmission-distribution interface when planning system access. Some also see the potential for new market opportunities for congestion management. There is also recognition of the consumer benefits that could be unlocked through better incentivisation of short notice outage change as well as opportunities to develop arrangements with TOs for RIIO-2.

[93] http://www.energynetworks.org/electricity/futures/open-networks-project/future-worlds/future-worlds-consultation.html

7.4.6. Cost-benefit analysis

We estimate the benefits here to be £549 million over RIIO-2. This gives an NPV of £469 million over RIIO-2.

For future RDPs, we have assumed they deliver the same benefit from avoiding build costs as the RDPs seen above in RIIO 1, £13 million – and the carbon savings from the extra renewable generation – 278 MW. We have avoided 'double counting' by assuming half the RDPs have avoided build savings with the other half and have achieved carbon savings.

Our responsibilities for system operability mean that we need to ensure we are looking for new ways of sourcing system needs. Increasingly we are considering market-based solutions and in a decentralised and digitised future this provides many new opportunities. Examples of this work include Power Potential, where we are working with UKPN to develop coordinated market solution for transmission and distribution voltage needs. We are also exploring new markets through our voltage and stability pathfinder projects.

The quantitative benefits stated above have been calculated by considering the cost of the current operability challenges, around £600 million. From our recent stability pathfinder[94] we estimate that these challenges could be solved with an investment of £2.25 billion. We further assume that this cost will be spread over a potential 40-year asset life, which leads to a discounted net benefit of around £10 billion over 40 years. To reflect the uncertainty here, we have assumed that 50 per cent of these net benefits are realised, giving £125.5 million a year net benefits from 2022/23.

This is against a baseline assumption of operating the system as today and not embedding RDPs.

This activity depends of two other transformational activities:

1. Build the future balancing service and wholesale markets (Theme 2) - ensuing the new markets have been developed to support zero carbon system operation
2. Control centre architecture and systems (Theme 1) – ensuing the control has the tools required to operate a zero carbon system

In order to deliver this activity, we require third parties to deliver solutions, this could either be investment in assets or commercial solutions

Our analysis suggested that accounting for market, delivery and third-party uncertainty the net present value could credibly be between £608 million and £333 million

See Annex 2 - CBA report section 5.3 for more details..

Proposed performance metrics

We are proposing to measure the savings in balancing costs that have been achieved through our new operability approaches. We would measure this through an outturn vs. forecast calculation, with the forecast to be taken at a specified time. The implementation of new operability tools will help to reduce the cost of managing the network, which ultimately will mean increased value for consumers.

Additionally, we propose to measure the capacity unlocked by our network operability processes. These creates more space for more potential participants to enter the market by optimising the utilisation of existing infrastructure. Providing that the market is able to fill this capacity the increased competition could lead to a more diverse market through new connections resulting in a potential reduction in bills to end consumers.

7.5. Delivering consumer benefits from improved network access planning

7.5.1. Costs

We facilitate efficient access to the network by Transmission Owners for maintenance and construction activities. We do this through assessing the security of the system for a wide range of potential scenarios to ensure overall system resilience. Our RIIO-2 plans seek to enhance this capability for the benefit of network owners and consumers.

Network access planning		Five-Year Strategy				
		Two-Year BP				
	RIIO-1	2021/22	2022/23	2023/24	2024/25	2025/26
Capex (£m)	0	0.4	0.4	1.2	1.4	1.4
Opex (£m)	4.3	4.7	4.9	5.3	5.4	5.3
FTE	60	61	63	67	66	66

Highlights

We will support increased levels of co-ordination across the transmission – distribution interface to deliver significant consumer benefits and facilitate the connection of low carbon generation.

7.5.2. Ongoing activities and enhancements

Network owners need access to their assets to carry out maintenance, as well as to deliver major infrastructure projects. However, taking transmission equipment out of service reduces the capacity of the transmission grid. Our Network Access Planning (NAP) function ensures that this is coordinated with the needs of parties

[94] https://www.nationalgrideso.com/insights/network-options-assessment-noa/network-development-roadmap

connected to the network, while maintaining security of supply and minimising balancing costs. Longer-term plans are developed from eight years ahead. To meet customer needs and overall efficiency, we optimise the overall programme up to a day ahead, after which it is led by our Control Centre. This means that TO and customer needs for access to the system are coordinated, while also maintaining security of supply and minimising the balancing costs associated with outages on the network.

There is a significant, customer-facing aspect to this role as outages are planned in coordination with parties connected to the network wherever possible. Customers, including generators and DNOs, are expecting increased levels of service both from ourselves and TOs to minimise disruptions made at short notice and to improve communication of any changes as ultimately this leads to additional cost.

Our role with DNOs also has a coordination aspect, because we need to ensure distribution and transmission access programmes are planned on a whole system basis. Additionally, he increasingly active role played by distribution networks present opportunities for market-based solutions to system access.

7.5.2.1. Enhancements made in RIIO-1 to our ongoing service:

- developed specifications for, and started agile delivery of the replacement of our outage notification and planning tool (TOGA). This followed extensive engagement to understand user needs and will provide better service to customers.
- carried out a customer-journey mapping exercise with the England and Wales TO, to better understand our customers' requirements.
- communicated with all affected parties to understand the reasons for and to reduce the overall volume of outage changes particularly at short notice.
- established a coordinated approach to access planning with TOs, to facilitate efficient outage delivery for customers (the NAP process).
- increased efficiency through the automation of selected processes.
- trialled deeper access coordination for major infrastructure projects.

7.5.2.2. Enhancements proposed in RIIO-2

In RIIO-2 we will build on our automation techniques to optimise access planning solutions, taking full advantage of the greater availability of data and modelling. We will use machine learning to set up and undertake system analysis studies more quickly.

Through facilitating these enhancements, and synergies with the transformational projects below, we believe our FTE headcount for BAU activities can be reduced by one in 2021/22.

7.5.3. Transformational proposals

The net present value of delivering consumer benefits from improved network access planning is estimated at £205 million and deliver £29 of benefits for every £1 spent over RIIO-2. The net benefits are positive from 2021/22 onwards.

Our transformational proposals build on much of the work we have been undertaking in RIIO-1 to enhance ways of working across the whole electricity system.

7.5.3.1. Enhancing the NAP process with TOs

We recognise the potential consumer benefits that can be unlocked by transforming our approach to system access. The SO-TO mechanism, which was introduced through the System Operator Transmission Owner Code and allows Scottish TOs to recover the cost of moving outages on request from the ESO, has brought significant consumer benefit. We forecast that this mechanism will have provided between £16 million and £37 million of consumer benefit in 2018/19 alone.

There is further opportunity to reduce overall system-operating costs, by extending this mechanism to cover changes to project delivery plans in the long and medium term. We have worked with the Scottish TOs to introduce this new methodology in summer 2019, so it can be used in developing future project delivery plans.

We therefore propose to extend these mechanisms across Great Britain by 2023. If all TOs can recover the cost of moving outages or implementing changes to project delivery plans in the long and medium term – at the request of the ESO – there is potential to unlock further benefits. This is supported in principle by the TOs and we have started to talk about how this might work in practice.

We believe that the extension of Scottish cost-recovery mechanisms, in conjunction with the NAP process across England and Wales, will deliver considerable benefits, as shown in the Annex 2 – CBA report section 5.4. Therefore, we will look to progress this as quickly as possible from the start of RIIO-2. We will also provide greater visibility of the costs associated with changing outages, through increased system analysis and cost assessments. This will enhance our ability to understand, and make the right trade-offs, between spending to ensure secure system operation during outages, and spending to defer outages to times where securing them might be cheaper.

We will deliver this rollout with one additional FTE from 2021/22.

7.5.3.2. Working more closely with DNOs and DER to facilitate network access

Distribution networks are becoming increasingly active, as greater volumes of DER connect to the system. As a result, DNOs are developing system operator

capabilities and enhancing their abilities in areas such as demand transfer and substation reconfigurations. Additionally, both ourselves and DNOs will be increasingly procuring flexibility services from DER to help us collectively manage the system, including the facilitation of outages. We will need to work more closely with DNOs to both coordinate these requirements and ensure we are collectively optimising flows across all network assets. Our proposal will improve network safety and reliability, through increased coordination and optimisation of network access – and will facilitate timely construction and maintenance of assets.

Increased collaboration – through the sharing of network data and models, particularly between network organisations, and by opening up flexibility markets that facilitate outages to more parties – will enable a more efficient and coordinated approach to developing and operating both the transmission system as well as distribution networks. This will help lower system operator costs, such as congestion management, that would otherwise be incurred.

Two FTEs will be required from 2022/23 as we develop more extensive working relationships with DNOs to use DSO techniques and DER markets to facilitate efficient access for network owners across the transmission - distribution interface. These will be recruited on a staged basis from 2022/23 to a total of four FTEs in 2023/34.

More active distribution networks present opportunities for market-based solutions to system access. To stimulate potential DER markets, we believe there is value in extending our current advanced outage notification system (TOGA), which has been recently upgraded, to cover a wider range of stakeholders, with differing business models and needs. As part of this, we will develop TOGA to become a more interactive experience for customers, stakeholders and the market. For example, by using mobile apps, alerts, social media feeds and new, digital-enabler technologies. We propose the investment for this system will be £6.1 million across the RIIO-2 period. One additional FTE will scope this project from 2021/22 A team of three FTEs will be required to deliver this project from 2023/24 onwards, dropping to two FTEs as the project enters delivery phase in 2024/25. See Annex 4 - Technology investment report, investment reference 350 - Planning and Outage Data Exchange.

7.5.4. Investment roadmap

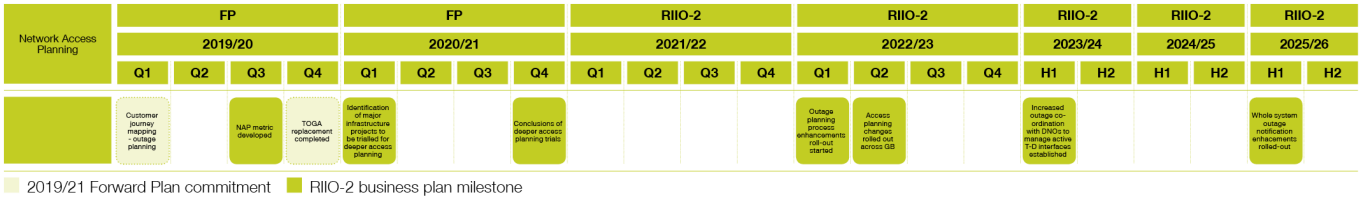


Figure 37

7.5.5. Stakeholder feedback

In developing our transformational proposals, we have engaged with both users of the network and parties who need to take outages to work on their assets. We have talked to large and small generation and demand companies, DNOs, TOs and a consumer-interest organisation. We sought wider feedback through our RIIO-2 webinars and workshops and *Our RIIO-2 Ambition* consultation. We also spoke bilaterally to DNOs and TOs. In addition, we presented our proposals at our OC2 Forum on 1 May 2019, which is an event that focuses specifically on the subject of system access.

Early in the engagement process, we talked to stakeholders at our RIIO-2 events in December 2018 and April 2019. Discussions focused on possible incentives related to system-access planning, whether we should consider developing them further, and whether they should apply to the TO or ESO. Network companies had mixed views on whether a new incentive was required. Some cited existing obligations as sufficient for driving the right behaviours in access planning.

Some other stakeholders, such as generators and developers, supported a greater role for incentives in signalling the cost of system access to TOs. They felt that such a mechanism would facilitate lower congestion levels and be of benefit in either the short or long term. We agree that such signals may unlock consumer benefits. But we also recognise the need to think carefully about the design of any such incentive, to minimise the potential for unintended consequences. DNOs and a consumer-interest organisation in particular agreed that an incentive would need to be carefully considered to avoid negative outcomes for consumers.

Since publication of our July Business Plan, we have engaged further with TOs on the subject of incentives in this area. Two of the TOs told us that existing SO-TO code obligations and processes provide sufficient incentive to deliver value for consumers. One TO did, however, feel that the ESO and TOs could do more to work together two to three years ahead to influence outage durations and ways of working – and bring further benefits to consumers. We agree and our proposals are complementary to this feedback. We therefore propose to extend current mechanisms and to work more closely with network companies, rather than proposing a financial incentive in this area.

We also talked to stakeholders about extending our TOGA system to cover a wider range of users at our RIIO-2 event in April 2019. Potential distribution-connected service providers could see merit in such enhanced capability. But only when arrangements exist to allow them to participate in constraint-management services. For this reason, we propose to introduce these system changes towards the end of the RIIO-2 period in 2025/26, giving time for such markets to emerge. Two network companies were concerned that any notifications to parties connected to their systems should go via their network company, to avoid confusion. We will continue to engage with networks as we develop the scope of theses system developments further.

We have begun discussing our proposals for increased coordination with DNOs at bilateral meetings, which have met with broad agreement. DNOs have also expressed interest in extending the NAP process to cross transmission-distribution coordination. They also support the need for more clearly identified roles and responsibilities across the transmission-distribution interface, and between network owners and operators.

7.5.6. Cost-benefit analysis

We estimate the benefits to be £224 million over RIIO-2. This gives an NPV of £205 million over RIIO-2.

Our proposal will bring significant benefits. For example, transmission and distribution connected parties will receive better notification of planned outages and their impacts on the networks. DNOs, meanwhile, will benefit from increased liaison, including greater procurement and coordination of flexibility services from DER.

The quantitative benefits stated above have been calculated by taking the benefits realised though rolling this proposal out through Scotland and extrapolating that the percentage benefit savings for England and Wales will be seven per cent. Taking these percentage savings, we then used forecast constraint costs from *NOA* for England and Wales to estimate the consumer benefits.

This is against a baseline assumption of not rolling out the NAP to England and Wales.

This activity requires code modifications and financial arrangements to be in place to support it. We also require DNOs, TOs to engage with the new process, for

which there may be a cost to implement the new arrangements.

Our analysis suggested that accounting for market, delivery and third-party uncertainty the net present value could credibly be between £310 million and £98 million See Annex 2 - CBA report section 5.4 for more details.

7.5.7. Proposed performance metrics

We propose to measure the customer value that has been created through innovative ways of working with TOs and DNOs to release capacity across the whole electricity system. This metric closely aligns to our proposals set out earlier in the document and would measure the MWhrs of capacity saving created through a more efficient outage planning process against a counterfactual. This would then lead to the ESO requiring to take less residual action allowing for a more efficient market outcome.

8. Open data unlocking zero carbon system operation and markets

8.1. Five-year strategy

Digitisation of the energy system is key to capturing the benefits of the low carbon energy transition for consumers. Open data is the lifeblood of efficient markets and plays a crucial role in enabling innovation. As digitisation continues to expand, the availability of quality data will be increasingly fundamental to developing new markets and empowering efficient decision-making.

Open data supporting net zero

Access to usable data will drive the development of innovative solutions to network and market challenges – and enable efficient and reliable system operation in a net zero world with large volumes of renewable and decentralised generation.

This chapter sets out how we will transform the data we make available, to facilitate new and efficient markets – and zero carbon system operation.

To realise the potential that data can unlock, our stakeholders have told us that the energy industry must transform the way data is managed, structured and shared. We need to move from a world where there is very limited access to usable data, to one where data is seen as open and shareable by default and is both accessible and fit for purpose.

To ensure a joined-up approach and outcomes, we will align our work on data transparency with the objectives of the Department for Business, Energy and Industrial Strategy (BEIS) Energy Data Taskforce. We will also work closely with other relevant data-sharing projects. Our work on open data will support the development of industry-wide data-management tools. Alongside ourselves, we expect a wide range of parties to innovate based on the data we share, imagining new solutions to system operability challenges and optimising market efficiency.

As one of the main custodians of energy data in the UK, we will play a central role in fulfilling its potential. As the number and diversity of market participants continue to increase, as system operations move closer to real-time, and as we develop whole electricity system solutions, the data sources that we use to operate the system will also increase. To maximise the value of the data that we hold – and to respond to our stakeholders' needs – our default approach will be that all our data should be presumed open unless subject to commercial, legal, network or cybersecurity risks or restrictions.

Building on initial steps taken in the RIIO-1 period, in the first two years of RIIO-2 we will develop a Data Portal to provide easy access to our data and share it in a user-friendly format. Enabled by the Data Platform (described in Theme 1), from the start of RIIO-2 we will follow a process to assess, validate and structure all of the operational and market data that we hold, sharing it according to published criteria. Our first focus will be on data sets that are identified as of highest value to stakeholders and we will aim to have published all of our relevant data by the end of the period.

8.2. Costs

Open data		Five-Year Strategy				
		Two-Year BP				
	RIIO-1	2021/22	2022/23	2023/24	2024/25	2025/26
Capex (£m)	0.0	1.3	1.3	1.1	0.6	0.0
Opex (£m)	0.0	1.8	1.9	1.8	1.6	1.2
FTE	0	9	9	8	8	7

Highlights

The investment covered in this section will deliver a digital engagement capability supporting a number of our external facing activities, including the Data portal, Single markets platform (Theme 2) and Connections portal (Theme 4).

A majority of the investment in this area will deliver our digital market engagement platform. This will create a single point of access for all ESO data and services, including the balancing services and capacity markets, connections, digitised Grid Code management and Data Portal. It sits at the heart of our vision for digital enablement across all of our Themes, providing a common engagement experience for stakeholders. More detail on this investment is provided in the Annex 4 -Technology investment report.

The volume of data we will be managing, along with our interaction with data consumers, will increase significantly from our work in RIIO-1. We will need a dedicated team of specialists to transform, adapt and manage the data. These resources will be brought in from the first year of the RIIO-2 period. We propose setting up a dedicated Data Stewardship team to deliver

this activity. Further information on the activities of this team is provided below.

8.2.1. Our current role

We currently facilitate the market by providing information and insights that support the transparency of our actions. This includes:

- developing reports, forecasts and insight in areas such as demand, balancing costs and ancillary services.
- managing the interface with Elexon for data provision.
- delivering systems and process changes to support data publishing.
- providing review, challenge and reporting on ESO balancing actions.
- supporting Electricity Operational Forums three times a year to share our insight and engage with stakeholders on balancing actions and associated costs.

These activities are currently delivered by three FTEs who are part of the Performance Reporting team that is accounted for under Theme 1.

8.2.1.1. Stakeholder feedback on how we do it now

A wide range of stakeholders including generators, service providers and suppliers have told us that where our data is currently published, its aggregated nature, format and structure often makes it difficult to reuse or manipulate. It is also frequently insufficient and difficult to locate, leading to inefficiencies and frustration. Stakeholders would like 'one source of the truth' and a one-stop shop to access all the data that we publish.

They have encouraged us to share as much of our operational and market data in its raw format as possible. This will allow them to perform their own analysis and interpretation.

8.2.1.2. Ongoing activities

We have consistently evolved our approach to sharing the data that we hold through:

- publishing roadmaps on the data we plan to share.
- publishing half-hourly photovoltaic (solar) forecasts and trade data at near real-time.
- providing access to an explorer page on our website, which makes it easier to navigate our data
- holding monthly visits to our Control Centre to provide insight into our commercial operations and support greater transparency.
- adding 'insight into control room difficult days' as a standing agenda item at our Electricity Operational Forums to explain the control room decision making process.

8.2.1.3. Further enhancements we will deliver in the RIIO-1 period

In RIIO-1, we will deliver a foundational portal capability for data publishing. We will proactively engage with our stakeholders to understand the features and structure that best suit their needs. We will use their feedback to inform the development of our RIIO-2 solution.

In this period, we will start to move the data that we share onto the foundational portal. We will also share new data-sets, including data on constraint boundaries as detailed in our *Forward Plan*. Where we can remove manual uploading of our data-sets through automation efficiently, we will do so. However, during this period, the provision of automated data feeds will be constrained by our underlying data-management solutions. The replacement of these systems (more detail in Theme 1) will be a key enabler for automated and real-time data publishing in RIIO-2.

We will continue to make improvements in this period and start to share new data-sets and insight. These activities will include:

- publishing information on voltage constraint, thermal constraint and day-ahead constraint boundaries, signalling where there is insufficient network capacity to transfer electricity.
- making improvements to the Monthly Balancing Services Summary (MBSS).
- publishing four additional wind forecasts and an additional day-ahead demand update as documented in our 2019-21 *Forward Plan*[95].
- engaging with stakeholders to find out what data is valuable, share complementary analysis and insight of how we make decisions and support stakeholders in understanding this data using webinars to enhance transparency of control room decision making

8.3. Transformational activities

In the Transforming participation in smart and sustainable markets chapter, we have highlighted the need to attract new sources of flexibility to the market, to support the operation of a reliable and secure system at the least cost to consumers.

Existing and potential market participants have told us that enhanced data and insight are essential for price discovery, efficient investment and operational decision-making. Understanding current and future trends in both the technical characteristics of system operation (such as constraints and inertia) and market dynamics (such as prices and volumes), can help market participants identify future opportunities.

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

This will lead to investments in the kinds of services that society needs, meaning those services will be there when consumers need them. This information also supports the optimisation of operational and commercial decisions, within market timescales, which drives market efficiency.

Supported by underlying changes to our data-management capabilities, in RIIO-2 we will build on the steps we have taken in RIIO-1 and transform the quantity and quality of data-sets we can make available. The implementation of our Data Platform will allow real-time access to all of our operational data. It will enable us to automate data, publish all of our raw data, and add new data-sets quickly and efficiently.

Stakeholders have told us that, initially, we should focus on providing a forward-looking view of system requirements. This would include a whole electricity system view of constraints and real-time margins and utilisation. By providing insights into future balancing service requirements, these data-sets will enable better investment decisions. They will also help market participants to identify innovative solutions to managing operability issues – at the least cost to consumers. Throughout this period, we will continue to work with stakeholders to prioritise the data we publish, so we deliver the highest value data-sets first.

When our stakeholders identify a need, we will continue to provide analysis, insight and guidance to them, and help them understand the data we provide. In one example, balancing-market participants have asked for more transparency around the decision-making processes in our Control Centre. As a result, we will explain how Control Centre decisions were made, referencing the relevant data.

All published data-sets will meet defined quality standards and we will provide powerful and logical search capabilities that make it faster and easier to navigate our data. All of our data will be available through an application programming interface and the raw data for all visualisations or insights will be provided.

The data portal will become a tool for sharing the outputs of our enhanced data and modelling collaborations with other organisations.

While we will adopt a 'presumed-open' philosophy, we will remain a champion for data security and data privacy. We will stay vigilant to potential misuse of data, which might threaten the system or distort markets. We will implement a transparent process for assessing any requirement for aggregation or anonymisation of data-sets, according to published criteria, including:

- **consumer privacy** – for example, personally identifiable information not publicly available.
- **security** – for example, the location of critical national infrastructure (CNI) assets and systems, not otherwise generally visible directly or through other sources.
- **commercially sensitive** – for example, Capacity Market auction bid information and Business Plans.
- **negative consumer impact** – for example, data that is likely to drive actions, intentional or otherwise, which will negatively impact consumers.

To help users understand and make the best use of our data, the portal will allow them to actively engage with us on the data-sets we share, with functionality provided to comment and ask questions.

In the first year of the RIIO-2 period, we will publish a schedule for sharing our data on the Data Portal. This will provide a clear roadmap for when we will make data-sets available. There is a considerable volume of operational and commercial data that the ESO holds, which will need to be assessed in advance of sharing. It will take significant effort to conduct the necessary preparation work, including system interfaces, risk assessment, analysis and presentation to ensure it is fit for sharing with the market.

In the second year of RIIO-2, all of our published data will be available in one place on the portal. Tools and processes to facilitate reuse of data will also go live, for example through standard application planning interfaces (APIs). In the third year, all ESO published data will be available on the portal in machine-readable format.

Achieving the outputs that our stakeholders want in this area will require wholesale changes to our IT infrastructure.

We will need to replace our internal data-management systems with a new platform that pulls together data from a variety of CNI and non-CNI sources.

Our new, underlying data-management capability will be designed to be extendable, scalable and interoperable. It will integrate with the Data Portal, which will enable rapid and scalable publication of ESO operational data.

To deliver the activities described above we will create a new Data Stewardship team.

This will include two data analysts to:

- administer Data Platform management and operate cataloguing tools to ensure a single source of operational data is used across multiple systems, applications, and/or processes.
- carry out master-data profiling and analysis to review source data and understand its structure, content and interrelationships.
- maintain guidelines and ensure proper training of end users of data sources.
- lead and/or support projects related to master-data management and drive further improvements as part of continuous progress.
- investigate gaps around the creation and change of master data, which leads to inaccurate reporting. Our analysts will initiate measures for improvement and support the IT team during development and implementation.

The team will also include two data engagement and transformation officers to:

- engage with stakeholders on new data requirements.
- lead on code changes needed to support sharing of new data-sets.
- create new data-sets on the portal.
- maintain existing data-sets.
- respond to internal and external queries and comments.
- manage our data-publishing pipeline.
- carry out external engagement to support future developments.

It will also include two data quality and assurance officers to:

- ensure appropriate governance and standards for data publishing.
- analyse data to ensure it meets agreed standards.
- lead on exercises which improve data quality.
- create data-assurance reports.
- liaise with stakeholders and IT to progress change, and maintain and improve data integrity.
- guide and support data-cleansing projects for older and less accessible data.
- ensure the data dictionary, the set of information describing the contents, format, relationships and structure of data, and meta-data standards, descriptive or contextual information for a piece of data, are applied correctly.
- manage and monitor the access rights to data-sets via the data portal.

Investment roadmap

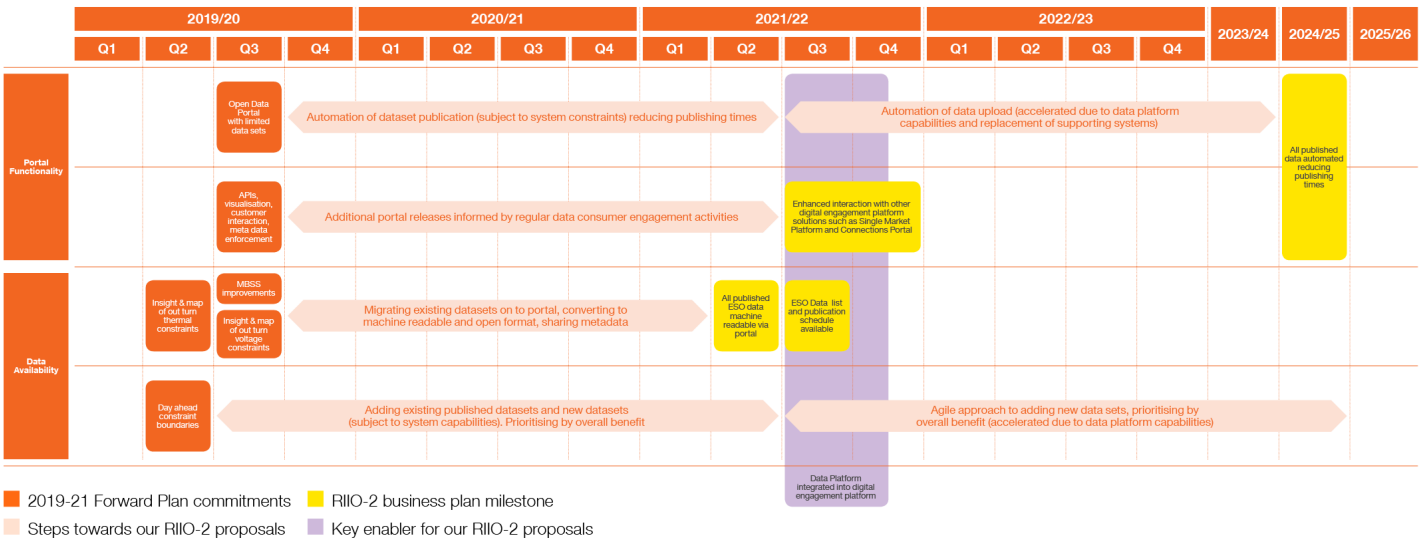


Figure 38

Our views here are informed by the experiences of organisations that have embarked on similar transformations, such as the Office for National Statistics[96]. We have developed our resourcing plans for this activity in reference to those organisations and believe our delivery model is efficient. For example, the Office for National Statistics[97] is currently undertaking a digital and technology transformation. This includes an upgrade to user experience, efficient and secure platforms for data processing, and simpler and cheaper ways for data to be collected and verified.

To deliver these changes, for transformation alone, the UK Statistics Authority has forecasted an average of 253 FTEs per year over a five-year period. While this activity is not directly comparable with the data transformation we are undertaking, there are many similarities.

8.4. Stakeholder feedback

A wide range of stakeholders, including suppliers, generators, aggregators, and demand-side service providers, have consistently called on us to share all of our data. However, there is a wider range of opinions on whether sharing data is sufficient.

ERSG supports our proposals in relation to open data.

The vast majority of stakeholders agree that sharing as much raw data as possible, in a format easily interpreted by their own systems, should be our immediate priority.

Both large and small market players, as well as project developers, also told us that some level of analysis and insight, to explain the data and what it means, is needed.

While many parties would also like to have more leading-edge functionality, such as advanced analytics and sophisticated data-manipulation tools, this was generally considered a 'nice to have'. In addition, several stakeholders observed that this is not our core competence. They felt that by providing advanced analytics and insight we may be squeezing out potential innovation that other parties could deliver better than us. All the stakeholder views that were captured have informed our proposal.

For this activity we have undertaken a break-even analysis, for details see, Annex 2 - CBA report section 6.1

McKinsey Global Institute

Research by the McKinsey Global Institute. suggests that open data can help create $3 trillion (£2.4 trillion) a year of value in seven areas of the global economy, with the potential to add between $340 billion (£276 billion) and $580 billion (£470 billion) of value annually across the electricity sector. By clarifying current inefficiencies and potential opportunities, open data can help support the innovation and improvements needed to drive considerable efficiencies.

Transport for London (TfL)

Research conducted by Deloitte shows that by providing open data to developers, TfL is improving journeys, saving people time, supporting innovation and creating jobs. This approach is also generating annual economic benefits and savings of up to £130 million a year.

TfL has adopted a strategy of making its open data freely available to third parties and engaging with developers to deliver new products, apps and services for customers.

The provision of its data and APIs has driven innovation, by enabling thousands of developers to work on designing and building applications, services and tools, leading to the significant economic benefits and savings stated above.

There are many similarities in the transformation undertaken by TfL and our ambition for open data. This provides confidence around our view that the costs of this activity are far outweighed by the potential benefits.

8.5. Proposed performance metrics

We propose to measure the proportion of 'shareable' data-sets held by the ESO that we have published.

As noted above, we will document the data-sets that we hold and publish this list. In line with our presumed-open policy, we will work through the data-sets and publish those that do not have any commercial, security, privacy or sensitivity risks. This metric will measure the proportion of the data-sets, identified through this process as shareable, that we publish over time.

We have consistently been told that transparency of data is a key enabler of efficient markets and innovation. Our progress in data-sharing is therefore a good measure of our contribution to efficient, competitive markets and our role as a key facilitator of innovation across the whole energy system.

Service providers and industry associations consulted have welcomed a metric along these lines.

[96] https://www.statisticsauthority.gov.uk/wp-content/uploads/2017/10/6.3908_SA_Better-Statistics-Better-Decisions-A5-Booklet_FINAL_WEB.pdf

[97] https://www.statisticsauthority.gov.uk/wp-content/uploads/2017/10/6.3908_SA_Better-Statistics-Better-Decisions-A5-Booklet_FINAL_WEB.pdf

9. Cost movements between RIIO-1 and RIIO-2

9.1. Context

The electricity system has undergone an unprecedented amount of change since 2007, with 28 GW coal-fired generation coming off the system to be replaced by 20 GW of wind and 13 GW of solar generation, along with 5 GW of interconnectors in total. Whilst we anticipated the system would change during the RIIO-1 period, the pace at which it has changed and the form it has taken were not expected; the UK energy system is the fastest decarbonising system in the G20. Distribution-connected generation now makes up a third of all generating capacity, resulting in different challenges to manage on the system and a much higher number of market participants to interact with, with new and different needs.

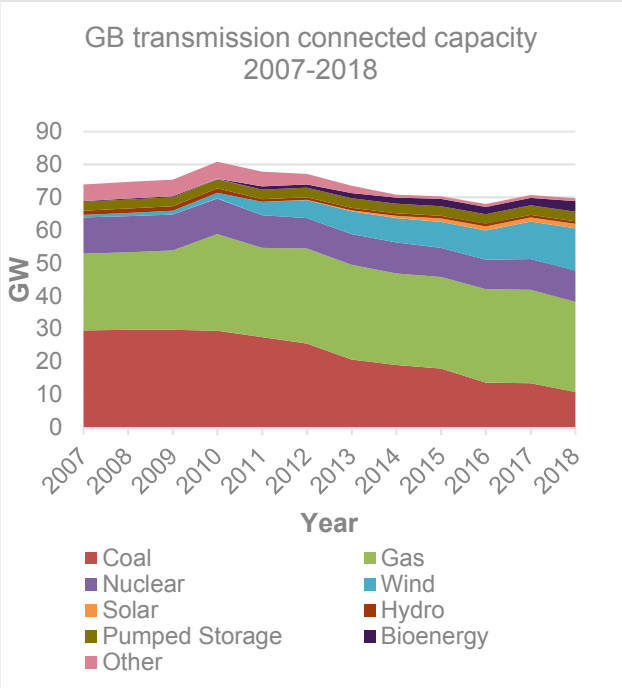


Figure 39: Changes in GB transmission connection capacity

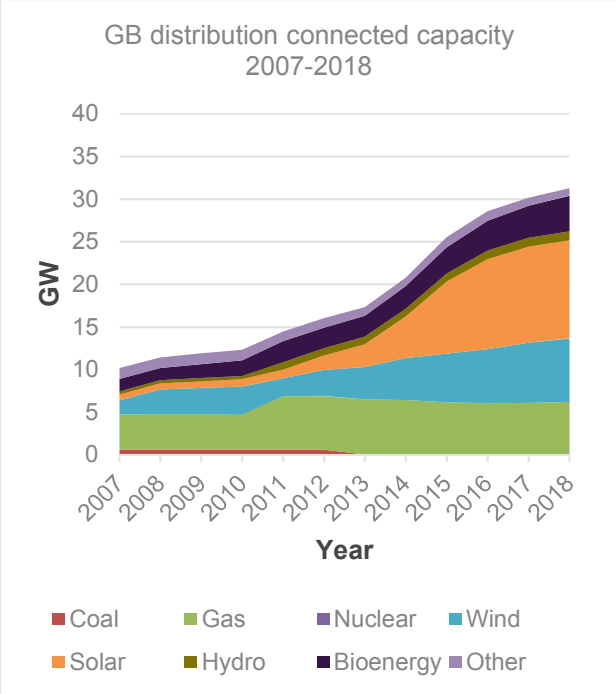


Figure 40 Changes in GB distribution connection capacity

This unprecedented level of change in the electricity sector has led a step change in the task of balancing the system for the ESO, well beyond the extent anticipated at the time of the RIIO-1 settlement. The industry has changed in significant ways which has substantially increased the demands on the ESO, for example:

- the mix of participants on the system has changed fundamentally which makes the task of operating the system more complex through intermittency and two-way flows of power, as well as different generation and demand patterns; and
- the nature of the participants on the system has changed, which gives rise to a need for very different tools and capabilities to operate the system. Specifically, there are increased numbers of participants with non-traditional business models. Our customers now have different and diverse needs, and have different levels of experience of operating in this industry.

The level of influence of EU regulation has also expanded over the period, increasing the importance of our involvement and resulting in changes to our GB systems.

We are also influenced by changes beyond the makeup of the GB electricity system, with the changing cyber environment bringing new and increased risks to our

Critical National Infrastructure (CNI) over the period and changing the way in which we manage cyber security.

Adapting to the changing electricity system has required us to make decisions and take action on how we respond as the two price control periods have progressed. We have developed new tools and support systems to interact with service providers, such as the Power Responsive[98] programme and the recent distributed energy resource desk in the control room. We have innovated in the way we procure balancing services to reduce barriers to entry and drive more competitive markets. Our interactions with Europe have evolved over the period too, and this has required increased resources to ensure the GB market continues to evolve as needed in line with developments in Europe.

Whilst delivering against our role and outputs agreed at the beginning of the price controls, we have taken on new roles in RIIO-1, which themselves drive additional value for consumers and help us adapt to the changing electricity system. These include:

- Taking in an extended ESO role through the Integrated Transmission Planning Regime (ITPR), including running the *Network Options Assessment* (*NOA*) process to coordinate efficient and economic network investment across GB.
- Becoming the Electricity Market Reform delivery body, in which we run Capacity Market and Contracts for Difference auctions and provide analysis to support Government decisions related to these.
- Implementing products to ensure sufficient generation capacity in advance of the introduction of the Capacity Market (Supplemental and Demand Side Balance Reserve).
- Leading the Power Responsive programme to stimulate increased participation in balancing markets from flexible technology.
- Taking forward actions required to legally separate the ESO from the wider National Grid Group.

Additional allowances were agreed for all of these activities, although at times we have spent and invested ahead of their agreement at risk to the business, such as our Power Responsive programme, and investment on cyber security and new data centres. The additional totex allowances over the first four years of the RIIO-1 period (2013/14 to 2017/18) are set out in figure 41 below. The mid-period review included allowances for ITPR, supplemental and demand side balancing reserve and Power Responsive.

Even within these new roles there has been a significant amount change since they were introduced, particularly in relation to EMR. The scale and nature of change has been far greater than anyone expected in 2015 when we took on the delivery body role, including Ofgem and BEIS. Among other things, there have been major changes in the number, nature and needs of market participants (e.g. a 400 per cent increase in the number of Capacity Market applications, with over 90 per cent of applicants of less than 100 MW). We have also seen a large volume of change to the Regulations and rules by BEIS and Ofgem year-on-year.

Despite the challenge of a fast decarbonising network we have worked hard to ensure we continue to manage down balancing costs against a set of external drivers pushing up costs (increased variable, decentralised and non-synchronous generation). We feel we have made the right decisions to flex within, and where necessary go above, our allowances to ensure a secure and reliable system which delivers value for consumers.

9.2. RIIO-1 efficiencies

In 2018 we launched our Performance Excellence (PEx) value initiative. This used Lean manufacturing principles to realign our service levels, streamline processes, remove waste activity; and create cross function process efficiencies. One example of the changes made was a reduction in the number of control room shift teams from six to five. This helped to prepare the organisation for legal separation and to consolidate the gains we had made through improving change capability across the business. As a result we have released resources across the business equivalent to a £7 million annual saving, spread across the different parts of the business as detailed in the sections that follow.

Alongside these major organisational reviews, we have continued to make more targeted changes to capability and structure through the RIIO-1 price control period, such as in data and artificial intelligence, improved customer contract process efficiency to accelerate connection offers, and control room training as wel as reduced resourcing and authorisation costs for key positions. We will continue to review our structures and processes for further efficiency opportunities.

9.3. Comparison to RIIO-1

We now summarise the cost movements at overall ESO and sub-activity (Theme) level between:

- The average annual cost for RIIO-1 to date (2013/14-2018/19)
- Our proposed average annual spending for the first two years of RIIO-2

The data described below uses a different RIIO-1 average to the tables in section 2 of this document. Below we use the average RIIO-1 cost to date, as required by the Challenge Group. In chapters 4 to 8 of the Business Plan, we refer to RIIO-1 cost as average cost since legal separation. This provides an alternative view of cost movements since RIIO-1 that better reflects the current structure of the ESO.

[98] http://powerresponsive.com/

Costs are rounded to the nearest million.

We begin looking in detail at 8 sub-activity areas that, in total, account for the overall cost movements, then summarise the impact on the overall ESO.

9.3.1. Theme 1: ensure reliable and secure system operation, to deliver energy when consumers need it

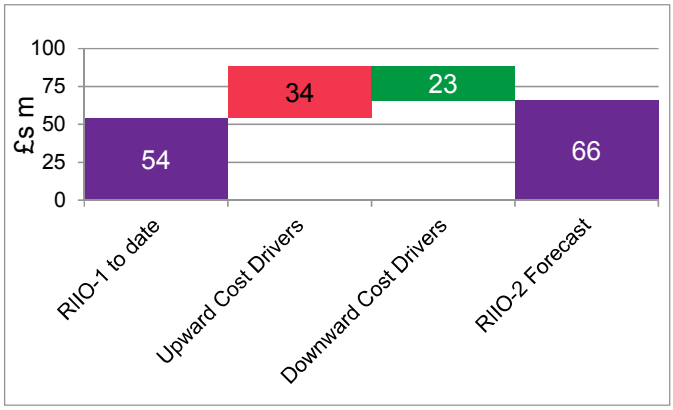


Figure 41

Upward cost drivers

The upward cost drivers are as a result of the unprecedented changes in the energy landscape since the start of RIIO-1, which have increased the operational challenges the control centre manages every day. For example:

- Increasing numbers of active market participants are driving an increased volume of decision-making, from around 200 per hour today to around double that volume at the end of RIIO-2.
- More intermittent, renewable generation is connected at the distribution level which is less visible to us. Distribution-connected generation capacity has increased by 80 per cent since 2013[99].
- Declining levels of traditional generation are bringing increased operability challenges, for example due to lower levels of system inertia. In Q1 2019 renewable generation was the second highest on record and in line with the trend that has seen renewable generation rise 70 per cent since 2014[100] while fossil fuels have declined by 26 per cent.
- We are redispatching an increasing percentage of the market in the balancing mechanism from around four per cent in 2008 to around seven per cent today. This reflects the increasing number and complexity of system and operability issues we have to address through this mechanism.

The UK has committed to net zero emissions by 2050 and as ESO we will be able to operate a carbon free system by 2025. To achieve this, against the backdrop of significant change to the operating environment, we need to:

- Transform our control centre architecture and systems, developing enhanced balancing capability and transforming network control. We will do this in an agile and modular way by reengineering our control centre architecture.
- Upgrade our control centre training and simulation capabilities, by enhancing training material, upgrading our training simulation and technology and through updated workforce and change management tools.
- Evolve our restoration procedures to ensure they meet the expectations of consumers in a highly-electrified world, through ensuring we are compliant with the new restoration standard, building on our NIC project.

The cost increases therefore represent

- £31 million of transformational opex and capex investment, supported by stakeholders, to deliver a net present value of £254 million benefits, as detailed in chapter 4. These investments have been subject to cost-benefit analysis and the IT components benchmarked for efficiency.
- Increased opex of £1 million to improve our ongoing forecasting and operability strategy work, while maintaining our legacy balancing and situational awareness tools.

There is also a £2 million increase in the cost of our membership of Coreso, the coordination body for security of supply in Europe.

Downward cost drivers

The downward cost drivers are:

- £19 million savings in ongoing IT costs from the ending of IT investment programmes including on balancing systems and the integrated energy management system (IEMS).
- £3 million efficiency savings through process improvement in RIIO-1, including a reduction in the number of control room shift teams from six to five.

[99] Digest of UK energy statistics table 5.12 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/826562/DUKES_5.12.xls

[100] Digest of UK Energy Statistics table 5.1 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/811878/ET_5.1.xls

9.3.2. Theme 2: transforming participation in smart and sustainable markets

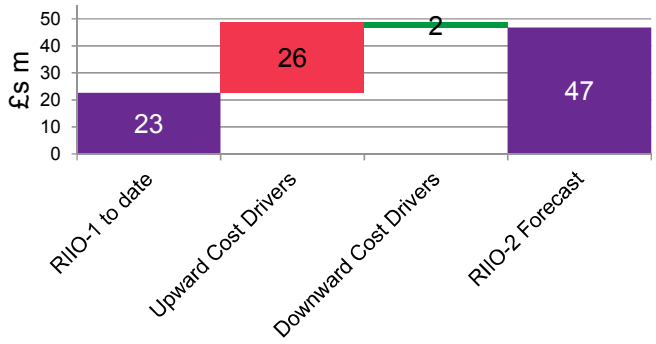


Figure 42

Upward cost drivers

Efficient, well-functioning markets are essential to our ability to operate a carbon free system by 2025. We must operate this system with much higher volumes of low carbon generation and a significant increase of flexible sources of energy such as demand-side response and storage. Upward cost drivers include:

- Increasing numbers of balancing market participants from around 20 in 2016 to over 350 today. Between 30 and 50 per cent of balancing services tenders in 2018/19 were received from demand side providers
- Increasing applications for participation in the capacity market: the number has risen fourfold since the start of EMR in 2014, and the number of units below 100MW has increased by 200%. In 2017/18 we received almost 2000 applications of which 91% were below 100MW.
- Work to remove barriers to market entry, such as reducing minimum participation size for Fast Frequency Response (FFR) from 10 MW to 1 MW, has led to a significant growth in the service providers we have to contract with from 75 in 2017 to over 250 in 2019.
- Based on current TEC register numbers, 11 new interconnectors (~13 GW) are due to connect in the period 2021 to 2026. Work will be needed so that agreements are in place in time for these connections.

Competing priorities mean we face a bottleneck in being able to deliver multiple projects simultaneously. We have also been told by stakeholders that we need to deliver tangible change faster than our current capability allows.

To ensure that consumers benefit from effective competition in these markets, we need to remove barriers to entry to new participants and help ensure that industry frameworks can change at pace. In RIIO-2 we therefore propose investment to:

- Build the future balancing services and wholesale markets, so that by 2023 all participants sized 1MW and above will have equal access to all markets
- Transform access to the capacity market so that security of supply will be delivered with a technology mix that supports the UK's net zero commitment at minimum cost to consumers
- Develop codes and charging arrangements that are fit for the future, able to facilitate the rapid change required to deliver the UK's net zero ambition.

The cost increases therefore represent:

- £12 million of transformational opex and capex investment, supported by stakeholders, to deliver a net present value of £411 million benefits. These investments have been subject to cost-benefit analysis and the IT components benchmarked for efficiency. More detail is in chapter 6 of this Business Plan.
- £2 million increase in ongoing opex relating to both IT maintenance for Project Terre investments and the cost of ENTSOE membership
- £2 million ongoing opex increases on service improvements including code administration service, enhancing support to balancing service providers, managing relationships and contracts with growing numbers of service providers
- £1 million represents our new EMR role and our Power Responsive programme (as these programmes began part-way through RIIO-1, the full cost is not represented in the RIIO-1 average cost)

We have also had to invest around £9 million in mandatory changes to systems as a result of European Network Code changes.

Downward cost drivers

The downward cost drivers are £2 million of efficiencies from process improvements and team reorganisations as part of our RIIO-1 Pex Value initiative. This included investment in helping market participants become more informed about the contract management process in order to create fewer questions for the team which involved increasing the amount of material online, together with simplification and standardisation of contracts. The use of virtual teams across the ESO created efficiencies in development and implementation of European and GB codes, and in the development of balancing service markets. In part these efficiencies were offset by increases in code administration costs to improve the service we provide to code parties.

9.3.3. Theme 3: unlocking consumer value through competition

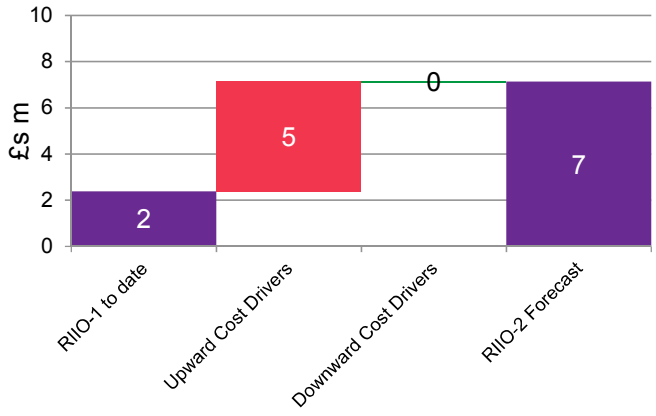


Figure 43

Upward cost drivers

Under this Theme the cost increases are due to our proposed transformational investments to increase the use of competition in network development, delivering a net present value of £663 million over RIIO-2. Chapter 7 of our Business Plan sets out the detail on our proposed investments, supported by stakeholders, that account for the £5 million cost increase. These include:

- Delivering new competitive processes, so asset and non-asset based solutions can compete to meet future system needs.
- extending and enhancing the *Network Options Assessment* (*NOA*) approach, bringing the significant cost savings the *NOA* has already achieved for consumers to other areas, such as end of life asset replacement decisions.
- undertaking, with industry, a review of the System Quality and Security of Supply standard (SQSS) so system standards are appropriate for the decarbonised energy system of the future.
- supporting Ofgem to develop its thinking on competitively appointed transmission owners, bringing the benefits of competition to a wider range of consumers.

These investments have been subject to cost-benefit analysis and the IT components benchmarked for efficiency.

Downward cost drivers

While costs are not reducing in RIIO-2, we will deliver our ongoing activities without further cost increases on the RIIO-1 average, realising process efficiencies from improved analytical and modelling capabilities. This will enable us to deliver more outputs for around the same level of resource. For example, we will:

- analyse double the number of network solutions.
- manage a significant increase in the complexity of the network needs we will model. This complexity is driven by the continuing growth of distributed generation and new technologies, which create operability challenges such as system inertia and reactive demand[101].
- accommodate the potential for integrated offshore networks, and on interactions between different energy sources, such as gas and electricity.

[101] Please see the glossary for an explanation of these terms

9.3.4. Theme 4: driving towards a sustainable, whole energy future

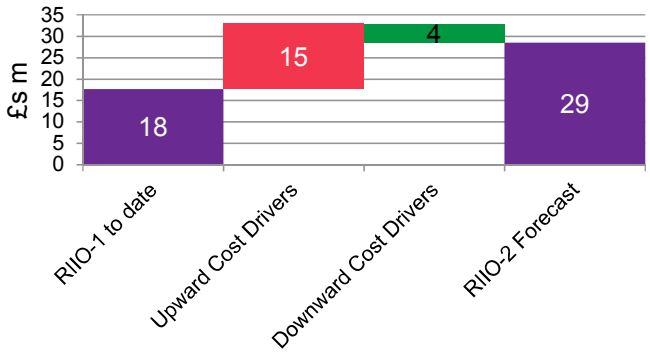


Figure 44

Upward cost drivers

As the energy system transforms, the ESO must transform its approach to system planning and the provision of insights and analysis to facilitate the transition to net zero. Cost drivers include:

- **The number and mix of parties connecting to the system:** in the last 12 months applications from new market participants have increased by 60 per cent, driven by new small generation units for battery storage and solar connections, new interconnectors and new demand points for data centres and independent DNOs. We forecast that this trend will continue in RIIO-2, with an increasing number of applicants being small, new players that require more support
- **The generation mix:** Declining levels of traditional generation are bringing increased operability challenges, for example due to lower levels of system inertia. In Q1 2019 renewable generation was the second highest on record and in line with the trend that has seen renewable generation rise 70 per cent since 2014[102] while fossil fuels have declined by 26 per cent.
- **Significant increases in distribution-connected generation:** this requires us to be able to model the operational characteristics of distribution networks with much higher volumes of data. Distribution-connected generation capacity has increased by 80 per cent since 2013 and in 2018, 77 per cent of this capacity was renewable[103].

These drivers mean that we need to strengthen our coordination and collaboration with distribution network operators to improve efficiency and optimise investments across the transmission-distribution interface. We will therefore invest in:

- Our capability to lead the debate on whole energy system issues, providing insights and policy pathways to achieve the UK's low carbon goals, focusing on areas including clean heat, carbon capture, use and storage, electric vehicles and energy data.
- Our generator connections process, to accommodate the growing numbers of parties seeking to connect to the network, and their more complex needs.
- Capability to undertake more complex system modelling including data exchange, sharing and analysis.
- Improvements to the outage planning process, taking into account effects across the transmission and distribution networks and coordinating with a much larger customer base.

These cost increases therefore represent:

- £13 million of transformational opex and capex investment, supported by stakeholders, to deliver a net present value of £676 million. These investments have been subject to cost-benefit analysis and the IT components benchmarked for efficiency. Our proposals focus on:
  - leading the debate on decarbonisation of the GB energy industry, harnessing our significant expertise to identify pathways to achieving the 2050 net zero target, and policy decisions that must be made
  - working more closely with Distribution Network Operators (DNOs) and Transmission Owners (TOs) to streamline the connection process, so that parties can take a more efficient, whole system view
  - defining a pathway for zero carbon, whole system operability so we can find innovative ways to operate the zero carbon system of the future developing a whole system approach to accessing electricity networks, therefore tackling an area of significant consumer cost
  - More detail is in chapter 7 of this Business Plan.
- £2 million to enhance our ongoing activities, for example rolling out additional regional development programmes to explore, with DNOs, the potential to release additional capacity for the connection of low carbon generation.

Downward cost drivers

The downward cost drivers are:

- £2 million of efficiencies from process improvements as part of our RIIO-1 Pex Value initiative, including benefits from outsourcing some of our engineering modelling work (for more details, please see the case study in chapter 4).
- £2 million of IT savings since the beginning of RIIO-1. In RIIO-2 we plan to replace or upgrade some of the IT systems under this Theme and those costs have been included in our transformational

102 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/811878/ET_5.1.xls

103 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/826562/DUKES_5.12.xls

proposals after being subject to cost-benefit analysis

Any small discrepancies are due to rounding.

9.3.5. Cross-cutting teams

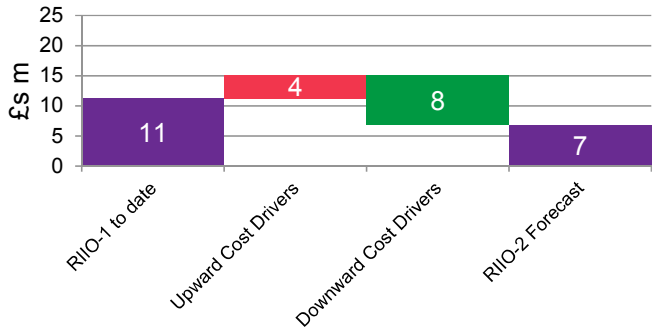


Figure 45

Cross-cutting teams support the business in delivering services for our customers and stakeholders. These cross-cutting teams are:

- customer and stakeholder
- ESO regulation
- business change
- assurance.

More detail on these teams and their proposed spending in RIIO-2 is in chapter 14.

Upward cost drivers

The cost increases in this area are due to:

- £2 million to create a dedicated ESO regulation team after legal separation. The cost of this team in RIIO-2 includes the costs of managing a two-year business planning and incentives cycle
- £1 million to create a dedicated ESO customer and stakeholder team
- £1 million transfer of insurance costs to the ESO after legal separation.

Downward cost drivers

The downward cost drivers are:

- Restructuring of our business change capability, which saw a move to a 'hub and spoke' model enabling £3 million of efficiencies to be realised
- The ending of programmes relating to legal separation, accounting for £3 million of the decrease
- The close down of organisational efficiency programmes, accounting for £1 million of the decrease
- £1 million of efficiencies from process streamlining and team restructuring, for example by reducing the number of senior roles.

9.3.6. Shared IT investments supporting the ESO

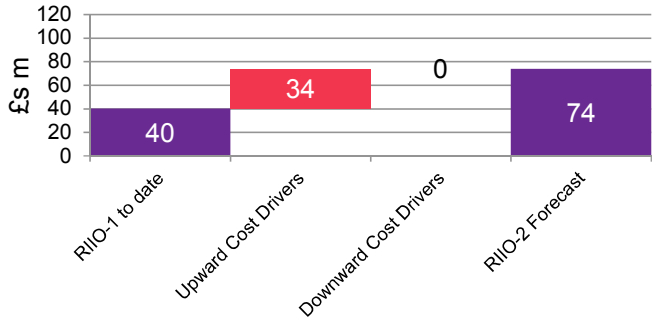


Figure 46

The IT sub-activity examined here covers the shared investments that are made centrally within National Grid Group IT. These investments leverage Group IT to deliver the underpinning IT environment – hardware, storage, devices, operating systems etc – that provides ESO with efficient, scalable, reliable IT services. This enables the economies of scale for procurement and unlocks access to global support providers.

The IT costs for ESO-specific (non-shared) investments have been covered in the sections above covering Themes 1-4.

Upward cost drivers

- £15 million infrastructure capex to support the IT investments planned for RIIO-2 and as part of our transformational proposals. This includes hardware storage expansion, devices, operating system build and upgrade etc and reflects a revision of our asset health policies. At the start of RIIO-1, we responded to the challenge from Ofgem to reassess our IT asset health policies by extending the technical life of our IT infrastructure, accepting higher levels of controlled risk whilst maintaining levels of availability. However, by 2018/19 our employees said that IT was becoming a significant blocker to effectiveness, affecting the service value and quality levels given to our customers. Over the same period, the escalating threat of cyber-attack on our IT systems meant that we had to look again at how we managed our infrastructure so that we could proactively monitor and remediate cyber threats. In light of this, we revised our IT asset health policies, which have been reviewed by Gartner – a recognised IT benchmarking organisation – who confirmed that the policies in place are in line with industry practice.
- £12 million for data centre capex and ongoing costs (hosting, maintenance etc) following the approval of additional funding in RIIO-1 for these investments. This approval was part of a formal reopener and subject to scrutiny on the needs case and the efficiency of the proposed costs
- £ 4 million investment on digital risk and security measures, including the cost of complying with the NIS Directive security standards
- £ 3 million on capex to support corporate services investments, such as an upgrade and refresh of our core Enterprise Resource Planning (ERP) system and associated financial systems relating to tax, treasury and banking. More information is the shared services chapter of this Business Plan.

Any small discrepancies are due to rounding.

9.3.7. Business support shared services

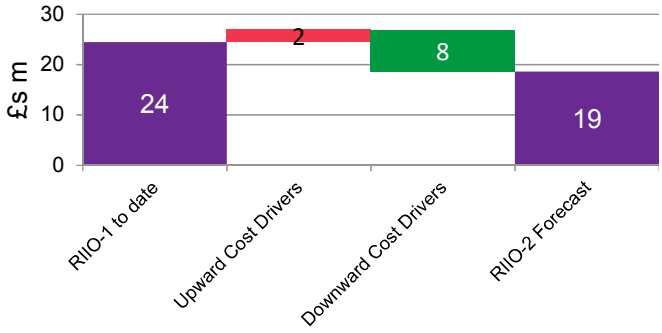


Figure 47

Upward cost drivers

- £1 million cost increases in our HR function, relating to an increased allocation to the ESO based on our forecast headcount.
- £1 million property capex associated with creating a separate office for the ESO in Warwick, and additional work in Wokingham forecast for 2022-23.

Downward cost drivers

Benchmarking of our shared services shows that these functions are equivalent to the most efficient companies after adjusting for costs of being a regulated network[104], and the additional security measures we take to protect our operations from threat. Our property and procurement functions are equivalent to the 25% most efficient comparator companies, and our proposed HR costs for RIIO-2 reflect our aim to move to upper quartile efficiency in this area.

The downward cost drivers in the graph represent:

- £4 million from the transfer of regulation, customer and stakeholder, and insurance costs to the ESO after legal separation. These cost decreases are therefore offset by cost increases to the ESO's cross-cutting teams.
- £2 million from the ending of programmes relating to legal separation in our finance function, and

[104] These costs are driven by the need to operate a regulation function, the need to perform regulatory cost and output reporting in addition to statutory reporting performed by most companies, and the fact that we need to do more compliance activities.

efficiencies from streamlining activities, outsourcing and reviewing structures in finance and audit teams.

- £1 million corporate functions efficiencies, including through creating a global communications team to support best practice and exploit synergies across the group, and team restructuring following the sale of the gas distribution business.
- £1 million property costs efficiencies. Our benchmarking study found that our property management costs are comparable to the 25% most efficient companies in the comparator group.

9.3.8. Overall ESO

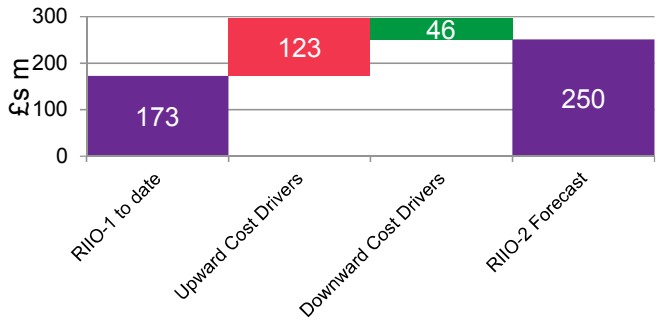


Figure 48

The movements in the chart above are explained by the previous sections and summarised below.

Upward cost drivers

£60 million new and transformational investments to deliver £2 billion[105] consumer benefits.

The majority of upwards movements in cost is accounted for our proposed new and transformational investments in RIIO-2 that will deliver a net present value of £2 billion for consumers. These account for £60 million of the upward cost movements in the chart above. These investments have been subject to cost-benefit analysis and endorsed by stakeholders

The IT components of these proposed costs have been benchmarked for efficiency. More details can be found above in chapters 11 and 3 of this Business Plan.

£44 million IT investments to improve cyber security and implement mandatory regulatory changes

£44 million of upwards cost movements are due to ongoing IT cost increases. More details are in the previous sections and the main components are:

- £16 million of the £44 million is investment in cyber security data centres and digital risk and security measures.
- A further £15 million of the £44 million is for infrastructure investments that reflect appropriate asset health policies, and will support our RIIO-2 proposals.
- £9 million is investment to implement mandatory changes from European Network codes.

£11 million ongoing cost increases to respond to the changing energy landscape

Significantly increased levels of intermittent renewable generation, increased numbers of participants in the balancing and capacity markets, and a greater proportion of generation at distribution level, have all brought challenges to our ongoing role of system operation. We have managed these within existing allowances over RIIO-1, but now we need to invest in new control room systems, market platforms, and data and modelling capability. These relate to around £11 million of investment across all of our activities. More details are given under the graphs for each individual Theme above.

£4 million opex for regulatory requirements and membership of European organisations

£2 million increase relates to both IT maintenance for the mandatory Trans European Replacement Reserves Exchange (TERRE) project[106] investments and the cost of ENTSOE membership. A further £2 million reflects the increased cost of our membership of Coreso, the coordination body for security of supply in Europe.

£4 million investment to create the legally-separate ESO

£4 million of the cost increases reflect the setting up of separate ESO regulation and customer and stakeholder teams, plus the transfer of insurance costs to the ESO after legal separation.

[105] The NPV applies to the five-year RIIO-2 period

[106] https://www.entsoe.eu/network_codes/eb/terre/

Downward cost drivers

£22 million reduction in ongoing IT investment

£19 million of the £22 million reduction is due to the ending of IT investment programmes in our balancing and energy management systems.

£3 million is from IT cost savings under Theme 4.

£16 million ongoing direct opex savings

The biggest portion of these savings is due to our RIIO-1 Performance Excellence (PEx) value initiative. This enabled us to release resources across the business equivalent to a £7 million annual saving. We also restructured our business change capability, releasing £3 million.

A further £3 million of these £16 million opex savings is due to the ending of programmes relating to legal separation, and the ending of investment in efficiency programmes has reduced RIIO-1 direct opex costs by a further £1.4 million.

£8 million ongoing shared opex savings

Half of these savings are due to the transfer of functions to the ESO as a result of legal separation, and are offset by increases in the ESO cross cutting teams. £4 million of savings are from efficiencies realised in central functions from process streamlining and team restructuring.

Any small discrepancies in the totals are due to rounding[107].

9.4. Sensitivity analysis: RIIO-1 average cost impact

Our Business Plan for RIIO-2 is ambitious and supported by stakeholder feedback. We have heard from industry stakeholders that the scale of positive influence we have in the industry outweighs our relative cost. As such we have presented a bold, ambitious Business Plan which provides leadership and sets out the investments to deliver the future needs of a rapidly changing industry.

As set out in the previous section, the average annual cost change between RIIO-1 to date and RIIO-2 is due to:

£123 million upward cost movements reflecting:

- £60 million new and transformational investments to deliver £2 billion[108] net consumer benefits
- £44 million IT investments to improve cyber security and implement mandatory regulatory changes
- £11 million ongoing cost increases to respond to the changing energy landscape
- £4 million opex for regulatory requirements and membership of European organisations
- £4 million investment to create the legally-separate ESO

£46 million downward cost movements reflecting:

- £22 million reduction in ongoing IT investment
- £16 million ongoing direct opex savings
- £8 million ongoing shared opex savings.

9.4.1. Reduction of RIIO-2 annual cost to RIIO-1 average to date

The challenge group has asked what a Business Plan would look like if the average spend were kept at the RIIO-1 annual average of £173 million.

The current, ambitious Business Plan has been developed in a holistic manner with many interdependencies in cost assumptions between different transformational projects and between ongoing and transformational work. It is therefore not a straightforward task to remove discrete activities from the plan to deliver a coherent plan within budget.

Using the costs above, an approach to take is to cap any additional spending to £48 million, equivalent to the downward cost movements. At a minimum we would not be able to invest in any of the proposed new and transformational activities to deliver the outputs that stakeholders want, that is represented by the £60 million increase in average annual costs. Net benefits of £2 billion would not be achieved for consumers. As

[107] We also have not included a waterfall chart for our open data proposals, which account for a cost increase of £3 million.

[108] The NPV applies to the five-year RIIO-2 period

capex is a significant proportion of the spending increase, we have undertaken an analysis of our IT investments to create a cost profile that is within the £48 million "cap", prioritising activities which are either a regulatory requirement or to replace key systems whose lifespan is due to expire during RIIO-2. A number of our proposed transformational activities also replace an aging system that would require replacement. As such we have assumed that we would be undertaking asset refresh programmes to ensure that the system would remain operable in RIIO-2. In the analysis, we assume that costs of individual projects cannot be driven down significantly from the costs in the Business Plan as we have extensively benchmarked the projects and proposed radically different approaches to project delivery from those currently employed, in order to drive down costs.

Working within the financial parameters in this scenario means that our IT capacity would not even enable us to have the same functionality that we have today. Against a backdrop of increasing complexity of the system this only serves to increase the risk to network reliability, and the cost of balancing the network. In addition, the scale of mandatory changes related to GB and EU regulation is increasing in RIIO-2, driven by programmes such as Project TERRE and MARI. Under this scenario, therefore, the ESO would not be able to deliver the standard of service required by our licence and we would be unable to operate a safe and reliable system.

The challenge group has asked for a list of IT investments that would be subject to reopeners in this scenario. Below we have listed the IT investments that would require asset refreshes and/or scope reduction, and those that would need to be subject to reopeners. The reference numbers correspond to the further detail provided in Annex 4 - Technology investment report.

Investments that would require scope reduction and / or asset refreshes to be delivered within the £173 million cap. These examples reduce scope (and therefore benefits) while increasing overall costs due to the need for asset refresh:

- 110 – Network control
- 180 – Enhanced balancing capability
- 210 – Balancing asset health
- 220 – Data and analytics platform
- 420 – Auction capability
- 480 – Ancillary services dispatch

Investments that would not be delivered or be subject to reopeners:

- 200 – Future training simulator and tools
- 250 – Digital engagement
- 260 – Forecasting enhancements
- 280 – GB regulation
- 330 – Digitalised code management
- 340 – RDP implementation and extension
- 380 – Connections platform
- 390 – NOA enhancements
- 400 – Single markets platform
- 450 – Future innovation productionisation
- 460 – Restoration
- 500 – Zero carbon operability
- 510 – Restoration decision support

In many cases the need for this investment is immediate. Where investments are due to take place beyond 2022/23 we are providing for preparatory and scoping work in the early years of RIIO-1, in line with the urgency which with stakeholders are calling for change. Under-investment in IT systems at this stage only creates a larger problem in the future and could end up costing consumers more in the longer term. This is because beneficial industry change would be delayed, including:

- Investment in our control centre architecture and systems, so we can operate a zero carbon system by 2025. Direct benefits come from reduced emissions and lower consumer bills through better access to lower-cost interconnection and reduced balancing costs – delivering consumers a net present value of £242 million
- Working more closely across transmission and distribution networks to take a whole system view of zero carbon operability. This will reduce consumer bills through avoided network costs and constraint cost savings – delivering consumers a net present value of £469 million
- Transforming network planning by introducing competition between network and commercial solutions. This will promote innovation in 'non-build' solutions and reduce bills through avoided asset investment and lower constraint costs – delivering consumers a net present value of £663 million.

Consumers will also pay more for the cost of late or remedial action, compared with the cost of investing at the right time.

- Dramatic changes in the electricity system that are required to support the delivery of net zero emissions by 2050. An ESO focused primarily on managing costs rather than delivering benefits will be a blocker to decarbonisation rather than an enabler of the transition to a low carbon system.
- A full CBA of a reduced plan has not been formally carried out. However, all the estimated £2 billion of benefits delivered by the transformational activities would be foregone for an annual saving of around £77 million. Taking the approach of focusing primarily on costs would deliver a much worse cost benefit for consumers than the current plan.

9.4.2. Reduction of RIIO-2 annual investment to RIIO-1 levels, minus two per cent

Under this scenario the ESO's investment in 2021-22 would be capped to £169 million and in 2022-23 it would be £166 million. The situation above would be exacerbated. We would have to release an extra £5 million through reductions in scope. IT investment would be below the level needed to maintain existing functionality. This would not enable us to maintain the same levels of service and reliability, given the need for upgrades and additional investment to address the complexities of the changing energy landscape.

We would not invest to deliver a NPV of £2 billion for consumers and the ESO would be more likely to hinder, rather than facilitate, the transition to net zero emissions by 2050.

Part 3 Setting the ESO up for success

10. Financing our plan

In this section, we consider the ESO's financing arrangements: our revenues, their impact on consumer bills and the financial assumptions underpinning our plan.

RIIO-2 represents a rare opportunity to design a tailored regulatory framework for the ESO: a unique enabling business that provides specialist services; manages significant risk; and delivers, and enables others to deliver, real value for consumers across the energy system.

In April 2019, the ESO was legally separated from National Grid Electricity Transmission (NGET). It is important that our framework reflects this by funding the ESO on the basis of the credit rating it would receive as a standalone business, without support from National Grid Group. This new price control is critical to the success of legal separation and ensuring that the ESO can demonstrate that we are a financeable, credit-worthy and sustainable business.

Ofgem has a statutory duty to have regard to the need to secure that the ESO is able to finance our licensed activities. In order to be financeable, we need to be able to: maintain an investment grade credit rating; operate on a standalone basis, cover the costs of our own financing; and provide a fair return to investors for the services we deliver and the risks we take on behalf of industry and consumers.

We have undertaken a financeability assessment in this Business Plan based on Ofgem's working assumptions for the ESO, and we do not believe they support a financeable business unless further adjustments are made.

Bringing cash forward to RIIO-2 from future price controls by changing the capitalisation rate or asset lives can improve metrics in the near term, but does not create a sustainable solution to the underlying financeability issues.

Ofgem's working assumptions do not remunerate us for some of the services we provide and the risks we hold, namely those that are not correlated to our regulatory asset value (RAV) due to their asset-light nature. We propose alternative assumptions for our financeability assessment in this chapter. We believe that the appropriate funding model for the ESO includes an element that uses a weighted average cost of capital (WACC) against our RAV (RAV*WACC) based on these alternative assumptions, as well as additional remuneration to fully recognise the services we provide and the risks we hold, and to drive the right behaviours from the ESO.

We believe that our proposed funding arrangements will enable us to deliver our plan and create a framework that facilitates the ambitious and proactive ESO that stakeholders and Ofgem want us to be.

We believe that fully remunerating the services we provide and the risks we hold will allow us to demonstrate that we are a financeable, credit worthy and sustainable business, facilitating the ambitious and proactive ESO that stakeholders and Ofgem want us to be.

Context

Ofgem consulted on its proposed regulatory framework for the ESO in December 2018 and May 2019, and published decisions in May and August 2019.[109] We published our responses to the December and May consultations on our website.[110] Ofgem consulted again in August with working assumptions on our financial parameters and a methodology to assess the ESO's financeability, as well as on the design of the ESO's incentive scheme.[111] Our consultation response is on our website.[112]

In line with Ofgem's guidance, we have presented our draft Business Plan based on the financial assumptions set out in the August ESO Methodology Decision Document (ESOMDD). We have also presented alternative parameter proposals as allowed under Ofgem's process.

In this chapter, we outline:

1. How we recover our costs via revenues
2. The impact our Business Plan will have on consumer bills
3. Ofgem's working assumptions for our financial package, as well as our proposed alternatives based on evidence and analysis collated
4. Our initial financeability assessment, based on Ofgem's current working assumptions, and on our proposed alternatives
5. An explanation of how we have treated other financial policies and costs

[109] https://www.ofgem.gov.uk/publications-and-updates/riio-2-sector-specific-methodology-decision
[110] https://www.nationalgrideso.com/document/139766/download; https://www.nationalgrideso.com/document/147026/download
[111] https://www.ofgem.gov.uk/system/files/docs/2019/08/riio-2_methodology_for_the_electricity_system_operator_-_decision_and_further_consultation.pdf
[112] https://www.nationalgrideso.com/media-test/esos-response-ofgems-riio-2-finance-methodology

We expect Ofgem's decision on its ESOMDD consultation to be published in late October. We will update our final Business Plan in December based on relevant information in that decision. Ofgem will confirm the value of the ESO's financial parameters and incentive scheme in Draft Determinations in the second quarter 2020.

Ofgem's ESOMDD consultation on our financial methodology was published on 28 August, which means that key aspects of the regulatory regime remain uncertain at this time. The evolving nature of the regime is such that, in some areas, the analysis and evidence presented in this chapter and Annex 5 are limited or indicative in places. This will be updated in our December Business Plan.

Equally, Ofgem's business plan financial model was not available for use until 20 September. As a consequence, and as agreed with Ofgem, the analysis presented in this draft version of the plan has been undertaken using ESO financial models. We have included limited analysis and stress testing at this stage until we have an agreed financial model on which to base such analysis. We will include full analysis in our December Business Plan; this will use the Ofgem model and may present different results. Any material differences will be explained.

10.1. How we recover our costs via revenues

RIIO-2 is the regulatory process that will set the amounts that we are able to recover from customers for the services we provide. This process looks to make sure the costs we incur are appropriately shared between current and future customers. Our price control framework defines how this will be done. In its ESOMDD, Ofgem confirmed the use of a RAV-based model for the ESO, which splits the ESO's expenditure between that which is paid for by customers over time ('slow money'), and that which is paid for immediately ('fast money'). Figure 49 sets out the building blocks of Ofgem's proposed price control framework for the ESO.

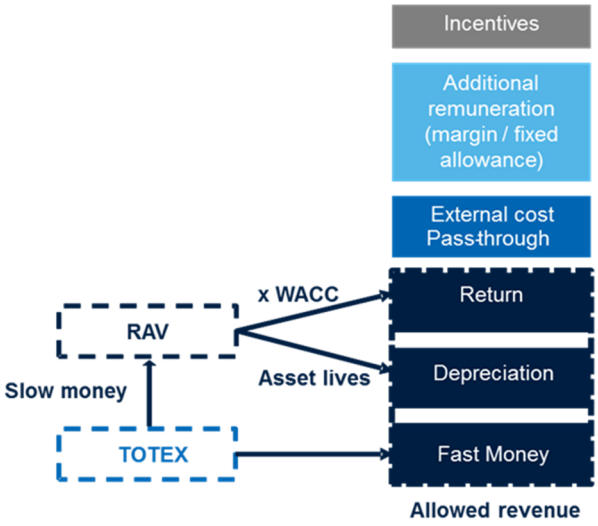


Figure 49 ESO price-control framework

Our Business Plan makes an estimate of revenues in line with Ofgem's principles. A key part of this is our review and assessment of the appropriate financial parameters, including allowed return, and whether under these proposals we are able to attract and retain the investment needed to deliver our activities.

Our revenues are recovered through use of system charges levied on generators and suppliers. The ESO has two main streams of revenue:

- Revenues associated with our internal costs to deliver our licence commitments, which are the main focus of RIIO-2. These are:
- RAV and totex-related revenues
- other costs to support the broad industry role we play in supporting networks and balancing, such as business rates and pension costs
- Revenues associated with the direct cost of undertaking electricity balancing activities (BSUoS[113]). These are recovered from balancing participants.

In addition to the above revenue streams, the ESO also performs an industry revenue management role, where we collect transmission charges (TNUoS[114]) from network users on behalf of the transmission owners (TOs), as depicted in figure 50 below.

[113] Balancing Services Use of System charges

[114] Transmission Network Use of System charges

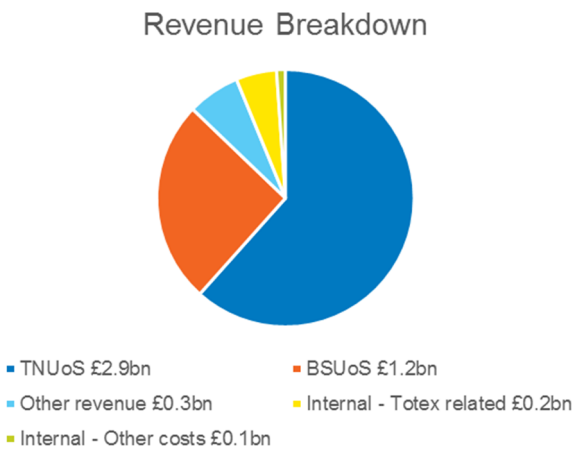


Figure 50 - Breakdown of ESO average RIIO-2 revenue streams in 2018/19 prices

Below, we set out our estimated total internal expenditure across the RIIO-2 period and associated internal revenue using Ofgem's proposed parameters.

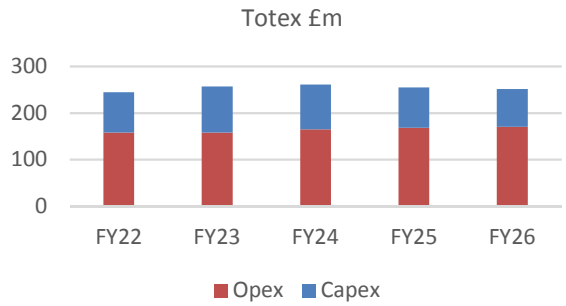


Figure 51 - ESO totex spend in 2018/19 prices

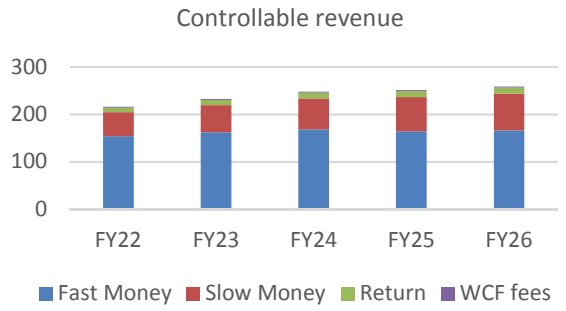


Figure 52 - ESO controllable revenues in 2018/19 prices

10.2. Our impact on consumer bills

The average GB consumer's annual electricity bill is £612, based on Ofgem's latest analysis in August 2019. Using this draft plan, we have used a simple top-down approach aligned with the methodology used by Ofgem[115] to calculate our impact on the average household bill.

We estimate that the average GB household will pay £1.65 per year on average for the ESO during the first two years of RIIO-2 (2018/19 prices). This equates to around 0.3% of the total electricity bill and less than 0.2% of the dual fuel bill.

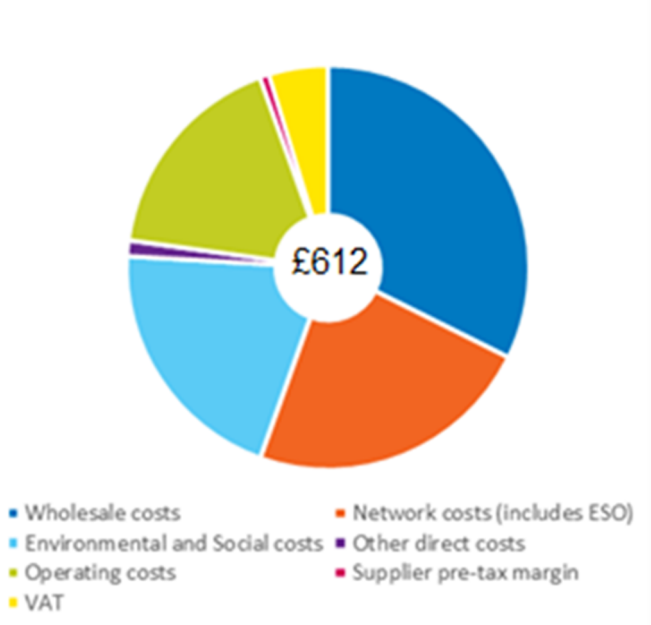


Figure 53 – Breakdown of an average consumer electricity bill

We have historically referenced the ESO contribution to the consumer bill to be around £1. The increase to £1.65 is partly accounted for by an update to present in 2018/19 prices (from 2009/10 prices). This is further influenced by a steady decrease in the electricity demand volume across RIIO-1, which is expected to continue into RIIO-2, as well as the increase in investment proposed in this Business Plan to deliver the outputs that stakeholders want.

Although the ESO contribution to the average bill increases across the RIIO-2 period if looked at in isolation, when put in the context of the overall average consumer bill it would account for less than a 0.02% annual increase, based on Ofgem's latest analysis. Feedback from stakeholders indicates general support to increase ESO costs to achieve better industry outcomes and the delivery of zero carbon targets. Our Business Plan proposes new and transformational outputs that could lead to a reduction of around £4.80 on consumers' bills, so the ESO's impact on consumer bills is a net saving of more than £3 annually in the first two years of RIIO-2.

[115] Understand your gas and electricity bills (Ofgem 2019) available at https://www.ofgem.gov.uk/publications-and-updates/infographic-bills-prices-and-profits and www.ofgem.gov.uk/consumers/household-gas-and-electricity-guide/understand-your-gas-and-electricity-bills

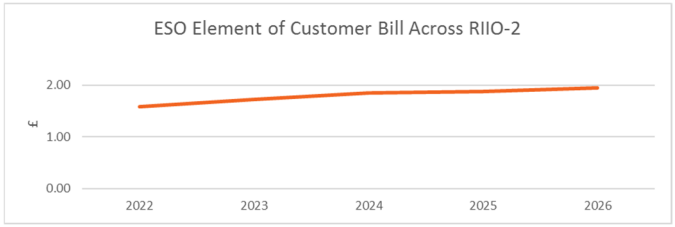


Figure 54 - ESO contribution to the average household consumer electricity bill in 2018/19 prices

Efficiency is important. As set out in chapter 3, each of the cost areas in our Business Plan has been tested for efficiency, either through cross-sector benchmarking, cost-benefit analysis or the application of an efficiency target. We are therefore confident that we will start RIIO-2 at the efficiency frontier. Furthermore, several of our stakeholders recognise the fact that, while our proportion of the average customer bill is increasing, this still represents a very small portion of the total and reflects the significant ambition they wish us to exhibit:

"We would highlight that the System Operator internal costs are generally small relative to the significant benefit that they may be able to generate for consumers and therefore there is higher risk for consumers should the focus be disproportionately placed on budget and cost management. It is important to ensure an adequate business model that provides appropriate funding for the System Operator activities in order to allow them to focus on those areas that can generate greatest consumer and system benefits."
DNO

"The ESO performs a crucial role within the energy system and its actions and expenditure influence much greater sums of industry costs. This means it is a far greater risk to consumers that the price control framework for the ESO does not provide adequate incentives to pursue initiatives that may realise value, compared to the ESO being overcompensated."
Generator

10.3. Ofgem's working assumption and the ESO's financial package

The ESO is an asset-light company providing a suite of services, including operating and balancing services, market and industry services, as well as an industry revenue management service (figure 55). Our assets are largely intangible assets realised through the skills and expertise of our workforce and the enabling information systems we use to underpin the services we provide.

Three core functions of the ESO
Operating and balancing the system – generation despatch to meet demand and balance the system in real time. This function ensures that the lights stay on across GB in a safe and economically efficient manner

Market and industry services – range of activities to support the wider system and industry including optimising long-term network planning and administering industry codes and standards

Industry revenue management – responsible for collecting, managing and distributing over £4bn of TNUoS, BSUoS and Connection charges annually

Figure 55 – Three core functions of the ESO

Our financing requirements are therefore more centered around funding shorter-term requirements: investment in our workforce and continual reinvestment in our enabling systems to ensure that we maintain (and improve) the reliable level of service that has come to be expected of us.

The intention of the recent legal separation of the ESO from NGET was to establish an ESO with a governance structure that mitigates potential or perceived conflicts of interest and that can adapt further to the changing energy system. It is important that our framework reflects this by funding the ESO on the basis of the credit rating it would receive as a standalone business, without support from National Grid Group. This new price control is critical to the success of legal separation and ensuring that the ESO is able to demonstrate that we are a financeable, credit-worthy and sustainable business.

We are a unique investment offering given the roles we undertake and our central position within the industry. The ESO has a licence obligation to hold an investment grade credit rating, which is important to provide confidence to our counterparties and other stakeholders in relation to the important roles we play at the heart of the industry.

We must be able to attract both equity and debt investors so we can finance the services we provide. It is therefore critical that we consider both our debt and equity investor propositions as we set out our financial package.

10.3.1. Cost of debt

The ESO is structurally and operationally different to the RIIO network companies: we are relatively asset-light, with IT systems being our main assets rather than large electricity infrastructure. We carry a very significant risk of working capital fluctuation due to our industry revenue management role and relative size of pass-through costs. These risks, and our high operational gearing, mean that we have two main sources of debt financing; financing our RAV, and financing working capital fluctuations.

We believe a bespoke cost of debt mechanism is required to reflect the unique characteristics of the ESO and the significant growth in our RAV that our ambitious Business Plan represents.

Approach to financing our RAV

The ESO expects high levels of capital growth in the RIIO-2 period, with the RAV almost doubling over this time. A key requirement of our revenue is to ensure we can service our efficiently incurred debt.

The ESO currently holds medium term debt of £120 million. Although this is expected to steadily increase across RIIO-2, each individual issue is likely to be modest in market terms, and below the level required for efficient access to the bond markets. We anticipate, as a result, that the ESO will rely more heavily on bank debt.

In our Business Plan, we have used Ofgem's working assumption of an average cost of debt of 0.25% (CPIH stripped). We will assess the impact of Ofgem's cost of debt methodology when it is published in late October, and include our consideration of it in our December Business Plan.

We respect Ofgem's proposal in its ESOMDD consultation to retain full indexation of cost of debt allowances to reduce risk to consumers as well as to the ESO. Setting a cost of debt allowance based on relevant market benchmarks, reflective of the circumstances of the relevant business, incentivises efficient debt finance.

When considering the credit rating impact, we believe that it would be appropriate to use only BBB rated UK non-financial corporates as comparators for the ESO. Not only is the ESO actually rated within the BBB range, a credit rating agency (Moody's Investors Service (Moody's)) has explicitly cited an assumed level of National Grid Group support in determining this rating; the clear implication of this is that the notional ESO has a lower rating. Any use of combined A/BBB rated bonds would leave the ESO exposed to under-funding.

At present, Ofgem's working assumption does not explicitly include any allowance for the transaction costs of borrowing. Previous regulatory precedent from Ofgem and other regulators[116] has included assumed transaction costs. We propose the inclusion of funding accordingly.

In our response to Ofgem's ESOMDD consultation, we have proposed a cost of debt allowance that looks to approximate the efficiently incurred costs associated with bank debt, which we believe is more reflective of the business characteristics and borrowing needs of the ESO, and therefore in consumers' interests. It comprises an allowance based on LIBOR[117], or its subsequent replacement, plus a credit spread associated with the five to seven and seven to ten year BBB rated UK non-financial iBoxx indices, with the inclusion of an allowance to cover the transaction costs of borrowing and the acknowledgement of costs of funding a standalone ESO. We set out more detail of our proposal in the annex to this plan.

Working capital facility

A working capital facility (WCF) is key to managing the ESO's short-term liquidity. Such a facility for the ESO differs to most businesses because of our industry revenue management role and the scale of revenues that we transact (over £4 billion in network charges), compared to the size of our asset base (around £230

[116] https://www.ofgem.gov.uk/ofgem-publications/92249/riio-ed1finaldeterminationoverview-updatedfrontcoverpdf and https://www.uregni.gov.uk/sites/uregni.gov.uk/files/media-files/2016-2-22_SONI_PC_Final_Determination_2015-2020_Final.pdf

[117] The London inter-bank offer rate (LIBOR) is a benchmark interest rate at which major global banks lend to one another in the international interbank market for short-term loans. It serves as a key benchmark interest rate.

million[118]) or our internal expenditure (around £250 million per year[119]).

Our WCF has been sized predominantly to cover the major risks associated with revenue management, where there is a significant risk of under-collection, with often a two-year delay in being able to recover cash from customers. These risks include TNUoS charges collection risk ('K' term) as well as risks around customer estimated billings, large termination payments and customer insolvency.

We have prepared our Business Plan on the basis of a £550 million WCF.[120] The sizing does not cover the maximum possible cash exposure, but reflects the size of our plausible exposure rather than probable exposure, and reflects the actual facility we have in place today. This gives comfort that we can meet our licence obligation around sufficiency of resources with minimal additional cost to consumers.

This facility is sized in line with our current risk exposure. We are aware that Ofgem is consulting on whether to transfer the TNUoS revenue collection risk that we hold to other parties, and note that our Business Plan contemplates additional risk in BSUoS charges revenue collection as a result of any conclusions from the charging task force. We would expect funding to cover the appropriate facility size taking into account our exposure for RIIO-2, and recognise that the current facility will remain in place for the first year of RIIO-2.

We note Ofgem's consultation on proposed funding mechanisms for a WCF.[121] We do not believe that a pass-through mechanism that recovers only the fixed facility fees[122] would fairly remunerate all the revenue risks that the ESO manages. For example:

- Most risks that are mitigated through the provision of a WCF do not attract interest funding when they are subsequently recovered in revenues. For example, any shortfall in recovery of revenues as a result of inaccurate customer forecasts, which would be funded through the WCF, would not attract any interest funding.
- Borrowing costs on the working capital facility are linked to LIBOR, hence the ESO would be taking on additional interest rate risk.
- There is no recognition of the contingent equity capital that underpins any WCF.
- Exposure could exceed the value of the WCF, and the ability to access additional funding at short notice would likely carry a cost premium, as well as impacting the ESO's credit rating and investor confidence. The shareholder consequently has further contingent equity invested in the business.

We are continuing to develop our risk modelling to provide further quantitative evidence to support our favoured approach to funding risk. This is further discussed in section 10.3.2. We have assumed, for the purposes of this Business Plan and our financeability assessment under Ofgem's working assumptions, that all costs of the WCF including any costs of borrowing are passed through.

10.3.2. Cost of equity and investor return

The cost of equity is an estimate of the return that equity investors expect for the risks they take when investing in the ESO. Investors receive their return through dividends and asset growth funded by the cost of equity allowance and any additional remuneration.

In its ESOMDD consultation, Ofgem's working assumption is that a cost of equity of 7.81% should suffice to ensure a financeable ESO. Ofgem's approach is to continue to apply the Capital Asset Pricing Model (CAPM) for the ESO, supplementing with additional remuneration as deemed necessary. This provides a return to equity holders aligned with the capital invested in the RAV. For the purposes of this Business Plan we have adopted Ofgem's working assumption of 7.81% cost of equity and no additional remuneration, but include our thoughts on those assumptions below.

The CAPM approach involves three different elements to calculate the cost of equity in the following formula:

$$\begin{matrix}\text{Cost}\\ \text{of}\\ \text{Equity}\end{matrix} = \begin{matrix}\text{Risk}\\ \text{free}\\ \text{rate}\end{matrix} + \begin{matrix}\text{Equity}\\ \text{beta}\end{matrix} X \left(\begin{matrix}\text{Total}\\ \text{market}\\ \text{return}\end{matrix} - \begin{matrix}\text{Risk}\\ \text{free}\\ \text{rate}\end{matrix} \right)$$

Risk-free rate (RFR)

RFRs tend to be estimated with reference to UK government debt as a proxy for a riskless UK investment. We agree with Ofgem's proposal that cost of equity indexation is best achieved through the indexation of the RFR. We have used Ofgem's assumption of -0.75% as the average real CPIH-stripped RFR for the purposes of our Business Plan.

Total market return (TMR)

TMR is the estimate of the return that investors expect for taking the market-average level of risk. Ofgem has proposed setting a forward estimate for TMR across the RIIO-2 period using historic data. It is generally accepted that TMR is stable over time.

Ofgem has used this method to set an expected TMR range of 6.25%-6.75% (real CPIH). We have again used this working assumption in our Business Plan but note that our position is consistent with the views of the ENA members as presented in various ENA submissions

[118] Based on our opening RAV in nominal prices
[119] Average totex across RIIO-2 in 2018/19 prices
[120] The size of the facility is assumed in 2018/19 prices and for simplicity of financeability modelling is assumed to index to nominal prices
[121] https://www.ofgem.gov.uk/system/files/docs/2019/08/riio-2_methodology_for_the_electricity_system_operator_-_decision_and_further_consultation.pdf
[122] 'Fixed' fees being arrangement fee, extension fee and annual commitment fee.

during the RIIO-2 engagement,[123] which would suggest this working assumption is downwardly biased.

Equity beta

Within CAPM, the equity beta represents the level of systematic risk within an organisation for which investors expect a return. In unlisted businesses, it is estimated using the formula below. This considers the asset beta of the organisation in comparison to other organisations with similar characteristics.

$$Equity\ beta = \frac{asset\ beta}{1 - gearing} - debt\ beta * \frac{gearing}{1 - gearing}$$

Ofgem has provided a working assumption of an asset beta of 0.6, aligning with recent SONI precedent. We agree that SONI is a good comparator organisation to the ESO, undertaking many similar roles to us and providing similar services, and therefore agree with the use of this as an initial working assumption.

We commissioned Oxera to write an independent report into the appropriate cost of equity for the ESO and have used it to inform our views on equity beta. Within its report, Oxera estimated an appropriate asset beta range for the ESO of 0.60-0.65,[124] based on observing comparator organisations and regulatory precedent.

In arriving at its equity beta working assumption, Ofgem has assumed a debt beta of 0.125. We believe that this assumption is inappropriate and that a debt beta assumption of 0.05 should be used. The empirical analysis prepared by Oxera for the ENA shows that current market evidence supports a debt beta of 0.05.[125]

Notional gearing

Gearing is a measure of the financial leverage of an organisation. Notional gearing represents the percentage of net debt in relation to RAV for the notional company. Notional gearing is a key consideration in setting a price control as it links many of the financial parameters together.

Notional gearing for RIIO-1 provided a range of 55 - 65%. As a significantly more asset-light organisation than the network companies, economic theory suggests that the ESO would not be able to bear as much debt as these organisations. Ofgem recognised this in its ESOMDD decision document and consultation, which sets out a working assumption of 55% notional gearing to RAV for the ESO. Ofgem noted that it will continue to review this in light of the riskiness of the overall price control settlement and the ability of the notional ESO to sustain downsides.

As outlined in our consultation response,[126] we anticipate an appropriate range in notional gearing of 50-55%.

Our overall cost of equity

The evidence outlined in our response to the ESO MDD consultation[127] and above indicate that a cost of equity in the range of 7.6%-9.3% can be supported.

	Ofgem working assumptions (CPIH)	ESO alternative assumptions (CPIH)
Risk Free Rate	-0.75%	-0.75%
TMR	6.50%	6.50%
Asset Beta	0.6	0.6-0.65
Debt Beta	0.125	0.05
Gearing	55%	50-55%
Equity Beta	1.18	1.15-1.38
Cost of Equity	**7.81%**	**7.59-9.28%**

Figure 56 Cost of equity

Return cross-checks

The ESO is a legally separate, for-profit business; an asset-light, people and services business, unlike the network companies. We are also different to the majority of system operators who are not-for-profit, integrated with transmission businesses, or state-owned. Ofgem acknowledged this in its December 2018 Sector Specific consultation: “The ESO, unlike other sectors, is relatively asset-light. Therefore, a RAV-based remuneration model may not be appropriate or necessarily deliver the most efficient outcomes”.[128]

A pass-through with margins-based approach to remuneration based on the ESO’s activities make sense given the asset-light nature of the system operator that makes conventional RAV*WACC approach unsuitable”.
(Generator)

[123] https://www.ofgem.gov.uk/publications-and-updates/riio-2-sector-specific-methodology-consultation
[124] https://www.nationalgrideso.com/document/153396/download
[125] Oxera (2019),’Review of RIIO-2 finance issues’, 20 March
[126] https://www.nationalgrideso.com/media-test/esos-response-ofgems-riio-2-finance-methodology
[127] https://www.nationalgrideso.com/media-test/esos-response-ofgems-riio-2-finance-methodology
[128] https://www.ofgem.gov.uk/system/files/docs/2018/12/riio-2_eso_annex_0.pdf

Given the specific attributes of the ESO and significant stakeholder feedback that a RAV-based remuneration model may not appropriately fund the business, we have also considered appropriate additional remuneration. We outline the results of this analysis below, supported by independent expert reports from KPMG and Oxera.

We acknowledge that both the CAPM and margin benchmark methods are 'imperfect' for use by the ESO. CAPM is limited in its consideration of asymmetric risk and the return is only applied to the RAV, while margin benchmarking suffers from a lack of directly comparable UK-listed, regulated entities. Given these challenges, we believe that it is important not to rely on a single method of assessment.

We have undertaken an exercise, using Ofgem's proposed process in the ESOMDD, to understand the risks the ESO is exposed to; whether any of these are not recognised by the RAV*WACC model or are fully mitigated in our regulatory framework, and therefore whether additional remuneration is required. We have started by undertaking a quantitative assessment of the ESO risk framework and the high-level capital requirements to support the total risk. A return can then be applied to that capital requirement. We have cross-checked this to a margin-based approach, which considers the margins we could expect for the three distinct roles we perform based on suitable benchmarks.

It is also relevant that, under our licence, the ESO must provide assurance on an annual basis that we have sufficient resources available to support our activities for the following 12 months; this inherently includes sufficient risk provision. We therefore need to maintain sufficient capital to finance the risks (whether point in time or permanent losses) to ensure financial resilience and financeability. Much of this capital requirement is related to activities and risks that are not correlated to the RAV or the capital directly employed in the RAV, and covers all three of the core functions of the ESO.

To provide this quantitative assessment of the ESO risk framework, we commissioned an independent report from KPMG. The report builds on the risks we have already recognised by identifying the underlying drivers and consequences of the risks, and quantifies a plausible range of downsides. KPMG's assessment indicates that the total capital requirement for the ESO business is in the range of £955 million to £1,060 million, of which the RAV is £325 million to £375 million. Capital must be secured ahead of need, as no provider of finance would commit capital ex post to cover losses incurred, hence capital must be committed ex ante to cover losses in case they arise. In order to provide financial resilience in the case of risk impacts, judgement is required in considering the size and likelihood of these risks. The capital committed must be sufficient for the business to manage severe but plausible downside shocks.

The contingent capital that is committed to the business over and above the capital directly employed in the RAV needs to be remunerated. KPMG has provided an illustrative cost of remunerating the capital employed based on overall company WACC.[129] This suggests that the ESO could expect an overall return in the range of £55 million to £61 million, and therefore suggests a funding gap in the range of £36 million to £39 million.

This top-down approach to sizing the capital employed across our risks provides a useful assessment of the magnitude of the additional returns that could be required. It is then important to cross-check this with a margin-based assessment that benchmarks returns to other comparator sectors or companies, to give appropriate consideration to where competitive forces and regulatory precedent have driven remuneration levels.

We have cross-checked the outcome of the KPMG analysis using other margin-based benchmarks for each of the ESO roles, as follows:

- For the industry revenue management role, we have used the independent report we commissioned from Oxera, which estimates an appropriate margin on external costs by drawing on two pieces of analysis. The first is a benchmark analysis against comparator companies that undertake financial intermediation activities. The second examines regulatory precedents; more specifically the regulatory parameters following the SONI CMA appeal, the relevant price control parameters for EirGrid, and the final determination for SEMO.[130] This results in a point estimate of a margin on external revenues of 35 basis points (bps, 0.35%).
- For the market and industry services role, we have used KPMG's benchmark analysis of 72 comparator companies in the professional and commercial services industry as set out in their report published alongside our July consultation response.[131] This indicates an EBIT margin of 11%.
- For the operating and balancing role, we have used KPMG's benchmark margin, which is based on the London Stock Exchange forecast operating margin adjusted to remove ESO's RAV return. This suggests a comparable operating margin of 13.9%.

If we apply the above margin assumptions, this suggests a funding gap compared to the RAV*WACC funding model of £32 million to £36 million.

We recognise that our quantitative analysis needs further development and we will continue to engage with Ofgem to develop this. Nevertheless, at this stage we can conclude that:

[129] WACC of 5.7% Nominal, CPIH stripped applied as set out as working assumption per August ESOMDD

[130] SEMO – Single Electricity Market Operator, which operates a single wholesale market for Ireland and Northern Ireland.

[131] https://www.nationalgrideso.com/document/147601/download

- Not all our risks scale to RAV.
- There is a significant amount of capital committed to the business for the management of risk.
- A simple RAV*WACC funding model does not fully remunerate this capital and therefore does not provide a fair return for the services we provide.

Investor return

We have engaged with equity investors through individual meetings and National Grid plc's annual investor survey. Coupled with analyst commentary, the emerging Themes at this stage in the RIIO-2 process are:

- Dividends are of fundamental importance to equity investors.
- Recognition that the allowed return proposed by Ofgem could decrease the ability to attract equity finance.
- Political and regulatory risk are seen as increasing compared with the lead up to RIIO-1.

We note that Ofgem has provided a working assumption to the network companies of 3% dividend yield,[132] in comparison to its cost of equity working assumption of 4.8% (before applying any outperformance assumption). Applying the same pay-out ratio, the ESO dividend yield would be around 4.9% based on Ofgem's working assumption of 7.81% cost of equity.

A stable dividend policy sends a strong signal of confidence to investors. We believe that a stable notional dividend policy of 5% and 1.5x dividend cover is appropriate for the ESO.[133] This is consistent with our UK and European peer group over the last 10 years, against which we would be competing for investment.

Further detail on the investor position and the importance of appropriate return is provided in Annex 5.

10.3.3. Capitalisation Rates

The capitalisation rate is the proportion of totex expenditure added to the RAV each year and paid for by future customers via a regulatory depreciation allowance as part of our revenue.

During RIIO-1, the capitalisation rate was based on the portion of capex within the overall totex plan. This was 28 per cent for the ESO.

A number of uncertainty mechanisms were used in RIIO-1 to allow for new roles to be undertaken by the ESO (e.g. EMR delivery body), and to fund requirements that were known but not sufficiently defined at the beginning of the price control (e.g. data centre and cyber security investment). These items were proportionately more capex intensive and we forecast that capex will outturn at 33 per cent of totex at the end of RIIO-1.

In RIIO-2 we anticipate capital investment to continue to form a greater proportion of our activities, suggesting that an equivalent capitalisation rate would be nearer 35 per cent[134] across the five-years or 37 per cent for the first two years of the RIIO-2 period, based on the same principles as RIIO-1.

The ESOMDD set out an expectation that the capitalisation rate would be based on operational practice to date, with consideration of the expected ratio of capex to totex; but would be set by means of the ESO business plan submissions every two years.

We have included this assumption within our Business Plan, and we explore the impacts of and sensitivities to this within the financeability section of our plan.

10.3.4. Asset lives and regulatory depreciation

Principles established in previous price controls set out that charges to consumers should appropriately balance the interests of current and future consumers.

In line with Ofgem's guidance, we have modelled regulatory depreciation using an average asset life of seven years on a straight-line basis. This is in line with our historic average useful economic life of our assets.

Our forward investment plan suggests some shortening of the average economic life of our assets as we progress through RIIO-2. At this stage our plan does not seek to adjust the regulatory asset life.

10.4. Our initial financeability assessment

We have put forward an ambitious plan that we believe will deliver against the needs of industry and consumers across the RIIO-2 period. This plan requires investment over and above RIIO-1 levels to ensure these ambitions are met.

As a company that acts as counterparty to more than £4 billion of industry revenues and to ensure the efficient functioning of the market, it is critical that the ESO is able to maintain a strong investment grade credit rating for the actual company. Ofgem has a statutory duty to have regard to the need to secure that the company is able to finance its licensed activities, with this being interpreted as ensuring the notionally efficient company can attract and provide appropriate returns to its investors. However, should the actual company not remain a strong counterparty to industry, this would not be in the interests of consumers. To be a strong counterparty means ensuring that the cost of debt fully reflects all the costs of any debt finance, and that the

[132] A 3% yield has been agreed with Ofgem in line with the network company working assumption for notional company financeability modelling purposes in the absence of a specific working assumption being set out in the ESOMDD

[133] For the purposes of financeability analysis we have assumed this as 5% of equity RAV and will develop modelling of dividend on contingent capital for our December plan

[134] Total capex for the five years of RIIO-2 divided by totex for the five years of RIIO-2

cost of equity provides a return to equity that will both provide an adequate return to current investors, and attract any necessary additional funds as required.

Our initial assessment is that Ofgem's working assumptions do not provide for a financeable ESO unless further adjustments are made.

We explore financeability on both a notional and actual company basis.

For this purpose, we assume the notional company to be an efficient standalone organisation which sits outside of the National Grid Group and therefore does not benefit from any parental support. Its finances are influenced by an assumed capital structure, with net debt comprising 55 per cent of its RAV, and includes regulatory depreciation of its assets.

By contrast the actual company reflects our actual capital structure and accounting policies, including the statutory depreciation of assets as well as our position within the National Grid Group.

10.4.1. Assessing financeability

In performing our assessment, we have used Ofgem's working assumptions and our own internal modelling in the absence of Ofgem's business plan financial model for the ESO. We have approached our assessment through the review of a base case tested against a number of sensitivities, to evaluate the notional and actual company against a range of potential outcomes in line with Ofgem's guidance.

We also present alternative assumptions in Annex 5 where we believe they are justified.

The table below sets out the main assumptions used in our analysis. All return numbers quoted are CPIH stripped.

Parameter	Core assumption
Cost of equity	7.81%
Cost of debt allowance	25bps
Index linked debt	0%
Working capital facility expense	Pass-through of facility costs, assumed with zero draw down
Interest expense	Equal to cost of debt(but incurred nominal)
Gearing	55% opening position
Inflation	CPIH of 2%
Dividend Yield	3% on equity RAV[135]
Capitalisation rate	Aligned to capex proportion of totex, reset every 2 years – 37% for 2012/22 and 2022/23
Regulatory depreciation period	7 years
Incentive performance	No under/ out performance[136]
Additional remuneration	None assumed

Figure 57 – Working assumptions

[135] A 3% yield has been agreed with Ofgem in line with the network company working assumption for financeability modelling purposes in the absence of a specific working assumption being set out in the ESOMDD

[136] Ofgem is currently consulting on ESO incentive scheme. At present, no financial parameters have been consulted on or set as working assumptions for business planning purposes.

As set out in section 10.3.2 above, both debt and equity investment are needed to provide the ESO with the capital necessary to deliver our activities and services. In order to ensure our plan is financeable, we have undertaken a review both of metrics used by credit rating agencies and a suite of other credit and equity metrics to ensure that the different investor positions are considered. We continue to consider alternative metrics in addition to those reviewed for inclusion in our December Business Plan. We believe that this is increasingly important given the asset-light nature of the ESO and our inherent cash flow volatility.

We target a credit rating of at least Baa1/BBB+ for the actual company. We believe this provides an appropriate level of company resilience as well as providing confidence to stakeholders.

The legally separate NGESO Ltd obtained its initial rating in March 2019. Moody's assigned a rating of Baa1 with a stable outlook to the ESO as an initial rating.[137]

Moody's indicated a grid rating score of A1 based on the qualitative and quantitate metrics used under the Regulated Electricity and Gas Utilities Methodology it applied. This A1 grid rating was then notched down by three notches to its final rating of Baa1. Moody's stated:

"the outcome of the methodology grid is A1 on a forward-looking basis [following the legal separation of NG ESO from NGET]. The assigned rating is three notches lower, reflecting NG ESO's unusually high cash flow volatility and associated liquidity risks, offset by its ownership by National Grid plc."
Moody's

A clear implication of this is that the standalone company has a weaker credit profile than implied by our published rating. Moody's has made two areas of judgement in reaching its final rating: 1) a downward adjustment of several notches due to ESO-specific issues, such as the levels of volatility experienced by the ESO and the inherent instability in our metrics and, 2) an upward adjustment for parental support.

Moody's has not issued any quantitative guidance for the ESO, which we believe is because the business is subject to high levels of volatility in its metrics. This makes a quantitative assessment of ESO credit strength based on financial metrics challenging.

It is clear that, despite strong debt metrics giving a grid rating of A1, Moody's still reduced the rating for the ESO down to Baa1, and that it would have been even lower without support. In this context, deterioration in the debt metrics to below a grid rating of A1 creates a potential risk that the ESO would no longer be investment grade on a notional basis. Such an outcome should be avoided, both to avoid an increase in financing costs and therefore direct costs to consumers, and to avoid any concern among industry counterparties around the credit worthiness of the ESO in our operating and balancing and revenue management roles. In the following sections, we have set out potential amendments that could be made to the parameters to improve the financeability of the ESO, as well as sensitivity analysis. The detailed findings for all these variations are presented in Annex 5.

10.4.2. Financeability assessment of the notional company

Ofgem has set a notional gearing assumption of 55 per cent net debt to RAV. Under Ofgem's working assumptions, gearing rises above notional levels, indicating the need for equity injections to enable us to deliver our plan. For the purposes of the Business Plan, we have assumed equity injections to maintain gearing within a tolerance of 5 per cent of notional levels at a cost of 5 per cent of any equity raised.

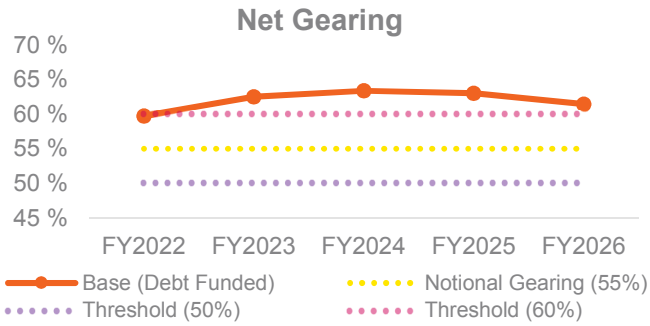


Figure 58 – Net gearing level of notional company with Ofgem working assumptions before any equity injection

[137] https://www.moodys.com/research/Moodys-assigns-Baa1-rating-to-National-Grid-Electricity-System-Operator--PR_396553

Notional company debt financeability

A review of the quantitative metrics used in the ESO's rating results in an average grid score one notch lower than the grid that led to our actual rating of Baa1. This is against a baseline demonstrating no volatility as a result of our industry revenue management role or incentives results.

We note that many of the debt-based metrics traditionally used, including those used by Moody's, are of limited value when considered in the context of the ESO. Our short asset lives mean that we exhibit relatively high Funds From Operations (FFO) or Cashflow From Operating activities (CFO). This, coupled with capex that is not particularly discretionary and is trending above depreciation, shows metrics that may give an overly positive perspective and lead in part to the high grid rating score.

Debt metrics that place more emphasis on including consideration of capex and/or depreciation impacts are more meaningful given the largely non-discretionary nature of our capex programme[138].

The Adjusted Interest Cover Ratio (AICR) does include consideration of regulatory depreciation levels. The average RIIO-2 period cover is 2.4x; under Moody's Regulated Electricity and Gas Networks Methodology, this would indicate a rating for that metric of A. It should be remembered that the scenario used to generate these illustrations does not include utilisation of the WCF, which we believe is not a realistic assumption given the exposure to volatility that the ESO sees. Any use of a WCF will depress the interest cover ratio. If we assume the facility was to be fully drawn, the AICR would reduce to 1.6x with full pass-through of all WCF costs, or 1.0x with the recovery of no interest costs, indicating that there is the potential for significant movement in this metric based on our short-term liquidity requirements.

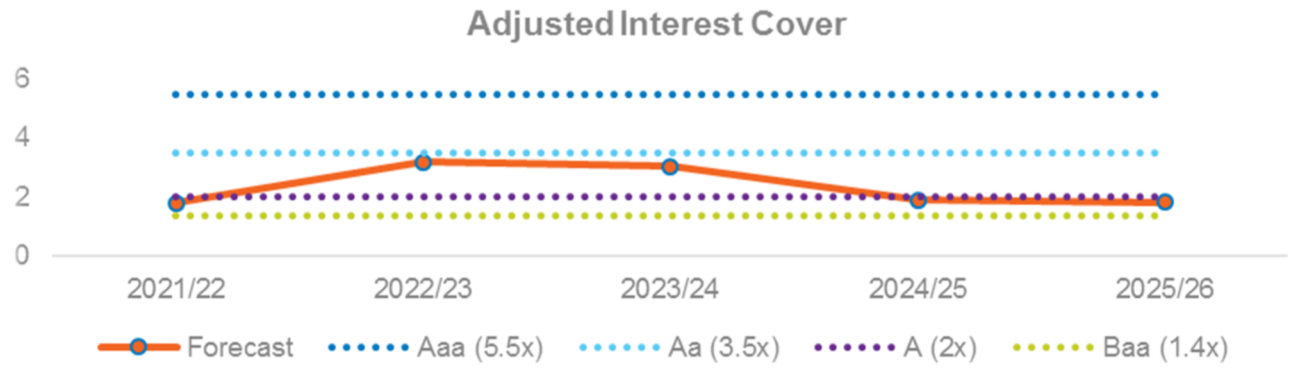


Figure 59 – Adjusted interest cover for notional company with Ofgem working assumptions

[138] A large proportion of ESO capex is used to provide robust IS systems used to support our balancing services role

Notional company equity financeability

Extending our assessment into more equity-based metrics, we question the overall financeability of the plan using Ofgem's working assumptions.

As outlined above, the notional company uses a profile of equity injections to set and maintain its gearing and capital structure. Using the Ofgem working assumptions, equity injections are required across the RIIO-2 period as follows:

£m	2021/22	2022/23	2023/24	2024/25	2025/26
Equity Injections	23	4	3	3	1

Figure 60 – Equity injections required in the notional company under Ofgem working assumptions

EBIT margin on controllable revenues in the notional company averages 5.9 per cent in the RIIO-2 period, which is below the benchmark position set out by Oxera and KPMG in their reports.

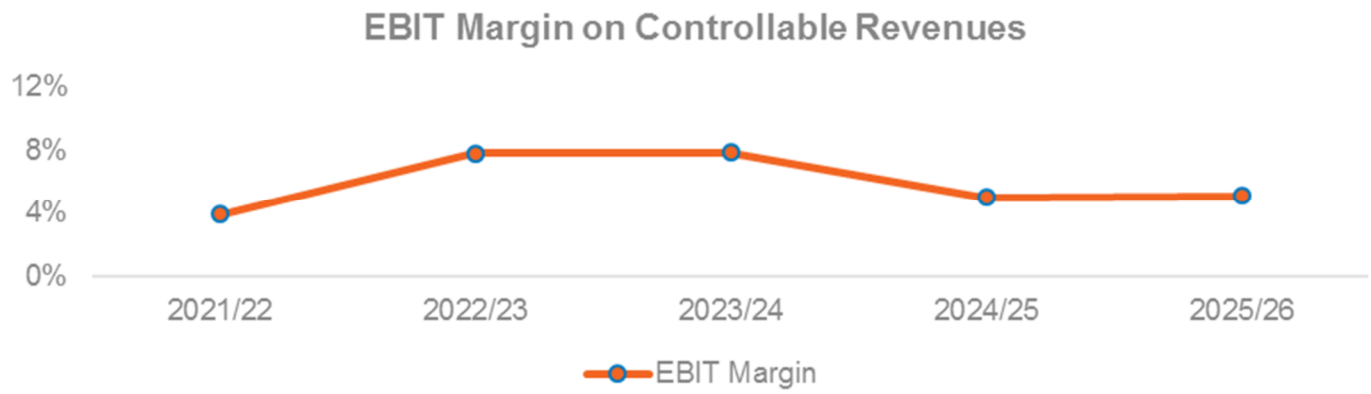


Figure 61 – EBIT margin on controllable revenues for notional company using Ofgem working assumptions

Although in this scenario we would be able to cover a 3 per cent dividend yield on average, EBIT levels are below those required for the services provided and fail to remunerate the contingent capital employed to support risks held.

Metric	2021/22	2022/23	2023/24	2024/25	2025/26	*Average*
Dividend Cover	0.6	2.8	2.6	1.0	0.9	1.6

Figure 62 – Dividend cover for notional company under Ofgem working assumptions

These metrics, combined with the need to inject new equity into the organisation, suggest that the levels of return within the notional company would not provide an attractive offering to investors to ensure that we are equity financeable.

Sensitivity analysis

We have looked at the impact of several events on our plan, all of which are reasonable things that could happen. For each of these scenarios we consider the impact on debt and equity metrics. The scenarios considered are:

Factor	Scenario
Interest rate scenario	+/- 1% compared to forward implied rates in each year (for RFR, LIBOR and iBoxx inputs)
Revenue timing	£75m timing impact in each year driving an average working capital use of £150m in any one year, assuming a two-year lag in recovery.
Mixed revenue collection profile	Mixed revenue collection profile with some years showing an under-recovery and others an over-recovery
Totex timing	+/- 10% in each year

Figure 63 – Scenarios considered for financeability assessment

Below, we set out highlights of the impact of these scenarios on the notional company under Ofgem's working assumptions. Further details of the results on the notional company and the impact of these scenarios on the actual company are shown in Annex 5.

Interest rate scenario – the results presented have assumed our proposed cost of debt methodology approximating the costs of efficiently incurred bank debt. In this scenario, a one per cent movement in interest rates affects cost of debt revenue allowances, and the nominal cost of servicing the debt held equally. If this scenario were to run assuming a cost of debt methodology based on bond financing, we would expect more extreme results due to the impact of longer trailing average periods.

In the +1 per cent interest scenario we see a reduction in all metrics, with AICR, for example, reducing to a RIIO-2 average of 2.0x, this drives a one-notch reduction from our actual rating grid.

Revenue timing – as expected, this scenario shows a significant reduction in all metrics, effectively removing £150 million of cash and profit from the plan. AICR, dividend cover and EBIT margin metrics all return negative results on average across the RIIO-2 period. This would drive a three-notch reduction from our actual rating grid when looking at the RIIO-2 average.

Totex timing – similar to the revenue scenario above, the negative of this scenario considers a situation where costs exceed ex ante allowances but have no long-term impact, being returned in revenues in two years. This would drive a three-notch reduction from our actual rating grid when looking at the RIIO-2 average.

Mixed revenue collection profile - we have also run an additional sensitivity that shows a mixed revenue collection profile, with some years showing an under-recovery and others an over-recovery. These are set out in the table below. Such a scenario shows a highly volatile position within the various metrics leaving, on average across RIIO-2, a negative AICR of 1.5x, EBIT losses and a three-notch reduction compared to our actual rating grid.

	2021/22	2022/23	2023/24	2024/25	2025/26	*Average*
Revenue timing within year	(70)	(130)	(60)	(100)	(80)	***(88)***
Revenue timing at year end	(100)	20	60	(200)	(50)	***(54)***

Figure 64 – Mixed revenue collection profile

Summary - we would expect that a two to three-notch reduction in grid rating indicates a potential risk of downward adjustment from a debt perspective when considered in comparison to Moody's recent rating. We do not believe that the baseline package would be financeable from either a debt or equity investor perspective.

We will continue to develop and refine our analysis as we develop our December Business Plan in light of new information and guidance from Ofgem, including assessment of our plan within the Ofgem Business Plan financial model. We anticipate that this will highlight differences; any material differences will be explained in our December plan.

10.4.3. Financeability assessment of the actual company

The actual company differs to the notional company in three important ways. The actual company contains reserves, has capital employed on the balance sheet and uses a dividend policy appropriate to its position in the industry, while the notional company does not. The three per cent dividend yield assumption that applies to the notional company is replaced with a stable dividend yield of 5 per cent as we set out in the investor return section.

The second factor that affects the actual company is the difference between accounting depreciation expense and the regulatory depreciation received in revenues. This has been impacted by differences between capitalisation rates and the actual proportion of capex as part of totex as a result of re-openers, as well as the timing impact relating to some RIIO-1 IT system projects that took several years to complete. In line with policy, these started depreciating after commissioning, which in some cases was a period of time after the initial expense. We therefore see a profit impact in RIIO-2 of depreciation expense outstripping regulatory depreciation.

Thirdly, the actual company contains the impact of any expected adjustments resulting from the outturn of RIIO-1.

Actual company debt financeability

Under this scenario, AICR improves to 3.0x due to the impact of cash related to RIIO-1 revenue adjustments via SOMOD[139] coming into the first two years of RIIO-2.

A review of the quantitative metrics used in the credit rating also shows improvement relative to the notional company.

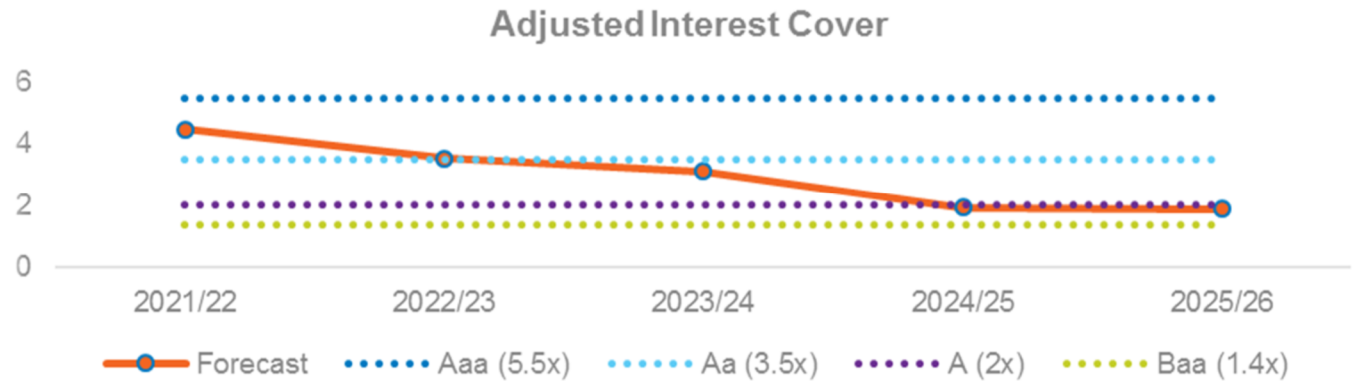


Figure 64 - Adjusted interest cover for actual company using Ofgem working assumptions

[139] SOMOD is a specific revenue adjustment term in the ESO licence.

Actual company equity financeability

Actual company equity metrics show a deteriorated position compared to the notional company. While the actual company is affected by the difference between the nominal cost of debt and the real cost of debt allowance, as well as short-term differences in fast money, it is also affected by a divergence between regulatory and accounting depreciation. As the figures tend towards normalising for this divergence, we can see that the actual company equity metrics show a similar profile to those of the notional company.

If we consider EBIT margin without the historic actual accounting divergence, we see an improvement over the notional company in the first two years of the plan due to a RIIO-1 SOMOD coming through revenue but positions returning very close to those seen in the notional company later in the plan; well below the equity metric thresholds we believe are appropriate.

Under this case, the returns to equity are insufficient to attract the required equity, rendering the proposals unfinanceable.

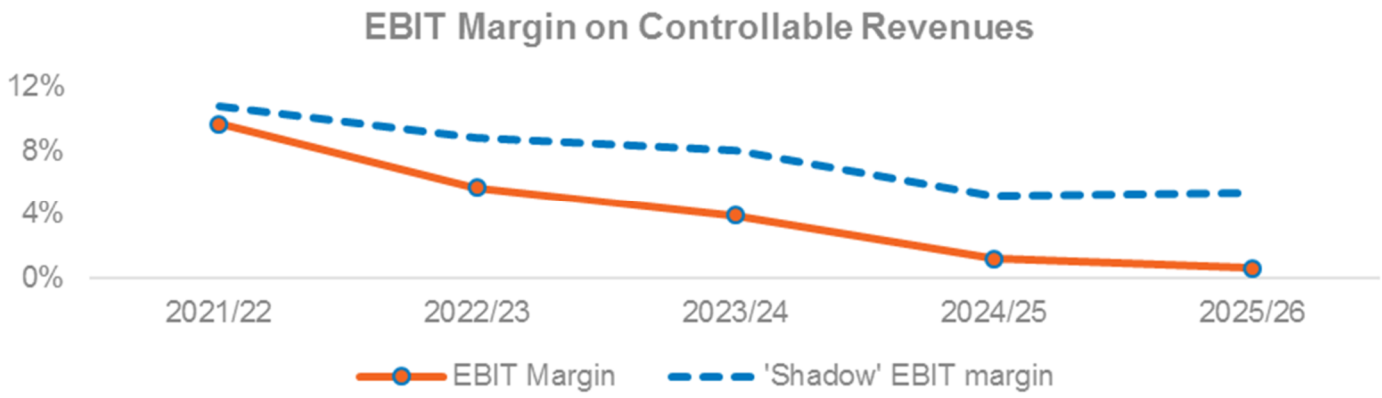


Figure 65 – EBIT margin on controllable revenues for actual company using Ofgem working assumptions

10.4.4. Making the ESO financeable

Ofgem set out a number of potential levers in the ESOMDD consultation that could be used to improve financeability. We consider a number of these below in relation to the notional company under Ofgem's working assumptions.

Dividend yield assumption – moving away from the stable 3 per cent assumption in the modelling, and removing the payment of any dividend, has no significant effect on key metrics. It does reduce the amount of equity injection required over the period from £34 million to £25 million (note that £23 million of this is required to re-gear to the new notional level of 55 per cent). This reduction is not enough to make a difference to the overall attractiveness of the proposition, and would rely on equity investors delaying their return, something that our investor survey indicates they are not willing to do.

Additional remuneration – Throughout this chapter, we have referred to additional remuneration required to appropriately remunerate the ESO for the services we deliver and the risks we hold. As we set out above, the inclusion of this additional remuneration would improve the financeability on a sustainable basis.

Capitalisation rate – the rate used in these scenarios is informed by our ratio of capex to totex. Across RIIO-2, that rate averages at 35 per cent but is reset biannually. If the rate was to be reduced and 32.5 per cent were to be applied instead, the effect would be to increase revenue, as more of the spend would be reimbursed through fast money rather than being deferred as slow money. Doing this increases the EBIT margin on controllable revenues to an average of 9.1 per cent. While on the face of it this is a better result, we do not propose this action as it is likely to create problems in the future. In addition, rating agencies often 'look through' the provision of additional fast money giving no rating benefit to it, this would apply equally to changes in regulatory depreciation periods if not underpinned by an equal change in asset life. The option to adjust the capitalisation rate could be used to a small degree for short-term support but this is not a long-term solution and should not be deployed to a significant extent.

Regulatory depreciation period – the regulatory depreciation period is currently seven years. Should this be shortened to six years, this would effectively release slow money into revenue earlier. If the existing RAV and new RAV additions were considered, this would bring c.£40m into the plan from RIIO-3. Although this would significantly improve short-term metrics, it would have a negative impact on long-term financeability as it does not address the underlying causes of the financeability issues. We do not believe that this is a sustainable option.

Bolstering financeability metrics in this way does not adequately address the underlying challenges within the financeability of the organisation, and is unlikely to support improved credit ratings; rating agencies can look through this 'excess cash' to the underlying business dynamics. Further, such an approach used in a longer-term capacity may run contra to the principles of intergenerational fairness and approximating revenues over the lives of the assets in use.

Of the options reviewed, we believe the only solution that provides for a more sustainably financeable ESO is the inclusion of additional remuneration for our services and risks that are not fully funded and we anticipate developing this option with Ofgem based on the ESOMDD consultation. Although the other options have the potential to provide greater short term liquidity, they do so by bringing forward cash from future periods and fail to address the underlying issue that the ESO provides services and incurs risks that are not adequately reflected by the RAV.

10.5. Other financial policies for the ESO

10.5.1. Pensions

Our Business Plan fully reflects Ofgem's pensions methodology, as set out in its various consultation documents and in line with the RIIO-2 Sector Specific Methodology Decision Finance Annex.

The ESO is a participating employer of the National Grid Electricity Group of the Electricity Supply Pension Scheme (NGEG), which is a defined benefit scheme.

Ofgem has confirmed its intent to continue to review network operators' pensions scheme deficit costs triennially as part of the Pensions Deficit Allocation Methodology (PDAM), which runs parallel to (but outside of) the RIIO Price Control process. Our Business Plan reflects our best estimate based on the PDAM methodology and latest formal triennial valuation (March 2016) and known market movements.

£m 2018/19 prices	2021/22	2022/23	2023/24	2024/25	2025/26
Deficit costs	11.9	12.0	12.1	12.3	12.4
Incremental Deficit costs	0.1	0.1	0.1	0.1	0.1
Scheme admin and PPF levy	0.6	0.6	0.6	0.6	0.6
Ongoing service	8.3	8.3	8.6	8.5	8.3

Figure 66 – Employer contributions for pension schemes

Incremental deficit costs that relate to pensionable service after 31 March 2012 are also recalculated triennially as part of the PDAM process. These incremental deficit costs are included within totex.

Pension scheme administration costs and Pension Protection Fund (PPF) levy costs have also been reflected in our Business Plan totex. Costs associated with administration of the scheme are essential to ensure effective management of the schemes and the protection of members.

Our defined benefit pensions scheme closed to new members in 2006. Contribution rates for future service accruals are expected to increase from today's levels due to the aging of active members and future forecast market conditions. The number of contributing employees is expected to decline, offsetting any increase in contribution rates.

	2021/22	2022/23	Rate reset 2023/24	2024/25	2025/26
NGEG	[redacted]				
YouPlan	13.7%	13.7%	13.8%	13.8%	13.8%

Figure 67 – Annual employer contribution rates

Further detail and explanation of pension costs can be found in Annex 5.

10.5.2. Corporation Tax

During RIIO-1, a tax allowance was set based on the estimated tax costs of a notional, efficient company. Ofgem's current business plan financial model for the network companies continues with this approach while considering alternative mechanisms.

One of the mechanisms under consideration is the double-lock – we do not believe this is appropriate for the ESO, due to the potential volatility in taxable profit resultant from timing issues within our accounting revenues, which we may experience due to our industry revenue management role. Such a mechanism would leave the ESO inappropriately and materially underfunded for tax.

Our draft Business Plan does not explore tax impacts in detail. We will include these in our December plan once the ESO business plan financial model becomes available.

10.5.3. Other finance items

Other finance items are covered in Annex 5 to this Business Plan. Annex 5 is confidential.

Ofgem's ESO Methodology Decision Document ESOMDD consultation on our financial methodology was published on 28 August, which means that key aspects of the regulatory regime remain uncertain at this time. Ofgem's Business Plan financial model was not available for our use until 20 September. As a consequence, and as agreed with Ofgem, the analysis presented in this draft version of the plan has been undertaken using ESO financial models and, in the absence of an agreed model, we have used Finance Annex 5 to play back further detail behind our workings for Ofgem.

Given that the detailed results presented in the finance annex are likely to change they could lead to confusion. Our assessment of both Ofgem's assumptions as well as our alternative assumptions is included in the main section of the draft Business Plan which is published on our website.

We expect Ofgem's decision on its August consultation to be published in late October. We will update our final Business Plan in December based on relevant information in that decision

11.Technology underpinning our ambition

In this chapter, we set out why technology is inseparable from our ambition and how our information technology (IT) strategy is deeply embedded within our organisational strategy.

We show our vision for IT and how our technology will need to change to support our ambition and the wider energy transition. We also describe how the ESO is evolving its capability as an innovative, service-delivery organisation underpinned by technology. Plus, we explore the process for quantifying the levels of investment and how we have tested that with delivery and benchmarking organisations.

11.1. Introduction

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. We continue to innovate to anticipate and respond to new demands on technology as decarbonisation, decentralisation and digitalisation drive significant change across the energy sector.

The IT investments proposed within this Business Plan have been developed as part of a broader five-year roadmap. Many of the investments exceed the strict limits of the two-year Business Plan cycle, as a result we have signalled the five-year roadmap proposal.

In this two-year Business Plan, our view of IT investment specific to the ESO (as set out in the preceding chapters) represents an investment of £157 million (£120 million capex, £37 million opex) [140]. The full five-year roadmap totals £408 million (£322 million capex, £86 million opex). These investments are included in the cost tables in chapters 4 to 8 of this Business Plan.

A further £103 million over five years (with an initial two-year total of £55 million) covers ESO's share of group investments in cyber, infrastructure and business services technology (see shared investments supporting the ESO). The following table shows the cost of the shared investments (opex and capex) plus any other ongoing IT expenditure from RIIO-1.

£m	RIIO-1	2021 /22	2022/ 23	2023/ 24	2024/ 25	2025/ 26
Opex	40.7	57.5	51.7	50.7	51.5	54.4
Capex	62.8	49.1	47.4	34.0	30.4	32.8

Our core architecture and systems provide security-ringfenced, highly available and reliable services that support system operation and competitive open markets. Critical National Infrastructure systems provide dual-redundant (multiple backups), high-availability services across multiple data centres and control rooms, with contingency solutions to make sure the lights stay on around the clock. These systems analyse millions of data points a day across Great Britain's transmission grid. For example, we process 20,000 transmission network data points each second to inform our balancing mechanism system activities.

Our technologies support registration, forecasting and modelling capabilities to schedule supply, hours ahead of real time. This enables our real-time systems to dynamically meet demand, on a second by second basis, by instructing balancing services to increase or decrease power through 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.

The changing energy landscape is transforming how consumers and other parties interact. Technologies such as machine learning and artificial intelligence will unlock the rich insight that is inherent in our data. Visualisation of the whole energy network, generation mix, weather events, and network constraints will create a real-time picture to inform decision making and maximise transparency.

With the energy transformation comes greater system complexity, vast growth in the volume of data, and an expectation from external stakeholders for our data and insights to be shared. Cyber threats associated with the energy sector have been growing in terms of their sophistication and frequency. The threat of an attack on critical infrastructure is becoming an ever-increasing reality.

[140] The ESO will generate a net saving for consumers in RIIO-2. The proposed spending in this chapter will help to deliver this net saving

11.2. Vision for ESO IT

Our technologies must enable a market where anyone can participate, regardless of their generation type or the maturity of their in-house systems and technical capability. We will advance our use and integration of technologies to enable the running of a carbon free network. And we will support access to an even wider range of generation, demand and service providers. We must do all of this while ensuring safe, reliable system operation and managing our risks appropriately.

Through our IS change forum, we received feedback that a greater level of technological integration is required. This echoes our ambition to utilise proven technologies and methodologies to transform traditional models of doing business within the energy sector.

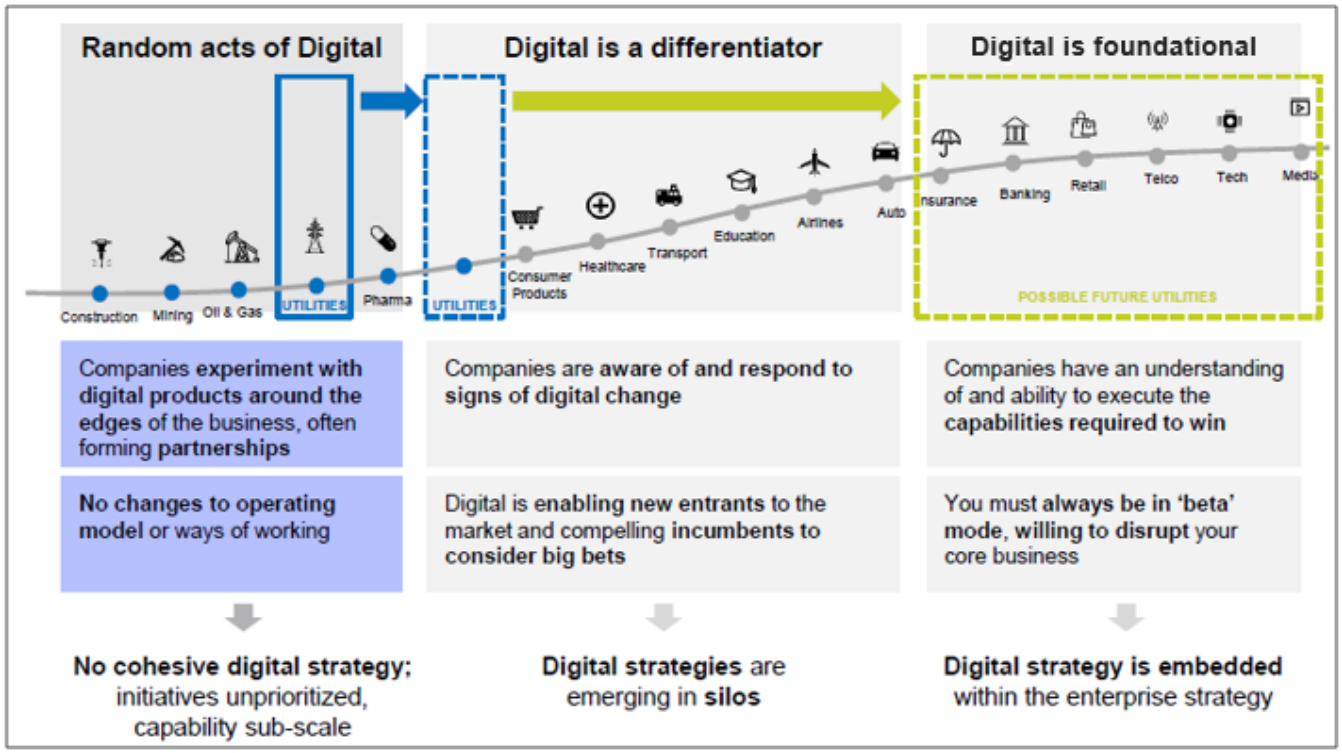


Figure 68: The progression of digital maturity

"National Grid ESO's processes and systems were designed for human-speed, but these both need to mature to match the speed of new energy technologies."
Andy Hadland, Chief Development Officer, Arenko Group

Utilities are in the early stages of digitalisation. Leaders are moving to achieve increased back-office automation, data-driven decision making and increased customer insights through analysis of customer journeys. Digital will become foundational to participation in the marketplace and is likely to open many further opportunities across the electricity system operation value chain.

To achieve our digital ambitions, we need to think beyond the application of technology and consider our culture and ways of working. Capturing meaningful value from digital is more than just the application of digital tools.

Enabler	Why this is important
 Technical design	• Business capabilities are often underpinned by high-quality, easily-accessible data, and efficient core IT platforms • A critical focus is to invest in data (consistency, accuracy, and timely access) where it is a pre-requisite to success
 Operating model	• We are targeting efficient delivery of our ambitions by concentrating capability into delivery centres • These serve to bring the right capabilities together with a common purpose to deliver at pace
 Governance	• Our new governance model will see us move from disconnected digital solutions to strict prioritisation of digital applications that hold a clear value case • Combined with iterative delivery methodologies (e.g. Agile), we will see value released incrementally in-line with stakeholder priorities
 People capability and culture	• It is critical for us to build the right technical skills and bring them together with business expertise in dedicated delivery teams • This will become a core capability over time and we need to start advancing our capability now • Culture is typically the biggest challenge in successful digital transformation and we are supporting and promoting leaders in the organisation who are change drivers • This is explored further in our people and capability chapter

Figure 69: The enablers that will make our digital approach successful

11.3. Technical design underpinning our ambition

In this section, we show how we will bring together applications as components of a modular, platform-based architecture. This architecture allows us to invest in building blocks, such as a data platform that can be re-used and extended to meet the use cases of each ambition.

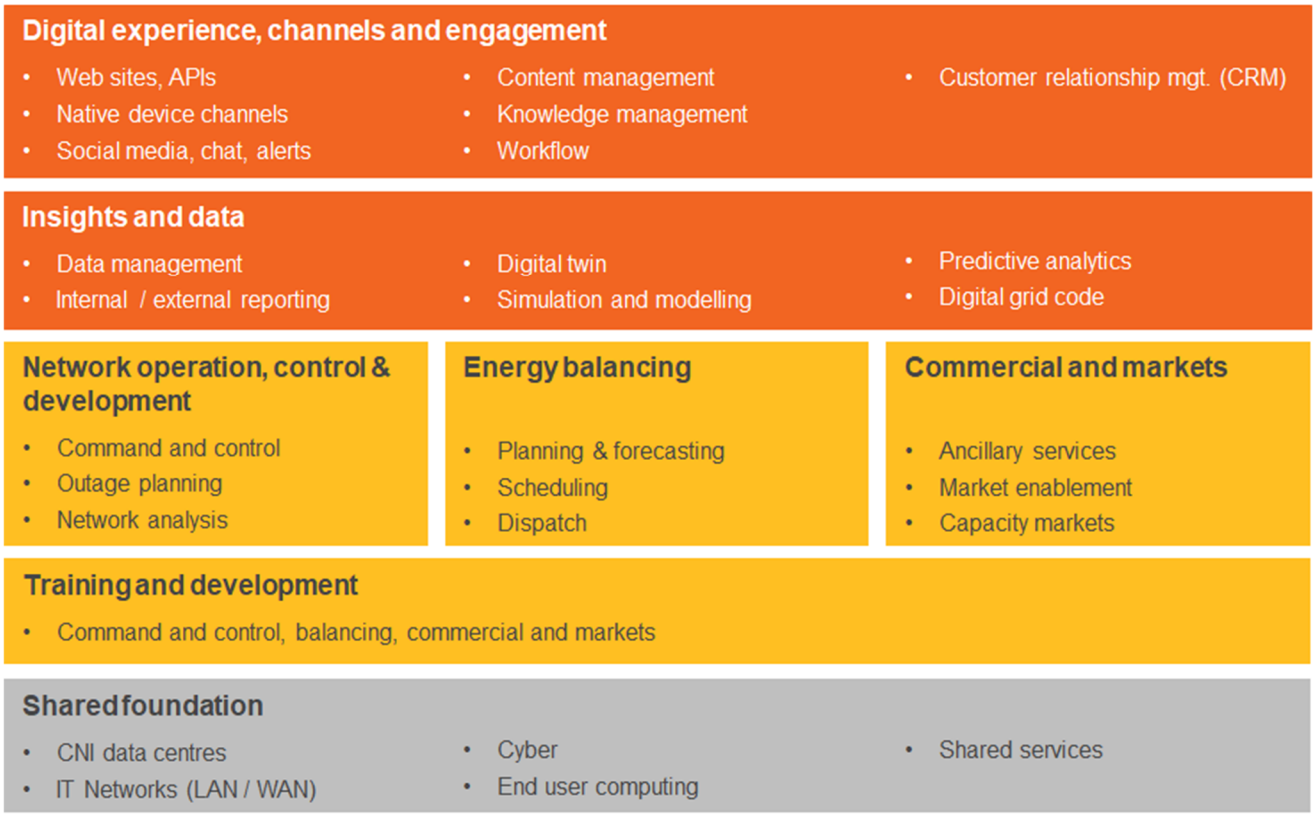


Figure 70: The target ESO landscape

11.3.1. ESO target landscape

We have developed our application landscape over time to ensure the safe, reliable operation of a traditional generation and demand model for electricity. This involved the adoption of proven information technology to enable the management and operation of the electricity grid.

As changing demands on the generation landscape accelerated, additional application solutions were implemented, IT solution packages extended, and greater analytic capability introduced. These changes allowed us to continue to operate the grid. However, the drivers for change across the wider energy and electricity landscape developed at different rates. Without an agreed, wider strategic vision, this led to the creation of capability and data in silos. These solutions are effective and addressed internal and external needs. However, this approach created elements of inefficiency and duplication of capability.

As the electricity environment changes, continuing to evolve our IT solutions in the same way would mean our costs and delivery timescales to stakeholders and customers would increase exponentially as the complexity and maintenance of siloed solutions grow.

The growth of innovative IT technology and new service and consumption models, combined with changing business markets, creates an opportunity to transform the IT landscape. This would see us switch from specific applications for each capability to a platform-based architecture that can support multiple capabilities, making maximum use of their efficiencies.

As an example, across the ESO IT landscape there are multiple applications for modelling different generation types and further applications for analysis and reporting. They use different sets of data across the business process, which can be consolidated onto common platforms using a consistent set of data.

11.3.2. Platform architecture

Our approach will be to consolidate these multiple applications and capabilities onto standard platforms. Enabling these platforms will lay the foundations that move us away from interdependent systems and enable consistent adoption of digital initiatives.

A platform approach will change the building blocks of our architecture, but also change the methods in which we implement change. This will make us more agile and flexible in adapting to market changes. We will introduce multiple platforms, including a digital engagement platform, data platform, integration platform, and engineering services platform.

Within our platforms, we will embed modelling, simulation and artificial intelligence technologies. The platforms will be designed to grow in line with customer priorities. We will use cloud computing and on-premise[141] services to achieve this.

Digital twin definition from Theme 1: A digital twin is an offline replica of our digital control room IT estate with live data feeds that we can use to simulate both markets and the operation of the GB transmission system. It can be used as a testing and/or pre-production environment to validate the benefits and impacts of changes to the market and physical network. It will use AI to run multiple, complex scenarios in a parallel timeline (i.e. we can run scenarios faster than real time to model outcomes).

In parallel to building and transitioning to the platforms of the future, we must continue to provide at least the same level of service as today. We will need to continue with lifecycle upgrades, feature enhancement for near-term requirements.

Our first step will be to develop platform designs and a plan for delivery. The designs will support bespoke in-house and standardised off-the-shelf solutions. To support growth, we will look to design, build and deploy consistent standard components that can be combined to create flexible solutions that deliver change by reconfiguration.

Future market demand, changes in the codes used to govern and operate the markets, and an expectation of greater flexibility in solutions all present an opportunity for a holistic approach to the delivery of market systems.

Our approach to delivery will be underpinned by platforms that enable modelling of problems and simulation of operation. We conducted market analysis of similar problem solving, for example visiting Formula 1 racing manufactures, to further develop this approach. This forms the digital twin proposed in Theme 1. The outputs will be used to build, deploy and operate future capabilities on our newly formed platforms,

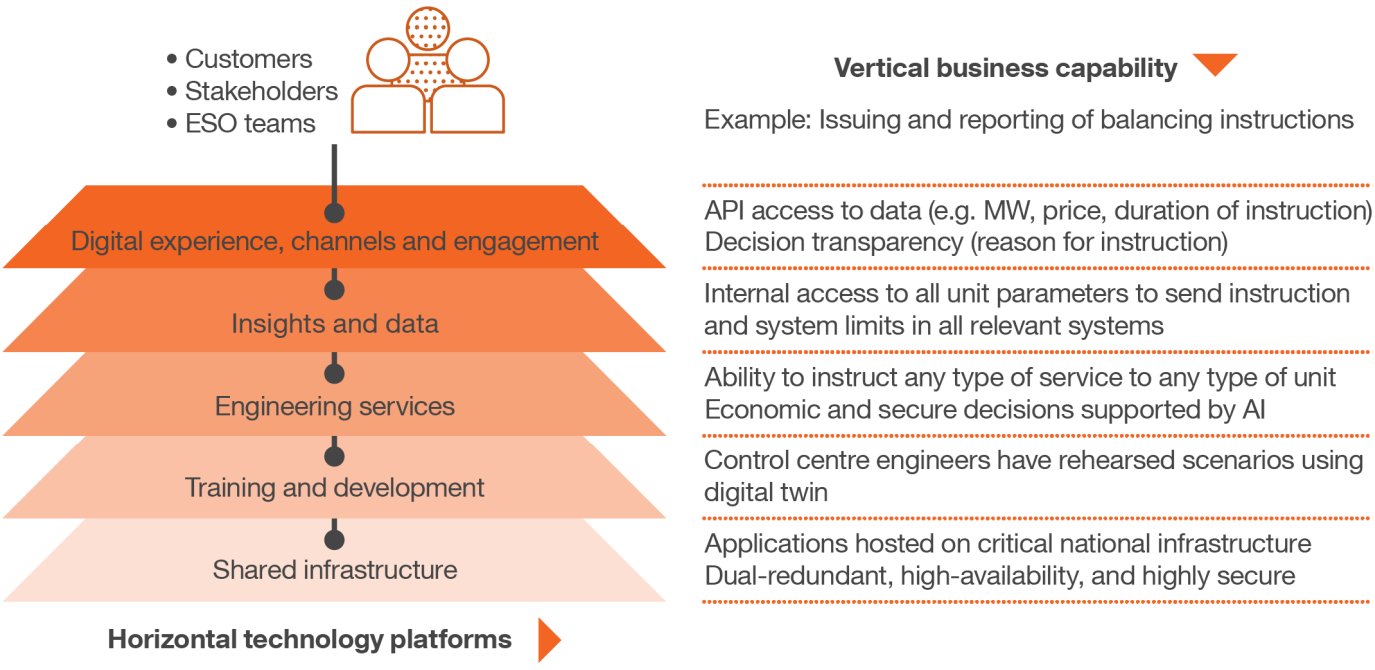


Figure 71: The platform architecture

[141] On-premise are in-house platforms, solutions and systems to support CNI.

A platform-aligned architecture, for the delivery of business capability, provides benefits and improvements over our current IT landscape. It creates operational cost reductions (licence, skills scope, infrastructure); development and delivery improvement (reuse, simplified integration, testing efficiencies); and strategic business alignment and enterprise capability reuse (cloud platforms, enterprise customer platforms, business support services). This approach will enable us to deliver customer priorities in a more efficient and timely way.

11.4. Shared investments supporting the ESO

Shared investments are made centrally within National Grid Group IT. These investments leverage Group IT to deliver the underpinning IT environment that provides ESO with efficient, scalable, reliable IT services. This enables the economies of scale for procurement and unlocks access to global support providers.

ESO's share of group investments is £107 million over five years and covers cyber, infrastructure and business services.

ESO IT infrastructure costs in RIIO-2 £m

£m	RIIO-1 average	2021/22	2022/23	2023/24	2024/25	2025/26
Capex	22.6	26.5	28.3	17.4	14.2	17.2
Opex	40.7	47	45.4	44.3	44.9	45.1

IT investments are allocated to the ESO and the other entities within the National Grid Group using a process that reflects usage and the specific drivers of cost for that entity.

The remainder of IT costs that are shared in nature are allocated based on the universal cost allocation model (UCAM) agreed with Ofgem and updated annually. Under this model, for example, end user-related costs are allocated based on headcount. Other allocation methods include taking a view of project activity by organisation where the costs relate solely to projects. For more details please see chapter [shared services]. Assumptions for RIIO-2 are based on our forecast position at the end of 2020/21 based on the above allocation methodology, with incremental maintenance costs and efficiency assumptions then overlaid for the RIIO-2 period.

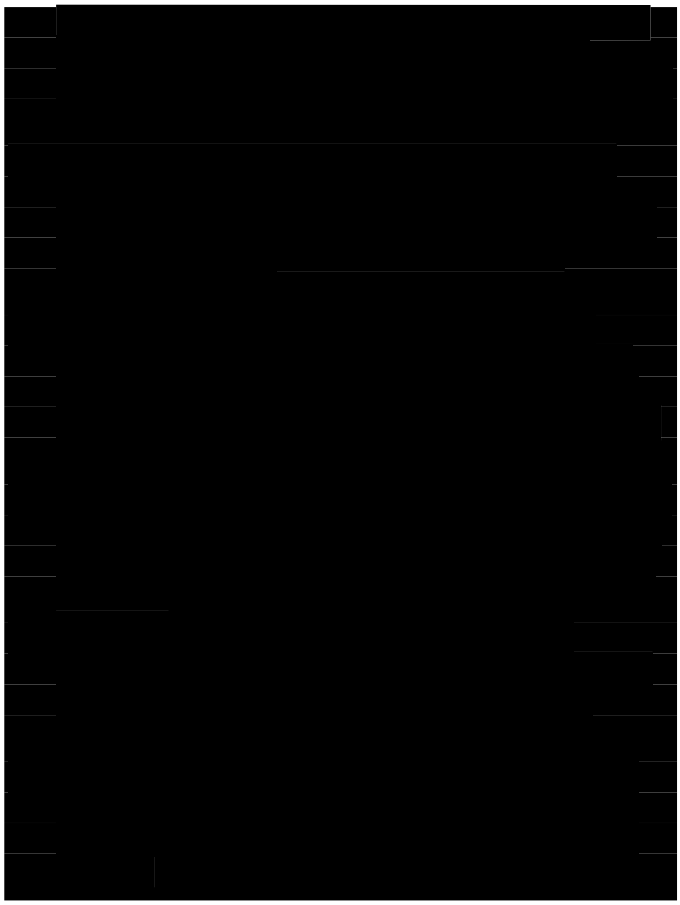
11.4.1. Cyber security

The cyber-security threats faced in our Critical National Infrastructure (CNI) and ESO environments are becoming increasingly sophisticated and prevalent. New business activities, such as the planned expansion of the GB energy market, reduction in entry level to the Balancing Mechanism and introduction of pan-European ancillary services, all significantly increase the cyber-security threat.

As we introduce new technologies, our exposure to cyber-attacks expands through the increased connection to external systems. Previously, our energy networks operated primarily as a closed system, where any concern fell on internal devices, systems and infrastructure. This is now transforming into a decentralised and interconnected mesh of systems, devices and partners, which all play an integral role in the operation of the energy network across the industry. Our solutions and capabilities to tackle threats need to grow and adapt to handle this complexity.

These threats are particularly significant in the control centre. As an example, any disruption to communications between the control centre and generators, or a loss of visibility of the status of the network, could lead to blackouts or the system being overwhelmed.

As these threats continue to evolve, it is vital that our control systems and critical infrastructure are kept safe, secure and resilient. This will require delivery of a robust cyber capability. This includes delivering enhancements to:



Investments to refresh legacy assets and infrastructure will be important in building a strong foundation for continued investments in new cyber-security capability. Such investments will be carried out with scalability and interoperability in mind. This will create a sustainable model for cyber security that aligns with business objectives and cyber-security goals during the agreed price control period.

Our continued alignment with best practice and standards, as defined in the National Institute of Standards and Technology Cyber Security Framework (NIST CSF), allows us to identify and manage risk through a comprehensive range of security controls and measures. Ongoing engagement with UK National Cyber Security Centre (NCSC), Centre for the Protection of National Infrastructure (CPNI) and the Department for Business, Energy and Industrial Strategy (BEIS) will be central to the protection of our systems.

These capabilities will also be aligned with new regulations, such as the EU Directive on the security of network and information systems (NIS Directive). We will continue to work with the NIS Competent Authority (comprising Ofgem and BEIS) to help shape our investment plans, identifying the most effective and efficient way to meet them.

11.4.2. IT infrastructure

IT infrastructure is the cornerstone that underpins the ESO business, delivering a safe, secure and reliable operating environment for our customers. IT infrastructure must be future-proofed against industry and technological change to support the rapid pace of change in the utility industry. The delivery, management and maintenance of all IT infrastructure services, which are needed and consumed by the business, are provided by the group IT function ensuring efficiency of delivery and value for money by leveraging the economies of scale.

These technologies are at the foundation of cyber security and are key to enabling our ongoing digital transformation, including improved quality and customer experience.

At the start of RIIO-1, we responded to the challenge from Ofgem to reassess our IT asset health policies by extending the technical life of our IT infrastructure, accepting higher levels of controlled risk whilst maintaining levels of availability.

However, by 2018/19 our employees fed back that IT was becoming a significant blocker to effectiveness, affecting the service value and quality levels given to our customers. Over the same period, the escalating threat of cyber-attack on our IT systems meant that we had to look again at how we managed our infrastructure so that we could proactively monitor and remediate cyber threats.

In light of this, we revised our IT asset health policies, which have been reviewed by Gartner – a recognised IT benchmarking organisation – who confirmed the policies in place are in line with industry practice.

We have invested to ensure our workforce have the tools to stay productive and to enable lower operating costs and maintaining effective cyber security and controls in our business support services.

Our IT investment portfolio for the RIIO-2 period continues the work we have begun in RIIO-1 to bring our IT infrastructure assets in line with asset health policies, so our people have the right tools and equipment to work effectively, respond to the growing cyber threat, enable us to share data securely and effectively, and to promote cross sector collaboration.

11.4.3. Business Services

Our business support functions provide services such as property management, HR and finance to all the National Grid businesses. They help with the delivery of our core activities, for example by procuring materials, helping us to find and retain our people, and managing our property estate. Our support functions also perform key business activities such as financial control, health and safety and legal compliance.

Each of these functions are dependent on modern, high-quality IT tools and services to ensure high-class delivery at the efficiency threshold.

Group IT makes investments on behalf of these business service functions to maintain the asset health and ensure availability of cost-effective IT solutions. This enables the business service functions to operate in an efficient and affordable model and provide value for money.

During RIIO-1, National Grid invested in its SAP platform. This SAP solution will need to be refreshed at the end of RIIO-2 to maintain the asset health of the platform.

Investment in compliance and controls over the RIIO-2 period ensures we remain compliant with all appropriate regulation and legislation.

11.5. How we will support the transformation

11.5.1. Our IT operating model

The IT organisation is undergoing a significant transformation to prepare itself for the demands of the future, in terms of its capability and the methods and approaches it will use to provide value for our customers and stakeholders.

Historically, the IT organisation has been reactive to business demand and held a greater bias towards the use of suppliers across key phases of delivery. While this approach was successful for our RIIO-1 ambitions, we are moving towards a greater level of change in RIIO-2. To lead this change there is a Head of IT for the ESO who has end-to-end accountability from IT strategy, through to delivery and maintenance. The delivery team will leverage the wider group IT organisation to deliver products and services. This provides a greater level of focus on the requirements of the ESO, while balancing risk, responsibilities and obligations to our customers and stakeholders.

The key features of this operating model are in the diagram below:

Figure 72: The key features of the operating model

11.5.2. Delivery approach

Our approach to delivery will involve creating a transformation programme that will link the ESO strategy and ambition with execution. This will provide alignment and transparency across the ESO business and delivery teams.

The programme will apply delivery methods such as Scaled Agile Framework (SAFe)[142], and Agile Scrum so business value can be achieved faster, and with higher degrees of predictability and quality. The programme will build a common platform-based architecture across all systems allowing for greater modularity and ease of integration. It will use multi-functional teams with a greater bias towards in-house skills, creating release teams that will enable continuous delivery and release solutions as required. This is particularly relevant for our market and regulatory reporting systems where regular releases will support the pace of change stakeholders are seeking.

The programme will follow a three-stage approach, consisting of an enabling, transforming and sustaining phase:

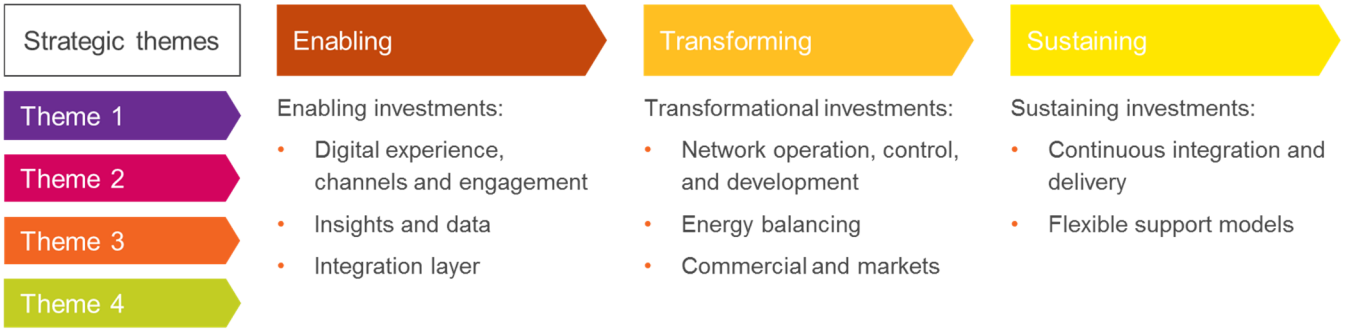


Figure 73: The transformation programme delivery approach

Enabling phase: we will lay the foundations for the programme by creating our digital market engagement, data and integration platforms. We will use these to progressively develop our core engineering services platforms.

Transforming phase: we will develop the engineering services platforms that will enable significant growth and transformation across our core energy balancing, network operations and control, and commercial platforms. We will continue to maintain resilience and compliance across our existing systems and services while transitioning to our new platform-based architecture.

We will take a prototyping-based approach to the development of these platforms, where early releases can be ready for external testing to gain early feedback on new functionality. This will allow us to be more responsive in the development lifecycle.

[142] https://www.scaledagile.com/enterprise-solutions/what-is-safe/

The introduction of an ESO design authority (see figure 74 below) will allow us to consult and engage on the experience of interacting with the ESO. It will also encourage input into key design, development and testing phases of our solutions development. Feedback from our stakeholders at our IS Change Forum, trade-associated round tables and RIIO-2 workshops tells us that this is a positive step forward. Market participants have told us they want to understand and have transparency of the decision-making logic behind our systems. And they spoke positively about their experiences with the development of the Platform for Ancillary Services (PAS) system.

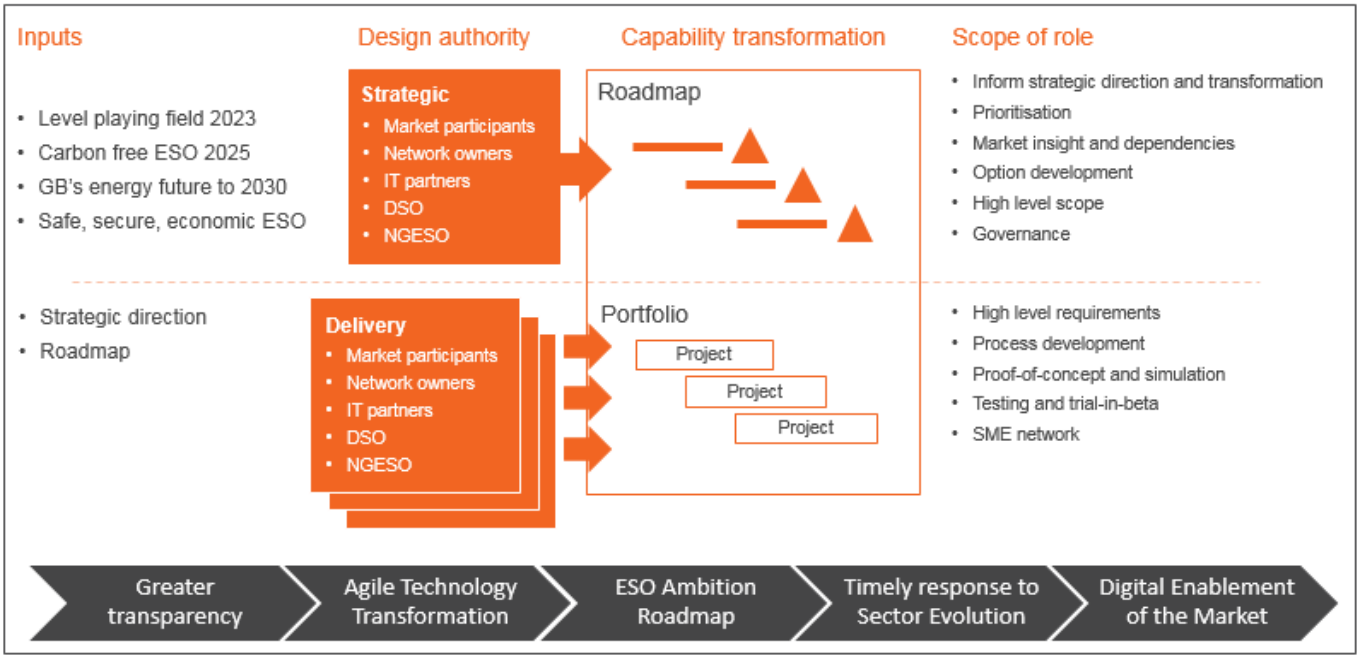


Figure 74: The relationship between engagement, development, operations and feedback

Sustaining phase: we will transition our platforms and systems into operation, using methods such as continuous integration and continuous delivery. This is particularly important for applications that will undergo significant change during their operational service life, such as our energy balancing and commercial and markets platforms.

Offshoring

We offshore supporting capabilities across our projects delivery and ongoing support activities. This encompasses capabilities such as development, testing, third line support.

Application development and maintenance partners

We have recently run a competitive tendering process and engaged four technology partners in a framework agreement. This has been enabled us to achieve a market-tested commercial agreement across multiple suppliers to support our application development and maintenance activities. This framework has overlap in capabilities to generate competition within the framework.

Our framework contracts provide the option to conduct service provision on a time and material basis, fixed price, or combination of the two. We also expect to leverage suppliers using a risk / reward model to ensure the risks across our deliveries are appropriately shared.

Outsourcing

We do not expect to outsource in full any direct technology investments. We plan to augment our teams with our framework suppliers. There are services at a group level (shared services) that we may outsource.

Examples include end-user devices such as laptop and print provision.

Technology transition from RIIO-1 to RIIO-2

We are expecting to leverage our existing RIIO-1 investment (where applicable) to support the development of our future architecture. In addition, we plan to build detailed strategies across the platforms we will be developing in RIIO-2 within 2020/21, to ensure we have a robust understanding of the components we need for delivery in 2021/22.

Furthermore, we are building the IT delivery capability to support our future platform-based architecture. Work in this area has started – our solution development team are transitioning to a new structure and recruiting staff to develop this model. The changes required in other supporting functions is underway and will be developed over the course of 2019/20 and 2020/21.

Metrics

With technology being inseparable from our ambition, we have heard from stakeholders that they believe it is important for the ESO to measure the delivery of our activities and a metric tracking technology implementation would provide confidence. We need to understand the most effective measurement that incorporates agile delivery and increased stakeholder engagement. Further detail on this metric will be included in our December Business Plan.

11.5.3. Architecture approach

Currently, stakeholders access our applications on a point-by-point[143] basis, and we rely on users self-navigating through the content. As we transition towards the future environment, the user journey will be enhanced. They will be guided through a more intuitive process, with higher levels of consistency in the user experience.

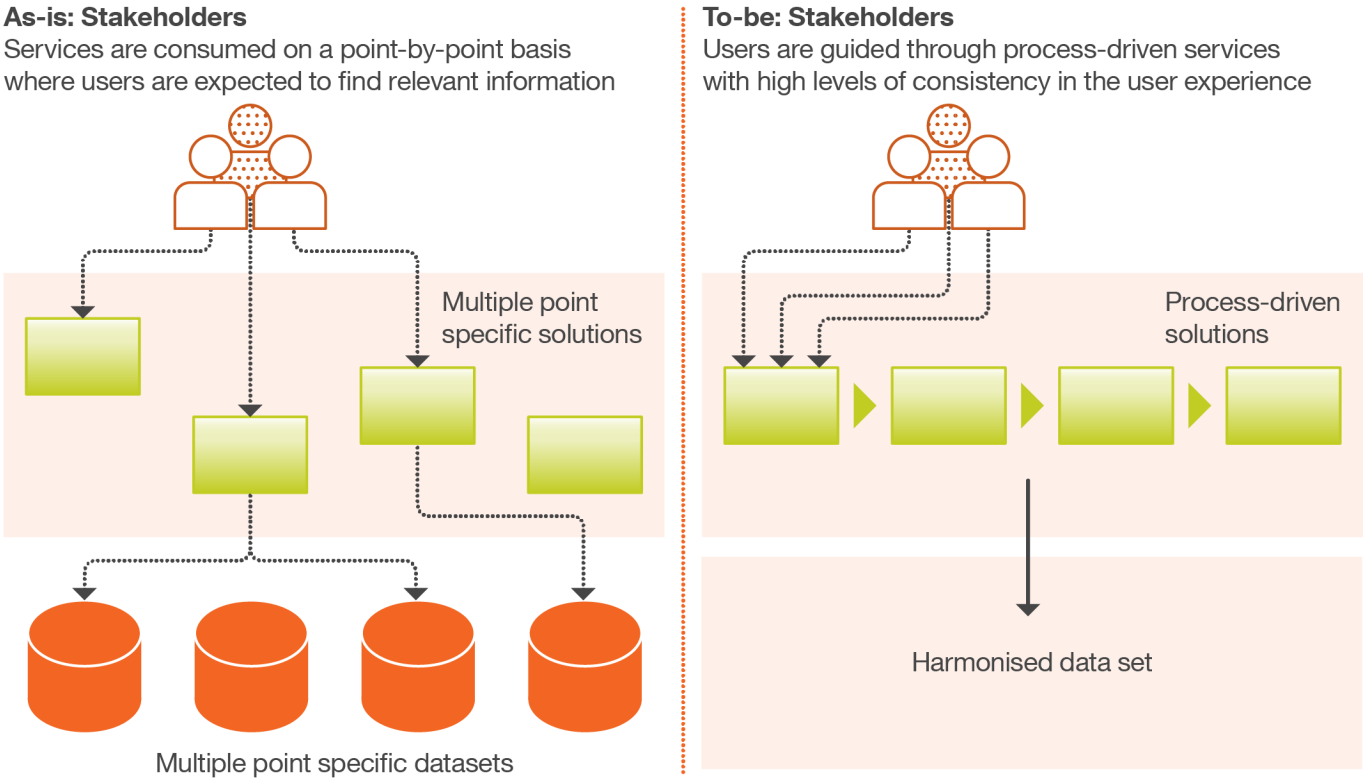


Figure 75: The as-is and to-be architectural approaches

[143] This refers to the fragmented sections where our information can be found. For example, stakeholders will need to go to one space for ancillary services and then another for connections. We want to join up the experience so there is a more seamless flow through the services we offer.

The underlying architecture will be migrated in two stages. The first will establish the base level platforms with a leading use case. The second stage will be to build on that platform, migrating other use cases before eventually retiring the old, legacy applications. This will run in parallel with existing applications. This modular approach will allow us to release functionality quickly, and gain feedback and learnings.

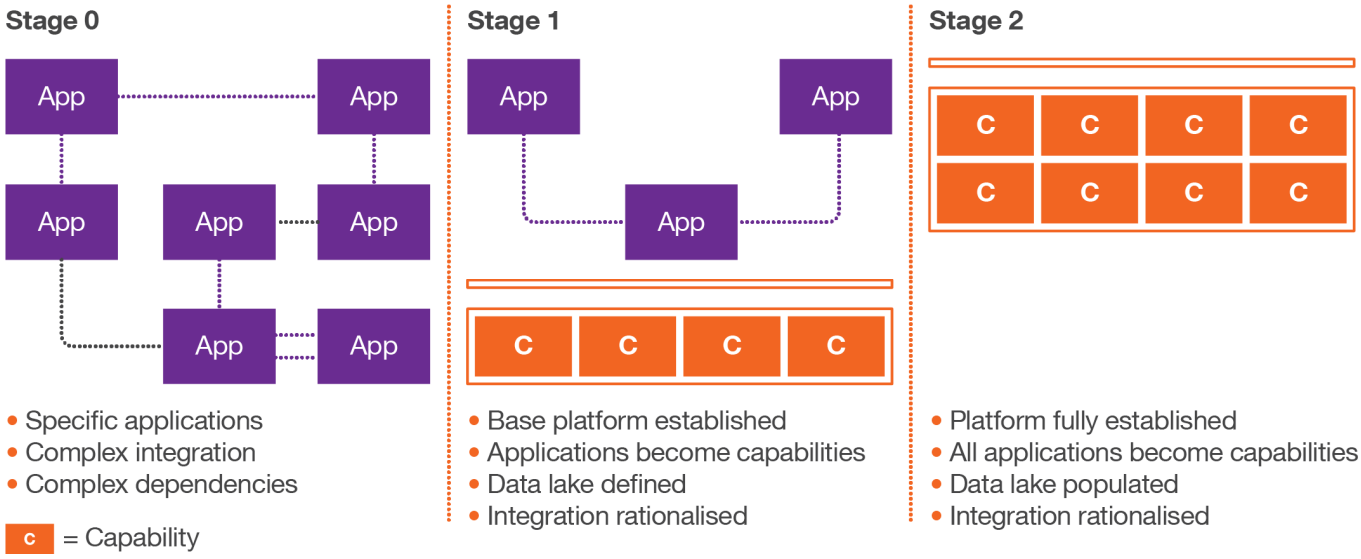


Figure 76: The approach to architectural transition

11.6. RIIO-2 Investment benchmarking

Investments, and the associated benefits, are summarised by activity in each of the Theme chapters. To ensure that the IT component of those investments are realistic, efficient, and comparable to our peers, we have carried out independent benchmarking of each investment.

11.6.1. Basis for investment calculation

The cross-functional nature of technology means that, in many instances, we will be able to meet multiple ambitions through the establishment and re-use of technology platforms. This approach requires investment in a flexible base technology, with incremental funding for each associated use-case.

We have mapped our ambitions and generated logical investments, each with a high-level scope. This has been used to define the requisite IT capabilities and identify any gap between our existing offering and the target architecture. You can find out more about this work in Annex 4 -Technology investment report.

With this understanding, we have engaged Gartner - a technology benchmarking organisation - as well as our application development and maintenance partners (Capgemini, IBM, TCS, Wipro) for high-level estimations. This, combined with our own intellectual property from comparable projects and cross-functional technology teams, has led us to the proposed investment profile.

11.6.2. Industry benchmarking of investments

Independent technology benchmarking

Throughout the RIIO 2 submission work, we have continuously engaged Gartner to assess our approach and estimations as they evolved. Gartner benchmarked the costs of supporting and maintaining our IT systems. It compared our costs for each of the key activities that IT performs (e.g. application support, networks, storage, end user computing) with the costs in their database of other companies, on a workload basis (i.e. number of applications, number of services, number of users).

Across the investment portfolio, several approaches are taken to benchmarking each of the individual investment proposals. Gartner takes comparative data and conducts a verification of what is planned in the future, based on what we know today.

For example, where we have planned an asset refresh, Gartner has a clear and tangible starting point. It knows the technology to be refreshed, the scale and scope is usually clear, and it has accurate data on the component costs of an upgrade (hardware, software, people costs) based on today's prices. Similarly, for a new application, Gartner can estimate the size of this based on a large database of project implementations. It can benchmark against known comparable projects, normalised for the actual estimated size of our requirement. In both instances, known costs to deliver are used and normalised for scope. Using a combination of historical trend data and research analysts predicting future trends, Gartner can model a future cost and provide the benchmark. While this is an estimate, the materiality[144] of this part is typically very small.

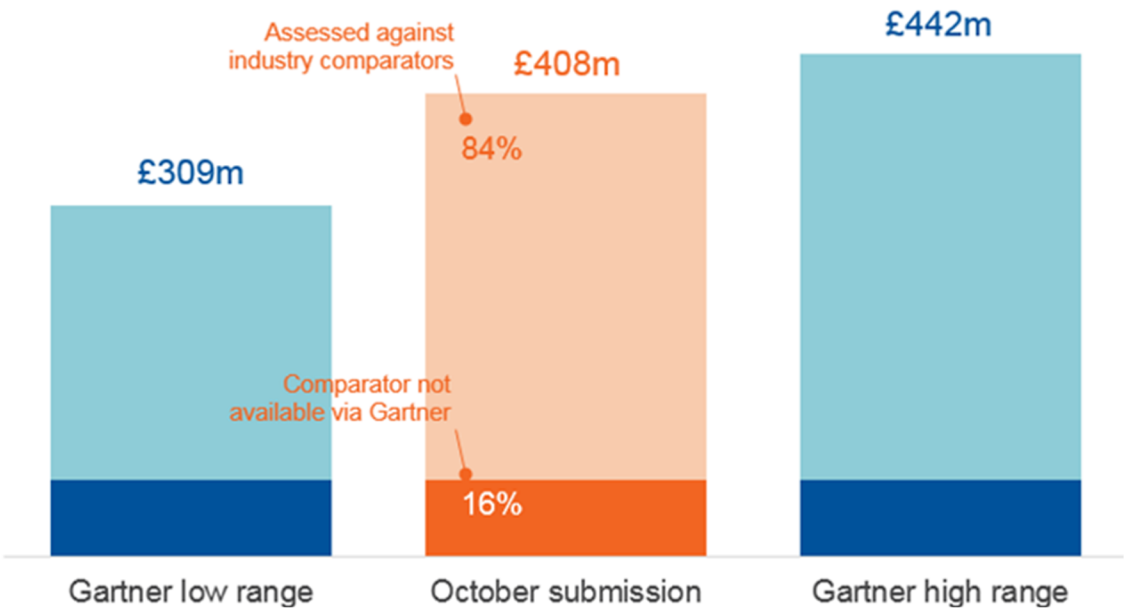


Figure 77: Total IT direct investments (£m) over the RIIO-2 period and the alignment between our investments and Gartner benchmarking

Gartner can provide benchmarking for systems that are common across multiple organisations (Finance, HR and others). Within ESO, there are systems or activities that are niche to our industry and, in some cases, to our organisation and market, such as our asset health and Regional Development Program activities. These cannot easily be benchmarked by Gartner. In this instance, Gartner passes through our estimates, as they are the most accurate values available – and this accounts for 16 per cent of the investment value.

Where technologies and systems are common, industry benchmarking was performed against 84 per cent of the investment value. They found that the mix of investment areas, the individual project costs and our costs on project teams were all in line with their expectations, formed from their knowledge of IT investments made by other utility companies.

[144] This is the difference between their estimates and what happens in reality.

We also engaged Hackett - a recognised business benchmarking organisation, who, on a cost per end user basis, found our IT infrastructure costs to be higher than those of similar sized organisations. These higher cost values are justified given our dependence on IT systems to operate and monitor the electricity transmission network, which is independent of the number of IT users in our organisation.

Gartner's more detailed analysis found that, after adjusting for levels of workload (number of servers, volume of storage, scale of LAN provision), our IT costs are in line with peers while delivering higher levels of system availability. In some areas, such as our WAN network and servers, our costs were best in class efficiency defined by Gartner as within the 50th and 25th centiles of cost.

In other areas, Gartner found we spend more than our peers on maintaining our networks (LAN) and in supporting end user applications. The proposed IT infrastructure investment plan for RIIO-2 will support us in achieving best in class efficiency across our IT costs, as well as improving cyber security and will bring our IT costs to upper quartile efficiency by the end of the RIIO-2 period.

You can find more information in Annex 4 – Technology investment report.

Application development and maintenance partners

National Grid Group IT has a multi-partner framework with Capgemini, IBM, TCS and Wipro that provides IT services, such as application development and maintenance services. These partners have invaluable delivery experience and are familiar with the ESO's operating environment. They have provided insight into our architectural approach, drawing on experience with other clients and technology providers.

Our partners have reviewed the requirements across each of the Themes and have provided their outline estimates for design, development and implementation. These estimates were further benchmarked across industry and used to inform our investment plan.

11.7. Engagement

Engagement and collaboration are critical to our success. In line with our overall stakeholder engagement approach, we will continue to consult broadly on our IT strategy during the RIIO-2 period. This includes:

- **Strategy and approach**: we will continue to engage with governing bodies, RIIO stakeholder groups, IS Change Forum, bilateral meetings and consultancies to make sure our strategic direction and approach are sound.
- **Transformation delivery**: based on positive industry feedback, we will introduce an ESO design authority. This will see industry stakeholders providing their input across the analysis and design phases of our change initiatives. It will also allow us to gain regular, market-tested feedback from customers and stakeholders as we progress through our development lifecycle. This will ensure we can be responsive to change.
- **Technology disruptors and innovators**: engaging with technology-centric organisations, which have disrupted their marketplaces, will give us insight into opportunities and new ways of working within the energy sector.
- **Non-utility industry leaders**: drawing on examples from large data processors (e.g. banking), simulation and modelling experts (e.g. Formula 1), and engagement specialists (e.g. media) will provide us with best-practice methods to inform our approach.
- **Parallel regulated industries**: engaging with international utilities, air traffic control and transport organisations will provide context-specific examples to inform our approach.
- **Technology partners and benchmark organisations**: we regularly engage with our framework technology partners and benchmark organisations for technology selection, solution design, cost comparators, and delivery approaches.

Stakeholder feedback

ERSG supports our technology proposals.

Through our engagement programme, particularly for Themes 1 and 2, we have received feedback from stakeholders on our approach to developing and implementing IT capability. Generally, stakeholders (particularly service providers) have said that this is something we need to improve. They have told us that we need to learn from our previous projects to ensure transparency around our processes and to deliver in a more agile way. Service providers also asked that we develop clear roadmaps and ensure we communicate the new systems that they will need to interface with in the future.

"None of us have had a good experience so far – what are you going to do differently?"
ESO service provider, trade association meeting

Stakeholders acknowledged that IT development can take a long time and that there can be implementation issues. By the time changes are delivered, things have

sometimes moved on, which means a modular approach to IT delivery is more pragmatic. This was echoed by feedback at our IS Change Forum, where service providers liked the more agile approach that we propose. Similarly, at our stakeholder engagement event on 11 April 2019, stakeholders asked us to avoid 'big bang' IT projects as they often fail, both within the energy sector and elsewhere.

"… the agile development approach worked well … and we got a better system as a result."

Generator/ supplier, trade association meeting

We received wide stakeholder support when we tested our proposal in Theme 1 for using a cross-sector design authority to implement new control capabilities. At our IS Change Forum, all those we spoke to support this proposal for capability development and implementation. We received expressions of interest to be part of the cross-industry design authority from two market participants. We also identified two opportunities for further IT-focused engagement – one on adoption of artificial intelligence, the other was the idea of an IT 'hackathon', which included energy and non-energy industries.

12. Innovation at all levels of our business

Innovation plays a crucial role in helping us address the challenges from a rapidly changing energy system. Stakeholders from across the industry have highlighted that innovation will make a significant contribution in helping the UK to meet its target of net zero emissions by 2050. Following on from RIIO-1, innovation continues to be at the core of our operating model. It is a key enabler for delivering our Business Plan, driving efficiency, and helping us to lead the transition to a low carbon energy system. Innovation allows us to experiment and find viable, diverse solutions to uncertain future challenges; faster and more cost-effectively than would otherwise be possible.

The innovation function within the ESO works to foster and embed a culture of innovation in the business, while ensuring we stay focused on solving issues affecting the industry as well as our priority challenges. In this chapter, we present our innovation approach and methodology, along with areas where we will embed our learnings from RIIO-1 and further innovate in RIIO-2.

The innovation projects we launched in RIIO-1 will deliver savings for consumers. For example:

- our Samuel Inertia Element project[145] (SIM) aimed to reduce balancing costs associated with inaccuracies in estimating inertia. The ESO has successfully completed a public procurement process to provide inertia-monitoring services. It is estimated that this will provide up to a 15 per cent improvement in the accuracy of rate of change of frequency measurement. Which will deliver a saving of between £6 million and £10 million for consumers every year.
- the Optimisation of Energy Forecasting project explored whether the way we predict solar photovoltaics could be improved, using machine learning techniques and much larger, historical data-sets. One approach to machine learning, called random forest, was very effective at reducing forecast error by as much as 10 per cent. These findings will help improve the way we plan for balancing actions, caused by the intermittent nature of solar generation and reduce the cost of these for consumers.
- our Vector Shift initial performance assessment[146] set out to explore vector-shift settings used for protecting distribution-connected customers from loss of mains. The project concluded that the vector-shift method was less effective than measuring the rate of change of frequency (RoCoF), and resulted in a Distribution Code Modification (DC0079) to prohibit the use of vector shift as a loss-of-mains protection technique. The DC0079 workgroup is investigating whether the new requirement can be retrospectively applied to existing generators connected to the distribution networks. Estimated savings from these changes are around £240 million NPV by 2024, which will result in lower bills for consumers.

For more information on these and other ESO innovation projects, please see https://www.nationalgrideso.com/innovation/projects/network-innovation-allowance-nia.

12.1. Innovation in the ESO

Innovation, as one of the central pillars of RIIO, is about establishing a safe, collaborative space in which to explore higher-risk technologies and ways of working; developing novel solutions to specific, medium to long-term problems, identifying new methods to unlock additional consumer value and better prepare for the future.

Innovation is a dual-fuel function. In this chapter, we focus on our ESO-specific activities and funding.

Innovation timescales

In the following pages, we concentrate on longer-term innovation that yields improvements over a mid-to-long timeframe, often with benefits realised only much further in the future, on average more than four years ahead. This covers solutions that may not have been tested in a commercial environment – which require further development, or fundamental adjustments, to ensure safe implementation at the end of the testing cycle. On some occasions, they must be allowed to fail. Because of the high-risk nature of innovation, a dedicated funding mechanism is needed to support this activity.

In chapters 4 to 7 of this Business Plan, we highlight where shorter-term innovation activities are contributing to our proposals, this is also summarised at the end of this chapter.

We use two criteria to determine where innovation-stimulus funding can be most effective:

- **time: does the idea deliver value in the future (ideally within four to eight years)?** We believe that innovation-stimulus funding is best targeted at delivering higher risk solutions that need more time to properly develop and be tested. If a solution is more mature, and is closer to our ongoing activities, it should be funded through ongoing budgets. Solutions can, and have been, implemented quickly where results from innovation projects have proven immediately viable to be rolled-out into the business. However, we must aim for the four-to-eight-year timeframe so we can focus on the future

[145] https://www.smarternetworks.org/project/nia_nget0192
[146] http://www.smarternetworks.org/project/NIA_NGET0052

system challenges anticipated by our *Innovation Strategy*[147].

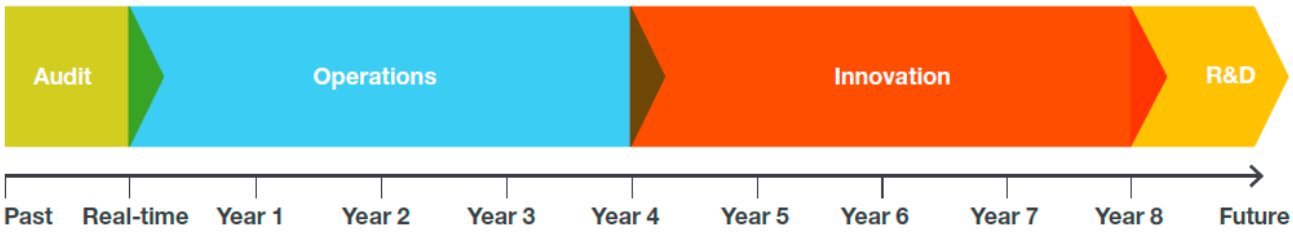


Figure 78

- **maturity: how well developed is the solution to the problem?**

  We tend to tackle projects in the later stages of research and development (R&D), rather than very early stage ideas. They are usually solutions with a low-to-medium Technology Readiness Level (TRL)[148], and we aim to progress these towards implementation-ready solutions (high TRL). We prioritise stimulus spending on more disruptive solutions that, if successful, could deliver step-change improvements and larger, system-wide benefits. Projects that only deliver small, incremental improvements in our day-to-day operations should be financed through our core funding. This focus on low-to-medium TRL activities further justifies why many of the benefits from innovation will only be realised much further into the future, as these higher-risk, unproven ideas take longer to develop to an implementation-ready (but potentially more disruptive) solution, and are where innovation stimulus is truly needed most.

Our innovation portfolio will continue to have a balance of research, development and demonstration projects, which we will undertake in collaboration with partners such as academics, consultants, manufacturers and network licensees. We will continue to innovate through a mix of activities in the Business Plan – and via ring-fenced innovation-stimulus funding.

Through the RIIO-2 period, the ESO will deliver an even wider range of innovation projects, covering late-stage research and development activities, up to real-world trials and implementation-ready solutions. The type of innovation project will determine the funding accessed, whether that is innovation stimulus, or funding through the Business Plan. Examples of potential innovations, identified against each of the Theme chapters, are detailed in section 12.4.

We believe that a ring-fenced stimulus for more disruptive, higher-risk, or longer-term innovation will ensure a healthy pipeline of future projects. It will enable us to respond to new energy-system challenges as they appear, and to better understand or test solutions, using new technologies, knowledge and business models.

12.1.1. Innovation methodology

We continue to refresh our innovation process, working with stakeholders to incorporate their feedback. Several stakeholders including network companies, service providers and technology providers amongst others commented on the high number of innovation projects underway. As a result we have focused the available funding and resources on larger, higher-impact projects, which are aligned with our *Innovation Strategy* for the System Operator (SO)[149]. The strategy prioritises expected consumer benefits, and provides clear roadmaps towards implementation of solutions into our ongoing activities.

Our portfolio will continue to be driven by the following three, tried-and-true, fundamental pillars of SO innovation, built upon best practice and innovation principles adopted by industry leaders across-sectors and methodologies well regarded by innovation experts:

- **a robust and systematic innovation process.** This is designed to quickly and efficiently assess each project proposal. It ensures that consumer benefits are at the heart of our approval criteria and costs are efficiently managed. It also ensures that we are aware of – and have a plan to mitigate – potential risks associated with each project.
- **a collaborative Open Innovation approach**. This has been especially effective in exposing the SO to the industry's latest solutions and technologies. We will continue to hold Open Innovation days, as well as other open calls for ideas and solutions. By doing so, we will make sure we take full advantage of today's vibrant start-up scene, while giving

[147] https://www.nationalgrideso.com/innovation/strategy
[148] Technology Readiness Level (TRL), as defined in Ofgem's NIA Governance Document v.3 https://www.ofgem.gov.uk/system/files/docs/2017/07/final_elec_nia_gov_doc_v3_0.pdf

[149] As the SO innovation team, we are responsible for producing an *Innovation Strategy* for both the ESO and the Gas System Operator (GSO).

everyone an opportunity to tackle some of Great Britain's priority energy challenges.

- **an annual refreshed *Innovation Strategy***. By producing a strategy and updating it each year, we ensure our innovation efforts remain relevant to the ESO's activities and the wider system's challenges. All our innovation projects must have a clear link to at least one of the priority challenges outlined in our strategy. Our top-down and bottom-up process to produce these innovation priorities enables us to align with major energy-system trends, our ambition as the ESO, and specific challenges identified from within the business areas (see below). Engagement with stakeholders allows us to test our innovation strategy and, by following this process each year, we gain feedback to further refine our priorities and identify new opportunities to collaborate with our stakeholders.

By adopting an 'open innovation' approach that involves System Operator colleagues and third parties, we use different tools, channels and events to scope out potential solutions. We use a number of channels to ensure we work closely with stakeholders and these include:

- Customer visits to understand their issues and explore ways to address them
- Themed "hackathons" and other dynamic events that explore creative approaches to difficult problems
- Online engagement through social media
- Calls for third-party proposals (e.g. NIC project ideas)
- Contribution to collaborative working groups (e.g. Energy Networks Association, Eurelectric, ENTSOE and ENTSOG)
- Engaging leading individuals and organisations in the sector, collaborating and sharing knowledge with network companies in GB and around the world.

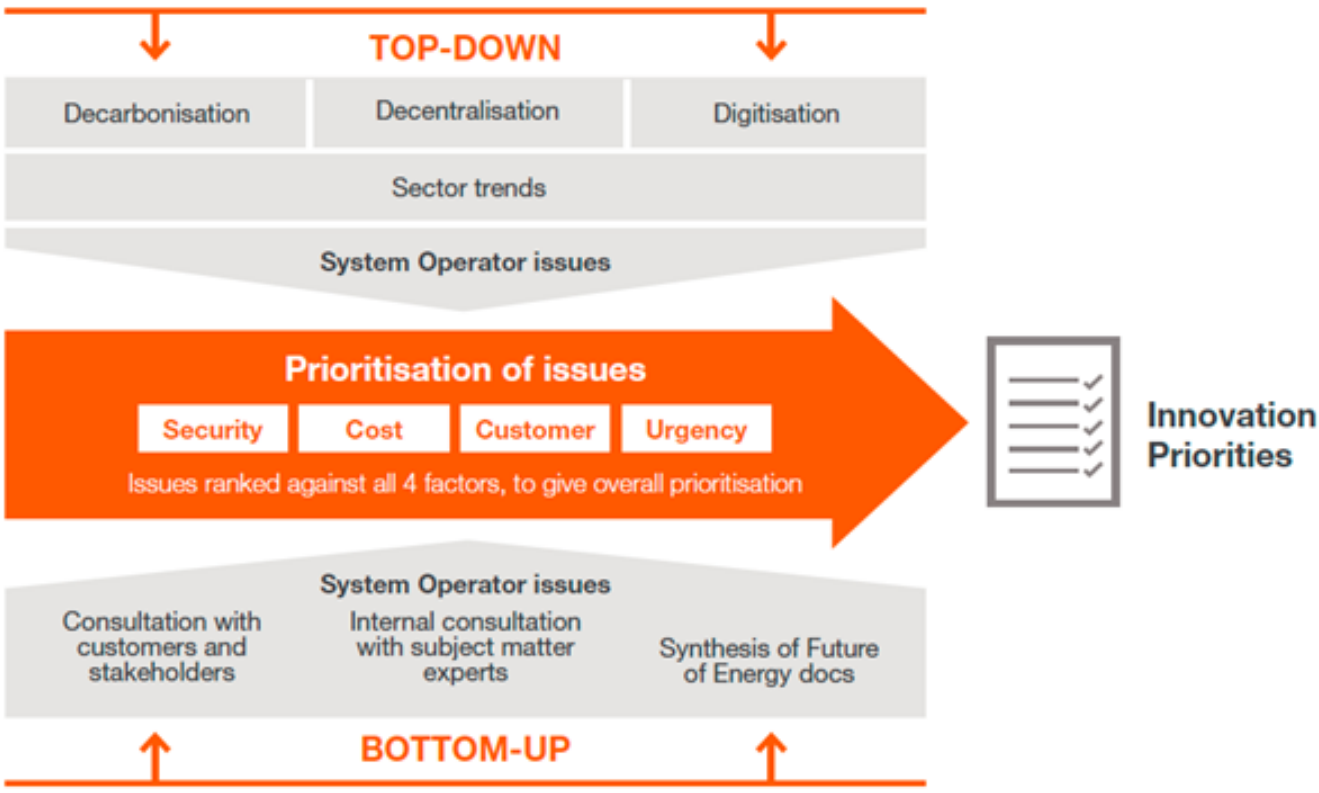


Figure 79 ESO Innovation Strategy priorities process[150]

[150] https://www.nationalgrideso.com/innovation/strategy

	Priority	Fuel
01	System stability	Electricity
02	Whole Electricity System	Electricity
03	Future markets	Electricity & Gas
04	Digital transformation	Electricity & Gas
05	Whole Energy System	Electricity & Gas
06	Whole Gas System	Gas
07	Long-term behavioural change in supply and demand	Electricity & Gas
08	Constraint management	Electricity & Gas
09	New types of gas	Gas
10	System restoration	Electricity

Figure 80. 2019-20 SO Innovation Strategy Priorities[151]

12.1.2. Investing in innovation in RIIO-2

The ESO's funding in RIIO-2 will be set ex ante, with efficient costs being passed through to consumers. We think that there is still a strong case for dedicated innovation funding within this model. This will ensure that our focus, longer-term vision and investment in higher-risk innovation is maintained. It will give our innovation partners (both internally and externally) confidence that they are allowed to fail (necessary element of a successful innovation mechanism) and that funding will not be disallowed as a result.

Investments in Innovation over RIIO-1

Over £11 million of Network Innovation Allowance (NIA) funding has been allocated to ESO innovation projects since 2013, the maximum allowance (approximately £3.4 million) was used in 2018/19 and the same is expected for 2019/20 (approximately £3.2 million). These figures are the result of over 40 different projects in six years, working with partners across industry and academia. More than 80 per cent of this funding has been spent outside the SO to research, develop and demonstrate novel solutions to benefit consumers and the wider energy system. These projects have improved our knowledge of the future challenges facing our electricity system, identified new challenges, helped us modify our internal processes, how we design markets, and provided new learnings to enhance the forecasts and insights we deliver for stakeholders.

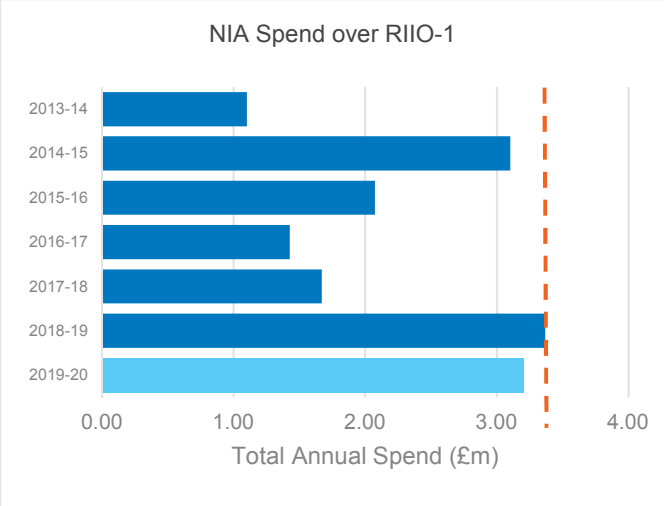


Figure 81

We have learned from the experience of operating the NIA in RIIO-1 and would like to highlight two key changes that would improve its effectiveness in RIIO-2:

- the current level of funding for the legally separate ESO (capped at around £3.4 million in the past three years of RIIO-1, due to legacy funding arrangements) is not sufficient given the scale and scope of the challenges facing the energy system and the ambitious outputs our stakeholders want us to deliver. We reached the full capacity of our allowances in 2018/19 and are forecast to do so again in 2019/20. The limit of our funds meant we were unable to support the evaluation phase of the BEIS Flexibility Exchange demonstration (FleX)[152] competition this year, despite demands for us to do so.
- the NIA is set up as an annual budget, with any funds not spent being returned to consumers. This has resulted in undue focus on ensuring that

[151] https://www.nationalgrideso.com/innovation/strategy

[152] https://www.gov.uk/government/publications/flexibility-exchange-demonstration-projects-flex-competition We will participate in the later stages of the process when a much smaller number of bids are being evaluated.

innovation projects fall within a specific timeline, rather than on delivering value most efficiently, which could require a multi-year approach (possibly with the majority of innovation spending occurring in a short window of time within the RIIO-2 period).

As our role transforms within an energy system that is itself transforming, the ESO has a greater role to play in facilitating innovation for the industry. This includes more partnerships to take into account changes to distribution system operation. In 2018 our Open Innovation day received more than 140 ideas and proposals, from universities as well as start-ups, small and medium-sized enterprises and larger industrial organisations. As a comparison, the ENA's 2018 call for ideas for a joint NIC proposal received 58 submissions in total. As the ESO is unique within the energy industry, we tend to get a higher level of interest from potential innovation partners than individual TOs or DNOs; if a DNO or a TO were to decline to fund a project, applicants could re-pitch their ideas to another DNO or TO. £14 million of NIA funding is split between three TOs each year, a further £28 million is split among nine different DNOs, but there is only one ESO to innovate for the industry.

The Flexibility Exchange (FleX) demonstration competition was established this year by BEIS, which we were asked to support. This provided us with an opportunity to show how we could work with the energy industry and their innovation efforts. The original BEIS guidance to participants was to engage with the ESO, which resulted in numerous flexibility platform providers contacting us and wanting to partner with us. However, we did not have the funds to engage with all of them. As a result, BEIS had to change the terms of the competition such that the ESO would only be involved in the final stages. With more funding we could have played a greater part and worked with all the participants.

We have looked at a range of other businesses to understand what an appropriate level of innovation funding could be for the ESO. The number of start-ups with innovative ideas we can work with, or potential solutions that we can test, is constantly increasing. According to the Beauhurst database of fast-growing companies, in the past five years UK start-up investment has increased from around £4 billion a year to over £9 billion. The scope and scale of our innovation funding needs to increase to take full advantage of this increasing opportunity to work with new talent, in a rapidly developing start up and technology landscape. In addition, a review of transmission system operator (TSO) standards shows a greater push into R&D and innovation. [redacted]. Similarly, other energy and electricity businesses in the UK invest in R&D and innovation on a yearly basis with budgets set at anything from one per cent of sales (for larger, asset-intensive oil and gas businesses) to up to nine per cent of revenue spend for lighter service and technology firms[154].

We therefore propose a £10 million annual innovation allowance for the ESO, available as an allowance for the length of RIIO-2. The ESO would contribute up to 10 per cent of costs from its core budget.

The increased funding level would allow ESO to support innovation across the industry, delivering the best outcome and benefits for our consumers. This would increase the number of solutions that can be implemented into ongoing activities.

Allowing funds to be used flexibly throughout the price control would create more certainty in investment, and better planning to allocate spending more efficiently across time periods.

We propose to invest in activities against each of the priorities identified in our Innovation Strategy, with highest spending allocated to the higher priority challenges, which would be refreshed according to how successful our efforts would be. Using a weighted approach to allocating funding against each electricity priority, an example allocation could see approximately £11 million invested in innovation for System Stability (currently the top priority challenge) over a five-year price control period, tapering down to £1.4 million invested in the lowest priority challenge over the same period (System Restoration). This is before internal, portfolio management and other costs (e.g. dissemination events) are deducted.

[redacted]

[154] Source: PwC 100 UK businesses ranked by R&D – not public document, available to subscribers.

	Priority
01	System stability
02	Whole Electricity System
03	Future markets
04	Digital transformation
05	Whole Energy System
06	Whole Gas System
07	Long-term behavioural change in supply and demand
08	Constraint management
09	New types of gas
10	System restoration

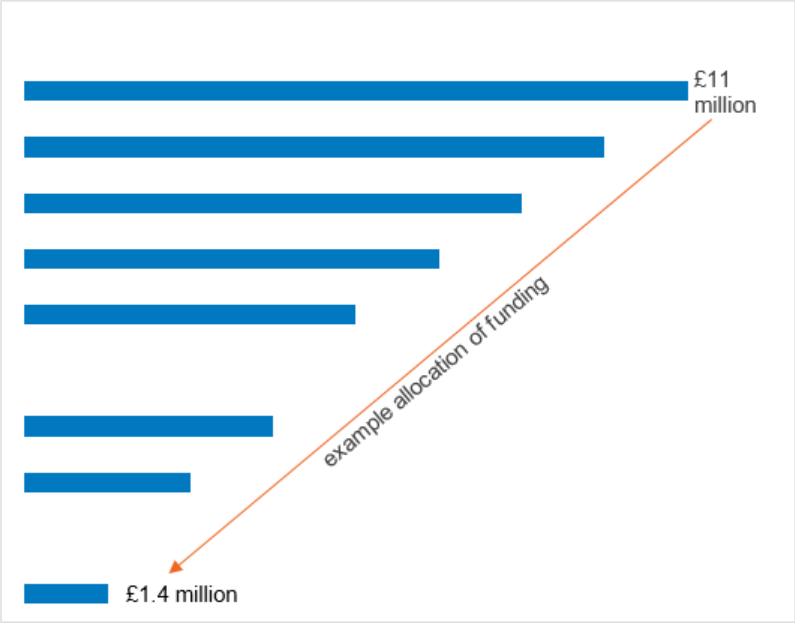


Figure 82

We are continuing to work with TOs to develop an agreed approach to funding governance and reporting in RIIO-2. We expect to have established this with them in the next few weeks and will reflect this in our December submission.

We recognise that projects which are the direct result of innovation funding would not be eligible for an incentive reward. However, the current proposals for the incentive scheme offer an opportunity to recognise where the results of innovation have been successfully rolled out into business as usual. Where innovation enables us to make progress against our long-term plans, this would have a greater evaluative focus (such as incentives for markets and networks activities), and where it feeds into short-term measurable improvements, this would have a higher focus on metrics (such as incentives for balancing).

Towards the end of RIIO-2, consideration would need to be given to how continuity can be ensured across the price-control periods, so projects continue to be funded and deliver benefits across price-control boundaries.

We believe there is also a role for a large, competitive funding pot similar to the Network Innovation Competition (NIC). In addition to a dedicated ESO innovation stimulus, we will look to access other forms of innovation funding during RIIO-2, including the Natural Environment Research Council (NERC), Innovate UK, Department for Business Energy and Industrial Strategy (BEIS) and other public competitions. Accessing other funding sources will help us increase the number of innovation projects we undertake with partners and optimise the use of any network-innovation stimulus, which will help us deliver even greater consumer benefits from the funding available. New external funding sources could also allow us to work with more diverse suppliers and project partners, who may otherwise be deterred by the terms of NIA funding which they are unable to meet.

12.1.3. Realising benefits from innovation

ESO-led innovation projects often do not result in direct benefits for the ESO itself. Value from innovation is realised across the energy system and ultimately by consumers. Examples include an NIA-funded project, which resulted in the creation of PV-live[155], a solar energy forecasting platform which is available for free and has become an industry standard. Better forecasting by the market, as a result of this tool, has delivered balancing cost savings for consumers. It has also brought savings for the whole industry, by reducing the need to develop individual forecasting tools. ESO innovation includes improvements to markets, policies and codes, and the creation of better forecasting platforms, more accurate models and more efficient control tools. It has also enabled other network companies' innovations, and created better strategic direction and knowledge for the industry based on research and development.

In order to track and report on the benefits arising from our innovation projects, we propose to follow the same mechanisms set out in our ESO-TOs Innovation governance document[156]. Given the asset-light nature of ESO however, we will differ in some respects.

We track and monitor benefits from innovation projects to ensure that benefits remain net positive and that a sufficiently high level of consumer value will be realised. To be approved, a project must meet a minimum threshold for consumer benefits as part of a robust cost-benefit analysis. In RIIO-2, we will develop and deploy a benefit-tracking framework that will help us identify and monitor both financial and non-financial benefits. This includes assessing expected reductions in consumer costs i.e, lower Balancing Services Use of System (BSUoS) charges on bills, environmental damage, improvements in safety and reliability, service quality and 'know-how'. The latter informs how we could mitigate future energy challenges, or better understand these and reduce the risk from implementing new solutions. Expected benefits will be quantified whenever possible during the project-development phase, and monitored once the solution has been successfully implemented into business as usual activities. Where benefits are difficult to quantify, we will assess or benchmark our performance against the other network licensees to ensure sufficient value is being realised for consumers.

As our criteria for innovation expects value to be delivered within four to eight years, it is too soon for us to be able to see clear results from most implemented solutions from RIIO-1. We continue to monitor project outputs, so we can better forecast the expected value they will deliver. Many of the projects we have funded through NIA are lower TRL (for example, late-stage research), so they will improve our understanding, help us avoid unviable solutions, and identify the correct roadmaps for industry to take to address specific challenges on behalf of consumers. Value is gained from de-risking future work, advancing the results being developed, and avoiding unnecessary costs from pursuing unviable solutions.

12.2. Building our innovation capability

In line with our innovation funding proposals, our innovation team will be further strengthened and restructured. This will enable us to better plan and respond more effectively to opportunities, use innovation funding even more effectively, and reprioritise our strategic challenges as new ones arise. Our preferred option is to retain a dedicated innovation team in RIIO-2, which will keep our focus on an overarching system strategy and further enhance our innovation capability across the ESO.

As stated before, innovation is a dual-fuel function. However, the costs below represent ESO only.

£m	RIIO-1	2021-22	2022-23	2023-24	2024-25	2025-26
Opex	0.4	0.8	0.8	0.8	0.8	0.8
FTEs	4	11	11	11	11	11

We will embed an innovation culture throughout the ESO and extend our external engagements to ensure we deliver our strategic priorities and, through collaboration, maximise benefits for consumers and energy industry stakeholders

The ESO innovation team was established in its current form in 2017. Our proposed team structure is based on having more maturity and experience, so although we are proposing an increase of 7 overall FTEs to the team, the structure will not be as top heavy, focussing instead on junior entry, high-potential talent. It will feature:

- an enlarged central innovation team with increased focus on cost-benefit analysis (CBA) and stakeholder engagement. We have allocated three new FTEs to this role, based on similar requirements and staffing levels elsewhere in the business. Stakeholder feedback has highlighted the need to focus resources on broader industry engagement. This will unlock our open innovation ambitions, allowing us to share internal knowhow, while leveraging industry insights and ingenuity. This enlarged team will also ensure more detailed and wider dissemination of the content generated by our projects, increasing the number of our

[155] https://www.solar.sheffield.ac.uk/pvlive/

[156] This document will be published later this year.

external events such as Open Innovation days or SOHacks.

- continued portfolio governance and project management, along with new, dedicated innovation business partners embedded in the business. This will drive the growth of our innovation culture, streamline the discovery of new ideas from our internal teams, and help to connect external ideas from our stakeholders with the right subject matter experts within the ESO. Having embedded innovation leads will also help ensure that innovative solutions are successfully deployed into ongoing activities. They will achieve this by staying close to our business operations – and by providing a clear link between ongoing and planned innovation activities and the teams responsible for implementing them. Portfolio governance and business-partner work will account for seven FTEs with one overseeing the whole innovation team.

We will continue to operate an efficient, matrix team structure[157] that does not monopolise innovation for the entire business, but instead governs activities that are delivered from our various business lines from a central team. We refer to this structure as Business Partnering; where Innovation Leads within each business department report to a central innovation team for the innovation activities, while remaining under direct management of their original teams for all other activities. This ensures close links between the business departments and the innovation function, helping to further embed innovation culture into the ESO.

The central innovation team will continue to govern our funding (including our innovation process; see the section on our innovation methodology above), have full ownership of our annual *Innovation Strategy*, be responsible for ensuring an open innovation approach with stakeholders, and manage the portfolio in a cost-efficient way. Having a central team in place frees the project teams from many of the administrative responsibilities that are essential to running successful innovation projects – such as contract negotiations, completing CBAs, regulatory reporting and stakeholder-engagement events. It allows them, and innovators within our partner organisations, to use their time more effectively and focus on innovation activities that add the most value.

The innovation team will act as a liaison between the ESO business and stakeholders to source new project ideas, ensure learnings are disseminated, and help implement successful solutions into the business. Projects will continue to be carefully planned, with steps taken to ensure successful outputs are effectively implemented into ongoing activities. This will include better coordination with our IT function to ensure sufficient resources are available for implementation. The team will also ensure there is committed buy-in from the relevant teams and senior management, to successfully realise benefits from our innovation projects.

12.2.1. Establishing an innovation culture

Our *Innovation Strategy* will be fully aligned to the ambitious goals of the ESO. It will clearly demonstrate where innovation links to achieving these goals and continue to focus on where it can deliver the most benefits to consumers and other stakeholders. We will maintain the profile of innovation across the ESO by showcasing our activities and encouraging more people to think innovatively. This will include internal events such as Hackathons, which have proven successful in taking employees out of their daily routine and helping them think about solving challenges in a collaborative, agile and innovative way. For more information on how our ESO culture will change, please see chapter 15.

12.2.2. Engaging and securing third-party participation

We will challenge and expand our own views on innovation – and our strategic priorities – by increasing our engagement with stakeholders. We innovate to solve a range of issues affecting the industry not just the System Operator. This means we are concerned with challenges affecting our customers and stakeholders, as well as the electricity and gas systems, all the way through to broader societal challenges. To achieve this, we need to draw on the expertise and skills of a wide range of organisations. This will include gathering feedback through webinars and workshops, participating in cross-industry forums and events, and holding bilateral meetings with small, medium and large enterprises across all sectors – including transport, utilities, digital technology and environmental charities.

Our ambition is to fully embrace an open innovation approach and to further accelerate innovation for the whole energy system, not just the ESO. This will be achieved by organising more open innovation days, to provide access to our subject matter experts for stakeholders seeking to develop new solutions. We will welcome ideas that go beyond addressing our own challenges, thus embracing our role at the heart of Great Britain's energy system and leveraging our full potential to create the system of tomorrow.

Along with establishing more open innovation days, we will extend our calls for new project bids to solve our priority challenges. This will give third parties more opportunity to work with ESO subject matter experts and develop innovation projects collaboratively. These activities will continue in parallel with internal innovation events, which are designed to promote creative thinking and build a strong culture of innovation within the ESO. Third parties (including academia, consultancies, manufacturers and other suppliers) will be invited to join these internal events more regularly. This will ensure that proposed activities are most relevant to customers and stakeholders, and will strengthen the potential for future collaboration.

[157] Matrix team structure: https://en.wikipedia.org/wiki/Matrix_management

We will also work with other network organisations through the Energy Networks Association (ENA) and other external engagement opportunities. This will include dissemination and collaboration activities, such as the ENA working groups, industry forums and the collaboration portal. By doing this, we will ensure other licensees are aware of our innovation activities, share any relevant learnings and provide suitable feedback on any new proposals. We continue to take an open approach to innovation, encouraging collaboration with third parties and bringing together the required skills and expertise from across industry, academia and other sectors.

12.2.3. Stakeholder feedback

Engagement with a wide variety of stakeholders has been extremely useful in developing our innovation approach. Stakeholder feedback from network associations, academics and technology providers has led us to develop and deliver a more focused and clear innovation strategy, consisting of more distinct and well-defined challenges. For example, our stakeholders wanted to better understand the different types of 'whole system' issues we were facing. This resulted in a breakdown of our whole system challenge into three separate priorities[158] – whole energy system, whole electricity system and whole gas system.

ERSG supports our innovation proposals with conditions.

"There has been an attempt to react on feedback but more improvements could be made. More information required on the consultation and engagement with academia which is an important part of innovation. Market collaboration should also play a larger part in innovation."

As part of our *SO Innovation Strategy* publication, we shared our process on how we decide which priority challenges to focus innovation projects on, and how stakeholders can work with us to explore new solutions to these. Our strategy will continue to be refreshed each year, following engagement with stakeholders, to ensure the priorities are fit for purpose, and reflect current industry understanding of energy-system challenges.

Stakeholders have consistently expressed the wish to have more clarity around which benefits we pursue – and how we realise them. As a result, we have made our CBA and innovation process public and will aim to constantly update our website to show the progress on each of our projects. As stated previously, it is our ambition to develop and deploy a comprehensive consumer-benefit tracking tool, to more effectively report benefits back to our stakeholders.

Through events such as our open innovation days, we have seen a large number of requests from external parties to get involved in ESO innovation, with over 140 ideas submitted ahead of the first ever event. We will aim to run similar events more frequently throughout the year. This will give third parties more opportunities to work with us in solving our priority challenges through innovation projects.

We received feedback from a number of stakeholders which included government, suppliers and service providers about our lack of visibility. They also found it confusing to distinguish between the many different publications and activities that are ongoing within ESO. We have been leveraging other stakeholder-engagement platforms, such as Power Responsive, to reach out to a wider audience and ensure as many stakeholders as possible are aware of our innovation activities.

At the April 2019 RIIO-2 workshop, we gathered feedback from a wide range of stakeholders from across sectors on their priorities for ESO innovation.

Stakeholders told us they would like even better communication and engagement on our activities throughout the year, to enable them to better understand our current and future priorities, and how we can work with them. To address this, we will focus on better external engagement throughout the remainder of RIIO-1. We will ensure we have a team resource focused on external communications, and continue this into RIIO-2, with more innovation events designed to engage stakeholders and help them partner with us on projects.

Stakeholders also told us they want us to continually improve our ongoing activities, as well as looking at 'big I' (larger, more disruptive) innovations. We have ensured that ongoing innovation is reflected in the Business Plan. This is captured in each Theme chapter and summarised below. This allows innovation stimulus to focus on the 'big I' activities.

As a result of our central role in the electricity system, stakeholders believe we should be helping to lead collaboration across the industry, as well as progressing innovation projects that solve industry problems. Through our strategy refresh process, we are taking this feedback on board. We will use stakeholder engagement to continue to ensure our priorities for innovation reflect whole system challenges, which the ESO is ideally placed to tackle.

Most stakeholders agreed there should be a retained innovation stimulus for the ESO, but there were mixed views around how innovation should be funded (eg, through BSUoS). We also believe a ring-fenced stimulus is necessary to encourage higher-risk innovation. We will make sure innovation is funded in the most appropriate way, ensuring consumers are not

[158] See *SO Innovation Strategy* priorities in section 13.1.1, Innovation methodology, and in full document: https://www.nationalgrideso.com/document/106786/download

overpaying and that any stimulus doesn't conflict with other ESO incentives or funding structures.

As with other proposals in our Business Plan, stakeholders highlighted the importance of working with other companies across the industry. Increasing our collaboration with external parties has been a priority in the lead up to RIIO-2. We will continue to engage with industry and other stakeholders to ensure we are providing the appropriate information and opportunities to encourage third-party participation.

12.3. Embedding innovation from RIIO-1

By the start of RIIO-2, we aim to have proven the viability of several innovations from RIIO-1 which will be implemented into the business. Examples of current innovation projects that could become ongoing activities during RIIO-2 include the following:

- RecorDER[159]

This project aims to develop and deploy a full-scale, blockchain-based asset register for flexible energy resources. This NIA-funded development and pilot demonstration project is being delivered as a collaboration between ourselves, Scottish Power Energy Networks, UK Power Networks and Electron. If successful, we will plan to implement the asset register during RIIO-2. This will realise system-wide benefits, including whole system visibility, easier asset trading, enhanced data management and dynamic asset registration, while also testing the viability of blockchain transactions.

- Frequency Response Auction Trial[160]

The aim of this trial is to test the hypothesis that closer to real-time procurement of frequency response will lower overall procurement costs, by increasing liquidity and transparency in the market – and delivering a stable market price for the relevant products. This NIA-funded project, developed in collaboration with EPEX Spot, and which will be supported and participated in by dozens of customers, is due to end in early 2021. If successful, this too will be implemented into our ongoing activities during the RIIO-2 period. Our conservative estimate of consumer benefits from this project is £360,000 a year, in the form of lower bills.

12.4. Ongoing innovation in RIIO-2

Innovation is embedded throughout this Business Plan. Within each Theme chapter, we have highlighted where our proposals have built on past innovations, and where we expect to further innovate to deliver benefits to consumers.

Below, we summarise the activities we have classified as ongoing or BAU innovation for each of the Themes. These are the higher TRL activities funded through the Business Plan and some of these follow on from innovation already completed during RIIO-1, such as NIA and NIC projects. Where additional innovation projects could assist in delivering these Themes (lower TRL activities which are difficult to define at this stage), we have classified these as Areas we may want to draw on ring-fenced innovation funding in RIIO-2. This funding will ensure we can research and develop possible new solutions, and address upcoming challenges as they arise.

[159] https://www.smarternetworks.org/project/NIA_NGSO0018

[160] https://www.smarternetworks.org/project/nia_ngso0017

Theme 1 – Ensure reliable, secure system operation to deliver electricity when consumers need it

BAU innovation

- Designing and building the new balancing and control capabilities in an agile, adaptable fashion through a digital twin.
- Developing situational awareness, new markets and services for the whole electricity system, not just transmission.
- Developing online and offline system modelling and forecasting tools to enhance decision-making, using new, advanced probabilistic techniques which are being developed by industry and academia.

Areas we may want to draw on ring-fenced innovation funding in RIIO-2

- Bringing artificial intelligence, machine learning and automation into the Control Centre processes. Given the changing energy landscape, it is unclear exactly what tools and systems – which may not exist presently – machine learning could be applied to. Therefore, this is an area where we need to be agile and respond to new opportunities as they appear (where ring-fenced funding is better utilised).

Theme 2 – Transforming participation in smart and sustainable markets

BAU innovation

- Underpinning an integrated ESO platform will be a single, industry-wide asset registration process for all ESO markets. Assets will be registered at component level on a single register.
- Enhancing our modelling capability will put our Capacity Market analysis at the forefront of modelling techniques. As a result, we will be leading the world in security of supply technical modelling.
- During the RIIO-1 period, we have introduced innovative approaches to engaging more widely with market participants, as demonstrated though Charging Futures. As we embed these lessons into the wider business, we will continue to seek new approaches over the RIIO-2 period that enable us to transform the code processes effectively.
- Implementing a digital, whole system Grid Code, supported by artificial intelligence to better signpost and improve the users' experience, will be the first of its kind in Great Britain's electricity industry. We will capture lessons, which can be shared with the wider industry to improve the experience for all codes.
- During the RIIO-2 period, we will continue to work closely with stakeholders, such as service providers and DNOs, to innovate and convert operability pilot projects into new markets. We will utilise our sandbox environment to develop learning and test enduring solutions for new markets.

Areas we may want to draw on ring-fenced innovation funding in RIIO-2

- The sandbox will enable innovation, so we will potentially draw on ring-fenced innovation funds, where appropriate, to test novel solutions to complex challenges. For example, system stability in ultra-low inertia scenarios.

Theme 3 – Unlocking consumer value through competition

BAU innovation

- We are currently exploring new modelling techniques, such as probabilistic modelling, to better identify the right level of investment needed on the networks. During RIIO2, we will build on this further to enhance these techniques, in particular to better reflect the interactions between different network issues.
- With increasing volume of analysis that needs to be completed, in shorter periods of time, we are currently undertaking an innovation project to test the tools we require. Subject to this being successful, we will implement these voltage assessment tools early in RIIO-2.
- During RIIO2, we will establish how we can best utilise our network-planning expertise to support interactions across different vectors.

Theme 4 – Driving towards a sustainable, whole energy future

BAU innovation

- We worked on the ENA Open Networks Project, alongside other network organisations. We will be taking the learnings from this project to establish deeper ways of working with DNOs at the start of RIIO-2. This will ensure consumer benefit is maximised in access planning across the transmission-distribution interface.
- We will deliver broader analysis and industry engagement to develop energy policy recommendations. Our ability to lead in this area is built on data-driven analysis, including data from innovation projects. One example is our NIA project on electric vehicles (EVs) charging behaviour, which allowed a step change in our modelling of electricity demand from EVs. Another is our self-funded carbon-intensity forecasting project, which used machine learning and automation to provide more accurate forecasts, which we publish continuously, enabling others to make more informed choices.
- We are developing a pathway for zero carbon, whole system operability and beyond. Our work to develop the capability to operate a zero carbon electricity system will use the learning from our Enhanced Frequency Capability Control (EFCC) and Power Potential innovation projects – and potentially our recently funded Black Start from Distributed Energy Resources (DER) project.

Areas we may want to draw on ring-fenced innovation funding in RIIO-2

- During RIIO-2, we will continue to innovate to take advantage of the opportunities presented by new technologies, such as automation and machine learning, to fill gaps in capability (ie, zero carbon operability) and to prepare for RIIO-3. We believe that this innovation will increasingly take a whole energy system view, particularly given the increasing penetration of EVs and the decarbonisation of heat. We will work with a broad range of stakeholders to further develop the whole energy system.

13. Leveraging value from shared functions

13.1. Business support shared services

The ESO uses services that are shared across all the National Grid businesses under a single function for several key support services. These include IT, property, HR, Procurement, Corporate Affairs, Legal and Finance. This shared services model means each National Grid business benefits from economies of scale and use of expertise in each area, as well as taking a proportion of the costs for each function. This creates efficiencies for each National Grid business, as it costs less than each business having its own functions. The shared service costs in this section have been benchmarked for efficiency. Furthermore, they include a 1 per cent efficiency stretch target to ensure we keep pace with the efficiency frontier in RIIO-2.

We make sure that each National Grid business pays a fair share of the costs of these functions, using the unified cost allocation model (UCAM) approach agreed with Ofgem. Cost allocations are reviewed annually to make sure these are fair, robust and have not been affected by changes to business activities.

1%
Annual efficiency savings on our shared service costs

The principles of the UCAM process are a simple, consistent and transparent method to allocate costs by maximising direct attribution of costs where possible and then using agreed drivers for costs not directly attributable (for example, headcount of the relevant companies). The annual review of allocation drivers ensures that the drivers remain robust and changes required from any business activities or structures that have changed.

This model was agreed to continue post legal separation in 2019 following agreement with Ofgem. Across these services, the ESO's share of costs will be on average £15 million in the first two years of RIIO-2. Benchmarking shows that our forecast costs for RIIO-2 are equivalent to the most efficient companies – after adjusting for costs of being a regulated network and the additional security measures we take to protect our operations from threat. Being a regulated network increases our costs through the need to perform regulatory cost and output reporting in addition to the statutory reporting performed by most companies, and the fact that we need to do more compliance activities.

Benchmarking helps us to know how the overall National Grid business support costs compare with those of similar size companies. This, along with the annual review of allocation methodologies, ensures that this model continues to provide the ESO with optimal and efficient services as part of this arrangement.

We think this remains the optimal model moving into RIIO-2 and continues to deliver value for consumers as opposed to procuring these services from elsewhere. This is demonstrated by the benefits ESO receive from the efficiency of the shared service model that is performing strongly against benchmark.

A number of business support areas have undergone restructuring in RIIO-1 to ensure they are providing services for efficient costs. Details of this, including comparisons to benchmarking are provided in the following pages.

There are three main components in the shared service model reflecting the degree of interaction and how embedded each service is in the ESO business. Key functions – Finance, Human Resources, Corporate Affairs, Legal and IT – are highly embedded, using a dedicated business partner model compared with Group Functions (for example, tax and treasury) that have a low degree of regular interaction.

ERSG does not support our shared functions proposals.

"Hard to justify why dedicated teams in shared functions are not a part of the ESO. This model must be fully transparent and there must be assurances that there is no potential 'leakage points'".

Shared services support model

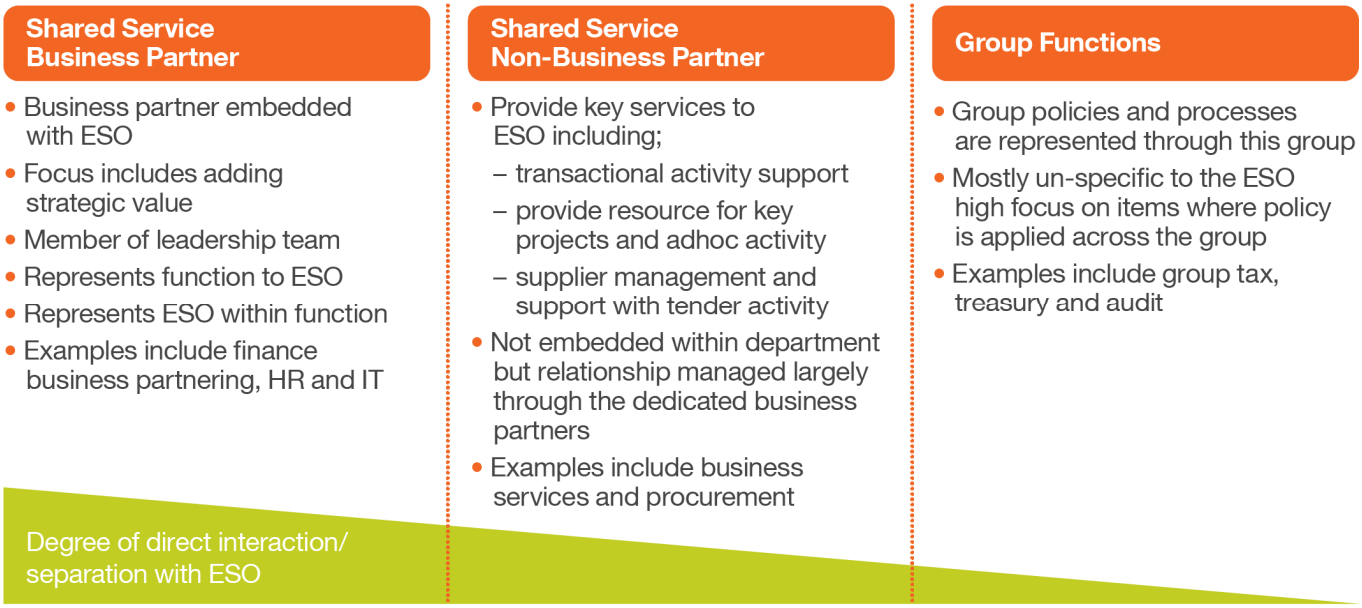


Figure 83

Within the ESO leadership team, lead business partners are accountable for the delivery of shared services. This includes IT, and we have provided more details on our approach to IT in chapter 11.

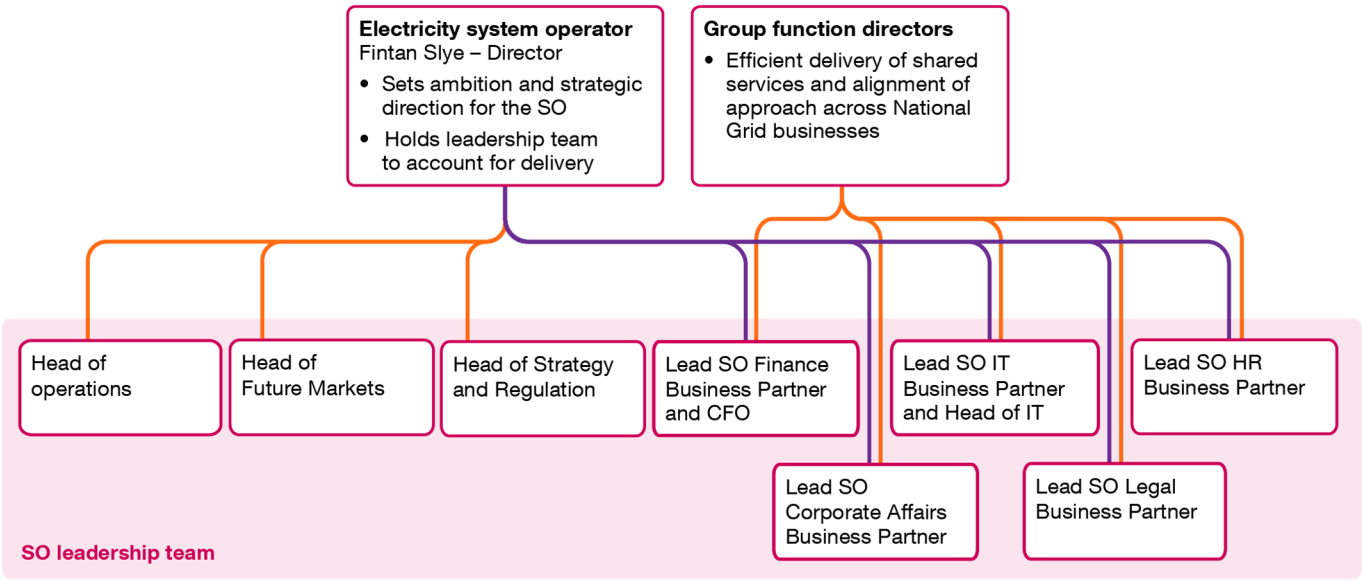


Figure 84 SO leadership team and lead business partners.
CFO = chief financial officer

Our approach to benchmarking of business support shared services

National Grid asked The Hackett Group[161] to compare the costs of business support shared service functions with those of similar-sized companies. Hackett were provided with the costs of shared services supporting the electricity transmission, gas transmission and electricity system operator businesses[162]. Using Ofgem's business support function definitions, Hackett identified comparable activity categories within their database. Hackett were asked to compare the costs to as many non-regulated companies from the group Ofgem had used for business support benchmarking for which Hackett still had current data. 19 companies from across multiple sectors formed the comparison group. Hackett performed the comparison to a peer group using a single metric for each business support area, such as costs as a percentage of revenue, or cost per full-time equivalent (FTE). Although this is a simplistic approach that averages out key differences (for example, how embedded IT is into an organisation's operations), it provides a reasonable foundation to start analysing and adjusting for more complex areas of the business support costs.

Where Hackett identified differences between National Grid costs and those of the comparison group, they were asked to perform more detailed comparisons on an activity-by-activity basis so National Grid could understand what explained the differences. For IT costs, Gartner were engaged to perform this further analysis, comparing costs for each of the key activities (e.g. application support, networks, storage, end-user computing) with those of other companies in their database, adjusting for workload (i.e. number of applications, number of services, number of users). More information is provided in our chapter on IT strategy.

The table below summarises our costs for shared services. This is broken down by area later in this chapter.

£m	RIIO-1 average	2021/22	2022/23	2023/24	2024/25	2025/26
Opex	18.1	16.0	16.0	16.1	16.2	16.2
Capex	2.2	2.3	4.3	2.3	2.7	2.7

13.1.1. Property

Our property function is responsible for:

- making sure our offices and other properties are in good condition and safe for our people to work in.
- managing the services to run our buildings, such as security, cleaning and catering.
- providing recycling services and using sustainable materials and energy.

The National Grid property function has undergone changes through the period to increase its efficiency. This has included rationalisation, adoption of smart workspaces and sharing of core estate. The key services are provided by outsource providers, including catering, maintenance and security, who can provide the services at a lower cost to National Grid. Property have been able to achieve efficiencies totalling £3 million across the National Grid portfolio which ESO has benefited from through lower allocations than would otherwise have been the case.

ESO property costs in RIIO-2, £m

£m	RIIO-1 average	2021/22	2022/23	2023/24	2024/25	2025/26
Property management opex	7.0	5.5	5.5	5.5	5.5	5.5
Property capex	2.2	2.3	4.3	2.3	2.7	2.7

The ESO's share of National Grid property costs is based on our use of National Grid sites, primarily in Wokingham where the Electricity National Control Centre is located, and National Grid's head office in Warwick where our Faraday House site is located. Our Wokingham site falls under the government's definition of Critical National Infrastructure (CNI) and the property management costs include maintaining the physical security of this site.

When the ESO business separated from National Grid's electricity transmission business, a portion of National Grid's Warwick head office was separated to house the ESO. The costs in RIIO-2 reflect this change, including the provision of separate building services to the ESO such as reception, security and catering. Our proposal includes a small cost to reflect our intention to create an ESO corporate presence in London that is separate from National Grid's London office.

National Grid allocates property opex specifically by site to the part of the business that is using the property. Shared properties are allocated based on usage, and overhead is then shared based on overall use of the property portfolio.

The benchmarking study showed that the costs we spend on property management are comparable to the top 25 per cent most efficient companies of the comparator group (upper quartile efficiency). This is after adjusting for our additional Critical National Infrastructure-related activities (e.g. operating our gas and electricity control centres on a 24-hour basis, and the enhanced physical security measures needed to protect our sites).

[161] The Hackett Group is a global business benchmarking organisation.

[162] 2020/21 costs

Property capex reflects spend forecast in RIIO-2 on ESO related properties. This is primarily spending on Wokingham and Reading and our share of capex required for the portion of National Grid's Warwick head office that houses the ESO. The spike in 2022/23 relates to additional work in Wokingham during that year.

13.1.2. Human resources (HR)

Our HR function helps our businesses attract and recruit the best people to work with us. It also ensures that our people reflect the diversity of the society we operate in. It provides training to make sure our workforce has the right skills and capability to deliver the ESO's roles and activities, and sets out how we support and reward our people so they feel valued, engaged and want to keep working with us. The chapter on 'people and capability' provides more information on our aspirations in this area, and how we will continue to ensure we have the right people, skills and leadership to deliver our ambition in RIIO-2.

During RIIO-1 our costs increased in HR to cover additional demand for services including resourcing, business partnering and learning that were required to support the business, including work required for the significant change agenda. Following the support given to the business with its PEx change programme, HR has started work to increase its own efficiency prior to the start of the RIIO-2 period. This is by streamlining HR activity, focussing on value add and adoption of new digital technology and platforms including the rollout of a new HR system. Efficiencies are already being realised with the ambition to reach upper quartile efficiency by the start of the RIIO-2 period reflected in our proposed costs.

The proposed annual costs also include an additional £0.4 million per annum for critical roles across the ESO. This is part of our planning to secure workforce resilience which is an important objective for ESO in RIIO-2. In the National Grid HR function, the costs also include circa £2 million of employee benefit costs across the various businesses, these are business costs but within our organisational structure are managed by HR.

ESO HR costs in RIIO-2, £m

RIIO-1 average	2021/22	2022/23	2023/24	2024/25	2025/26
2.0	2.4	2.4	2.4	2.4	2.4

The Hackett Group looked at the overall cost of National Grid's HR function, relative to the number of people in our organisation. Our proposed costs are lower than peer median but higher than peer upper quartile. We know we have to work harder in the energy sector to create an inclusive working environment, and our HR function supports these actions.

Adjusting for the critical roles and employee benefits, HR costs were in line with Hackett's world class cost of function (i.e. companies which are upper quartile efficient and effective in their operations), consistent with the additional focus we place on inclusion and diversity activities that drive cost over and above more transactional-focussed functions.

HR costs are allocated across National Grid, based mainly on headcount, which reflects the size of each team generating requirements from HR. There are some costs for the ESO that are allocated specifically and senior HR management costs are shared reflecting the focus across the different parts of National Grid. The ESO HR costs, excluding the £0.4 million per year. of additional critical roles, is flat compared to the RIIO-1 average reflecting an increased allocation of cost to the ESO based on our forecast headcount offset by the share of efficiencies.

Procurement

Our procurement function helps our businesses negotiate and manage our contracts for goods and services. It also makes sure we comply with the laws on how we buy goods and services.

Investment has been made in National Grid procurement to support efficiencies and cost reductions throughout the business through enhanced supplier management and management of tender processes. This has included the creation of a global procurement organisation across National Grid to take further advantages of economies of scale and expertise.

ESO procurement costs in RIIO-2, £m

RIIO-1 average	2021/22	2022/23	2023/24	2024/25	2025/26
0.6	0.7	0.7	0.7	0.7	0.7

The Hackett Group benchmarking study indicates that our procurement costs are in line with the upper quartile of their comparator group, demonstrating efficient spend in this area.

Procurement costs are mainly allocated using a measure considering various business factors (revenue, operating profit, assets and headcount). This is a recognised and established measure which reflects a fair allocation of costs across National Grid where a single measure might not be appropriate. Some separately identifiable costs are allocated specifically reflecting the area of the business they relate to.

The investments we will make in RIIO-2 relate to:

- Source-to-contract: this area of investment relates to the upgrades and refresh of systems that are required to enable maximum leverage and management of procurement spend on goods and services. Capabilities include contract management, to provide easy access and real-time alerts to vendor performance; supplier relationship management, to track vendor interactions and drive consistency in how we interact with suppliers; and benefits management, to accurately capture and

track value from strategic contracts and category management activities.

- Procure-to-pay: this area of investment relates to the upgrades and refresh of systems required to enable the integration of the purchasing function with the accounts payable function. Capabilities include supply management, purchase requisition, purchase order, receiving, invoice reconciliation and accounts payable.

13.1.3. Finance

Our finance function manages processes to record and report the costs, assets and other financial transactions of our businesses. It supports the business directors in their duty to ensure proper management by auditing key processes in the business, and manages our regulatory obligations, such as reporting our cost performance.

Finance has been a key part of the National Grid change programme to reduce costs and improve efficiency. This has resulted in savings across the group from several activities across finance, including streamlining activities, outsourcing and reviewing the organisational structure to ensure processes are carried out efficiently in the right teams.

ESO finance function costs in RIIO-2, £m

RIIO-1 average	2021/22	2022/23	2023/24	2024/25	2025/26
3.8	3.2	3.2	3.2	3.4	3.4

In RIIO-1, there were some one-off costs which accounted for the higher average cost. For example:

- We changed auditors within RIIO-1 to Deloitte, whose audit approach puts more emphasis on the checks and balances around our financial transactions. We know we have to work harder in this area in line with Sarbanes-Oxley requirements (i.e. additional controls around financial information that companies who are listed in the US must comply with). In readiness for this change in approach, we conducted our own review of our controls, resulting in a more robust control environment.
- The legal separation of the ESO required extra activity to set up the new ESO financial structures.
- The RIIO-1 costs also include the ESO's share of National Grid Group regulation costs. These are no longer allocated to the ESO since legal separation, as the ESO has its own regulation team.

In terms of capital investment, in RIIO-2 we need to upgrade and refresh the core Enterprise Resource Planning (ERP) system and associated financial systems relating to tax, treasury and banking. This will optimise our finance processes and enable the provision of the right information at the right time, backed up by robust processes and controls. This investment will ensure a fit-for-purpose, industry standard, best-practice ERP solution. It will provide best-in-class business services and deliver the right data to the business to make the right decisions.

We will also explore process automation technology, such as robotic process automation and artificial intelligence. These tools can improve the customer experience internally as well as collaboration between our offshore business process outsource partners.

The Hackett Group benchmarking study indicates that our finance costs are lower than peer median companies but higher than upper quartile efficiency. This reflects the additional focus we maintain on strong financial controls and are part of our Sarbanes-Oxley requirements. They also provide the strong level of assurance and governance required of a regulated business.

Finance costs are mainly allocated also using the measure considering various business factors (revenue, operating profit, assets and headcount) for the shared teams. Specific finance teams that support each part of the National Grid business are allocated specifically, including for example the finance business partner teams.

13.2. Other shared service costs

The ESO also pays for a share of these National Grid services:

- corporate functions
- health, safety and environment team costs
- insurance
- other shared service capex

Corporate functions have improved their efficiency over the RIIO-1 period. This has included the creation of a global communications team to support best practice and synergies across the group. This supplements the dedicated team supporting the ESO following legal separation. The change and strategy teams have also undergone restructuring to create a more agile team for change and project management to provide synergies across National Grid. Corporate functions were also affected by the sale of the gas distribution business and have created efficiencies to make sure fixed costs (e.g. legal and management teams) were not burdened on the remaining businesses in National Grid.

Insurance costs increased in some areas, including increased costs to protect for cyber security but this has been partly offset by premium savings and enhanced market conditions.

ESO share of other shared service costs in RIIO-2, £m

£m	RIIO-1 average	2021/22	2022/23	2023/24	2024/25	2025/26
Corporate Functions	4.5	3.2	3.2	3.2	3.2	3.2
Health, safety and environment	0.2	0.2	0.2	0.2	0.2	0.2
Insurance	0.6	0.8	0.8	0.9	0.9	0.9

Our corporate functions costs are lower than our peers, but benchmarking shows higher than upper quartile efficiency. This reflects the increased governance and legal costs associated with the regulated environment we operate in. This includes a separate governance process for the ESO including the ESO Board that was created post legal separation.

Corporate functions costs are mainly allocated also using the measure considering various business factors (revenue, operating profit, assets and headcount) for the shared teams. Some costs that support each part of the National Grid business are allocated specifically or using drivers that reflect the time and resource allocated to each part of National Grid.

National Grid insurance is provided through our licenced captive insurance company owned by the group wherever it is efficient to do so. Periodically, external consultants review the premiums considered achievable in the market for our risks, and compares these against premiums charged by our captive. This was last completed in 2019 and showed significant savings of over 30 per cent in our proposed premiums over RIIO-2 using our captive which the ESO will benefit from over the period.

Insurance costs are allocated specifically for premiums which are directly attributable to the ESO. An allocation of management costs is based on the measure considering various business factors (revenue, operating profit, assets and headcount).

Heath, safety and environment costs reflect spending to ensure the wellbeing of our employees, the communities we work in and other stakeholders are considered in our policies and objectives. The proposed costs reflect the allocation from National Grid for spend in this area.

14. Driving focus on customers and stakeholders

14.1. Overview

Delivering against our plan for and with our customers and stakeholders will be vital to a successful RIIO-2 period. To help us in this aim we are evolving our stakeholder strategy for the RIIO-2 period. We also have a number of cross-cutting teams who support the outputs and services we deliver, both in relation to our customers and stakeholders and more broadly:

- customer and stakeholder
- ESO regulation
- business change
- assurance

Our proposed spend on these teams in RIIO-2 is around £25 million over five years.

£m	RIIO-1 average	2021/22	2022/23	2023/24	2024/25	2025/26
Opex	15.1	5.5	5.1	5.1	5.1	5.1
Capex	0	0	0	0	0	0
FTE	58	61	61	61	61	61

14.1.1. Our stakeholder strategy in RIIO-2

Our stakeholder strategy will build on our work during RIIO-1, including the engagement carried out in developing this Business Plan. Our ambition for RIIO-2 is **to deliver an excellent experience and add value to our stakeholders**[163]. We have stated in our ESO Mission that success by 2025 includes the System Operator being a trusted partner. This means:

- **Building trust:** using solid expertise, delivering on our promises, building an improved understanding of our impact on stakeholder activities and objectives, and demonstrating our position as a neutral system operator
- **Building partnerships:** to deliver projects, to lead the debate, to jointly solve problems and build value, and to set up the energy transition for success

We will demonstrate that we are providing greater value for our stakeholders by making sure we have:

- a consistent approach to involving stakeholders in our business;
- stakeholder inclusive Business Plans and involvement in decision making; and
- an evolving approach as stakeholder expectations grow and evolve.

We will deliver this ambition through six work streams:

Building an improved understanding of stakeholders	Improving the experience we provide	Measuring our progress
1. Our insights and feedback strategy – a more holistic approach to continual feedback and data analysis, alongside improved stakeholder identification and segmentation to recognise their requirements and tailor our approach accordingly. This will also cover hard-to-reach groups and end-user consumers. 2. Our engagement and communications approach – ensuring that interactions become more regular, more collaborative and less "tell", plus we make them more tailored to the relevant audiences.	3. Our culture and capabilities – develop a culture agreement, undertake a gap analysis and targeted improvement activities to ensure we drive stakeholder focus in all our activities, processes and business planning. This will be reflected in the way we reward and recognise our leaders and our staff. 4. Our digital technology – improving our stakeholders' digital experience. 5. Our customer journeys – Improving journeys through our processes; through mapping and optimisation exercises.	6. Our performance data and metrics – developing a suite of KPIs, including more leading indicators and cultural measures. These will be used to gather evidence against stretching targets, benchmarked against best in class customer experience providers. We will also include evidence of where we have acted on stakeholder feedback.

[163] For the purpose of this strategy we use the term stakeholder to refer to customers, stakeholders and consumers

Our approach to stakeholder engagement has recently been reviewed as part of the ESO legal separation programme. This has included an external assessment and best practice identification (by Capgemini) alongside a review of stakeholder feedback during RIIO-1. This has helped us to identify the areas described above for future improvement as an important part of delivering our stakeholder ambition. We will continue to benchmark our approach through the RIIO-2 period through:

- Regular reviews of best practice across the energy sector and beyond by the SO Customer & Stakeholder team.
- Using data and feedback from stakeholders to identify improvements they would like us to make.
- Ensuring our stakeholder engagement is recognised as upper quartile against external benchmarks through the AA1000 health check.

We recognise that delivery of this ambition will require demonstrable and explicit leadership commitment. In addition to performance objectives and associated reward, there will be a governance structure through the SO leadership team. This will be called the ESO Customer and Stakeholder Experience Board and it will be chaired by Fintan Slye, Director of the UK System Operator. It will:

- Set the ESO's Customer and Stakeholder Experience ambition and agree the strategy to get us there
- Be accountable for customer and stakeholder performance, measured and monitored through agreed KPIs
- Monitor delivery of plans against the agreed strategy
- Approve the customer and stakeholder engagement plan
- Approve the culture agreement and drive cultural change
- Review recommendations relating to capability assessments and upskilling, and support delivery of this within teams
- Review and escalate risks, issues or blockers
- Share best practice and celebrate successes

14.2. Customer and stakeholder team

The customer and stakeholder team is a dual-fuel team providing strategic ownership and direction for the System Operator's customers and stakeholders. We use the term customers to refer to industry participants who pay us money, such as use of system charges for the transmission network. We define stakeholders as people or organisations with any interest in, or influence over, what we do.

The team is responsible for our customer and stakeholder strategy. Activities include supporting implementation of the strategy across the SO business in a consistent and coordinated way; supporting teams to deliver the strategic goals by providing best practice advice, expert guidance, toolkits, training and upskilling; and monitoring engagement activities. This includes providing regular updates on customer and stakeholder feedback and performance – and supplying insight and improvements to ensure continual optimisation.

This team is also the owner of the customer relationship management (CRM) IT system. This system will provide a critical function in understanding what our customers and stakeholders require, both now and in the future, so we can develop our strategy.

There is a growing requirement for this team to consider the SO's role in engaging and supporting end consumers in the energy transition. This is a relatively new focal point for the SO, and growth in this area will require a substantially different approach and skillset to those we have previously used.

14.2.1. What will this team look like in RIIO-2?

To support our RIIO-2 proposals, the team will increasingly become a more insight-driven and strategic function. It will work across the SO to provide a consistent stakeholder and customer experience, overseeing the governance, engagement and measurement of this. We will also step up our role in representing and championing the consumer experience, in line with the SO mission.

The table below shows what we will deliver for customers and stakeholders in RIIO-2.

For customers	• Ensure the SO offers an excellent customer experience, aiming to get it right first time across every touchpoint and service. This will include, for example, improved query management and data sharing, as well as better communication and engagement. We will also ensure that customers are increasingly involved in identifying and planning for changes to the SO's processes and activities early in the development stages. • Develop trusted partnerships with SO customers. • Understanding our customers' business models better, so the SO can better understand our impact upon them and help customers to be future ready. This will include educating and guiding them on how to take advantage of the energy transition.
For stakeholders	• The team will be responsible for making sure the SO is supporting stakeholders in driving the energy transition. It will use meetings and other touchpoints to ensure we are providing a balanced and knowledgeable voice to the relevant debates – lending expertise where appropriate and using our published insights and analysis. • We will facilitate conversations with stakeholders, enabling a collaborative relationship through meetings and forums. • The team will also make sure the SO is seen as a consumer champion by stakeholders, so we can be relied upon to provide the consumer perspective in all appropriate conversations.

In addition to this, we propose stepping up our role in relation to end-consumer engagement. There is a need to support consumers through the energy transition, to help them take advantage of the opportunities it may bring, as well as to consider their own priorities and value drivers. Because of our unique position as a balanced and neutral ESO, we are well placed to take on this role. We will develop our presence as a balanced and neutral partner to consumers, becoming a consumer champion across the energy markets and providing data and marketing to enable behaviour change around energy use. This work is likely to be a long-term journey, particularly as progress on decarbonisation of heat and transport begins to impact more directly upon greater numbers of consumers.

Consumer Engagement Proposition	
We empower understanding of the energy transformation	We will initially seek to partner with key suppliers and consumer groups to provide education support around energy use and the future of energy; further along this journey we would seek to work closely with others in the energy industry, not least the DNOs, as the impacts and opportunities both nationally and regionally become clearer.
We drive decarbonisation	We will also help to drive the decarbonisation agenda at the local consumer level through provision of data and analytics, pushing decarbonisation messages through our various communications and publications and encouraging behaviour change around energy use.
We champion the consumer	We will measure and consider consumer value in everything we do, and in our interactions across the energy industry and beyond.

Our intention during the RIIO-2 period is to partner with consumer organisations to raise awareness of future challenges and the need for consumers to change, as well as our role in supporting them and the wider industry through this process. This work will develop and evolve over the period as we build greater understanding of consumer value drivers and the likely extent and timings of the impacts of the energy transition

Figure 85

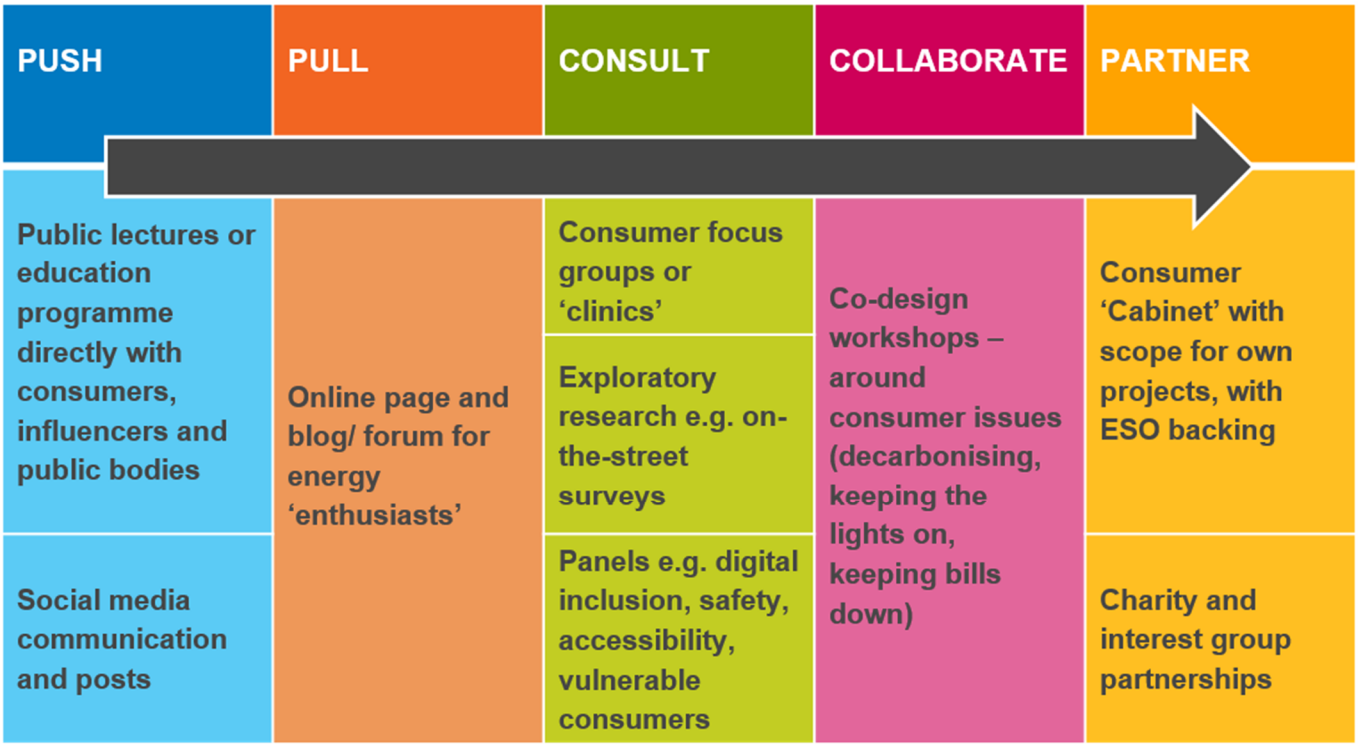


Figure 86

Delivery of this programme of work will be done by three new FTE within the Customer and Stakeholder Team. There will be an additional requirement for funding for consultant support and marketing and communications activity.

14.2.2. Costs

The ESO's share of customer and stakeholder team costs in RIIO-2, £m

	RIIO-1 average*	2021/22	2022/23	2023/24	2024/25	2025/26
Capex	0.2	0	0	0	0	0
Opex	0.7	1.0	1.0	1.0	1.0	1.0
FTEs	9	10	10	10	10	10

The lower RIIO-1 average cost reflects the fact that the team was set up in 2019-20 and has since been growing its activity in order to deliver our proposed expanded role in RIIO-2.

The three additional FTEs and the additional funding proposed in section 14.2.2 is not in the cost table above. It will be included in our December Business Plan.

14.2.3. Metrics

Alongside the activities where we have specified potential customer satisfaction survey metrics to understand performance, we propose to continue to undertake an ESO customer satisfaction survey to ensure that we are maintaining and improving the service that we deliver to our customers and stakeholders. We will use our RIIO-1 performance to set realistic benchmarks and targets as appropriate and will report annually our average satisfaction survey scores.

14.3. ESO regulation

ESO regulation is a new team, formed when the ESO became legally separate from the National Grid Electricity Transmission (the TO). It is responsible for supporting the ESO on all regulatory matters. This includes providing advice and guidance to the ESO on regulatory issues and risks, as well as management of the NGESO licence and supporting all licence amendments. The team is accountable for all formal regulatory reporting under the price control arrangements and all regulatory engagement and reporting for the ESO incentives scheme. It also supports the business on regulatory policy matters, including external consultation responses on behalf of the ESO.

14.3.1. What will this team look like in RIIO-2?

The ESO regulation team will be fully accountable for all routine regulatory reporting and management of the ESO incentives scheme under the new price control. At present, the nature of that reporting remains uncertain, because the ESO's new regulatory framework, including its incentive scheme, is yet to be finalised. The costs below reflect our assumptions about the resources needed to manage the proposed areas of:

- a shorter business-planning cycle, with a well-justified Business Plan required every two years
- ex ante[164] and ex post[165] reporting obligations
- incentive setting and reporting on a two-year cycle.

In addition, we anticipate continuing with an evolved version of the ESO RIIO-2 stakeholder group. It would have an ongoing role in challenging the development of our business plans, potentially reviewing our performance and challenging our level and breadth of stakeholder and consumer engagement on an ongoing basis. We will include a firmer proposal on the ongoing role of our stakeholder group in the December version of our Business Plan.

ESO regulation team costs in RIIO-2, £m

£m	RIIO-1	2021/22	2022/23	2023/24	2024/25	2025/26
Opex	2.2	2.3	2.0	2.0	2.0	2.0
FTEs	19	19	19	19	19	19

We have held costs steady over the RIIO-2 period with a slight cost increase in 2021-22 to reflect additional support required to embed the ESO's new funding model. Our staffing assumptions are based on anticipated workload for two-year budget and incentive cycles and reflect the resources that have been required in RIIO-1 to manage the ESO's incentive scheme, regulatory reporting and RIIO-2 preparation.

14.4. Business change

The business change team is a dual-fuel team responsible for the identification, prioritisation, planning and delivery of business change programmes in the System Operator. The team ensures all change programmes, projects and initiatives have robust business cases and trackable benefits. Activities include programme governance and assurance, change portfolio management and reporting, and delivery of business change programmes.

The team coordinates the business planning and prioritisation process across the SO. Activities include shaping a portfolio of changes to deliver SO objectives and targets, performing business change impact assessments, managing the change pipeline, and assigning and managing resources. As a result of efficiency initiatives in RIIO-1, the business change team was moved to a 'hub and spoke' model, with a smaller presence in the ESO linked to a central UK change hub. This provides a more flexible model that allows the business to leverage best practice and access a pool of change management professionals for deployment into prioritised programmes in ESO.

[164] Based on forecasts rather than actual results.

[165] Based on actual results rather than forecasts.

14.4.1. What will this team look like in RIIO-2?

To support our RIIO-2 outputs, the team will enhance the business planning and prioritisation process across the SO with increased focus on stakeholder, customer and consumer benefit. The team will plan and deliver key transformational and business change initiatives to enable the realisation of the ESO's RIIO-2 ambition. The fall in costs from RIIO-1 to RIIO-2 reflects the move to the hub and spoke operating model as described above. Furthermore, the RIIO-1 costs include additional allowances for delivering the legal separation of the ESO.

The ESO's share of business change team costs in RIIO-2, £m

£m	RIIO-1 average	2021/ 22	2022/ 23	2023/ 24	2024/ 25	2025/ 26
Opex	1.1	0.9	0.9	0.9	0.9	0.9
FTEs	16	8	8	8	8	8

14.5. Assurance

SO assurance is a dual-fuel team that embeds frameworks and tools, and builds capability that assures the SO is managing risk and meeting its obligations every day. This includes delivery of independent, risk-based assurance activities across the SO.

There are four teams in SO assurance covering risk, safety, audit, and data and compliance. The SO assurance team provides the SO business with cross-fuel insights to inform, protect and strengthen every aspect of our business; from people to performance, systems to strategy, business plans to business resilience.

14.5.1. What will this team look like in RIIO-2?

The insight and independence that SO assurance brings provides an invaluable safeguard across our complex and changing operating environment. In our RIIO-2 Business Plan, we have provided for some small growth in SO assurance. This is being driven by our ambitious commitments, increasingly demanding stakeholder expectations and a demand for specialist experience, alongside the need to attract the right calibre of core internal auditors into our in-house assurance team. Our costs also include around £200,000 annual legal and professional fees for external audits, data system and safety licences.

The ESO's share of assurance team costs in RIIO-2, £m

£m	RIIO-1 average	2021/ 22	2022/ 23	2023/ 24	2024/ 25	2025/ 26
Opex	1.1	1.3	1.3	1.3	1.3	1.3
FTEs	11	14	14	14	14	14

15. People, culture and capability

15.1. Five-year strategy: the ESO people ambition

As a service organisation, the ESO's most important resources are undoubtedly our people. Operating the system of the future and delivering our ambition and goals for 2025 successfully will require us to have the right people and capabilities in place to help us deliver this successfully. Our success at delivering is built on our sustained ability to attract, retain, train, motivate and engage our people. Therefore, to deliver the full commitments of our wider RIIO business pan, we require a resilient, agile, capable and diverse workforce.

We will develop and extend our position as being a customer service and asset-light organisation today, to a more technology- and data-led ESO tomorrow. Given the pace with which the energy industry and our role as an ESO at the heart of it will change, our people will need to be comfortable working with ambiguity and in a rapidly changing environment.

Within the ESO, power system engineering will remain at the core of our organisation, however advanced analytics and data management skills will be increasingly important and will require a significant shift in capability similar to other industries. Alongside these, customer-focused, stakeholder and commercial capabilities will remain critical.

Furthermore, we recognise the increasing importance of IT delivery capability to enable us to achieve our ambitions. As we work with industry to deliver IT systems infrastructure necessary to enable the energy transition, we will ensure we equip our teams with the right skills to drive projects in an agile, iterative manner, realising value as soon as possible

Our proactive strategic workforce planning, has meant that we can identify any emerging future workforce and capability gaps and risks and mitigate against them. We will be implementing a blended sourcing strategy to fill the gaps. This means we will continue to 'grow our own' workforce for our critical roles through our successful trainee intake; this builds a pipeline of resource and future capability. This will be supplemented by, external direct hires to help fill new and specialist roles as required. In doing so we will look to recruit a diverse workforce representing the industry we operate in.

We will continue to invest in training our existing workforce and building capability as identified through employee development plans and capability diagnostics.

Today, the ESO has a strong engaged workforce to leverage going into RIIO-2. In order to achieve our ambitious RIIO-2 Business Plan, we need to transform our business and take our employees along this change journey by continuing to adapt our ESO organisational culture. We are looking to make a number of key behavioural shifts, for example leading by empowering, embracing an enterprise and collaborative mindset, operating with agility & flexibility and balanced risk taking & speeder decision making. These shifts are supported by our stakeholders and will be reflected and reinforced across all elements of our ESO business operating model to ensure everything including leadership tone, governance, processes and systems support our desired end-state culture.

In order to turn ideas into action, to deliver our vision and ambitious RIIO-2 plan, we will attract, develop and enable the next generation of climate change leaders. We will look for people to join us to work on "the job that can't wait".

ERSG supports our People, culture and capability proposals.

"The chapter shows the company's understanding of current culture vs. where they need to get to. Could still add additional detail on change management aspects."

15.1.1. Stakeholder feedback

Through our conversations with a wide range of stakeholders, talking with trade union representatives and feedback from our ESO RIIO-2 stakeholder group, we were asked for additional detail on:

- Our existing and future capabilities requirements
- Our organisational culture today and how it needs to evolve to support our RIIO-2 plan
- How we will source the required people and capabilities
- How the ESO is confident in the deliverability of the RIIO-2 plan.

In this chapter, we have provided as much detail as is feasible and proportionate, noting that allocations of teams to Themes is an estimation. It is important to understand that Themes do not exist in isolation. The key to success lies in people collaborating and working across Themes.

Where we have not been able to implement or respond to stakeholder feedback, explanations have been captured in the Stakeholder report.

15.1.2. People and capability trends

Our workforce is made up of four different generations, which brings great diversity of thought and requires targeted management to ensure different needs are met. To appeal to different employees, we must review our people value proposition, especially in areas such as onboarding, employee development and retention to ensure we overcome the challenges of the future. Today employees have a greater choice of jobs, career fields and employers.

The major trends which may affect the ESO include:

- The rapid pace of change and technological advancement means that it is often difficult to predict the future skills required. The pace will not be slowing, so we need to accelerate deployment of our existing capabilities yet remain alert and pivot quickly in response to new requirements.
- Despite steady improvements in our higher education systems, the competition for STEM-qualified workers is ever increasing. New technology further drives this demand across all sectors.
- The 'gig economy' is growing – organisations will be increasing their interactions with independent workers for short-term employment engagements.

We want to make sure we can source and maintain a capable workforce to deliver the requirements in this Business Plan. We will:

- redefine our people value proposition so we remain an attractive employer
- increase collaboration and communication with education providers
- consider what type of contract is most suitable for which roles and required skills.

15.2. Our people profile

15.2.1. The 2020/21 workforce: our starting point

We forecast that by the end of March 2021, we will have a workforce of approximately 620 full-time equivalents (FTEs). The average age of our workforce is 40. This means that by the end of the RIIO-2 period, we estimate that five per cent of our current workforce will reach retirement age (including six per cent of all our engineers). Combined with the ESO historic attrition rates, we will anticipate a people turnover of 18 per cent by 2026.

In line with ESO workforce trends, we applied the following age band attrition rates:

Age band	Attrition
20-29	9.5%
30-39	7.9%
40-49	1.4%
50-59	1.1%
60-69	0.0%

Looking at the FTE profile requirements for the Business Plan against the current workforce (adjusted with forecasted retirement and attrition rates for the RIIO-2 period), we anticipate the following recruitment gap:

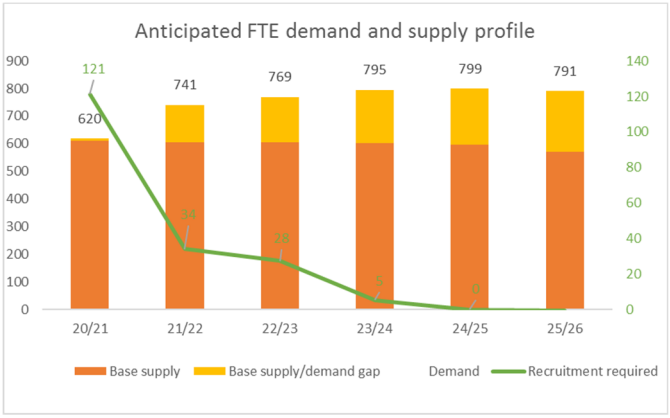


Figure 87 *Anticipated people demand and supply profile*

15.2.2. Our estimated future people profile

We recognise that to deliver the Business Plan, the balance of people and skills will have to change. Over half of the additional FTEs required for 2021 will be roles working on: EU codes engagement, transforming balancing, market platform related activities, data stewardship for the open data platform, policy-related activities and system operation innovation. Throughout the RIIO-2 period, we will also be increasing our

resources in our control room and those involved in the transforming the code modification process.

Below is an overview of the range of FTEs (approx.) allocated to each Theme and cross-cutting area. Many roles will be working across Themes.

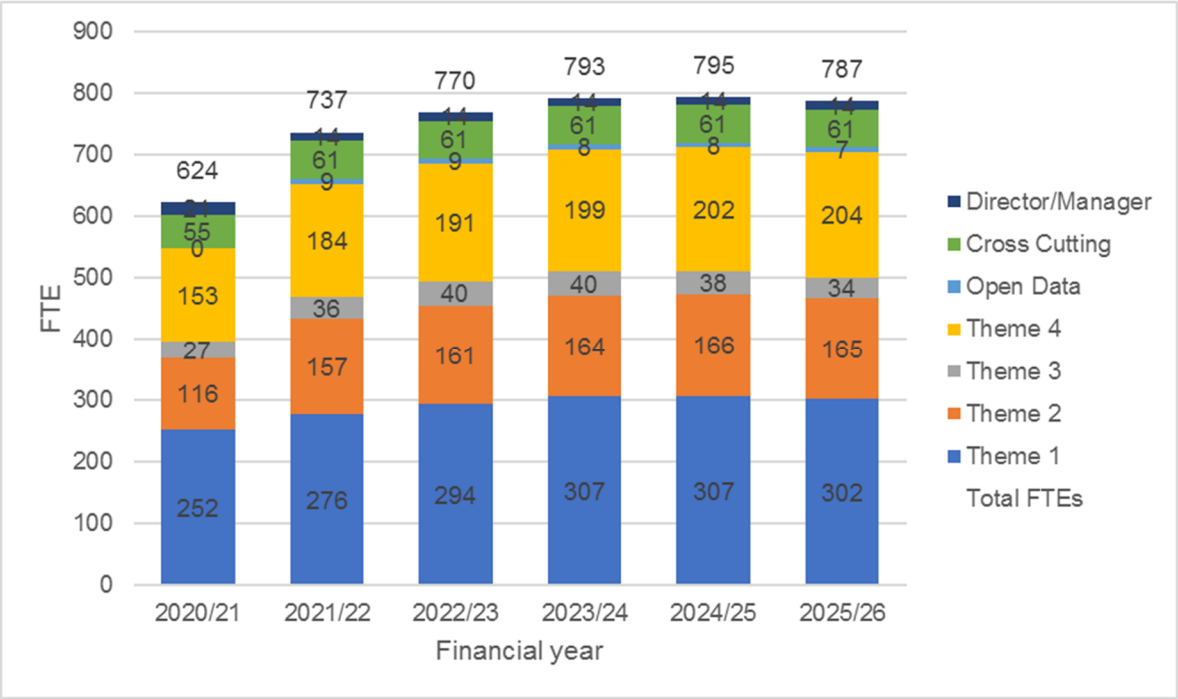


Figure 88 Estimated people profile by Theme

Due to the peak increase in year 1, there will need to be a strong recruitment drive ahead of the commencement of the RIIO-2 period.

The table below provides an overview of activities employees will focus on per Theme and key capabilities required. More detail on the capability shift is provided in section 15.3.

Theme 1 Reliable, secure system operation:

As we transition to a low carbon energy system, the control engineers of the future will have to extend their current power system engineering skills to include expertise in data analytics and technology. This will allow them to better understand the performance of the system and make best-use of the significant increase in data from those connecting to and using it. This will transform our system balancing and decision-making capabilities, and ensure we continue to make the right decisions in a highly complex energy environment.

Areas of focus:

- Expand and transform our Control Centre architecture and systems
- Transform training and simulation
- System restoration.

Key capabilities required (not exhaustive list):

- Power system engineering
- Data management
- Advanced analytics to increase situational awareness
- Customer- and stakeholder-facing capabilities.

Theme 2 Transforming participation in smart and sustainable markets:

We will design the future markets, codes and charging arrangements that embrace industry advancements and maximise benefits to consumers.

Areas of focus:

- Build the future balancing service and wholesale markets
- Transform access to the capacity market
- Develop code and charging arrangements that are fit for the future.

Key capabilities required (not exhaustive list):

- Customer- and stakeholder-facing capabilities
- Innovation with commercial mindset
- Economic analysis and modelling
- Data analytics and predictive analytics using machine learning
- IT project sponsorship and delivery.

Theme 3 Unlocking consumer value through competition:

We will continuously build on our successful *Network Options Assessment* (*NOA*) approach to facilitate competition across all dimensions.

Areas of focus:

- Embed the Network Development roadmap enhancements
- Extend and enhance the *Network Options Assessment* (*NOA*) approach
- Undertake, with industry, a review of the System Quality and Security of Supply standard (SQSS)
- Support Ofgem to develop its thinking on competitively appointed transmission owners.

Key capabilities required (not exhaustive list):

- Economic analysis
- Data management and analysis, programming capabilities
- Customer- and stakeholder-facing capabilities.

Theme 4 Driving towards a sustainable whole energy future:

We will increase strategic insights in the policy space to support the development of a smart, flexible energy system. This will include a clean-heat strategy and a pathway for ensuring the operability of a zero carbon electricity system.

Areas of focus:

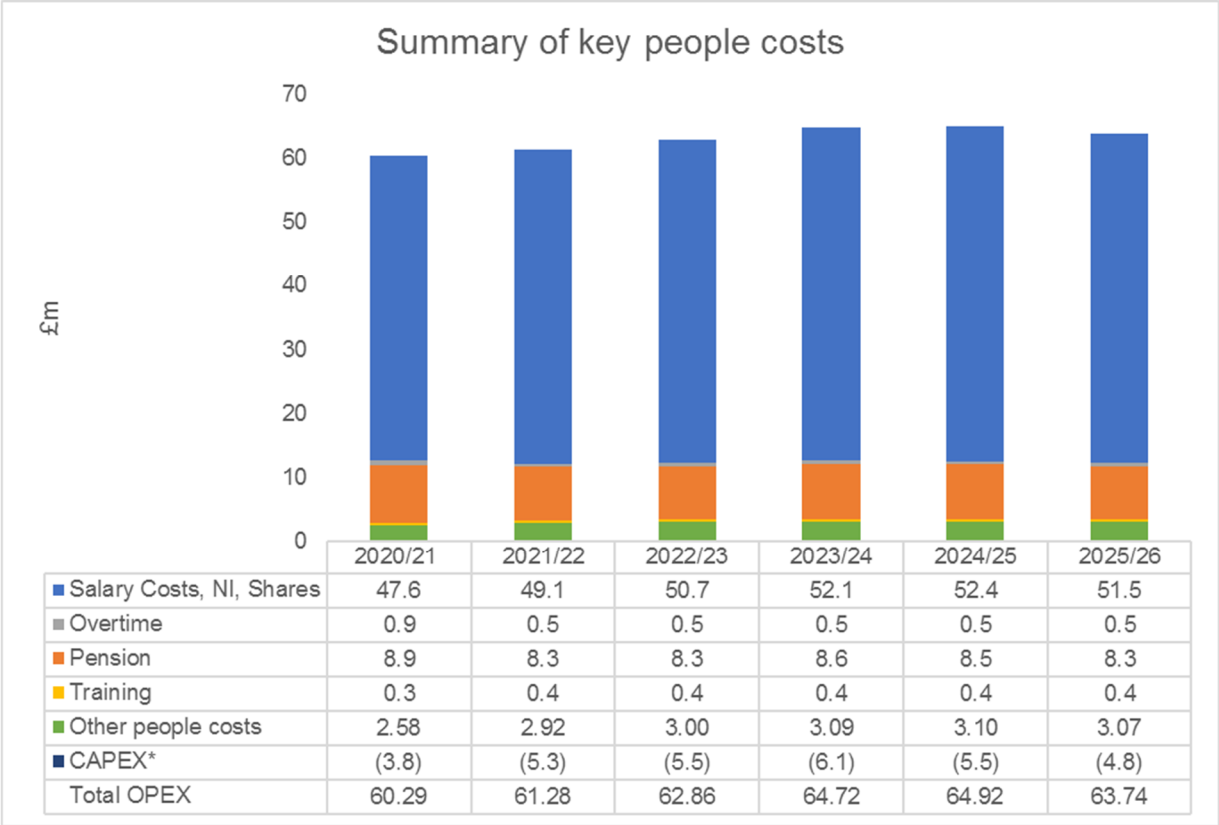
- Leading the debate on decarbonisation of the GB energy industry
- Working more closely with Distribution Network Operators (DNOs) and Transmission Owners (TOs) to streamline the connection process
- Defining a pathway for zero carbon, whole system operability
- Developing a whole system approach to accessing electricity networks.

Key capabilities required (not an exhaustive list):

- Economic analysis and modelling
- Data management and analysis
- Customer- and stakeholder-facing capabilities
- Leading the debate.

15.2.3. People costs

Below are our expected people costs in RIIO-2, in alignment with the current estimated FTE profile. We will continue to undertake measures that make sure our staff costs provide value for consumers while remaining an attractive employer.



	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26
Salary Costs, NI, Shares	47.6	49.1	50.7	52.1	52.4	51.5
Overtime	0.9	0.5	0.5	0.5	0.5	0.5
Pension	8.9	8.3	8.3	8.6	8.5	8.3
Training	0.3	0.4	0.4	0.4	0.4	0.4
Other people costs	2.58	2.92	3.00	3.09	3.10	3.07
CAPEX*	(3.8)	(5.3)	(5.5)	(6.1)	(5.5)	(4.8)
Total OPEX	60.29	61.28	62.86	64.72	64.92	63.74

Figure 89 Key people costs. These costs are one element of the total business opex, the costs only relate to staff cost (e.g salary, training etc).

* People CAPEX allocated to specific projects.

15.3. Our capabilities

In many ways, we will be undertaking the same activities we are doing today, but requiring new skills to tackle new challenges. For example, power system engineering will remain core, while we need to strengthen capabilities in data analytics, commerciality, IT delivery and leading the debate to meet new system operation and market demands. With accelerating change, increasing uncertainty, ambiguity and cross-industry dependency, our future workforce will require a more blended capability profile.

15.3.1. Capabilities to deliver current activities

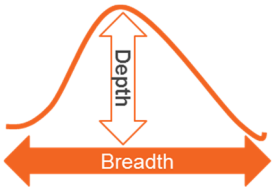
Two-thirds of our current workforce is comprised of engineering capabilities (mostly electrical network control engineering) and commerciality (mostly commercial operations, market development and energy trading).

We have also been increasing our strategic, customer and data capabilities during the RIIO-1 period to develop our role as a legally separate ESO in a fast-changing, consumer-driven energy industry.

The capabilities we have today will continue to be important, but they will need to evolve while we develop new capabilities detailed in the next section.

15.3.2. Our future capabilities

System operation of the future will become more complex, inter-dependent and ambiguous. As a result, our employees will require both a breadth and depth of capability in terms of skills, knowledge and experience. This is particularly true for the key capabilities needed across the ESO: power system engineering, data and analytics, commerciality, IT delivery and leading the debate.



- **Depth** - Primary capabilities at advanced or expert level
- **Breadth** - Mixture of secondary capabilities at foundational or skilled level

Figure 90 *Capability model*

We have described below why it is important for us to focus our attention on these five organisational capabilities. We considered what does that capability look like in the context of the ESO, and the shift in people skills required to achieve it.

We have described below why it is important for us to focus our attention on these five organisational capabilities. We considered what does that capability look like in the context of the ESO, and the shift in people skills required to achieve it.

Capability	Power systems engineering
Why it is important	To meet the increasing complexity of managing system operability and the new challenges presented by rapid disruption, technological development and changing system dynamics.
What it means for the ESO	Core power system engineer capabilities will remain essential, both in terms of planning ahead of time and managing the power system in real-time. Power system engineers (PSEs) of the future will have to be increasingly data literate and situationally aware as available data grows in volume, variety, velocity and veracity. They will be required to understand what this data tells us about the behaviour of the power system and its users, so that they can take actions that are cognisant of the impact on the whole electricity system and beyond. The ability to engage stakeholders and collaborate with others will become more relevant, to work with not only the DNOs/DSOs to manage networks across voltage levels, but also with policy makers and multi-vector players to understand broader impacts and maximise consumer benefit. This capability will be increasingly competitive to source within the industry, as the development of Distribution System Operation will also drive demand for PSEs.

Capability	**Data and analytics**
Why it is important	To use data to provide the rapid and automated predictive insights required, providing value for system operation and market participants.
What it means for the ESO	This capability includes data science, analysis, modelling and programming capabilities, working with machine learning algorithms and artificial intelligence, knowledge of statistics and neural networks. This capability will enable us to improve our use of data throughout the timescales in which we operate. Closer to real time, we will be better able to develop forecasting models for generation and demand (such as our recent machine learning innovations for Solar PV forecasts). We will be able to derive greater insights into system behaviour and use this to support the development and use of our balancing services to meet those operational needs. Further, we will be able to deploy these capabilities to support and improve our longer-term insights through our Future Energy Scenarios, Network Options Assessment and System Operability analysis. We will consider creating a central resource/centre of expertise to develop and share best practice, but it will be important to also have these capabilities embedded within certain teams. This capability will be required to successfully drive innovation in system operation. We recognise this is a scarce and highly sought-after skill. You can find more detail on how we will source it in section 16.6.

Capability	**Commerciality**
Why it is important	To understand and optimise commercial agreements and market solutions, driving value for consumers while meeting complex operational needs.
What it means for the ESO	Commerciality will need to be augmented so the needs of the power system can continue to be sourced through competitive processes. This capability will include: • Understanding of commercial frameworks and markets • Ability to balance requirements, e.g. of stakeholders, consumers and shareholders • Negotiation skills to find the lowest sustainable cost solutions to operability and network development challenges, where competitive procurement mechanisms might not be feasible This will cover, for example, the need to develop commercial terms for new balancing services and design new markets to meet emerging requirements, while broadening the access to existing services so that they can accommodate many new, smaller providers likely to require closer-to-real-time procurement (such as through auction processes). It will also cover the assessment of a range of ways to meet network development requirements, e.g. by comparing traditional asset build to other more service-based solutions from those that connect to networks – this activity will increase in both scale and scope during the RIIO-2 period.

Dedicated IT resources within a shared service model

As covered in the chapter 'technology underpinning our ambition', the dedicated ESO IT team will leverage the National Grid Group IT function for IT products and services as required. By centralising common capabilities, such as end user computing (laptop and desktop services, email, etc), enterprise application services we benefit from the economies of scale that the group offers and avoid duplication of resource and solutions.

We received feedback asking how ESO can provide confidence in large-scale technology delivery with no direct reporting line between the ESO leadership and the IT function. The feedback focused on whether the requisite levels of control could be exercised to ensure successful delivery.

We believe this concern is mitigated through our structure (introduced in August '18) that provides a dedicated ESO IT team who focus on strategy and planning, change delivery and service delivery. This team is dedicated to the ESO, led by the head of IT for ESO. This model allows the ESO IT team to focus on specific ESO requirements which differentiate the business from the wider National Grid organisation. It also allows the ESO IT team to scale quickly and efficiently through the broader National Grid IT function.

The head of IT for ESO has direct control over a team who are responsible for strategic engagement and planning, change delivery, and service delivery. This team draws on resource from the wider group who are dedicated to ESO (where there is a high dependence e.g. CNI) or leveraged where the requirement is more generic.

Figure 91 IT shared services provided by group IT.

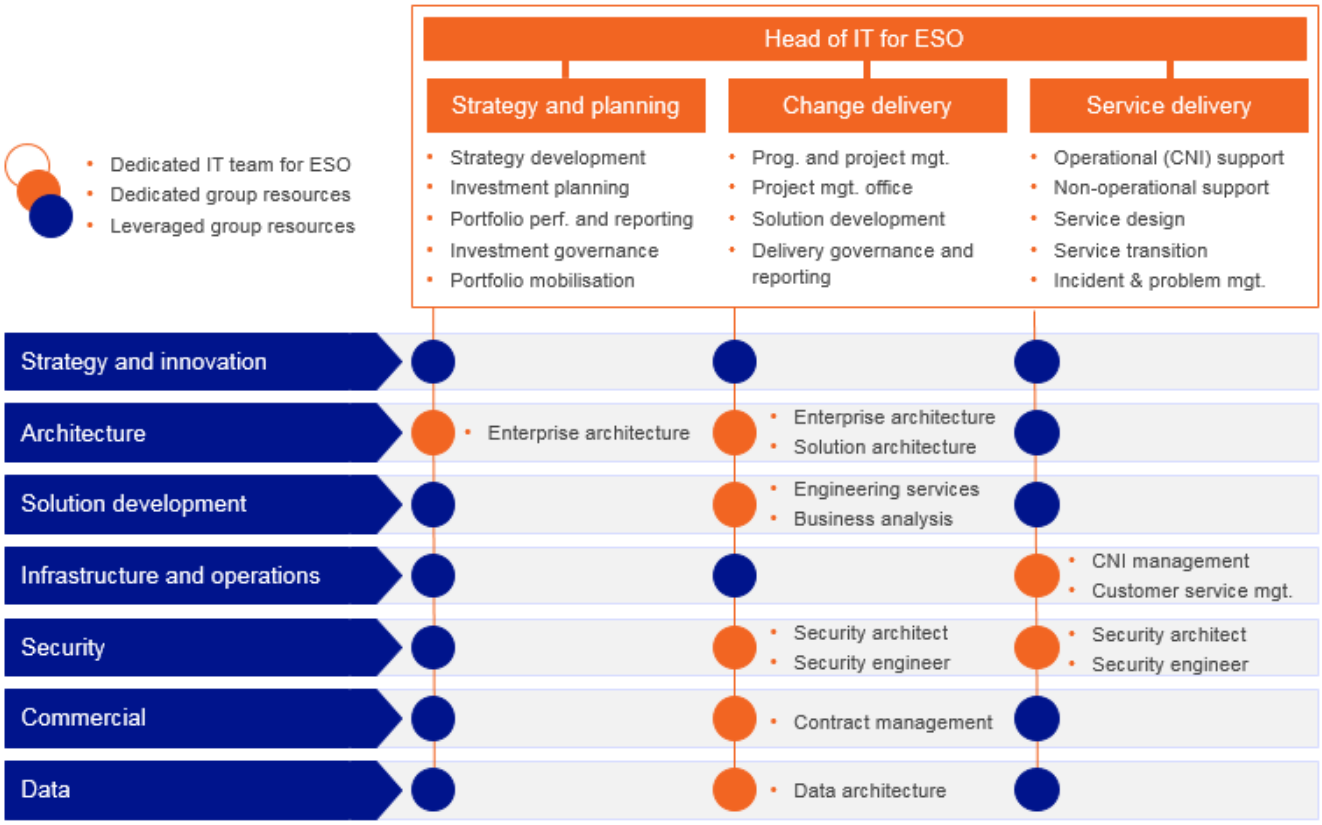


Figure 92 IT resources that are dedicated to ESO and where services will be drawn from the wider group.

Technology delivery

As referenced in chapter 10, we will need to strengthen our IT delivery capability across the ESO. This will see us move from predominantly waterfall project delivery to agile teams that are aligned to business channels.

Our IT transformation programme will apply the Scaled Agile Framework (SAFe) and Agile scrum and we will need to ensure our leaders are equipped to work in this environment.

This means being able to deliver large IT transformation programmes iteratively, incrementally, to high-standards of quality, within time and budget constraints that meet the high-levels of complexity, operational need and level of dependency across the industry.

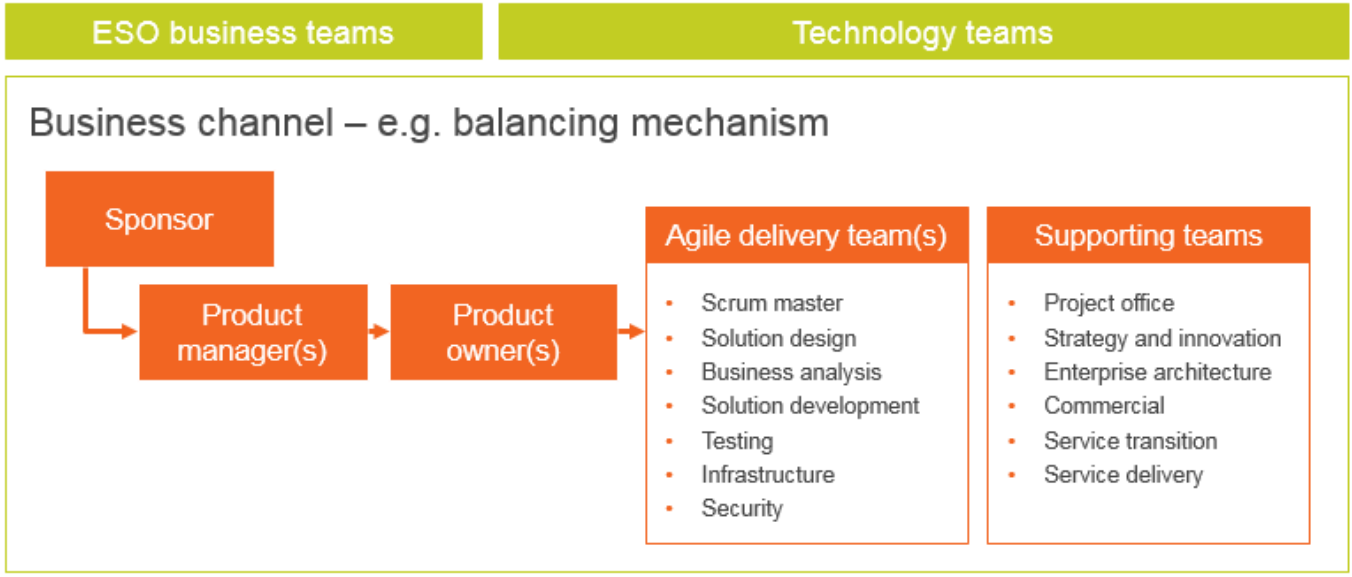


Figure 93 figure shows an example agile delivery team for a business channel

We are committed to building the technical depth and leadership capabilities to enable us to execute on our focus of being a technical thought leader. We have a programme committing our teams to a minimum of 40 hours of training per person per annum.

Technology capabilities

To enable the ESO to achieve the ambitions that drive value for our stakeholders and consumers, scalable, agile IT delivery teams are fundamental in the successful implementation of technology solutions. The following roles are being developed in addition to our current capability to enable our transformation towards agile delivery.

Scrum Masters – we utilise a large base of project managers across the delivery of our projects and programmes. As we have transitioned to a greater use of agile, we have invested in the role of scrum master. This is a facilitation role that coordinates the sharing of information across the agile development team. It is a transition from the traditional project manager role, as it acts as a servant leader, promoting team communities and shared decision making. In conjunction with the agile coach we are accelerating our transition towards an agile delivery culture.

Agile Coach – we are investing in agile coaches across the IT portfolio, to accelerate our cultural and process transformation. This role is necessary, particularly in the medium term (18-24 months) to ensure we embed the techniques and discipline of agile in the DNA of our delivery portfolio. This role will also allow us to train our teams and new joiners in an efficient and effective manner.

Product Owners – as our adoption of agile increases we are upskilling our business SMEs to become product owners. This role transforms the traditional role of business lead to become more active in the development of products and services. The product owner operates as a dedicated delivery role, providing the vision, priority and interface between the IT and business across projects and programmes. This role is critical to ensure our delivery initiatives continuously align to the needs of our customers and stakeholders.

Product Managers – we are extending the role of our IT strategy analysts to manage and oversee the full lifecycle of IT products and services. This role will ensure there is integrity between the strategic ambition, delivery and service life of our products and will ensure it maintains the interests of our internal and external customers and stakeholders as requirements and capabilities mature.

Capability	Leading the debate
Why it is important	To enable the energy transition through facilitating industry collaboration, taking a distinctive and leading voice, proactively engaging with stakeholders to progress conversations on key topics and support decisions across industry and policy, in the best interests of consumers.
What it means for the ESO	Our people will need to employ subject matter and content expertise, demonstrating strategic thinking across the energy landscape, to articulate the wider energy market needs, to be able to persuade and influence stakeholders. This includes: • having a clear understanding of the regulatory environment, energy markets (including trends and drivers beyond the implications of the Future Energy Scenarios), the wider business context of industry participants, and so the impact of decisions on them can be better understood • being able to effectively communicate the need for change and influence stakeholders and take them on a journey • having the strategic capability to see the bigger picture with an ability to translate this into robust deliverables and plans to drive delivery We are creating roles that are fully dedicated to leading the debate activities.

We will also need to enhance our existing capabilities;

- **Innovation:** Our leaders will need to have innovation hard wired into their everyday activities. The innovation team will continue to be the specialists, enabling the ESO to pursue necessary projects that have the potential to disrupt and create a step change towards reaching the net zero target by 2050.
- **Change leadership** and management: Given the level of change occurring across the energy landscape and within the ESO during the RIIO-2 period, the capability needed from our leaders and senior staff members will be to lead, enable and empower our people through periods of uncertainty.
- **Stakeholder engagement**: Given the increasing inter-dependency within the energy system, the ability to create long-term sustainable partnerships with stakeholders, use a systematic approach to proactively engage and collaborate with them and become a trusted partner will become progressively more important.
- **Economic analysis**: Our SMEs will be required to balance their focus on power system analysis with the economic performance of the system, so consumer benefit is maximised.
- **Leadership:** We will be empowering and enabling our leaders to set direction and the tone that reinforces our culture. We will continue to invest in our leadership development over the RIIO-2 period.

15.4. How we will attract and retain our talent

We have identified gaps in capability and capacity and are confident we can fill both with a blended sourcing strategy, using our unique people value proposition.

15.4.1. People value proposition

Our mission is to enable the transformation to a sustainable energy system and ensure the delivery of reliable, affordable energy for all consumers. This provides an exciting employee proposition, which helps us attract and retain new talent. Our employees have a strong purpose as they can anchor their contribution to the energy transformation at such an exciting time.

Our people value proposition is focused around:

- **Our purpose** – being at the heart of the energy transition and driving real change within the industry
- **Our development opportunities** – continuing to invest in our people, in line with our 'grow your own' and science, technology, engineering and maths (STEM) strategy
- **Our inclusive and diverse environment** – welcoming diverse talent and diversity of thought in an inclusive environment representing the communities we serve
- **Our strong focus on health and well-being** – looking after our people so they can perform to the best of their abilities and deliver outcomes for consumers

Sourcing an inclusive and diverse workforce

Our workforce will be representative of the communities we serve in all aspects of diversity.

- Increased diversity will make employees feel included. This improves wellbeing and enables us to deliver better outcomes for our customers and stakeholders when we better reflect communities internally.
- Being a socially-responsible employer, inclusion and diversity are important to us because by being diverse we amplify the range of ideas and innovation that our people can generate as well as enabling our people to thrive in a culture that represents the communities we serve.

National Grid has seen positive progress in inclusion and diversity (I&D). Our workforce demographics are becoming more diverse, and we have been recognised externally as leaders in this area – with our inclusion in The Times Top 50 Employers for Women.

Some 31 per cent of the workforce in ESO are female, and 24.6 per cent of the workforce are black and minority ethnic (BAME). There is still more to do. Our ambition is to achieve 50/50 gender parity in recruitment for engineering roles through growing and broadening the potential candidate pool, attracting females to apply for our engineering/STEM roles, demonstrating inclusive recruitment and onboarding processes, and retaining and developing our female talent. The strategic drivers to meet our I&D ambition are to:

- continue to build on our success to-date, evidenced by increased external recognition and our gender and BAME diversity progress.
- seek to attract diverse talent by being visible and appealing to a variety of potential employees.
- offer equal opportunities for everyone at ESO to develop and advance throughout the organisation.
- continue to work on inclusive leadership to raise awareness of our own biases, and seek out and consider different views and perspectives to inform better decision-making.

Focus on health and wellbeing

ESO has three aims in this space:

- A workforce where healthy, engaged and supportive employees can succeed and thrive, including with the demands of shift and operational working.
- A culture that enables everyone to perform to the best of their abilities, knowing they are well cared for and can talk openly about their health and wellbeing.
- Recognition as an employer that leads in employee wellbeing and this enables us to attract and retain the best talent around.

15.4.2. Pay and reward strategy

The ESO has a pay-for-performance philosophy. Our objective is to have a pay and reward strategy which is fair, competitive, sustainable and ensures the right value for consumers.

Senior management pay and reward is linked to achievement of personal objectives and ESO performance scorecard. The set of personal objectives will include achievement of the commitments in the Business Plan. Furthermore, the bonus has five measures; one relates specifically to achievement of SO incentives and another relates to customer satisfaction.

We carry out market benchmarking to make sure our compensation and benefits programmes remain competitive. Our aim is to be at the market median position in relation to our comparator group. The last review, conducted in 2018, showed that total cash remuneration is in line with median pay for a comparator of 130 entities in the utilities, oil and gas, and chemical sectors, with an average comparison ratio of 101 per cent.

We also benchmark individual role salaries annually and have established pay mechanisms to increase salaries where required, to close any capability gaps that the ESO faces, such as for specialist roles included on the government's Shortage Occupation List. Our assumptions for real pay growth during the RIIO-2

period are based on historic experience and external evidence. They will be refined as we receive more economic data. We work with the trade unions and employees to make sure we balance the requirement for cost efficiency with motivating employees, so the skills we require are available into the RIIO-2 period.

Figure 94 Sourcing strategies

We are continually looking to grow our own talent in core STEM areas through our higher apprenticeship and graduate programmes. To support the transformation of our organisation, we will supplement this approach by hiring new talent from the external market to fill gaps for emergent, scarce or urgently needed skills. Some of our core roles have a scarce talent pool and are recognised on the shortage occupation list in the UK. Where required we make use of the General Work Visa (Tier 2).

In addition, to maintain flexibility and manage peaks and troughs in our workload, we will continue to supplement our core workforce with contingent labour through dedicated managed service providers.

15.4.3. 'Grow your own' talent

Given the shortage of STEM talent, we aim to:

- attract talent by further enhancing our reputation as an award-winning engineering organisation, having top-quality entry programmes, and ensuring our engineers are professionally accredited.
- grow the UK talent pool in STEM, so we have a quality pipeline that we can recruit from. For example, via key partnerships with industry bodies such as the Royal Academy of Engineering and Energy and Utility Skills.

Internships, apprentices, undergraduates and graduates are at the heart of our ambitions, which is why we have been committed to investing in the futures of new talent for over 40 years. Higher apprenticeship schemes have worked for us in successfully providing a pipeline of 'grow your own' talent to our power system engineer roles. Furthermore, our graduate scheme has provided a pipeline for both engineering and non-technical and commercial routes. Our 18-month graduate scheme is accredited by the IMechE, IGEM and IET.

We will continue to adapt our current new talent schemes to better reflect what the ESO needs for the future. For example, we have increased our intake to the Higher Apprentice and Graduate scheme from 2021 to help mitigate our forecasted attrition. In order to retain our technical and STEM talent, we will consider creating new technical career and development paths.

Sourcing the power system engineer pipeline

As we manage the fundamental changes to operating the network and markets over the next decade, the capability of our people and engineers to manage and respond to changing operational challenges and environment will be vital.

Our STEM strategy will help source the power system engineers of the future, but it will not be enough to deliver the requirements under Theme 1. Hence, we propose an enhanced training strategy for system operators, as outlined below:

- In the short term, sponsoring dissertations and developing modules for existing courses related to system operation.
- In the longer term, if there is appetite, developing a more tailored course in electricity system operation.
- We will look at adapting our current higher apprenticeship scheme within the National Grid Academy to make sure it continues to meet our future needs.

We will:

- shorten and enhance initial control room job training and authorisation through online- and e-learning.
- enhance our existing facilities for off-line event simulation and team scenario training, using the digital twin to conduct a wider range of realistic "what-if" exercises.
- secure the exercising and team training necessary to maintain robust operational control room response to changing network conditions.

This initiative will:

- provide fulfilling development for our people that supports improved staff retention
- create a pool of talented people with the skills for the future, reducing our exposure to attrition.
- provide expertise of value across the electricity industry.

Sourcing IT capability

For IT capability, we are identifying roles that should be in-house, rather than delivered by partner suppliers. We are building an internal skill base that supports business engagement, intellectual property development, strategy, and architecture. Where greater depth or breadth of technical knowledge is required, we will draw upon a close partner network of suppliers.

We will develop a resource-acquisition approach to secure in-demand skillsets covering data, information, and digital toolsets and platforms. We will also create career pathways that develop staff and build a strong base of skills, knowledge and experience within the team. We will support this with the practices, processes and culture that enable our information technology (IT) function to operate as an innovative thought leader.

We anticipate that, in response to the ambitions of the business and increased stakeholder expectations, the volume and availability of business subject matter experts to integrate with delivery teams will increase. This will also support strategic value. The anticipated resource requirements have been embedded in the Theme papers and cost profile for IT.

We will draw on global IT delivery teams to provide consistent platforms, such as customer relationship management (CRM). This will allow us to use the economies of scale that come from being a multinational organisation. We will also minimise our dependency on specific vendors and utilise our commercial frameworks and engagements with technology suppliers and partners.

Sourcing data scientists

Data scientists are in high demand. As this is a scarce skill in the market, we will consider various sourcing options. As well as upskilling our own employees and partnering to source niche capability with academia, we will consider using specialist recruitment providers who will not only supply the resources, but will also provide training/development while the resources are assigned to us. As competition for these skills increases, we will consider technical career paths for certain roles to help retain them.

15.5. Our culture

A powerful and empowering organisational culture drives a surer route to organisational success.

To attract, recruit and retain talent in our organisation through the RIIO-2 period, we will have to adapt our existing ESO organisational culture. A strong organisational culture allows us to live our core values, enhances employee engagement and has a positive impact on performance and our employees' wellbeing.

Given the business challenges the ESO and industry faces over the coming years, change management provides the process, tools and techniques to manage our people through the period to achieve our business outcomes. We will develop and upskill our people in the tools and techniques they will need to use to enable the culture change required to deliver our ambitions.

We will need to augment our change management capabilities so we can make best use of the new operational tools and techniques made available by our proposed IT, data and analytical outputs. We will need to review and optimise our workflows from years-ahead planning through to real-time operation, so our systems and processes make best use of these new capabilities, to deliver customer and consumer value.

Leaders will need to challenge the status quo constructively and apply understanding of change behaviours and requirements to engage their teams as we transition to new systems and processes. They will need to think across ESO functions so systems and process efficiencies can be realised. Staff members will need to deploy change management methods to make sure we implement new capabilities consistently; maintaining close working relationships with IT partners as required.

We are seeking to make a number of key behavioural shifts which will allow us to build on our existing culture. This will enable us to make the shift required to support the ESO business in achieving its RIIO-2 Business Plan ambitions. Our stakeholders have been consulted on this proposal throughout our transformational activity engagement and have provided feedback which we have incorporated where relevant through the Business Plan. More information on the feedback we received and how we have incorporated it in our proposals is set out in the Stakeholder Report. Additionally, in order to build and embed our desired culture, we will need to make sure it is reflected and reinforced across all elements of our ESO business operating model, including leadership tone, governance, processes and systems.

15.5.1. Our culture today

The ESO today has a distinct organisational culture. Within the RIIO-1 period, we have embraced our values of "do the right thing" and "finding a better way". "Do the right thing" pulls together our foundational values of keeping each other and the public safe; complying with all the relevant rules, regulation, and policies, respecting our colleagues, customers and communities, and saying what we think and challenging constructively. "'Find a better way" challenges us to focus on performance and continuous improvement.

We are proud to have a strong engaged workforce today. Since 2016 our employee engagement survey results average at 72 per cent, with 76 per cent of our employees indicating they are proud to work with us and 77 per cent feeling aligned with our company's goals.

We need to build on these strong foundations internally and with the wider industry so we can deliver our ESO RIIO-2 Business Plan and provide maximum benefits for UK energy consumers.

15.5.2. Our culture tomorrow – The shift

Understanding the rate of change and our pivotal role in supporting the UK embracing new energy sources and achieving its decarbonisation targets, we need to enhance our culture to support the transformation required.

To enable successful delivery of the Business Plan, we are proposing the following behavioural shifts:

Figure 95 Behavioural shifts

Our ESO culture needs to continue to be supported by strong core leadership values to drive collaboration, create the future, take bold and brave actions, tell compelling stories which inspire belief, and lead with influence and presence.

Our desired culture-shift will enable us to operate with agility and achieve our ambitions. To achieve this, we need to reinforce our desired culture across all areas of our ESO business operating model (i.e. people, process and technology). The figure below demonstrates the spectrum of change across an organisation's operating model dimensions. We are working internally and consulting with our stakeholder groups on where we need to be across these dimensions so we can achieve our RIIO-2 ambitions.

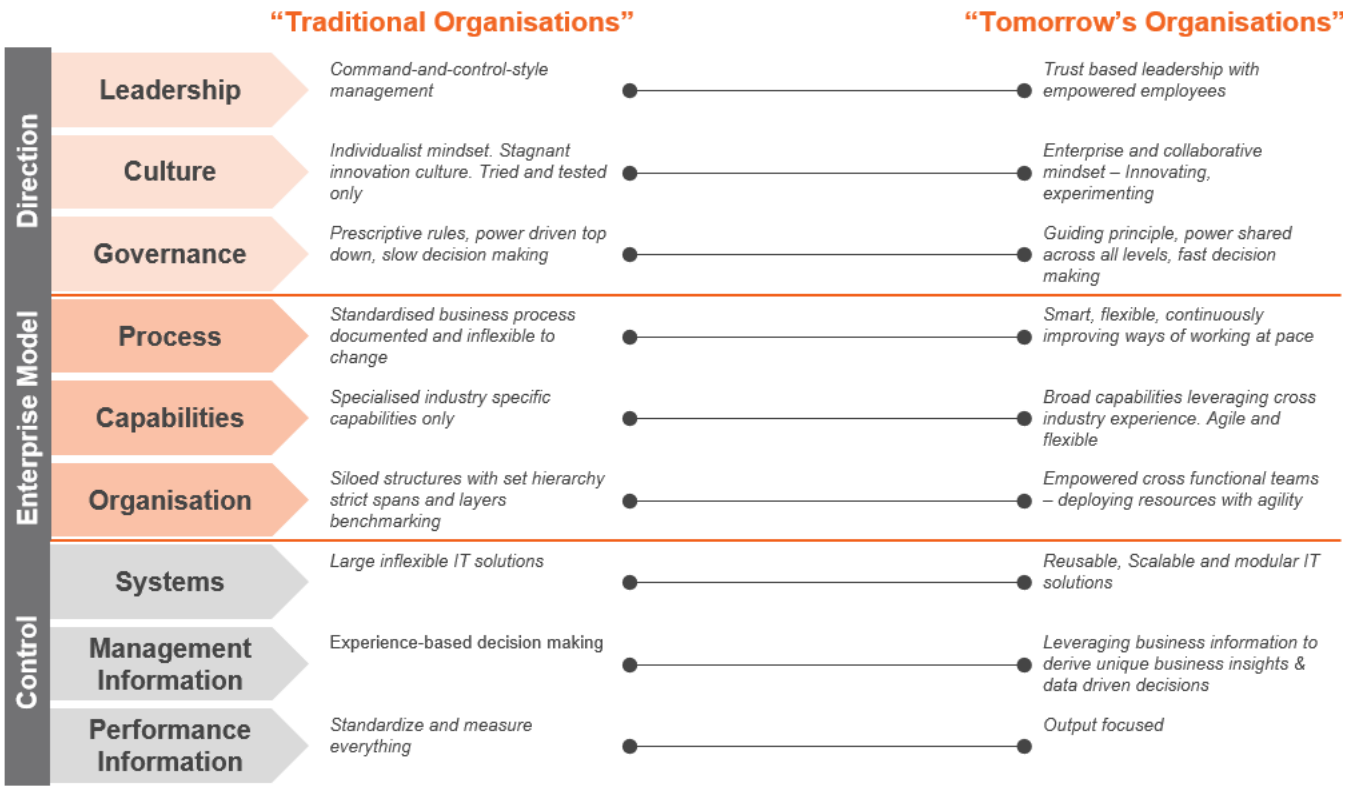


Figure 96 Spectrum of change across an organisation's operating model dimensions

Over the next few months, we will be finalising the design of our desired target culture and behavioural shifts required to help us to achieve our ambitions. During the RIIO-2 period, we will seek to put in place the changes required through a targeted, proportionate transformation programme that moves us towards our desired end state culture.

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