nationalgridESO

RIIO-2 Business Plan Draft

1 July 2019

Contents

1. Executive Summary

1.1 Introduction

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. The development of this business plan for RIIO-2 is an unprecedented and exciting opportunity for the ESO to engage extensively with stakeholders to define and develop our role during a time of significant change.

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 drive value for consumers in everything we do.

Our System Operator (SO) mission[1] is to enable the transformation to a sustainable energy system and ensure the delivery of reliable, affordable energy for all consumers.

Success in 2025 includes:

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

Our July draft business plan has been developed with the support of stakeholders and within it we expand upon the proposals in *Our RIIO-2 ambition*[2]. We provide the next level of detail on the new, transformational activities that we propose, and set out how they deliver net consumer benefits of £2.3 billion.

We provide an upfront overview of the big feedback themes we heard from stakeholders and how these have broadly shaped our business plan. We also set out, in each chapter of the plan, the specific stakeholder feedback that has influenced our detailed proposals. The broad consensus of stakeholders is that the ESO needs to have a stretching ambition that will facilitate the transition to a net zero economy by 2050 and that investment will be needed in RIIO-2 to achieve this. Accompanying this document is a RIIO-2 Stakeholder Report where you can find the full suite of feedback we received and how we have responded to it.

Context:

In its decision document published on 24 May, Ofgem stated that the ESO should produce a five-year strategy and a two-year business plan. Ofgem explained these should set out the ESO's costs, activities, deliverables and performance metrics for delivering its strategy over the first two years of the RIIO-2 period.

Consistent with Ofgem's request we are providing a strategy for a five-year period together with an initial view of our proposed outputs, activities and deliverables. This reflects the longer-term nature of many of the transformational outputs we propose.

The costs set out for the first two years of this period should be read as part of this longer-term investment proposal. Our cost-benefit analysis and data tables also look at a five-year period, as required by Ofgem.

1.2 Delivery of consumer benefits

Our draft business plan focuses on the new activities we propose for RIIO-2. We estimate that the proposed new activities will generate **net benefits of around £2.3 billion for consumers over the five-year RIIO-2 period** – delivering £6 of new benefits for every £1 of additional investment in the ESO. The cost of these new proposals is around £470 million on top of our core, ongoing business costs. 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 benefits that are

[1] Our mission applies to both our Electricity System Operator and our Gas System Operator businesses.
[2] https://www.nationalgrideso.com/about-us/business-plans/future-planning-2021-onwards

able to be quantified, and does not consider the wider benefits of our core role – providing a safe and reliable supply of electricity to underpin an economy worth £2 trillion.

The cost of undertaking our role today is equivalent to less than £1 on a consumer's annual energy bill. This incorporates the efficiencies and innovations we have delivered over the RIIO-T1 period.

The dramatically changing energy landscape has raised new challenges for operating the system. We have been able to manage these challenges without significant additional cost to consumers to date, however, the scale of the challenges and the changes in the energy landscape mean that we need to invest now in our systems and capability to enable us to drive value for consumers and continue operating at the same standard of security and reliability. We must also invest in our market platforms so we can deliver the service our customers expect and provide access to a far greater number of diverse participants.

Our current view of the overall cost[3] for the ESO in RIIO-2, including our core, ongoing outputs[4], is an average of £270 million per year[5]. This compares to around £180 million[6] cost per year for the ESO today.

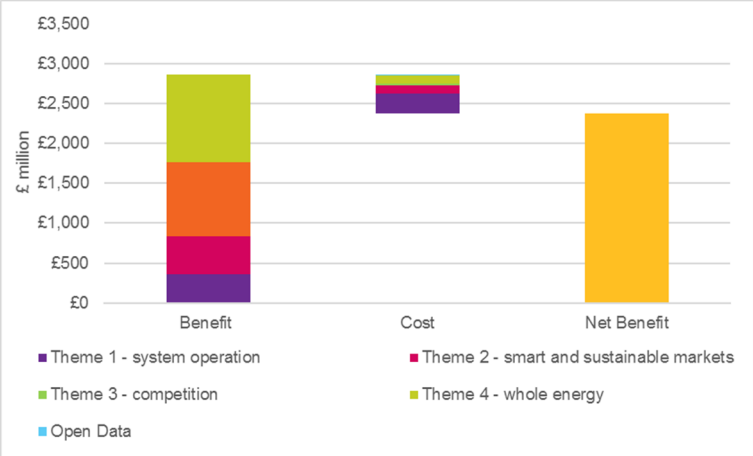


Figure 1 Summary of benefits

Funding model:

In parallel with the development of our business plan, Ofgem is designing a new regulatory framework for the ESO, covering how we will be funded and incentivised to deliver outcomes for consumers. While this is under development we are unable to include factors such as financing costs, and the impact of our proposals on consumer bills, in our plan.

We and Ofgem agree that our funding model should encourage us to be agile, ambitious and to invest in transformational activities that provide benefits for consumers.

The proposals in this plan have been developed with the assumption that the funding model will enable us to be financeable, and deliver the outputs proposed. Ofgem is currently consulting on funding models for the ESO and we will publish our response in July.

1.3 Overview of our proposals

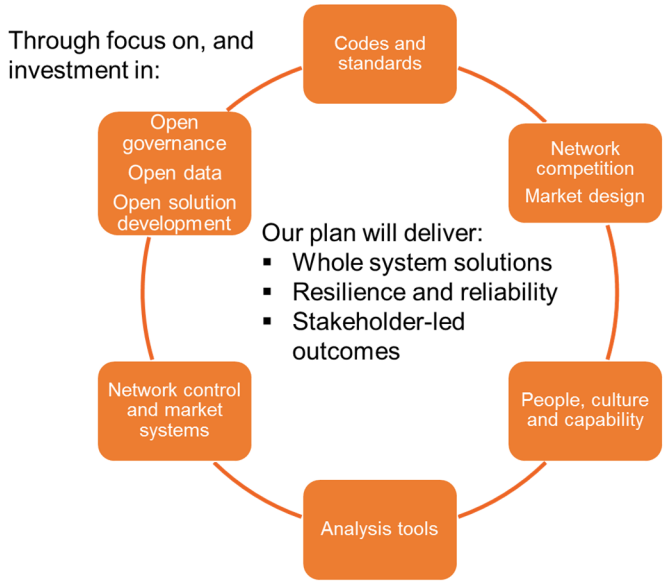
The shift towards a decentralised, decarbonised energy system is driving significant change in how energy is delivered and used. We have developed our proposals to

[3] Excluding items not classified as totex, for regulatory accounting purposes.
[4] The current classification of costs as ongoing and new is based on assumptions, for example replacement of existing IT systems is classified as new. We will further refine this definition as we work towards October.
[5] Please note these figures represent our proposed spending. The cost that is borne by consumers in any year will depend on the funding model chosen for the ESO.
[6] Around £180 million is the average price control spend over RIIO-T1, including the projected spend for the remaining two years.

support the future energy landscape, which will look different from today in a number of key areas, including:

- Renewable and low-carbon technology will begin to dominate how we generate electricity, the way we travel and how we heat our homes
- This technology will be more decentralised. The growth in distributed and local generation will continue, supported by energy storage and demand-side solutions
- Consumers will be able to 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
- All of this is enabled by increased digitisation. Advanced data and analytics will change the way market participants interact with us and each other, and will also allow them to make informed choices based on sharing data and open analytics
- There will be increasing need to ensure that whole system thinking is at the heart of how the energy system is decarbonised so that we can achieve the overall best outcome for society, the economy, consumers and citizens.

Stakeholders have told us that, as we work towards this future energy landscape, we must ensure the resilience and reliability of the electricity system. We must do this while delivering whole system solutions that reflect the increasing interaction between systems (electricity and gas, transmission and distribution) and sectors (power, transport, and heat). Importantly, stakeholders have also told us that they want to remain central to our efforts and engaged in the ongoing development and execution of our major deliverables.



The proposals in our plan have been designed as a coherent suite.

Each individual proposal plays a critical part in supporting the future energy landscape and delivering for stakeholders, customers. and consumers.

Figure 2 Our proposals have been designed as a coherent suite

To deliver on these ambitions, we need to change how we operate the electricity system. There will be increased coordination required across the transmission-distribution boundaries, and we will need to work with network and market companies to solve local and national balancing challenges together. Smart system operation, rather than spare asset capacity, will be key to ensuring a secure supply. Our systems and processes will

become increasingly automated, using artificial intelligence and machine learning. This means that we need new analysis tools and people with new skills and capabilities, especially in data analytics, to complement our technical understanding of power system engineering.

We will take advantage of, and champion, open data across the industry to inform our decisions and make them more transparent. To support this, the codes, framework and governance arrangements will need to change to ensure all market participants have fair and equal access. All of this will be built on the foundation of greater cooperation and engagement across the whole energy system – no one party has the solutions to these challenges, but by working together we can create the optimal solutions. Culture change within the ESO will support this transformation. The challenge is unprecedented but the time to act is now.

You can find a detailed description of the activities, investments and benefits provided in chapters 7 to 10 of our draft business plan. A high-level overview is provided below.

1.3.1 Theme 1: Reliable, secure system operation to deliver electricity when consumers need it

As we move to a low-carbon energy system, our operating environment continues to change dramatically. We will invest and adapt to maintain reliable and secure system operation and realise the benefits for consumers of a decarbonised energy system.

Our proposals focus around three areas of transformational activity:

- expand and transform our Control Centre architecture and systems
- training and simulation
- system restoration.

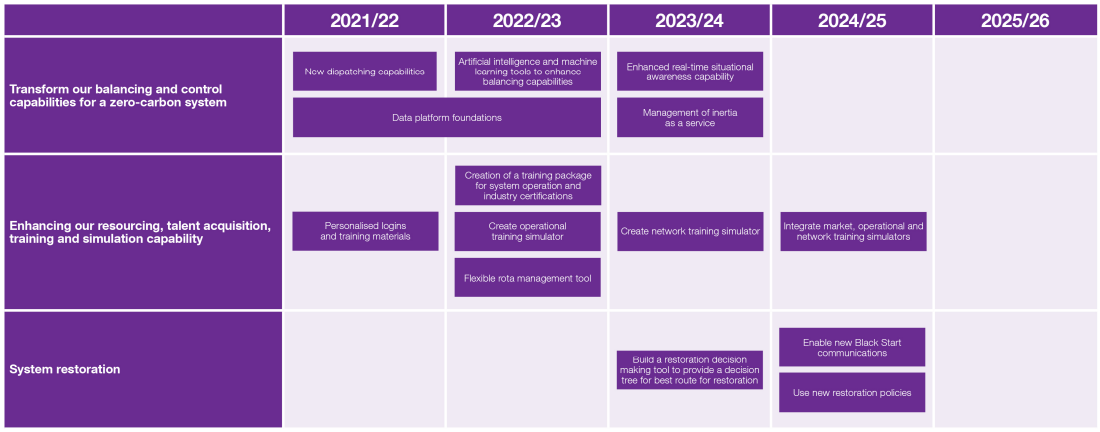


Figure 3: Summary of Theme 1 deliverables[7]

1.3.2 Theme 2: Transforming participation in smart and sustainable markets

Smart and sustainable new markets will be essential for operating a carbon-free electricity system. We will need to attract higher volumes of flexible energy, such as demand-side response and storage. Our balancing products, markets, processes and IT

[7] Please increase page zoom to 200% to view this diagram

infrastructure need to be transformed to effectively facilitate decarbonisation and the consumer benefits that follow.

Our proposals focus on three broad areas of new activity:

- 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.

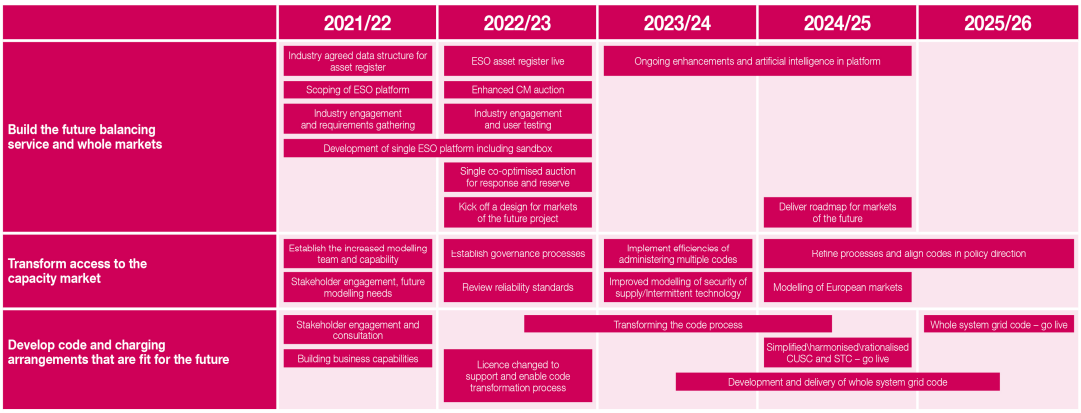


Figure 4: Summary of Theme 2 deliverables[8]

1.3.3 Theme 3: Unlocking consumer value through competition

One of the success criteria for our SO mission is 'competition everywhere'. Through facilitating greater competition in solutions to network problems, we can unlock significant consumer value.

During RIIO-2 we propose to:

- 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.

[8] Please increase page zoom to 200% to view this diagram

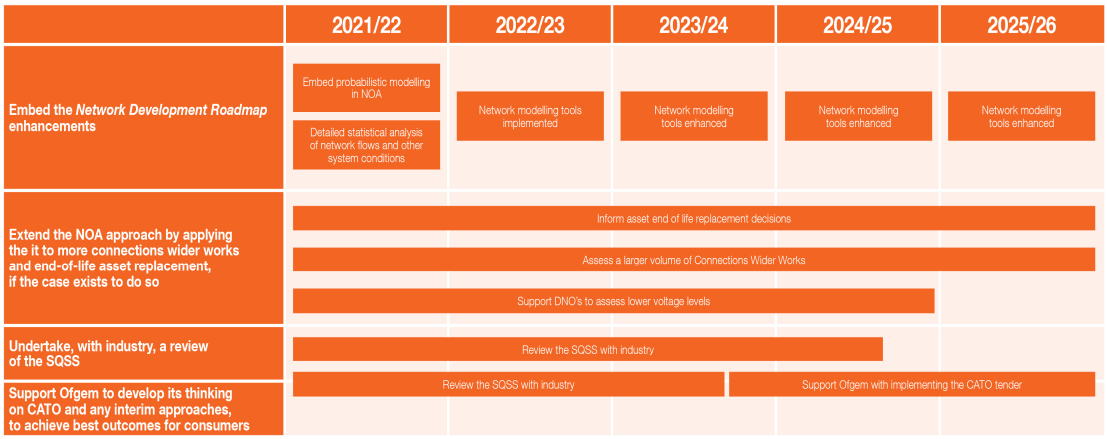


Figure 5: Summary of Theme 3 deliverables[9]

1.3.4 Theme 4: Driving towards a sustainable whole energy future

We need to take a whole system view of the changing energy landscape. In doing so, we can drive the transition to a low-carbon energy system in a way that maximises benefits to consumers. Our proposals focus on:

- 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.

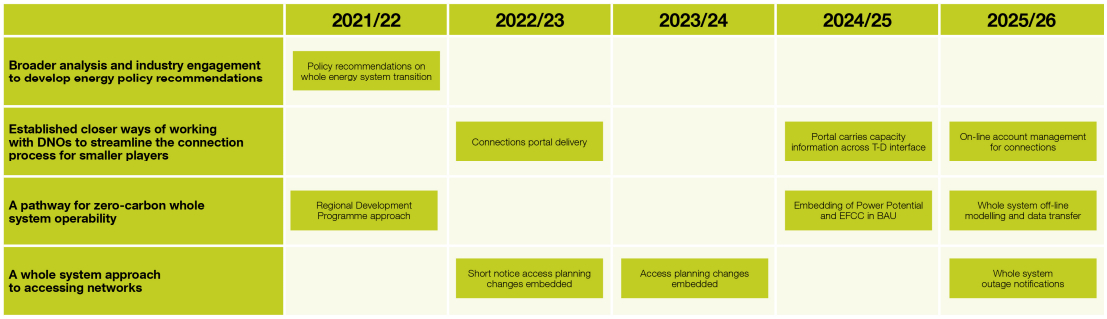


Figure 6: Summary of Theme 4 deliverables[10]

1.3.5 Setting the ESO up for success

Running through the themes set out above there are three building blocks critical to our success: information technology (IT), innovation, and people and capability. These important elements feature throughout the plan under each of the four themes. We set

[9] Please increase page zoom to 200% to view this diagram
[10] Please increase page zoom to 200% to view this diagram

out more broadly towards the end of the business plan how we think about, and position, these building blocks as central to the way we do business.

IT

Technology is inseparable from our ambition and our IT strategy is deeply embedded within our organisational strategy. The outputs in our plan are underpinned by IT. As a technology and service-delivery company at the heart of the energy industry, we will continue to invest in and maintain critical IT infrastructure. At the same time, we continue to innovate so we can anticipate, and respond to, new demands on technology as decarbonisation, decentralisation and digitalisation drive significant change across the energy sector.

People and capability

The ESO's most important assets are undoubtedly our people. Delivering our ambition successfully will require us to continue to attract, recruit, train, motivate and engage a diverse and inclusive workforce. During 2019 we will develop a strategic workforce plan to understand how to meet the requirements in RIIO-2. Within the ESO, advanced analytics and data management capabilities will be increasingly important. Alongside these, our power system engineering, customer service, stakeholder and contract management capabilities will remain critical.

Innovation

Innovation is interwoven throughout this plan. It plays a crucial role in helping us address the future challenges of a rapidly changing energy system. We will continue to run an innovation portfolio through a robust innovation process, a collaborative approach and a yearly innovation strategy that invests in our innovation capability. We propose to strengthen our central innovation team. This will enable us to better plan and respond to opportunities and strategic challenges, making best use of funding mechanisms and driving consumer benefits realisation from all the innovation activities we undertake.

1.3.6 Ongoing activities

As well as proposing to step up to deliver the new activities proposed in our business plan we will continue to deliver our core, ongoing role of operating the electricity system safely and securely. This involves:

- operating the electricity system to ensure a minute-by-minute balance of supply and demand of electricity
- actively managing balancing and constraints to minimise costs to consumers
- managing existing balancing service markets, developing future markets and making improvements to facilitate greater transparency, participation and competition
- managing industry revenue flows through setting charging methodologies and collecting charges for use of the transmission network, and balancing service charges
- continuing our electricity market reform (EMR) delivery body role
- managing connection applications for the transmission network, and acting as the contractual counter-party for these connections
- planning for the future of the electricity system, including network planning and the Network Options Assessment process, and how this interacts with the whole energy system.

- publishing a variety of insights and data, including our annual *Future Energy Scenarios*
- delivering IT system changes required by our customers, and those mandated by GB and EU regulations.

1.4 Conclusion and next steps

We are excited by the opportunity that RIIO-2 presents for us to step up and be the ambitious, consumer-focused ESO that our stakeholders want us to be. Our draft business plan represents our current thinking on specific outputs and activities, and could deliver net benefits of around £2.3 billion over the RIIO-2 period. We look forward to working with stakeholders and Ofgem to finalise our plan and the funding model that will underpin it. This should incentivise us to continually innovate and deliver benefits for consumers as we transition to the zero-carbon energy system of the future.

PART 1: CONTEXT

2. Introduction

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. As the landscape around us evolves, so does our role. We continually manage the risks of this uncertainty on behalf of consumers. Looking ahead to RIIO-2 and beyond, 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.

In April 2019, we published *Towards 2030: a system operator for GB's energy future*[11] which set out our longer-term vision of the future of energy. Alongside this, we published *Our RIIO-2 Ambition*[12] – our view of the outputs and activities that 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 stakeholder engagement, both through our normal business as usual engagement channels and through RIIO-2-specific engagement. Stakeholders have been universally supportive of the level of ambition set out in the document. Our key takeaways from our stakeholder engagement are that we need to:

- be ambitious and proactive - driving 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 right culture through all levels of the organisation.
- adopt a principle of open data to help facilitate open and efficient markets
- advise and make recommendations across the electricity industry, potentially including enhanced engagement with consumers
- transform our engagement approach – introducing a 'design authority' to involve stakeholders throughout RIIO-2 in the development and execution of our major deliverables
- ensure our funding model drives us to be ambitious and enables us to respond flexibly to new challenges as they arise, with strong incentives to deliver benefits for consumers over and above our day-to-day role.

In this, our July draft business plan, we provide the next level of detail on the new, transformational activities and set out how they deliver net consumer benefits of £2.3 billion. We also set out costs of delivering our plan in the context of the significant value we will create for consumers.

In its decision document published on 24 May[13], Ofgem stated that that the ESO should produce a five-year strategy and a two-year business plan. Ofgem explained these should set out the ESO's costs, activities, deliverables and performance metrics for delivering its strategy over the first two years of the RIIO-2 period.

In line with Ofgem's requirements, this version of our draft plan provides a five-year strategy together with proposed outputs, activities and deliverables. This reflects the longer-term nature of many of the transformational outputs we propose. The costs set out for the first two years of this period should be read as part of this longer-term investment proposal. Our cost-benefit analysis and data tables also look at a five-year period, as required by Ofgem.

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[11] https://www.nationalgrideso.com/document/141141/download
[12] https://www.nationalgrideso.com/about-us/business-plans/future-planning-2021-onwards
[13] https://www.ofgem.gov.uk/system/files/docs/2019/05/riio-2_sector_specific_methodoloy_decision_-_eso.pdf

We welcome feedback on this July draft business plan as we refine our nearer-term costs and work towards our final business plan that will be submitted to Ofgem in December 2019. Alongside the development of our business plan, a new funding model and incentive scheme is being designed for the ESO. The outputs proposed in this draft plan assume that we have a funding model and incentive scheme that will support our ambition and drive the delivery of the outputs proposed. More detail is in chapter 6.

Stakeholder input

Stakeholder input has been fundamental to the development of our proposals for RIIO-2. The proposals outlined in this plan have been through a rigorous stakeholder engagement process. Our process included a wide range of representative stakeholders to help us create, test and refine our options. Refined options were then subject to cost-benefit analysis to ensure economic robustness and overall benefit.

In addition, we have also applied our commercial and technical judgement to form a view on the criticality of a particular activity. For example, while our system restoration proposals have a negative cost benefit, being able to re-energise the GB electricity network in a low carbon and highly distributed energy future is of fundamental importance to society. Further detail of stakeholder feedback throughout the development of our proposals can be found in the supporting Stakeholder Report. In the Cost-Benefit Analysis Report you will see the detailed rationale and analysis for how the benefits were calculated.

2.1 The ESO Business

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

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.

The ESO holds a unique role within the energy system and, although relatively small in terms of our internal costs, we are able to influence industry costs that are many times higher.

We are a relatively asset-light organisation with an expected regulatory asset value (RAV) of around £220 million at 31 March 2021, resulting in a very small balance sheet compared to the more than £4 billion cash we transact in our industry revenue management collection role.

While we are an asset-light business, we rely on IT systems to deliver many of our activities, most notably in the control room to operate the electricity system in real time. Our IT systems have an asset life of between five to ten years. We invest heavily in people and have a directly employed workforce of around 600, many of whom hold specialist skills. The ESO also uses shared business support services from the wider National Grid Group. You can find more detail about these in Part 3 of this document.

Board assurance of our business plan

The ESO has a separate Board of Directors[14] who will have a crucial role in overseeing the development of our RIIO-2 business plan. The Board includes three independent non-executive directors. Over 2019 the Board will review our plan and proposed costs for accuracy, ambition and efficiency.

2.1.1 A rapidly transforming energy system

Since the start of the RIIO-T1 price control we have seen unprecedented change in the energy landscape:

- In May 2019, Britain had its first fortnight without using electricity from coal since the 1880s, with over 1000 coal free hours in total this year.
- 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 one GW of solar power capacity in GB; we now have over 12 GW.
- Embedded generation has risen from 12% to 27%, as we transition to an increasingly decarbonised system.
- There has been an increase of 60% in active Balancing Mechanism Units in the system and a 42% increase in ancillary service providers.

2.1.2 Business plan themes

Consistent with the approach taken in *Our RIIO-2 Ambition*, this plan sets out how we will build on our core roles as a system operator, so we can facilitate the transition to a zero-carbon energy system and generate consumer value.

We set out our proposals under the following four main themes:

1. reliable, secure system operation, to deliver electricity when consumers need it
2. transforming participation in smart and sustainable markets
3. unlocking consumer value through competition
4. driving towards a sustainable, whole energy future

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

Running through these themes there are three building blocks critical to our success: information technology (IT), innovation, and people and capability. While these important elements feature throughout the plan under each of the four themes, we also describe more broadly towards the end of the business plan, how we think about, and position, these building blocks as central to the way we do business.

2.1.3 Creating value for consumers through new transformational activities

This document focuses on the new activities we propose for RIIO-2, to deliver the ambition and the consumer benefits that our stakeholders want from us. We estimate that delivery of the proposed ***new activities will generate net benefits of around £2.3***

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

billion for consumers over the five-year RIIO-2 period – delivering £6 of new benefits for every £1 of additional investment in the ESO. The financial benefit figure we've estimated for consumers is likely to significantly understate the total benefits that the ESO will drive, as it only includes the benefits that are able to be quantified. It does not take into account the wider benefits of our core role – providing a safe and reliable supply of electricity that underpins an economy worth £2 trillion.

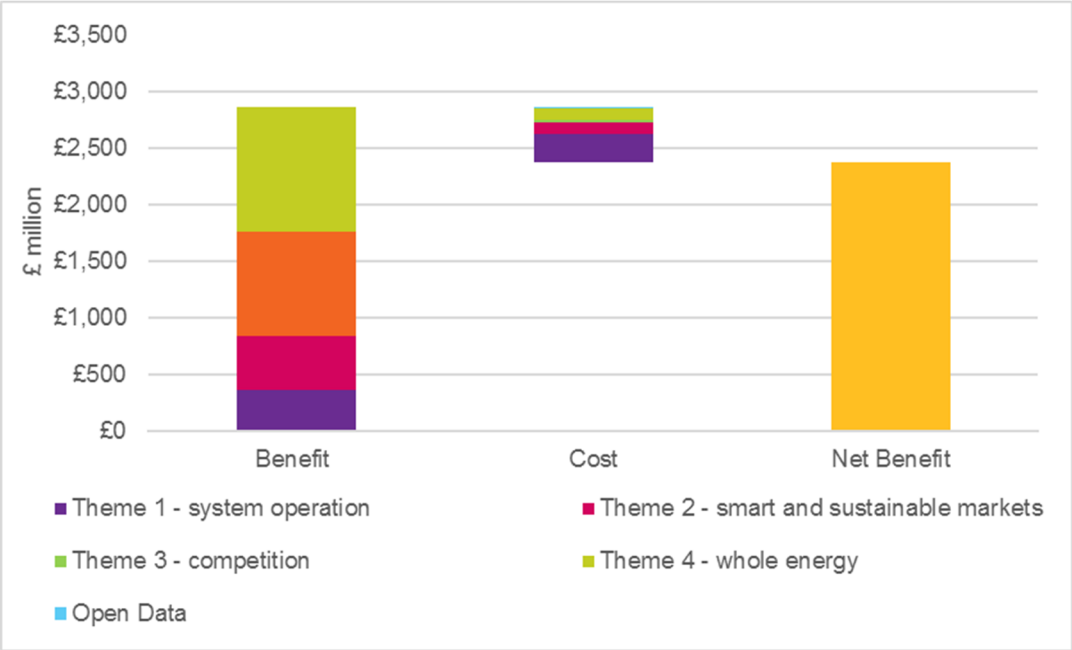


Figure 7: Current view of costs, benefits and net benefits of proposed new activities, 2021-26, £ billion

2.1.4 Total costs in RIIO-2

The cost of undertaking our role today is equivalent to less than £1 on a consumer's annual energy bill. This incorporates the efficiencies and innovations we have delivered over the RIIO-T1 period. However, the dramatically changing energy landscape has raised new challenges for operating the system.

We have managed these challenges without significant additional cost to consumers in RIIO-T1. Our plan reflects the need to invest now in our systems and capability to continue operating at the same standard of security and reliability. We must also invest in our market platforms to deliver the service our customers expect and provide access to a vastly increased number of diverse participants. Our current view of the overall cost[15] for the ESO in RIIO-2, including our core, ongoing outputs[16], is an average of £270 million annually. This compares to an annual cost of around £180 million[17] for the ESO today.

Costs

Throughout this document we set out the costs for the ESO. This cost represents our proposed spending. The costs that consumers will bear in any year will depend on the funding model chosen.

[15] Excluding items not classified as totex, for regulatory accounting purposes.
[16] The current classification of costs as ongoing and new is based on assumptions, for example replacement of existing IT systems is classified as new. We will further refine this definition as we work towards October.
[17] Around £180 million is the average spend over RIIO-T1, including the projected spend for the remaining two years.

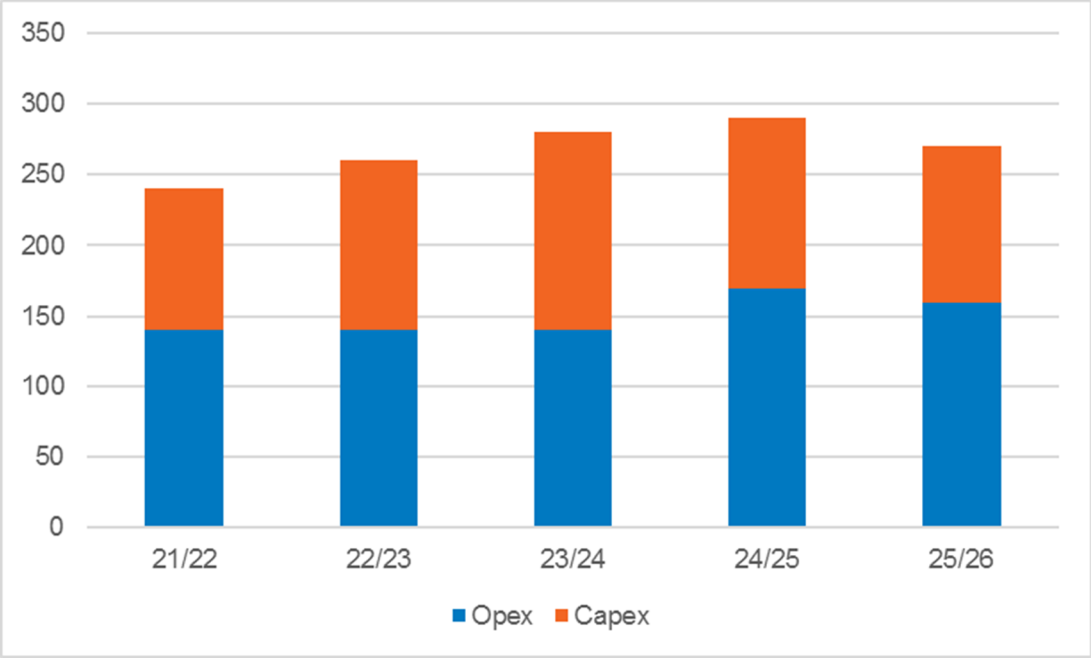


Figure 8: Current view of costs of the ESO, split by opex and capex, £m per year

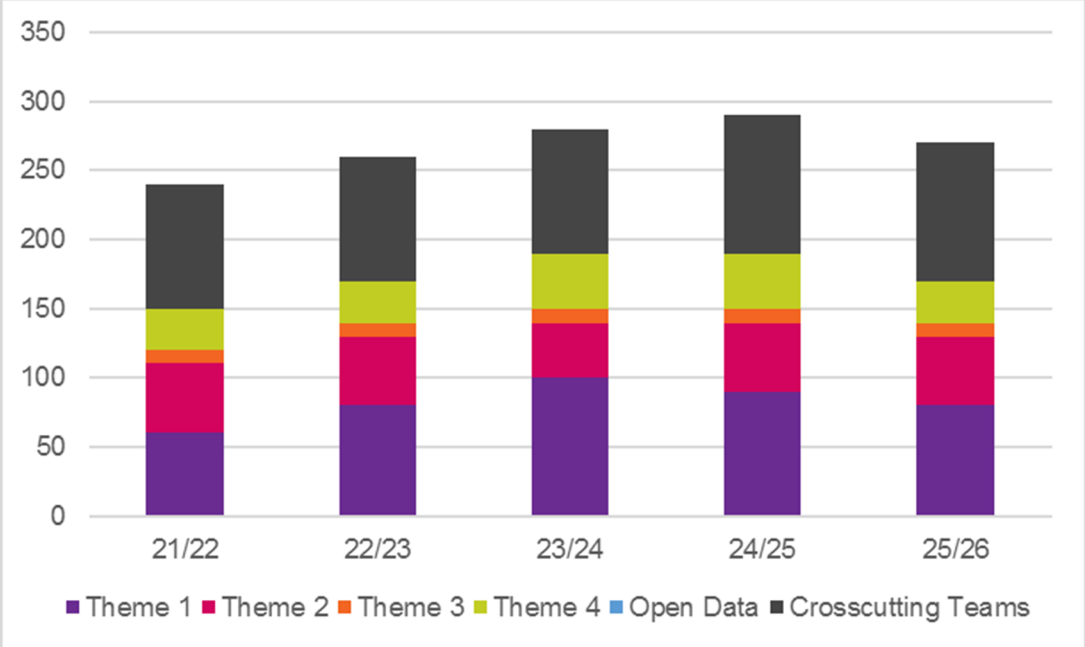


Figure 9: Current view of costs of the ESO, split by theme, £m per year.

Note – crosscutting teams includes business support shared services

While this business plan is focused on our proposed new and transformational investments, we have also identified the ongoing (sometimes referred to as 'business as usual' (BAU)) costs that will be required to maintain our core service. Early benchmarking of our ongoing costs suggests they are efficient. We will carry out further benchmarking work before publishing our updated business plan in October to provide assurance to Ofgem, the Challenge Group and stakeholders that this is the case.

We have already benchmarked our proposed business support shared service costs. We found they 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 threats.

How to use this document

This business plan is a work in progress. It provides a further level of detail on how we propose to deliver our RIIO-2 ambition through setting out our proposed outputs, along with our current thinking on the rationale for these outputs, the benefits and the costs over a five-year timeframe. We have also indicated how we intend to develop our plans further. It is not our final business plan, which will be published in December 2019, but rather a snapshot of our thinking reflecting the stakeholder feedback we have received to date. This plan assumes that the ESO will have a funding model that enables us to be financeable and deliver our proposed outputs.

We will provide metrics to reflect the delivery of our outputs in our October draft business plan.

The document is structured as follows:

- Part 1 (page 10) outlines the context for our plan: the changing energy landscape, the ESO's new regulatory framework, and how stakeholders have informed the development of our proposals.
- Part 2 (page 35) sets out our planned outputs for each theme, together with the benefits, costs and net present value of our proposed new activities. In the separate CBA report, you can find more detail on how we calculated these net present values.
- Part 3 (page 117) provides details on the parts of our business that underpin everything we deliver – open data, 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. It also contains details of our core activities that will continue into RIIO-2, alongside the proposals set out in Part 2.

You can find supporting information in our Cost-Benefit Analysis Report and the Stakeholder Report.

The delivery plans, benefits and costs in this document represent our current view and are in 2018-19 prices. We will refine them throughout 2019 as we incorporate stakeholder feedback and develop our plans further.

3. Our System Operator mission and ambition

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:

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

"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."

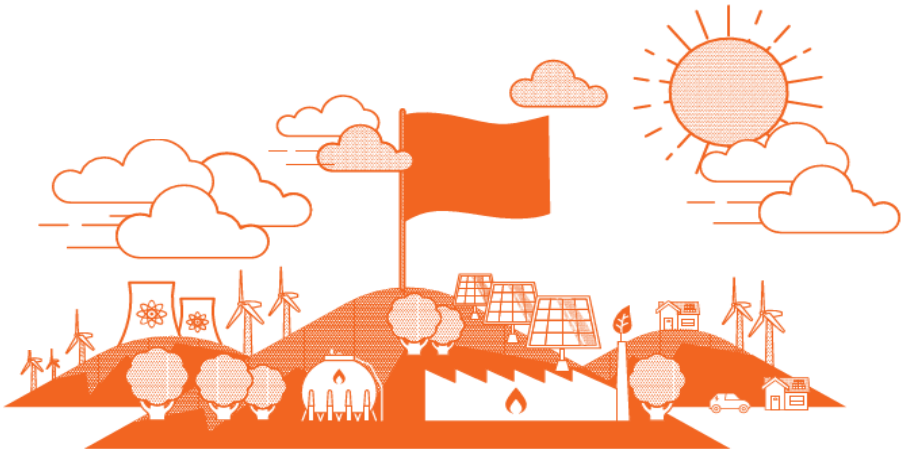
Wider Interest Group

To achieve our SO mission, we have set out five priority focus areas to guide us in this journey:

- the engineering transformation: ensuring reliable, secure system operation to deliver energy when consumers need it
- the market transformation: unlocking consumer value through competition
- the sustainability transformation: enabling and supporting the drive towards a sustainable whole energy future
- the smart transformation: driving innovation and increased participation across the energy landscape
- the capability transformation: developing the right people and systems to deliver the future.

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[18].

For our full ESO RIIO-2 ambition, please see our website[19].



[18] National Grid's gas system operator business is included in the RIIO-2 business plan for National Grid Gas Transmission.

[19] https://www.nationalgrideso.com/about-us/business-plans/future-planning-2021-onwards

4. A plan informed by our stakeholders

4.1 The importance of stakeholder views

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. Enhanced stakeholder engagement will enable us to create a plan that reflects their needs.

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 we focus on the right areas. It is critical that we produce a plan that reflects stakeholders' needs and ultimately provides value for consumers. 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 look to produce our final plan in Q4 2019.

Here we set out our key takeaways 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 are set out in the theme chapters and in more detail in the supporting Stakeholder Report.

In the creation of this plan we have used stakeholder and consumer insight from a variety of sources, including;

- academic research
- webinars
- workshops
- bilateral meetings
- surveys.

Alongside all these activities we have also, where possible, sought to use existing engagement channels in place across the ESO and utilise this stakeholder insight in the development of our plans such as Power Responsive and the *Future Energy Scenarios* (*FES*)[20]. The *FES* has engaged with over 600 individual stakeholders in the last year and their views on the future of energy and the constructive challenge they provide in developing our future scenarios are critical to understanding the landscape we will be operating in and therefore actives we propose.

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

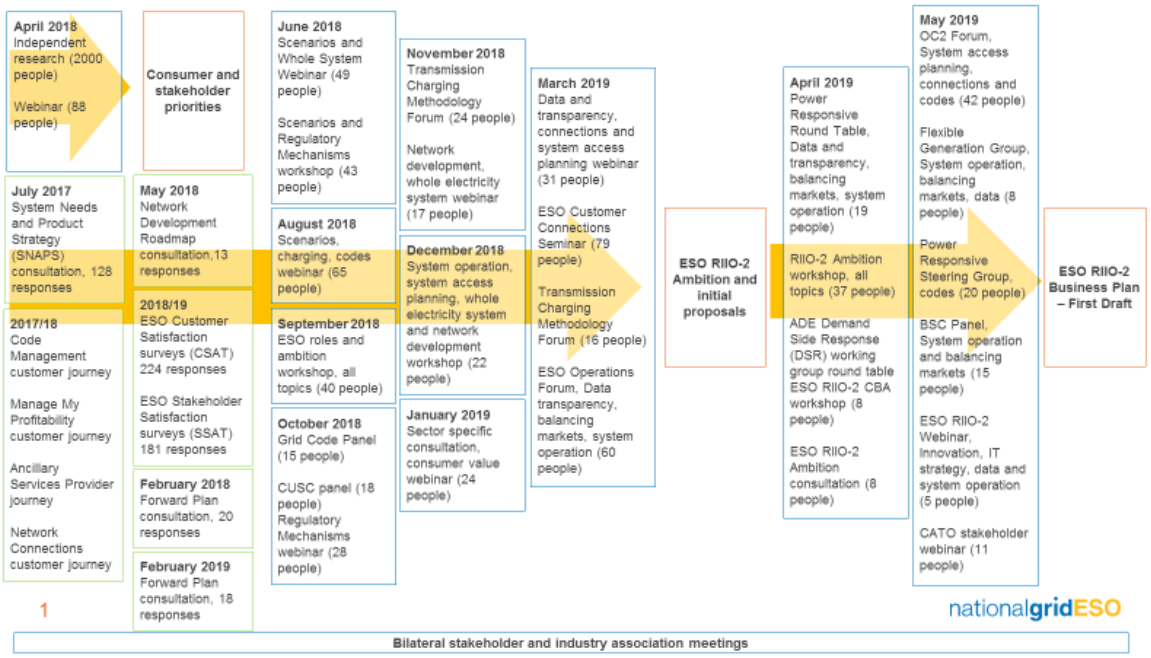


Figure 10 Stakeholder engagement overview

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. As we develop our more detailed business plan the ESRG will produce a report that sets out their views on our engagement activity and business plan.

4.1.1 Engagement key themes

Feedback from stakeholders has encouraged, supported, challenged and guided us towards the ambitious business plan presented here. Similarly, the deep 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, building on our role and capabilities today to reflect the evolving role we can play as system operator in the future. Our key takeaways are that we need to:

- be ambitious and proactive - driving 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 right culture through all levels of the organisation.
- adopt a principle of open data to help facilitate open and efficient markets
- advise and make recommendations across the electricity industry, potentially including enhanced engagement with consumers
- transform our engagement approach – introducing a ‘design authority’ to involve stakeholders throughout RIIO-2 in the development and execution of our major deliverables
- ensure our funding model drives us to be ambitious and enables us to respond flexibly to new challenges as they arise, with strong incentives to deliver benefits for consumers over and above our day-to-day role.

We received valuable feedback during the development of *Our RIIO-2 ambition* and in the months since it was published. From the 11 written responses we received, and the face-to-face engagement we have carried out since the document was published, the overarching feedback themes are as follows:

- Stakeholders are excited to see the level of ambition and activities we set out, in particular around carbon free system operation.
- We need to ensure though that we don't forget the basics and maintain focus on improving our current performance.
- We need to set out further detail and clarity on our proposals to enhance stakeholders' ability to feedback.
- We need to provide clarity on how our RIIO-2 ambition goes beyond our *2019-21 Forward Plan* commitments.
- A joined-up approach across electricity transmission and distribution is vital as well as greater evidence of coordination with wider industry change activities.

You can find a fuller summary of the written feedback to the consultation in the Stakeholder Report.

As a result of stakeholder feedback, we have changed our proposals in this business plan and:

- provided clarity on the intention of our ambition on operating a carbon free electricity system
- included delivery roadmaps to achieve our ambitions
- are taking an agile, modular approach to the development of our new balancing and control capabilities, including building them offline
- are transforming engagement in delivering all of our IT capabilities through fully involving stakeholders in its development via a design authority
- are further developing our resourcing and training proposals through engagement with universities and network companies
- are making participation in our markets easier through delivering a single integrated platform for both balancing service markets and the capacity market
- have adopted a principle of open data – committing to sharing our data (in machine readable format) whilst ensuring that we are protecting data confidentiality and security
- will ensure our code review activity is aligned with the Energy Codes Review to avoid duplication and resourcing issues with other organisations
- will investigate if there is a role for the ESO to support network planning processes and consistency across the whole electricity network.

We also set out more detailed changes throughout the business plan and the feedback that has informed this in our Stakeholder Report.

4.1.2 Understanding consumer views

As our engagement programme has developed, we have enhanced our approach to incorporating consumers' views. In the early phases, we took a dual approach to understanding consumers' views; 1) engaging directly with domestic and non-domestic consumer organisations and 2) including such organisations as members on the ESO RIIO-2 Stakeholder Group. In building on *Our RIIO-2 Ambition*, we want to go further so we can make sure we understand a sufficiently broad range of stakeholders' views. We

have carried out an initial review of available consumer and community stakeholder views. From this, we have understood the following further priorities in relation to our proposals and their costs to consumers:

Non-domestic

- 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 costs 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?

Domestic

- Through their New-Pin project, Sustainability First developed and tested a set of desired long-term public interest outcomes:
  - value for money – low prices, efficient
  - quality of service – modern, digital, accessible
  - clean – environmentally sustainable, low carbon, healthy
  - resilient – secure, financeable, safe
  - place – localism, inclusivity, well-being
  - fair - inter and intra generational, societal benefits, customer / taxpayer
- A significant proportion of people already struggle to pay their energy and water bills. In 2015 10% of households in England, 30% in Wales and 39% in Scotland were estimated to be in fuel poverty. In March 2019, 30% of those surveyed across the UK were worried about paying their energy bills.
- In March 2019, the public were most likely to be concerned about steep rises in energy prices in the future (75%), the UK not investing fast enough in alternative sources of energy (69%) and the UK becoming too dependent on energy from other countries (65%). 84% support the use of renewable energy.

This feedback has helped steer the proposals in this business plan. We will continue to build on this understanding as we go through the remainder of the business planning process, with additional feedback included in later submissions. We will also enhance the approach we take during the RIIO-2 period, which is set out in the business support section of this plan

4.2 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 removes linear time driven barriers and adopts a permanent invitation to engage.

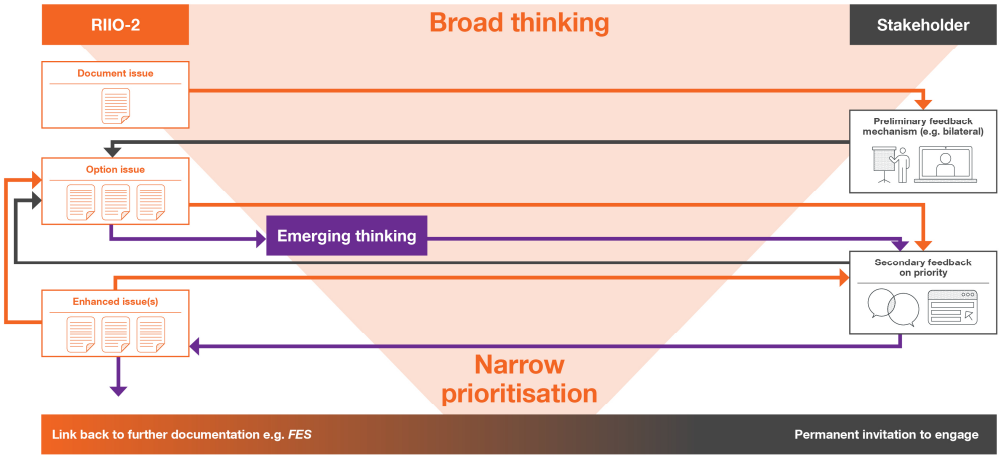


Figure 11: RIIO-2 stakeholder engagement strategy[21]

We seek to use the principles of the AA1000 Stakeholder Engagement Standard (SES) in our engagement approach so we can establish a benchmark. It means that we plan, prepare, implement and improve engagement activity so we can make sure we maximise the value of our engagement and be respectful of stakeholders' time.

4.3 Dynamic engagement through the business plan process

We have evolved our approach from the three phases set out in *Our RIIO-2 ambition* to one of continuous story creation. We are demonstrating the practical application of our stakeholders' feedback within our strategy and approach, which has been gained through a less linear engagement model and supports our stakeholder groups and their requirements.

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

Generator / supplier

[21] Please increase page zoom to 200% to view this diagram

4.3.1 Broad thinking

Consumers and stakeholders are at the heart of our preparations for RIIO-2. We began by understanding our consumer and stakeholder priorities to steer what we should deliver. These form the fundamental cornerstone of our plan.

We 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 an independent research study, reaching stakeholders, Members of Parliament and 2,000 members of the public. It also included regular direct conversations and an online stakeholder webinar with 88 attendees from 68 organisations. You can find out more about how they were created on our website[22].

Our Consumer and Stakeholder priorities are used throughout this document to assess how our activities will deliver value. We have indicated in each chapter how the activities contribute to meeting them.

Figure 12: ESO consumer and stakeholder priorities

4.3.2 Developing our proposals

We have continued to build on the priorities of consumers and stakeholders. Their views have informed the details of our business plan proposals. We have 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.

4.3.3 Testing our proposals

We are sharing how stakeholder views have shaped our proposals, so we can seek further feedback. We will continue to work with our stakeholders to develop these proposals ahead of our final submission to Ofgem in December 2019. The engagement channels will be similar to those we have used up to now but with greater opportunity for stakeholders to select the topics to discuss. We will also go further in using existing groups, such as trade association meetings and Power Responsive, and consider if there are further digital platforms we can use to enable easier engagement for those who find attending meetings in person more difficult. As you will see in this

> "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**

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

business plan, the proposals we engage on have been developed further to focus on the detailed activities and their associated costs and benefits.

4.3.4 Our engagement activity

Engaging with a representative group of stakeholders gives us confidence we have co-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, look to 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 to make sure we use every opportunity to engage. Additionally, collaboration with other bodies will give us access to wider and more specialist views in a way that is more efficient for the ESO and our stakeholders. We've 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. The most appropriate engagement method is chosen based on the level of content and area of interest for the audience.

We have engaged with more than 360 individual stakeholders, many at multiple events. Below is a summary of how we have engaged over and above our existing engagement channels. Throughout this plan, we show how stakeholder feedback has been used to develop our thinking, with this set out in more detail in the associated stakeholder report.

Interactive engagement, including: • Bilateral meetings • Workshops • Webinars	**To date we have held:** • 84 bilateral meetings • 6 workshops • 9 webinars	**Which have resulted in engagement with:** • Over 360 individuals from • Over 180 organisations
ESO RIIO-2 Stakeholder Group	**To date we have held:** • 5 meetings • 1 workshop • 1 electricity control centre visit	**This has involved:** • 19 of our key stakeholders
Published communications, including: • Bi-monthly bulletins • Website • Thought pieces • Podcasts	**To date we have published:** • 6 bulletins • 2 stakeholder reports • 3 thought pieces • 1 podcasts	**These have reached:** • An average of 900 individuals through our bulletins • 198 plays of the podcast

Figure 13: Summary of our RIIO-2 engagement

Stakeholder engagement numbers by segment

> "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**

We have met with more than 360 individuals from over 180 organisations through some 600 interactions. Generators, service providers and suppliers were the groups most commonly represented. It is worth noting that 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, consultants, charities and technology suppliers.

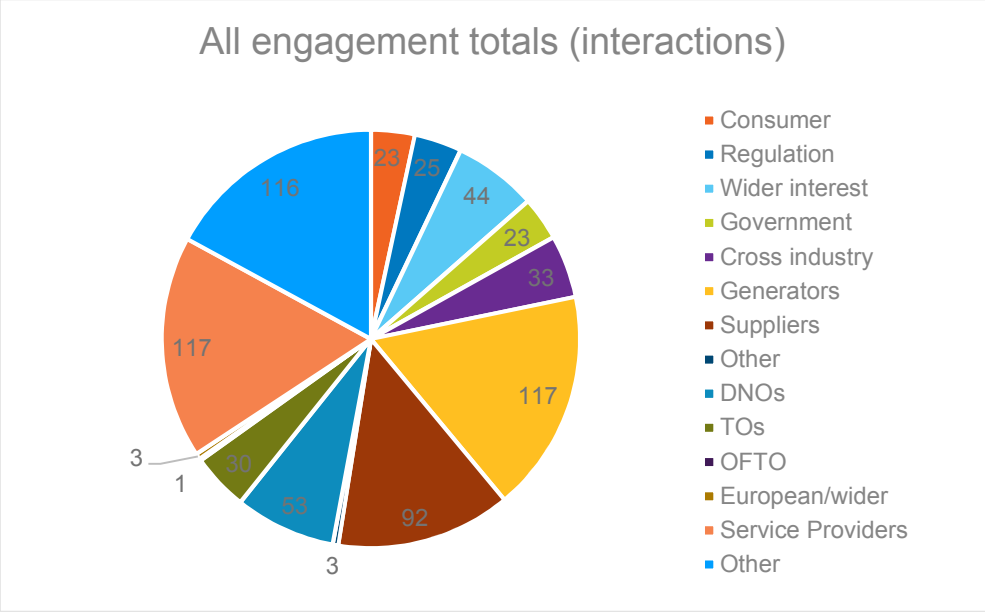


Figure 14: Stakeholder engagement by stakeholder types

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% were satisfied or very satisfied with the process. We will continue to utilise this broad range of engagement channels 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 this business plan and the Stakeholder Report alongside it go some way to addressing 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. As the year progresses we will continue to refine and further improve our engagement, for example by making our email communications more targeted to help stakeholders prioritise the importance of the content, engaging as much as possible through trade associations, and investigating enhancements to make the RIIO-2 parts of our website more accessible.

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

4.4 Enhanced stakeholder engagement

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.

4.4.1 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.

> "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[23]**

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. There is more information about our group and their discussions so far on our website[24] and 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**

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. There is more information about this group and our engagement with it in the Stakeholder Report.

4.4.2 Let's keep talking

We know that we have more to do and are very much still listening to what our stakeholders and customers want from the ESO in RIIO-2. We recently commissioned an independent review of our stakeholder engagement approach to ensure 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 and we will further embed many of these throughout 2019.

[23] https://www.nationalgrideso.com/news/eso-prepares-first-legally-separate-price-control
[24] https://www.nationalgrideso.com/about-us/business-plans/future-planning-2021-onwards/have-your-say-on-our-future-plans/eso-riio2-stakeholder-group

5. Changing energy landscape

The energy landscape has changed dramatically over the past decade, and we expect the pace and scale of change to increase over the RIIO-2 period. A robust and ambitious business plan must be based upon a good understanding of the future energy landscape. This view will help guide the design of the decision-making process and the investment the ESO makes and advises on.

5.1 The energy landscape in 2030 will look very different to today

Against the backdrop of our mission and ambition for the System Operator – driven by the needs of our stakeholders, customers and consumers, we have developed our business plan to support the future energy landscape which we know will look different from today:

- Renewable and low-carbon technology will begin to dominate how we generate electricity, the way we travel and how we heat our homes
- This technology will be more decentralised. The growth in distributed and local generation will continue, supported by energy storage and demand-side solutions
- Consumers will be able to 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
- All of this is enabled by increased digitisation. Advanced data and analytics will change the way market participants interact with us and each other, and will also allow them to make informed choices based on sharing data and open analytics
- There will be increasing need to ensure that whole system thinking is at the heart of how the energy system is decarbonised so that we can achieve the overall best outcome for society, the economy, consumers and citizens.

To deliver on these ambitions, we need to change how we operate the electricity system. There will be increased coordination required across the transmission-distribution boundaries, and we will need to work with network and market companies to solve local and national balancing challenges together.

Smart system operation, rather than spare asset capacity, will be key to ensuring a secure supply. Our systems and processes will become increasingly automated, using artificial intelligence and machine learning. This means that we need new analysis tools and people with new skills and capabilities, especially in data analytics, to complement our technical understanding of power system engineering.

We will take advantage of, and champion, open data across the industry to inform our decisions and make them more transparent. To support this, the codes, framework and governance arrangements will need to change to ensure all market participants have fair and equal access. All of this will be built on the foundation of greater cooperation and engagement across the whole energy system – no one party has the solutions to these challenges, but by working together we can create the optimal solutions. Culture change within the ESO will support this transformation.

5.2 The importance of scenarios

Although we know that the energy landscape in 2030 will look very different to today, the exact scale and pace of this transition is still unclear, with policy, technology and societal attributes challenging to predict. As we develop our business plan we need a process for

managing and responding to the future energy landscape against this backdrop of rapid and uncertain change.

Whilst 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 *FES 2018*[25], which meets the above criteria through its large collaborative stakeholder development process, and a view across fuels, networks and sectors. It is also used widely by the ESO and by stakeholders for a range of purposes. We have worked with our stakeholders to develop a robust and transparent process- ensuring our business plan meets the needs of current and future consumers against the backdrop of a fast-changing energy landscape. When *FES 2019* is published in July we will update our view to reflect any significant changes.

The diagram below provides a flavour of the uncertainty in the energy landscape out to 2030. For example, a high number of EVs could substantially increase peak and annual demand under a smart charging framework. The ESO would have a role in managing this demand, as well as in designing or governing such a framework. The level of wind capacity will affect constraints and the level of network reinforcement needed, materially changing the system the ESO operates.

Figure 15: Energy landscape uncertainty levels leading up to 2030

5.3 Consistent view of the future

In September 2018, there was a request by Ofgem's RIIO-2 Challenge Group for a "Consistent view of the future" across the RIIO-2 companies, for use in their business planning processes. This was formally noted in Ofgem's RIIO-2 Business Plans: Initial Guidance Document published 28 September 2018[26]:

[25] http://fes.nationalgrid.com/fes-document/
[26] https://www.ofgem.gov.uk/publications-and-updates/riio-2-business-plans-draft-guidance-document (updated guidance issued December 18 and June 19)

"While maintaining flexibility is paramount, it is also crucial that all networks have a consistent and coherent approach to building their view of the future".

All RIIO regulated companies, including the ESO, convened a new Scenarios & Forecasting Working Group under the Energy Networks Association (ENA) in October 2018 to undertaken this request. The group has produced a report, with an annex of detail, which addresses this request from Ofgem[27]. This report is accompanied by an independent report form the ESO's Energy Analysis team, scrutinising this work in the context of FES 2018. The core element of the work is a consistent view of the future, that is a set of consistent assumptions for key drivers e.g. for electric vehicles 10.1 to 10.6 million by 2030 across the RIIO companies for each company to reference in their business plans.

Where applicable, working with our stakeholders, we will look to fully reference this work in our October and December business plans, along with a review of our assumptions compared to *FES 2019*.

5.4 How we will manage uncertainty

Working with stakeholders we defined a set of *drivers of change* in the energy landscape, to understand how *FES 2018* was likely affect our business plan and ambitions.

The drivers of change are:

- consumer behaviour
- decarbonisation of electricity supply
- decarbonisation of heat
- decentralisation
- demand side response
- digitalisation and 'big data'
- electric vehicles
- policy and governance
- storage.

The activities in each of the theme chapters will have options associated with them. We have designed a process to test these options to make sure they are all valid, whatever energy landscape we ultimately end up in, ensuring our activities are robust.

This process was created to be robust against the length of any price control or uncertainty mechanism. While this is still uncertain, this decision will influence how we manage uncertainty and any formal course correction that may be required. To manage the uncertainty, we will undertake scenario and sensitivity analysis so we can make sure our decision-making reflects the changing energy landscape. However, as *FES* provides a broad envelop, we are confident the activities and options we develop are robust against a range of futures.

You can find more details in the cost-benefit analysis section.

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

6. Regulatory context and financeability

RIIO-2, and the introduction of a new regulatory framework for the ESO, is an opportunity to put in place a funding model and incentive scheme that supports the ESO to deliver the outputs that stakeholders want from us. In parallel with developing our RIIO-2 business plan, we are working with Ofgem as it designs this new framework. The framework needs to work as a coherent, holistic package so the ESO is financeable, incentivised to innovate and invest on behalf of consumers, and can earn a fair return for the risks we hold.

The ESO is a different business from the network companies regulated under RIIO. We are an asset-light business that delivers a range of services to the industry. These services also give rise to specific cashflow and revenue volatility at a scale many times greater than the ESO's size. Our funding model needs to reflect these unique characteristics.

We believe there is a shared desire between Ofgem, the ESO and stakeholders to design a funding model and framework for the ESO that fulfils the following criteria:

- is appropriate for the ESO business and the activities we perform
- drives the behaviours that allow us to invest and innovate on behalf of consumers to drive benefits across the whole system
- is flexible and sustainable for the future
- ensures we are financeable as a standalone business
- recognises the tripartite agreement around legal separation.

We have prepared this business plan on the assumption that the ESO will have a sustainable funding model along the lines of the layered model, with margins to account for the risks we hold, as described below.

6.1 A financeable ESO that is empowered to drive consumer benefits across the whole energy system

As a legally separate business, the ESO is required by its licence to hold an investment grade credit rating and be financeable as a standalone, notional company without support from the National Grid Group. The ESO's funding model must provide a fair return for the risk we hold on behalf of consumers. It must also enable us to manage the impact of substantial fluctuations in cashflow and earnings arising from the role we play at the heart of the industry.

We believe the most appropriate model to achieve an ESO that is financeable, incentivised to innovate and invest on behalf of consumers, and can earn a fair return for the risks we hold, is a **layered funding model**. This would combine a return on our Regulatory Asset Value (RAV) with margins based on our other business activities to reflect the different scale of risk. For example, for our industry revenue management role, it would be appropriate to have a margin on the revenues we transact to reflect the significant cashflow and profit volatility this role creates. This approach supports Ofgem's aim to make sure our services remain discrete, so they can potentially be opened up to competition in the future. By seeking to align the remuneration of risk to the relevant costs also sees the reward scaling with the risk; increasing the sustainability of the framework to a wider range of future scenarios.

The diagram below illustrates the different risks the ESO holds, which is similar to other regulated companies. However, the difference for the ESO is the potential scale of those risks compared to the size of the underlying business. This has an impact on the financeability of the ESO.

6.1.1 Risks the ESO holds on behalf of consumers

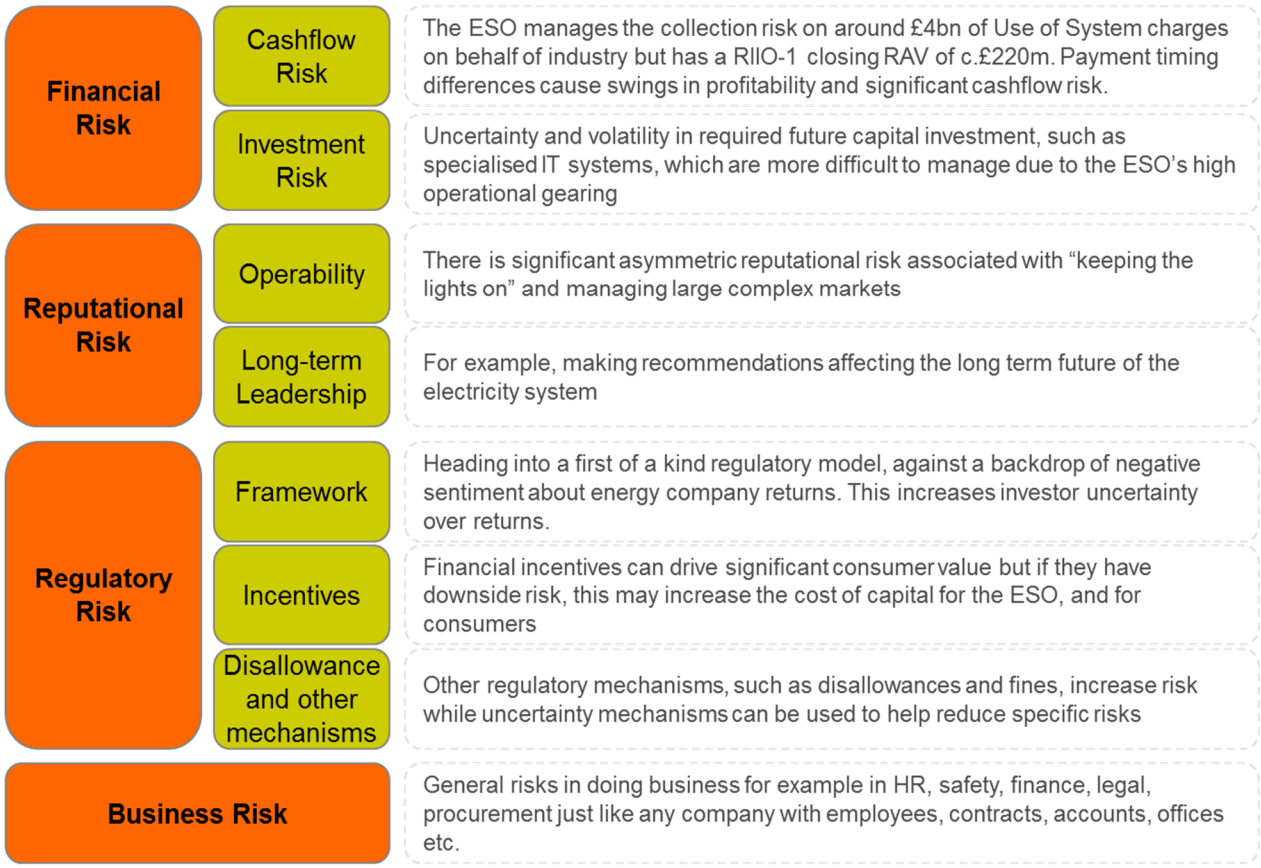


Figure 16: The ESO risks

One of our biggest financial risks arises from our role in collecting and disbursing use of system charges. We manage the flow of around £4 billion of funds across the industry each year, consisting of around £3 billion Transmission Network Use of System Charges (TNUoS) and £1 billion Balancing Services Use of System Charges (BSUoS). This figure is many times larger than the size of the ESO, with a regulatory asset value of around £220 million in 2021[28]. We act as the contractual counterparty for those paying the charges and bear the short-term costs of any discrepancies between the amounts collected and amounts paid. During RIIO-T1, these discrepancies for TNUoS have ranged between +£56 million and -£110 million in a year.

Our analysis shows that the traditional model for calculating allowed returns for network companies, based on applying a weighted average cost of capital (WACC) to the value of the company's RAV, may not provide an adequate level of return for the ESO to be

[28] This figure represents closing RAV plus inflation, from source https://www.ofgem.gov.uk/publications-and-updates/riio-et1-financial-model-following-annual-iteration-process-2018

financeable over the RIIO-2 period and beyond. This is because the ESO has a small RAV relative to the scale of operations, risks and total assets used by the ESO:

- The RAV is small in relation to the comparatively high level of costs it manages (for example opex costs are c.73% of RAV for the ESO compared to 1-2% for electricity transmission and 7-10% for electricity distribution organisations29).
- The proportion of revenues obtained via the RAV is also small in comparison to the overall revenues transacted by the ESO, which are approximately 20 times its RAV[30] and its price control revenues. In comparison, the Northern Ireland System Operator, SONI, plays a similar role but the revenues it transacts are a much smaller multiple of its price control revenues – around five times greater[31].

These are both in contrast to larger, asset-heavy network companies. The ESO is more similar in nature to other service-based organisations, which tend not to be regulated solely using a RAV-based framework. The large scale of the costs we manage, compared to the underlying scale of the ESO business, means we need a different arrangement to the other network companies. We believe that a layered model provides additional flexibility for remuneration to be tuned to the different risks.

The layered model consists of:

1. RAV*WACC layer for capital expenditure – allowing the cost of investments to be spread between customers that enjoy the benefits, over the lifetime of the assets
   - To recognise the capital we invest in our IT infrastructure and tools used to underpin the services we deliver
   - To provide funding for the big investments we want to make in line with the lifetime of these capital investments (5-10 years)
   - The WACC should reflect the specific and unique characteristics of the ESO – not necessarily the same as that proposed for network companies.
2. Margin(s) on operational costs[32] - allowing revenues to automatically flex to reflect changes in risk from a greater scale or differing mix of activities
   - To make us a financeable business against a backdrop of a changing industry this would give us the capacity to be flexible, experiment and take risks in delivering the plans our stakeholders want
   - To allow us to absorb downside risk (cost disallowance risk, potential incentive downside, Black Start cost disallowance)

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[29] Figures quoted are calculated using average figures for RIIOT1 and ED1 to 2017/18 included from sources https://www.ofgem.gov.uk/publications-and-updates/riio-et1-financial-model-following-annual-iteration-process-2018 and https://www.ofgem.gov.uk/publications-and-updates/riio-ed1-financial-model-following-annual-iteration-process-2018

[30] This figure represents opening RIIO-2 RAV of approximately £220m with expected Use of System and Connection charges in the same period of approximately £4bn.

[31] CMA ruling on SONI's price control, paragraph 7.330 "SONI's revenues including its revenue collection and dispatch balancing functions are approximately five times its Price Control revenues. Given this scale, we do not accept that any other regulated company, nor any private company, would accept such very significant cash flow management risks without some form of remuneration for doing so." https://www.gov.uk/cma-cases/energy-licence-modification-appeal-soni

[32] It is likely that the ESO would only earn its margins against spend set out in the business plan, therefore mitigating against the risk of the ESO increasing internal and external costs to inflate its margin.

- The appropriate margin will depend on the activities being remunerated and the risk associated with them.

3. Margin on external costs – remunerating the risk of managing such large financial transactions
    - A return to reflect, and scale with, the risk and profit volatility we are exposed to in this role. This is also in line with regulatory precedent
    - This risk is not addressed by a working capital facility
    - Our analysis, and regulatory precedent, suggests that a margin of around 0.5% may be appropriate.

Other elements that need to be considered as part of our financeability are the appropriate gearing, fast/slow money split and capitalisation rate, and the design of the incentive scheme and its interaction with the funding model. For more information on the key dynamics affecting business plan financeability, please see Annex C.

6.2 What we know about the ESO's regulatory framework so far

Ofgem consulted on its proposed regulatory framework for the ESO in December 2018 and published a decision and further consultation in May 2019[33]. We have published our full response to the December consultation on our website[34].

Ofgem's May decision document confirmed the following aspects of the ESO's RIIO-2 regulatory framework:

- the ESO will have a two-year business planning cycle within a longer price control. Its business plan should detail proposed costs, activities, deliverables and performance metrics for the first two years of the RIIO-2 period. The ESO must also set out a five-year strategy and a long-term vision out to 2030 and beyond.
- there will be no totex incentive mechanism (sharing factor) on business plan costs, which means that consumers will bear 100% of any difference between anticipated and actual costs on a lagged basis. In effect, the efficient costs will be "passed through" to consumers over time. Cost disallowance will align to the approach for other RIIO companies.
- the ESO will continue with an evaluative incentive scheme that retrospectively assesses the ESO's performance. Ofgem will consult on the design of this scheme in the summer. Ofgem is also consulting to determine if the scheme should be asymmetric. The Black Start incentive will remain as a standalone cost disallowance of up to 10%.
- there will be continued innovation funding, which Ofgem will consult on in the summer.

Ofgem is consulting on options for the ESO's funding model. Ofgem divides the possible options using two model groups:

[33] https://www.ofgem.gov.uk/publications-and-updates/riio-2-sector-specific-methodology-decision

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

1. Model 1: Remunerate the ESO with a RAV-based, slow money[35] model for capex, and fund opex as fast money via pass-through. The approach for calculating the WACC would follow that of the other RIIO companies, but would reflect ESO-specific considerations in relation to gearing, cost of debt and cost of equity
2. Model 2: Remunerate both capex and opex as fast money[36] via pass-through, thus potentially reducing the need for debt financing.

Either model could include a margin to be applied to internal or external costs, if necessary. Ofgem is asking for views on whether an additional margin is warranted, and its form.

Ofgem would also require the ESO to procure a working capital facility, the cost of which would be passed through.

We are disappointed in the direction of travel of the two basic funding model options, as we do not think they fulfil the criteria set out at the beginning of this chapter, and will not drive us to be the ambitious ESO that stakeholders want.

Specifically, the two basic models in the consultation risk:

- driving cautious behaviour due to a lack of financial resilience, by not recognising or remunerating the varying nature of ESO activities and associated risks. This could focus our spending on trying to minimise risk, for example only contracting with large, traditional companies to deliver our IT investment rather than exploring more innovative routes with new providers, which could be better value for consumers
- not providing sufficient liquidity to support investment or absorb shocks or downside scenarios
- being unattractive to equity investors, making the ESO a business that is not financially sustainable.

The addition of margins to Model 1 would turn this into a layered model, which we think would mitigate these risks.

We are assessing the impact that the options that Ofgem is proposing may have on the ESO's financeability and our ability to deliver our business plan. Without a finalised funding model, we have been unable to include factors such as financing costs, and the impact of our proposals on consumer bills, in this version of the plan.

6.3 Next steps

We continue to share our work on financeability with Ofgem and to discuss the development of an appropriate funding model for the ESO. We will publish our response to Ofgem's consultation in early July, and update our October business plan in the light of that latest information on the ESO's funding model.

[35] Slow money is where costs are added to the RAV and therefore, revenues are recovered slowly (e.g. over 20 years) from both current and future consumers.

[36] 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 into the RAV (slow money).

PART 2: OUR PROPOSALS

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

7.1 Overview

As the Electricity System Operator, we operate the electricity transmission networks across Great Britain and we are the residual balancer for Great Britain. Both roles enable us to maintain system security in real-time. To meet our stakeholder-endorsed ambition to have the ability to operate a zero-carbon system, with highly competitive and diverse markets by 2025, we need to implement significant change.

Our ambitions are:

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

We have engaged widely on developing our new balancing and control capabilities, particularly given the level of investment associated with our proposals. Engagement included the Electricity Operational Forum in March 2019, industry roundtables at Power Responsive, The Association for Decentralised Energy and the Flexible Generators Group, our April 2019 ESO RIIO-2 stakeholder event and the April 2019 IS Change Forum. We have also engaged many stakeholders bilaterally and via webinars.

We are responding to stakeholder views in this area, which are:

- A request for clarity on our 2025 carbon-free ambition. Some asked if the ESO would be forcing the system to be carbon-free, while others wondered if it meant operating a no-transmission or no-synchronous generation system.
- A request to see a roadmap out to 2025 to understand how key milestones would be delivered.
- Support from many stakeholders for the proposal to develop new balancing and control capabilities, although due to the challenges the operating environment brings to the system, some had concerns over the scale and deliverability of big IT projects.
- Endorsement in the main of us setting up a design authority as we look to develop a ‘digital twin’ for our control room infrastructure. Stakeholders want us to be transparent with how the system is created and how decisions are made.

The net benefits of our proposals are estimated at around £100 million.

Within this theme we will expand and transform our control centre architecture and systems to meet the needs of changing networks, markets and energy usage and continue to deliver for our customers and consumers.

- We will expand our balancing capabilities so we are still able to monitor, schedule and balance the system through dispatch of market participants economically and efficiently to ensure system security.
- We will transform network control to enable effective management of the more changeable and variable network conditions through to 2030.
- We will reengineer our control centre infrastructure so we can develop balancing capabilities and network control in an agile way, while maintaining

> “This is where we would want you to be” (on our ability to operate a zero-carbon system ambition)
>
> **Trade Association body**

security and robustness expected for critical national infrastructure. Central to this is the creation of a digital twin control room, a replica of our balancing and situational awareness tools in a realistic working environment offline.

Alongside developing the new control centre architecture, we will need to make sure we have control engineers with the right capability and the right experience. We'll also need to continue fostering a learning culture within the ESO.

We will enhance our people and data capability. We will do this by developing simulation and training capability through creation of a digital twin, and through improvements in our training capability for control engineers and the wider ESO. Developing our understanding of human factors in decision making in highly complex environments will ensure the wellbeing and resilience of our control room engineers.

We will make sure system restoration continues to be robust and will evolve as new restoration standards are introduced in 2021/22. The evolution in the standards for our future economy will require us to expand our systems capabilities. We will continue to build on our innovation project in restoration to enable additional restoration capabilities. Out to 2030 there will be an increasing reliance on electricity and an increasing expectation on improved restoration capabilities. This means we will need to deliver the requirements for future restoration in a high electric world.

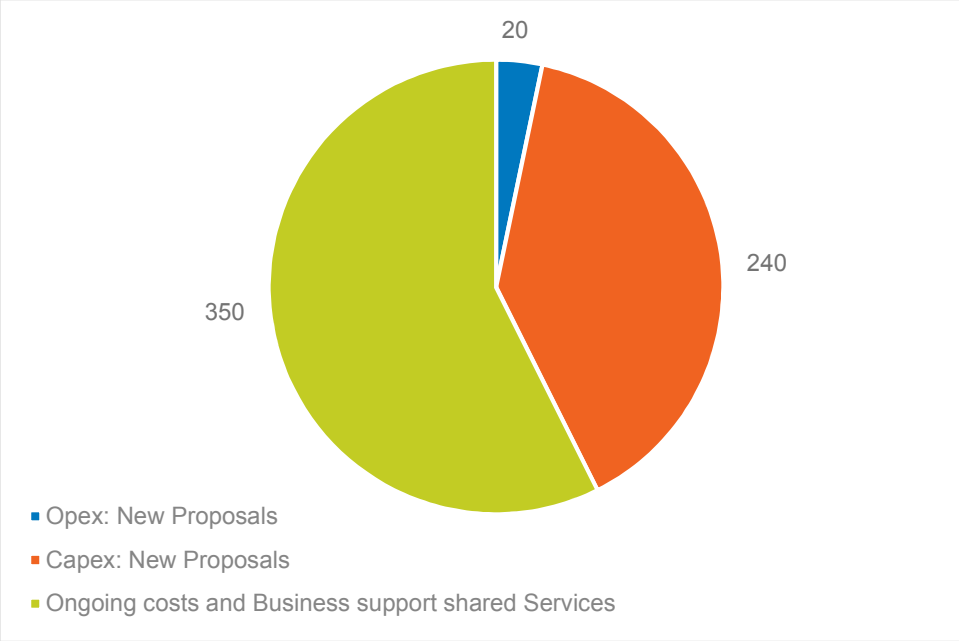

Figure 17: Current view of costs of Theme 1, £m, (FY 2021-26)

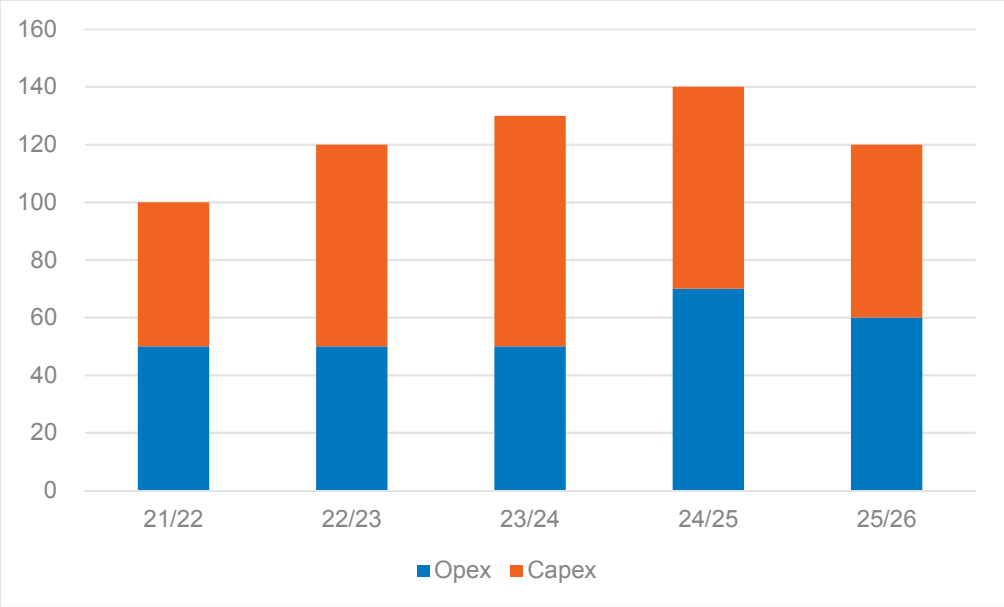

Figure 18: Current view of costs of Theme 1 (ongoing and new costs), split by opex and capex, £m per year.

7.1.1 Stakeholder views on the 2025 carbon-free ambition

During our engagement, stakeholders were universally supportive of our 2025 carbon-free ambition although many asked us to clarify the exact intention. Some asked if the ESO would be forcing the system to be carbon-free, while others wondered if it meant operating a no-transmission or no-synchronous generation system.

In response to this feedback, we have restated our ambition to clarify that it is the ability to run a carbon-free system if that is what the market provides. We have recently seen a rapid move towards carbon-free operation, from the UK's first coal-free generation day in April 2017 to over 18 days in May and June 2019. The ESO will continue to remain technology neutral and operate the system in an economic and efficient manner, consistent with our licence conditions, but we must prepare for the low-carbon future targeted by the Government through the UK Climate Change Act and the Paris Agreement.

A few stakeholders said the ambition would 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 we need to deliver to meet this ambition. This document, including the investment roadmap shown later in this section, therefore provides stakeholders with further detail on the individual capabilities that are needed. Some service providers commented that fixed dates and deliverables are needed that must be achievable with the ESO held to account to deliver it. Service providers said that this was important to ensure efficient adaptation of their own systems and interfaces in response to our new systems as required. We will provide more details as our thinking evolves.

Stakeholders at a round table discussion at our RIIO-2 stakeholder event in April 2019 reflected that, while they were very 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 said we need to

think about short and long-term consumer benefit and remain agile around our plan as we move closer to 2025. This will be reviewed as plans develop.

7.2 Control centre architecture and systems

Our control centre architecture and systems play a critical role in enabling us to carry out our core roles of maintaining network security and residual balancing, and continued collaboration with our stakeholders will be key to the success of future developments. For this business plan, we have separated out the control centre architecture and systems into three key areas: expand balancing capabilities, transforming network control and control room infrastructure.

7.2.1 Expand balancing capabilities

To meet our 2025 ambition of being able to operate a carbon-free system, a complete overhaul of our existing control centre architecture and system is required. This will enable us to efficiently balance the market and provide the service that customers expect from us. As the market changes, user behaviour and weather play a larger role in energy production and usage than they do today. Overall, we will have to consider a greater number of variables than we do today. A greater number of smaller participants will need to be dispatched to balance and maintain a secure network. To do this and meet the needs of our customers and stakeholders, we will need systems upgraded in scale and scope. We will also need to make better use of the data available to us by applying machine learning, artificial intelligence and automated control. We will need to use different techniques to take more actions on more units in more networks more often.

A key activity in this role is to:

- refresh and upgrade existing systems to balance the network as they come to end-of-life
- upgrade architecture to modern systems and capabilities that are quicker and more agile at reacting to the evolving markets.

Stakeholder views

Our stakeholders prefer an agile, modular approach to new capability development as they feel this helps to mitigate against costly delays. We will learn from other projects such as Electricity Balancing System (EBS), over which some stakeholders have raised concerns, in the development of our IT architecture. Service providers at our IS Change Forum and a trade association round table mentioned that the approach to developing the Platform for Ancillary Services (PAS), which is similar to our proposals, worked well.

The key requirement for some smaller service providers for any new system development was to have transparency around the algorithms and back end decision making. We will consider this as we further develop proposals for a design group, which is proposed in section 7.2.3. It was also recommended that we benchmark our proposals against other system operators and comparable sectors; we will provide more details on the outcome of this in our October and December 2019 submissions.

The ERSG commented that it may be challenging to deliver new systems that are as fit for purpose for as many people as possible given the number of participants and variety of preferences. We will consider this as we develop proposals for the design group, introduced in section 7.2.3. The ERSG also enquired about the cost impact on users of integrating our new capabilities with their systems. The detail of this is still to be

determined, however the offline development of new control systems through the design group will ensure we develop systems that meet the needs of users who interface with the control room and can be accessed by users to meet their needs for situational awareness and market data.

Rationale for proposals

As the market decentralises, we need to make sure we have no barriers to market participation and service provision arising from our architecture and systems and this is something we have heard consistently from our stakeholders. This means that by 2023 we need the system capability to dispatch potentially thousands of market players, so we can ensure the lowest balancing costs for consumers and a level playing field for service providers. This is a significant shift from today, where we have dispatch and settlement systems designed for hundreds of units. We can no longer rely on the incremental evolution of our existing and ageing technology. Bolting on solutions to existing systems will hinder future flexibility and adaptability in system operation. It will also hinder the variety and agility of our stakeholders[37].

Failure to be able to adapt to the market and effectively manage and use the data provided by network and market parties would have consequences. It would result in significant sub-optimal real-time balancing of the market, and an overall higher cost to consumers.

7.2.2 Transform network control

As the operating environment changes, we need to enhance our network control. This includes:

- informed visibility of the status of the network, compared to operational limits of the network
- improved capability around interfaces with other networks like DNOs and offshore transmission owners
- new tools to forecast, monitor, assess and manage the technical parameters of the network now and into the future, so we can ensure ongoing reliable operation of the power system.

This will provide the confidence and accuracy to support increased optimisation of actions (ensuring we do not create a new problem by solving another) across an increasing number of networks and parties as we move to a more integrated electricity system.

Stakeholder views

Stakeholders have in the main been supportive of our proposals to introduce enhanced network monitoring such as inertia monitoring and some at the Operational Forum, at our RIIO-2 event in April 2019 and at the OC2 Forum have stressed the challenges that managing a low-inertia system in future will bring. Our enhanced monitoring will work towards enhancing our visibility of the system and therefore control. We were also asked to be clear on what monitoring will be delivered in RIIO-T1 as part of the Forward Plan and what will be delivered in RIIO-2. This has been set out in our roadmap and we will further enhance this detail in our October and December business plans.

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[37] University of Cambridge and Imperial College London: Delivering future-proof infrastructure https://www.nic.org.uk/wp-content/uploads/Delivering-future-proof-energy-infrastructure-Goran-Strbac-et-al.pdf

At our December 2018 stakeholder workshop, attendees highlighted the need for us to be clear on the interfaces with DNOs and how we will work with them, which these deliverables will work towards us achieving.

Rationale for proposals

We will need to expand the focus of our current network control systems. Today, our systems focus on managing the primary energy flows on the networks. This is because historically the binding constraints on the networks have been related to thermal capacity. As the providers and users of energy change, we will need to be more aware of other physical properties of the network, including reactive power flows, system inertia, fault infeed, harmonics, and dynamic and transient stability. To be able to manage these other physical properties effectively we will need to improve our ability to monitor and forecast them.

The changes will also give rise to more dynamic networks with less predictable and reliable flows than we have seen previously. We will need to overhaul the way we monitor and predict network flows and propose to introduce modern, human-machine collaborative decision-making capability. We require development of intelligent situational awareness tools, including network simulation. We also need to further bring machine-learning into our forecasting capabilities.

> "Yes, a significant change is required - since NETA the landscape has changed"
>
> **Generator**, IS Change Forum (in response to question on whether new control capabilities are required within the ESO)

7.2.3 Control room infrastructure

We must make changes in smarter and quicker ways than we have previously managed, so we can meet the challenges we see ahead. We will develop new control system capabilities offline in a digital twin environment, supported by stakeholders through a cross-sector design group.

A digital twin will replicate our balancing and situational awareness tools offline. To ensure the design group is representative and has the required expertise, it could consist of the ESO, network companies, market players, technologies companies and academics. The ESO would retain overall decision-making responsibility.

Stakeholder views

Stakeholders have endorsed the establishment of a cross-sector design group to support the development programme, commenting that we need to make this representative, especially for smaller players who may have limited resources to commit and prevent it becoming a 'talking shop'.

The ERSG asked how we intend to involve stakeholders in the development of systems. This will be primarily through the design group, but we are also working with other data-enabled organisations to adopt best practice, where possible, in these areas. In addition, they commented it may be challenging to deliver new systems that are fit for purpose for as many people as possible given the number of participants and variety of preferences. We will consider this as we develop proposals for the design group.

Rationale for proposals

This approach builds on the recommendations of the National Infrastructure Commission[38]. It also allows agile development and a safe environment to test and improve. Working with a design group will make sure the new control capabilities reflect future market needs and have transparency inherently built in.

Design authority

The ESO design authority will give stakeholders the opportunity to inform the direction of the ESO, and provide input into the design of services and capabilities. It will also provide transparency of the decision-making process and prioritisation of investments. At a more detailed level, it will allow us to consult and engage on the experience of interacting with the ESO and invite input into key design, development and testing phases of our solutions development. It will also provide transparency of the decision-making logic behind our systems.

We envisage the design authority could consist of the ESO, network and market participants, technology companies and academics. It would be advisory, with the ESO retaining decision making responsibility. Our initial thinking is that the group could meet every six months, starting towards the end of RIIO-T1 and review the frequency to meet the transformation requirements.

What is a digital twin?

By digital twin we mean a replica of our physical control room assets, operational processes and IT systems that we can use to simulate both markets and the operability of the GB transmission system. This will enable us to develop new control room capabilities in a 'sand box' environment before transitioning to real time operation.

We already have physical replicas of our control room hardware in our training simulator and we will refresh these through the course of normal asset replacement. However, today, most of our offline IT tools and online real time IT tools use data sets that are different to the real-time data we work with in the control room. They are largely limited to modelling technical operation. Through digital twinning, we aim to replicate the online real time IT tools in an offline 'twin' and use the same real time data sets.

This digital twin will include our market systems and tools so that we can model and assess technical and commercial interactions holistically. This means we will be able to better train our control room engineers, develop critical new systems in a safe environment, perform higher quality optimisation of the system closer to real time, and be able to assess future operability challenges before they happen.

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

Cost-benefit analysis

Net benefit of all our proposals against the status quo is between minus £62m and plus £214m, with a central estimate of £124 million over the RIIO period.

These net benefits have been calculated considering costs and benefits over the five-year period up to 2025/26. There will be benefits beyond this period, so this analysis will conservatively underestimate the true net benefits.

The total additional costs for the period are £185 million. Of this, £174 million is capex and £11 million is opex. This investment will transform our control centre architecture and systems so we can effectively manage the decarbonised and decentralised energy system of the future. It will deliver an operational environment where there are no barriers to market participation and service provision, enabling us to maximise the consumer benefit that flexibility and residual balancing services provide.

The benefits of the preferred option are outlined in a qualitative way in the table below:

Benefit	Description
Improved safety and reliability	• allows more balancing and ancillary service market participants to enter, leading to a greater diversity of technologies and services available to the ESO and less reliance on a limited range of products • a better understanding of the operational limits of the system through enhanced situational awareness greater forecasting and modelling capability • making better operational decisions through improved control room equipment, leading to faster decisions and less outage time.
Improved quality of service	• greater transparency of our control room decision making process, through designing the new systems, capabilities and communication links with transparency in mind • giving the ESO closer ties to DNOs and DSOs, from greater visibility of distributed resource through the ancillary service dispatch work • better operational decisions, a faster acting ESO and less outage times from improved control room asset health.
Lower bills than would otherwise be the case	• increasing our flexibility via the introduction of markets and allowing market participants to drive increased competition in markets. This leads to increased liquidity, and in turn to lower cost per unit of our services • providing the ESO with a better understanding of the operational limits of the system and enhancing our forecasting and modelling capability, so we can run the system to a tighter tolerance and optimise the levels of reserve we carry • making more efficient operational decisions through improved control room tools, leading to faster decisions and less balancing mechanisms outages times

	• allowing more interconnectors to connect, giving access to new sources of potentially cheaper and greener energy.
Reduced environmental damage	• allows the ESO to use market-provided low carbon solutions • having a better understanding of the operational limits of the system, so we can optimise the amount of reserve we carry, typically supplied by traditional fossil fuel generators. • facilitating the connection of interconnectors, allowing the transfer of low-carbon energy between markets.

A robust counterfactual that represents the absence of these benefits is difficult to identify. We are certain that increasing complexity would increase costs and risk over time, leading to higher bills and increased carbon emissions. However, it is uncertain by what magnitude and when. We have produced our CBA focusing on lower bills and reduced environmental damage:

- Lower bills than would otherwise be the case are predominantly derived using the Committee on Climate Change (CCC)report 'Roadmap for Flexibility Services to 2030'[39]. This sets out benefits of between £3.2 billion and £4.7 billion, achievable through attracting new sources of flexibility to the electricity system. For the purposes of this analysis we have conservatively assumed that our control centre architecture and systems investment could unlock between one and three per cent of these benefits, ramping up progressively over time. We have also included an estimated benefit for improvements in decision making through better network control.
- Reduced environmental damage is quantified by deriving a reduction in carbon intensity from the difference between our Consumer Evolution scenario (slow decarbonisation) and our Two Degrees scenario (fast decarbonisation); and estimating that our investment could unlock this reduction for our control centre residual balancing actions.

The estimated net benefit of our preferred option using the identified costs and benefits is £124 million over the RIIO-2 period. This is before consideration of benefits (and run-the-business costs) for future periods and on the conservative basis set out above. Therefore, it is likely that the actual net benefit will be higher, if either a broader range of the benefits identified qualitatively are realised, or if a higher impact is achieved unlocking greater benefits.

7.2.4 Other options considered

We have considered four options for the transforming and expansion of our systems. These form a 2x2 matrix based on whether we deliver transformational investment or simply maintain our current capabilities, and how we deliver it - either within the current architecture while the current control room is online, or offline in a digital twin with new architecture.

[39] Committee on Climate Change: Roadmap for Flexibility Services to 2030. https://www.theccc.org.uk/wp-content/uploads/2017/06/Roadmap-for-flexibility-services-to-2030-Poyry-and-Imperial-College-London.pdf

Options for developing our balancing and control capabilities		Investment	
		BAU	BAU and transformational
Delivery method	Online within the current architecture	Option 1	Option 3
	Offline in a digital twin with new architecture	Option 2	Option 4

In all options, we will continue to operate the electricity transmission system safely, economically and efficiently, consistent with our licence obligations.

1. Business-as-usual: replace the current systems as needed, online and within the current architecture

Under this option, we would upgrade our core systems so we remain compliant with our licence obligations, but not deliver new and transformational capabilities. While this option would have the lowest direct cost, the capabilities we currently have and would refresh are based on tried and tested architecture and systems. These are designed for a market place with a relatively small number of large centralised participants and are not capable of being easily modified for a decentralised and decarbonised world. Fundamentally, this option would not deliver the balancing and control capabilities we need and would mean that we cannot meet our 2025 ambition.

2. Replace the current systems as needed within a new architecture developed offline

This option would deliver a new architecture, designed and developed offline, but would only refresh systems as per option 1. This would not deliver the system benefits we need and so we do not see a justification for using an offline digital twin. Therefore, we have not taken this option forward for full cost-benefit analysis.

3. Deliver new and upgraded balancing and control systems online within the current architecture.

The transformational capabilities we have described would be built and installed into the existing control room while it is still online. Although this would deliver new capabilities, there is higher complexity in amending large interdependent IT systems while they are live. This would lead to slower implementation times and increased operational and commercial risk, which may not meet the needs of market participants. We also recognise that this approach is akin to the way we have developed systems historically and that this has not delivered the rate of change to our capabilities that stakeholders want.

Proceeding with this option would make it significantly more challenging to meet our 2025 zero-carbon ambition, because the current systems rely heavily on a point-to-point communication architecture. So, a change to one system will trigger multiple changes on other systems – this would restrict the flexibility we need.

To model this option, we assumed that costs would increase by ten per cent due to the need to embed systems into ageing architecture and the knock-on effect that the current point-to-point communication channels have from the implementation of one system on others. We have also assumed it would take two years longer to implement benefits. This option is delivers negative net benefits.

4. **Preferred option:** deliver new and upgraded balancing and control architecture and systems, designed and developed using an offline digital twin. This is the proposal described above, delivered with stakeholders in an agile, modular and transparent way. You can find more detail about the costs and benefits of this option, compared to the BAU counterfactual, in the CBA annex.

How we will approach this activity

Our first step will be to develop a core control room infrastructure that enables components to be incorporated into the architecture when adding new capability. The architecture will support component development and the adoption of off-the-shelf package components. This approach will provide the flexibility we need to change further, saving more time and costs than previously experienced. Once the core architecture is in place, we will design, build and deploy modular, component-based models and solutions. This is an approach that has been welcomed by the majority of stakeholders we have engaged with. They are keen to avoid big IT projects that often fail.

This foundation work will unlock capabilities for other investments like the market platform and data portal to provide the value we've described in Theme 2.

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

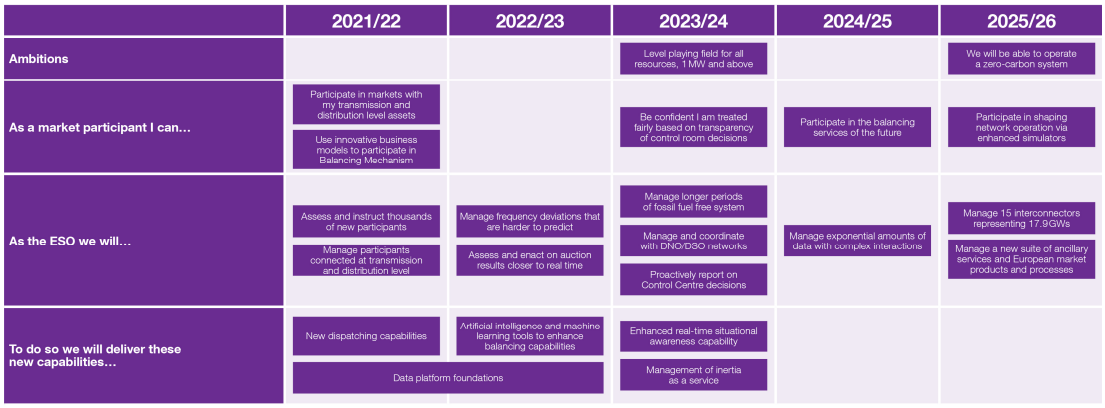

Figure 19: Deliverables and activities timeline for Theme 1[40]

[40] Please increase page zoom to 200% to view this diagram

Innovation

The innovation we will undertake in RIIO-2 as part of our business plan includes:

Designing and building the new balancing and control capabilities in an agile, modular and adaptable way via a digital twin. This is a similar concept to the digital twin the National Infrastructure Commission has recommended the UK develop.

Developing situational awareness for the whole electricity system, not just transmission, building on the RecorDER project and Project SIM.

Online and offline system modelling and forecasting to enhance decision making.

Areas we may want to draw on innovation funding in RIIO-2 include:

Bringing artificial intelligence, machine learning and automation into the control room processes. This is the approach we currently take through the ESO Lab, our applied internal research centre. Given the changing energy landscape, it is unclear exactly what tools and systems, which may not exist presently, machine learning could be applied to.

7.3 Training simulators

We propose to develop new training simulators to accurately reflect the changing energy landscape to train power system engineers on a range of future scenarios. The new facility will allow us to better understand the operational limits of the system, both now and in the future in a safe environment. This will enable more efficient real-time operation.

Opportunities arise through developing enhanced training and simulation tools, which are extended to include balancing simulation and reflect the changing operational control requirements. We will also make training more accessible and flexible by exploring new approaches, such as desktop or app-based exercises.

We will support the DNO to DSO transition through opening our training capabilities to other parties, providing and participating in cross-sector secondment opportunities and developing best practice and prevention techniques through simulating past real-time events. This will provide greater consistency in the quality of training, negates the need for as much one-to-one training and will reduce the time taken for users to become fully functional.

We set out our broader proposals for improving training and understanding human factors in our Chapter 16: People and Capability.

Stakeholder views

We sought stakeholders' views on our objectives to develop our people at the ESO RIIO-2 event in April 2019 and through *Our RIIO-2 Ambition* consultation document. 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 the industry. On resourcing, we heard that it is important for people capability, health and wellbeing to be 'upgraded' as well as systems. More specifically on skill sets, stakeholders agreed the ESO will increasingly need data and computer science skills to complement our power system engineering capabilities, and that the DNO to DSO transition will only increase demand. There were some differing views on how to solve this issue, and whether it was the responsibility of the ESO to solve wider market issues. Some stakeholders felt it should be left to the market to solve, others thought we need to be partnering with universities, government initiatives and technology companies to train talent, building on our existing programmes. In response to *Our RIIO-2 Ambition* consultation, one stakeholder pointed out that we proposed to train and develop our people but didn't mention the retention of our people. We agree that this is key to a resourcing strategy and have provided more details on this in the People & Capability section. We agree that talent retention is important, but we are also conscious that we need to future-proof against our current age profile in our critical operational roles.

> "Ensuring that people as well as systems are 'upgraded' for the new world is vital and often missed when discussing the new world" **Generator**, in response to the ESO RIIO-2 Ambition consultation

The ERSG commented that to keep high calibre people we need to offer a good work-life balance. This includes being able to increase our flexible working practices in the control room and ensuring control room engineers remain "in practice" whilst on maternity, paternity or adoption leave, and allow for more part-time working. We already have wellbeing support available, conduct regular health surveillance, have an on-site gym and look at rota patterns to ensure staff wellbeing. We are committed to assessing and stretching ourselves to be at the leading edge of the latest thinking in this area, especially in relation to the shift working necessary in our round-the-clock operation. We will look to increase the amount of flexible working available, balancing against the requirements operational and shift work brings.

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

Given this feedback, we will undertake further engagement to develop our resourcing and training proposals:

- We will engage universities to understand the process for setting up and delivering an academic course and to look for possible partnerships. We want to determine the level of support we would need to provide an existing academic institution to ensure the most relevant subjects are being covered. We could support the teaching of these courses by providing tutor exposure to real-time operations and by providing guest lectures on relevant topics and tools
- We will engage bilaterally with DNOs and TOs on these proposals. We will discuss proposals on new control capability and system interfaces, the content of future power system engineer training requirements and talent exchange. We will also discuss our proposals for system restoration with DNOs and TOs.

- We will explore partnerships with government initiatives, for example the Office for Artificial Intelligence and the National Skills Academy for Power to make the best use of existing schemes and see how we can support them.

Rationale

The current average age profile of critical power engineering roles is 45. To ensure high capability standards are maintained, we have to continually search the market for replacement resource for skills that are recognised to be on the shortage occupation list. Previous national and international resourcing campaigns have fallen short of the quantity required, which has led to the in-house development of training schemes.

The control centre architecture and systems section sets out the changing requirements of how we operate the system. These highlight a need for our control engineers to not only be experts in managing power systems, but also carry expertise in new areas such as data science. The less predictable and more varied characteristics of the system will require our control engineers to be resilient to a faster pace of operations. They will need in-depth understanding of how automated and supportive systems help in their decision making.

With the evolution of distribution network operation to distribution system operation, there will be increasing demand for power system engineer skillsets across the industry. There is potential for significant value in developing operating engineers in partnership to meet the overall industry demand. This will also potentially help accelerate the development of DSOs and future system operator capability, recognising that we need to develop skillsets that are fundamentally different from the past.

A reasonable assumption is that there will be around 100 full-time equivalents (FTEs) in the ESO control room (five shifts of 20 FTEs), and 50 FTEs in each of the 14 potential DSO control rooms, covering multiple shifts, totalling 800 FTE in all control rooms. Using the average UK attrition rate of 15% gives 120 FTE needing training each year. This does not include staff across other departments who would benefit from the qualification.

Cost-benefit analysis

Net benefit of all our proposal against the status quo is between £5 million and £41 million, with a central estimate of £22 million over the RIIO period.

These net benefits have been calculated considering costs and benefits over the five-year period up to 2025/26. There will be benefits beyond this period, so this analysis will underestimate the net benefits.

The total additional costs for the period are £19 million, split between £18 million in capex and £1 million in opex. The capex cost consists of workflow and change management tools and the development of new simulator and training facilities.

This investment will transform our people and data capability so our people can effectively use the transformed control centre architecture and systems to manage the decarbonised and decentralised energy system of the future. It will deliver an operational capability with a greater breadth of skills, greater depth of understanding of new technology and higher resilience in a faster-paced, higher complexity decision making environment. This will make sure we are prepared to deliver benefits in the RIIO-2 period and beyond. Importantly, it will also give us the confidence we can do this in an environment where these skills will be in high demand and can also deliver value elsewhere in the sector, for example in the DNO to DSO transition.

The benefits of the preferred option are outlined in a qualitative way in the table below:

Benefit	Description
Improved safety and reliability	• from better operational and whole-system decision making, updated training practices, enhanced simulation capability and healthier control room staff • people who better understand the overall system and market, not just control capability, delivered through the suite of training material
Improved quality of service	• cheaper training for all parties in the electricity industry, through sharing our resources and working with partners to develop training material • opportunity for partnerships and secondments across the industry to spread knowledge and develop an understanding of other system parties • greater cross-sector data sharing and collaborative decision making through training other parties and sharing best practice.
Lower bills than would otherwise be the case	• from better operational decision making, through being able to train control room staff on the latest systems, on handling future events and improving our lessons learnt exercise • better whole system decision making and using resources across the system through a better understanding of needs and implications of actions • cheaper run the business costs through modern workforce planning and agile training and higher retention rates.
Reduced environmental damage	• from better operational and whole-system decision making, driven by control room staff being able to handle and decarbonised and decentralised energy landscape
Benefits for society as a whole	• promoting STEM and developing talent, through partnering with universities, industry and government initiatives to offer courses.

Failure to develop our people and data capability will lead to a continual decline in the quality of our decision making, adversely affecting the costs of balancing the system in real time and leading to higher consumer bills. We have therefore produced our CBA by deriving an estimate of the benefit of improving our capability on lowering balancing costs. For the purposes of this analysis, we have conservatively assumed that we could achieve a two per cent reduction on balancing costs of approximately £1 billion annually through better decision making, from 2021/22 when we deliver our new simulation and training capability.

The estimated net benefit of our preferred option using the identified costs and benefits is £22 million over the RIIO-2 period. This is before consideration of benefits (and run-the-business costs) for future periods and on the conservative basis set out above.

Therefore, it is possible that the actual net benefit will be higher, if a higher impact is achieved unlocking greater benefits.

7.3.1 Other options considered

We have considered one alternate option to our proposed approach (above) which we have compared in a CBA. This alternate option is to maintain the status quo and continue with our current training and simulation activities. However, we do not support this approach because:

- Our workforce planning and resource profiles indicate we will be unable to effectively resource our activities.
- Our current training simulators are not fit for purpose and must be upgraded.
- The training timescales and our staff attrition rate are similar, leading to an unsustainable business model.
- We need skills in new areas.

How we will approach this activity

The roadmap below sets out what we will deliver and when, to develop our people over the RIIO-2 period.

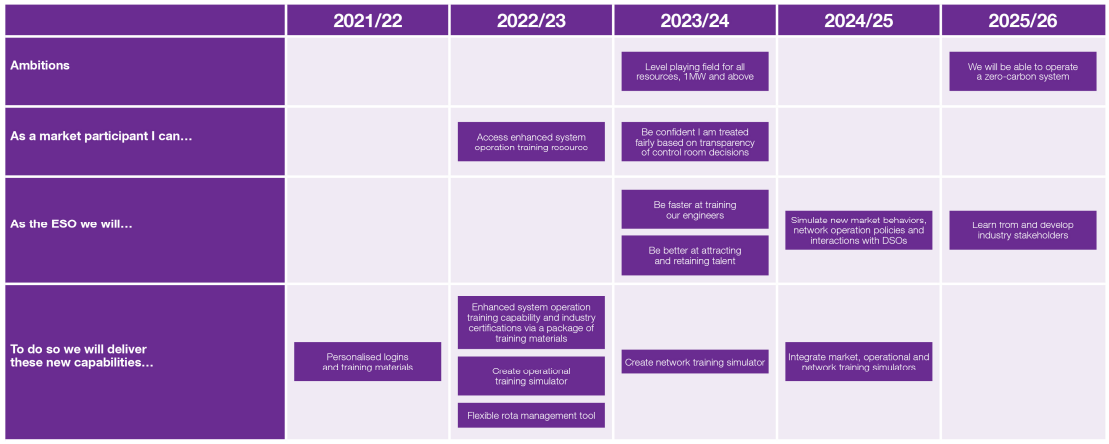

Figure 21: Our timeline for enhancing our people and data capability[41]

Innovation

The innovation we will undertake in RIIO-2 includes using a digital twin of the network to create state-of-the-art simulators, so we can improve our control room engineers decision-making ability in real world scenarios. These simulators will be able to model real life 'what-if' scenarios and allow for tailored lessons learnt exercises in the unique situations where control centre operators work.

[41] Please increase page zoom to 200% to view this diagram

7.4 Restoration

System restoration is the ultimate backstop upon 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 zero-carbon network by 2025 due to reliance on old methods, processes and technologies. System restoration will need to become a much more 'self-healing' process, featuring automated power supply recovery, and a whole system process with the appropriate system control, simulation and training tools in place, facilitated by highly trained power system engineers across all networks. To meet our ambition, the ESO must be able to meet both the system restoration standards and expectations of stakeholders in a no-carbon and no transmission generation scenario. The Black Start Task Group, a cross-industry government-led group, is currently developing a national standard (with a potential regional requirement) for restoration, using an evidence-based methodology that includes socio-economic impacts and likelihood of a shutdown event. This work is due to conclude by the end of 2021/22

Stakeholder views

We have been involved in discussions on the future system restoration standard at various industry forums. These include the Black Start Task Group, the Electricity Task Group, and Energy Networks Association-led Emergency Planning Managers Forum and Electricity Networks and Futures Group. It is this standard that will have a bearing on our training and simulation requirements for restoration.

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 our 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 as to what role different technologies, including renewables, can play in providing restoration services. A renewable developer, in response to our RIIO-2 Ambition consultation, commented that we talked a lot in our ambition about use of DER for Black Start but that there is a role to play for large-scale transmission connection renewables in Black Start service provision.

Also, in response to our ambition consultation document one stakeholder said that it is vital that learnings from innovation projects (such as the Black Start NIC project) are taken into BAU and extended into future scenarios such as "stationary" and "cold" starts where there could be a high dependency on electricity for transport and heat respectively. Another stakeholder said that they also welcomed our proposal to build upon the findings from the innovation project.

More widely, stakeholders are supportive of faster restoration timescales, committing to a standard, and allowing new products and technologies to provide restoration services. They are keen to work with us to develop these and we will engage further with stakeholders on the costs and benefits presented here.

7.4.1 New restoration standards

We will need to deliver against an expected new standard for future system restoration, set by the government. We expect a restoration standard to be implemented during 2021/22, by which time we need to have the system and capabilities to deliver against this.

To support this, we will develop a restoration decision-making support tool that would run live and advise our control room engineers on the best route for restoration at any given time.

7.4.2 Innovation project in restoration

We have secured funding through the Network Innovation Competition (NIC) to explore providing restoration services from distributed energy resources through our Distributed Restoration project.[42] This is due to conclude in 2022. The project will produce a whole system project output including the technology required to facilitate and dispatch DER. This will include tools and communications, and any associated regulatory and commercial framework changes that will need to be put in place.

> "It is vital that learnings from innovation projects are taken into BAU and extended into future scenarios such as cold and stationary Black Starts."
>
> **Generator**, in response to the ESO RIIO-2 Ambition consultation

This project will demonstrate a world first – coordinating many distributed energy resources to enable a restoration strategy to be enhanced with this additional capability. This will increase competition in the market. It will also deliver cost and carbon emissions reductions to the Black Start provider fleet, contributing to our ambitions.

Completing this project and the resulting outputs will be a key deliverable during the RIIO-2 period. We agree with stakeholders who said that it was important to embed the outputs of the innovation project into business as usual, which is included in the business plan.

7.4.3 Future restoration in a high electric world

Our *Future Energy Scenarios 2018* show that by 2030 there could be 11 million electric vehicles in GB and by 2040 up to 41 million electric heat pumps. As society relies more on electricity for transport and heating, system restoration standards will need to change, as will the capabilities we need to implement them.

During this period, we will set out new requirements to meet the evolving challenge of restoration including creating potential access for all technologies. This was something that stakeholders at our RIIO-2 event in April 2019 were keen to see. They particularly wanted to understand the opportunities for renewables.

Rationale

We have worked to maintain restoration costs in recent years as generators we rely on have operated less. As the market continues to evolve this is an issue we will continue to manage. We will continue to procure restoration services as economically and efficiently as we can. Creating a collaborative and comprehensive solution between the ESO and DNOs, to allow DER to participate in the restoration market, will bring significant financial benefits to consumers through increased competition and lower costs. This will provide further support for community-led energy schemes and potentially achieve shorter restoration times.

7.4.4 Cost-benefit analysis

The net benefits of our proposal are estimated at minus £36 million.

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[42] National Grid Electricity System Operator: Black Start from Distributed Energy Resources. https://www.ofgem.gov.uk/system/files/docs/2018/11/redacted_electricity_nic_submission_2018_esoen01_v03.pdf

This net benefit has been calculated considering costs and benefits over the 5-year period up to 2025/26. The total additional costs for the period are £41 million of which £34 million is in capex and the remainder in opex.

Our restoration policies are the ultimate insurance policy. Allowing new technologies to provide restoration services and implementing our restoration decision-making tool will ensure that, should a system restoration ever be required, we minimise the cost to the GB economy resulting from lost energy supply in a Black Start scenario.

Given the £115 million net benefit from 2025 to 2050 of our Black Start from Distributed Energy Resources project, we anticipate our proposals delivering net benefits over the period to 2050.

The benefits of the preferred option are outlined in a qualitative way in the table below:

Benefit	Description
Improved safety and reliability	• a level playing field with new parties able to participate in restoration will lead to more diversity in restoration providers, giving the ESO more options for system restoration • the restoration decision-making tool will make restoration options more visible, leading to faster decisions and enabling quicker system restoration.
Improved quality of service	• quicker restoration, in line with acceptable stakeholder timescales, will follow from implementing our restoration decision-making tool
Lower bills than would otherwise be the case	• a level playing field for restoration services, with new parties leading to increased competition in restoration, resulting in lower restoration costs • introducing a restoration decision-making tool will allow the control room to make optimal restoration decisions with less need to warm plant, lowering restoration costs.
Reduced environmental damage	• wider service diversity will mean less need to maintain readiness (warmth) of thermal plants as new, low-carbon providers will be part of the restoration fleet.

This investment will transform our Black Start capability in readiness for operating a zero-carbon system by 2025. It will also provide the foundation as we move towards the period beyond 2025 and the need for preparedness for black, stationary and cold start.

7.4.5 Other options considered

The only alternative option is to maintain the status quo and continue with our current Black Start procurement activities. However, this approach is untenable because it will simply not meet the needs of the future energy system. It would be undeliverable because significant elements of the services procured today (which include large coal power stations) will not be available towards the end of the RIIO-2 period and beyond.

Furthermore, the cost of a total black start could be extremely high – without considering the detrimental impact on future inward investment confidence into Great Britain, disruption to the whole economy could have a high direct cost on consumers and businesses if even a small percentage of the £5.7 billion[43] per day UK Gross Domestic Product was disrupted.

How we will approach this activity

The roadmap below sets out the high-level milestones that we propose to deliver in the RIIO-2 period for restoration to meet our ambitions.

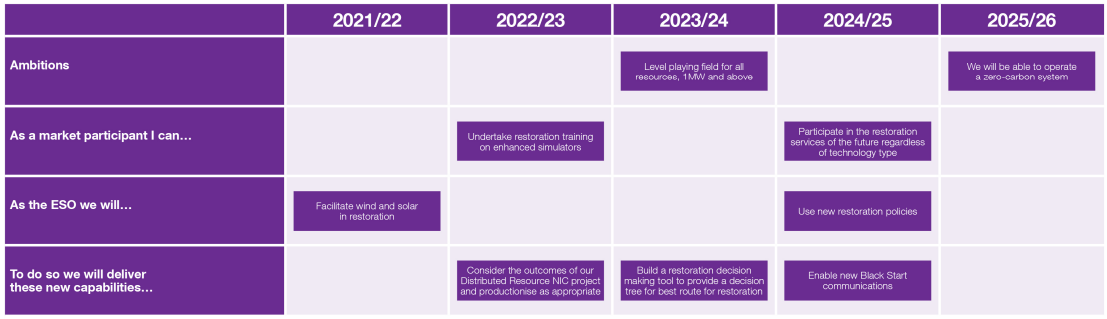

Figure 22: Timeline for high-level milestones proposed for delivery in the RIIO-2 period for restoration[44]

Innovation

Where innovation funded under RIIO-T1 has contributed to the proposals in this chapter:

We hope to use the findings and results of studies from the NIC-funded Distributed Restoration innovation project to decide on a technical solution and productionise this through business as usual. This could lead to us implementing a new service, allowing restoration capability to be procured from distributed energy resources in future.

[43] Office for National Statistics: Gross Domestic Product: https://www.ons.gov.uk/economy/grossdomesticproductgdp/timeseries/abmi/2019 Q1 values pro-rated to a daily value

[44] Please increase page zoom to 200% to view this diagram

7.5 Next steps

We will continue to develop our proposals and refine the costs and benefits, focusing on:

- providing more detail on investment timelines and details
- considering the role and structure of the cross-industry design group
- exploring partnerships for training with academia and other parties in the energy industry
- testing the assumptions around our costs and benefits
- proposing metrics to measure the outputs we are delivering
- continuing to engage on our proposals, particularly those activities highlighted.

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

8.1 Overview

Our *RIIO-2 Ambition* document set out that smart and sustainable markets will be essential for operating a carbon-free electricity system by 2025. We will need to maintain security of supply with much higher volumes of low-carbon generation. This will require a significant increase in flexible sources of energy, such as demand-side response and storage.

Our ambitions are:

- By 2023, all market participants 1 MW and above will be able to participate directly in our ESO-administered balancing service markets through a single platform, which also provides access to the Capacity Market. Participation in the balancing services markets of smaller assets, such as household storage and electric vehicles, will also be enabled through, for example, aggregation.
- A sandbox experimental market environment will sit alongside our established markets to enable co-development of solutions to emerging operability issues, such as system inertia and stability.
- By 2025, the ESO will deliver security of supply against a clear standard agreed with the government and is responsible for all elements of the Capacity Market: advising the government on the volume to purchase; managing the rules change process; and running the auction and managing the contracts. By transforming these, it delivers security of supply with a technology mix that supports delivery of the 2050 targets at the lowest possible cost to consumers.
- By 2025, our codes and code governance will no longer be perceived as a barrier to change but will instead facilitate the rapid changes required to deliver the carbon targets. We will work with all stakeholders to create a fully-digitalised Grid Code. This will provide minimum standards, be simple to understand and navigate, and will enable the flexibility required to support the energy transition.

We have received consistent and clear messaging on our role in relation to balancing and wholesale markets, starting with the *System Needs and Products Strategy* consultation in July 2017, our ancillary services customer journey in June and July 2018, codes administration customer journey work and Codes Administrators Code of Practice survey results. We then expanded our engagement to talk more specifically about our RIIO-2 proposals. Engagement included the Electricity Operational Forum in March 2019, industry roundtables at Power Responsive, The Association for Decentralised Energy and the Flexible Generators Group, and our December 2018 and April 2019 ESO RIIO-2 stakeholder events. We have also engaged many stakeholders bilaterally and via webinars.

We're responding to stakeholder views in this area, which are that:

- Having a single, integrated portal for ESO markets will transform the experience and significantly improve the efficiency of market participation for service providers.
- The sandbox environment will enhance our ability to move quickly enough in response to changing market conditions.
- Questions whether BEIS or Ofgem are better placed than us to lead the reform of wholesale and balancing markets, with stakeholders being more comfortable when it is framed in the context of reducing the role of the residual balancer by facilitating more efficient markets.
- Codes are not fit for purpose and would welcome significant improvement in this area but we should be mindful of the ongoing review by BEIS and Ofgem.

The net benefits of our proposals are estimated at around £350 million.

Several of the benefits have not been monetized, and this is based on a small subset of benefits, so the actual benefits are likely to be significantly increased.

To achieve these ambitions, we will focus on three broad areas of transformational activity:

- 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.

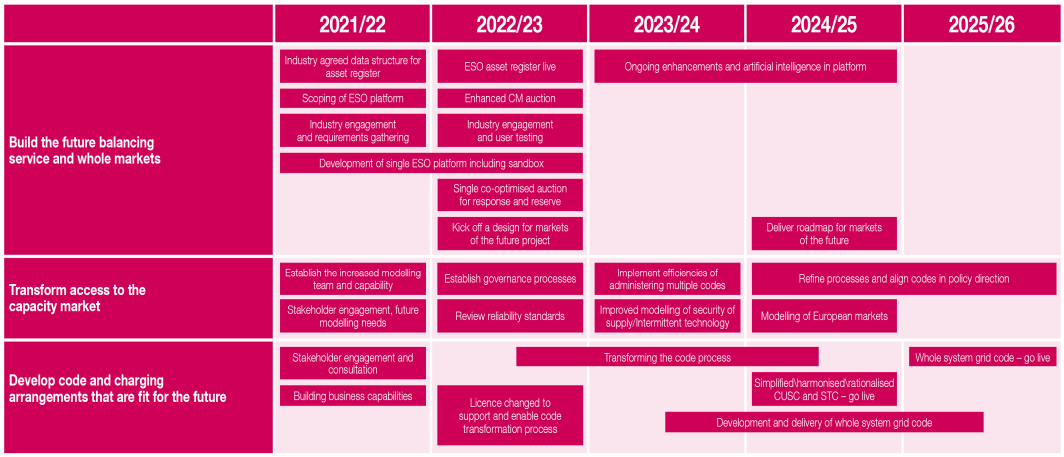

Figure 23: Deliverables timeline for Theme 2[45]

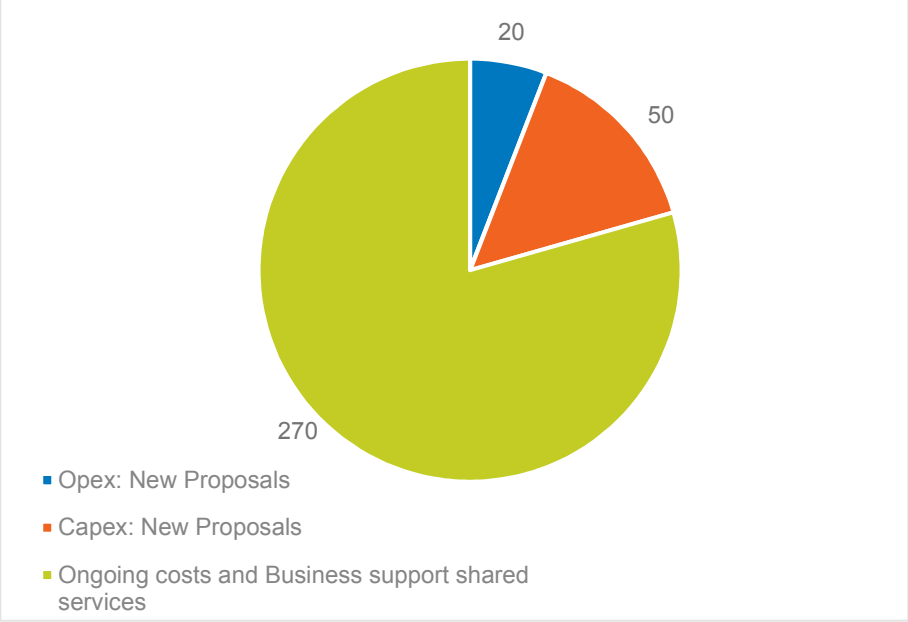

Figure 24: Current view of costs of Theme 2, £m, (FY 2021-26)

[45] Please increase page zoom to 200% to view this diagram

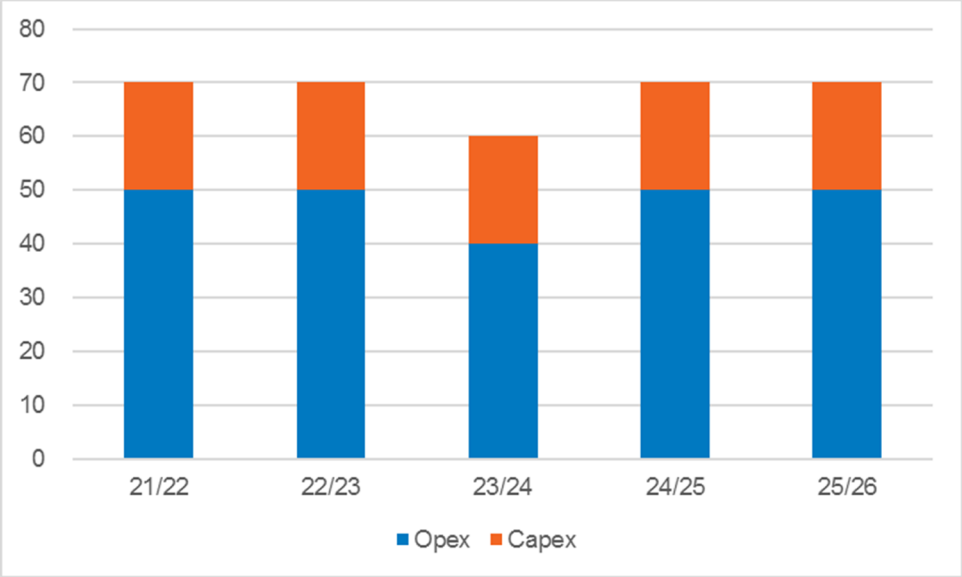

Figure 25: Current view of costs of Theme 2, split by opex and capex, £m per year.

8.2 Build the future balancing service and wholesale markets

Achieving our ambition in this area is contingent on the proposals outlined earlier within Theme 1 to upgrade our systems and processes to dispatch large numbers of smaller assets.

Underpinning all this work is the UK's commitment to net-zero emissions by 2050. The volumes of flexible energy required to manage a low-carbon system will be higher than that purchased today, whilst the availability of sources of flexible generation traditionally used to manage the system such as CCGTs and coal plant is decreasing. We therefore need to attract significant sources of new flexibility onto the system such as demand side response and storage. Our stakeholders have told us that our balancing products, markets, processes and IT infrastructure need to be transformed as they will not be fit for purpose in this new world. We have made significant progress in this area 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 resulted in significantly more competitive markets. However, further change is required to attract the volume of flexibility we will require in the future and manage the daily variation of this volume which is driven by the generation mix on the system.

In this chapter, we describe the market reforms that the ESO will deliver:

8.2.1 A single day-ahead response and reserve market

We're responding to stakeholder needs by delivering a single day-ahead response and reserve market which considers the impact on distribution system operation when this information becomes available. This will provide a transparent, open and regular procurement opportunity for all market providers, and deliver 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.

> "We particularly welcome ambitions to deliver day-ahead markets for response and reserve products, which we hope can be delivered at the beginning of the RIIO-2 period."
>
> **Generator**

Stakeholder views

Our proposal is to move our established markets for balancing services close to real time to manage the high variability in requirements from day to day for response and reserve and to attract new sources of flexibility. Many stakeholders, particularly renewable and

decentralised parties, endorsed this approach as deep, liquid markets can provide a strong investment signal. We have received some feedback that we should go closer to real time than day ahead i.e. within day. Conversely, some stakeholders have also told us that long term contracts are required to incentivise investment in new assets to provide services. Whilst 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, Further information on the transformation of network planning through competition can be found in Theme 3. As articulated in our sandbox proposal, we are also developing the ability to trial different procurement approaches in a more agile way.

We have also heard from current and potential service providers that we need to be clearer how our RIIO-2 proposals will build on work we have already initiated. Therefore, we have shown how the market platform will build on our ongoing work to reform markets through the *System Needs and Product Strategy* roadmaps.

Rationale for proposal

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 and so we buy 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 then managed using mandatory response on CCGTs and coal plant. This plant will run less frequently in the future and so a new approach is required.

In the future, we could simply buy sufficient volume at the month or quarter ahead stage to meet our view of the maximum amount we would need to buy on any single day. However, this would result in purchasing significantly more volume than we would require in practice and 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 increased certainty regarding 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 and reduce the use of mandatory products which potentially distort market signals. These two factors will result in a liquid, transparent market which provides a clear and consistent price signal for investors and drives down costs to consumers.

In addition, these changes would remove a barrier to entry for sources of flexibility such as wind, solar and DSR. These providers have told us they find it difficult to participate in the current monthly tenders as their availability to provide services is highly uncertain at the month ahead stage. These providers have more certainty of their available volume at the day-ahead stage and so can optimise their bidding into the markets much more effectively.

In this price control period, we have launched an innovation project to trial a weekly auction for frequency response; the learnings from this will create the foundations for a move to day-ahead markets.

8.2.2 Markets for voltage and thermal constraints close to real time

Establishing markets for voltage and thermal constraints close to real time will open up procurement to a broad range of providers, driving competition to lower costs to consumers.

Stakeholder views

We received consistent and strong feedback from service providers through our previous engagement on the System Needs and Products Strategy for us to move away from primarily bilateral contracts for voltage and thermal constraints to more transparent tenders or auctions close to real time. This has continued to be a theme through our more recent engagement along with a desire to also see longer term tenders for these system needs.

> "There has to be an ongoing conversation across the industry if we are to create a safe, affordable and sustainable energy system – the ESO's role in delivering transparent and accessible markets is vitally important to this."
>
> **Industry trade body**

Rationale for proposals

Much of our balancing services reform to date has been focused on response and reserve markets. As the technology mix on the system evolves our operability challenges are increasing and we need to develop our markets to resolve these issues. Strong stakeholder views have informed these proposals.

8.2.3 A single, integrated portal for ESO markets

This one-stop-shop will provide a portal to participate in all our ESO balancing service markets, the Capacity Market and the Contracts for Difference[46] (CfD) auctions. It will also give access to both historical and forecast data to support investment cases and decision making. It will be expanded as other markets develop to allow the integration and data sharing required to enable efficient decisions to be made across markets. The foundation of the platform will be an asset register which identifies 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 significantly improve the efficiency of market participation for service providers.

Stakeholder views

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

> "This could be a complex and difficult project to implement and care needs to be taken when designing and scoping the technical specifications and deliverables of this platform."
>
> **Generator** at RIIO-2 workshop

Many parties participate in both the balancing services markets and the Capacity Market. From analysis of their feedback on the separate markets, we recognised that they experience similar pain points with both and that there is significant duplication of effort in managing their participation in both markets. We therefore 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 deliver a single integrated platform to participate in balancing service markets and the Capacity Market. This approach has the added advantage that it will 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, significantly reducing the overhead in participating in the markets. In addition, this increases market transparency as there is a

[46] A contract between the Low Carbon Contracts Company (LCCC) and a low carbon electricity generator, designed to reduce its exposure to volatile wholesale prices.

clear register of assets connected to the transmission and distribution systems which are participating in markets.

Our initial view was that we should provide comprehensive data analytics on the platform for participants to analyse the market data. However, we received feedback that many participants simply want access to the data and that we should not 'crowd out' other market actors who are better placed than us to provide value added analysis. We therefore, as a no-regrets step, propose to have application programming interfaces (API) to provide access to the data. This delivers the functionality that stakeholders require and is less expensive than our original proposal. Further information on stakeholder views on data provision can be found in the Open data unlocking zero-carbon system operation and markets section in Part 3 of this document.

We have consistently been told 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 try to be all things to all people. 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 made it clearer that the ESO market platform will interface with other market platforms, including those at the distribution level. This will improve market efficiency by allowing each participant to make co-ordinated decisions across the range of markets open to them.

Rationale for proposals

The single market platform is designed to remove the current pain points identified by stakeholders and facilitate easier participation in a range of markets.

Many of the existing processes for participation in our balancing markets require differing methods and systems and any portfolio management has to be done manually by the provider. This creates an administrative burden on both market participants and the ESO and increases the risk of human error and associated rework. The market platform will significantly reduce the time and effort required to participate in markets through enabling processes such as procurement event participation and portfolio management to be done online. Integration with the asset register, data portal and auction platforms will also significantly reduce the overhead of market participation and enhance the efficiency of market outcomes.

8.2.4 A sandbox, experimental market environment

Alongside our established markets, the sandbox experimental market environment will be used to test ideas such as a market for system inertia with the industry in a rapid and dynamic way. The sandbox will be an important enabler of further innovation, particularly in giving third parties more opportunity to find innovative market solutions they can test out in this environment.

Stakeholder views

The sandbox environment was welcomed by stakeholders sometimes frustrated by our ability to move quickly enough in response to changing market conditions. It will allow us to trial alternative procurement methodologies to meet different system needs such as the longer-term contracts mentioned earlier, as well as new technologies and market structures.

> "I don't see how you can't do it; you need to test things and find out if they don't work."
>
> **Service Provider** at RIIO-2 workshop

Rationale for proposals

Solutions for emerging operability issues such as inertia and system stability cannot be developed overnight and so a sandbox environment will valuable in trialling potential solutions and learning by doing. The sandbox approach will allow us to support new entrants and technologies and increase implementation speed to market. Through this approach we will also reduce the regret spend in developing and testing new products and ultimately drive down costs to consumers.

Cost-benefit analysis

The focus of this work is on attracting new flexibility into the markets to drive down the costs of operating the system in a low-carbon world and so we are primarily concerned with delivering a large future benefit to consumers. This helps to deliver policy objectives on CO_2 reduction and aids the transition to a sustainable energy system.

A report to the Committee on Climate Change[47] (CCC) has indicated that system costs to consumers could increase by £3.2 billion to £4.7 billion per annum by 2030 unless significant new sources of flexibility are attracted onto the system. Of this, between 25 per cent and 40 per cent is due to reduced system operation cost, against the counterfactual of not delivering system flexibility.

Taking their Balance scenario, which considers a balanced generation pathway to reach 100gCO_2/kW by 2030, this aligns well with the average of our FES scenarios[48]. It would give £800 million of savings per annum that could not be delivered without market transformation.

It is therefore imperative that we don't delay this work as the cost to consumers is high if we don't deliver enough flexibility. Indeed, this is why we developed the Power Responsive campaign in 2015 and are continuing to reform our markets in the current price control.

This work will also deliver important consumer benefits in the near term. By attracting new sources of flexibility onto the system we are driving up competition in the balancing, wholesale and capacity markets.

Consumers currently spend over £35 billion annually across these markets[49]. We believe our proposals will drive efficiency into these markets, stimulating innovation and further competition to reduce this £35 billion cost. Even a modest 1 per cent improvement in market efficiency would equate to a near-term annual consumer benefit of £350 million.

Our work to build the future balancing services markets consists of two broad areas for which we have considered the costs and benefits:

- transforming participation in balancing and capacity markets; and
- designing the markets of the future.

We have considered the cost and benefits of each separately. The results for designing the markets of the future are included in that section.

How we will approach this activity

We will make investments in the first two years to develop the portal for the response and reserve markets. By the end of 2022/23 we expect to have a single day-ahead market in operation for these products.

In later years, we will target spending on operability markets such as voltage, thermal constraints and inertia. We also anticipate that we will need to evolve the portal as markets in the distribution networks develop so that we make efficient, whole electricity system decisions in our markets. We will therefore increase our headcount to:

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[47] https://www.theccc.org.uk/wp-content/uploads/2017/06/Roadmap-for-flexibility-services-to-2030-Poyry-and-Imperial-College-London.pdf

[48] Carbon Intensity (gCO2/KWh) of the *FES 2018* scenarios CR – 75, TD – 48, SP – 117, CE – 147. Average – 96.

[49] Digest of UK Energy statistics 2018, Table 1.7 sales of electricity and gas by sector. All consumers total selling value £ million for 2017. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/736148/DUKES_2018.pdf

- work closely with stakeholders, such as service providers and DNOs, to design and deliver these markets
- convert operability pilot projects into new markets
- run our sandbox experimental market environment to develop learning and test the enduring solution
- increase the scope and scale of the Power Responsive campaign to increase interactions between the ESO and the DNOs to support the growing number of small distributed market participants and the development of markets in the distribution network.

8.2.5 Transforming participation in balancing and capacity markets

The net benefits of our proposal are estimated at £40 million, and to deliver £2.30 of benefits for each £1 spent. The net benefits are positive from 2023/24.

These net benefits have been calculated considering costs and benefits over the 5-year period up to 2025/26. There will be benefits beyond this period and so this analysis will underestimate the net benefits.

The total additional costs for our preferred option are £32 million. This consists of an increase of £24 million in capex compared with the status quo and an increase of £8 million in opex.

The capex is to develop the portal and adapt it as new markets develop. The opex is for new people to work on the sandbox environment and develop the new markets from a whole electricity system perspective, working closely with DNOs, plus the additional costs of operating the newly-developed systems.

The benefits of the preferred option are outlined in a qualitative way in the table below:

Benefit	Description
Improved safety and reliability	• proposal ensures that there is sufficient flexible energy to maintain security of supply in a low-carbon world • proposal ensures that operability can be maintained by delivering market solutions to manage voltage, constraints and system stability in a low-carbon world.
Improved quality of service	• the single platform is designed to remove the current pain points identified by stakeholders and facilitate easier participation in a range of markets.
Lower bills than would otherwise be the case	• the primary focus of this work is to contribute to delivering the savings forecast in the CCC report through attracting sufficient flexibility onto the system. The work here on markets is necessary but not sufficient to deliver these savings. Some savings that can be directly attributable to this work are: • reduced price of balancing services compared to the status quo due to increased competition in markets • reduced volume of services purchased due to move to day-ahead • improved efficiency in capacity mechanism due to increased market liquidity • reduced costs for market participants due to more efficient systems and processes are passed on to consumers.

Reduced environmental damage	• increased flexible generation on the system will result in less curtailment of low-carbon generation and there will be less part-load running of thermal plant for response and reserve. This will allow our carbon targets to be reached more rapidly and cost efficiently.

As it is difficult to put a monetary value on all these benefits and it is uncertain exactly how future markets will respond, especially given the unknown political, regulatory and economics landscape. Therefore, the numerical calculation for the CBA is focused on lower bills.

A small subset of the benefits has been taken in the CBA, namely a reduction in the cost of response and reserve through moving to day-ahead markets to increase liquidity and to optimise the volume to be purchased. These benefits are estimated at £72 million accrued over the final three years of the period.

The net benefit of the preferred option using the identified costs and benefits above is £40.5 million over the RIIO-2 period, which is highly positive. The actual benefits will likely be much greater than this because in this analysis we have considered only a small subset of the benefits. We are therefore confident that this transformational activity will deliver significant benefit for consumers out to 2030.

8.2.6 Other options considered

As well as the proposal outlined above, we considered two other options for transforming participation in balancing and capacity markets:

1. status quo: maintain current approach of monthly and quarterly tenders for balancing services with a separate system for the capacity market
2. enhanced data analytics of balancing services markets.

We did not consider the status quo to be a viable option as we transition to a low-carbon system. Current processes were designed for tens of participants rather than the hundreds or potentially thousands that we will have in the future and will need to be changed.

Costs to consumers would increase compared with alternative solutions as renewable and demand side response participation would be limited due to uncertainty of availability at tendering stage. Increased volumes would also need to be purchased in tenders to manage daily variation as availability of mandatory services reduces. The requirements of stakeholders are not met.

Enhanced data analytics of balancing services markets was rejected as it would be more expensive than our preferred option. Stakeholder feedback also suggests that the extra proposed functionality is not valued by most stakeholders.

This would result in a lower net benefit than our preferred option. There was an additional concern that this option would result in us ‘crowding out’ other market actors who are better placed than we are to provide value added analysis, reducing competition. Further context on this option is provided in the Open data and digital engagement chapter of this document.

8.2.7 A design for markets of the future

The ESO will step up to lead a review of wholesale and balancing markets, delivering a new design by March 2026, working closely with all stakeholders. Key considerations will include gate closure period, length of balancing period and the impact of large volumes of zero marginal cost generation on efficient market design.

Stakeholder views

There is a general agreement on need to reform wholesale and balancing markets with a focus on efficient price discovery. A large majority of parties (including all of the smaller market participants) thought the ESO was best placed to lead a review of these markets. A minority of stakeholders questioned this, suggesting BEIS or Ofgem were better placed to lead this activity. Some of these stakeholders were more comfortable when the proposal was framed in the context of reducing the role of the residual balancer by facilitating more efficient markets. We also understand that we need to be clearer on the consultative and collaborative approach to be followed that will ensure we are able to represent a wide range of views and evidence supported recommendations.

> "Elephant in the room is [that current arrangements are] not delivering clear signals or joined up."
>
> **Generator** at RIIO-2 workshop

There was also feedback that we need more clarity on scope and the outcome we are trying to achieve with the market review; our intention would be to work with key stakeholders to scope the project and define the desired outcome to ensure that the project is collaborative and meeting stakeholder needs and expectations from the start.

Market parties were also conscious that this activity needs to join up with long-term future of the Capacity Market as well as other industry transformations such as energy codes, charging and access reviews as well as decarbonisation of heat and transport policies. We share this view and indeed we created the Future Markets team within the System Operator with the specific intent of considering such changes holistically. The intent is that this work is scoped to meet these requirements.

Rationale for proposals

The current balancing and wholesale markets were both designed and implemented nearly 20 years ago, in a world which was predominately centralised with large transmission plant helping to manage both security of supply and operability issues. Since that time the characteristics of the parties connected to and using the transmission system, the way in which the transmission system is used by those parties and their expectations, as well as those of current and future consumers, has fundamentally changed.

> "There has to be an ongoing conversation across the industry if we are to create a safe, affordable and sustainable energy system – the ESO's role in delivering transparent and accessible markets is vitally important to this."
>
> **Industry trade body**

By 2025 - by which time the ESO will be able to operate a zero-carbon system - there will be significantly more renewable energy connected to the transmission and distribution systems. There will be a much smarter and more flexible energy system with much greater levels of aggregation, demand side response and storage. In this world, the markets of 20 years ago, are highly unlikely to be the most efficient markets to effectively facilitate decarbonisation. For example, a gate closure time closer to real time could facilitate intermittent generation having more confidence over their trading position and there would be greater information to enable an efficient balanced position. This in turn could provide more granular imbalance settlement. In addition to targeting cost in the market to those causing those costs this would also provide further opportunities to facilitate smarter use of such renewable capacity by market participants.

Cost benefit analysis

The costs of this proposal over the RIIO-2 period are £3.2 million.

Our proposal is to undertake a project to design the markets of the future. This project does not include implementing a new market design. A separate CBA would be required for the whole industry before implementation.

The total additional costs for the RIIO-2 period are £3.2 million, consisting of the opex needed to fund additional headcount and consultancy support to undertake the study and to

develop the roadmap. This proposal includes up to 10 FTEs in the final three years of RIIO-2 as well as £2 million for consultancy spend.

The benefits of our proposal are outlined in a qualitative way in the table below:

Benefit	Description
Improved safety and reliability	• the proposal ensures that there is sufficient flexible energy to maintain security of supply in a low-carbon world.
Improved quality of service	• the markets will be designed with the future needs of market participants in mind and not their past needs as is presently the case.
Lower bills than would otherwise be the case	• the focus of this work is to contribute to delivering the savings forecast in the CCC report by attracting sufficient flexibility onto the system. This work on markets is necessary but not sufficient to deliver these savings. Some savings that are expected to be attributed to this work include improved efficiency in both wholesale and balancing markets which in theory should result in reduced costs and prices in those markets.
Reduced environmental damage	• markets designed with the future in mind will be more conducive to decarbonisation and so reduced carbon will therefore result in reduced environmental damage.

The monetary value of the benefit of this work is difficult to quantify, but it is anticipated that it will result in improved efficiency in wholesale and balancing markets. Given the annual spend in these markets is about £35 billion, even a small improvement in efficiency would result in large consumer benefit.

It should be noted that a study into future market design would not, by itself, deliver quantifiable benefits. Instead, the costs can be viewed as an option fee to allow a change to be made in the future if the costs of implementation across the entire industry were outweighed by the benefits of more efficient markets.

8.2.8 Other options considered

As well as the proposal outlined above, we considered and discounted other options for designing the markets of the future:

- status quo: do not undertake a project to design the markets of the future. This is not considered a viable option as we transition to a low-carbon system. Current markets were designed for market participants which were significantly different in the past than they are today. The future will involve different needs and customers. These changes are only going to increase over time. It is essential that the market design attracts sufficient flexibility by rewarding it appropriately.
- alternative lead for project: we considered whether an alternative market actor should lead this project. Based on our unique position in the market and stakeholder feedback, we believe that we are best placed to deliver this work.

8.2.9 How we will approach this activity

To deliver a design for markets of the future efficiently we will create a small team to work closely with expert consultants and our stakeholders. It will draw on experience gained through Charging Futures and Power Responsive. The project will be set up in 2023/24 with the two-year project being undertaken to deliver a report and roadmap by March 2026.

We would work closely with the wider industry to plan and scope the project and use the lessons we have learned through Power Responsive and Charging Futures to engage stakeholders throughout. The project would develop recommendations through transparent analysis and representation of industry and stakeholder views and seek to recommend a preferred direction for these markets (from a selection of other options) by March 2026.

The project would not seek to implement the market design of the future but would provide a good foundation to consider the time, scope and costs related to its implementation. This would allow this project to move to the next stage at the appropriate time to ensure that the markets of the future have been designed with the future in mind.

Innovation:

Across the RIIO-T1 period the ESO has supported and engaged in innovation-funded projects to facilitate the transition to a smart, flexible and low-carbon electricity system. These T1-funded innovation projects will form the bedrock of many elements of the proposals in this chapter.

A single day-ahead response and reserve market will build on the learnings from the weekly auction trial.

A single portal for ESO markets integrated with DSO flexibility markets and platforms will build on learnings from the Cornwall Local Energy Market, and engagement with the BEIS FleX competition.

Facilitating all market participants 1 MW will be further developed through learnings from our work on Residential Response, V2GB (Vehicle to Grid Market Feasibility Study) and Frequency Response from Waste Water innovation projects.

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, using our sandbox environment to develop learning and test enduring solutions for new markets. We will also draw on innovation funds where appropriate to test novel solutions to complex challenges such as system stability in ultra-low inertia scenarios.

8.5 Transform access to the Capacity Market

By 2025, the ESO will deliver security of supply against a clear standard agreed with the Government. We will be responsible for all elements of the Capacity Market; advising the government on the volume to purchase, managing the rules change process, running the auction and managing the contracts.

By transforming how we facilitate these activities, security of supply will be delivered with a plant 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 in a fair way and participants will feel that they are fairly rewarded for their contribution to security of supply.

Since the suspension of the Capacity Market on 15 November 2018, the ESO has been working with BEIS and the industry towards restoration of the Capacity Market. The ESO considers that Capacity Market has met its core objective to ensure electricity security of supply during times of winter peak demand at the lowest cost to consumers. As such, we believe that there is a need to continue the Capacity Market, and that this is the correct mechanism to promote long-term stable investment in capacity by providing a stable and reliable longer-term price signal.

We are confident that the Capacity Market will be restored and will evolve to continue to be a key pillar of the transition to a low-carbon energy future. We would like to explore our transformational activities in more detail with stakeholders over the next few months.

Stakeholders have told us that they want a decarbonised energy system, affordable bills and reliable energy supplies. They want

the ESO to facilitate active markets for a wide range of products and services, and they want access to comprehensive, accurate and user-friendly information and systems.

Below we set out the activities needed in this area.

8.5.1 Deliver a new platform for the Capacity Market within the single, integrated ESO markets platform

As described above, participants have told us that this platform will improve their experience by driving market efficiencies. Artificial intelligence will be used to help participants understand how they can participate in the Capacity Market and will guide them through the process.

Stakeholder views

As set out in the previous section, many parties participate in both the balancing services markets and the Capacity Market. From analysis of their feedback on the separate markets, we recognised that they experience similar pain points with both and that there is significant duplication of effort in managing their participation in both markets. We have therefore responded to stakeholder feedback by moving away from our original proposal of a new platform for balancing alongside an improved Capacity Market portal and instead will deliver a single integrated platform to participate in balancing service markets and the Capacity Market. This approach has the added advantage that it will be simpler and more efficient to build and maintain than two separate systems.

Rationale for proposals

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

The Capacity Market will be an important component in delivering against this objective. We will work with stakeholders to improve customer experience and ensure our systems and processes do not act as a barrier to entry but facilitate wide market participation.

8.5.2 Take on responsibility for the development and management of the Capacity Market Rules

The principles of the code governance review will be used to make the rules clear, proportionate and fair. There will be a clear roadmap for change, which will be developed through industry engagement.

Stakeholder views

We are conscious that there are multiple ongoing BEIS and Ofgem activities in relation to EMR (e.g. Five-Year Review of the Capacity Market) and we will continue to ensure there is co-ordination and consistency with these activities.

Customers have advised us that the Capacity Market process is unnecessarily complicated, which can be a barrier to entry. While the ESO's role in administrating EMR has been successful in delivering all the required outcomes, there are concerns about how long the change takes to be implemented and the transparency in which policy and system changes are taken forward. Considering this, there has been support for the ESO to take on responsibility for EMR rule development and that there is benefit in aligning EMR rule development more closely with the ESO's existing code governance role.

Stakeholders have questioned how the ESO administering the rules would interface with the government policy which underpins them. This interaction would need to be carefully designed to ensure accountabilities were clear.

As there has not been consistent support for this proposal it will be a focus of our engagement between now and the submission of our final business plan.

Rationale for proposals

The EMR Capacity Market rules are currently administered by Ofgem, in their recent Five Year Review consultation Ofgem have proposed changes to the rules process and governance. Some stakeholders have also highlighted the need for change here. We agree with this rationale and believe the ESO is best placed to take on the responsibly for the rule administration and that we can create benefits for consumers.

There are natural synergies with our role as EMR delivery body, allowing us to build on our knowledge and experience here. There is also a synergy with our existing role as code administrator, allowing for efficient administration, again building on our knowledge and experience here.

When combined with our ambition to transform the process to amend our codes this activity will further enhance our ability to facilitate the future direction of the market, and to coordinate rule development across multiple markets and codes. This should result in a more beneficial outcome for consumers and industry participants.

8.5.3 Improve our security of supply modelling capability

We will provide world-leading security of supply modelling for a system with significant levels of intermittent renewables, distributed flexible generation and demand side response. This will be used together with granular data to determine the optimal volume of capacity to purchase.

Stakeholder views

The EMR analysis role is seen as a core ESO activity. Stakeholders have expressed support for the need to enhance our modelling tools to correctly analyse the growing interactions of new technologies. This will ensure that the contributions of all market participants to security of supply remain appropriate and that the GB reliability standard is met.

Many stakeholders agree that, to facilitate this enhanced modelling, the ESO requires access to more granular data for all demand and supply sources. In addition, 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.

With growing interconnection between GB and other countries, our pan-European modelling needs to be able to adapt to modelling different markets, e.g. participation of interconnectors and/or foreign generators in the Capacity Market.

Rationale for proposals

In a world of rapidly changing energy systems with growing amounts of intermittent and distribution-connected generation, duration-limited storage and demand response, a step change in our analysis capability will be required to keep pace with these changes.

The aim of this work is to ensure security of supply at the lowest possible cost to consumers by maximising participation in the Capacity Market and building a strong modelling foundation so that there is confidence in the volume to be purchased.

Cost-benefit analysis

As described above, attracting new flexibility into the market will drive down the costs of operating the system in a low-carbon world, as the report to the CCC has indicates

This work will also deliver important consumer benefits in the near term. Consumers currently spend approximately £1 billion per year in the Capacity Market and so a one per cent improvement in efficiency would deliver consumer benefits of £10 million per annum.

The cost to society of disconnection due to security of supply issues is high with the Value of Lost Load (VoLL) currently equal to £6,000/MWh. High quality modelling is important for avoiding these costs without purchasing excessive volumes of capacity at increased costs to consumers.

The net benefits of our proposal are estimated at £46 million, and to deliver £2.60 of benefits for every £1 spent. The net benefits are positive from 2022/23 onwards.

This net benefit has been calculated considering costs and benefits over the 5-year period up to 2025/26. There will be benefits beyond this period and so this analysis will underestimate the ultimate net benefit.

The total additional costs for the period are £29 million, consisting of an increase of £25 million of capex compared with the status quo and an increase of £4 million of opex. The capex is to develop the new platforms required to transform access to the market, while the opex is the additional cost of running these systems and to deliver our enhanced modelling capability.

The benefits of the preferred option are outlined in a qualitative way in the table below:

Benefit	Description
Improved safety and reliability	• proposal facilitates a Capacity Market that is open to a broader mix of participants, including generators, storage and demand-side resources. • this ensures there is sufficient capacity to maintain security of supply in a low-carbon world.
Improved quality of service	• clearer, better coordinated rule change process reduces complexity and administrative burden for market participants. • enhanced modelling ensures participants are rewarded fairly for their contribution to security of supply.
Lower bills than would otherwise be the case	• the primary focus of this work is to contribute to delivering the savings forecast in the CCC report by attracting sufficient capacity and flexibility onto the system. • enabling greater access to the Capacity Market will facilitate competition and maximise liquidity in the auctions. • enhanced modelling will ensure the right amount of capacity is secured, minimising the risk of procuring more capacity than is needed. • all of this means security of supply will be provided at the lowest possible cost to consumers.
Reduced environmental damage	• an open and accessible Capacity Market, with a diverse mix of participants, supports meeting the UK's 2050 carbon reduction target.
Benefits for society as a whole	• a level playing field for markets with reduced barriers to entry enables new and small parties to participate, supporting the wider economy.

Again, it is uncertain exactly how future markets will respond especially given the unknown political, regulatory and economics landscape. Therefore, the numerical calculation for the CBA is focused on lower bills by facilitating a more efficient and liquid Capacity Market auction.

A small subset of the benefits has been taken in the CBA: a reduction in industry time and workload through reduced complexity and lower barriers to entry; and enhanced modelling

capability delivering more refined capacity volumes to the market. This reduces the risk of purchasing capacity that is not needed.

The net benefit of the preferred option using the identified costs and benefits above is £46 million over the RIIO-2 period, which is highly positive, before the consideration of increased auction efficiency through more liquid markets.

The actual net benefit will be much higher than this because in this analysis we have considered only a small subset of the benefits. We are therefore confident that this transformational activity will deliver significant value for end consumers.

8.5.4 Other options considered

- status quo: maintain our current rule administration role and modelling capabilities. This is considered a sub-optimal option as the full benefits of evolving markets may not be realised. At present our role is focused on administrating the Capacity Market rules. We are constrained in driving the development of these rules. This limits our ability to facilitate the future direction of the market, and to coordinate rule development across multiple markets and codes. While incremental modelling improvements would continue, the level of change that could be supported would be limited. This option would not meet the requirements of stakeholders.
- only enhance our modelling and analysis capabilities. In this option, we would increase our modelling resources which would enable us to deliver enhanced analysis e.g. treatment of new and emerging supply and demand side technologies as well as enhanced data. However, as we would remain limited to rule administration, this option would still not enable us to drive rule development to ensure efficient operation of the Capacity Market and coordination across all codes and markets. Given that significant value is driven by reduced costs to participants from more efficient operation, this would have a lower net benefit than our preferred option.

8.5.5 How we will approach this activity

We will make investments in the first two years to develop the asset register and Capacity Market portion of the portal. By 2022/23 market participants will be able to manage their portfolio at a component level for both the Capacity Market and balancing services markets.

The functionality of the portal will build on the enhancements made to the current Capacity Market system in the final two years of the current RIIO period. These will be focused on addressing pain points identified by participants.

We will need to evolve the portal as the market develops and we will invest in greater use of artificial intelligence to further make the Capacity Market and other markets more efficient to navigate.

We will increase our headcount to take on responsibility for the development and management of the Capacity Market Rules. The ESO will align the Capacity Market Rules process with other industry codes allowing the market to realise the benefits of holistically and transparently prioritised change quicker.

This will also align with benefits of the Government and Ofgem Energy Codes review. Efficiencies of the existing industry code governance processes administered by the ESO can be leveraged, however we would create a small team with specific Capacity Market knowledge.

We will increase our headcount to significantly improve our modelling capability of security of supply in a low-carbon world. In addition to key projects that will be identified through stakeholder engagement, we have identified three transformational packages of work to deliver over the first three years of the period:

- review the method for calculating the contribution to security of supply of intermittent technologies (both DSR and generation) as more participate in the Capacity Market by enhancing the modelling of the interaction between different technologies and any network connection constraints.
- investigate the suitability of Loss of Load Expectation and other potential reliability metrics for a market with more duration-limited technologies.
- enhance our modelling of European markets to calculate the changing contribution from interconnectors over time as more are built and generation mixes change across Europe.

Innovation

Underpinning the 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. From this register market participants will be able to flexibly allocate components across markets and portfolios driving efficiency across the industry.

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.

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

We have engaged stakeholders on our roles in codes and charging arrangements 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 in this area at our RIIO-2 stakeholder events in September 2018 and April 2019.

The aim of this work is to transform the process to amend our codes, allowing strategic change to be prioritized and implemented efficiently, while ensuring that it is much simpler and less time-consuming than now to make incremental improvements. This will result in greater accessibility for all participants and the flexibility to deliver forward-looking change much more quickly.

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

Below we describe the activities to achieve our ambition in this area.

8.6.1 Transform the process to amend our codes

This 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 views

Stakeholders have told us that the current governance framework is not fit for purpose. They believe that the pace of change is too slow and that there is a need to have a 'critical friend' throughout the code change process.

Stakeholders commented that code management and change need to be more accessible, including adoption of plain English and a move to web-based processes. There needs to be more signposting and better provision of information to allow market participants to access the codes and make changes in a more agile way.

Through our Forward Plan, we are targeting improvements to make the current code process more accessible. Our proposals to transform the code change process seek to address the wider framework concerns.

We have also received feedback that the Energy Codes Review is still in flight. Some stakeholders are concerned that our proposals are pre-empting the outcome of the review.

We fully support the Energy Codes Review and have set out the changes that we believe should be made to our codes based on industry engagement so far. We recognise that our RIIO-2 proposals will require further changes and amendments to frameworks allow our ambition to be fully realised, should they not fully align with the outcomes of the Energy Codes Review.

We tested options for the role that we should play in the RIIO-2 period. Commenting on our historical performance as a code administrator, some stakeholders suggested that we should focus on improving our performance as a code administrator. There was also a desire to ensure that by taking on additional strategic activities, our BAU code administration activities did not suffer.

As evidenced by our improved Code Administrator Code of Practise (CACoP) scores, and endorsed by Ofgem, stakeholders have noted a significant improvement in our performance. We are committed to continued performance improvement through our Forward Plan deliverables.

Furthermore, through engagement on our RIIO-2 ambition we found that a majority of stakeholders support the option for us to retain our current codes and to step up to transform the process to provide the required support.

We have shared initial high-level thinking of the revised characteristics that we as code administrator would introduce to transform the code process with overall support from industry. We have set out more detailed thoughts on these characteristics in the code administration CBA. We intend to test these further with stakeholders.

Rationale for proposals

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 low-carbon system from 2025.

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 from improving code processes, through merging some code bodies to radical change to the structure of codes. We are taking a leadership position in this review. We will advocate for changes aligned with our desire to transform the process to amend our codes and create a fully digitalised whole-system grid code by 2025. This also applies to the proposal below.

Cost benefit analysis

The costs of this proposal over the RIIO-2 period are £6 million.

The total additional costs for the period are £6 million, consisting of an increase in opex to strengthen the capability and capacity of our teams to step up to the role of code manager.

The benefits of the preferred option are outlined in a qualitative way in the table below:

Benefit	Description
Improved safety and reliability	• ensures codes always remain appropriate for emerging markets and business models to contribute to safe and reliable operation of the system in future.
Improved quality of service	• the modification process is more efficient and reduces the time impact on customers for this and codes more generally. The most expected benefits are easily prioritised. • newer and smaller providers are now better served by more tailored and suitable arrangements allowing for more players to enter a more competitive market.
Lower bills than would otherwise be the case	• the primary focus of this work is to drive efficiency into the codes and code change process by reducing barriers to entry and increasing information provision. The result is to contribute to the creation of more efficient and competitive markets. This reduces wholesale market costs, as well as BSUoS and TNUoS costs, depending on the code in question and against a counterfactual of no change to the process. • there are also internal efficiency savings for industry participants as there is a quicker and less resource-intensive change process and a better 'critical friend'.
Reduced environmental damage	• there will be minor consequential benefits to the environment as a result of these changes, e.g. more efficient codes contribute to more efficient decarbonisation.

We see two significant ways that these benefits will be delivered:

- overall process efficiency for ESO and industry. For example, fewer meetings, more focused discussions etc. These efficiencies are likely to be realised year-on-year, by the average number of codes modifications which the ESO facilitates a year[50]. We have assumed these benefits are delivered over four years, given a one year start up for the process
- realising the benefits of code modifications to the market quicker. Particularly, this would prioritise high-value code modifications. This is likely to be realised over a single year from a high-value modification being delivered one year earlier.

Quantifying the benefits of improving the code frameworks is not straightforward. However, more efficient change will allow benefits from modifications to be realised sooner, releasing value to consumers earlier. A more open efficient code process will also reduce barriers to entry in the market, creating the opportunity for more diverse parties to participate in the process.

It is useful to consider historical code changes when considering which benefits might be delivered in the future. The Ofgem cost-benefit analysis for CMP264 and CMP265 on embedded benefits indicated that a one-year delay in implementation could cost consumers £300 million.

Given the volume of transformational change required over the RIIO-2 period it is not unreasonable to assume that a similar size benefit can be delivered in the period. Indeed, we only need benefits of two per cent of this to break even over the period. This could be delivered by one high-value modification such as embedded benefits or a few smaller-value modifications. We can therefore be confident that this activity will deliver benefits which far exceed the costs of implementation.

8.6.2 Other options considered

Working with stakeholders, we have considered a range of options for our future code administration role but discounted these in favour of our proposal:

- pass responsibility of our codes to another party. This option was ruled out based on feedback from wider stakeholders and Ofgem's RIIO-2 sector specific methodology ESO annex[51] which supported retaining code administrator roles as a function within the ESO. We do not believe we should relinquish our code administration role. We are the experts in our codes and the processes and activities set out in them, We are therefore in the best position to maximise consumer value.
- take on responsibility for other codes. This option was ruled out due to Ofgem’s feedback from the sector-specific consultation regarding retaining current roles and based on feedback from wider stakeholders.
- status quo: continue as a code administrator for our codes. This option is not supported. Our stakeholders have told us that the current code process is not fit for purpose. Without action, our codes will continue to be an increasing barrier to innovation, competition and consumer value. This view has been reinforced by the joint BEIS and Ofgem Energy Codes Review.

8.6.3 Work with all stakeholders to create a fully digitalised whole system Grid Code by 2025

We will develop a single code for distribution and transmission, with a focus on providing minimum standards to allow safe and secure operation of the electricity systems. Artificial

[50] For the CUSC there are on average 15 modifications a year.
[51] https://www.ofgem.gov.uk/system/files/docs/2018/12/riio-2_eso_annex_0.pdf

intelligence will be used to support navigation of the codes (i.e. being tailored to each code user). Supporting documents will provide examples of how the requirements might be met.

Stakeholder views

Consistent with the overarching views above on the current state of industry codes and code governance, there is general support for our ambition to create a fully digitalised 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. They noted the extensive stakeholder engagement required and the need for suitable resourcing. We recognise these challenges and have sought to resource this activity appropriately in this Business Plan.

There was support for the final product but a general view on the need to make it clear that regulatory compliance is still the obligation of the industry participants and this ambition does not remove the requirement for due diligence from the industry in relation to compliance.

A number of stakeholders noted the interaction with the Energy Codes Review and that we should endeavour to align to this process as much as possible to avoid duplication and resourcing issues with their organisations.

We agree with both these points and will seek to embed it in the objectives of the project. We will also work particularly closely with industry, including the ENA and the Distribution Network Owners, to further explore the scope and objectives of this activity.

Rationale for proposals

As in previous section

Cost benefit analysis

The net benefits of our proposal are estimated at £1million, and to deliver £1.10 of benefits for every £1 spent. The net benefits are positive from 2024/25 onwards.

The total additional costs for the period are £5.5 million, consisting of an increase of £2 million in capex compared with the status quo and an increase of £3.5million in opex.

The capex is to develop the digital platform for the new digitised code, and the opex is to prepare the material and operate the system on an enduring basis. The proposal assumed additional FTEs in the second to fourth years of the period, together with consultancy support.

The benefits of the preferred option are outlined in a qualitative way in the table below:

Benefit	Description
Improved safety and reliability	• a digitised code will improve the understanding and enhance compliance.
Improved quality of service	• a simplified code will enable enhanced visibility of requirements for customers' connection projects, driving earlier and more efficient decision making. • customers will have an additional source of information which will provide critical information as and when they need it. • there will be an efficiency saving for customers in the time and effort required to engage with ESO in future. • future amendments to the code will be automatically updated, improving visibility of updates and impacts for customers.

Lower bills than would otherwise be the case	• future connection application decisions will be facilitated in a more timely and efficient manner, which will reduce the manpower and effort required by industry. • a clearer understanding of the rules will determine more financially appropriate procurement decisions by all industry stakeholders.
Reduced environmental damage	• there will be minor consequential benefits to the environment as a result of these changes e.g. more efficient codes contribute to more efficient decarbonisation.

The benefits of a digitised whole-system grid code are a more user friendly, inclusive and tailored experience which will work efficiently for the diverse needs of our customers.

A grid code that is easier to understand will provide efficiencies in 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 in the market will also aid the support for new smaller entrants and innovation in the market. New parties in a more liquid market will deliver efficiencies and benefits, and lower cost for consumers in the long run.

Again, as it is uncertain exactly how future markets will respond, especially given the unknown political, regulatory and economics landscape. Therefore, the numerical calculation for the CBA is focused on reduced industry time spent through transformed processes. A small subset of the benefits has been taken in the CBA. These benefits are estimated at £23 million accrued over the period to 2030.

The net benefit of the preferred option using the identified costs and benefits above is £16 million out to 2030 which is three times the costs. The actual net benefit will be much higher than this because in this analysis we have considered only a small subset of the benefits. We are therefore confident that this transformational activity will deliver significant value for end consumers.

8.6.4 Other options considered

We have considered two further options in addition to our proposal, which we discounted as they produced lower consumer value:

- status quo: leave the grid code as is. As highlighted under our code reform proposals, the codes are currently not fit for purpose. Continuing to maintain the status quo arrangements in light of the Ofgem and BEIS joint Energy Codes Review as well as the feedback we have received in this area from industry would not be sustainable.
- have a digitised grid code for transmission only. This was discounted because many of the benefits arise from the co-ordinated approach for distributed assets. Given the large anticipated rise in the number of these assets, considering a transmission-only code would not deliver these benefits.

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

Partially fixing BSUoS will provide the desired greater stability for our customers, if this is in the best interests of consumers. A BSUoS taskforce has been set up to consider these types of issues.

This will require wide collaboration with industry stakeholders to ensure actual and perceived barriers to change are removed and that our customers support the proposed changes. We will work in conjunction with the BEIS Energy Codes Review as well as other ongoing OFGEM code reviews relating to charging and access.

Stakeholder views

Payers of BSUoS have consistently told us that the lack of predictability in the way BSUoS is currently charged exposes them to risk premia that are passed on to consumers. A majority of them expressed support for our proposal to look at fully or partially fixing one or more components of BSUoS charges in the RIIO-2 period and 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 value of this work. We will continue to refine our views of the premia to feed into the next iteration of our Business Plan.

We have also been asked to consider the implications of this activity for ESO funding and regulatory arrangements, particularly regarding significant new cash-flow costs for the ESO due to the challenge of forecasting BSUoS to a sufficient degree of accuracy. In our Cost-Benefit Analysis appendix, we have provided further information on our assumptions for the costs of financing this activity throughout RIIO-2.

Rationale for proposals

One element of the existing code system that is scrutinised regularly by industry stakeholders relates to BSUoS. Due to the increasing volatility, complexity and difficulty of forecasting these charges, which are set on an ex-post basis, there have historically been calls from several parties to move to an ex-ante charge with a notice period.

This in effect transfers forecasting risk from industry to ESO and 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 due to Ofgem’s desire 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, the recent work by the BSUoS Task Force has concluded that BSUoS does not have role in providing a forward signal that can influence market participant behaviour and drive down costs. If Ofgem agrees with this conclusion as part of its Targeted Charging Review, this suggests that BSUoS is therefore focused purely on cost recovery and it would be appropriate to revisit the subject of fixing.

The CBA will be updated by September 2019. If this demonstrates 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 CUSC modification in this incentive period to allow fixing to commence as close to the start of the RIIO-2 as possible. We currently believe that a start date of 1 April 2022 would be possible.

Cost benefit analysis

The net benefits of our proposal are estimated at £290 million, and to deliver £11 of benefits for every £1 spent. The net benefits are positive from 2022/23 onwards.

These net benefits have been calculated considering costs and benefits over a 5-year period to 2025/26 in a conservative manner. There will be benefits beyond this period and so this analysis will underestimate the overall net benefit.

Under the status quo, the BSUoS price is set ex-post, and stakeholders tell us that they do not like the volatility and unpredictability of the product. This variability leads them to add risk premia to their prices, pushing up the overall cost to consumers.

Fixing the BSUoS price will likely reduce the risk premia added by market parties, but instead replaces it with a cost of managing the forecasting and cashflow risk borne by the ESO. These lower overall costs will result in savings to consumers.

Based on previous internal analysis undertaken before legal separation, the cost of new arrangements to cover additional ESO cash-flow risk (e.g. through a revolving credit facility with a commercial bank) as a result of a move from ex-post to ex-ante charging arrangements could be in the region of £2.2 million to £7.4 million per annum from implementation of the change, assumed to be from 1 April 2022.

However, it should be noted that this analysis was carried out before legal separation. Financing significant additional sums of money may be more expensive for the ESO and other costs and implications of the regime may need to be considered. We will do further work to refine the expected ESO costs by September 2019.

The benefits of the preferred option are outlined in a qualitative way in the table below:

Benefit	Description
Lower bills than would otherwise be the case	• additional costs to consumers incurred through the RIIO-2 arrangements with ESO (and added to BSUoS) are expected to be lower than the current costs to consumers incurred due to risk premia being added by chargeable parties in respect of forecasting uncertainty and an inability to hedge BSUoS.

Based on previous industry analysis undertaken by a CUSC Work Group exploring fixing BSUoS with a notice period (as demonstrated in the Final Modification Report for CMP250) an illustrative annual saving to consumers of between £80 million to £200 million per annum was recorded for one of the scenarios considered.

While both estimated costs and estimated benefits require refinement there is currently a significant differential based on the most recent estimates available. As such, we expect there to be the potential for substantial consumer savings for a change to the arrangements for any cost-recovery elements of BSUoS.

Other options considered

We have considered one further option in addition to our proposal, which we have discounted as we expect it to produce lower consumer value:

- status quo: leave BSUoS as is. In the event a positive CBA is demonstrated for the change we do not believe this option is viable as it would not be in the interests of consumers.

8.6.6 How we will approach this activity

To deliver these ambitions we have developed a programme of change which first focuses on transforming the code process. This will be followed by the introduction of a whole-system grid code. There is a phased approach:

- building business capabilities. The first year of RIIO will focus on building initial business capabilities and enabling licence changes to provide the necessary powers to allow us to transform the code modification process.
- transforming the code process. Over the second and third years we will undertake the bulk of the code transformation process. We will work with stakeholders to drive

through the right changes to allow strategic change to be prioritised and implemented efficiently. This would include. among other transformations, rationalising, harmonising and simplifying both CUSC and STC.

- development and delivery of a whole system Grid Code. The final phase of deliverables will focus on developing and implementing the whole-system grid code. A digitised code will improve the understanding and enhance compliance for end consumers. This would also include rationalising, harmonising and simplifying of the grid code. We envisage a three-year programme delivering the final product by 2025.

To transform the code process, we will incrementally increase the resource in this area. We plan to have additional FTEs, compared with current BAU resource in the first year of RIIO-2, increasing to around 20 further FTE by 2026. This FTE will not only support the transformation but also our ongoing increased responsibilities to drive through strategic change.

Developing and implementing the whole-system grid code will require significant engagement with stakeholders. It will also need significant simplification, rationalisation, harmonisation and the development of IT systems to digitise.

We would create a small team over the three-year programme to deliver this work. The team would be supported by an external consultant, allowing us to flex skill and capability support through the project life cycle.

In terms of examining fixing one or more components of BSUoS, we will work with Ofgem and wider stakeholders to refine and validate the CBA. Once a positive CBA has been demonstrated and appropriate regulatory and funding arrangements confirmed for ESO through the RIIO-2 process, we will raise a Code Modification with the aim to implement changes from 1 April 2022.

Innovation

During the RIIO-T1 period we have introduced new 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 innovative approaches over the RIIO-2 period to 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 the GB electricity industry. We will capture lessons which can be shared with the wider industry to improve the experience for all codes.

8.7 Next steps

We will continue to develop and refine our proposals and the cost-benefit analysis, in consultation with stakeholders, and provide an updated view in the next iteration of the business plan. We will also develop metrics to track the key outputs we propose to deliver.

9. Theme 3: Unlocking consumer value through competition

We are developing proposals for two types of competition in the RIIO-2 period. Firstly, we will expand the use of competition for network solutions as part of an expansion of our *Network Options Assessment* (*NOA*) process, which has received strong support from stakeholders. This creates significant value for consumers; our 2018/19 *NOA*[52] recommends a set of investment options that could save consumers between £1.85 billion and £2.67 billion over the next 11 years[53]. The second way we are considering competition is through helping Ofgem develop its proposals for competition in networks, on which we have received mixed views on stakeholders. We outline our thoughts on this at the end of this chapter.

We set out in our ambition document the potential to unlock even more value through opening network development to more competition and by enhancing and extending our analytical capabilities. Our ambitions are:

- We will facilitate competition across all dimensions, enabling all viable options to compete for delivery of solutions to network challenges. We will remain technology-agnostic, selecting solutions based on the consumer value they can deliver.
- We will actively support Ofgem and industry to deliver a model for onshore competition that maximises consumer value, playing our part in setting up, and then operating within, the framework.

We have engaged through a number of routes on our competition in network solutions proposals, including the *Network Development Roadmap* consultation in May 2018, our December 2018 and April 2019 ESO RIIO-2 stakeholder events, webinars on network development and onshore competition in transmission build. We have also engaged many stakeholders bilaterally and via webinars.

We're responding to stakeholders' views in this area, which are:

- We should introduce competition in solutions to meet transmission network needs as far as it is within our gift and supported our proposals to expand our approach to seek both network and non-network solutions
- We should extend the *NOA* to other areas of development, however some stakeholders wanted clarification on how this would complement work undertaken already by the TOs.
- Mixed views on whether a fundamental review of Security and Quality of Supply Standard (SQSS) is required or necessary.
- Different views regarding our role in future competitive processes for transmission assets. Some feel the potential for conflicts of interest whereas others thought it could be managed.

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[52] https://www.nationalgrideso.com/insights/network-options-assessment-noa
[53] 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 https://www.nationalgrideso.com/insights/network-options-assessment-noa Consumer priorities

This chapter details how we plan to undertake these transformational activities, informed by our customers and stakeholders.

The net benefits of our proposals are estimated at around £900 million.

Our proposals fall into two areas:

1. Expand and enhance the *NOA* to facilitate effective competition between transmission and distribution and market solutions.
2. Support competition by helping to establish the Competitively Appointed Transmission (CATO) regime.

The charts below summarise our proposed investments and delivery timeline for our proposed activities in this area.

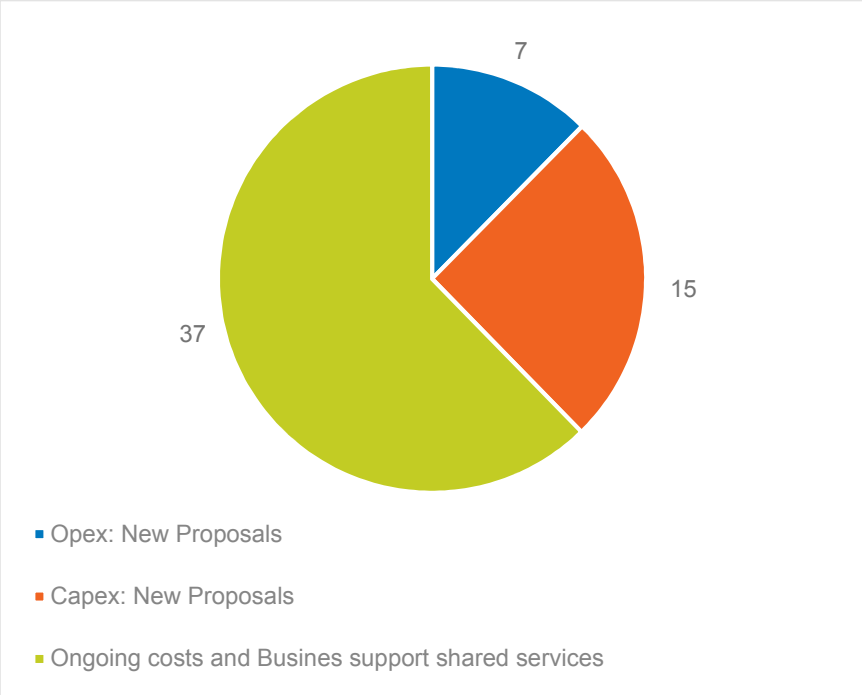

Figure 26: Current view of costs of Theme 3, £m, (FY 2021-26)

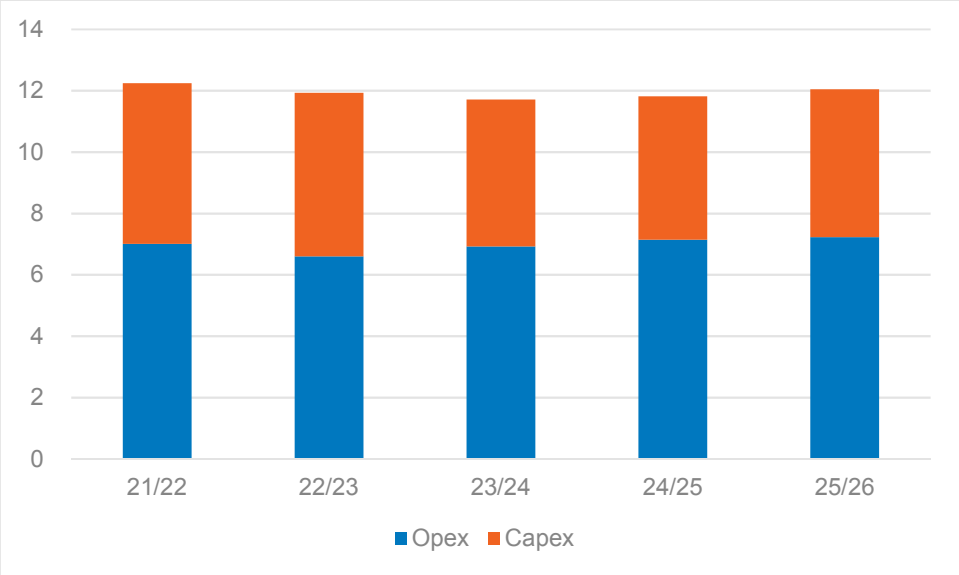

Figure 27: Current view of investments in Theme 3, split by opex and capex, £m per year.

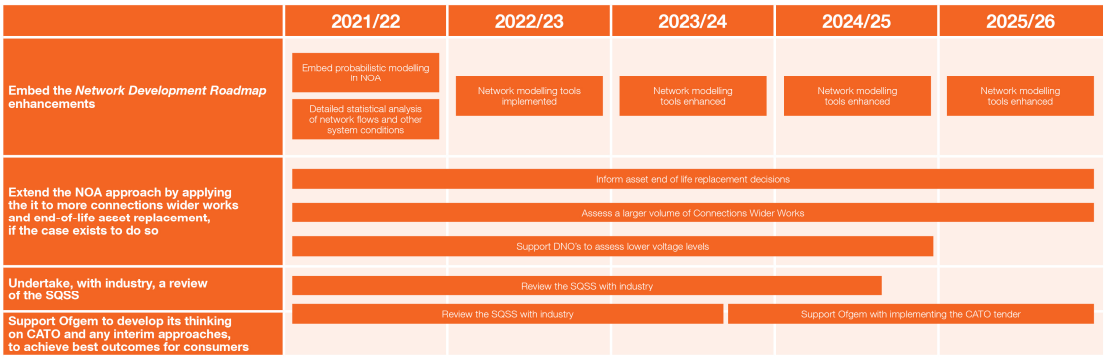

Figure 28: Deliverables and activities timeline for Theme 3

9.1 Expand and enhance the *NOA* to facilitate effective competition

As set out in our ambition document, we are transforming our network planning through the introduction of competition to address network needs. Alongside this, we are also enhancing our analytical capabilities to respond to the increased complexity of network issues.

"We welcome proposals to build on the *Network Options Assessment* (*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

Our *Network Development Roadmap*[54]*,* which we previously consulted on, has already started this transformation and by the end of RIIO-T1 our Pathfinder Projects will have identified and addressed many of the challenges involved.

However, both the increasing complexity and the introduction of competition represent significant change. Therefore, during RIIO-2 we will use the learning from our pathfinders to embed and improve new analytical and competitive processes that ensure the maximum benefit for consumers.

We also propose to unlock yet more value by assessing more elements of network investment. Traditionally, we only assessed network investment that provided increased capacity across regional network boundaries. This is already beginning to change, for example, through our pathfinder projects looking at future voltage requirements. However, there is more beyond this where we can add value.

Our proposals focus on six options:

Transforming network planning through competition

1. Implement and enhance competition to enable all solution types to compete to meet transmission needs. Building on the learning from our pathfinders, which are a collaborative learning by doing approach, we will introduce enduring processes that enable all potential solution types to compete fairly and equally to provide network solutions.

Extending *NOA* to other areas of network development

2. Extend the *NOA* approach to end-of-life asset replacement decisions. We will assess decisions to replace large assets that are at their end of life to recommend whether replacing with a different asset could lead to greater benefits.
3. Extend the *NOA* approach to all connections wider works. We already assess some wider works but will expand this so that all connections' wider works are assessed.
4. Support decision-making for investment at the distribution level. We do not believe it would be good value for the ESO to undertake *NOA* type assessments at the distribution level. However, we will add value by supporting DNOs to develop their own assessment capabilities.

Support actions across all our transformational activity

5. Implement and enhance improved analytical capabilities. To support all this activity, including much of our work in Theme 4, we need IT systems that enable the modelling of the increasingly complex network needs and solutions.
6. Undertake, with industry, a review of the Security and Quality of Supply Standards (SQSS). The SQSS underpins all network planning. Given the changing nature of generation and developments in network planning in recent and upcoming years, it is widely agreed that the standards need to be reviewed. We intend to lead this review with support from network companies.

The net benefits of our proposals are estimated at around £900 million.

Rationale

The ESO's operational and analytical expertise allows us to recommend which investment decisions will bring the biggest value and the best time to invest. This saves

[54] https://www.nationalgrideso.com/insights/network-options-assessment-noa/network-development-roadmap

billions of pounds for consumers through reduced system balancing costs and avoided network investment.

There are additional areas of network investment (end of life asset replacement and all connections' wider works) where we could bring similar levels of consumer benefits as we do for the investments we already assess.

Beyond this, our unique, independent position means we are well placed to consider alternatives to transmission asset investment, such as commercial or distribution network solutions.

Through our Pathfinder Projects (e.g. Voltage Pathfinder in the Mersey area), we are beginning to introduce competition across these different solution types to identify the best-value options. Through this we will also help to drive innovation and increased participation across the energy landscape.

Our analysis this year suggests that using commercial solutions, such as intertrip schemes, for network issues could save consumers between £0.77 billion and £1.1 billion over the next 10 years[55]. We would expect further savings can also be gained from competition to address other network needs, such as voltage and stability.

As well as introducing competition, we must prepare to be able to operate a carbon-free network in 2025. The continuing growth of distributed generation and new technologies is driving an increase in the volume and complexity of network modelling requirements we undertake.

The network is becoming more difficult to operate due to reducing system inertia and changing reactive demand among numerous other challenges. The overall operability costs forecast for these are £596 million per year over the period 2021-2026. Effective network planning will allow us to reduce these costs in the future and plan for a network that enables us to run a carbon-free network by 2025.

Network planning is becoming much more complex. Traditionally, the ESO's planning focused on winter peak capacity requirements. However, changing use of the network means better decisions could be made if we analyse more points across the year.

In addition, with the decline in traditional synchronous generation and a changing demand base, we now need to plan for a much broader range of network needs, such as voltage and stability.

The cost of managing voltage is forecast to be £130 million per year for 2021-2026 inclusive and these numbers are trending upwards. Meanwhile, stability is of growing importance for network planning. Stability is the ability of the system to quickly return to acceptable operation following a disturbance.

Due to the inherent stabilising effect of synchronous generation this subject area has not previously required the same focus. However, as synchronous generation capacity decreases, we must be much more proactive in monitoring, understanding and maintaining system stability.

[55] 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

We have already begun developing our processes and capabilities for these growing challenges. However, we need to continue to develop our expertise during RIIO-2. In particular, there is significant interaction between these different network needs.

For example, 'stability' refers to a broad range of topics including voltage, frequency, inertia and short circuit levels. As our modelling and capabilities increase, we will focus increasingly on these interactions.

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 RIIO-2 we will build on this further to enhance these techniques, in particular to better reflect the interactions between different network issues.

With the increasing volume of analysis that needs to be completed, in shorter periods of time, we are currently assessing the tools we require. Subject to this being successful we will implement these voltage assessment tools early in the RIIO-2 period.

During RIIO-2 we will establish how we can best utilise our network planning expertise to support interactions across different vectors.

9.2 Transforming network planning through competition

9.2.1 Implement and enhance competition to enable all solution types to compete to meet transmission needs

The net benefits of our proposal are estimated at £593 million, and to deliver £133 of benefits for every £1 spent. The net benefits are positive from 2021/22 onwards.

As consulted on and set out in our *Network Development Roadmap*, by the end of RIIO-T1 we will have run tenders for longer-term voltage needs in the Mersey and Pennine regions, stability needs in Scotland and constraint management needs[56]. Stakeholders are strongly supportive of these developments and are keen for them to deliver as soon as possible.

These pathfinder projects are ongoing but we anticipate that significant value could be achieved by embedding these processes in RIIO-2.

Tendering to compare asset solutions with non-network solutions, and comparing regulated businesses with non-regulated businesses, is challenging. By the start of RIIO-2 our pathfinders will have given us a large amount of learning to address the technical, commercial and regulatory challenges. However, much more will need to be done to gain the maximum value from this transformation. Specifically, we will need to:

- **optimise the assessment and communication of future needs**

  Stakeholders have told us that they want us to communicate future needs to them more clearly so they can participate in the market. As our modelling of

[56]Subject to the outcome of the Requests for Information stages of the pathfinders and ongoing network need assessment.

these issues and potential solutions grows, we will need to continue to improve how we communicate 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. For example, we know stakeholders want to see better alignment across our tendering for different needs to support their business case 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 Transmission Owner (TO), with funding allocated through their price controls.

  This regime is now changing and so the supporting frameworks also need to change. During the remainder of RIIO-T1 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 these changes. There will also be transitional arrangements to manage, such as bridging the gap between RIIO-2 and RIIO-ED2 and legacy from RIIO-T1.

Stakeholder views

Our stakeholders have told us they want us to introduce competition for transmission solutions. In response to last year's consultation on our Network Development Roadmap, three quarters of respondents supported our proposals to expand our approach to seek both network and non-network solutions.

Most stakeholders at our RIIO-2 event in April also confirmed this view. However, two generator stakeholders highlighted that we need to be careful of the impact this could have on energy markets.

At our Network Development event on 16 May 2019, several of the 21 stakeholders in attendance highlighted that optimising the alignment of how we communicate and tender different needs could significantly help more providers to enter the market by supporting the business case needed for them to invest in new assets. This is part of what we are testing through our pathfinder project approach.

Rationale for proposals

Our unique, independent position means we are well placed to consider alternatives to transmission asset investment, such as commercial or distribution network solutions.

Through our Pathfinder Projects (e.g. Voltage Pathfinder in the Mersey area), we are beginning to introduce competition across these different solution types to identify the best-value options. Through this we will also help to drive innovation and increased participation across the energy landscape.

Our analysis this year suggests that using commercial solutions, such as intertrip schemes, for network issues could save consumers between £0.77 billion and £1.1 billion

over the next 10 years[57]. We would expect further savings can also be gained from competition to address other network needs, such as voltage and stability.

Network planning is becoming much more complex. Traditionally, the ESO's planning focused on winter peak capacity requirements. However, changing use of the network means better decisions could be made if we analyse more points across the year.

In addition, with the decline in traditional synchronous generation and a changing demand base, we now need to plan for a much broader range of network needs, such as voltage and stability.

The cost of managing voltage is forecast to be £130 million per year for 2021-2026 inclusive and these numbers are trending upwards. Meanwhile, stability is of growing importance for network planning. Stability is the ability of the system to quickly return to acceptable operation following a disturbance.

Due to the inherent stabilising effect of synchronous generation this subject area has not previously required the same focus. However, as synchronous generation capacity decreases, we must be much more proactive in monitoring, understanding and maintaining system stability.

We have already begun developing our processes and capabilities for these growing challenges. However, we need to continue to develop our expertise during RIIO-2. In particular, there is significant interaction between these different network needs.

For example, 'stability' refers to a broad range of topics including voltage, frequency, inertia and short circuit levels. As our modelling and capabilities increase, we will focus increasingly on these interactions.

9.3 Extending *NOA* to other areas of network development

9.3.1 Extending *NOA* to end of life asset replacement decisions

The net benefits of our proposal are estimated at £142 million, and to deliver £28 of benefits for every £1 spent. The net benefits are positive from 2022/23 onwards.

We propose to expand our network planning processes to look at end of life asset replacement decisions for large assets. Currently, TOs consider the best way to replace assets that are reaching the end of their life. However, TOs do not have access to the same level of operational data as the ESO.

We believe that by reviewing decisions, the ESO would be able to recommend a different approach. For example, there may be occasions when there would be value in replacing an asset with an upgraded asset to address a wider issue on the network.

Stakeholder views

During our *Network Development Roadmap* consultation, respondents thought we could apply a *NOA*-type approach to a broader range of transmission investments.

At an event in December 2018, stakeholders supported our rationale to broaden our assessments. Some TOs, however, wanted to know how this would complement the assessment they already undertake themselves.

[57] 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-optionsassessment-noa

The ESO assessment would add to the TOs' own assessment because the ESO has access to additional operational data. TOs were also interested to better understand how the process and timing might work. Almost all stakeholders at our April event supported our proposal to expand our processes.

We will work with TOs to gather more information on likely numbers of asset replacements over RIIO-2, to determine the size or type of assets that should be assessed by the ESO and to agree appropriate processes.

Rationale for proposals

The ESO's operational and analytical expertise allows us to recommend which investment decisions will bring the biggest value and the best time to invest. This saves billions of pounds for consumers through reduced system balancing costs and avoided network investment.

There are additional areas of network investment (end of life asset replacement and all connections' wider works) where we could bring similar levels of consumer benefits as we do for the investments we already assess.

9.3.2 Extend the *NOA* approach to connections' wider works

The net benefits of our proposal are estimated at £143 million, and to deliver £28 of benefits for every £1 spent. The net benefits are positive from 2022/23 onwards.

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 assessed.

The transmission system is split by regional boundaries that 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-T1 and the subsequent evolution of the network means that there are areas of significant network investment that does not cross these boundaries. 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.

Stakeholder views

During our *Network Development Roadmap* consultation respondents thought we could apply a *NOA*-type approach to wider works. At our December RIIO-2 event stakeholders similarly supported our rationale to cover all wider works.

However, some were interested to understand how this would affect timeframes in connections' wider works. Most connections' wider works are already assessed by *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.

9.3.3 Support decision-making for investment at the distribution level

The net benefits of our proposal are estimated at £35 million, and to deliver £8 of benefits for every £1 spent. The net benefits are positive from 2022/23 onwards.

Given the ESO's experience in delivering *NOA* type assessments, we believe we could add value to network planning at the distribution level by supporting DNOs to develop

effective processes. We already work closely with DNOs through Open Networks to share learning and we publish our *NOA* methodology.

In addition to this, 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 through an overall co-ordinated approach as both transmission and distribution system needs evolve.

We will also provide some bespoke support to individual DNOs, on request, to help them develop their own processes.

Stakeholder views

During our December event stakeholders indicated they had limited appetite for the ESO to undertake assessments at lower voltage networks, citing how different those networks were to the transmission networks.

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 were supportive of the ESO having a role in providing support and a consistent analytical approach to network planning at lower voltage levels.

However, one generation stakeholder felt that we could undertake these assessments depending on the respective future roles of DSOs and the ESO and that these still need to be clarified.

Rationale for proposals

The ESO currently assesses investment decisions for transmission networks (which includes the 132kV networks in Scotland). We considered whether there would be value in expanding the ESO's role further to also undertake a *NOA* type process at the 132kV networks in England and Wales.

We know the ESO brings significant consumer benefits at the transmission level and so there is potential to bring similar benefits at the lower voltage levels.

However, in order to undertake this assessment, the ESO would need to develop new expertise because the 132kV networks are significantly different in nature to the transmission networks.

The ESO would need to gain a thorough understanding of these networks and develop relevant modelling and analytical tools. The amount of expected investment at this voltage level is expected to be relatively low (around £40m per year, compared with around £1bn per year at the transmission level). Therefore, we believe there is much more value to be gained through the ESO focusing on the other areas outlined above rather than expanding to the 132kV networks currently.

However, we do believe there is value to be gained from the DNOs adopting a *NOA* type approach to their investment decisions. Applying this approach at the distribution level could led to similar enhancements to decision-making for distribution investment, potentially generating savings of £10 million for consumers.

9.3.4 Support activities across all our transformational activity

The activities below are needed to support all our deliverables in Theme 3 and many in Theme 4. We therefore have not produced CBAs specifically on these areas. The costs of delivering these have been accounted for in the overall net benefit for Theme 3.

9.3.5 Implement and enhance improved analytical capabilities

Our modelling capabilities underpin all our deliverables in Theme 3 and many in Theme 4, enabling us to unlock significant benefits.

We need to be able to manage the increasing number of scenarios and modelling complexity that is driven by the growing interaction between network different needs. The better we understand likely needs the better we can identify where and when to invest.

Our current analytical tools focus on thermal needs 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 anticipate 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 to optimise the economic decision-making.

Asset health investment is also needed to ensure the tools continue to run on supported hardware and that user-developed models and algorithms can be integrated into the IT estate.

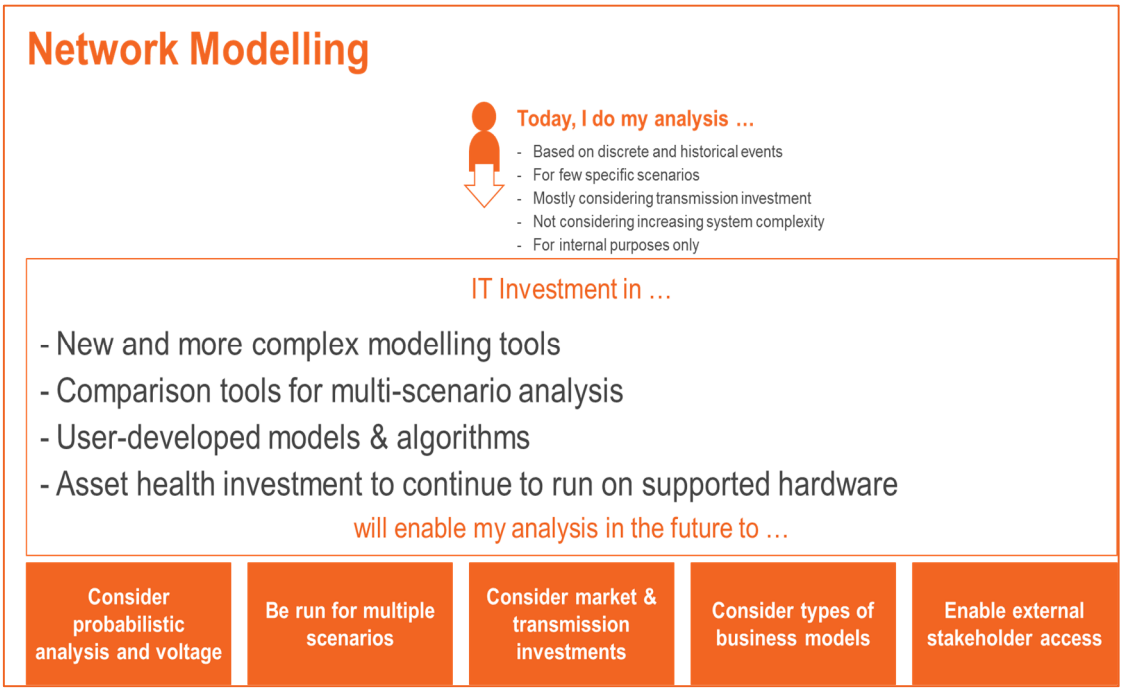

Figure 29: Network modelling user journey

Specific tools we need to develop are:

- **economic assessment**. Our economic assessment 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 replaced at the end of RIIO-T1. As part of this replacement, we will transform the economic modelling capability to go beyond the current thermal and limited voltage assessments to assess all energy-related network issues (such as all voltage issues, stability, RoCoF).

  We will also integrate our economic assessment tools with our power system modelling tools and will build in the processing power to solve ever more complicated optimisations.

  These enhancements will allow us to further pinpoint the most economical time to invest the networks and the most efficient solution. As set out above, correctly identifying the best time to invest in the network saves consumers many millions of pounds.

  In addition to our future network planning, this tool will also support our year-ahead outage planning by providing a more refined understanding of the networks.

- **probabilistic modelling**. Probabilistic modelling allows detailed statistical analysis of network flows and other system conditions. This 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. During RIIO-2 we intend to develop the modelling further to account for System Operator actions used to optimise the capability of the network, such as using network assets to direct and control the power flow across the network.

  We also intend to model potential alternative options to traditional transmission reinforcement such as commercial options, flexible power flow devices and energy storage to enhance our capability to compare multiple options in the *NOA* process.

  Also, by integrating this tool with our other network planning tools, we will be able to better optimise the decision-making process by combining the economic and technical studies within a single platform.

  Lastly, during RIIO-2, we intend to 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 are unable to cope with 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 Concept is successful, a new voltage optimisation tool will be developed early in RIIO-2.

During RIIO-2 we would also 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.

Voltage issues are responsible for £130m per year of the forecast operability costs for 2021-2026 inclusive and these numbers are trending upwards. 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 save around 70 per cent of the forecast costs.

- **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 connection technology, and the corresponding decline of synchronous generation, means that we have had to become much more proactive in monitoring, understanding and maintaining stability. This is essential to maintain a reliable network.

  Investigation is currently being carried out into new algorithms to allow faster assessment for control room purposes. In addition, we also require improved tools to allow us to identify and plan for future stability issues.

  These requirements are even more complex than the algorithms currently being developed as our ability to rely on established generation equipment representation reduces. Investment is required in RIIO-2 to allow us to develop and implement new tools to assess future stability needs. Without intervention, we anticipate managing stability would cost around £234 million and limit the potential for GB to reduce its carbon emissions.

9.3.6 Review of the SQSS

In line with the majority of stakeholder views, we suggest that a focused review of the SQSS, addressing a targeted set of known concerns (to be agreed with Ofgem) would be an effective first step. We therefore propose to take forward work to scope and progress the changes with the highest consumer value.

Potentially we would move to a larger-scale review if the initial exploration showed value in this and therefore costs and timeframes for this are not accounted for here. To scope and progress priority areas would take around four years. The review would need to be supported by TOs and other affected stakeholders.

Stakeholder views

We engaged with stakeholders on our proposal to review the SQSS at our webinar in November 2018, our December 2018 RIIO-2 event, and at our RIIO-2 workshop in April 2019.

Stakeholder views were mixed on whether a fundamental review was necessary. In our RIIO-2 November webinar, six out of eight participants supported a fundamental review of some form. However, at our December consultation event there was no clear agreement on whether a fundamental review was required.

Several stakeholders felt that a fundamental review was unnecessary and potentially lengthy, whereas others felt that undertaking a review would help to resolve the debate. At our April event, of the seven stakeholders that gave a view the majority supported some form of

> "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 ESO RIIO-2 Ambition consultation

review but there was no definitive view on whether this should be light-touch or fundamental.

One 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 proportionate review would be more appropriate than a fundamental review. 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 and it was unclear what we would expect to be radically different at the end. It was noted that a fundamental review was begun 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.

Rationale for proposals

The SQSS sets the technical standards that transmission owners 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. These include reviewing the deterministic standards approach to reflect the recent introduction of the *NOA*. There is also potential to enhance the offshore section, which has evolved over several years.

In addition, there are a range of other issues to consider such as alignment with the equivalent standards at the distribution level and a number of other smaller amendments to update the document. There could also be merit in considering whether the operational standards, which underpin the amount of investment that is required, are still the most appropriate approach.

As a result, there has been ongoing debate about whether the time is right for a fundamental review of the SQSS. We have been testing this with our stakeholders. A fundamental review would enable us to consider if there are even bigger benefits that could be gained from a broader change of approach.

At our engagement events, stakeholders have had mixed views on whether a fundamental review of the standard is required, whereas the TOs all considered that a proportionate review would be more appropriate than a fundamental review.

We are mindful of the feedback we have received in related areas, 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 progress timely change in this area while a broader review is developed.

Cost-benefit analysis

We considered three broad options:

- status quo. Continue the developments outlined in the Network Development Roadmap to the end of RIIO-T1 but make no further changes in RIIO-2. This would allow us to embed improved analytical capabilities and competition, which is already under way. However, there would be a missed opportunity

from not expanding our analysis to also look at other areas of transmission investment.

- extend network planning to other areas of transmission investments levels (preferred option). Build on option 1 by extending our analysis to cover end-of-life asset replacement decision and all connections' wider works. This allows the ESO to capitalise on areas of expertise and concentrate on maximising the value of these, without stretching even further to cover the lower voltage levels.
- single network planner. Build on option 2 to also make recommendations on investment at the 132kV level. We do not recommend this option. The level of investment expected for the 132kV networks does not justify the significant new capabilities the ESO would need to develop to assess the lower voltage networks. Supporting DNOs to do this themselves appears to be a better value option.

Cost-benefit analysis for preferred option

A cost-benefit analysis has been carried out for the preferred option only using the status quo as a reference. For ease of analysis it is assumed that the status quo has no ongoing investment costs whereas some incremental investment would be required.

As a result, the relative net benefit of the preferred option will be underestimated, but this will not impact the investment decision.

- the net benefit of implementing and enhancing competition to enable all solution types to compete equally is £593 million.
- the net benefit of including end-of-life asset replacement in the *NOA* is £142 million.
- the net benefit of using the *NOA* for connections' wider works is between £143 million and £208 million.
- the net benefit of extending *NOA* lower voltage levels is £35 million.
- the cost of a review of the SQSS is £1 million.

For more information on our workings, please see the cost benefit report.

The benefits of the preferred option are outlined in a qualitative way in the table below:

Benefit	Description
Improved safety and reliability	• timely, effective and competitive network development 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.
Improved quality of service	• learning from our current pathfinders will allow us to embed efficient competitive processes that best meet the needs of potential providers. We will continue to improve how we communicate network needs in a way that supports different provider types participating. As these are new processes, we will continually seek feedback to

	refine and improve the quality of the service we provide.
Lower bills than would otherwise be the case	• rigorous analysis of energy system needs and how different options meet them allows optimisation across investment and constraint costs. This leads to efficient choices of what network assets to invest in and when. Comparison of different technologies and services on a consistent basis creates a more level playing field, improving competition, increasing the incentive for providers to innovate and find efficiencies to bring down costs. Both these drivers reduce the cost of networks for consumers. • our analysis suggests that non-build solutions to network issues, such as intertrip schemes, could deliver consumer benefits of between £0.77 billion and £1.1 billion over the next 10 years. Our 2018/19 *NOA* recommends a set of investment options that could save consumers between £1.85 billion and £2.67 billion over the next 11 years[58].
Reduced environmental damage	• securing sufficient investment in network capacity will ensure that new, low-carbon sources of electricity are able to connect and continue to decarbonise the energy system. Allowing parties to compete to provide the best solutions could stimulate innovation in more environmentally-friendly infrastructure, or solutions that do not require additional infrastructure to be built at all.

9.4 Support competition through helping to establish the CATO regime

Ofgem has confirmed its ongoing intention to introduce the CATO regime for onshore transmission networks. Ahead of legislation being introduced, we will continue to help Ofgem develop its thinking and any interim approaches to achieve the best outcomes for consumers.

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

We believe the best outcome for consumers would be achieved through early models of competition, whereby competition can be used to drive innovation in the options proposed

[58] 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-optionsassessment-noa

to meet future new, separable and high-value transmission network needs, and the solutions being put forward for assessment.

During RIIO-2, we propose to:

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

Stakeholder views

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

Stakeholders have expressed different views on our role in future competitive processes for transmission assets. Some stakeholders, including a potential CATO and a generator and supplier, feel the potential for conflicts of interest, given our position within the National Grid Group and hence proximity to National Grid TO and Ventures. They feel this precludes a substantive role. Others feel that such potential conflicts could be managed.

> "The early competition model is preferable, but it is new and difficult. It makes sense to start with a late model which is more deliverable, recognising that the early model is best in the longer term."
>
> **Developer,** ESO onshore competition webinar

We believe we are uniquely placed to deploy our skills and expertise in this complex area. The measures we have put in place from April 2019 to support us as a new standalone business within National Grid, legally separate from all other parts of the National Grid Group, seek to provide assurance of our independence.

The fact that we now have our own Board, with staff being physically separate from all other parts of National Grid, will provide the right environment to deliver a balanced and impartial ESO that can realise real benefits for consumers as we transition to a more decentralised, decarbonised electricity system.

Rationale

Through the RIIO-T1 period we have continued to engage with Ofgem on developing competition in onshore electricity transmission. In June 2017, Ofgem stated that it was deferring further development of the CATO regime until the timing of the necessary legislation is more certain.

Ofgem's preferred model for delivering CATO remains uncertain currently. We support the introduction of competition for new-build onshore transmission assets where this can be shown to deliver value to the end consumer. We believe that optimal consumer value can be delivered by introducing competition at the earlier stages of the development of a transmission reinforcement. This approach will allow the full benefits from innovation in design, technology, risk management and delivery to be realised.

There will be certain activities that we would expect to undertake regardless of the model of competition. However, there will also be specific activities that depend on the model chosen. The later models of competition bring with them the need to develop new capabilities within the ESO.

The activities presented here are on the basis of our involvement in the development of an early model of the CATO regime and supporting Ofgem in the running of associated tender processes.

9.4.1 Continuing to play our part in identifying the need for transmission investment

We have previously noted that our network planning process makes recommendations on whether and when to invest billions of pounds in the transmission network. This year's *Network Options Assessment* (*NOA*) recommended that Transmission Owners (TOs) should invest £59.8 million in 2019/20 to progress 25 projects with a combined value of £5.4 billion.

Our associated competition assessment[59] identified seven reinforcements and three connection projects that meet Ofgem's competition criteria. We will continue to develop our network planning process to deliver best value to consumers.

9.4.2 Supporting Ofgem to establish the most cost-effective approaches to run its preferred model, expanding the role of the ESO where required

We continue to support the introduction of competition for new-build onshore transmission assets where this can be shown to deliver value to the end consumer.

Previous work has identified several variants between the extremities of early and late models, with different requirements placed upon the ESO, depending on the point of transfer of responsibilities to a CATO.

For us to support the establishment of an early tender model, we expect that we would need to develop and deploy the following capabilities:

- identify network need. This is a current ESO role. We will need to ensure we have the capacity to articulate the network needs in a manner suitable for tendering against.
- identify strategic options to tender against. This is currently a TO role, so will require the ESO to establish the capability to translate network needs into strategic options for asset or reduced-build solutions.
- support the design of the tender process. We have significant experience in designing and operating tender processes. We will use this expertise to support the design of the CATO tender process.

9.4.3 Supporting Ofgem with running the tender once the regime is introduced (for example, articulating the need, assisting with technical assessment of bid)

For us to support the running of a preferred tender model, we expect that we would need to resource, develop and operate the following activities:

- support the operation of the tender process. We would anticipate that we could deploy our existing expertise in managing tender processes to support tenders resulting from Ofgem's preferred competition model. However, we currently only work with three TOs in the context of the current *NOA* process.

[59] 5 reinforcements/3 connections in Scotland/North of England, 1 reinforcement in the South/East of England, and 1 reinforcement in Wales/West Midlands.

We would expect to have to deal with many more in a CATO context, and anticipate that the time taken to provide appropriate support to them (for example, to discuss specific network needs) could materially increase from current levels.

- technical assessment of options against need. We expect that the increased volume of technical assessment work required to analyse tender submissions would require additional power system engineer resources.
- commercial benefit of options vs cost. We anticipate a higher volume of options that need to be addressed in the *NOA* process. This would require extra resource to deal with the assessment of those options, alongside additional IT infrastructure to deliver the analysis.

Cost-benefit analysis

As part of its recent RIIO sector-specific consultation, Ofgem undertook an impact assessment on applying late competition to future new, separable and high-value projects in electricity and gas networks during the RIIO-2 period.

The analysis suggested introducing or replicating competition could deliver savings to consumers. Based on our view of the relative merits of early and late models, we expect the savings to customers from an early approach to be greater than for a late one.

The focus of this work is on establishing the capability within ESO to support competitive tendering of onshore transmission assets and capabilities. They represent ESO's initial setup and ongoing operational costs of supporting the operation of a competitive onshore regime.

Options considered

We considered two options:

1. **Status quo**. This provides for ongoing support to Ofgem in developing onshore competition processes in line with current provisions.

2. **Preferred option**. This allows us to deliver the proposals outlined above in an 'early model' context, with some additional ESO roles needing to be developed. We believe this option combines the natural evolution of the ESO role with an approach that ensures optimal consumer value can be delivered by introducing competition at the very early stages of the development of a transmission reinforcement. This would allow the full benefits from innovation in design, technology, risk management and delivery to be realised.

We do not consider the status quo to be a viable option as we would not have the capability to provide Ofgem with the support required to develop the tender process and assess tendered options. Our proposed activities and costs are based on our preferred option, compared with the status quo position.

Costs

We anticipate that, for us to continue to provide effective support for Ofgem as it develops and implements its preferred tender option, we will need to increase resourcing. Further details on resourcing this are included within the Theme 3 section of the CBA report.

The costs of this proposal over the RIIO-2 period are £2.8 million.

The monetary value of the benefits of this work is difficult to determine, given that the preferred option outlined above is only an enabler for our support of competitive onshore transmission activities.

However, the benefits are likely to be small compared to the potential benefits to consumers of the CATO approach. Benefits are outlined in a qualitative way in the table below:

Benefit	Description
Improved safety and reliability	• timely, effective and competitive network development 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.
Improved quality of service	• additional resource, supported by a CRM system, will enable a high quality of service to be provided to those participating in tender processes.
Lower bills than would otherwise be the case	• competition in offshore transmission infrastructure is estimated to have saved consumers between £0.6 billion and £1.2 billion since 2009. We can help to unlock further value by introducing competition as early as possible, before the solution is decided, to help stimulate innovation and find better solutions. • we believe that optimal consumer value can be delivered by introducing competition in the earlier stages of the development of a transmission reinforcement. This would allow the full benefits from innovation in design, technology, risk management and delivery to be realised.
Reduced environmental damage	• securing sufficient investment in network capacity will ensure that new, low-carbon sources of electricity are able to connect and continue to decarbonise the energy system. Allowing parties to compete to provide the best solutions could stimulate innovation in less damaging infrastructure, or solutions that do not require additional infrastructure to be built at all.

The scale of the projects that will be exposed to competition means that even small efficiencies in future derived from implementing and running a suitable CATO regime will far outweigh the cost to the consumer of ESO's related activities in the RIIO-2 period.

9.5 Next steps

We will continue to engage stakeholders and refine the proposals in this chapter. In particular, we will join up our proposals on codes and standards with our proposed activities under Theme 2. We will develop proposals for performance metrics and provide more clarity on how our proposed activities will be enabled through innovation, IT and open data.

Ofgem has, in its RIIO-2 Sector Specific Methodology Decision and further consultation - Electricity System Operator (24 May 2019), explained that they are continuing to investigate and develop the ESO's ability and capacity to facilitate early competition. As part of this Ofgem has requested the ESO include an Early Competition Plan in its December RIIO-2 business plan. We will work to meet this deliverable noting that such a plan needs to be informed by stakeholders, particularly as many of the activities involved do not form part of the ESO's current areas of expertise (e.g. consents).

10. Theme 4: Driving towards a sustainable whole energy future

10.1 Overview

Our Ambition document sets out the need to take a whole-system view of the changing energy landscape to operate a zero-carbon electricity system by 2025 that delivers value for consumers. To achieve this, we will change and deepen the ways we work with others to plan and operate the Great Britain electricity transmission system.

Our ambition is to work with all stakeholders, and particularly other network companies, to ensure a whole-system approach is taken to optimise planning, development and operation of Great Britain's energy networks.

We will bring our expertise to complement that of others and drive industry as it navigates a complex energy transition. We will facilitate informed decision-making that accounts for whole-system impacts and minimises unintended costs or consequences.

By doing this we will help participants to experience a smoother process during interactions anywhere on the electricity network, for example connecting to the transmission or distribution network, while accelerating the efficiency and effectiveness of the energy transformation.

> "With its intimate knowledge of network users combined with its grid operation role, the ESO is ideally placed to offer insights into how transition can be delivered efficiently and retain value to consumers."
>
> **Generator**, in response to the ESO RIIO-2 Ambition consultation

We have engaged our stakeholders through a number of channels to establish their views on our whole system proposals. This included our December 2018 and April 2019 ESO RIIO-2 stakeholder events, bilaterally and via webinars. We are responding to their views in this area, which are:

- Whole energy system solutions are essential to transformation of the energy landscape and 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 broad support for us to develop policy recommendations as there is a 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 to drive the energy system transition.
- Our proposal to create a connections portal which guides customers through the process is a positive development and there is merit in them having access to connection and delay charges, user liabilities and construction progress through the portal.

The charts below summarise the proposed investments and delivery plan for these activities

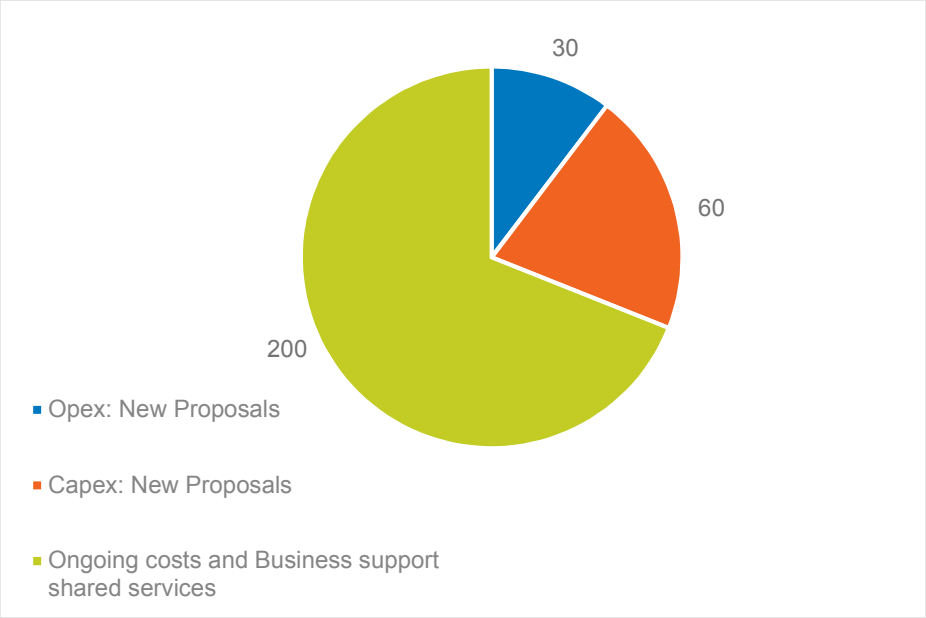

Figure 30: Current view of costs of Theme 4, £m, (FY 2021-26)

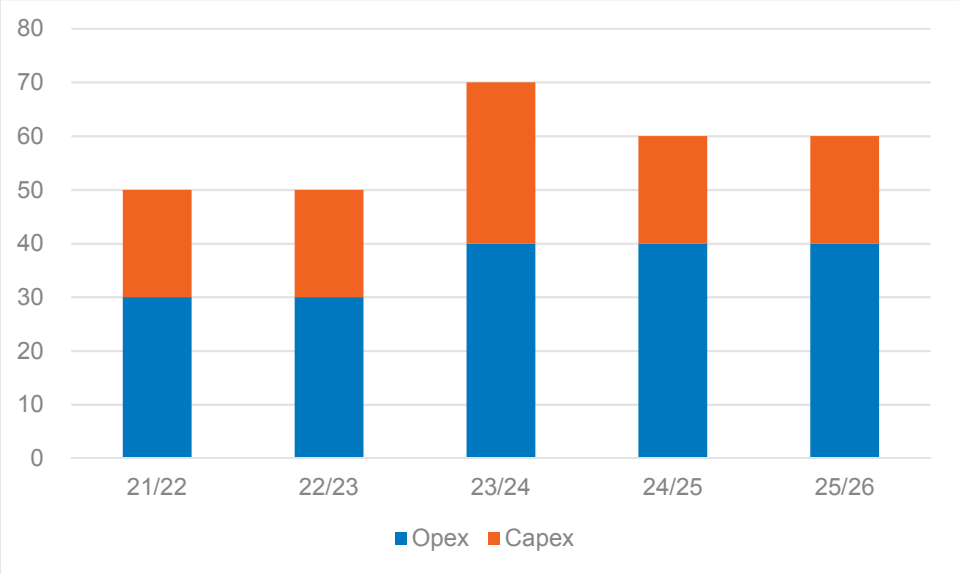

Figure 31: Current view of costs of Theme 4, split by opex and capex, £m per year.

	2021/22	2022/23	2023/24	2024/25	2025/26
Broader analysis and industry engagement to develop energy policy recommendations	Policy recommendations on whole energy system transition				
Established closer ways of working with DNOs to streamline the connection process for smaller players		Connections portal delivery		Portal carries capacity information across T-D interface	On-line account management for connections
A pathway for zero-carbon whole system operability	Regional Development Programme approach			Embedding of Power Potential and EFCC in BAU	Whole system off-line modelling and data transfer
A whole system approach to accessing networks		Short notice access planning changes embedded	Access planning changes embedded		Whole system outage notifications

Figure 32: Deliverables timeline for Theme 4

The net benefits of our proposals are estimated at around £1 billion.

To achieve this ambition, the ESO will deliver:

Broader analysis and industry engagement

We will respond to stakeholder feedback to carry out broader analysis and engage with industry to develop energy policy recommendations that build on the valued insights we already produce through our *Future Energy Scenarios* (*FES*) and associated documents.

> "ESO's core role should move beyond keeping the lights on, to also include facilitating the energy transition."
>
> **Flexibility provider**

We will use our unique position to apply long term modelling and analysis tools, capabilities and processes to closely support the development of energy policy recommendations. We will partner closely with key decision makers and stakeholders and bridge the gap between our deep understanding of system operability and policy recommendations, focusing on the delivery of a clean heat strategy, zero-carbon electricity grid operation, and the delivery of a smart, flexible, low-carbon energy system. These areas will focus discussion of the many constituent areas (including hydrogen, Carbon Capture Use and Storage (CCUS), storage, electric vehicles, energy data) on how to deliver the best outcomes for consumers.

We will lead the industry engagement and collaboration to identify and resolve critical issues which are blocking certainty and clear direction for policy and industry, enabling the wider energy sector to deliver the maximum benefit for existing and future consumers. We will facilitate an ongoing and structured conversation, including the full breadth of industry voices to collaboratively review and challenge data, analysis and recommendations.

We value transparency highly and will publish our data, analysis and insight to further facilitate and progress debate across a range of different audiences. This will potentially include deepening our relationships and co-ordination with DNOs and TOs as they look to develop regional future scenarios. We will provide further information in this area in our October submission.

Stakeholder views

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

Through our annual engagement cycle on our *FES*, a range of stakeholders have told us that we should be going beyond simply presenting the "what" of possible futures. We have been challenged to provide greater insight and direction on how different pathways could be realised. In response to *Our RIIO-2 Ambition* publication stakeholders have expressed a range of views on our role. Several stakeholders agreed that the ESO is well placed to deploy insight and analysis to lead the debate and provide recommendations on the optimal path for GB decarbonisation. The transition to clean heat was highlighted as an area where we can add value. Other parties were of the view that the ESO should restrict itself to providing information and analysis to advise government on implications of energy policy for system operability and network costs of different pathways. We need to engage further with a wider group of stakeholders on this activity to better define our role in this space.

> "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

Rationale for proposals

The GB energy must change at an unprecedented speed and scale in order to support the delivery of a credible and operable industry pathway that delivers the UK's 2050 net-zero ambitions. Issues such as the decarbonisation of heat have no clear path forward and cut across existing industry governance and organisational structures; our whole system perspective and experience with analysis such as the *Future Energy Scenarios* means that we can support the critical policy, regulatory, and industry decisions that need to be made throughout this transition.

Stakeholders have endorsed our ambition to lead the debate in this area, in written responses to *Our RIIO-2 Ambition* document and in meetings. There is a 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 to drive the energy system transition.

Cost benefit analysis

The benefits of these activities are outlined qualitatively in the table below:

Benefit	Description
Improved safety and reliability	• By providing a clear view of the future, we help steer the energy system away from pathways that could lead to safety and reliability problems before they become an issue.
Lower bills than would otherwise be the case	• 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.
Reduced environmental damage	• A detailed understanding of the whole energy system is essential to design effective policies to decarbonise it. By providing trusted guidance on heat and transport decarbonisation pathways and related policy

		requirements, we will increase the likelihood that the UK hits its decarbonisation targets.
Benefits for society as a whole	•	As ESO, we will provide an independent view of how the Great Britain energy system transition should happen. This will reduce uncertainty for investors and accelerate the development of the technologies needed to deliver the transition. These can then be exported to other countries, providing economic benefit to Great Britain.

10.2 Establish closer ways of working with network organisations to drive a more consistent connection application process across GB, irrespective of voltage level

Stakeholders are supportive of our proposals to enhance support for those wanting to connect to the network. 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. We will also drive a consistent application process across Great Britain irrespective of voltage level.

We will work more closely with DNOs to facilitate the connection of low-carbon generation sources through a nationally rolled-out Regional Development Programme (RDP) approach.

Supporting these activities will be our customer connections hub, providing a single point of contact for connections to electricity networks that will guide customers through the connection process. The hub will advise new and existing customers of capacity opportunities on both the distribution and transmission networks. This will respond to stakeholder feedback that we need to work more closely with other network organisations across the transmission/distribution interface to streamline the connection process.

The hub will facilitate a consistent way of applying for connection across GB with standard data requirements, costs and technical requirements. Through RIIO-2 we will work with stakeholders to further develop this tool so that it provides a one-stop-shop for all connection-related information needs such as signed agreements, charges, operational notifications, etc. It will be fully integrated with our external data portal and Customer Relationship Management tools to provide a seamless experience to customers and stakeholders.

We propose to build this capability incrementally. Initially, it will provide a central repository of information regarding the connections process and in time give customers information on available capacity at each grid supply point (GSP). This will take the form of a geographic heatmap indicating where there is capacity headroom. It could be extended to show the need for balancing services. We will also add the capability to integrate with other network organisations' websites and tools. This received wide support during engagement at our RIIO-2 events, including a RIIO-2 webinar in March where stakeholders told us it was critical for the energy transition. We are aware that network companies have started to develop their own heat maps. Stakeholders saw benefit in making sure these are all consistent and found in one place.

We also propose to extend our existing customer seminars to a broader whole-system audience. Plus, we will provide dedicated support to smaller parties who may have transmission-related issues to their connections.

Stakeholder views

The need for consistent whole system approaches and collaborative working was highlighted in our engagement on customer connections. Smaller parties, such as those connected to distribution networks talked about the value of appropriate support to help facilitate their connection. Our connections proposals were welcomed by a number of stakeholders at our Customer Seminars in March 2019, our RIIO-2 event in April 2019 and in some of the responses to our RIIO-2 Ambition consultation document. We have received stakeholder support for our central hub proposal, particularly from smaller connected parties and service providers who could see benefit in have a single point to find all connection related information regardless of voltage level. In response to our RIIO-2 Ambition document, two network companies reflected that our proposals should not duplicate effort and existing activities of other network companies. We also recognise that we will need to work closely with those companies to deliver our connections proposals and that they may have similar proposals that we need to work collaboratively to develop prior to the start of RIIO-2.

Rationale for proposals

The connections portal will ultimately provide the capability for customers to access their account information online. Customers will be able to view information regarding their connection agreements, and track the progress of their connections through the process. When we engaged stakeholders on this proposal, they also saw merit in having access to connection and delay charges, user liabilities and construction progress through the portal.

> "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

In response to our RIIO-2 Ambition consultation document, we received questions about whether the support we provide 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. And we can add value for the customer where there are connection-related issues across the transmission/distribution interface.

Cost benefit analysis

The cost of these transformational activities is around £5 million across the RIIO-2 period. Roughly £2 million of capex spend is associated with the connections hub and its functionalities.

The benefits of these activities are outlined qualitatively in the table below:

Benefit	Description
Improved quality of service	• Providing more coordinated support with distribution network organisations for parties wishing to connect to networks will improve overall customer service. This includes front-line support as well as easier access to coordinated information, allowing navigation around complex industry processes. • Providing customers with information on available network capacity to support their connection decisions.
Lower bills than would otherwise be the case	• With the additional support and information provided on the connections hub, we believe we can reduce the need for additional account managers. We estimate this

	potential saving to be around £2 million over the RIIO-2 period. This is quantified in our CBA annex.
Reduced environmental damage	• 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.

The net benefits of our proposal are estimated at £3 million, and to deliver £1.70 of benefits for every £1 spent. The net benefits are positive from 2023/24 onwards.

It is difficult to put a monetary value on all these benefits, so our numerical calculation for the CBA is focused on lower bills. The net benefit that we calculated for the preferred option is based on efficiency savings to the ESO and broader industry. We have estimated this to be £3 million over the RIIO-2 period.

10.3 A pathway for zero-carbon whole-system operability and beyond

We are working now, through initiatives and innovation projects, to understand system needs and potential options that will facilitate operability in a zero-carbon system. In RIIO-2 we will embed these learnings while developing our operability needs through the rest of the decade as cross-vector considerations such as heat and electric vehicles become more prominent.

We will ensure that stakeholders have access to the data and models they have told us they need to securely develop and operate the system along with clearly defined roles and responsibilities. These will be underpinned by codes and frameworks that work for the decentralised energy landscape.

We will work with stakeholders across industry to develop tools and processes to enable operation of a zero-carbon system. Our proposed transformational activities are comprised of three elements:

- embedding targeted, deeper ways of working using the developed Regional Development Programmes (RDP) ethos. This is all about facilitating new low-carbon connections in areas of the system with limited network capacity. There will be a minimum of three in progress RDPs a year through the RIIO-2 period. This will increase towards five later in the RIIO-2 period, reflecting the growing drive to optimise the whole electricity system.
- rolling out learnings from our innovation projects – Enhanced Frequency Control Capability (EFCC) and Power Potential – to support the ESO's ambition to have an operable zero-carbon system by 2025.
- identifying future operability needs, looking beyond our need to operate a zero-carbon system by 2025.

Developing the tools, frameworks and processes to enable the above will comprise:

- offline network modelling and data exchange. We anticipate that our offline network modelling tools will require ongoing enhancement throughout the RIIO-2 period. This will be necessary to address the needs above and some of our related activities, such as deeper outage planning and real-time optimisation of transmission and distribution assets. To achieve this, we will take a probabilistic approach to modelling. We will develop the ability to undertake more complex modelling, where a greater number of scenarios are considered. It is envisaged

that most 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.

- we will deepen our existing relationships with DNOs by investing in our capability to increase offline system modelling and data management. We plan to develop our existing package to provide increased visibility of distribution networks and their operational characteristics between the ESO and DNOs, across all timescales. Data volumes will increase significantly as we move from a single, limited annual view to establishing and sharing one that covers network modelling, demands and generation at all times of the day and year. While initial works would be undertaken in the period 2021-23, we would see most development from the start of RIIO-ED2 in April 2023. This will reflect the additional drive to distribution system operation expected in this price control period.
- in coordination with our Theme 2 activity – to lead the development of a whole system Grid Code – we will take the lead on aligning technical codes and frameworks across transmission and distribution to facilitate whole-system development and operation.
- embedding the learnings from the ENA Open Networks Project ahead of RIIO-ED2.

Stakeholder views;

We have explored whole electricity system questions in more detail through our own events and the ENA Open Networks Project. Stakeholders recognise the inherent value of a whole electricity system perspective and the benefits of common ways of working across all network organisations. We have reviewed the 48 responses to the 2018 ENA Future Worlds consultation and used this to develop our thinking on both the ESO role in RIIO-2 and the transformational activities needed. Whilst there has been support for all five future worlds developed, responses indicate the strongest consensus, supported by analysis, is for the co-ordinated and collaborative future provided through 'World B'.

"The proposals to share models, data, analysis, and take on whole-system thinking will benefit not only the ESO's customers, but also DNOs as they begin to develop their own business plans as part of the staggered RIIO-2 process."

Generator, in response to the ESO RIIO-2 Ambition consultation

Responses to the Future Worlds consultation have 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, citing potential benefit to both ESO's customers and DNOs as they head into their ED2 price control discussions. Stakeholders have indicated a need for aligned codes and frameworks to support the energy transition and 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 similarly recognised that we need to work with emerging DSOs to ensure efficient design and operation of the whole electricity system, with some seeing our existing skills as complimentary and the potential benefits of 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.

"The ESO will be the driving force behind the whole systems approach."

Environmental Group

Stakeholders recognise the importance for closer working relationships across the transmission – distribution interface when planning system access with some seeing the potential for new market opportunities for congestion management. There is also recognition of the potential consumer value released through better incentivisation of short notice outage change and the opportunities to develop arrangements with transmission owners for RIIO-2.

In our dedicated stakeholder engagement report, we provide further context on these areas of feedback and how they have informed the development of the business plan.

Rationale

Network owners, of both transmission and distribution networks, need to take their assets out of service periodically for maintenance or construction purposes. We have a responsibility to ensure this access is co-ordinated in a secure and efficient manner that delivers value for the end consumer.

At a transmission level this means facilitating access that both minimizes disruption to connected customers whilst also optimizes the costs of operating the system. Whilst the former of these elements is relevant to distribution access planning, the need to manage operational costs is emerging and will affect the way we work with DNOs to co-ordinate access across the transmission – distribution interface, potentially creating new opportunities for flexibility service providers.

Cost benefit analysis

The cost of these transformational activities is estimated at around £83 million over the five-year period. Further details on how these costs are broken down can be found in the detailed CBA annex.

The benefits of these activities are outlined in a qualitative way in the table below:

Benefit	Description
Improved safety and reliability	• Our proposal ensures future operability of the whole electricity system, with clearly defined roles and responsibilities for both the ESO and emerging DSOs.
Improved quality of service	• We need to ensure that the content of technical codes and frameworks is aligned to facilitate understanding by stakeholders.
Lower bills than would otherwise be the case	• 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.
Reduced environmental damage	• Deepening our relationship with DNOs in the design and development process will embed the RDP ethos and facilitate the faster connection of low-carbon generation.

The net benefits of our proposal are estimated at £842 million, and to deliver £11 of benefits for every £1 spent. The net benefits are positive from 2021/22 onwards.

The net benefit of the preferred option using the identified costs and quantifiable benefits described in the CBA annex is £842 million over the RIIO-2 period, which is highly positive. The actual net benefit will be much higher, because in this analysis we have considered only a small subset of benefits. We are therefore confident that this transformational activity will deliver significant value for end consumers.

10.4 A whole system approach to accessing networks

We recognise the potential consumer benefits that can be realised by transforming our approach to system access.

The SO-TO mechanism introduced via the System Operator Transmission Owner code, which allows the Scottish TOs to recover the cost of moving outages within year on request from the ESO, has brought significant consumer benefit. For example, we forecast that this mechanism will provide between £16 million and £37 million of consumer benefit in 2018/19 alone.

We recognise that 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 and have been working with the Scottish TOs to introduce this new methodology.

We therefore propose to extend this enhanced mechanism across GB, for transmission networks first, but with the potential to extend further. We also propose that we extend the arrangement beyond the within-year timeframe. If the ESO can request that outages be moved or changed further ahead, when project delivery plans are being built, the potential costs to TOs of moving their outages can be minimised, thereby unlocking further value.

We will increasingly be procuring flexibility services from DER to facilitate outages. As a result, we will need to work more closely with other network organisations to both co-ordinate these requirements and ensure we are collectively optimising flows across all network assets. We think there is value in extending our current advanced outage notification system (TOGA) to cover a wider range of stakeholders with differing business models and needs. As part of this, we will develop TOGA to engage more interactively with customers, stakeholders and the market. For example, by using mobile apps, alerts, social media feeds and new digital-enabler technologies.

In RIIO-2 we will deliver:

- increased notification of upcoming system outages allowing DER to have forward visibility of potential service opportunities
- established ways of working with network organisations that ensure consumers get optimised value from regulatory assets while facilitating timely and efficient co-ordinated procurement and dispatch planning of DER for system-needs.

We will continue to consider whether the value of our activities in this area could be increased, either through appropriate incentivisation or expansion of the existing methodology to DNOs.

Stakeholder views

We talked about possible incentives related to system access planning with stakeholders at our RIIO-2 engagement events in December 2018 and April 2019. Network companies had mixed views as to whether a new incentive was required. Some cited existing obligations as sufficient for driving the right behaviour in access planning.

Some other stakeholders have supported a greater role for incentives in signalling the cost of system access to TOs. They believe that such a mechanism would facilitate lower congestion levels and be of benefit in either shorter or longer timescales. We agree that such signals may derive consumer benefit, but also recognise the need to think carefully about the design of any such incentive to minimise the potential for unintended consequences. We continue to work on potential options in this area and will provide further detail in our October submission document.

When we talked to stakeholders about extending TOGA to cover a wider range of users at our RIIO-2 engagement event in April 2019, potential distributed connected service providers could see merit in such enhanced capability. But only when the 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 expressed concern that any notifications to parties connected to their systems should go via the network company, to avoid confusion. We will continue to engage on the detail of this proposal over the coming months.

Cost benefit analysis

We recognise the potential consumer benefits that can be realised by transforming our approach to system access.

The net benefits of our proposal are estimated at £161 million, and to deliver £18 of benefits for every £1 spent. The net benefits are positive from 2021/22 onwards.

Again, it is difficult to put a monetary value on all these benefits, so the numerical calculation for the CBA is focused on lower bills. To realise these benefits, we will work closely with transmission and distribution network owners.

Our quantified assessment has therefore focused on the benefits generated through rolling out the NAP process and SO-TO mechanism across Great Britain. This has derived a net present value, when considering all transformational activities in this area, of between £161 million and £321 million. This is highly positive, particularly when considering the number of qualitative benefits that have not been considered. We are confident that this transformational activity will deliver significant value for end consumers.

The cost of these transformational activities is estimated at around £10 million over the five-year period. Further details on how these costs are broken down can be found in the detailed CBA annex.

The benefits of the preferred option are outlined in a qualitative way in the table below:

Benefit	Description
Improved safety and reliability	• Increased coordination and optimisation of network access will facilitate timely construction and maintenance of assets, improving safety and reliability.
Improved quality of service	• Increased access to power system knowledge for new parties connected to the distribution networks, with coverage extended from Scotland to across Great Britain.

Lower bills than would otherwise be the case	• Increased sharing of network data and models, particularly between network organisations, will help us develop and operate the transmission system more efficiently. This will reduce the need for expensive actions to manage congestion or build unnecessary assets. • By opening up flexibility markets that facilitate outages to more parties connected to distribution networks, we will reduce the cost of congestion. • 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.
Reduced environmental damage	• Facilitating the connection of new low-carbon generation.

How we will approach this activity

In RIIO-2 we will undertake activities across the whole electricity system to both minimize access disruption to customers and optimize operational costs associated with system outages.

In the period 2021-23 we will increase our head-count to enable us to deliver a Great Britain wide roll-out of the Network Access Planning process and STCP cost recovery mechanism. This will introduce best practice techniques across the whole of GB releasing consumer value. These resources will also support our initial work to develop access planning arrangements with DNOs, including increased procurement and co-ordination of flexibility services from DER to facilitate efficient outages across the transmission – distribution interface.

We foresee that this second element of work will increase from the start of RIIO ED2 in April 2023 as we move to GB wide implementation. To stimulate these potential markets for flexibility services we will invest in providing greater levels of data and information relating to outages to a wider range of interested parties. This includes enhancing our currently inflight replacement for the existing outage notification tool to better notify distribution connected parties as well as providing remote accessibility reflecting their needs. This also covers the greater extent to which we will model the impact of distribution networks on the transmission system during outage periods. We plan to reduce our headcount in this area towards the end of RIIO-T2 as the outage planning tool enhancements are completed.

10.5 How the ESO could drive the whole energy transition

Over the last twelve months there has been much industry discussion and development on the whole energy transition, and we have been actively involved. In this chapter, we consider how the ESO role needs to evolve to drive the whole energy transition. We believe, during RIIO-2, that this focus will be most greatly defined in the whole electricity system space where we will need to work with TOs and DSOs to develop whole system

ways of working and release consumer value. We have considered three broad options to this relationship.

- **Status quo:** maintain current approach to our relationship with other network organisations. Stakeholders are generally agreed that the ESO model used for RIIO-T1 is not tenable through the next price control period and that we need to evolve to harness the opportunities and meet the challenges of the decentralised energy landscape. However, we believe there is value in using this position as a benchmark for option 2 below.
- **Preferred option**: deeper relationship with DNOs. We believe this option combines the natural evolution of the ESO role with the lowest cost of industry implementation and facilitates a whole system view that will deliver consumer value. This approach is supported by a wide stakeholder base. We have therefore built our business plan around this approach, which we believe provides a pragmatic least regrets path to the whole system transition. Our relationship with TOs in this option is similar to status quo, but we will continue to enhance this relationship looking for opportunities to release consumer value in a changing energy landscape.
- **Extend the ESO role into distribution system operation:** whilst there is some industry support for extending the ESO role into active management of distribution networks the costs of this level of industry reform would be higher and the potential benefits would be unclear at this stage of the energy transformation. We have not progressed this option further.

Our proposed transformational activities and supporting costs benefit analysis are based on the preferred option. Our CBA measures the value of these activities against the status quo position. We do provide a further option in the area of 'whole system approach to accessing networks' relating to potential incentive opportunities, but this is not costed at this stage.

Central to the work we are currently doing is our collaboration with other network organisations in the Energy Network Association (ENA) Open Networks Project. A significant part of this work has considered a range of future industry arrangements referred to as 'Future Worlds'. Recognising the inherent uncertainty in these arrangements, we have listened to stakeholder feedback to this work and have built our plan around the ethos of the broadly supported world where the ESO works collaboratively with Distribution System Operators (DSOs) to make whole system decisions that deliver consumer value (similar to 'World B'). We believe that this is an appropriate way forward at this time because;

- Such a future is a natural evolution from current arrangements building on the ESO's relationships with both DNOs and also commercial entities across the whole electricity system.
- It is supported by the recently published independent assessment carried out by Baringa as a credible pathway for development through the RIIO-2 period and beyond.
- It has strong support across a wide cross-section of the industry.

Through the RIIO-2 period we believe that whole system considerations will develop more broadly than just the electricity sector and need to take a whole energy system view. This will be driven by emerging policy topics such as the decarbonisation of heat and transport. The ESO will need to bring its expertise and analysis to lead the debate

and help drive the overall energy transition that will support the UK's 2050 carbon reduction target.

Innovation

Where innovation funding during RIIO-T1 has contributed to the proposals in this chapter:

- Our ability to lead the debate is built upon data driven analysis, including data from innovation projects. One example is as 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 much more accurate forecasts, which we publish continuously enabling others to make more informed choices.
- Our work to develop the capability to operate a zero-carbon electricity system will use the learning from our Enhanced Frequency Capability and Control (EFCC[60]) and Power Potential[61] innovation projects, and potentially also our recently funded 'Distributed Restoration[62] innovation project.

10.6 Next steps

We will continue to develop the proposals in this chapter. In particular, we will further define how we intend to lead the debate through our analysis, insights and industry engagement.

We will also progress our thinking on the need for incentive mechanisms to more accurately assign the benefits and costs of outages, under our system access proposals. This includes developing a system access roadmap for distribution network issues. We will develop proposed performance metrics to accompany the outputs we deliver. Finally, we will work to better understand the links between the activities proposed in the operability area and those in other areas, including the apportioning of benefits.

[60] https://www.nationalgrideso.com/innovation/projects/enhanced-frequency-control-capability-efcc
[61] https://www.nationalgrideso.com/innovation/projects/power-potential
[62] https://www.nationalgrideso.com/project-black-start-from-der

PART 3: SETTING THE ESO UP FOR SUCCESS

11. Open data unlocking zero-carbon system operation and markets

11.1 Overview

Digitisation of the energy system is key for capturing the benefits of the low-carbon energy transition for consumers. Open data is the lifeblood of efficient markets and plays a crucial role enabling innovation. Stakeholders across all sectors have consistently given us strong messages that we need to share our data to support better functioning energy markets.

The ESO portal will provide a single point of contact for all ESO data and services including the markets platform and the Connections Portal. It sits at the heart of our vision for digital enablement across all our themes.

This section sets out how we will facilitate new and efficient markets and zero-carbon system operation by transforming the data we make available. Users of the data will be able to derive value from it and drive value for consumers.

We will provide a single point of contact for all ESO data and services. At its heart, will sit a single interface for our core market and operational information that can be easily accessed and interrogated with industry-standard application programming interfaces.

To maximise its value and respond to our stakeholders, our default approach will be that all the data we hold should be presumed open unless subject to commercial, legal, network or cyber security risks or restrictions.

As the number and diversity of market participants continues to increase and system operations move closer to real time, the data sources that we use to operate the system will also increase. Sharing accurate, timely and reliable data in the correct format is essential to ensure that our stakeholders have the information they need to make informed decisions.

To achieve this ambition, we will work with our stakeholders to deliver an ESO portal to share the data that we hold and provide a single point of access to our services and markets.

A joined up and consistent approach to data management across the industry will drive significant value for consumers. We will align our work on data transparency with the objectives of the BEIS Energy Data Taskforce and work closely with other relevant data sharing projects such as the Energy Networks Association Open Networks product on data sharing across transmission and distribution.

Our work on open data will support the development of industry-wide data management tools such as a data catalogue or digital system map.

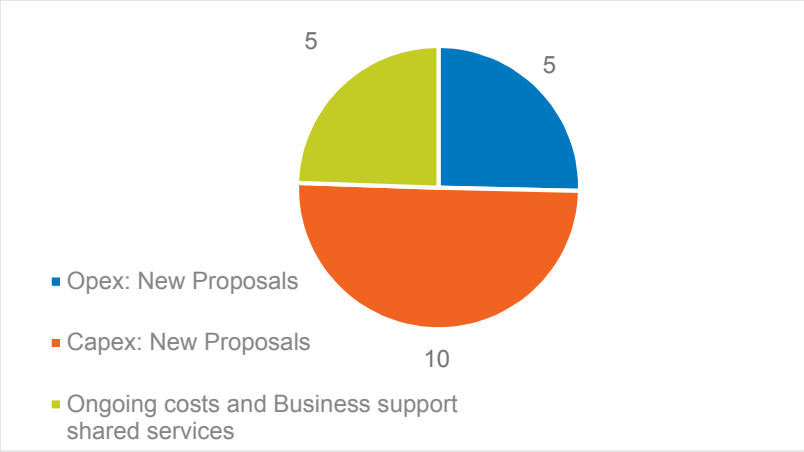

Figure 33: Current view of costs of open data, £m, (FY 2021-26)

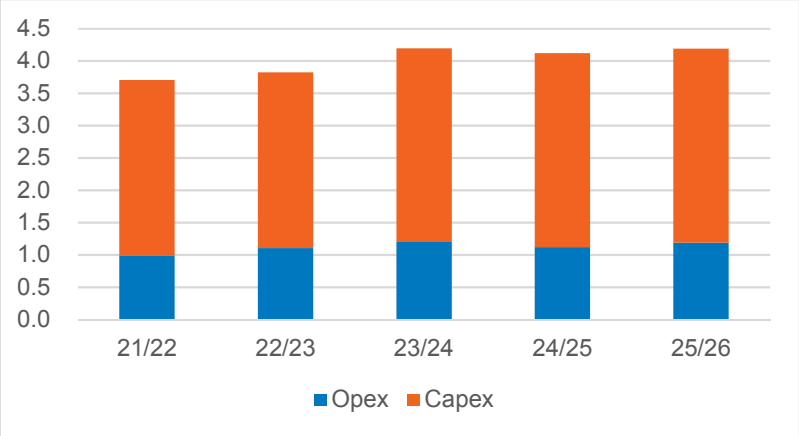

Figure 34: Current view of costs of open data, split by opex and capex, £m per year.

The cost of our proposals for RIIO-2 is £14 million over 5 years, therefore an annual benefit of £3 million represents a break-even outcome. We anticipate that the benefits of this activity will be significantly greater than this value.

11.2 Stakeholder views

A wide range of stakeholders including suppliers, generators, aggregators, and demand side service providers have clearly and consistently called on us to share all our data. However, there is a wider range of opinions on whether sharing data is sufficient.

The realisation of our ambition for open data will provide a foundation on which market participants and service providers can develop innovative service offerings for the ESO and the market that will generate additional and unforeseen value.

The vast majority of stakeholders agree that sharing as much raw data as possible in a format easily interpreted by computers 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.

Whilst many respondents would also like to have the more advanced functionality, such as advanced analysis 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 and that by providing advanced analytics and insight we may be squeezing out potential innovation that other parties may deliver better than us. All the stakeholder views captured have informed our preferred option.

There is a very wide range and huge volume of operational and commercial data that the ESO holds and may be able to share. However, there is significant effort in conducting the necessary preparation work including system interfaces, risk assessment, analysis and presentation to ensure it is fit for sharing with the market.

We therefore need to prioritise which datasets we share first. Stakeholders told us that forward-looking view of system requirements; whole electricity system view of constraints; transparency on control room decision-making processes; and real-time margins and utilisation were the priority datasets (in that order).

ESO data portal

To meet our stakeholders' current and future needs we must transform the way we process, store and share data.

The limitations of our existing IT infrastructure mean that our data is currently held across numerous operational systems, which were not designed to support the sharing of mass data.

Stakeholders have told us that the range of operational and market information we currently publish does not meet their needs and that they would like us to publish all our available operational and market data, both historical and forward-looking.

Where data is published, the disaggregated nature, format and structure often makes it difficult to reuse or manipulate. It is frequently also insufficient, difficult to locate, or in the wrong format, leading to inefficient use of our data and frustration for stakeholders. They would like 'one source of the truth', a one-stop-shop to access all the data that we publish.

Our Forward Plan commitments

In the 2019-21 ESO Forward Plan we have committed to transforming how we interact with the market by trialling different solutions for a data portal. We will use comparatively low levels of investment in Application Programming Interfaces (APIs) or similar solutions to make the data we share more accessible.

In this period, we will start to move the data that we share onto this portal, and we will share data and information for the first time, including insights on balancing decisions taken and constraint boundaries.

The pilot portal will focus on refining our understanding of the enduring solution. We will test new functionality on a number of datasets prioritised by market participants and we will seek stakeholder feedback to understand further what is valued. For example, we will collect data on how the portal is navigated and searched to refine how we structure and catalogue our data. We will also test new tools and features to understand how users want to interact with and consume our data.

RIIO-2

In RIIO-2 we will use the feedback from the pilot portal to support the implementation of our enduring solution to better meet stakeholders' needs. While this portal will perform a critical role in informing our enduring solution, our ESO portal solution for RIIO-2 will represent a step change from this in both the data made available and functionality.

Additionally, it will play an important role in providing a single point of access to key elements of digital enablement including the Market Platform and Connections Portal.

Facilitated by the implementation of a new underlying data architecture, our immediate focus in RIIO-2 will be to share as much of our data as possible in a machine-readable

format. All published datasets will be categorised, supporting navigation via a logical, and easy to understand, structure. We will add tags and metadata to support searching the data efficiently.

As we work through the data that we hold, we will continue to seek stakeholder feedback to make the highest priority data available first. We will publish a schedule for sharing our data on the ESO portal. This will give stakeholders a clear roadmap for when we will make datasets available.

Stakeholders have told us that the first datasets we should focus on in order of priority are forward-looking view of system requirements; whole electricity system view of constraints and real-time margins and utilisation. We will continue to listen and refine our view of the datasets that will drive the most value.

As well as sharing core ESO operational and market data, the ESO portal will be a tool for sharing the outputs of the enhanced data and modelling sharing with other organisations. This activity is outlined in Theme 4, A pathway for zero-carbon whole-system operability and beyond.

Where we are generating spatial data and digital network maps for our own internal operational analysis, we would also aim to openly share these value-added datasets as well as the underlying source data.

While we will adopt a 'presumed open' philosophy, we will be a champion for data security and data privacy. We will remain vigilant to potential misuse of data that might threaten the system or distort markets. We will implement a transparent process for assessing any restrictions on datasets according to published criteria including:

- **Consumer privacy –** (e.g. personally identifiable information not publicly available)
- **Security –** (e.g. the location of CNI assets/systems not otherwise generally visible directly or through other sources)
- **Commercially sensitive –** (e.g. Capacity Market Auction bid information, business plans)
- **Negative consumer impact –** (data that is likely to drive actions, intentional or otherwise, which will negatively impact consumers).

We will provide API functionality to allow our data to be integrated into third-party applications and to reduce the transactional costs of using our data. This approach will also facilitate third-party innovation, enabling academia and industry to develop new tools, products and insights to help drive the energy transition.

As part of our wider strategy to facilitate digital enablement with ESO markets and services, the ESO portal will support capabilities such as multi-platform interaction and mobile applications. Further information on our wider digital experience and communications platform can be found in the IT chapter of this Business Plan.

To help grow a shared understanding of our data and to support effective data utilisation, the portal will also allow consumers of our data to comment and ask questions on the data provided.

We will further develop our service offering by providing analysis and insight to support a wide range of stakeholders to understand and use the data that we provide. Our stakeholders have identified transparency of control room decision-making processes as a key area that they would like to better understand. We will explain how control room decisions were made, referencing the relevant data.

The volume of data we will be managing and the interaction with data consumers will increase significantly from our work in RIIO T-1 and will need the support of 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. This view is informed by experiences of organisations that have embarked on similar transformations such as the Office for National Statistics[63].

Achieving the outputs our stakeholders want in this area will require wholesale changes to our IT infrastructure. This will allow us to transform both the range and volume of information that we share as well as the usability and accessibility of that data.

We will need to replace our internal data management systems with a new data platform that pulls together data from a variety of critical national infrastructure (CNI) and non-CNI sources.

Our new underlying data management capability will be designed to be extensible and scalable and will integrate with the ESO portal, which will enable rapid and scalable publication of ESO operational data.

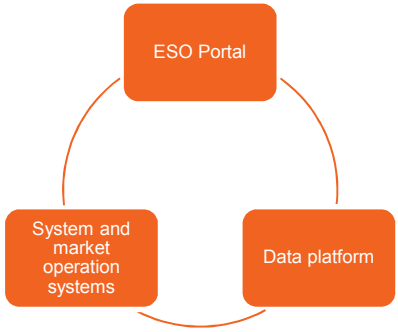

Figure 35: IT Infrastructure relationship

[63] https://www.statisticsauthority.gov.uk/wp-content/uploads/2017/10/6.3908_SA_Better-Statistics-Better-Decisions-A5-Booklet_FINAL_WEB.pdf

Delivery overview

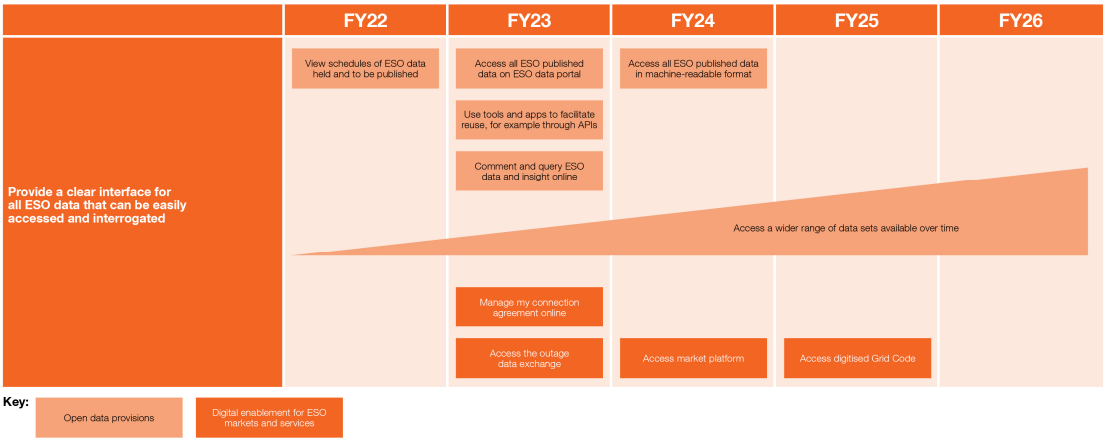

Figure 36: Timeline for ESO data accessibility[64]

11.3 Rationale

As noted in Theme 1, with the changing energy mix, system operation is becoming ever more challenging. In the 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 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.

This will lead to investments in the kinds of services that society needs, meaning that those services will be there when consumers need them. This information also supports the optimisation of operational and commercial decisions in market timescales, driving market efficiency.

The benefits of improved decision-making across timescales will lead to lower consumer bills. By providing greater clarity on our current and future needs we will promote greater self-balancing, reducing the need for the system operator to take actions.

It will also mean that the services we do require will be procured from more efficient solutions. This will directly drive lower BSUoS bills than would otherwise be the case.

In addition, the decisions that will be informed by our enhanced data and insight provision will also influence investment in assets that will participate in wholesale and capacity markets, also driving more efficient costs in those markets.

Finally, by enhancing the standard of the data we provide and the channels through which it is consumed we will lower transactional costs for stakeholders. Our portal will

[64] Please increase page zoom to 200% to view this clearly

support automation and provide data in a standard format which can remove the need for human interaction to retrieve our data. Similarly, costs of doing business with the ESO will be reduced through the single interface provided by the ESO portal for ESO markets and services.

11.4 Case studies & research

McKinsey Global Institute

Research by the McKinsey Global Institute[65] suggests that open data can help create $3 trillion a year of value in seven areas of the global economy, with the potential to add $340 billion to $580 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.

As examples of potential efficiencies, transforming our data into a machine-readable format and making the right tools available to consume our data, can remove significant transactional costs for our stakeholders associated with locating, understanding, manipulating and ingesting our data

Transport for London (TfL)[66]

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 significant economic benefit and savings.

There are many similarities in the transformation undertaken by TfL and our ambition for open data. This provides confidence around our estimates of the value attributable and further demonstrates the potential value captured in the breakeven analysis below.

Office for National Statistics[67]

The UK Statistics authority is currently undertaking a digital and technology transformation, which 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 annum over a 5-year period. While this activity is not directly comparable with the data transformation we are undertaking, there are many

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[65] https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/open-data-unlocking-innovation-and-performance-with-liquid-information
[66] http://content.tfl.gov.uk/deloitte-report-tfl-open-data.pdf
[67] https://www.statisticsauthority.gov.uk/wp-content/uploads/2017/10/6.3908_SA_Better-Statistics-Better-Decisions-A5-Booklet_FINAL_WEB.pdf

similarities. The resource required to achieve this activity provides additional context to support the measurement of our proposals.

11.5 Breakeven analysis

Based on the low end of the potential benefit range for the electricity sector ($340 billion) in the research by the McKinsey Global Institute[68] and the current per cent of the global GDP for the UK (3.5 per cent[69]), it could be considered that there is potential to unlock ~£9.1 billion of value annually[70] through the provision of open data in the UK.

As one of the main custodians of electricity data in GB, it is reasonable to assume that based on these findings, by publishing as much of our data as possible in a digestible format, we could unlock a meaningful proportion of this benefit.

As the total costs for this transformational activity are £14 million over the 5-year RIIO-2 period, we would only need to achieve an annual benefit of less than 0.04% of the potential £9.1 billion benefit to breakeven, which is £3.2 million per year.

We believe the benefits that will be delivered by this activity are significantly larger than this value.

Our expectations are that, as we see an increase in adoption of the new functionality and the volume of data we share throughout the RIIO period, we expect the amount of benefit derived from open data to also increase proportionately.

Benefit will also build throughout the period as the data and insight that we provide is used to support previously unimagined innovative solutions to the ESO and the market.

Enabling benefits across ESO markets and services

As noted above, the data delivered through the portal as well as the underlying capability provided will provide significant consumer benefit across other areas of our Business Plan such as market participation and customer connections. These benefits are captured elsewhere in our proposals.

By providing historical and future market data and a user-friendly gateway to the market platform and the digital grid code, the ESO data portal is a key enabler of the significant benefits captured in Theme 2.

The interface functionality delivered through the ESO data portal is also a driver of benefit realised under the customer connections portal and the outage data exchange.

The benefits of the preferred option are outlined in a qualitative way in the table below:

Benefit	Description
Improved safety and reliability	• enhanced transparency through access to operational and commercial data will help to attract new sources of flexibility to the balancing markets, ensuring we

[68] https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/open-data-unlocking-innovation-and-performance-with-liquid-information
[69] https://www.imf.org/external/datamapper/NGDP_RPCH@WEO/OEMDC/ADVEC/WEOWORLD
[70] Using FX rate of £1 = $1.3

	have the tools to operate a secure and reliable system.
Improved quality of service	• our data platform will transform the user experience of accessing our data by making all our data published machine readable and available in one place with the tools and functionality required for efficient consumption. • intuitive structuring and a comprehensive search functionality will also make the enhanced datasets more user friendly
Lower bills than would otherwise be the case	• enhanced transparency through access to operational and commercial data will support efficient investment decision-making across balancing, wholesale and capacity markets. • innovation facilitated by the availability and quality of our data could lead to the emergence of new markets and further drive competition. • transactional costs with accessing our data will be lowered through automated consumption of our data.
Reduced environmental damage	• through supporting enhanced understanding of system and market dynamics, open data can enable non-traditional energy sources, such as renewables, to refine their capabilities and offer operability solutions to the ESO.

11.6 Options considered

We considered three options for enhancing data and transparency:

1. **Provision of data only:** With this option, we would develop a simple data portal to provide access to as much of our raw data as possible. This option has minimal functionality and therefore the lowest investment and people costs.

   Data would be shared at a slower rate and would be managed by existing resources. Not all data will be machine-readable and API functionality would not be supported. A strong stakeholder consensus is that this is expected as a bare minimum and some have told us that this is sufficient.

   However, many stakeholders have told us that while we should focus on this capability first, it doesn't fully meet their needs and there is risk that data is misinterpreted or meaningless.

2. **Preferred option - provision of machine-readable data, tools, functionality and insight:** With this option, data will be machine-readable wherever possible. All published datasets will be categorised and navigated to via a logical and easy to understand structure, and we will add tags/metadata to support efficient searching of our data.

   We will provide focused insight on the datasets of most interest to our stakeholders and we will have the facility to interact with consumers of our data around the datasets they are interested in.

We will provide API functionality to allow our data to be integrated into third-party applications. This option will also provide multi-platform interaction and mobile functionality supporting the other proposals reliant on this technology.

It is considered an important addition to simply sharing raw data as it allows stakeholders to better interpret the data that we are sharing, adding value to it and reducing risk of misinterpretation and misuse. This option meets the requirements of the majority of our stakeholders and is our preferred option.

3. **Data and advanced functionality:** This option delivers all the content and functionality of option 2 but significantly enhances the level of service. This could include enhanced analysis, such as sentiment analysis and enhanced interactivity, such as webchat.

   In this option, we would also consider making our calculation engines available through the portal for third parties to recreate our calculations using their own inputs. This would allow them to run analysis using their own inputs and to conduct their own stress testing and scenario analysis.

   While many stakeholders have shown an interest in this functionality, this is often caveated with the fact that it is 'nice to have' and that we should focus on options 1 and 2. Others have told us that we should not over-stretch as we are not best placed to do this and may stifle innovation by crowding out other parties.

11.7 Next steps

We will continue to work with stakeholders to refine our proposals and understand the costs of our proposed open data outputs and the benefits they deliver across all our RIIO-2 themes. In particular, we will focus on our ESO portal functionality and delivery approach through engaging with other organisations that have been on similar open data transformations. We will also further develop our delivery plan for which datasets we will target for delivery and when.

12. IT strategy

This chapter establishes why technology is inseparable from our ambition and that our information technology (IT) strategy is deeply embedded within our organisational strategy.

It shows 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.

12.1 Introduction

Our ambitions are underpinned by IT infrastructure. As a technology and service-delivery company at the heart of the energy industry, we invest in, and maintain, critical IT infrastructure for Great Britain's economy. We continue to innovate both to anticipate, and respond to, new demands on technology as decarbonisation, decentralisation and digitisation drive significant change across the energy sector.

In this business plan, our current view of IT investment specific to the ESO (as set out in the preceding chapters) is £460 million over five years.

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 ensure the lights stay on around the clock. These systems analyse up to 40 million data points a day across Great Britain's transmission grid. One example is that 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 by instructing balancing services to provide power via 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.

12.2 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 have received feedback that a greater level of technological integration is required.

12.2.1 Feedback from Arenko Group, 'The Voice of the Customer' – IS Change Forum April 2019

Arenko Group[71] is building an energy-storage portfolio aimed at easing the increasing impact of intermittent renewable energy generation. Its Chief Development Officer spoke at our IS Change Forum in April 2019 about the technical challenges the company is facing in this changing marketplace.

The feedback focused on the need for our systems to move from human-interaction speeds to a level of maturity where control room updates can be submitted as fast as customer systems can process information (milliseconds) – and where we provide just enough detail to allow for dispatch to be automated. Arenko Group is finding that there are opportunities to make the market more dynamic, competitive, and accessible by utilising technologies that are already well proven in other sectors.

> "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

This feedback echoes our own ambition to leverage new technologies and methodologies to transform traditional models of doing business within the energy sector. Utilities are in the early stages of digitisation and leaders are moving to capture meaningful value faster. Digital will become 'table stakes[72]' in that it is foundational to participation in the marketplace.

[71] https://arenko.group/
[72] Minimum entry level requirement to enter a market or business arrangement.

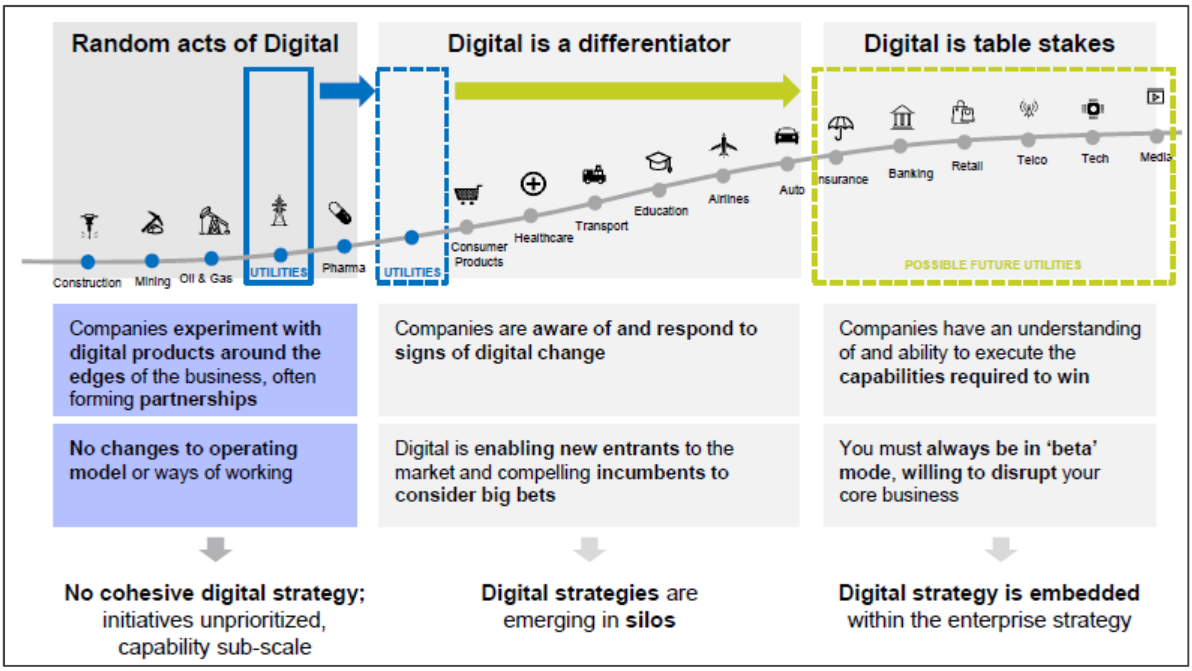

Figure 37: The progression of digital maturity

To achieve our digital ambitions, we need to think beyond the simple 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 important
Governance	▪ A new governance model is required to move from 'thousand flowers' / **random points of digital** to strict prioritisation of digital applications that hold a clear value case; teams held to account on capturing that value
Capability	▪ **Digital is often described as a "people problem"** – it is critical to hire / bring together / train enough of the right digital capabilities, and pair them up with the right business expertise into dedicated scrum teams ▪ Digital capability will only **increasingly be a core capability for the organisation over time**, we need to start advancing our capability now
Op model	▪ Of the 30 organisations surveyed, all target meaningful value from digital through **concentrated capability into 'Digital Hubs'** ▪ **Digital hubs** serve to bring the right capabilities together, with a common purpose, to deliver at pace
Culture	▪ Culture typically becomes the **biggest challenge** in successful execution of a **digital transformation** ▪ Key to overcoming the culture challenge is leadership support, and **promoting leaders in the organisation who are change drivers**
IT stack	▪ **Digital use-cases** are often underpinned by high-quality and easily accessible data, and efficient core IT platforms ▪ Therefore a critical focus from the outset needs to be **on investing in foundational data** where it might hinder success of Digital

Figure 38: The enablers that make a digital approach successful

We explore this further in the section 'how we will support the transformation'.

12.3 IT underpinning our ambition

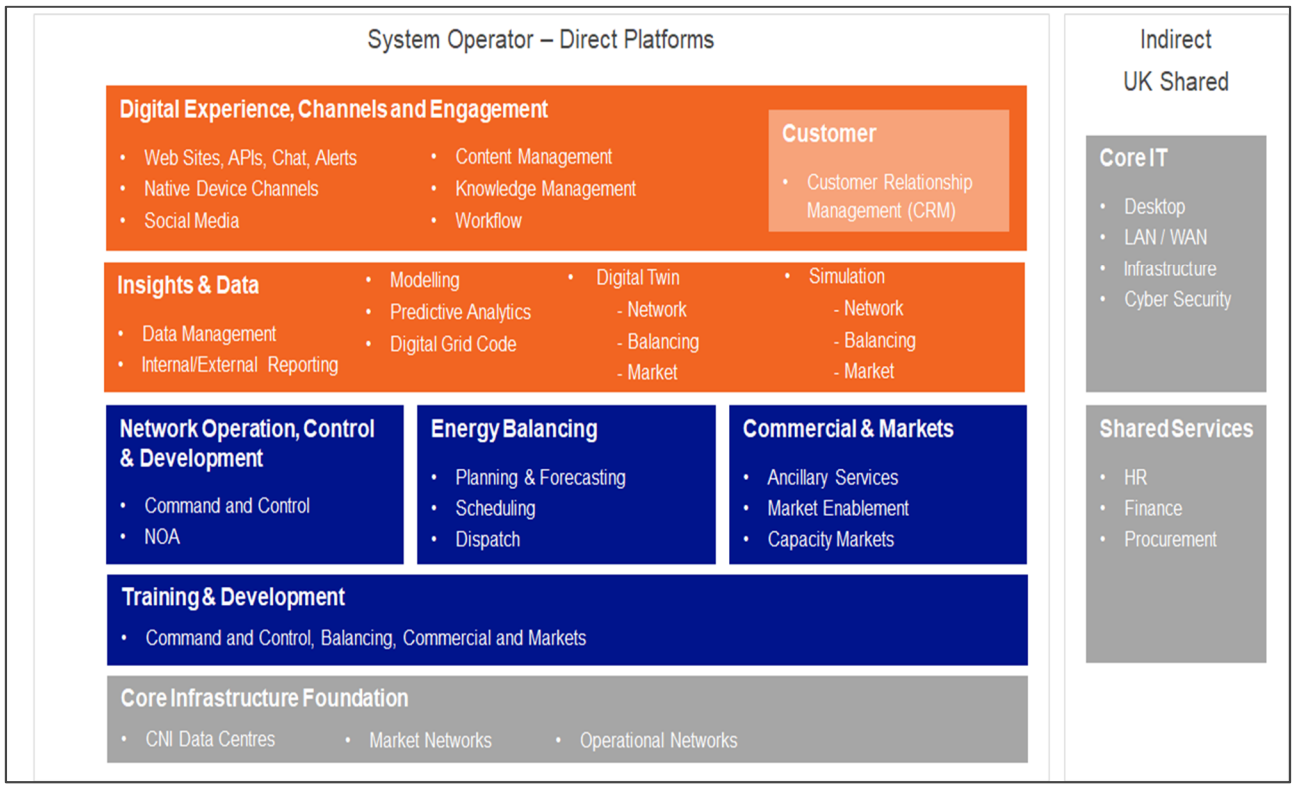

Figure 39: The target ESO landscape

12.3.1 ESO target landscape

Our application landscape has been developed over time to ensure the safe, reliable operation of a traditional generation and demand model for electricity. This involved the adoption of proven IT package solutions to enable the management and operation of the electricity grid.

As changing demands on the generation landscape accelerated, additional application solutions were implemented, 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 vison, this led to the creation of capability and data in silos. These solutions are efficient in their own right and addressed internal and external needs. However, this approach created elements of inefficiency and duplication of capability.

As the electricity environment changes, if we continued to evolve our IT solutions in the same manner, our costs and delivery timescales would increase exponentially as the complexity and maintenance of siloed solutions grows.

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, where we switch away from specific applications per capability to a platform-based architecture that can support multiple capabilities.

As an example, across the ESO IT landscape there are multiple applications for modelling different generation types and multiple applications for analysis and reporting. They use different sets of data across the process timeframe, which can be consolidated onto common platforms utilising a consistent set of data.

Our approach will be to consolidate these multiple applications and capabilities onto enterprise platforms. Enabling these platforms will lay the foundations that move us away from tightly coupled point solutions.

A platform approach will change our solutions 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 a multi-tier platform approach, comprising a digital engagement platform, data platform, integration platform, and engineering services platform. These will be the enablers for implementing the technologies required to achieve the ambitions of all parts of the business. For example, unlocking the value of the data we hold by exposing more of it in more consumable ways that respond to the needs of the industry.

Within our platforms, we will embed modelling, simulation and artificial intelligence technologies. They will enable control room and operational teams to make decisions faster and across a wider range of variables. Simulation approaches and the use of artificial intelligence tools will enable us to gain greater understanding of how market services and market code changes can facilitate improvement to wider energy markets.

The platforms will be designed to be extensible and scalable, using cloud data centre and other capabilities to facilitate rapid provisioning, growth and demand response. They will also consider both Critical National Infrastructure (CNI) and non-CNI needs.

In parallel to building and transitioning to the tools and capabilities 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, and the transition of new capabilities into our existing core balancing system landscape to manage the rapidly evolving electricity market.

Our first step will be to identify a reference architecture. One that supports the co-existence of bespoke component development and the adoption of off-the-shelf package components. It will need to provide the flexibility to deliver increased levels of change, while incurring less time and cost than before, so we deliver value. To achieve this, we will look to design, build and deploy modular, component-based architecture models and solution designs. They will enable change delivery via configuration, isolate change impact to component boundaries, and facilitate simplified introduction of new components.

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 an architecture that enables a digital-twin concept. This will see us model, simulate, build, deploy and operate new capabilities and functions as we introduce them. It will enable us to carry out virtual ‘what if’ scenarios and test the implications of changes such as distributed generation deployment or electric vehicle (EV) driven demand growth. This will allow us to better determine the impact of emerging technologies across our operations, while enabling a faster feedback loop from internal and external stakeholders as we shape new capabilities and functions.

12.3.2 Platform architecture

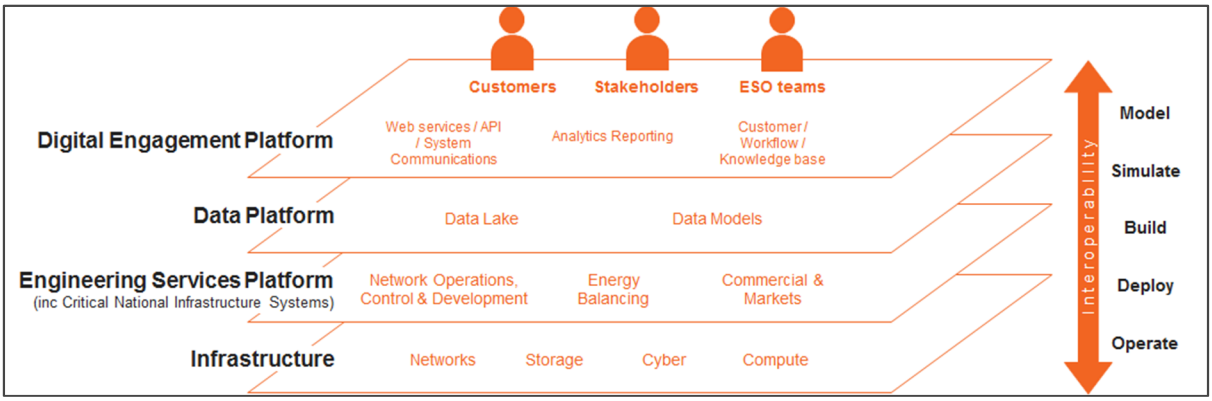

Figure 40: The platform architecture

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).

Vertical business capabilities[73] will be created, or services enabled using these platforms that facilitate change via configuration. Where required, we will supplement this platform with bespoke components. As we migrate data sets into the data platform, we will build from machine learning and artificial intelligence capabilities. The data utilised to drive these technologies will then be available for use by not just our internal teams, but external stakeholders and customers.

Our method of 'model, simulate, build, deploy, operate' will enable us to reduce our requirements and analysis lifecycles. We will build from concept to prototype to solution faster, while the transition to deployment and operation will be driven by business need. Existing legacy IT constraints and blockers will be removed.

12.3.3 Digital experience and communication platform

Most of the platforms are described in the relevant role chapters within this document. However, digital experience and communications applies across all roles and is therefore described here.

Within this capability, our investment centres on technologies that support digital-market engagement. A range of approaches is required, from enhanced publication of raw data, through to publication of analysis and insights. Ease of access and user experience are key to its success.

We propose to create an external data portal, which will provide a single point of contact into the ESO systems and external-facing processes. It will also offer secure, open access to data, compliant with data classification policies and standards. It will

[73] Refers to the core business services that we perform and offer out to our stakeholders. For example, balancing services. Our business capabilities such as data and analytics, run along horizontal technology platforms. A vertical business capability dissects through the horizontal platforms to help configure technology accordingly instead of having segmented process changes.

consolidate the existing ESO data publication and reporting channels. The portal will provide a range of methods for stakeholders to access our data, including multi-device capability and provision of industry-standard application programming interfaces (APIs). We will also provide simple insights for stakeholders to help enable their business models assessment.

Data access and submission is expected to increase for our critical and supporting processes. This will result in a corresponding increase in data sources, volumes and frequency of updates. Enabling this increase in stakeholder engagement – incorporating smaller Great Britain and European market participants, and distribution network operators (DNOs) and distribution system operators (DSOs) – while ensuring quality and security of data, will require a strong investment across the RIIO-2 period.

The data portal will be integrated with our customer relationship management (CRM) and operational systems. It will be supported by a range of tools that ensure data quality, and provide search and knowledge-management capabilities. With the large increase in participation and data, investment will also be required to provide improved and more responsive access management, and to enforce publication policy.

The portal will provide the foundation for investments in other areas. For example, the markets platform, connections portal and digitised grid code management, in order to provide a common engagement experience for stakeholders.

New tools will be used to support document management, collaboration, digital rights management, version management and workflow planning. This will provide greater clarity on areas such as the progress and status of code modifications and connection contracts.

The level of investment in this area is explained by the need to apply data consolidation technologies that ensure a single source of truth when giving data to our stakeholders. This same investment will ensure all external processes can be driven and updated from this single platform, connecting seamlessly to our internal critical systems.

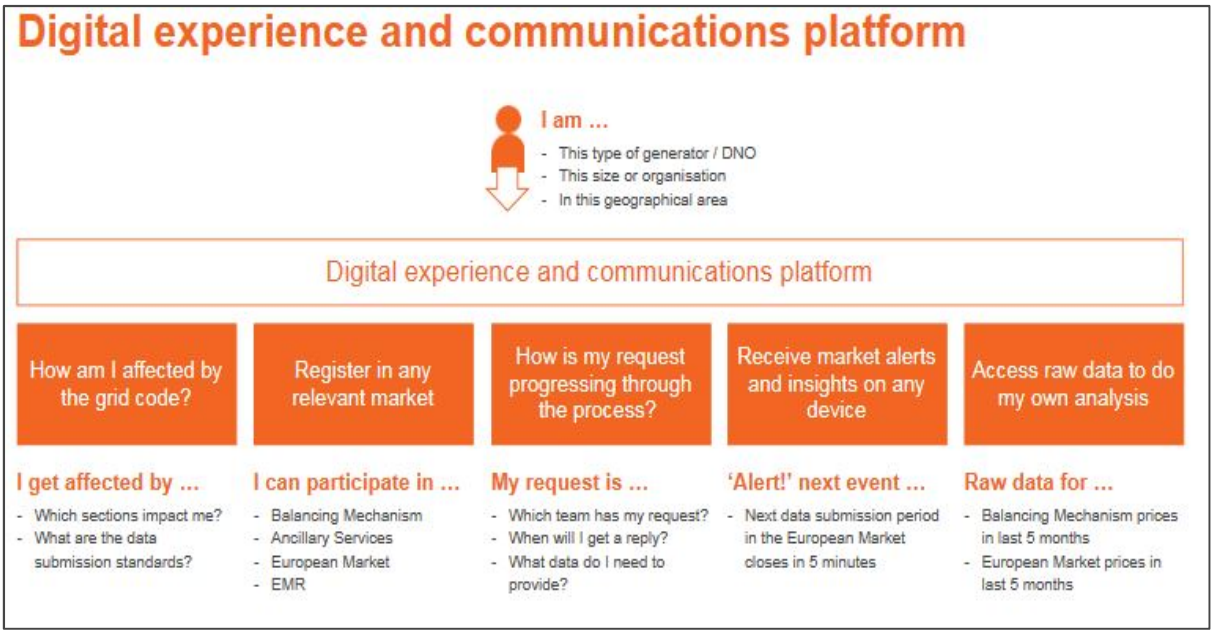

Figure 41: The scale of our ambition in this area

12.4 World-class cyber security

The cyber-security threats faced in our CNI and ESO environments are becoming increasingly sophisticated and prevalent. New business activities, such as the planned expansion of the UK 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. 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. Our goals include:

- ensuring resilience of the electricity network against cyber threats and keeping it functional even in the event of an attempted cyber-security attack
- taking prudent and proportionate measures to protect our systems and mitigate threats, balancing risk with cost, and re-using existing security capability where possible
- maintaining a comprehensive view of IT asset health, so that remediation activities can be prioritised according to risk, impact and criticality
- enabling secure delivery of new and emerging technology to ensure the level of security capability remains commensurate with an acceptable level of risk
- maintaining ongoing compliance with physical and cyber-security regulatory mandates.

We will focus on defence-in-depth architectures and security controls to prevent unauthorised access to, or compromise of, our critical environments. Embedded use of threat intelligence, and the adoption of the National Institute of Standards and Technology Cyber Security Framework (NIST CSF), will address key risk areas across the organisation.

This includes continuously monitoring our threat landscape, routinely testing our defences and delivering a new cyber capability to identify, detect, protect, respond and recover from emerging threats. Threat intelligence – gathered through government and private interactions and enriched with internal threat data – will also play a pivotal role in ensuring we generate actionable information that can be used to improve the security of our infrastructure and assets.

Our continued alignment with best practice and standards, as defined in the NIST CSF, allows us to identify and manage risk through a comprehensive range of security controls and measures. Constant engagement with UK National Cyber Security Centre (NCSC) and the Department for Business, Energy and Industrial Strategy (BEIS) will be central to the protection of our systems.

These capabilities will also need to align with new regulations, such as the EU Directive on the security of network and information systems (NIS Directive). Engagement with agencies such as the NCSC and Centre for the Protection of National Infrastructure (CPNI) will be vital in identifying the most effective and efficient way to meet them.

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.

Effective, sustainable cyber security will also require a company culture that fosters a cyber-aware workforce with the skills to identify and manage cyber risks within the business. This will be achieved through education, awareness training and use of industry expertise.

The successful implementation of these plans will result in many benefits. These include the mitigation of cyber-security risks to industry and UK government standards, agile and efficient response to changing internal and external threats, safeguarding of critical business services and data, improved reliability of digital infrastructure, and improved ability to demonstrate compliance with regulatory requirements.

Major, centralised investments in cyber security planned over the RIIO-2 period include:

- enhancing the foundations delivered in RIIO-T1 and building out our cyber capability
- identity management and controls that enhance our identity management for cloud applications
- security operations and controls that expand our existing capabilities, including 24/7 monitoring of the new capabilities and systems deployed in RIIO-2
- threat-resistant networks, which will continue to strengthen our segmentation and isolation capabilities within our enterprise networks
- secure endpoint solutions to enhance our capabilities in areas such as USB port scanning.

The costs in this document include our current view of cyber-security spending.

12.5 How we will support the transformation

12.5.1 IT stakeholder engagement – feedback

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.

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, stakeholders asked us to avoid ‘big bang’ IT projects as they often fail, both within the energy sector and elsewhere.

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 supported 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. We will follow up on these in the coming months.

12.5.2 Rethinking our IT operating model

ESO’s IT systems and services are delivered through the National Grid global IT organisation. This is undergoing a significant transformation to prepare itself for the demands of the future, both in terms of its capability and the methods and approaches it will use to deliver value to 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 delivered across our RIIO-T1 ambitions, we are transitioning towards a greater level of transformational change. These investments require a different IT operating model; one that enables the ESO to become a ‘digital’ organisation, while balancing risk, responsibilities and obligations to our customers and stakeholders.

The key features of this operating model are:

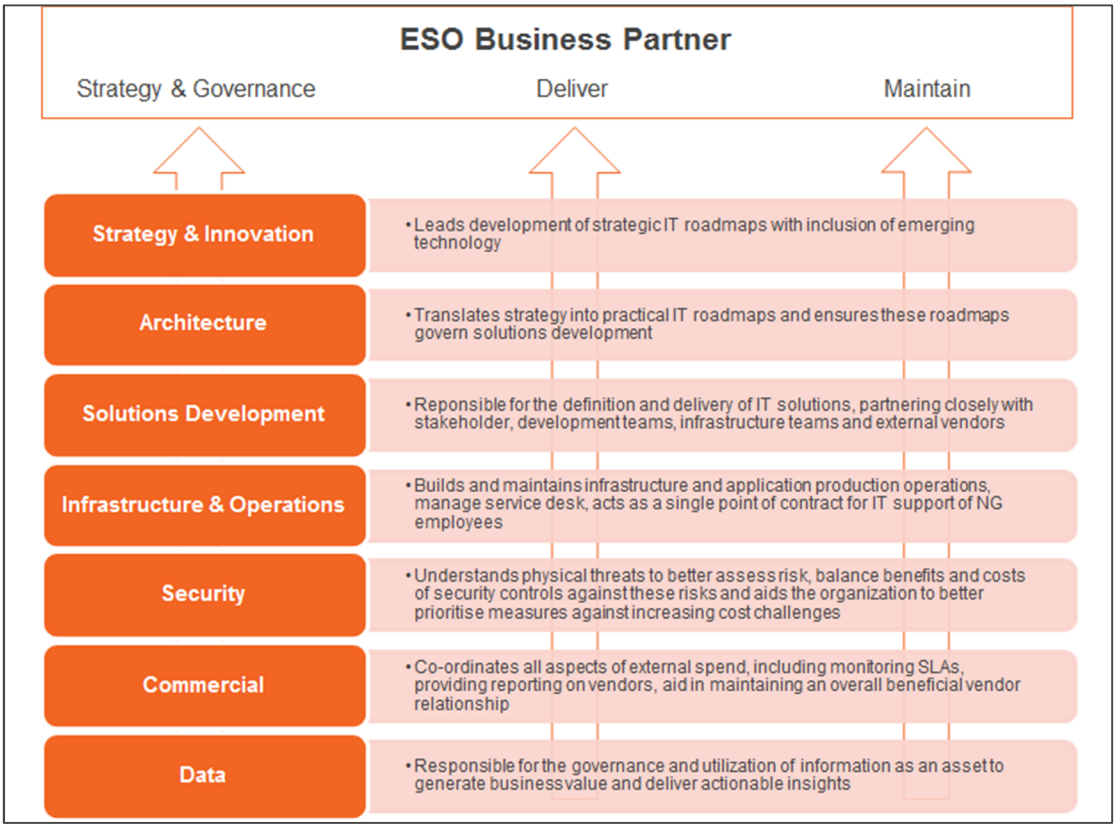

Figure 42: The key features of the operating model

12.5.3 Delivery approach

Our approach to delivery will involve the creation of a transformation programme that will link the ESO strategy and ambition with on-the-ground execution. This will provide alignment and transparency across the ESO business and delivery teams.

The programme will apply methods such as Agile, Scaled Agile Framework (SAFe), and Scrum to enable business value to be delivered faster, and with higher degrees of predictability and quality. To deliver the cadence of business change, the programme will take a platform-centric delivery approach. It will build cross-functional, in-house capability to create release teams that will enable continuous delivery and release solutions as required. This is particularly relevant for our market and regulatory reporting systems.

The programme will follow a three-stage approach, consisting of an enabling, transforming and sustaining phase:

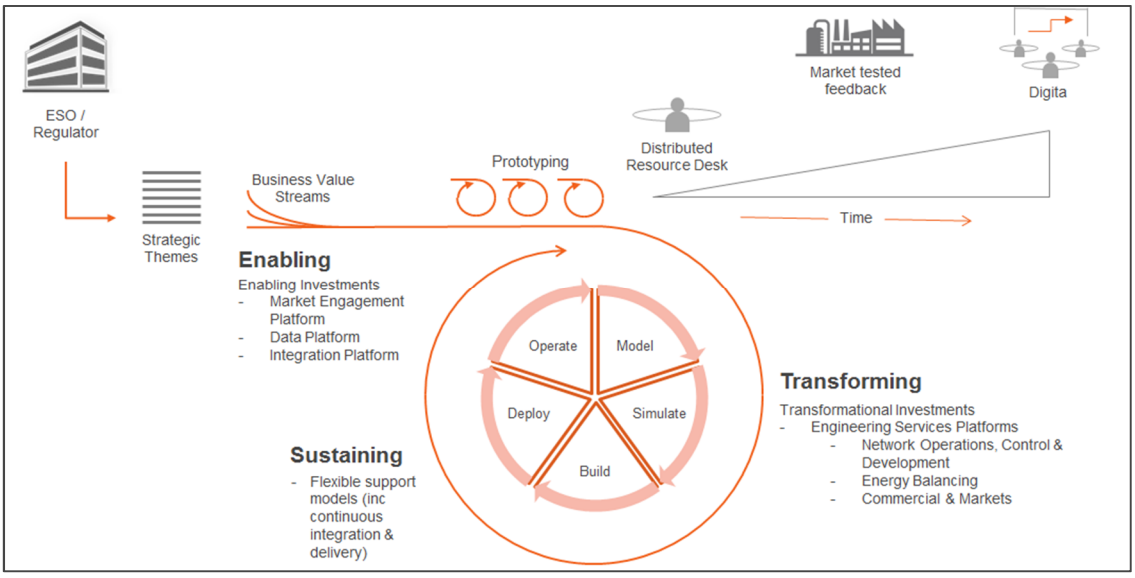

Figure 43: The transformation programme delivery approach

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 deliver significant growth and transformation, across our core energy balancing, network operations and control, and commercial platforms. We will use a bi-model approach to deliver these changes, so we 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. Early releases of new functionality will be trialled in beta to gain rapid feedback, allowing us to be more responsive in the development lifecycle. The introduction of an ESO design authority (see figure 42 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. Service providers, in particular, 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.

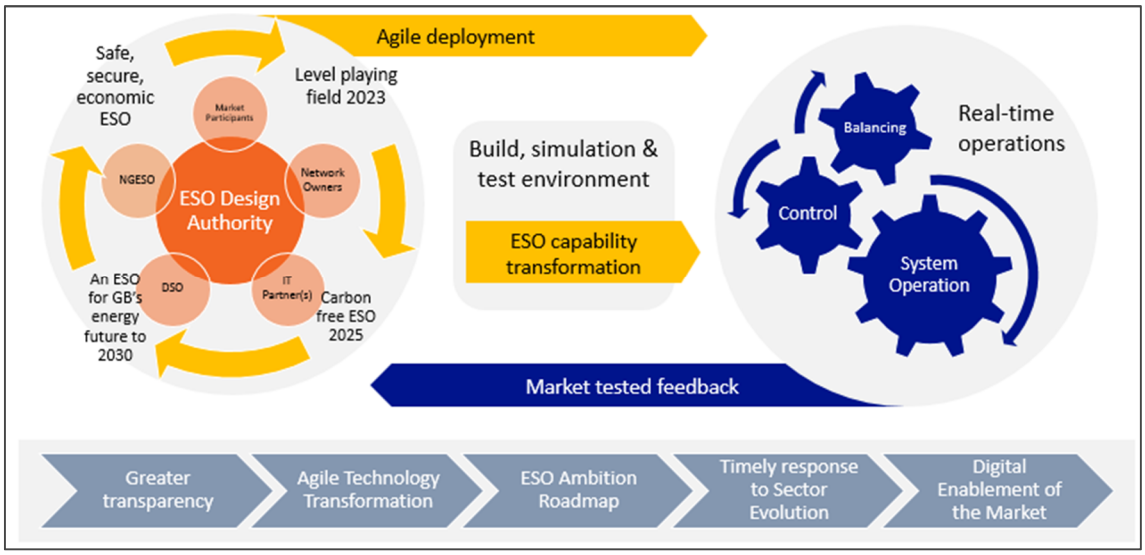

Figure 44: The relationship between engagement, development, operations and feedback

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.

12.5.4 Architecture approach

Currently, stakeholders access our applications on a point-by-point[74] 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.

[74] 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.

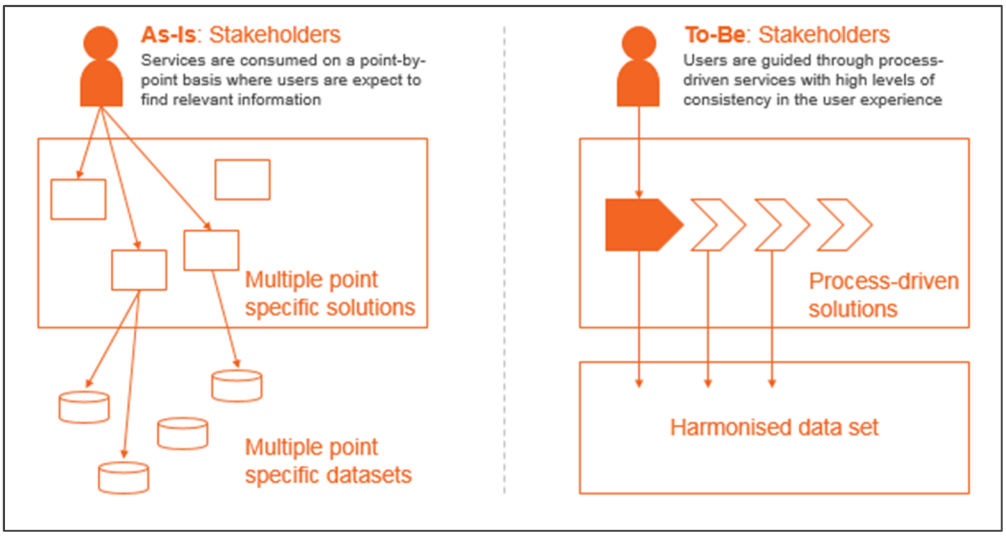

Figure 45: The as-is and to-be architectural approaches

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 would 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.

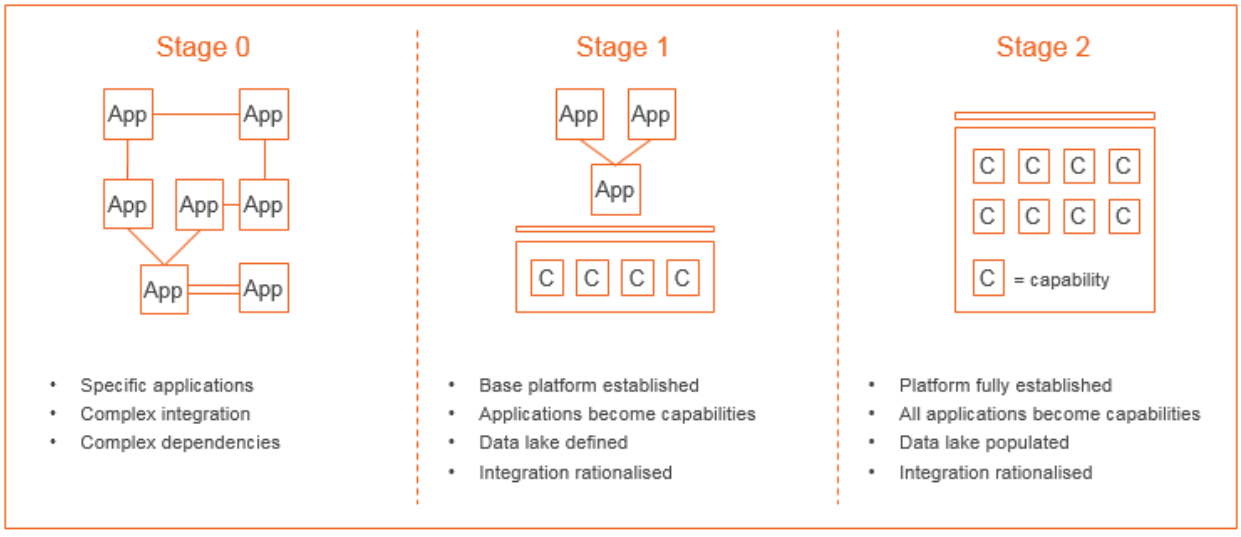

Figure 46: The approach to architectural transition

12.5.5 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:

> "None of us have had a good experience so far – what are you going to do differently?"
>
> **ESO service provider**, trade association meeting

- **Strategy and approach**: we will continue to engage with governing bodies, RIIO stakeholder groups, IS Change Forum, bilateral meetings and consultancies to ensure 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.

12.6 Investment analysis

Investments, and the associated benefits, are summarised by activity in each of the role chapters. The IT aspect of that investment is outlined below. It shows how the values have been calculated, gives an overview of costs, and shows how these investments compare to industry benchmarks.

12.6.1 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.

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.

12.6.2 Industry benchmarking of investments

12.6.2.1 Technology benchmarking

We have engaged Gartner, an industry-recognised technology benchmark organisation, to assess our approach and estimations. 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 individual line items. 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[75] of this part is typically very small.

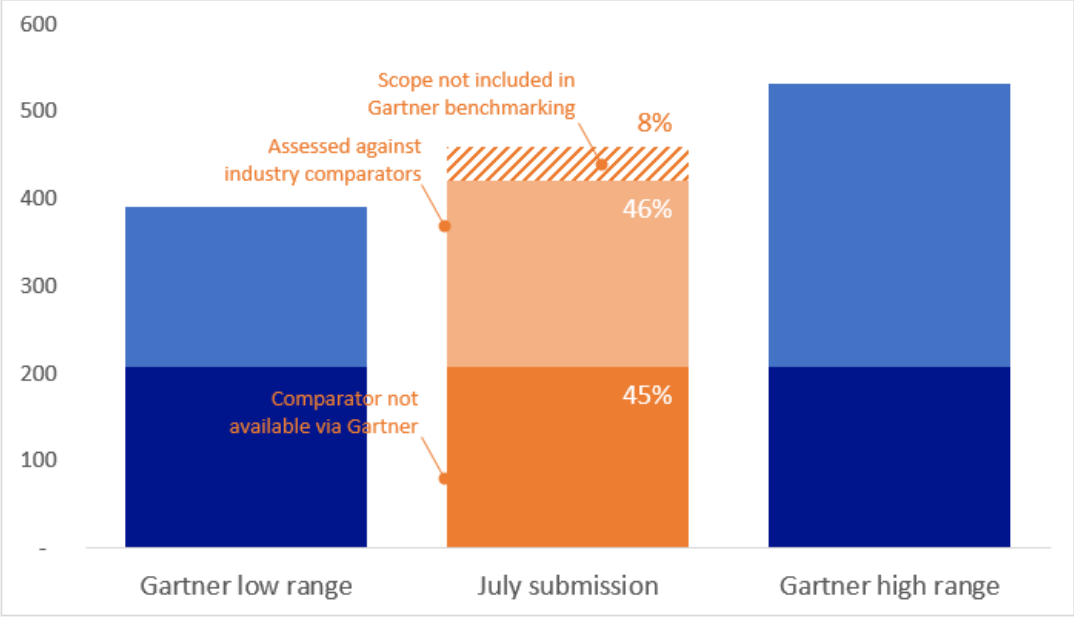

Figure 47: Total IT direct investments (£m) over the RIIO-2 period and the alignment between our investments and the adjusted Gartner benchmarking

[75] This is the difference between their estimates and what happens in reality.

Gartner can provide benchmarking for commodity systems that have multi-organisational uses. Within ESO, there are systems of differentiation that are not commoditised. These systems 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 45% of the investment value.

Where technologies are more commoditised, industry benchmarking was performed against 46% of the investment value. A further 8% of newly scoped items are in the process of being benchmarked.

Our IT costs are higher than those of comparably sized organisations. This is in line with our expectations, as we are unable to fully benefit from the economy of scale that other organisations can access. This is the case, because we are required to maintain separation of key systems that manage the electricity and gas transmission networks.

Gartner's more detailed analysis found that, after adjusting for levels of workload, our IT costs were in line with peers whilst 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 applications and end users. 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.

12.6.2.2 Application development and maintenance partners

Our application development and maintenance (ADAM) partners reviewed the required IT capabilities and provided outline estimates for implementation. These align to our July submission values.

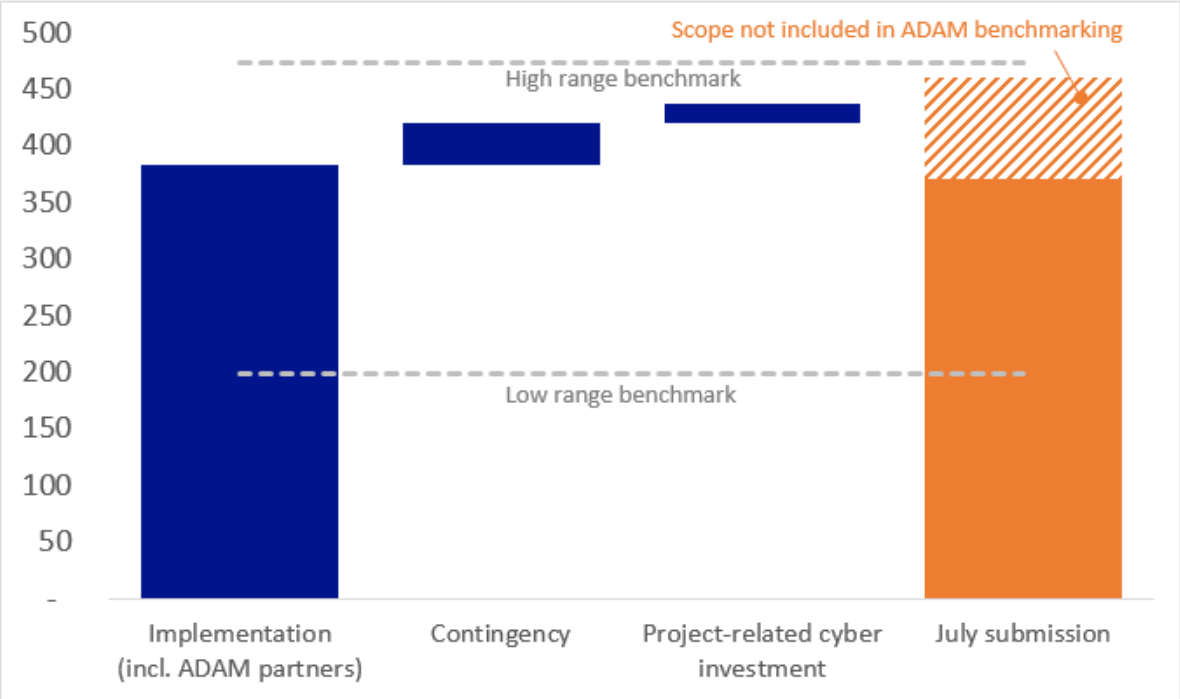

Figure 48: Total IT direct investments (£m) over the RIIO-2 period and the alignment between our investments and the ADAM partner benchmarking

To arrive at a comparable investment profile, we have considered the following.

Ranges in the above chart are driven by high and low estimates from suppliers, with the average forming the waterfall chart. In some instances, partners also provide contingency where items had higher levels of uncertainty.

Implementation – partner costs include development and technology expertise, while intellectual property roles (e.g. scoping, requirements, architecture, security, solution design, governance) would be retained within the ESO. These costs are based on a sample of comparable projects.

Cyber security has been highlighted separately due to its criticality. This is in addition to our core infrastructure investments shown in the shared business support services. The central investments allow us to inherit cyber compliance at a platform level and focus investment at an application level.

Scope not included in benchmarking – also included in the portfolio are regulatory and provisional items that were not included in benchmarking, due to the uncertain nature of their scope. Future levels of regulatory and market-driven change are difficult to predict or benchmark. Estimates have therefore been included in the portfolio based on recent historical trends. Provisional items are dependent on the outcome of innovation projects and are similarly difficult to predict or benchmark.

12.7 Next steps

We will continue to refine the scope of investments, revisit and challenge the benchmarking, and extend our delivery roadmap to look at the transition from RIIO-T1 to RIIO-2 and the timing of investments.

13. Innovation

Innovation plays a crucial role in helping us address the future challenges from a rapidly changing energy system. The trends of decarbonisation, decentralisation and digitisation are shaping the global energy landscape and presenting unique challenges for the ESO and wider industry. Following on from RIIO-T1 and our *2019-21 Forward Plan*, innovation continues to be at the core of our operating model. It is a key enabler for delivering our business plan and helping us take a lead role in making Great Britain's energy system future-ready.

We believe that innovating in the way we work, the services we provide, and the quality of our interactions will help enable the transformation to a sustainable energy system. It will also ensure delivery of reliable, affordable energy for all consumers. Innovation allows us to experiment and find viable, diverse new solutions to uncertain future challenges. And we get there faster and more cost-effectively than would otherwise be possible.

Within this chapter, we present our innovation approach and methodology, as well as areas where we will embed our learnings from RIIO-T1 and further innovate in RIIO-2.

13.1 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 new ways of working. This includes developing novel solutions to target specific medium-to-long-term problems, identifying new ways to unlock additional consumer benefit, and becoming better prepared for the future. We determine the scope in which innovation can be most effective using two criteria:

- **Time:** does the project deliver value within four to eight years? Innovation is not effective in delivering rapid solutions, as short timeframes do not provide enough time to properly test and assess new, higher-risk products and services.
-

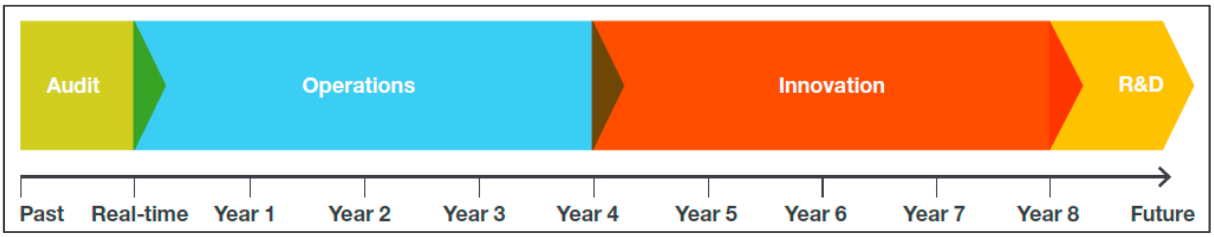

Figure 49: Innovation timeline

- **Maturity:** how well developed is the solution to the problem? We tend to tackle projects in later stages of research and development rather than very early-stage ideas. These are classified as R&D in the diagram above and are more than 8 years away from being implemented. They are usually solutions with a low-to-medium technology readiness level (TRL), with the aim of progressing towards an implementation-ready solution (i.e. high TRL). We prioritise more disruptive solutions that, if successful, could deliver step-change improvements and larger, system-wide benefits. These take priority over projects that only deliver small, incremental improvements in our day-to-day operations.

Through the RIIO-2 period, we will deliver a wider range of innovation projects covering late-stage research and development activities up to real-world trials and implementation-ready solutions. Examples of potential innovations are identified against some of the activities.

Our innovation pipeline is balanced between solutions that are already being progressed towards implementation and newer technologies or ways of working that are less proven, or higher-risk options. Our portfolio will have a balanced mix of research, development and demonstration projects, which we undertake in collaboration with partners (e.g. academics, consultants, manufacturers and network licensees). We will continue to innovate through a combination of activities included within the business plan and via ring-fenced innovation stimulus[76]. The latter will support delivery of projects that cannot be planned in advance, or which represent solutions unable to be reflected appropriately in our business plan (e.g. lower TRL, higher-risk activities). We expect there to be a flow of valuable outputs from innovation projects undertaken during RIIO-T1. These will allow us to better prepare roadmaps and the proposed activities included in our business plan for RIIO-2 (see examples in 'Realising benefits from innovation' below).

13.1.1 Innovation methodology

Our portfolio will continue to be driven by our three tried-and-true, fundamental pillars of innovation:

- **A robust and systematic innovation process.** This is designed to quickly and efficiently assess each project proposal. The process ensures consumer benefits are at the heart of our approval criteria, while keeping a rein on costs and ensuring we are aware of, and have a plan to mitigate, potential risks with each project. We will continue to fine tune the process to ensure we only select the most effective, innovative ways to unlock consumer benefits and address the anticipated challenges faced from the decarbonisation, decentralisation and digitisation of the Great Britain energy system.
- **A collaborative, open innovation approach.** This has been especially effective in exposing the ESO to the industry's latest solutions and technologies. We will continue to hold Open Innovation days, as well as other wide-scale calls for ideas and solutions. By doing so, we will take full advantage of today's vibrant start-up scene, as well as give everyone an opportunity to tackle some of Great Britain's most pressing energy challenges.
- **An annual refreshed *Innovation Strategy*.** By producing a strategy and refreshing this each year, we ensure that our innovation efforts remain relevant to the ESO's suite of activities and the wider system's challenges. All our innovation projects have a clear link to at least one of the priority challenges that must be addressed. Our top-down and bottom-up process to produce our innovation priorities (see diagram below) enables us to align with the major energy-system trends and our ambition as the ESO. Specific challenges are also identified from within the business areas. We will refresh our priorities each year to ensure we continue to focus on solving the highest priority challenges, while reflecting our latest understanding of these potential future issues. Our engagement with stakeholders enables us to test our *Innovation Strategy* and process each year. It allows for feedback that further sharpens our priorities and helps identify opportunities to collaborate further with stakeholders.

[76] This refers to dedicated funding for innovation.

	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 50: 2019/20 SO Innovation Strategy Priorities

13.1.2 Investing in innovation

In RIIO-2 we hope to continue employing a combination of different funding methods for innovation. These will include the current innovation stimulus Network Innovation Allowance (NIA), and competitive funding pot the Network Innovation Competition (NIC), wherever these are most appropriate and can cover innovation that we are unable to include in our business plan.

More than £11 million of NIA funding has been allocated to ESO innovation projects since 2013, and approximately £3.4 million of this within the last year alone (2018/19 financial year). These figures are the result of almost 40 different projects over six years, working with partners in both industry and academia. More than 80 per cent of this funding has been spent outside the ESO to research, develop and demonstrate novel solutions to benefit consumers and the wider energy system. These projects have improved our knowledge of challenges facing the future system and identified new challenges. They have helped us adjust our internal processes, improve the way we design markets, and feed new learnings into the forecasts and insights we produce for stakeholders.

We will also seek to access other forms of innovation funding during RIIO-2. This includes the Natural Environment Research Council (NERC), Innovate UK, Department for Business Energy and Industrial Strategy (BEIS) and other public competitions. This will help us increase the amount of innovation activities we are able to undertake and optimise the use of network innovation funding to deliver greater consumer benefits.

13.1.3 Realising benefits from innovation

As a system operator, we will track and monitor benefits from innovation projects to ensure maximum consumer benefit is being realised. We will develop and deploy a benefit tracking framework that will help us identify and monitor both financial and non-

financial benefits. This will include assessing expected reductions in consumer costs (e.g. lower BSUoS – charges on bills), environmental damage, and improvements in safety and reliability, service quality and know-how. The latter will inform how we could mitigate future energy challenges, or better understand these and de-risk potential solutions. Expected benefits will be quantified as much as possible during the project development phase – and monitored once the solution has been successfully implemented into business as usual (BAU).

Many of the benefits we have realised to-date are difficult to quantify. This is due to their indirect impact on costs, and because of the resources required to do this analysis afterwards. We do, however, understand the need to quantify benefits, where possible, and assess and benchmark our performance against other network licensees to ensure sufficient value is being realised for consumers.

As our criteria for innovation asserts that value is delivered within four to eight years, it is too soon to see clear results from most implemented solutions. Therefore, we continue to monitor project outputs to better forecast the expected value these will deliver. Many of the projects we have funded through NIA are lower TRL (e.g. later stage research) and will not be implemented into BAU in the traditional sense. However, they will improve our understanding, help us avoid unviable solutions, and identify the correct roadmaps for industry to take in order to address specific challenges on behalf of consumers. In this respect, value is gained from de-risking future work that the industry does, advancing the results being developed, and avoiding unnecessary costs of pursuing unviable solutions. Calculating the direct financial savings that would result for consumers may often be an onerous task, and beyond the scope and budget of the original innovation project itself. So, we believe a robust forecast of expected benefits could be a practical alternative in many instances.

We propose taking a more holistic approach to how we value and track consumer benefits. We will continue to ensure there is a clear benefits case for projects to be first approved and then monitor and reassess the cost-benefit analysis of the projects. Following an agile approach should enable us to demonstrate sufficient evidence to justify that consumer benefits will be delivered from an innovation project within our portfolio. Proposals that do not meet the minimum threshold for delivering consumer benefits won't be approved. Projects that no longer meet the criteria of the CBA will be closed early, thus avoiding unnecessary additional costs to consumers and redirecting remaining funds to more effective projects.

Some examples of innovation projects implemented into business as usual during RIIO-T1 include:

- **SIM – Samuel Inertia Element[77]:** the project tested the assumption that system inertia could be directly measured, as opposed to estimated, with the aim of reducing balancing costs associated with inaccuracies in the inertia estimation. The project verified its assumption with laboratory tests supported by a small set of real-time measurements. We are currently negotiating for real-time inertia monitoring to improve visibility of network inertia. This will help prepare the system for more distributed, intermittent renewable generation and reduce the likelihood of network faults.

[77] http://www.smarternetworks.org/project/NIA_NGET0192

- **Optimisation of Energy Forecasting[78]:** the project explored whether solar photovoltaic (PV) forecasting could be improved, using much larger data sets combined with deep learning and machine learning techniques. It was found that one approach to machine learning, called random forest, was very effective at reducing solar generation forecast error by as much as 10 per cent. Following completion of the project, our agile delivery team took the new output model, validated, tested and combined it with many other types of machine learning to create a multi-ensemble forecast. This resulted in solar forecast error being cut by more than 30 per cent. We believe this could help improve the way we plan for balancing actions due to the intermittency of solar PV generation in future – and reduce the cost for consumers.
- **Vector Shift Initial Performance Assessment[79]:** this project set out to explore and review Vector Shift settings used in Great Britain for protecting distribution-connected customers from loss of mains supply. It evaluated whether Vector Shift protection was more effective than the Rate of Change of Frequency (RoCoF) technique at detecting an islanding condition. The project concluded that Vector Shift was less effective than RoCoF. This 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 distributed generators. The savings estimated from these changes to protection settings are around £240 million net benefits by 2024, which will result in significantly lower bills for consumers.

13.1.4 Delivering projects effectively

Part of our targeted approach to innovation includes taking both a short-to-medium-term view and a longer-term view. We propose to continue with an innovation approach that enables us to critically select which projects are of highest importance for the coming year. We will also continue to work closely with our *Future Energy Scenarios (FES)* team and stakeholders to ensure longer-term strategic energy issues are reflected in our innovation strategy – and addressed through projects in the innovation portfolio.

We will continue to improve our processes by establishing a back-to-back approach. This is about ensuring there is sufficient capacity and budget available within the business to implement innovative solutions successfully, so we can be more effective in delivering consumer benefits.

Our close relationship with various parts of the business (for example, the business-partnering structure of the innovation team, which ensures a strategic link between projects and department objectives), means we can quickly establish if solutions are viable or not. It enables us to identify and assess options already in the market that could be applied to the ESO, and avoids duplication of existing work. Our iterative process for developing and approving new proposals is shown in the diagram below.

[78] http://www.smarternetworks.org/project/NIA_NGSO0001
[79] http://www.smarternetworks.org/project/NIA_NGET0205

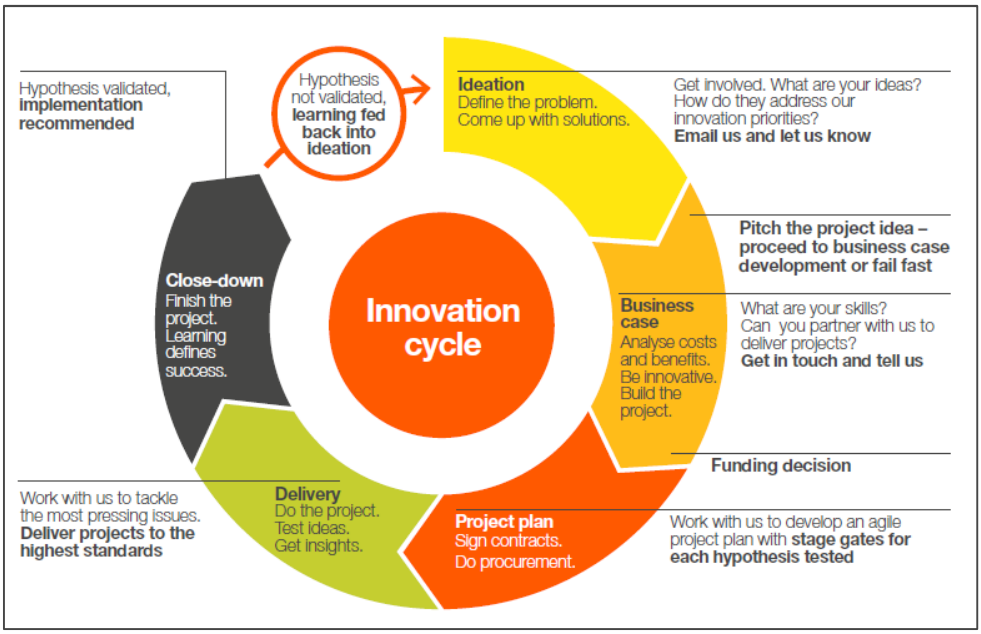

Figure 51: ESO Innovation cycle diagram

13.2 Building our innovation capability

Our innovation team will be further strengthened and structured to enable us to better plan for, and respond more effectively to, ad hoc opportunities using the funding mechanisms and to prioritise strategic challenges as they arise. Our preferred option is to retain a dedicated innovation team in RIIO-2 to keep our focus on an overarching system strategy. And then to further enhance our innovation capability across the ESO by embedding new innovation leads within business areas. These will act as focal points to ensure the spread of an innovation culture. They will source new ideas from subject matter experts and connect external ideas with subject matter experts within the ESO business. The embedded leads will also help with the deployment of innovative solutions into BAU.

ESO innovation team costs in RIIO-2, £m

RIIO-1 average	2021-22	2022-23	2023-24	2024-25	2025-26	Total
0.5	0.8	0.8	0.8	0.8	0.8	4

The central team will continue to govern funding, and thus the innovation process. It will have full ownership of the annual Innovation Strategy, and be responsible for the open innovation approach, as well as managing the portfolio in a cost-efficient way. This will allow us to continue having a top-down approach as a function. It will foster innovation within the ESO to enable others to innovate effectively, avoid excessive overheads on projects, and minimise both the possibility of vanity projects and the need to outsource innovation management to an external party. Having a central team also frees project teams from many of the administrative responsibilities necessary for running successful projects (e.g. contract negotiations, completing a cost-benefit analysis, regulatory reporting). This allows them, and innovators within our partner organisations, to use their time more effectively, focusing on only the most value-adding innovation tasks.

The central innovation team will act as a liaison between the ESO business (through the embedded innovation leads) and stakeholders, to source new project ideas, and ensure learnings are disseminated and successful solutions are implemented into the business. Projects will continue to be carefully planned, with steps taken to ensure outputs are effectively rolled out into BAU. This will include better coordination with our IT function to ensure sufficient resources are available for implementation. We will also ensure there is committed buy-in from the relevant teams and senior management to successfully realise the benefits from innovation projects.

13.2.1 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 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 includes 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.

13.2.2 Engaging and securing third-party participation

We will challenge and expand our own views on innovation and strategic priorities by increasing our engagement with stakeholders. This includes gathering feedback via webinars and workshops, participating in cross-industry forums and events, and holding bilateral meetings with small, medium and large enterprises across all sectors (e.g. transport, utilities, digital technology, environmental charities).

Our ambition is to fully embrace an open innovation approach and further accelerate innovation for the whole Great Britain system, not just the ESO. This will be achieved by leveraging our Open Innovation days to provide access to our subject matter experts for those seeking to develop their specific solutions, not only to address our challenges. By doing so, we will embrace our role at the heart of Great Britain's energy system and flex our full potential to create the system of tomorrow.

We will establish more Open Innovation days, where we invite external suppliers and stakeholders to discuss new project ideas. We will also extend our calls for new project bids to solve the priority challenges. All of this will give third parties more opportunity to work with ESO subject matter experts to develop innovation projects collaboratively. These activities will continue in parallel with internal innovation events that are designed to promote ideation and build a strong culture of innovation within the ESO. Third parties will be invited to join our internal events more often. This will ensure that proposed activities are most relevant to customers and stakeholders, and strengthen the potential for future collaboration opportunities.

We will work with other network organisations through the Energy Networks Association (ENA) and other external engagement opportunities. These include dissemination and collaboration opportunities, such as the ENA working groups, industry forums and the collaboration portal. Engaging in this way ensures other licensees are aware of our innovation activities. We can share any relevant learnings and provide 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.

13.2.3 Stakeholder views

Engagement with stakeholders has been extremely useful in developing our innovation approach. Stakeholder feedback led us to generate and deliver a more focused and clear innovation strategy made up of discreet and well-defined challenges. Our stakeholders then wanted to better understand the differences between the types of whole-system issues we'd been having. This resulted in us breaking down the whole system into three separate priorities. From stakeholder engagement during our annual Innovation Strategy refresh, we have had positive feedback pertaining to our process. Stakeholders tell us that it is sufficiently robust and well designed to ensure that the most viable projects, with high potential consumer benefits, continue to be funded. Our Open Innovation days are a result of the frequent requests from stakeholders to get involved in ESO innovation and to enable opportunities for third parties to work with us in developing new projects. As part of our *Innovation Strategy*[80] publication, we have shared our process for deciding 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. This ensures our priorities are fit for purpose, and reflect current industry understanding of the 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've made our CBA and innovation process public. We also constantly update our website to show progress on each of our projects. It is our ambition to be able to develop and deploy a comprehensive consumer-benefit tracking tool in order to more effectively report back to our stakeholders.

We have had feedback, too, concerning our lack of visibility. Stakeholders tell us it is confusing to distinguish between the many different publications and activities that are ongoing within ESO and industry. Therefore, we have been leveraging our other platforms, such as Power Responsive, in order to reach out to a wider audience and ensure as many of them are aware of our activities as possible.

At a recent RIIO-2 workshop, we gathered feedback from a wide range of stakeholders from across sectors who told us:

- they would like even better communication and engagement on our activities throughout the year, to enable them to better understand the current and future priorities, or how we can work with them.
- they would like us to be more visible.
- they want us to continually improve BAU activities as well as potential wider industry innovations.
- due to our central role, they believe we should be helping lead collaboration across the industry as well as innovation projects that solve industry problems.
- (most told us) there should be a retained innovation stimulus for ESO but there were mixed views around how innovation should be funded (e.g. through BSUoS).
- how important it is that we work with other companies across the industry.

We are committed to working more closely with stakeholders throughout the development of our final business plan. We will delve further into the detail of what this feedback

[80] https://www.nationalgrideso.com/document/106786/download

means for our innovation activities, our strategy, proposed organisational structure and refined processes as part of RIIO-2 and beyond.

13.3 Embedding innovation from RIIO-T1

By the start of RIIO-2 we aim to have proven the viability of several innovations which will be implemented into the business. Examples of current innovation projects that could be implemented into BAU during the RIIO-2 period include:

- **RecorDER[81]:** the development and deployment of a full-scale, blockchain-based asset register for flexible energy resources. This NIA-funded development and pilot demonstration project is currently 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 to realise energy system-wide benefits. These include whole-system visibility, easier asset trading, enhanced data management and dynamic asset registration. It will also test the viability of blockchain transactions.
- **Frequency Response Auction Trial[82]:** the aim of the trial is to test the hypothesis that closer to real-time procurement of frequency response will lower overall procurement costs. This would occur because of more liquidity and transparency in the market, delivering a stable market price for the relevant products. This NIA-funded project, developed in collaboration with EPEX Spot, and supported and participated in by dozens of customers, is due to end in early 2021. If successful, it will be implemented into BAU during the RIIO-2 period. Our conservative estimate of consumer benefits is £360,000 per annum of savings off consumer bills.

13.4 Innovation in RIIO-2

Innovation is embedded throughout this business plan. In each chapter, we have highlighted areas where our proposals have built on past innovation, or where we expect to further innovate to deliver benefits to consumers.

Below, we have summarised innovation within each of the ESO's four themes, classified by:

1. BAU innovation – proposed activities that follow on from RIIO-T1 (NIA and NIC projects) as part of our business plan.
2. where innovation funding during RIIO-T1 has contributed to proposals in the respective theme.
3. areas we may want to draw on innovation funding in RIIO-2.

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 via a digital twin.

[81] https://www.smarternetworks.org/project/NIA_NGSO0018
[82] https://www.smarternetworks.org/project/nia_ngso0017

- developing situational awareness and new markets and services for the whole electricity system, not just transmission.
- 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.
- utilising a digital twin of the networks to create state-of-the-art simulators and improve staff training.

Where innovation funding during RIIO-T1 has contributed to proposals under this theme:

- we intend to use the findings and results of studies from the Distributed Restoration NIC project to decide on a technical solution – and productionise this through BAU.

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 (i.e. where ring-fenced funding is suitable).

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 the technical modelling of security of supply.
- during the RIIO-T1 period we have introduced new, 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 innovative approaches over the RIIO-2 period to 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. This will be the first of its kind in the Great Britain electricity industry. We will capture lessons which can be shared with the industry to improve the experience for all codes.

Where innovation funding during RIIO-T1 has contributed to proposals under this theme:

- a single, industry-wide asset registration process underpinning an integrated ESO portal could build from the learnings of the ongoing RecorDER project.
- a single, day-ahead response and reserve market will build on the learnings from the weekly auction trial project
- a single portal for ESO markets integrated with distribution service operator (DSO) flexibility markets and platforms will build on learnings from the Cornwall Local Energy Market, and engagement with the BEIS FleX competition.

- facilitating all market participants of 1 MW will be further developed through learnings from our work on Residential Response NIA[83], Vehicle to Grid Market Feasibility Study[84] (V2GB) and Frequency Response from Waste Water[85] innovation projects.

Areas we may want to draw on ring-fenced innovation funding in RIIO-2:

- 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 and draw on innovation funds where appropriate to test novel solutions to complex challenges such as system stability in ultra-low inertia scenarios.

Theme 3 – Unlocking consumer value through competition

Where innovation funding during RIIO-T1 has contributed to proposals under this theme:

- we are currently exploring new modelling techniques, such as probabilistic modelling, to better identify the right level of investment needed on the networks. During RIIO-2, we will build on this further to enhance these techniques, particularly to better reflect the interactions between different network issues.
- an innovation project is currently investigating the possibility of a new voltage assessment tool that is able to examine more scenarios, more quickly. If successful, this capability will be implemented early in RIIO-2, with ongoing enhancement through the remainder of the period.

Theme 4 – Driving towards a sustainable whole energy future

Where innovation funding during RIIO-T1 has contributed to proposals under this theme:

- our ability to lead the debate is built on data-driven analysis, including data from innovation projects. One example is our NIA project on electric vehicles (EVs) charging behaviour[86], which allowed a step change in our modelling of electricity demand from EVs.
- our self-funded Carbon Intensity Forecasting project, which used machine learning and automation to provide much more accurate forecasts (published continuously, and available through an Application Programming Interface [API]), will enable others to make more informed choices about their energy usage.
- the work to develop our capability to operate a zero-carbon electricity system will use the learning from our Enhanced Frequency Control Capability (EFCC) and Power Potential NIC innovation projects, and potentially also our recently funded Distributed Restoration NIC project.

Areas we may want to draw on ring-fenced innovation funding in RIIO-2:

[83] NGSO0025 https://www.smarternetworks.org/project/nia_ngso0025
[84] https://gtr.ukri.org/projects?ref=133490
[85] NIA_NGSO0024 https://www.smarternetworks.org/project/nia_ngso0024
[86] NIA_NGSO0021 https://www.smarternetworks.org/project/nia_ngso0021

- during RIIO-2 we will continue to innovate to take advantage of the opportunities presented by new technologies (e.g. automation, machine learning) to fill gaps in capability (e.g. zero-carbon operability) and prepare for RIIO-3. We believe this will increasingly take a whole energy system view, particularly given the increasing uptake of EVs and decarbonisation of heat.

We also believe that some proposals in the business plans are activities that will enable further innovation, in particular increasing third-party involvement in innovative projects over RIIO-2. Proposals such as the sandbox environment, new data portals and other platforms will make it easier for third parties to access relevant data and build new applications around this. They will also be able to test new business models in a safe space and in close collaboration with ESO experts.

Better and increased communication with our stakeholders through new portals will mean that learnings and outcomes from the innovation projects we undertake can be disseminated. By being more accessible, it will be easier for industry to replicate results, adopt best practice, and guide their own innovative ideas.

13.5 Next steps

We will further validate our BAU innovation projects and reconcile them with our IT investments.

We will continue to consult with Ofgem and stakeholders about how the ring-fenced innovation stimulus (NIA) should be funded for the ESO. This will include the amount of funding available to enable delivery of these projects as well as what conditions should be in place regarding the use of this funding (e.g. how the strategy is set, allowable internal spending, benefits tracking).

14. Ongoing costs and benchmarking

14.1 Overview

Part 2 of our business plan outlined the new, transformational activities that we propose to deliver in RIIO-2, to meet the ambitions that our stakeholders have for us. As well as stepping up to this role, we will continue to deliver our core, ongoing role of operating the electricity system safely and securely. The chart below shows that these costs continue to form a substantial part of the ESO's overall costs.

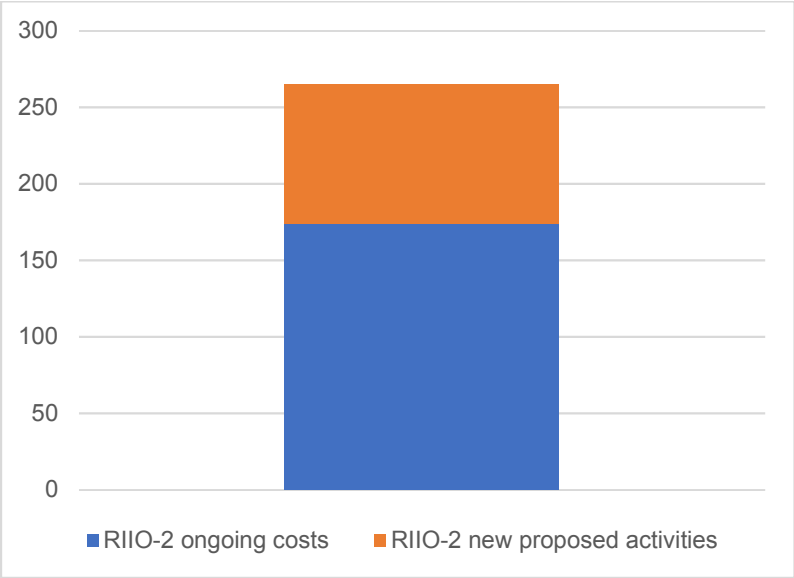

Figure 52: Ongoing costs and new proposed costs (opex and capex), £m per year average

Please note that the chart represents our current, simplified, annualised view of how ongoing and transformational costs are defined. This is work in progress and continues to be refined.[87]

Our ongoing activities for RIIO-2 include:

- operating the electricity system to ensure a minute-by-minute balance of supply and demand of electricity.
- actively managing balancing and constraints to minimise costs to consumers.
- managing existing balancing service markets, developing future markets and making improvements to facilitate greater transparency, participation and competition.
- managing industry revenue flows by setting charging methodologies and collecting charges for using the transmission network, as well as balancing service charges.
- our electricity market reform (EMR) delivery body role.
- managing connection applications for the transmission network and acting as the contractual counter-party for these connections.

[87] For example, in this view, all IT infrastructure has been classified as ongoing and the replacement of existing IT systems has been classed as new investment.

- planning for the future of the electricity system, including network planning and the Network Options Assessment process, and how this interacts with the whole energy system.
- publishing a variety of insights and data, including our annual *Future Energy Scenarios (FES).*
- IT system changes required by our customers and those mandated by Great Britain and EU regulatory change.

These ongoing costs also include the cross-cutting teams and shared business support services that support all our work across the ESO. For more information on these teams and costs, please see the next chapter.

14.2 Ongoing activities

Our ongoing activities are set out in the *2019-21 Forward Plan*[88] and in our licence.

The activities set out in chapters 7 to 10 show how we and stakeholders would like to see our activities transform to deliver better service and maximise the consumer benefit delivered.

Below, we summarise our ongoing activities under the themes set out earlier in this document. This is slightly different to the presentation in the *2019-21 Forward Plan,* but should aid comparison against our proposed transformational activities.

Theme	Activities
Theme 1 – reliable, secure system operation, to deliver electricity when consumers need it	• round-the-clock monitoring and operation of the electricity system • real-time network balancing • energy forecasting • making sure the electricity system can recover safely and quickly from a total loss of power
Theme 2 – transforming participation in smart and sustainable markets	• manage existing balancing service markets • continue the Power Responsive campaign to support growth of demand-side flexibility • modelling to support the development of new balancing services • billing and charging • running the key EMR Delivery Body processes – Capacity Market and Contract for Difference (CfD) auctions and EMR modelling • market development and change • EU code change • code management

[88] https://www.nationalgrideso.com/document/140736/download

Theme 3 – unlocking consumer value through competition	• network development, including economic assessment • deliver *Network Options Assessment* (*NOA*) and *Electricity Ten Year Statement* (*ETYS*)
Theme 4 – driving towards a sustainable energy future	• network access planning and planning outages ranging from capital projects to maintenance • network operability • strategic insights, creation of FES, Summer and Winter Outlooks • electricity connection compliance and contract management

14.3 Historic cost performance

To understand whether our proposed ongoing activities are efficient, it is helpful to consider historic cost performance and the reasons for any potential changes between RIIO-1 and RIIO-2. The table below shows our opex and capex performance over the RIIO-1 period to date, with provisional forecasts for the remaining three years or RIIO-1. Please note that the 2018/19 to 2020/21 costs are indicative and subject to change. The RIIO-2 costs are our proposed ongoing costs (as currently defined) for our core activities, ie, excluding the transformational costs described in Part 2, which have been subject to cost-benefit analysis.

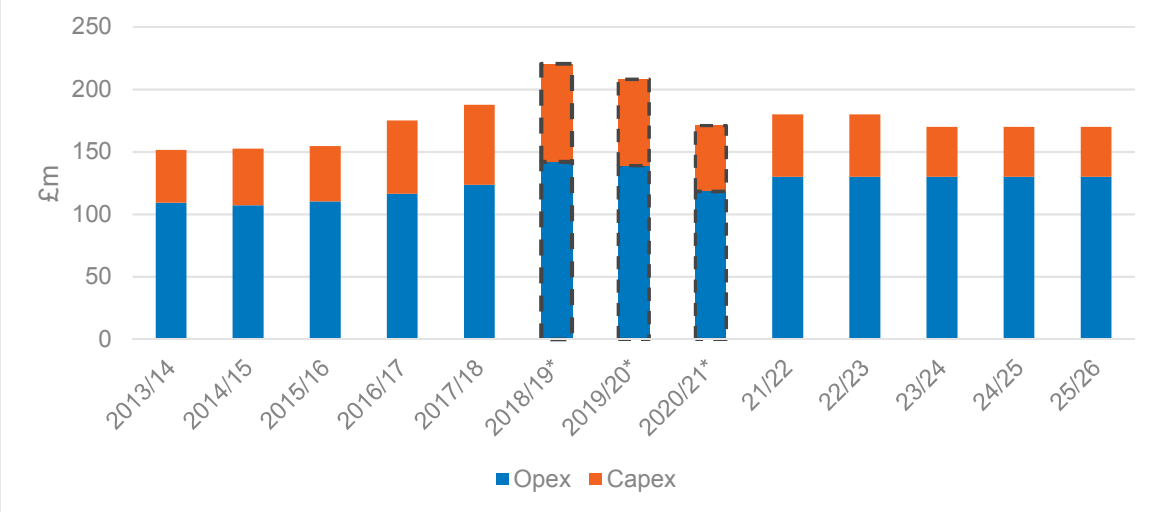

*Figure 53: Opex and capex (2018-19 prices) in RIIO-1 and ongoing costs in RIIO-2. *2018-19, 2019-20 and 2020-21 costs are indicative and subject to change.*

14.3.1 Changes to RIIO-1 expenditure

The profile of our expenditure over RIIO-1 reflects how we have prioritised resources in response to the rapidly changing energy landscape, and the challenges this brings to electricity system operation. We have also taken on new roles, with associated allowances, to drive additional value for consumers and further enable the transformation of the electricity system. These new roles include the Electricity Market Reform (EMR) delivery body, running the *Network Options Assessment* (*NOA*) process to coordinate

efficient and economic network investment across GB, and leading the Power Responsive programme. It also reflects the efficiency programmes we have implemented, which are described in more detail later in this section.

The increase in our 2017/18 opex is driven by:

- Costs associated with the legal separation of the ESO from NGET
- The cost of delivering our customer-led efficiencies programme – see below for more details
- Guaranteed Minimum Pensions Adjustment[89]

The increase in capex is attributed to:

- Increased spend on our Critical National Infrastructure (CNI) data centres programme as the programme moves fully into its delivery phases
- Increased spend in relation to the legal separation of the ESO with the preparation of property and financial systems to deliver new licence requirements
- Spend on readying systems in respect of European Network Code changes
- Reductions in Integrated Energy Management System (iEMS) expenditure following completion of this project, which offset some of the costs above.

In the remaining years of RIIO-1 we expect opex to reduce as legal separation is delivered, but with the enduring costs of running as a legally-separate company remaining. We expect capex costs to reduce following the 2018/19 peak as property work to prepare for legal separation completes and the level of investment in the Electricity Balancing System (EBS) drops off. The data centres programme is forecast to complete in 2020/21.

Within the new roles we have undertaken, there has also been a significant amount of change since they were introduced, particularly in relation to EMR. The scale and nature of change has been far greater than expected in 2015 when we took on the delivery body role. Among other things, there have been major changes in the number, nature and needs of market participants (e.g. a 400% increase in the number of Capacity Market applications, with over 90% of applicants of less than 100 MW). We have also seen a large volume of change to the regulations and rules set by government and Ofgem.

Working in an increasingly complex operating environment has also put pressure on costs of operation. This is generally seen through increased requirements on our staff and pressures on staffing levels. The cost of doing business is also increasing, in particular in relation to governance, assurance and compliance with legislation. This can be seen in the level of changes in European Codes which need to be embedded in the business as well as the cost of ensuring financial governance is appropriate, with new requirements through Sarbanes Oxley and changing accounting standards.

[89] Settlement required following a High Court ruling on historic equalisation of pension benefits. https://home.kpmg/uk/en/home/insights/2018/11/guaranteed-minimum-pension-equalisation-actions-for-pension-sche.html

14.3.2 Efficiency in RIIO-1

We use Performance Excellence[90] as a way of identifying and driving efficiency in what we do. This focus has allowed us to continually release and reinvest time into the areas of greatest need whilst balancing overall cost to consumers.

During RIIO-T1 we have also delivered two major organisational changes to support the continuing evolution of the business.

- UK Operating Model – ensuring the business was the right size, structure and skillset to deliver our RIIO-T1 commitments efficiently
- Customer-led efficiency programme – to drive increased and sustainable efficiency and prepare the business for RIIO-2. To identify the savings opportunities, we worked "bottom up" through the business to find methods of reducing our opex costs.

We are undertaking a number of activities to improve efficiency. Examples include automating processes, centralising change resource and offshoring repeatable processes.

14.3.3 Cost drivers in RIIO-2

We forecast an increase in our ongoing, business-as-usual costs in RIIO-2. The increase is our early expectation of the costs required to ensure the complex systems we operate are maintained and enhanced to deal with the challenges of operating the network over the next price control period. This would include replacing and refreshing some systems and making changes to our existing systems to implement the mandated changes from new regulation e.g. impacts on EMR, charging and settlement changes, as well as the continual evolution of our offline modelling and customer tools in response to these and other changes.

The key cost drivers for the ESO in RIIO-2 relate to the continuing need to respond to the transition to a decentralised, decarbonised and digitised energy system. These include:

- **The changing operating environment and the shift to decentralised, renewable generation.** In RIIO-2 we must invest in new control room systems, such as real-time inertia monitoring, management and forecasting tools, to allow us to better understand the state of the system and manage the interface between different parties. The adoption of new technologies, such as electricity storage, and the increasing need for distribution system operation, will require new engineering and operational processes across the transmission-distribution boundary. The continued expansion in the number of market participants will increase the volume of technical and commercial data to be analysed and exchanged with other system users. The cost of these investments will be outweighed by the reduction in balancing costs[91].

[90] https://www.leancompetency.org/national-grid-accreditation/

[91] An example of this in RIIO-1 is the spend on Power Responsive that has been outweighed by the reductions in cost in the reserve and frequency response markets that actions through it have driven. A further example is the work done to change embedded generator protection systems. We currently use commercial actions to manage a system operability problem caused by protection systems on some embedded generators. This spend is an external component of Balancing use of System charges, a pass-through cost to the end-consumer. The problem is referred to in the industry as Loss of Mains protection, rate

- **A greater number of smaller participants in the market.** This drives the need to invest in market platforms and create new balancing service markets to improve access to information, enable market participants to make more informed decisions and will open up our markets to a greater number of participants, also helping manage balancing costs. A report for the Committee on Climate Change[92] has indicated that system costs to consumers could increase by £3.2 to £4.7 billion per annum by 2030 unless significant new sources of flexibility are attracted onto the system. Our work on future markets is undertaken with these savings in mind; our focus is on removing barriers to market entry and attracting new sources of flexibility to deliver savings to consumers.
- **An increasingly complex and challenging cyber threat landscape**. Advances in technology and the changing nature of the electricity grid present a wider and ever increasing cyber threat landscape with potential for increased frequency and sophistication of attack. We will invest further in cyber security to identify, prevent and manage these increased threats in an effort to ensure continued safe and reliable system operation.
- **Regulatory change.** Due to the rapidly changing electricity market, and degree of political scrutiny, we anticipate that the high level of regulatory change will continue throughout RIIO-2. These changes include implementation of the EU Clean Energy (4th) Package in a phased manner and completing implementation of manual Frequency Restoration Reserves[93] required for compliance with European Network Codes.

14.4 International benchmarking

The results presented in this report represent our current thinking. We will refine our benchmarking studies throughout 2019.

We have undertaken a benchmarking exercise to assess the efficiency of our proposed ongoing direct operating costs. Our proposed new and transformational costs have been subjected to cost-benefit analysis and are outlined in part 2 of this report. Chapters 11 and 15 describe the benchmarking we have carried out on shared service and IT costs.

of change of frequency and Vector Shift. Between 2019 and 2022, we will run a programme to change the protection settings of affected embedded generators. The programme is currently forecast to cost £60 million but it will reduce the commercial cost of managing the problem to zero. We forecast this will deliver a benefit in the region of £170 million per year from 2022.

[92] The Committee on Climate Change Roadmap for Flexibility Services to 2030, May 2017 https://www.theccc.org.uk/publication/roadmap-for-flexibility-services-to-2030-poyry-and-imperial-college-london/. The price base of the quoted figures is not stated.

[93] https://www.entsoe.eu/network_codes/eb/mari/

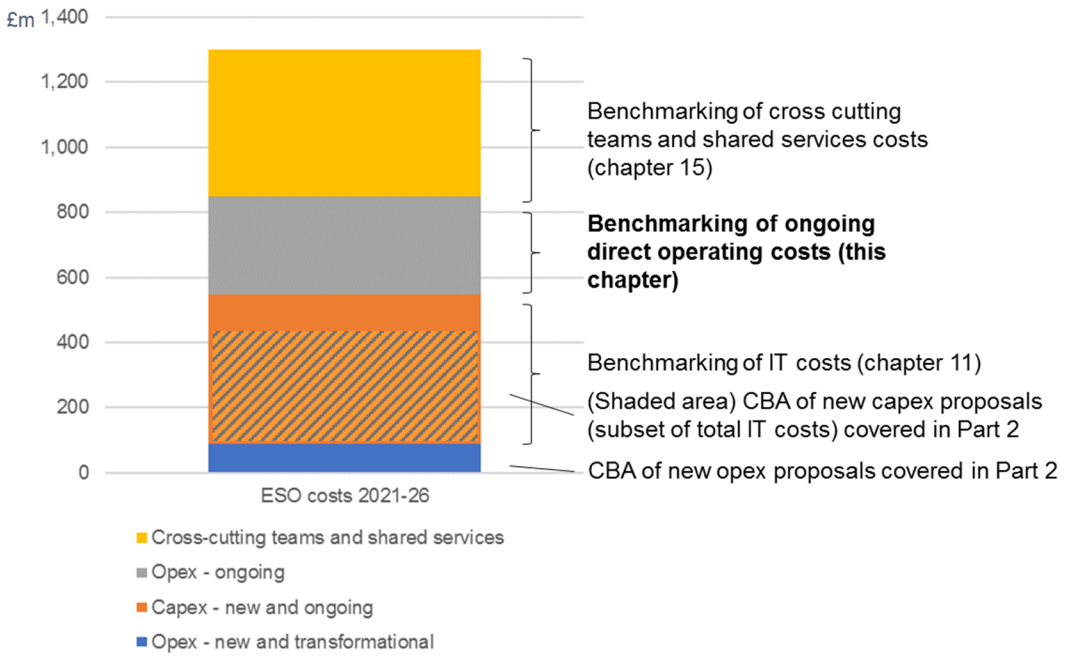

Figure 54: Benchmarking our £1.3 billion business plan costs

This is the beginning of an overall process to develop meaningful benchmarks, which we can consider with our stakeholders.

14.4.1 High-level cost benchmarking

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. Please see Annex C for full details of our methodology.

The figure below shows our initial results for:

- 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.

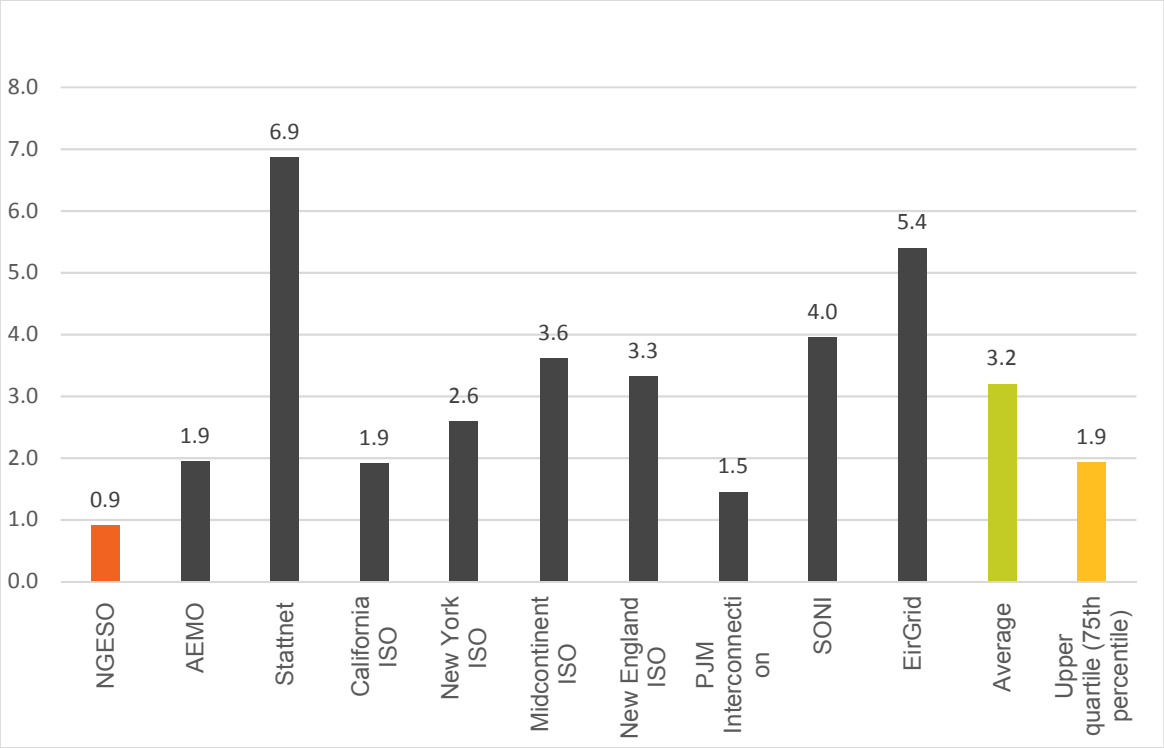

Figure 55: High-level benchmarking – direct operating costs per capita (£ million, 2018 prices)

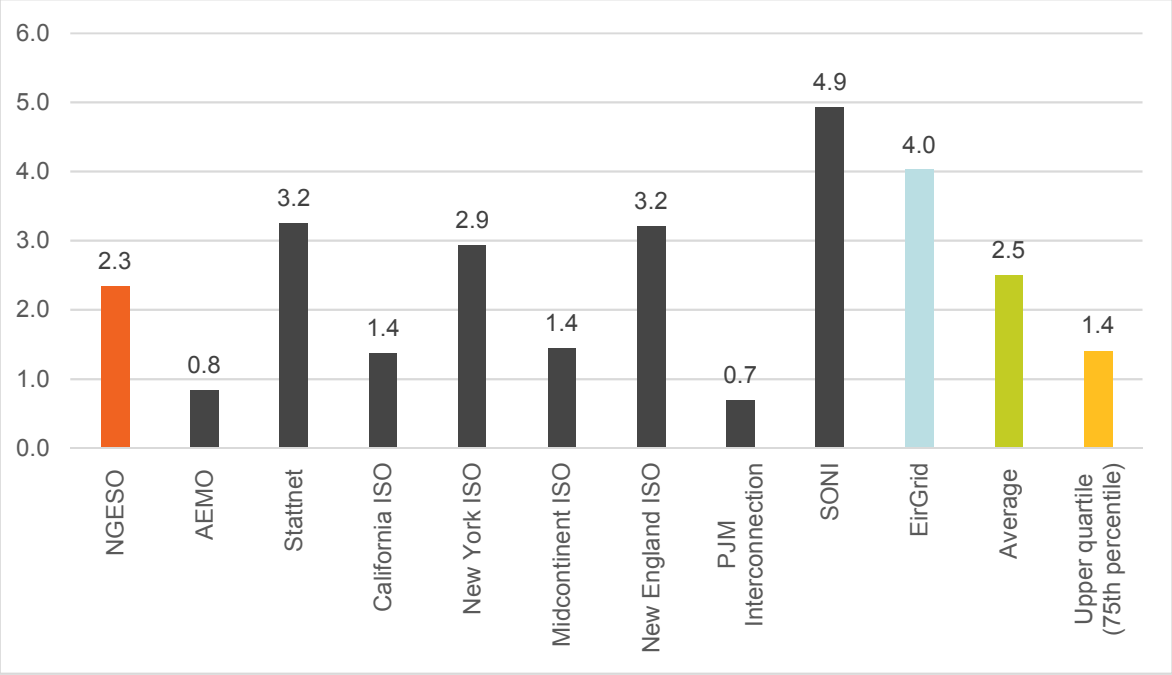

Figure 56: High-level benchmarking – direct operating costs per km of network (£ milion, 2018 prices)

Work is ongoing to identify and test a full range of characteristics that should be controlled for (both now and future looking), as well as the appropriate metrics to use to make robust adjustments to the cost data. It is also noted that while we have adjusted for scale, economies of scale and scope have not been currently addressed. These early

results should not be used or relied upon at this stage, as we anticipate significant changes to them.

14.4.2. High-level benchmarking of cost trends

This section provides early outputs that illustrate historical adjusted (but not normalised) cost trends versus the comparator companies. The costs are expressed in 2018 prices, using the retail price index (RPI).

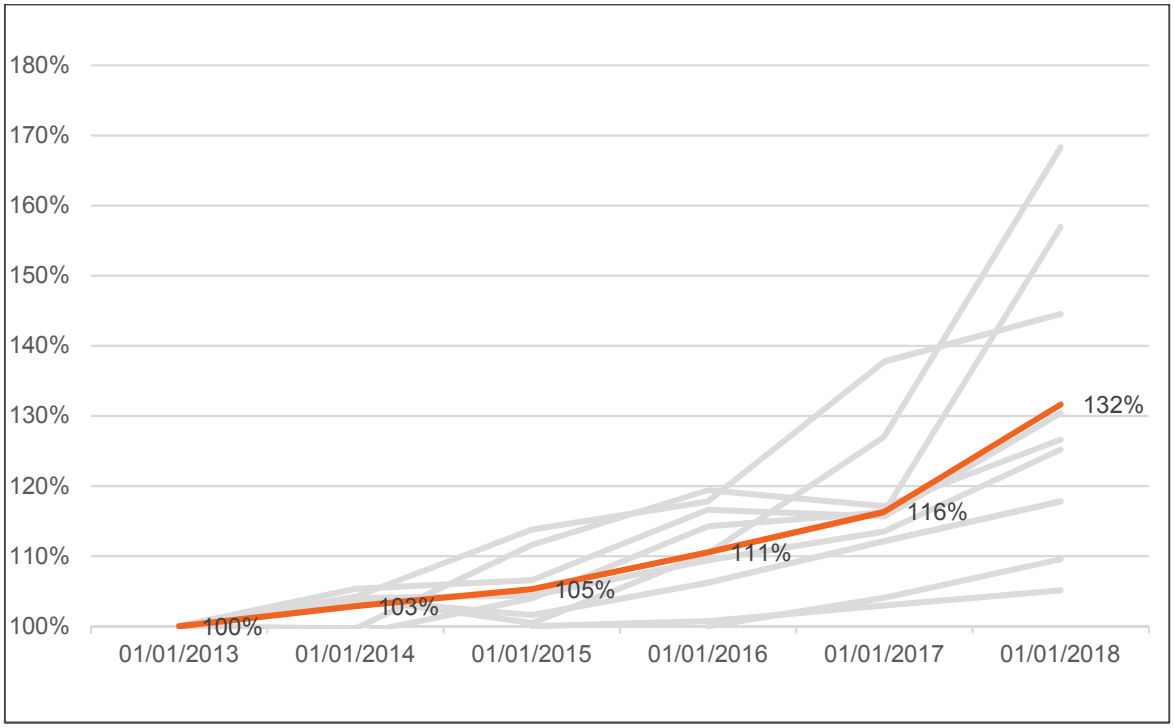

Figure 57: Historic real costs index (RPI inflation adjusted)[94]

The bold line on the graph shows average increasing real costs through the period 2015-18, with the grey lines showing individual organisations. Reviews of the commentary in the accounts and financial statements of the company reports 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.

Cleaner forms of energy, such as wind and solar, are increasingly replacing traditional fossil fuel generation. These changes "will present huge challenges for the infrastructure and security of energy supplies, which lie at the heart of our role as Great Britain's System Operator – and we too will need to evolve to meet these challenges if we are to remain at the heart of Great Britain's energy system".[95]

The challenges mentioned in the quote above translate to additional complexity and higher costs. This is also recognised by other system operators. For example, the

[94] Note: the analysis presented above does not control for any normalisation factors such as the varying levels of complexity across various networks.
[95] https://www.nationalgrideso.com/document/140736/download page 2

Australian energy market operator AEMO[96], 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”. Further, 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. Consulting costs provisioned in 2018/19 include specialist advice and support relating to modernising our markets and managing the complexities of the grid”.[97]

14.5 Next steps

We will continue our benchmarking of ongoing direct operating costs as described above, while further refining the definition of ongoing and new proposed costs in our cost tables. We will also provide a more comprehensive picture of our core costs, including a specific look at staff and IT costs.

[96] 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
[97] AEMO Electricity Final Budget and Fees 2018/19, page 6

15. Cross-cutting teams and business support shared services

15.1 Overview

A number of cross-cutting teams support the outputs and services we deliver:

- customer and stakeholder
- ESO regulation
- business change
- assurance.

Our proposed spend on these teams in RIIO-2 is around £25m over five years. In addition, our business makes use of shared services from National Grid Group. This includes:

- property
- human resources
- procurement
- finance
- broad information technology (IT) infrastructure, such as servers, laptops, and networks
- corporate functions (CEO, group management and legal).

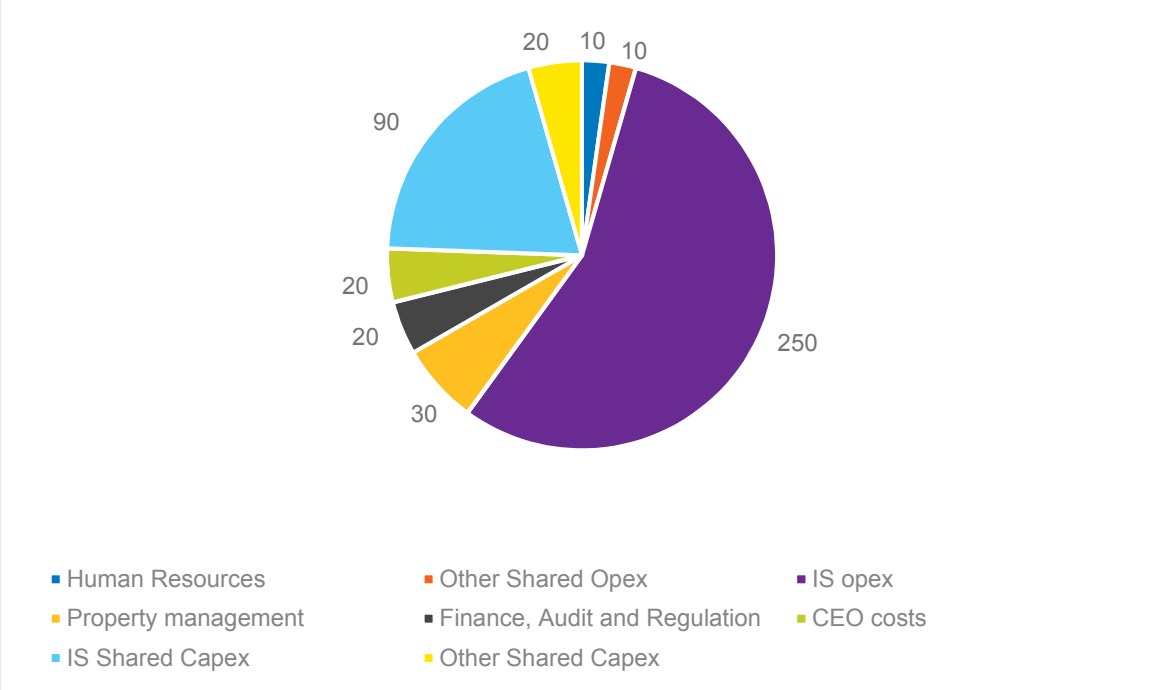

Figure 58: Current view of main categories of business support opex and capex costs, £m rounded, 2021-26.

This chapter outlines how these functions will support the ESO to deliver our proposed outputs in RIIO-2. It shows the proposed cost of these functions, how they will evolve, and how we will work to ensure these costs are efficient and that we benefit from a high standard of performance. The chapter covers all of the functions listed above, with the exception of our ESO-level IT strategy. This has its own chapter in this business plan. The IT costs covered in this chapter relate to the shared services element of IT infrastructure and associated opex.

15.2 Cross-cutting teams

15.2.1 Customer and stakeholder

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, for example use of system charges for the transmission network.

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. It will provide a critical function in understanding what our customers and stakeholders require, both now and in the future, in order to develop our strategy.

There is a growing requirement for this team to consider the SO's role in engaging and supporting the end consumer 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.

15.2.1.1 What will this team look like in RIIO-2?

To support our RIIO-2 proposals, the team will move from being a data repository and survey administrator to 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.

We are currently developing our plans for this enhanced role and will provide more details in our final business plan. The table below shows what we will deliver for customers, stakeholders and consumers in RIIO-2.

For consumers	• 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. This work is likely to be a long-term journey, particularly as progress on decarbonisation of heat and transport begins to impact more directly on greater numbers of consumers. Initially, we will seek to partner with key suppliers and consumer groups to champion the consumer, providing education support around energy use and the future of energy. Further along the journey, we would seek to work closely with others in the energy industry, not least the distribution network operators (DNOs), as the impacts and opportunities both nationally and regionally become clearer.

	• As well as supporting consumers, this role will enable us to become a consumer champion across the energy markets, helping to drive overall consumer benefit. • We will use our experiences with campaigns such as Power Responsive to identify the best ways of doing this. • We will also help to drive the decarbonisation agenda at the local consumer level by providing carbon-neutral data, leading on decarbonisation marketing, and enabling behaviour change around energy use. • Internally, the customer and stakeholder team will champion the priorities of the consumer within the SO. It will ensure that all organisational decisions and behaviours are done with the consumer front and centre, while supporting teams across the ESO to measure consumer benefits.
For customers	• Ensure the SO offers an excellent customer experience across every touchpoint and service, including journey optimisation, insight gathering and key performance indicator (KPI) tracking. • Develop trusted partnerships with SO customers. • Support the SO to 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 ensuring that 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 leveraging our published insights and analysis. • We will facilitate conversations with stakeholders, enabling a collaborative relationship through meetings and forums. • The team will also ensure that 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.

The ESO's share of customer and stakeholder team costs in RIIO-2, £m

RIIO-T1 average*	2021/22	2022/23	2023/24	2024/25	2025/26	Total
0.6	0.5	0.5	0.5	0.5	0.5	2.5

*Average of 2019/20 and 2020/21. The team was set up in 2019/20.

15.2.2 ESO regulation

ESO regulation is a new team, formed when the ESO became legally separate from the National Grid 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. Finally, the team also supports the business on regulatory policy matters, including external consultation responses on behalf of the ESO.

15.2.2.1 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[98] and ex-post[99] 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. This would continue to have a role in challenging the development of our business plans, reviewing our performance and challenging our level and breadth of stakeholder and consumer engagement on an ongoing basis.

ESO regulation team costs in RIIO-2, £m

RIIO-T1 average*	2021/22	2022/23	2023/24	2024/25	2025/26	Total
1.8	2.8	2.5	2.5	2.5	2.5	12.9

*Costs since legal separation in 2018/19. Includes preparation for RIIO-2 and subsequent price controls with the assumption of a five-year regulatory framework with two-year budget and incentive cycles.

15.2.3 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-T1, 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.

15.2.3.1 What will this team look like in RIIO-2?

[98] Based on forecasts rather than actual results.
[99] Based on actual results rather than forecasts.

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-T1 to RIIO-2 reflects the move to the hub and spoke operating model as described above. Furthermore, the RIIO-T1 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

RIIO-T1 average	2021/22	2022/23	2023/24	2024/25	2025/26	Total
5.7	0.9	0.9	0.9	0.9	0.9	4.5

15.2.4 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.

15.2.4.1 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 to cover our expanding risk. 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.

The ESO's share of assurance team costs in RIIO-2, £m

RIIO-T1 average	2021/22	2022/23	2023/24	2024/25	2025/26	Total
1.6	1.3	1.3	1.3	1.3	1.3	6.5

15.3 Business support shared services

The ESO uses services that are shared across all of the National Grid businesses. These include property, HR, procurement and finance. We use a shared services model, where each of the National Grid businesses is supported by the same shared function. This costs less than each business having its own functions. We make sure that each National Grid business pays a fair share of the costs of these functions, using an approach agreed with Ofgem[100].

Across these services, the ESO's share of costs will be £450 million in the five years of RIIO-2. Benchmarking has shown that our forecast costs for RIIO-2 are equivalent to the

[100] The Unified Cost Allocation Model (UCAM) uses allocation drivers (for example, headcount of the relevant companies) to allocate business support costs to each business.

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.

Benchmarking of business support shared services

We asked The Hackett Group[101] to compare the costs of our business support shared service functions with those of similar-sized companies. We provided Hackett with the costs of shared services supporting our electricity transmission, gas transmission and electricity system operator businesses. Using Ofgem's business support function definitions, Hackett identified comparable activity categories within their database. We asked Hackett to compare our costs to as many non-regulated companies from the group Ofgem had used for T1 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 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 our support costs.

Where Hackett identified differences between our costs and those of the comparison group, we asked them to perform more detailed comparisons on an activity-by-activity basis so that we could understand what explained the differences. For our IT costs, we engaged Gartner (an industry-recognised specialist in IT benchmarking) to perform this further analysis, comparing our 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 can be found in our chapter on IT strategy.

15.3.1 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 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. Our Wokingham site falls under the government's definition of Critical National Infrastructure (CNI) and the property management costs include ensuring 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 proposed costs reflect our

[101] The Hackett Group is a global business benchmarking organisation.

intention to create an ESO corporate presence in London that is separate from National Grid's London office.

ESO property costs in RIIO-2, £m

	RIIO-T1 average	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Property management opex	6.5	5.5	5.5	5.5	5.5	5.5	27.5
Property capex	2.4	0.5	0.5	0.5	0.5	0.5	2.5

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).

15.3.2 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, happy 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.

ESO HR costs in RIIO-2, £m

RIIO-1 average	2021/22	2022/23	2023/24	2024/25	2025/26	Total
1.8	2	2	2	2	2	10

The Hackett Group looked at the overall cost of National Grid's HR function, relative to the number of people in our organisation. Our HR 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.

The small increase in HR costs compared to the RIIO-1 average reflects an increased allocation of cost to the ESO based on our forecast headcount.

15.3.3 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.

ESO procurement costs in RIIO-2, £m

RIIO-T1 average	2021/22	2022/23	2023/24	2024/25	2025/26	Total
0.6	0.7	0.7	0.7	0.7	0.7	3.5

The Hackett Group benchmarking study indicates that our procurement costs are in line with the upper quartile of their comparator group.

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.

15.3.4 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.

ESO finance function costs in RIIO-2, £m

RIIO-T1 average	2021/22	2022/23	2023/24	2024/25	2025/26	Total
6.5	3.2	3.2	3.2	3.4	3.4	16.4

In RIIO-T1, there were some one-off costs which accounted for the higher average cost. For example:

- we changed auditors within RIIO-T1 to Deloitte, whose audit approach puts more emphasis on the checks and balances around our financial transactions. 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-T1 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.

15.3.5 IT infrastructure

IT infrastructure is the cornerstone that underpins the National Grid business, delivering a safe, secure and reliable operating environment for our customers. IT infrastructure must be future-proofed against industry and technological change in order 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, include:

- **Cloud and hosting:** data centres host National Grid data and provide computer power to run mission-critical applications. They include the management of infrastructure in a hybrid cloud environment, on-premise data centres and hosted data centres. We are striving to provide more effective, fit-for-purpose solutions with the cloud, reducing old technology constraints.
- **Network:** National Grid's network securely and efficiently connects our business users to internally and externally hosted data, as well as the tools required to meet their objectives. This includes wide area network (WAN), local area network (LAN), wireless (wi-fi) and voice.
- **Supplier management:** we work very closely with all suppliers in our IT eco-system to deliver, manage and support all infrastructure strategies. The supplier base is changing, with the consumption of cloud services increasing, alongside changes in end-user service demands.

We manage these services to be efficient and reliable, in line with expectations and service level agreements. They are laying the foundation for our ongoing digital transformation, including improved quality and customer experience. Our key performance indicators (KPIs) are aligned to business performance and our success is measured in terms of business outcomes.

Our chapter on IT strategy provides more detail on how we will invest in IT to underpin the roles and activities we propose in this document, including cyber security. The costs below represent IT infrastructure only.

ESO IT infrastructure costs in RIIO-2, £m

	RIIO-T1 average	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Opex	30.6	50.5	50.4	49.7	49.5	20	250.3
Capex	14.0	22.4	24.7	14.9	11.8	13.2	86.9

During RIIO-T1, we were able to extend the asset life of IT infrastructure, while still maintaining reliable services with an accepted increase of risk. The increase in cyber threat during RIIO-T1 has forced changes to IT asset health policy to enable real-time cyber monitoring, patching of operating system updates, and original equipment manufacturer support as part of a holistic cyber response.

Our RIIO-2 investment reflects the revised asset health policies, ensuring these security issues are addressed to acceptable levels of risk. The revised asset health policies – independently benchmarked as industry good practice – drive an increase in cost relative to the RIIO-T1 period in order to maintain a secure and resilient operational environment.

15.3.5.1 IT infrastructure in RIIO-2

IT infrastructure is critical to National Grid's ability to run its day-to-day operations, while simultaneously supporting an environment conducive to innovation. In the face of

increasing market and industry uncertainty, prioritising innovation is a crucial part of delivering consumer benefit in a rapidly changing environment. Our main objectives over the RIIO-2 period are to:

- enable the move to cloud-based solutions in order to create more flexible and scalable infrastructure. This will help to drive further infrastructure efficiency as well as enable rapid change within the business – at the same time as ensuring stability for all of our key systems. We expect to increase our use of cloud from the current level of 25 per cent of our hosting to 75 per cent over the period.
- drive the provision of flexible and scalable solutions to enable effective and efficient application development and deployment. Cloud-based tools play an important role in accelerating knowledge transfer and information sharing.
- Invest and upgrade our infrastructure. Approximately 60 per cent of servers and operating systems are at the end of support. This makes it difficult to support new business demands and our digital workplace. It also creates a cyber-security risk and consumes considerable resources and budget with ever-diminishing return.

We aim to provide industry-leading infrastructure that supports the business in delivering greater value to customers with faster and smarter technology. We will ultimately gain efficiencies for longer-term cost savings and service delivery advancement.

On a cost per end user basis, Hackett found our IT costs to be higher than those of similar sized organisations. This is consistent with extent to which we use, and are reliant on, IT systems to operate and monitor the Gas and Electricity transmission networks 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, our IT costs were in line with peers whilst 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 our chapter on IT strategy, we provide more information on the benchmarking we have done of our IT costs.

15.3.6 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.

ESO share of other shared service costs in RIIO-2, £m

	RIIO-T1 average	2021/22	2022/23	2023/24	2024/25	2025/26	Total
corporate functions	4.5	3.9	3.9	3.9	3.9	3.9	19.5
Health, safety and environment	0.2	0.2	0.2	0.2	0.2	0.2	1

Insurance	1	0.1	0.1	0.1	0.1	0.1	0.5
Other shared service capex	1.3	4.1	3.6	2.6	2.4	4.0	16.7

Our corporate functions costs are lower than our peers, but benchmarking shows that upper quartile efficient companies have lower costs. We are working to understand this more, particularly as these costs represent a range of different activities (such as legal support, employee and external communications) that will vary widely depending on the type of business.

The insurance team costs fall in RIIO-2 because the way this cost is allocated to the ESO has changed. Therefore, the ESO bears a smaller portion of insurance costs as a shared service.

16. People and capability

The ESO's most important resources are undoubtedly our people. Delivering our ambition successfully will require us to continue to attract, recruit, train, motivate and engage people.

The energy industry and the ESO are facing massive transformation. It is imperative that we ensure we have the right people and capabilities to support our ambition and operate the system of the future. Within the ESO, advanced analytics and data management capabilities will be increasingly important. Alongside these, our power system engineering, customer service, stakeholder and contract management capabilities will remain critical.

We are currently reviewing our strategic workforce plan over a minimum period of 10 years, and we will use this to understand our workforce planning requirements for RIIO-2. We will use analytical methods to plan and forecast the workforce of the RIIO-2 period. We will consider business supply and demand scenarios and highlight any emerging headcount gaps and risks in future years.

Our plan will highlight the workforce demand required to deliver against our RIIO-2 ambitions and then identify resourcing gaps, both in terms of number of people and capabilities. This will enable us to write a strategy that addresses this gap for RIIO-2. The strategy will consider relevant investment in development for our current workforce, through attracting the capabilities from outside the company as well as 'growing our own' to build a pipeline of resource and capability. We will look to recruit and retain a diverse workforce representing the industry we operate in.

16.1 The ESO today

16.1.1 Current capabilities

Two-thirds of our current workforce is comprised of engineering capabilities (mostly electrical network control engineering) and sales and commercial capabilities (mostly commercial operations, market development and energy trading).

We have also been increasing our strategic, customer and data capabilities to develop our role as an ESO in a fast-changing, consumer-driven energy industry.

"We recognise that the ESO may require different levels and a different mix of resources, compared to the RIIO-T1 profile, to deliver against the RIIO-2 ambitions. It is crucial the ESO is sufficiently resourced and with the appropriate mix of skills."

Supplier

Figure 59: Capabilities split

16.1.2 Specialist skills

Ofgem's consultation document has set initial criteria for defining the critical workforce by focusing on field-based technical skills. However, our view is that this should be widened for the ESO, to include non-field force staff who are critical to us because of the role they play in delivering a resilient network on a day-to-day basis. For example, our power system engineers. We will highlight those roles in our submission and put a particularly strong focus on ensuring the resilience of this critical workforce.

We are also expecting some roles to require specialist skills that will be difficult to source, such as those relating to data analysis and analytics. These will be highlighted as specialist roles – and will be determined once we have completed our strategic workforce planning activity.

Next steps: We will provide clarity on what we believe our critical and specialist roles are in our RIIO-2 submission.

16.2 Delivering our RIIO-2 ambition

16.2.1 The 2020/21 workforce: our starting point

We forecast that by the end of our *2019-21 Forward Plan*, we will have a workforce of approximately 620 full-time equivalents (FTEs). This starting point may change, based on the strategic workforce planning analysis we will carry out in the coming months.

16.2.2 RIIO-2 workforce demand forecast

To fulfil our ongoing and transformational activities, as defined under our four roles, we will employ and develop our core, cross-ESO capabilities.

We will require the resources set out in the chart below to deliver our RIIO-2 business plan. After an initial increase in resources in 2022/23, we plan to steadily reduce our number of FTE resources from 870 in 2021/22 to 825 in 2025/26.

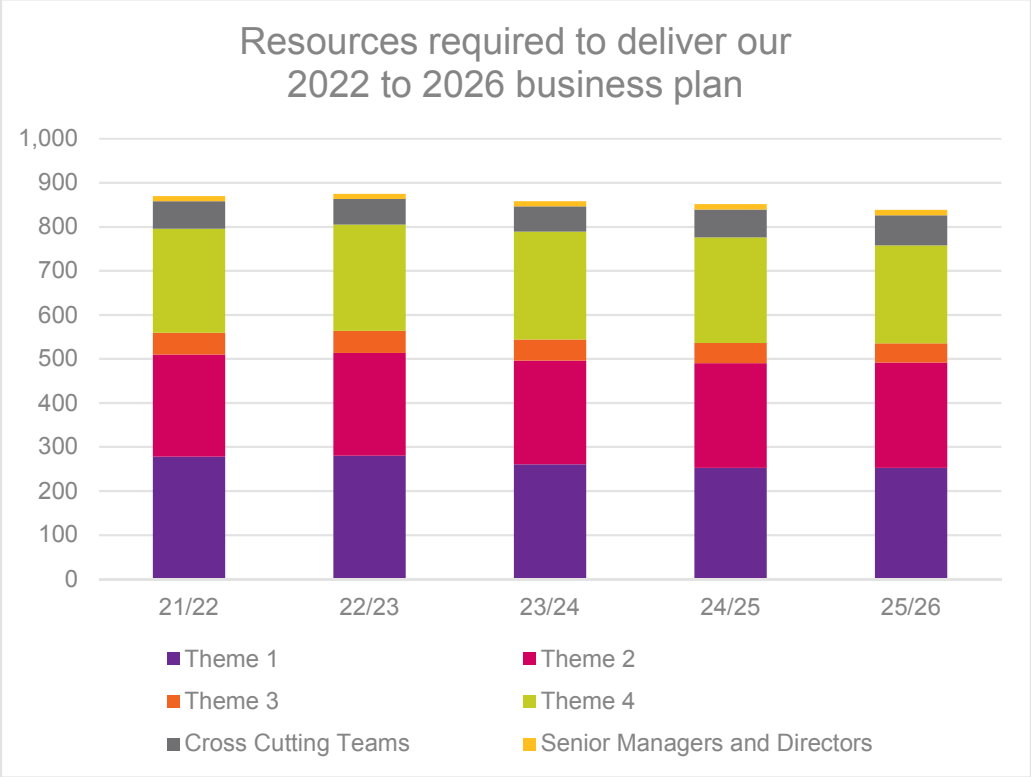

Figure 60: Resources required to deliver our RIIO-2 business plan

This workforce will enable us to deliver our RIIO-2 ambitions, carrying out activities such as active network management, flexible networks and intelligent monitoring, operating the system against a backdrop of more renewables generation, energy storage and electric

vehicle usage. Our workforce will have the capability to employ artificial intelligence, machine learning, robotics and automation – and use them to benefit our control centre processes.

As a result, we will develop and extend our position from being a customer service and asset-light organisation today, to a more technology- and data-led ESO tomorrow. And given the pace with which the energy industry and our role as an ESO is changing, our people will need to be comfortable working with ambiguity and change, across all four of our ESO roles. In one example of how we will help identify and address potential ambiguities, we will develop new training simulators to undertake scenario and what-if control centre exercises. All of this will require a transformational change in our people and capabilities (as illustrated in the theme-by-theme narrative below). Our power system engineers, for example, will need to expand their engineering capabilities to include data management and stakeholder engagement capabilities.

Next steps: the below narrative gives an overview of the shifts in capabilities we believe will be required to deliver the ambition for each role, both in our business as usual (BAU) and transformational activities.

Theme 1 – ensure reliable, secure system operation to deliver electricity when consumers need it	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: • transform our balancing system and decision-making capabilities, and ensure we continue to make the right decisions in a highly complex energy environment. • necessitate the building of new training simulators, to provide better-quality, lower-cost and more scalable training for our power system engineers. At the same time, we will develop our customer- and stakeholder-facing capabilities to share how we make balancing decisions, in a simple and transparent way.
Theme 2 – transforming participation in smart and sustainable markets	To continuously design the markets, codes and charging arrangements that deliver benefits to consumers in the future, we require: • regulatory and commercial understanding of existing and potential service providers' business models, technologies and capabilities. • strong strategic market development capabilities to design and deliver our balancing service markets and the Capacity Market of the future. This will need to be backed by strong modelling capabilities, to simulate the results of potential changes to markets, and innovative procurement approaches. Skills required include coding, machine learning, data analytics and predictive analytics.

	• The design of those markets and codes changes will have to be supported by: • strong customer and stakeholder management capabilities. • the technology capabilities to understand the functional requirements of the ESO's customer-facing technologies, which will be key to successfully deliver the market portal. This capability will also allow us to continuously improve our systems, as they become increasingly automated and intelligent, thereby freeing up teams to focus on higher value work (as they shift away from administrative to strategic skills).
Theme 3 – unlocking consumer value through competition	Our people and systems will continuously build on our successful *Network Options Assessment* (*NOA*) approach to facilitate competition across all dimensions. This will require us to transform our data management and analysis, as well as our modelling capabilities in an enduring way. As a result, our cost benefit analyses will cover a wider and more complex range of solutions (from transmission asset investment, commercial solutions and distribution network solutions). These capabilities will need to be supported by strong programming capabilities, in order to integrate those solutions into existing or refreshed tools.
Theme 4 – driving towards a sustainable whole energy future	Stronger data management, analysis and modelling capabilities will also be required to optimise the planning, development, investment and operation of the whole system. These capabilities are also important to deliver our connections portal and Transmission Outage and Generator Availability (TOGA) enhancements. In line with theme 3, this will need to be supported by programming capabilities, for integration of those solutions into existing or refreshed tools. Additional supporting capabilities include: • enhanced customer relationship and contract management capabilities across transmission and distribution boundaries, specifically for the customer connections portal. • enhanced stakeholder engagement capabilities to ensure we co-create whole-system solutions with the industry in the most relevant way. We will also need enhanced strategic insight and analysis capabilities. This is particularly important in the policy space, to support the development of a smart, flexible energy system (including a clean-heat strategy and zero-carbon electricity).

Next steps: The above narrative will be adjusted once the strategic workforce planning exercise has been carried out.

16.2.3 Example initiative: Improvements in our training and understanding human factors

In Theme 1 (chapter 7) we are proposing activities to enhance our people and data capability and delivery of a digital twin training facility. Improved training and understanding human factors are covered in more detail here.

16.2.3.1 Improvements in our training capability

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. We will:

1. shorten and enhance initial control room job training and authorisation
2. improve ongoing individual and team training
3. enhance our existing facilities for off-line event simulation and team scenario training
4. reduce the time for new control engineers to be qualified for the role and ensure the exercising and team training necessary to maintain robust operational control room response to changing network conditions.

We expect this will involve partnering with universities and other industry parties to create a GB training standard. It will also involve designing and developing content, syllabus and multi-device training platforms. This could take the form of a qualification or degree (or modules thereof) in electricity system operation.

Our previous links with universities have been focused on power system equipment teaching. We will explore opportunities to work with universities to create a recognised qualification that better reflects the role the ESO and other operators take, including system operation, market structures, finance, regulation and strategy. We will explore possible partnership with DNOs, energy industry players, universities and other commercial partners to develop this.

We expect the skills we will be developing will be in high demand and can also deliver value elsewhere in the sector, for example in the DNO to DSO transition. In that context, our proposal will have two positive effects:

- on individuals in our business, by providing fulfilling development for our people that supports improved staff retention
- on our business, by creating a pool of talented people with the skills for the future, reducing our exposure to attrition.

16.2.3.2 Understanding human factors

We understand the impact shift work in a complex and stressful environment can have. We will adopt more flexible working practices to ensure the wellbeing and resilience of staff as the complexities of system operation increase.

The changing environment means we must rely less on historic experience and instead use more simulation and on-the-job training so control engineers remain able to respond securely to a wide range of operational scenarios. We have begun adopting this approach and have developed our business plan based on experience to date and good practice from other sectors.

Our proposed approach is like that used in other mission-critical processes, such as aviation and large industrial process control. It includes a combination of robust individual and team teaming, and scenario exercises with ESO personnel and relevant personnel from across the industry. As well as allowing us to deliver the necessary level of competence for operations, the facility will also allow joint training and development on new interfaces for DSO personnel and others across the industry.

16.3 Highlighting the big gaps in capacity and capability

As well as providing insights into future workforce demand, the strategic workforce planning analysis will help us understand the challenges we face on the supply side. This means looking into retirement and attrition rate – and understanding where supply will not meet demand both in terms of capacity and capability.

As an example, due to the drastic evolution in capabilities that our power system engineers need to have, we recognise the market will potentially not be able to supply us with the capabilities we require. This is one of the ESO's challenges in RIIO-2 – and we have outlined proposals to resolve this within the Theme 1 chapter.

Next steps: Our strategic workforce planning exercise will highlight any significant capacity and capability gaps that we will have to supply.

16.4 Our strategy for workforce resilience in RIIO-2

16.4.1 Sourcing a capable workforce

Once we have identified where the gaps are, in terms of capacity and capability, we then need to decide how we will fill them. We are expecting some of the gaps to require a transformational sourcing strategy – for example, where we need to drastically increase the headcount in a particular area or where we require new capabilities that we have never had to source before. The questions we need to solve are how do we make sure we have the right people and capabilities at the right time; and how do we source them at the lowest cost for the consumer?

Next steps: Based on our demand and supply analysis, we will design a strategy for how we fill the big capacity and capability gaps in our workforce (e.g. power system engineering as outlined below).

16.4.2 Power system engineering capability gap

Science, Technology, Engineering and Mathematics (STEM) talent is a key workforce requirement for the ESO and it is in short supply. To ensure an ongoing, resilient STEM pipeline, we need to take ambitious steps to make an impact in this challenging environment. 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.

This STEM strategy will help source the power system engineers of the future, but it won't be enough to deliver the requirements under Theme 1. Hence, we propose the creation

of a Centre of Excellence training strategy for system operators across the whole electricity industry, as outlined below.

- We propose the creation of a Great Britain training standard. We would partner with academia to design and develop content, syllabus and multi-device training platforms.
- This would take the form of a degree, or modules thereof, in energy system operation. Our previous links with universities have been focused on power system equipment teaching.
- We would look to develop a course that better reflects the role the ESO and other operators take, including system operation, market structures, finance, regulation and strategy. We will explore possible partnerships with distribution network operators (DNOs) to develop this.

16.4.3 Technology 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.

We will draw on global IT delivery teams to provide consistent platforms, such as customer relationship management (CRM). This will allow us to leverage 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.

16.4.4 Sourcing an inclusive and diverse workforce

It is not enough to source a highly capable workforce; we also want to make sure that it is inclusive and diverse – thereby representing the communities we serve.

National Grid has seen positive incremental 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 Forbes Top 500 Employers for Diversity and 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, as we aim to be representative of the communities we serve. 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.
- actively 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 actively seek out and consider different views and perspectives to inform better decision-making.

16.5 Attracting and retaining a capable and diverse workforce

We use a blended approach to attract and retain our employees, by:

- ensuring that they are paid and rewarded at the right level.
- making sure they have opportunities for development in line with both employee and company priorities.
- being mindful of their health and wellbeing.

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 talent. Our employees have a strong purpose as they can anchor their contribution to the energy transformation at such an exciting time.

16.5.1 Focus on pay and reward

The ESO has a pay-for-performance philosophy.

One of the key aims of our compensation and benefits programmes is to be at the market median position in relation to our comparator group for remuneration. We carry out market benchmarking to ensure we remain market competitive. 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. We also have established pay mechanisms available to increase salaries where required, to close any capability gaps that the ESO is confronted with.

16.5.2 Focus on health and wellbeing

National Grid UK and ESO have 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.
- To create and embed 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.
- We are recognised as an employer that leads in employee wellbeing and this enables us to attract and retain the best talent around.

16.5.3 Cultural change

The right culture is key to enabling our transformation. We will look to ensure the right culture change levers are in place to reinforce behaviours such as;

- leading by empowering

- enterprise and collaborative mindset
- external scanning, customer, future-orientation
- agile and flexible
- acting at pace
- innovation, experimentation, balanced risk-taking, speedier decision making.

Once we have identified the desired culture we will work on a plan to close the gap from where we are now to the desired state.

16.6 Next steps

We will update this chapter after we have developed our strategic workforce plan. Our resource investments will be set out in the data tables and we will design, and develop a culture-change programme, which we will expand on in October.

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