nationalgridESO

ESO Digitalisation Strategy

December 2019

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Executive summary

Digitalisation of the energy system is key to capturing the benefits of the low carbon energy transition for consumers. Open data is the lifeblood of efficient markets and plays a crucial role in enabling innovation. As the energy revolution continues, the availability of quality data will be increasingly fundamental to developing new markets and empowering efficient decision-making and system operation.

Our mission as System Operator is to enable the transformation to a sustainable energy system and deliver reliable, affordable energy for all consumers. Use of data and digital technologies is critical to this.

We are in the early stages of digitalisation. We are moving to achieve enhanced data analysis and data-driven decision making, using an ever-increasing range of data sets. As the energy system becomes fully digital, many further opportunities will open up across the electricity system.

As the Electricity System Operator (ESO), we will deploy data and digital technologies to drive the energy transition and delivery of consumer value. Our strategic intent is to transform our capabilities to:

> **Accelerate our evolution as a world-leading system operator through the application of digital technology to drive design and operation of the energy system and markets**

We will achieve this by delivering the three pillars of our digital strategy:

1. **Deliver open data and digital market enablement**
   Adopting the principle of 'presumed open' and making all of our shareable data available in an accessible format to inform efficient business decision-making across the industry and drive innovation. Removing barriers to market participation and transforming the customer experience through digital enablement.
2. **Build our core capability through digital technology**
   Transforming our business processes such as energy forecasting, system operation and network planning to enable secure and efficient operation of the electricity system and markets.
3. **Transform our organisational culture and digital ways of working**
   Developing the right capabilities and skills in our workforce alongside a supporting culture and behaviours to foster an agile, innovative and experimental operating environment.

The following chapters set out what we need to do to deliver each of the three strategic pillars through a phased approach.

Realising the potential of digitalisation and open data for energy consumers will require significant collaboration across and beyond our industry. Our digital strategy is anchored in the recommendations of the Energy Data Taskforce (EDTF) and we will play a leading role in their delivery. Throughout this document we signpost how our plans support delivery of the recommendations.

We will continue to learn from others, both inside and outside the energy sector, and openly share our experiences and learnings. We welcome review and constructive feedback on our strategy and offer opportunities for stakeholders to engage us in the *Continuous development of our Digitalisation Strategy* section of this document.

1. Introduction and context

1.1 The future is already here

As the ESO 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 when they need it. We operate markets to ensure we have the energy, capacity and services we need to maintain a reliable and secure system at least cost to consumers. We have a unique position in the energy system and our own transformation is essential to enabling the broader energy transition.

The 'three Ds' – decentralisation, decarbonisation and digitalisation – have transformed the energy sector, defining an energy system where:

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

This energy future brings significant opportunities for creating consumer value through more efficient markets and new tools to ensure network security in a zero-carbon market. In *Our RIIO-2 ambition* document[1], we set out our ambition to be able to operate a zero carbon system by 2025. This will require significant additional flexibility in the system. Our control centre engineers will need to make more decisions in an increasingly unpredictable environment. We will need new markets and new procurement approaches to attract the flexibility required through cost-efficient market mechanisms. Our stakeholders have told us to be ambitious as our role is critical to the successful decarbonisation of the sector.

In 2021 the ESO will begin operating under a new regulatory framework, RIIO-2. This will be the first bespoke regulatory deal for the ESO as a separate business from NGET, the electricity transmission owner for England and Wales. Our RIIO-2 Business Plan[2], sets out our goals and delivery plans for transforming our capabilities and facilitating the energy transition across four themes:

Theme 1: Reliable, secure system operation, to deliver electricity when consumers need it - how we will expand and transform our control centre architecture and systems, so that we can operate a zero carbon electricity system by 2025

Theme 2: Transforming participation in smart and sustainable markets – how we will attract the flexibility we need to manage a zero carbon system through building new balancing services markets and developing industry frameworks that are fit for purpose in the new world

Theme 3: Unlocking consumer value through competition - developing new competitive processes to allow asset and non-asset solutions to compete to meet future system needs at lowest cost to the consumer

Theme 4: Driving towards a sustainable, whole energy future – working with Distribition Network Operators (DNOs) to enhance our whole system modelling and

[1] https://www.nationalgrideso.com/document/141256/download
[2] https://www.nationalgrideso.com/about-us/business-planning-riio/riio-2-draft-business-plan

analysis; define innovative ways of achieving zero carbon, whole system operation; and optimising the connections and system access processes

A full description of our planned activities, including cost-benefit analysis, can be found in our RIIO-2 Business Plan.

1.2 Harnessing the potential of digital technology to enable zero carbon system operation and markets

Harnessing the power of open data and digital technologies, such as artificial intelligence and machine learning, will be crucial to delivering our RIIO-2 business plan and achieving **whole system, zero carbon system operation underpinned by efficient markets**.

The Energy Data Taskforce (EDTF) was established to provide Government, Ofgem and Industry with a set of recommendations on how data can assist with unlocking the opportunities provided by a modern, decarbonised and decentralised energy system at the best value to consumers.

"Digitalisation and data are essential to managing the energy system efficiently and securely through the energy transition. We welcome this industry-wide Digitalisation Strategy and we look forward to closely supporting it's delivery."

Fintan Slye, Director, ESO

We provided critical input into the EDTF's deliberations and have formally endorsed the recommendations. Our Digitalisation Strategy is anchored in these and will reference our actions to deliver them throughout this strategy.

We agree with the EDTF that access to more and better data and the application of digital technologies will deliver benefits including:

- Enhancing the efficiency of system operation through optimised decision support
- Improving the efficiency of balancing services procurement
- Enabling innovation for new operability services and business models
- Enhancing whole system modelling to support future operability strategies.

We will deploy data and digital technologies to drive the energy transition and deliver consumer value. Our strategic intent is to:

> **Accelerate our evolution as a world-leading system operator through the application of digital technology to drive design and operation of the energy system and markets**

We will fulfill this strategic intent through delivering the three pillars of our digital strategy:

Deliver open data and digital market enablement
Adopting the principle of 'presumed open' and making all of our shareable data available in an accessible format to inform efficient business decision-making across the industry and drive innovation. Removing barriers to market participation and transforming the customer experience through digital enablement.

Build our core capability through digital technology
Transforming our business processes such as energy forecasting, system operation and network planning to enable secure and efficient operation of the electricity system and markets.

What are digitalisation and open data?

In this strategy we use the term **digitalisation** to mean the application of data and digital technologies, such as Artificial Intelligence (AI) and machine learning, to fundamentally change and improve how we do our job.

According to the Open Data Institute **Open data** refers to data that is available to everyone to access, use and share.

Transforming our organisational culture and digital ways of working
Developing the right capabilities and skills in our workforce alongside a supporting culture and behaviours to foster an agile, innovative and experimental operating environment.

These three pillars will maximise the consumer value of applying digital technologies across our activities as framed by the four themes of our RIIO buisiness plan. A high-level overview of how the pillars of our Digitalisation Strategy map to our business plan themes and the EDTF recommendations can be seen the graphic on the next page.

We are currently deploying new data and digital technologies to enhance our activities including energy forecasting, balancing and network analysis. We are also increasing data sharing across the energy industry as well as using digital technologies to enhance the customer experience.

This document outlines the steps we are taking now and our future plans for using new data and digital technologies across everything that we do.

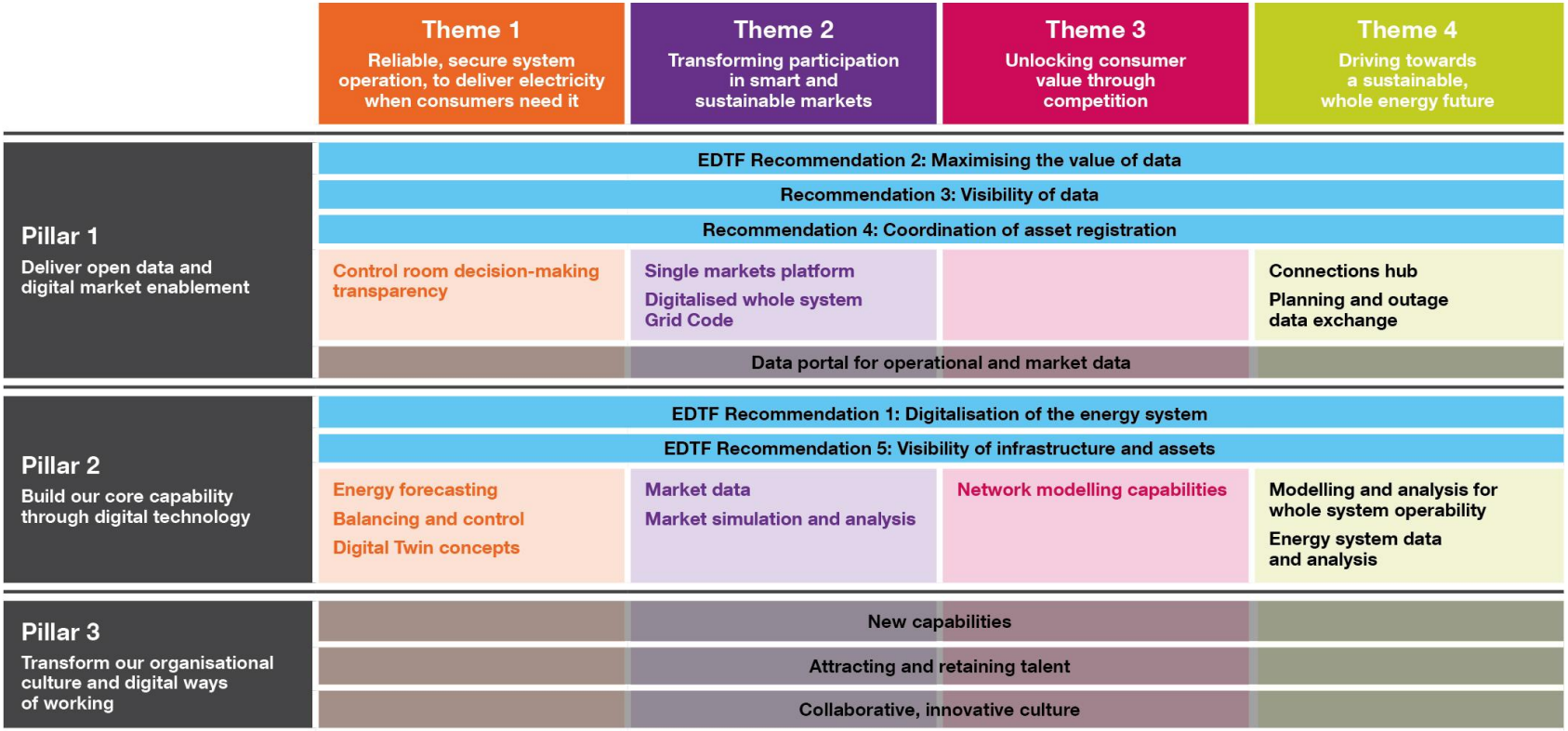


Figure 1 - ESO digitalisation landscape

2. Pillar 1: Deliver open data and digital market enablement

We need to attract new sources of flexibility to support the operation of a reliable and secure zero carbon electricity system at least cost to consumers.

Strategic pillar 1 ‘Deliver open data and digital enablement’ is key to maximising participation in efficient markets. Open data will enable efficient investment and operational decision-making and drive innovation across the industry. Digital market engagement will remove barriers to market participation, increasing efficiency of markets.

Across all our activities we will be using a **digital engagement platform** to create a seamless user experience for doing business with us. Major uses of the digital market engagement platform explained in this chapter include:

- data portal
- single markets platform
- digitalised whole system Grid Code
- connections hub
- planning and outage data exchange.

The figure below shows the services our customers and stakeholders will be able to access through the **digital engagment platform**. All external-facing processes will be driven and updated from the **digital engagement platform** and new tools will be introduced to support document management, collaboration, digital rights management, version management and workflow planning.

The figure also illustrates how those services will use the capabilities of the foundational **data and analytics platform** to share data.

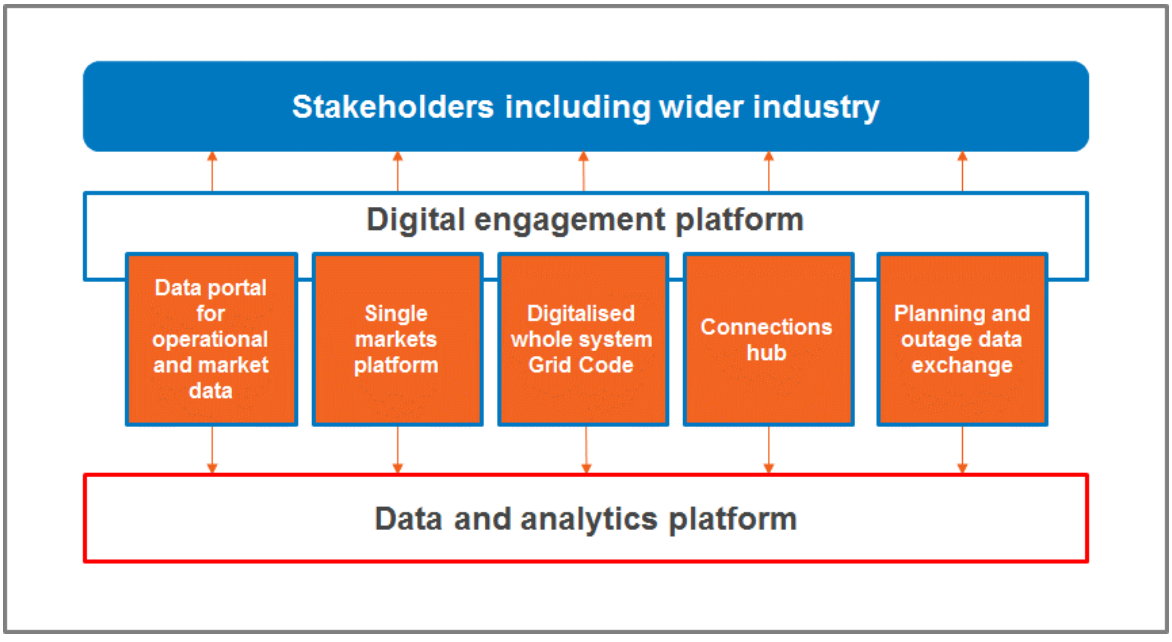


Figure 2 - ESO Digital engagement platform

2.1 Open data enabling efficient markets and zero carbon system operation

With ever-expanding digitalisation, the availability of quality data will be increasingly fundamental to developing new markets and empowering efficient decision-making.

To realise that potential, our stakeholders have told us that the energy industry must transform the way in which data is managed, structured and shared. We must move from a world where there is very limited access to usable data to one where data is seen as open and shareable by default, both accessible and fit for purpose.

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 for solutions to benefit consumers. Current and potential market participants have told us enhanced data and insight are essential for price discovery, efficient investment and operational decision-making.

Stakeholders have also told us that the initial areas we should focus on are forward-looking view of system requirements; a whole electricity system view of constraints; and real-time margins and utilisation. Providing insights into future balancing service requirements will enable better investment decisions and innovative solutions to managing operability challenges, thereby reducing costs for consumers.

In addition to raw data, where our stakeholders identify a need, we will continue to provide analysis, insight and guidance to support and understand our data. For example, balancing market participants have identified better understanding of control room decision-making processes as a key area. We will explain how control room decisions are made, referencing the relevant data.

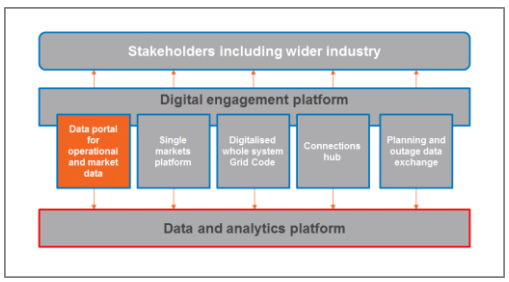
Sharing our data and providing enhanced transparency will lead to investments in the services that society needs, so they will be available when consumers need them. This information also supports the optimisation of operational and commercial decisions in market timescales, driving market efficiency.

2.1.1 Strategic actions to deliver open data

2.1.1.1 Data portal

As one of the main custodians of energy data in the UK, we will play a central role in fulfilling its potential. As the number and diversity of market participants continues to increase, system operation moves closer to real time and whole electricity system solutions are developed; the data sources we use to operate the system and markets will also increase. To maximise the value of our data and respond to our stakeholders' needs, our default approach will be: all the data we hold is 'presumed open' unless subject to commercial, legal, network or cyber security risks or restrictions. In support of this we intend to adopt a licensing approach based on the Open Government Licence[3].

Our work on open data will support the development of industry-wide data management tools such as the Data Catalogue, **EDTF recommendation 3: Visibility of data**. We expect a wide range of parties to use data we share to innovate, imagining new solutions to system operability challenges and optimising market efficiency.



We are currently developing a foundational data portal, which will initially address the issues our stakeholders have voiced around

[3] http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/

the accessibility, understanding and consumption of our data.

Through this portal, we will create a centralised repository for all published ESO data; we will develop a clear and intuitive user interface for searching and querying our data. It will allow us to add rich metadata to each dataset and a powerful Application Programming Interface (API) for all datasets. Additionally, it will offer features such as on-screen visualisation and data manipulation tools to support understanding and consumption.

Supported by underlying changes to our data management capabilities, we will continually transform the quantity and quality of the datasets we make available. The implementation of the data and analytics platform, outlined in Pillar 2 will allow real-time access to all our operational data, allowing us to automate data publishing and to add new datasets quickly and efficiently.

Our work in this area will support the delivery of **EDTF recommendations 2: Maximising the value of data and 3: Visibility of data.**

From the start of the RIIO-2 period we will assess, validate and structure all of our operational and market data, sharing it according to published criteria. We will first target datasets identified as of highest value to stakeholders and aim to have published all our relevant data by the end of the period.

In the first year of the RIIO-2 period we will publish a schedule for sharing our data on the ESO portal, providing a clear roadmap for when we will make datasets available.

All published datasets will meet defined quality standards, in line with the EDTF's recommendations that data should be discoverable, searchable and understandable. This will include publication of metadata about the data sets. We will provide powerful and logical search capabilities to support navigation. All our data will be available via an API and we will provide raw data for all visualisations or insights.

The data portal will also be a tool for sharing outputs of our enhanced data and modelling collaborations with other organisations. Further information on options, delivery and cost benefit analysis can be found in our RIIO-2 proposals:

- ESO RIIO-2 Business Plan section Activity A17, chapter 8, section 8.2.1.2.
- Annex 2 - Cost-benefit analysis (CBA) report, section 6.
- Annex 4 - Technology investment report, 6.1, IT investment 250.

2.1.1.2 Data security and privacy

While we will adopt a "presumed open" philosophy, we will remain 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 requirement for aggregation or anonymisation of datasets according to published criteria including:

Consumer privacy – for example, personally identifiable information not publicly available

Security – for example, the location of Critical National Infrastructure (CNI) assets/systems not otherwise generally visible directly or through other sources

Commercially sensitive – for example, Capacity Market auction bid information

Negative consumer impact – data that is likely to drive actions, intentional or otherwise, which will negatively impact consumers.

2.2 Transforming the customer experience through digital market enablement

We manage many markets, industry processes and frameworks that influence the efficiency of market outcomes. We believe there is great potential to improve the

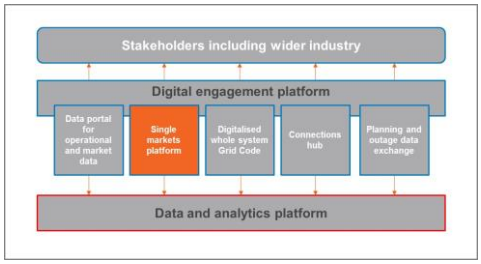
efficiency of energy markets through applying digital technologies to enhance the customer experience of interacting with us.

Our customers and stakeholders currently have many touch points with us across activities such as participating in market processes, providing balancing services, understanding or changing industry frameworks, making connection applications or managing system access. We use a range of tools and channels for managing these interactions. Many include a mixture of email, offline spreadsheets, online forms and online platforms. Our proposals will streamline customer interactions with us across key services.

2.2.1 Strategic actions to deliver digital market enablement

2.2.1.1 Single markets platform

We are implementing a number of actions now to enhance the service provider experience and reduce barriers to entry through digital market enablement technologies. For example, we have enabled online completion of pre-qualification and registration processes for wider access to the Balancing Mechanism.



Going forward, we will move an increasing number of customer facing balancing services procurement processes online and in one place.

We are making it easier for all parties to sell services to us through the development of a single markets platform. This one-stop-shop will provide a focal point for parties of 1 MW and above to participate in all our ESO balancing service markets. It will also provide access to the Capacity Market and the Contracts for Difference auctions.

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

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

The foundation of the platform will be an asset register identifying each unique asset on the transmission or distribution system that is participating in the markets. Participants will be able to manage their portfolio by aggregating assets from these underlying components to participate in the markets. We will seek opportunities to align further development of asset registers to support participation in ESO markets with **EDTF Recommendation 4: Coordination of asset registration**.

Our work in this area will support the delivery of **EDTF Recommendation 4: Coordination of asset registration**

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

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

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

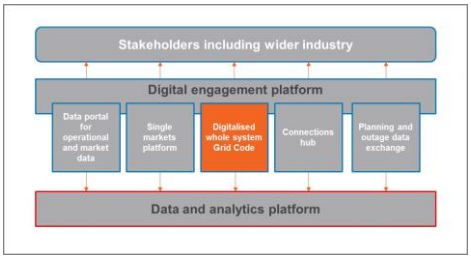
The market platform will significantly reduce overheads of market participation by streamlining the process, reducing manual input and checking, making market outcomes more efficient. Extensive stakeholder engagement has told us this will transform the experience and make participating much more efficient.

Further information on options, delivery and cost benefit analysis can be found in our RIIO-2 proposals:

- ESO RIIO-2 Business Plan section Activity A4.4, chapter 5, section 5.2.3.2.
- Annex 2 - Cost-benefit analysis (CBA) report, section 3.1.
- Annex 4 - Technology investment report, section 3.6, IT investment 400.

2.2.1.2 Fully digitalised whole system Grid Code

In the RIIO-2 period we will use digital technologies to make it easier to understand and manage industry frameworks and participate in the process to manage and modify them.



As part of our proposal to develop a single technical code for distribution and transmission we will use the latest data technologies to support navigation of the codes, tailored to each code user's individual needs. A more user-friendly and inclusive experience will better meet the diverse needs of our customers.

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

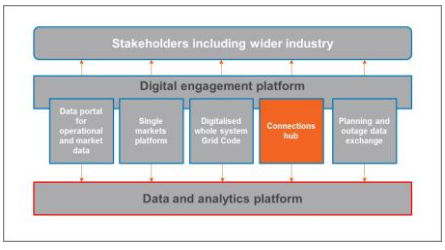
By making it easier to understand and navigate industry codes, we will also improve access for new, smaller entrants and encourage innovation in the market.

Further information on options, delivery and cost benefit analysis can be found in our RIIO-2 proposals:

- ESO RIIO-2 Business Plan section Activity A6.5, chapter 5, section 5.4.3.2
- Annex 2 - Cost-benefit analysis (CBA) report, section 3.5
- Annex 4 - Technology investment report, section 3.5, IT investment 330

2.2.1.3 Connections hub

As the ESO we play a central role in helping energy resources to connect to the GB electricity transmission system. To enhance our service provision, we will develop, in co-ordination with other network organisations, a connections hub that provides a seamless connections experience to customers.



The connections hub will enable participants to access specific information on available network

capacity as well as on-line account management. Being able to quickly understand where network capacity exists should help low carbon developers more quickly navigate the connections process. This will speed up the decarbonisation of the energy sector.

We will work with other network organisations to develop the connections hub. It will feature information provided by different parties as well as links to the appropriate network organisation for customers' needs whether they want to connect at the transmission or distribution level. Facilitating access to information across the whole electricity system will allow informed, efficient connection decisions, whether to connect to the transmission system or a distribution network.

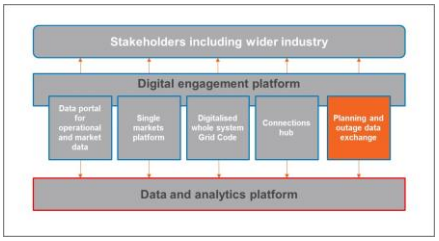
Further information on options, delivery and cost benefit analysis can be found in our RIIO-2 proposals:

- ESO RIIO-2 Business Plan section Activity A14.4, chapter 7, section 7.2.3.
- Annex 2 - Cost-benefit analysis (CBA) report, section 5.2.
- Annex 4 - Technology investment report, section 5.4, IT investment 380.

2.2.1.4 Planning and outage data exchange

We facilitate efficient access to the network by Transmission Owners (TOs) and connected parties for maintenance and construction activities.

Customers, including generators and DNOs, are expecting increased levels of service both from us and TOs to minimise short-notice disruptions and to improve communication of any changes as ultimately this leads to additional cost. At the same time, more active distribution networks present opportunities for market-based solutions to system access.



To address our customers' needs and stimulate potential DER markets we will improve and extend our outage notification system. We believe 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. We will develop TOGA to offer a more interactive experience for customers, stakeholders and the market. This will include the use of mobile apps, alerts and other digitally-enabled technologies. Further information on options, delivery and cost benefit analysis can be found in our RIIO-2 proposals:

- ESO RIIO-2 Business Plan section Activity A16.4, chapter 7, section 7.4.5.3.
- Annex 2 - Cost-benefit analysis (CBA) report, section 5.4.
- Annex 4 - Technology investment report, section 5.2, IT investment 350.

3. Pillar 2: Build our core capability through digital technology

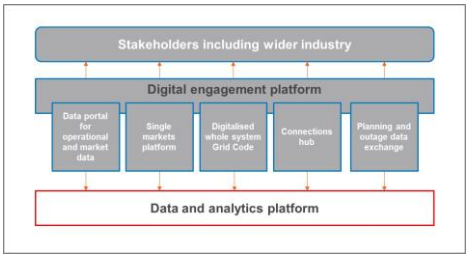
Consistent with **EDTF Recommendation 1: Digitalisation of the energy system**, we agree that more detailed, accurate and timely data will enable new operational paradigms and business models.

Effective use of data and digital technologies is absolutely critical to delivery of our goal to be able to operate a zero carbon electricity system by 2025.

The changing energy system, including high proportions of renewable and distribution-connected generation and more active demand, brings with it challenges for planning and operating an efficient and secure electricity system. We believe the application of digitial tools such as automation and AI to existing and new data to enhance capabilities across our business can help us to meet these challenges.

Supporting delivery of our digitalisation goals and the EDTF recommendations will require wholesale changes to our IT infrastructure. We will replace our internal data management systems with a new **data and analytics 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 extensible, scalable and interoperable. The data and analytics platform will be a key enabler for all of the data rich activities across our organisation outlined in the following sections as well as our open data proposals described in the previous section.



Further information on our data and analytics platform can be found in our RIIO-2 proposals:

- ESO RIIO-2 Business Plan section Activity D1.4.1, chapter 4, section 4.2.3.3.
- Annex 4 - Technology investment report, section 2.10, IT investment 220.

In this section further information on the challenges, opportunities and how the ESO is applying data and digital technologies to transform our operations is provided for each of the four themes of our RIIO-2 Business Plan.

3.1 Theme 1 - Reliable, secure system operation, to deliver electricity when consumers need it

3.1.1 The challenge

With the transition to more renewable and distributed sources of electricity supply and more active energy users, system operation becomes more complex.

We need new sources of data to better understand the real time characteristics of this new system. Forecasting supply and demand becomes more challenging. Our control centre needs to take more and faster actions to balance supply and demand and operate a secure network.

3.1.2 The opportunity

In line with the EDTF principle of ‘new data needs’ we believe access to more and better data as well as automation and advanced analysis tools can transform system operations. These tools will allow us to operate a secure, zero-carbon electricity system at least cost to consumers including:

- machine learning and AI to support improved supply and demand forecasting
- more predictive and automated approaches to system management enabling more efficient and secure operation of the system

- greater visibility of assets on the system and their behaviour providing a wider range of options for system operation actions andimproved outcomes
- enhanced data-sharing and operational interfaces with DNOs will provide an expanded toolkit for managing the system.

3.1.3 Delivering our digital strategy

3.1.3.1 Energy forecasting

Our forecasts contribute to the decision making of market participants through operational and pricing decisions delivering better functioning markets. Better forecasts with less uncertainty also benefit consumers, as less uncertainty means our control centre needs to hold fewer balancing services in reserve, resulting in lower spend on response and reserve services.

We are using modern digital technology to build a new platform for energy forecasting (PEF) to replace our current forecasting system. By March 2020 this will result in enhanced demand, wind and solar forecasts.

There are four digital enablers to this:

- Data management – implementing effective management, control and governance to create and maintain a trusted data set on which forecasting models, operations, the market and reporting can rely on.
- Reporting and analytics – data exploration and KPI reporting, embedding insights into operations and for market participants.
- Modelling and automation – wide enablement of automation and advanced modelling technologies, including machine learning, to streamline operations and deliver ongoing, sustainable improvements. To give an order of magnitude, the current estimate is that when wider access to the Balancing Mechanism comes in, we anticipate training in the order of 100,000 concurrent models daily which represents several orders of magnitude increase from the present day.
- Operational support and modelling – round-the-clock support, maintenance and troubleshooting for data capabilities, ensuring system stability, robustness and compliance with Grid Code and licence obligations.

Enhancing these capabilities has already led to a 12% improvement in our day-ahead demand forecasting. Further enhancements will substantially increase the number of forecasts we provide, including 24 daily demand, wind and solar forecasts.

Through our innovation projects in collaboration with the Alan Turing Institute and Sheffield Solar (part of the University of Sheffield), we have delivered a 33% improvement in solar forecasting. This has been through new advanced modelling capabilities and more accurate data.

We worked with the Alan Turing Institute to create a new ‘random forest’ approach to analyse 80 input variables, instead of just two we used previously. The random forest uses machine learning to train itself to find hundreds of different mathematical pathways (or decision trees) to arrive at an output generation figure.

We then combined this with enhanced solar PV forecasts, developed with Sheffield Solar. These were produced by combining accurate generation data from a sample of solar PV systems and using advanced statistical models to scale that to a national level.

3.1.3.2 Balancing and control

We are conducting foundational work to ensure our current systems can manage an increasing number of market participants, both as the market decentralises and from external initiatives such as wider access to the Balancing Mechanism.

We are working with the Smith Institute to update the modelling capabilities in our current Balancing Mechanism dispatch tool. This involves rewriting the algorithms in modern coding language and boosting the computing power to allow it to consider more variables and give a better solution.

We are also updating the API modules to allow more participants to communicate with our systems. We will move from hardwired point-to-point communication, which is cost prohibitive for many smaller parties, to web-based communication systems that can be scaled easily.

Moving towards the RIIO-2 period we will see a step change in our application of new data and digital technologies; enhancing our capabilities and enabling secure operation of a zero carbon electricity system.

Building on strategic design work and inertia forecasting and modelling in RIIO-1, automation, machine learning and AI will enable us to handle greater volumes of incoming data and balancing actions. We will be able to schedule and dispatch very high volumes of renewable and distributed generation. More efficient balance of supply and demand will minimise the costs of operating the system and bring benefits to consumers.

We will develop new online and offline modelling capabilities, including whole electricity system simulation and modelling aided by machine learning and probabilistic analysis. This enhanced look-ahead capability will allow us to predict transmission problems in a more volatile operating environment and take actions ahead of real-time to reduce cost. New situational awareness tools and upgrades to our control centre video walls and operator consoles will allow us to visualse and analyse more operational data. This will give us a better understanding of the 'operating envelope' and mean we can optimise decisions to run a more efficient system safely and at lower cost to consumers.

3.1.3.3 Digital twin technology

We will use simulation and hypothesis testing using digital twin technology to enhance the way we develop our new balancing and control tools, which will then be built offline in a modular and agile way. In a cultural shift, we will move away from large tools and IT systems, where the algorithms, data and control centre user interface sit together, to smaller tools that only house the system algorithms, with data sitting on the central data and analytics platform with the interface bundled up. This benefits future energy consumers, by making it easier for us to upgrade tools in the future as we will only need to amend the algorithms.

Our use of digital twin technology is aligned to the vision for the UK national digital twin (NDT). We will consider how to engage with stakeholders, such as via the Centre for Digital Built Britain Digital Twin Hub[4]. This aims to create a federation of digital twins, and could bring huge benefits for system operation. For example, connecting a digital twin of our electricity system balancing tools to those that model electric vehicles (EVs) could help us better understand the challenges and opportunities from increased EV uptake.

The digital twin technology will be aligned to the Gemini Principles[5], which guide the development of the NDT:

- **Must have clear purpose**: our digital twin technology will help inform the development of our new balancing and control tools and help the ESO make better operational decisions. It unlocks consumer benefits as we set out in us RIIO-2 cost-benefit analysis.

[4] https://www.cdbb.cam.ac.uk/DFTG/NDTHub
[5] Centre for a Digital Built Britain – Gemini Principles https://www.cdbb.cam.ac.uk/DFTG/GeminiPrinciples

- **Must be trustworthy**: the digital twin technology will create replicas of our critical national infrastucture (CNI) systems and will be subject to the appropriate levels of security. We will work with industry, in particular TOs and DNOs, to run joint training and simulation exercises using our digital twin technology and replicas of their own assets to faciliate increased whole system thinking and training.
- **Must function effectively**: using digital twin technology in a modular fashion as we develop our new balancing and control capabilities, means we will remain agile, able to adapt as technology and society evolve. Having flexilbility will be a key enabler to meeting the UK's net zero ambition by allowing us to take advantage of new services, technologiies and thinking that can support decarbonisation.

Further information on options, delivery and cost benefit analysis can be found in our RIIO-2 proposals:

- ESO RIIO-2 Business Plan chapter 4.
- Annex 2 - Cost-benefit analysis (CBA) report, section 2.
- Annex 4 - Technology investment report, section 2.

3.2 Theme 2 - Transforming participation in smart and sustainable markets

3.2.1 The challenge

To operate the zero carbon electricity system we will need a lot more flexible sources of energy supply and demand. We will need new markets for new services, such as stability services to manage the decline in system inertia. We will need to design, deliver and operate new markets with more and new participants with diverse characteristics and behaviours. We need new data to understand these participants and new tools to understand how new markets will perform.

We will also need new data sources and analytical tools to better understand future volumes of different types of flexibility and capacity we will need.

3.2.2 The opportunity

New data can help us to understand the characteristics of current and potential market participants. Advanced modelling techniques to simulate how markets may perform enable us to trial new markets and procurement approaches at pace. This will support procurement of balancing services at least cost to current and future consumers.

3.2.3 Delivering our digital strategy

3.2.3.1 Market data

We have been working to better understand our data needs to facilitate new markets and gain access to insightful data.

We are working with UK Power Networks, SP Energy Networks and Electron to develop and demonstrate an asset register for energy resources. The *RecorDER* project[6] seeks to define, assess and pilot a blockchain-based asset register, enabling parties to use a shared data set of generation and flexibility resources.

This project will inform EDTF Recommendation 4: Coordination of asset registration.

This project will help us to understand whether a shared asset register for flexibility assets will enhance whole-electricity-system visibility,

[6] https://www.smarternetworks.org/project/NIA_NGSO0018

data quality and accuracy, ultimately facilitating easier trading of assets across transmission and distribution.

As residential energy users and producers become more active, we need to understand their evolving characteristics and potential contribution to balancing markets. The *Residential Response* project[7] is developing new approaches for testing, monitoring and managing portfolios of residential-scale assets for participation in ESO balancing services.

Fit-for-purpose procedures for data capture and performance measurements are essential for wider participation in balancing services markets. The project will determine procedures for data capture and options for measuring power and frequency from large portfolios.

3.2.3.2 Market simulation and analysis

As we move towards the RIIO-2 period we will increasingly apply new sources of data and advanced modelling tools to simulate market behaviour.

We will enhance our balancing market simulation capability through trialling potential solutions in an experimental market sandbox environment. Our current analogue systems mean we currently trial new approaches through integration and testing with operational systems, making us risk-averse. In future, we will build digital replicas, using live data in an offline environment, allowing us to safely test new approaches, learn-by-doing and driving continuous improvement. This will allow scope for further iterations, benefitting future energy consumers.

To improve our security of supply modelling capability, ensuring we have the capacity we need in the future low carbon, more decentralised world, we will develop new data sets, models and methods to model; the growing interactions of non-conventional plants; the contribution from new combinations of technologies, e.g. co-located hybrid sites where there is connection limitation; and, with growing interconnection across Europe and GB, interactions of future plant mixes and operational regimes across Europe.

Further information on options, delivery and cost benefit analysis can be found in our RIIO-2 proposals:

- ESO RIIO-2 Business Plan chapter 6.
- Annex 2 - Cost-benefit analysis (CBA) report, section 3.
- Annex 4 - Technology investment report, section 3.

3.3 Theme 3 - Unlocking consumer value through competition

3.3.1 The challenge

Alongside the impacts on system operation, the continuing growth of distributed generation and new technologies makes network planning more challenging.

Effective network planning allows us to better manage associated costs of network development and operation in the future. We need to be able to manage the rising number of scenarios and increased modelling complexity driven by the growing interaction between different system needs, such as voltage and stability. We also need to consider a whole system approach to network development and plan for increased uncertainty across the year due to low carbon generation. The better we understand likely needs, the better we can identify where and when to efficiently invest.

3.3.2 The opportunity

Enhanced data management and network-modelling capabilities help us to respond to the increased volume and complexity of network challenges. By better understanding

[7] https://www.smarternetworks.org/project/nia_ngso0025

interactions, we can plan effectively for solutions that meet multiple needs. New tools and techniques, such as probabilistic modelling, allow us to have a wider and more refined view of network needs across the year rather than focusing on a single point in time, such as winter peak capacity.

Greater integration between the different modelling tools will allow us to better understand the interactions between different network needs – and optimise our economic decision-making.

3.3.3 Delivering our digital strategy

3.3.3.1 Network modelling capabilities

We are establishing new, more efficient ways to undertake more complex analysis and assess the growing number of interactions between different network issues. Through innovation projects, we are exploring ways to improve our modelling techniques to enhance our analysis and decision-making.

We are working with Strathclyde University to investigate 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. 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.

We will also integrate our economic-assessment tools with our power-system modelling tools, building in the processing power to solve ever more complicated network optimisations.

Our work in this area will support the delivery of **EDTF Recommendation 5: Visibility of infrastructure and assets** and the Digital System Map.

Subject to the success of our probabilistic modelling and voltage optimisation developments, from 2024 we will provide an online portal for stakeholders to see a visual representation of network needs and to potentially test high-level solutions.

Further information on options, delivery and cost benefit analysis can be found in our RIIO-2 proposals:

- ESO RIIO-2 Business Plan chapter 6.
- Annex 2 - Cost-benefit analysis (CBA) report, section 4.
- Annex 4 - Technology investment report, section 4.

3.4 Theme 4 - Driving towards a sustainable, whole energy future

3.4.1 The challenge

The growth of low carbon and renewable generation, closures of conventional thermal power stations and changing interactions across the whole of the power system are just a few of the areas that create operability challenges of the future electricity system. We need to improve our understanding of how the whole system will behave in the future and simulate potential solutions. For example, significant increases in distribution-connected generation require us to model the operational characteristics of distribution networks using much higher volumes of data.

Decarbonisation of the UK energy system will also require coordinated solutions across energy vectors including power, heat and transport. Providing analysis to support policy development is driving the need for new data sets and innovative approaches to complex interactions.

3.4.2 The opportunity

Through new data capture, increased sharing of network data and advanced modelling we are improving our understanding of the evolving characteristics of the whole electricity

system. The ability to undertake more complex system modelling including data exchange, sharing and analysis will help to develop a whole system approach for zero carbon operability.

Access to much more information and data relating to networks and parties across the whole energy system, enhanced long-term modelling and improved analysis tools and processes will enable us to provide broader and deeper insights to inform policy development.

3.4.3 Delivering our digital strategy

3.4.3.1 Modelling and data exchange for whole system operability

We are supporting cross-industry efforts to enhance data sharing and collaboration. One example isthe Energy Networks Association (ENA) Open Networks project proposal to build on the current Grid Code data requirements to exchange more granular information on distribution networks and distributed energy resources (DER). This data will help us more efficiently identify future transmission system needs and support timely connection of DER through the Statement of Works process. This is just the first step; more granular data can help us work with other network organisations to efficiently manage an increasingly decentralised grid.

Our increasingly probabilistic approach to modelling will help to accelerate scenario planning, including closer-to-real-time. We are also investigating the use of AI and automation to enable improvements in modelling.

We are also applying learnings from innovation projects to enhance our future operability analysis and planning including:

- Enhanced Frequency Control Capability (EFCC)[8] project to enhance visibility of frequency data at a regional level and facilitate the participation of demand side response (DSR) providers in balancing markets.
- Investigation & Modelling of Fast Frequency Phenomena[9] which will gather detailed information on frequency fluctuations from PMUs (Phasor Measurement Units) and develop a visualisation approach for overlaying the data on the GB power system. The project will also explore and evaluate whether current power system modelling software can comprehensively explain the observed phenomena and make recommendations for any improvements to the ESO's data, models or processes.

3.4.3.2 Energy system data and analysis

Our ability to provide insight to inform whole energy system policy is built on data-driven analysis, including data from our innovation projects including:

- The Network Innovation Allowance (NIA) project on EVs' charging behaviour[10], which has brought a step change in our modelling of electricity demand from EVs.
- Our self-funded carbon intensity forecasting project[11], which uses machine learning and automation to provide more accurate forecasts. We publish these forecasts to enable consumers, academics and

Our work in this area will support the delivery of **EDTF Recommendation 5: Visibility of infrastructure and assets** and the Digital System Map.

[8] https://www.smarternetworks.org/project/ngeten03
[9] https://www.smarternetworks.org/project/NIA_NGSO0007
[10] https://www.smarternetworks.org/project/nia_ngso0021
[11] https://carbonintensity.org.uk/

industry stakeholders to make more informed choices, and ultimately move the industry towards optimising the use of renewable electricity.

In future we will increase our collaboration with DNOs and a wider range of stakeholders to inform our insight on whole energy system policy. We will develop more granular models, both geographical and temporal, and incorporate increasing volumes of data, such as from smart meters. This includes developing local models with DNOs and gas distribution networks covering the whole year, not just at times of peak demand. Modelling along the demand curve allows us to better reflect how it may change due to increasing solar power and use of electric vehicles. We will also support DNOs to develop their regional *FES* by aligning our energy data capture, analysis and modelling processes.

We will continue to enhance our data capture and capabilities, including delivering modelling improvements such as a spatial heat model[12]. This innovation project will enable a more regional approach to be employed to understand the locational impact of heat decarbonisation. This improved evidence base will allow better network planning outcomes and faster adoption of optimised decarbonisation solutions across gas and electricity systems.

Further information on options, delivery and cost benefit analysis can be found in our RIIO-2 proposals:

- ESO RIIO-2 Business Plan chapter 7.
- Annex 2 - Cost-benefit analysis (CBA) report, section 5.
- Annex 4 - Technology investment report, section 5.

[12] https://www.smarternetworks.org/project/nia_nggt0154

4. Pillar 3: Transform our organisational culture and digital ways of working

Achieving our strategic intent to be a world-leading organisation in the application of digital technology and open data will require transformation across all aspects of our business, including capability, people and culture.

We will transform our capabilities to deploy digital technology and data at speed across our activities. To be successful, these capability and talent shifts will be underpinned by a collaborative, innovative and experimenting culture.

4.1 A collaborative, innovative and agile culture

Today, the ESO has a strongly-engaged workforce. To achieve our digital ambitions, we will transform our business and take our employees along this change journey by continuing to adapt our organisational culture.

We are planning key behavioural shifts, for example embracing an enterprise and collaborative mindset and operating with agility and flexibility. These behaviours will be reflected and reinforced across all elements of our business to ensure everything, including leadership tone, governance, processes and systems support our desired culture.

Our people will need to challenge the status quo constructively and understand change behaviours and requirements as we transition to new systems and processes. We will need to think across functions to deliver systems and process change. We will use change management methods to implement new capabilities consistently; maintaining close working relationships with IT partners.

4.2 The people and capability shift

Today, two-thirds of our workforce comprises engineering capabilities (mostly electrical network control engineering) and commerciality (mostly commercial operations, market development and energy trading). Power system engineering will remain at the core of our organisation; however, advanced analytics and data management skills will be increasingly important and will require a significant shift in capability similar to other industries.

Our RIIO-2 Business Plan identifies five key business capabilities we will need to deliver our ambitions: power systems engineering; data and analytics; commerciality; leading the debate; and IT delivery. Whilst each of these capabilities is crucial, successful delivery of our digitalisation goals will require a particular shift in data and analytics, and IT delivery:

Data and analytics:

- To use data to provide rapid and automated predictive insights, providing value for system operation and market participants. This includes data science, analysis, modelling and programming capabilities, working with machine learning algorithms and AI, knowledge of statistics and neural networks
- this will improve our use of data throughout the timescales in which we operate. We will consider creating a central resource/centre of expertise to develop and share best practice, but it will be important to also have these capabilities embedded within certain teams
- a central pool of mobile, flexible and collaborative people can support the accelerated roll-out of digital technologies across the ESO.

IT delivery:

- We will need to strengthen our IT delivery, this means being able to: interface with large IT transformation programmes; translate business requirements into IT technical requirements and vice-versa; deliver projects iteratively, incrementally, to high standards, on time and within budget that deliver high

levels of complexity, operational need and level of dependency across the industry
- this capability will require a culture shift towards more agility, flexibility, and ability to absorb change.

4.3 Phased delivery

We are not yet a fully-digital company. It is essential that we deliver digital projects whilst maintaining and protecting the integrity and security of critical existing systems and ongoing projects. It would be a high-risk approach to attempt to deliver digital transformation across our whole business with a 'big bang' philosophy.

We are adopting a phased approach to digital transformation. As outlined in *Pillar 1 - Delivering open data and digital market enablement* and *Pillar 2 - Transforming our core capabilities* we are already deploying pilot projects in areas with high potential for consumer value creation, such as energy forecasting. Through these projects we will develop our understanding of the potential of digital technologies, as well as what works and what doesn't. They also enable us to develop our utilisation capabilities in this area.

We will adopt a structured approach to identifying opportunities across our business. Developing our data and analytics and IT delivery capabilities will support the structured delivery phase of digitalisation roll-out to a wide range of activities.

4.4 Attracting and retaining talent

Our people are our most important asset. Delivering our strategic intent will require significant upgrading of our capabilities in certain core talent areas. We have identified gaps in capability and capacity and are confident we can fill them with a blended sourcing strategy. Our unique people value proposition will be a key asset.

Our mission is to enable the transformation to a sustainable energy system and ensure the delivery of reliable, affordable energy for all consumers. This exciting employee proposition helps us attract and retain new talent. Our employees have a strong purpose as they can anchor their contribution to the energy transformation at such an exciting time.

Our proactive strategic workforce planning has meant that we can identify and mitigate against future workforce and capability gaps. We will be using a blended sourcing strategy to fill the gaps. This means we will continue to 'grow our own' workforce for critical roles through our successful trainee intake; building a pipeline of resource and future capability. We will continue to invest in training our existing workforce and building capability identified through employee development plans and capability diagnostics.

This will be supplemented by external direct hires to fill new and specialist roles. We will recruit a diverse workforce representing our industry.

Two facets or our recruitment approach will drive us towards an employee base increasingly made up of 'digital natives': our ongoing intake of talent through our graduate programme tends to bring in younger, digitally-aware employees; direct hires are often recruited in areas where we are seeking to enhance our digital capabilities and skills base, such as data analytics and IT delivery. These individuals by nature of their professional inclination are more likely to be digitally confident.

The ongoing influx of digitally-confident staff will further embed and promote the digitally-enabled processes and culture we are seeking.

Further details of our how we will attract and retain talent can be found in chapter 14 People, culture and capability in our RIIO-2 business plan.

Data scientists, in particular, are in high demand. As this is a scarce skill, we will consider various sourcing options. As well as upskilling our own employees and partnering with academia to source niche capability, we will consider using specialist recruitment providers who will not only supply the resources but will also provide training/development while they are assigned to us. As competition for these skills increases, we will consider technical career paths for certain roles to help retain them.

4.5 Supporting tools

The Y and Z generation, who have grown up in a connected, collaborative and mobile world, will account for over half of our workforce before the end of the RIIO-2 period. This change in workforce balance will redefine corporate culture and expectations of work, shifting the business to think mobile first. Our systems will support flexible working, a more open and social approach to collaboration that is increasingly automated, intelligent and very data centric.

Unified communications and collaboration tools will increasingly support collaborative working objectives and improve productivity and employees' ability to collaborate remotely and reduce travel.

We are already moving from spreadsheet-enabled working processes to robotic process automation (RPA). Better tools and processes release our people to provide more value-added services to our customers and stakeholders in support of our strategic pillar to transform the customer experience through digital market enablement.

With the rapid development of technology services such as augmented reality, automation, and intelligent algorithms, opportunities will emerge through the RIIO-2 period that we can use to improve productivity and make efficiency savings.

5. 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 Great Britain 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 cyberattacks expands through the increased connection to external systems. Previously, our energy networks operated primarily as a closed system, where any issues concerned 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. Our solutions and capabilities to tackle threats need to grow and adapt to handle this complexity.

These threats are particularly significant in the Control Centre. As an example, any disruption to communications between the Control Centre and generators, or a loss of visibility of the status of the network, could have a significant impact on the electricity system.

As these threats continue to evolve, it is vital our control systems and critical infrastructure are kept safe, secure and resilient. This will require delivery of a robust cyber capability.

Investments to refresh legacy assets and infrastructure will be important in building a strong foundation for continued investments in new cyber-security. 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.

Our continued alignment with best practice and standards, as defined in the National Institute of Standards and Technology Cyber Security Framework (NIST CSF), allows us to identify and manage risk through a comprehensive range of security controls and measures. Ongoing engagement with UK National Cyber Security Centre (NCSC), Centre for the Protection of National Infrastructure (CPNI) and the Department for Business, Energy and Industrial Strategy (BEIS) will be central to the protection of our systems.

These capabilities will also be aligned with new regulations, such as the EU Directive on the security of network and information systems (NIS Directive). We will continue to work with the NIS Competent Authority (comprising Ofgem and BEIS) to shape our investment plans, identifying the most effective and efficient way to meet them.

For further details please see Annex 9 of our RIIO-2 Business Plan Business IT security report.

6. Delivering on the recommendations of the Energy Data Taskforce

The Taskforce produced five recommendations:

- two principles that the energy sector is encouraged to adopt and
- three building blocks that the sector should collaborate on to create the foundation for a modern, digitalised energy system.

Below is a summary of the recommendations and the actions we are taking to deliver them.

6.1 Recommendation 1: Digitalisation of the energy system (Principle)

EDTF recommendation: the energy sector should adopt the principle of "Digitalisation of the Energy System" in the consumers' interest in line with supporting principles of New data needs, Continuous improvement and Digitalisation strategies.

ESO action to deliver: In *Pillar 2 - Building our core capability through digital technology* section we outline how we will identify, capture and use the right data to transform the way we operate. We provide use cases from across our business to show how we are deploying data and advanced digital technologies such as AI and machine learning to supercharge our capability and deliver enhanced outcomes for current and future consumers.

In *Pillar 3 - Transform our organisational culture and digital ways of working* we discuss how we are addressing the challenges of future talent acquisition and retention in a world where highly skilled data users will be in high demand.

In the section 7 - *Continuous development of our digitalisation strategy* we outline how we will put stakeholder at the heart of our efforts to continuously improve of our digitalisation strategy.

6.2 Recommendation 2: Maximising the value of data (Principle)

EDTF recommendation: The energy sector should adopt the principle of 'presumed open' supported by requirements that data is discoverable, searchable and understandable with common structures, interfaces and standards.

ESO action to deliver: We have adopted the principle of presumed open and will share all the data deemed sharable according to Openness Triage criteria. In Pillar 1 – *Delivering open data and digital market enablement* we describe the steps we will take to make our data discoverable, searchable and understandable. We will develop a data portal where all our shareable data is accessible in one place in a user-friendly format. We will also support data users in understanding the data through explanation and analysis where required. Making our data open will drive industry collaboration and remove barriers to entry for new market participants, some of whom may be unfamiliar with the energy industry.

6.3 Recommendation 3: Visibility of data (Building block)

EDTF recommendation: A Data Catalogue should be established to provide visibility through standardised metadata of the energy system datasets across Government, the regulator and industry.

ESO action to deliver: In the *Facilitating industry transformation through open data* section we show how we will actively support the development of the data catalogue

through publishing a catalogue of the data that we share with metadata adopting the 'Dublin core[13]' standard.

6.4 Recommendation 4: Coordination of asset registration (Building block)

EDTF recommendation: An Asset Registration Strategy should be established to coordinate registration of energy assets, simplifying the experience for consumers through a user-friendly interface to increase registration compliance, improve the reliability of data and improve the efficiency of data collection.

ESO action to deliver: We fully support the coordination of asset registration across markets and network boundaries to reduce the administrative burden for parties that wish to participate in ESO markets, such as balancing services markets or the Capacity Market. In Pillar 1 – *Delivering open data and digital market enablement* we explain how we will support alignment across our processes and markets, including for asset registration.

6.5 Recommendation 5: Visibility of infrastructure and assets (Building block)

EDTF recommendation: A unified Digital System Map of the energy system should be established to increase visibility of the infrastructure and assets, enable optimisation of investment and inform the creation of new markets.

ESO action to deliver: We hold, and are developing, data sets that can enrich a unified digital system map of the energy system. These include our development of the connections heat maps, showing where capacity can be found on the network, and information on operability issues on different parts of the network may lend themselves well to this. We will make data available to support this deliverable as appropriate.

[13] The "Dublin Core" is a metadata standard that enables a minimum level of standardisation without being overly burdensome, with the option to extend the standard over time.

7. Continuous development of our Digitalisation Strategy

We will regularly update and publish our Digitalisation Strategy to reflect the ever-changing challenges we face as the electricity system and markets continue to transform.

Our continuous improvement methodology, Performance Excellence, uses Lean manufacturing principles to realign our service levels, streamline processes, remove waste activity and create cross-function process efficiencies. New data needs, data sharing and use of digital technologies to drive improvements will be identified by team and at department level as part of the ongoing application of Performance Excellence methodology.

At the same time, through development of our business strategy[14] and through our Innovation Strategy[15] we will identify key data, tools and capabilities to drive consumer value across our activities.

Many of the activities to deliver our Digitalisation Strategy are being progressed through innovation projects. As part of this hypotheses driven process, we evaluate the learnings from each project which in turn inform future developments including operationalisation of new tools and techniques. Insights from innovation projects will be central to the ongoing development of the Digitalisation Strategy.

7.1 A stakeholder-informed Digitalisation Strategy

Engaging with a wide range of stakeholders, including current and potential service providers, generators, networks and network operators, academics and energy users will be central to the continuous development of our Digitalisation Strategy.

We recognise that there are huge demands on the time and resource of energy industry stakeholders. To make best use of stakeholder time, we will seek input and feedback from this community through existing channels and forums including:

- our annual **Open Innovation** call for ideas[16] through which parties can propose innovative solutions to address our priority areas including digital transformation, system stability and whole electricity system
- our new strategic **Design Authority**, outlined in chapter 5 of our RIIO-2 Business Plan, will give stakeholders the opportunity to input into key design, development and testing phases of our solutions. This forum will provide an excellent opportunity for stakeholders to provide input into ongoing development of our Digitalisation Strategy
- our **Electricity Operational Forums**, regular meetings with our electricity customers to discuss the operation and performance of balancing services markets, are an excellent opportunity for stakeholders to tell us how we are performing against our open data and digital market enablement goals.
- we also hope to continue with an evolved version of the **ESO RIIO-2 stakeholder group** beyond development of this RIIO-2 Business Plan. This group has previously expressed an interest in engaging with us on our Digitalisation Strategy and we are currently exploring the potential remit with current members.

[14] https://www.nationalgrideso.com/news/towards-2030-system-operator-gbs-energy-future
[15] https://www.nationalgrideso.com/document/106786/download
[16] https://www.nationalgrideso.com/innovation/news-and-events/open-innovation-event

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