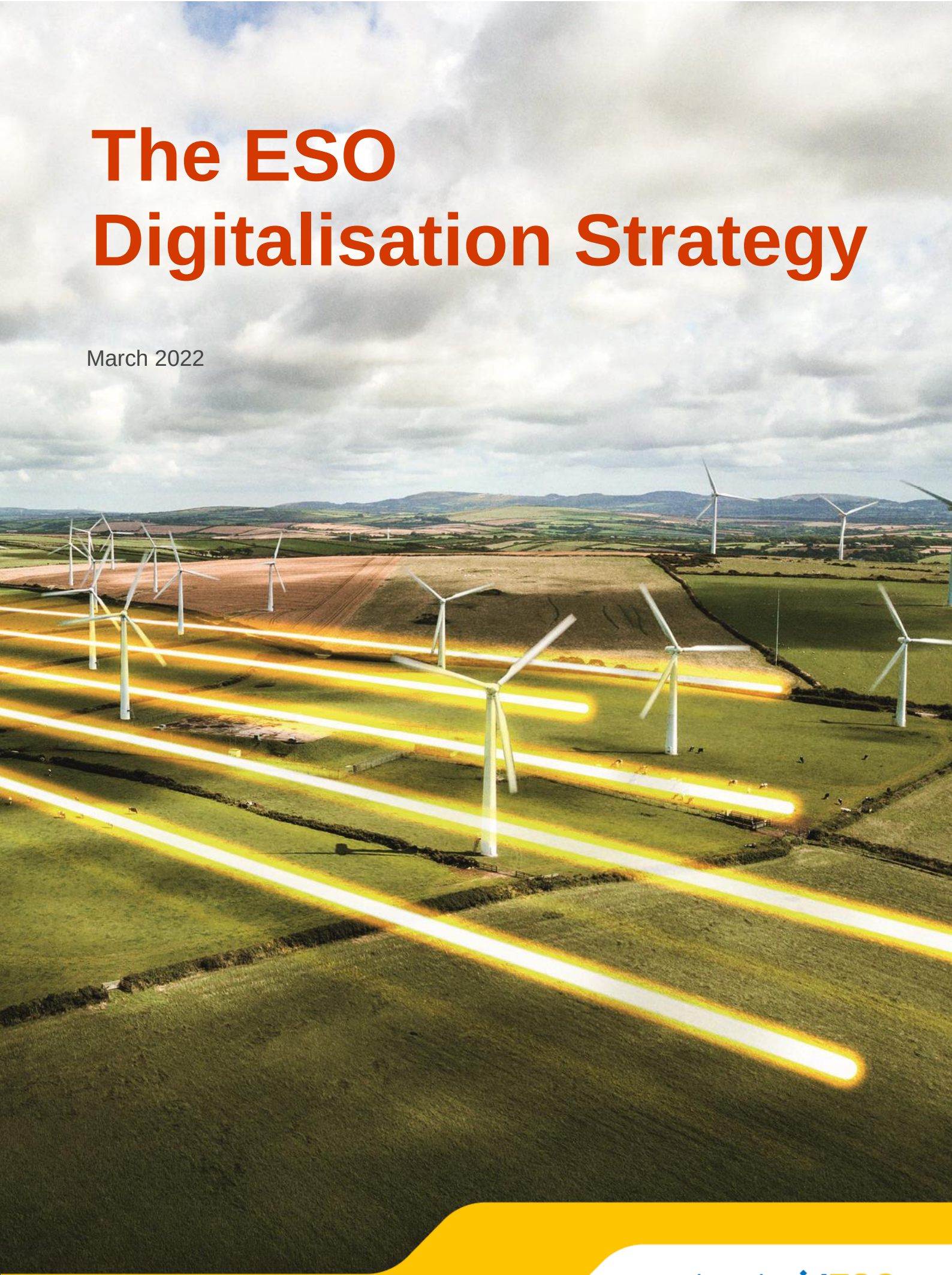
The ESO Digitalisation Strategy

March 2022



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Foreword

Our mission, as the Electricity System Operator, is to enable the transformation of a fully decarbonised electricity system by 2035 which is reliable, affordable and fair for all.

As the United Nations climate change conference, COP26, made very clear – the need to decarbonise the world's energy systems has never been greater. The ESO has a unique opportunity in shaping the way we use and consume energy for generations to come.

We have committed to being able to operate a zero carbon system by 2025, which supports the UK's plan to achieve net zero greenhouse gas emissions by 2050. This is an exciting and challenging time for the energy sector as we all work together towards a decarbonised and decentralised energy system.

We will reduce our reliance on traditional energy sources and move to a more inclusive energy system with hundreds of connected generation, storage, and consumption assets. Over 600,000 heat pumps could be installed per year by 2028; and with all new cars and vans required to be zero emissions from 2035, the number of electric vehicles connected to the energy network will soar.

Pivotal to the successful delivery of these initiatives is ensuring we have a robust strategy that outlines our approach to delivering open data and digitalisation. The ESO's digital transformation is not just an enabler, but a core component of our transition as we progress on our journey to reach zero carbon operability.

Digitalisation and democratisation of data, or open data, will underpin the transition to net zero operability through better monitoring and management of the system and improved sharing of high-quality data sets, and the analytics this enables. In addition, the digitalisation and democratisation of data will drive the development of customer-centric digital products and services.

We're excited and proud of the role we are playing in the decarbonisation of the energy system to help mitigate climate change and the opportunity to bring about greater value for consumers through digitalisation.

Norma Dove-Edwin

ESO Chief Information Officer

1. Introduction and context

1.1 Document purpose

In line with our RIIO-2 obligations, we are committed to refreshing our Digitalisation Strategy every two years, engaging across our business and consulting with our customers and broader stakeholders to ensure this strategy remains current and reflective of our broader business vision, ambition, and external market conditions. Similarly, we have ensured that our Action Plan is reviewed every six months, of which our last submission was published in December 2021[1]. This document represents the latest iteration of our Digitalisation Strategy and should be read in conjunction with our latest Action Plan update. It has been written in parallel with our RIIO-2 Business Plan 2 which will be published in August 2022.

1.2 ESO's mission and ambition

We are in the midst of an energy revolution. A range of factors can be said to be driving change in the energy industry, and chief amongst them are what we call the three Ds – **decarbonisation, decentralisation** and **digitalisation**. However, when it comes to Data, we should be adding the fourth D, **democratisation**.

The global focus on combatting climate change puts decarbonisation high up political and social agendas as nations across the world race to drastically reduce their reliance on fossil fuels. Decentralisation is becoming increasingly topical in the energy sector – as the growth in community renewables and local schemes sees the locus of power generation and transmission move closer to consumers, towards regional models.

The environment in which we operate is undergoing a level of disruption as electricity generation is decentralised and decarbonised. Our customers need us to digitalise data and processes as we head towards a democratised marketplace that is more accessible to an increasing number of people. Our independent role in the electricity industry also requires us to be increasingly transparent in all our activities.

Our mission, as the Electricity System Operator, is to enable the transformation of a fully decarbonised electricity system by 2035 which is reliable, affordable and fair for all.

Our ambitions are:

1. Ensuring the electricity system can operate carbon-free by 2025;
2. Being the net zero employer of choice;
3. Engaging as a trusted partner;
4. Driving competition everywhere; and
5. Being innovative, digital and data-driven.

We are clear about our mission and ambitions as the ESO. We are committed to realising the benefits that digitalising the GB energy system presents for our customers, and we recognise the central role and responsibilities that the ESO has in enabling the required energy transition. A transition that, through greater transparency and open data, will unlock significant value to the consumer and wider society; sustaining energy affordability and accelerating decarbonisation of the system, whilst enabling our customers to help us innovate and support us in ensuring system reliability and security.

Our ***Bridging the Gap to Net Zero***[2] programme has allowed us to take a closer look at what is required to reach the UK's 2050 net zero target. From this we identified several key topics:

1. Increased data availability and digitalisation of our systems will be fundamental to enable markets and technology to manage our energy peaks and troughs.
2. The technology to help manage these peaks and troughs is available now but it needs to be both smart and deployed at scale to be effective.
3. Our electricity markets need reforming, whether they are for short term trading or longer-term contracts, to provide the flexibility required to balance our energy system more effectively.

[1] See our December 2021 DSAP – https://www.nationalgrideso.com/document/227551/download
[2] Read more about Bridging the Gap on our website – https://www.nationalgrideso.com/document/187761/download

Digitalisation is one of our industry's strategic drivers, alongside decarbonisation, democratisation of data and decentralisation.

Digitalisation and open data will underpin the transition to net zero through better monitoring and management of the system, improved sharing of large quantities of high-quality data and the analytics this enables, as well as developing customer-centric digital capabilities. This is key to navigating increasing complexity at the lowest cost for consumers. It is a key enabler to our overall mission, broader strategies and investment plans.

1.3 Our vision for technology

Our vision for our technology transformation is to create a better everyday digital experience for our customers that puts them at the heart of technology solutions.

Building on the foundations laid so far in the RIIO-2 period, such as the rollout of the ESO data portal, we will continue to deliver on our commitments to open data and transparency. We believe that making the data that we hold open and accessible and enhancing the transparency of our decision-making processes can deliver significant industry and consumer benefits. We will also ensure that we actively manage the risk of sharing data and information that could be used in dangerous or inappropriate ways.

We will ensure that in addition to maintaining safe, reliable, system operation and managing risks appropriately, we support an open, accessible market where anyone can participate, and a network than can run carbon-free. This will require increasing amounts of back-office automation, data-driven decision making, and leveraging of customer insights through analysis of customer journeys to inform our delivery, complementing this with broader changes to our delivery culture and ways of working.

We can conceptualise our transformation journey as being composed of three pillars that will collectively enable our digitalisation strategy:

Figure 1 –Digitalisation Strategy Pillars underpinning our Vision

This Digitalisation Strategy sets out how we will modernise our tools and processes, through the usage of digital technology, establish the additional skills and capabilities we will require, and sets out the cultural transformation that we must carry out. Through digitalisation, we will transform traditional models of doing business within the energy sector.

We will achieve our Digitalisation Strategy by delivering an ambitious set of activities and programmes. As highlighted in the following chapters these have been informed by our services, data users, consumers and wider stakeholders' priorities and needs. We will deliver these, where appropriate, in coordination and collaboration with other network companies and energy system partners.

Our Digitalisation Strategy is now aligned with our three core delivery roles and addresses the common and specific areas of improvement identified by Ofgem. In addition, we have also highlighted where we support the recommendations of the Energy Data Taskforce (EDTF)[3] as we recognise the leading role we will play in their delivery. We reference where we are aligning with this in our work both within this document, and in further detail within our Digitalisation Action Plan (DSAP)[4], which provides a detailed view of our ongoing delivery and planned activities, breaking this down across our roles, and highlighting our activities, roadmaps, and a detailed view of how we have defined success and will measure progress.

[3] EDTF Recommendations - https://es.catapult.org.uk/reports/energy-data-taskforce-report/

[4] See our December 2021 DSAP – https://www.nationalgrideso.com/document/227551/download

1.4 Governance

The ESO leadership is fully committed to ensuring senior ownership and ESO Board accountability of our Digitalisation Strategy and associated Action Plan. Across the Non-Executive Directors on the ESO Board, there is significant experience in digitalisation and digital transformation.

The new ESO IT leadership team, led by our CIO, who sits on both the ESO Executive Team (ESOET) and the National Grid Group IT Leadership Team (ITLT), provides thought leadership and guidance into the short and long-term business and technology plans. They are paving our transition to a product model ways of working, changing ESO's culture to move into a TechOps (Technology and Operations), one team mindset.

In May 2021 we recruited a Head of Data, who will create a hub and spoke model to integrate our data strategy within our day-to-day delivery. Projects and programmes draw from this central expertise and have established multidisciplinary teams that adopt agile practices to deliver customer-centric products incrementally.

In March 2022 we were joined by a Director of Product, who will oversee the ESO's transition from a project to a product model and drive the ways of working transformation across the TechOps community, working closely with the wider ESO IT Leadership team.

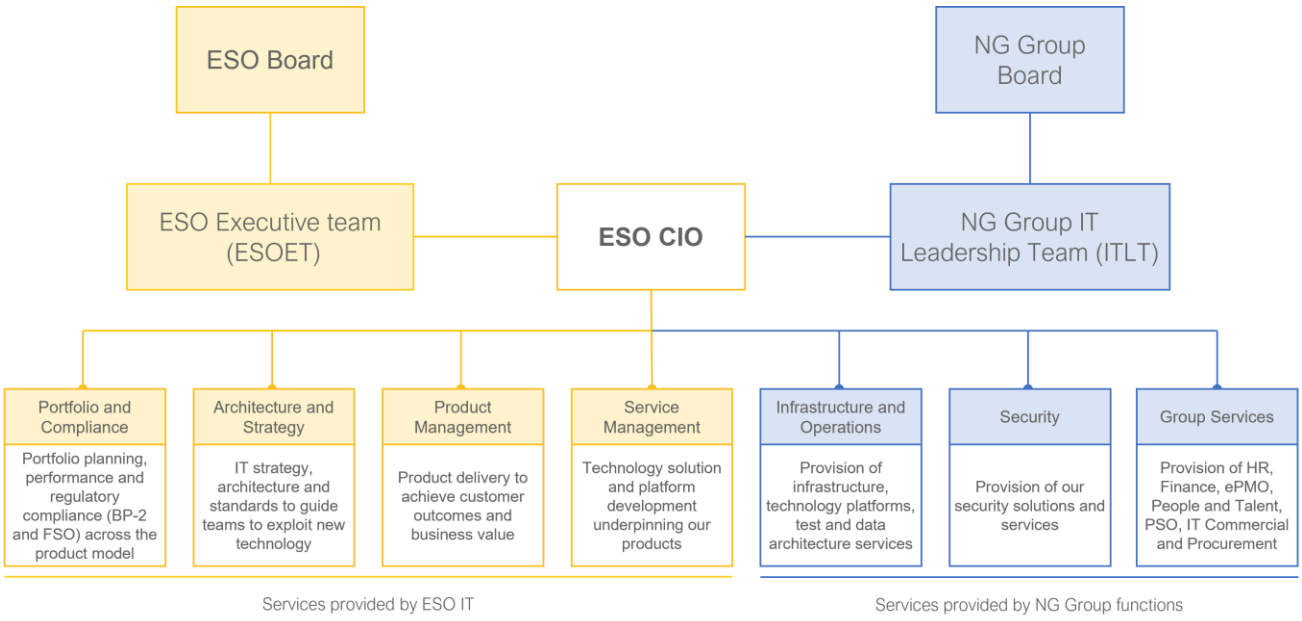

Figure 2 – Our ESO IT leadership team is led by our CIO

Our 2025 zero carbon ambition will need the support, insight and experience from the wider industry to help guide and inform the delivery of our transformational proposals. We committed in our RIIO-2 business plan to introduce a cross-sector Technology Advisory Council (TAC).

The TAC was launched in December 2020 with an independent Chair. Engagement from all members is extremely high and we are benefiting from the experience, skills, and contacts of the Council members. The TAC has had a strong influence on setting the overall direction of our Digitalisation Strategy and on holding us accountable to deliver our Action Plan. The TAC also supports us in various ways including:

1. Helping set the **strategic direction** of the ESO transformation journey in systems (including process and technology) development.
2. Providing **stakeholder input** into the ESO transformation, ensuring the changes we make reflect wider market needs.
3. Bringing **transparency** around our decision making and helping the ESO communicate change externally in the appropriate manner. This will help stakeholders plan their own IT system changes, including those that will interface with the ESO.
4. Ensuring **accountability** from the ESO for delivering on its promises and proactively communicating changes.
5. Allowing us to consult and engage o the experience of interacting with the ESO and **invite input into the key design, development, and testing phases of our solutions development.** It also provides transparency of the decision-making logic behind our systems.

2. Market drivers and development

This is a pivotal period on our journey to net zero. Nations around the world have made firm commitments to tackle Climate Change at COP26. Since 1990, the UK has halved its greenhouse gas emissions and has made a legal commitment to a 78% reduction by 2035. At National Grid ESO, we are dedicated to enabling the transition in the energy industry while continuing to provide the highest levels of reliability and value for our consumers. We believe reaching net zero by 2050 is possible if we work together urgently to reduce our emissions and agree on clear ways forward.

The GB energy landscape is undergoing a significant transformation as a result of decarbonisation and decentralisation of power generation and distribution. Low-carbon records are constantly broken and there is increasing interaction between fuels and across different industries. The energy sector is moving away from being siloed, becoming more integrated and multi-vector. The transformation, however, is not homogenous: network companies, customers and stakeholders are at various stages of maturity in leveraging the value of data for consumers, stakeholders and wider uses. The democratisation of data, through greater transparency, presumed open access and sharing is especially driving digitalisation across the whole system.

We are already experiencing the implications of greater system integration and centralisation, including the emergence of new players in the energy sectors, such as:

- Suppliers competing with digital, non-commodity and low-carbon offerings;
- Flexibility digital platform developers and operators;
- Start-ups creating value from consumer data (mainly in the electric vehicle space)

To deliver the significant transformation needed to meet net zero, even greater whole system thinking is required, and to achieve this, we must significantly increase our interactions amongst industry participants and ensure wider and secure data sharing amongst the relevant players.

As stated in our *Future Energy Scenarios 2021*: **As smart technologies and innovative business models develop, digitalisation and data will become increasingly important.**

As further set out in our FES[5] and on our Bridging the Gap to net zero[6] work, achieving net zero will result in a very significant increase in electricity consumption, along with increased intermittency of generation and potentially increased "spikiness" of demand. Innovation in data and digitalisation is therefore essential to meet such challenges and to ensure we can continue to do so in the most efficient manner.

We see the greater provision of energy system data creating value for consumers in two ways:

- By allowing the parts of the energy system access to the same consistent data, thus allowing them to work together more efficiently, lowering the system costs that get recovered via network charges.
- By providing relevant data to all network users allowing them to find their own value, including through innovation and adaptations to the way they interact with the system.

Furthermore, to drive additional cost efficiencies as the GB energy sector and wider economy transition to net zero, it is expected that our data requirement is expected to increase, potentially exponentially. The sections below set out some of the changes that we expect.

2.1 Networks

With the number of energy participants rapidly increasing, the complexity of energy network design decisions is also increasing. Combined with greater interaction between energy vectors (fuels) this will result in a greater need for data to ensure that efficient choices are made as the system progresses towards net zero.

There is likely to be greater emphasis on local energy systems linked to the geographical differences across Great Britain. This has implication for not only how energy is supplied but also how it is consumed. Access to data from within the energy industry and also external to the energy industry is required to underpin the analysis of future energy needs thereby ensuring that design choices can be robustly challenged and efficient choices progressed.

[5] Future Energy Scenarios - https://www.nationalgrideso.com/future-energy/future-energy-scenarios
[6] Bridging the gap to net zero - https://www.nationalgrideso.com/future-energy/future-energy-scenarios/bridging-the-gap-to-net-zero

Where there is more flexibility of the placement of assets this creates an opportunity to avoid network reinforcement as the traditional form of resolving constraints. Data is required to assess these options and test the effectiveness for all parties – for example, the siting of electrolysers will need to consider both the impact on the electricity network but also the gas or hydrogen network.

The networks will also need to ensure continued access to their assets for ongoing maintenance. As the energy flows across the networks become more variable and dynamic, it becomes harder to plan for outages. Data that would support short to medium term forecasting will help mitigate this, as would information about how flows could be reconfigured at the lowest cost.

2.2 Consumers

Consumer choices today and in the future will influence decarbonisation pathways and options for efficient whole system operation. Consumers will have an expanding role in achieving net zero through changing behaviours such as by altering their consumption patterns (e.g. smart appliances, thermal or electrical storage and vehicle to grid) or by self-generating power locally (e.g. solar PV). Savvy consumers may want to make their own choices here in which case they will be looking to the energy industry for data and insights that support their decision making. Alternatively, consumers may look to third parties such as suppliers to optimise their energy usage on their behalf.

As consumers become more active market participants, they will demand systems that are simple to interact with. They will need to register their assets and provide energy system services via digital platforms they can easily join, operate and leave. Consumers, and those supporting the decision making on behalf of consumers, will require access to data to ensure cost-optimal choices are made.

New large and potentially flexible electrical loads (e.g. heat pumps and EV charging) will mean that individual consumers will have a bigger impact on the whole system than they do today. Thus, consumers themselves may need to provide data to third parties – such as their consumption patterns, details about the energy efficiency of their home and their lifestyle – for solutions to be tailored to their individual needs. Access to consumers' increasing volumes and types of valuable data will need to be supported and safeguarded.

Mobility as a service and autonomous vehicles can change the way we travel but this will also affect the way energy is consumed and supplied too. In particular, commercial operators of shared fleet vehicles have different choices to make than individuals would under private ownership. Ultimately data will need to be brought together from both the energy and transport sides to assess, predict and deploy solutions.

2.3 Generation and flexibility

As set out in our Future Energy Scenarios, we see a substantial increase in the amount of renewable generation capacity on the system. As much of this is weather dependent it will need to be supported by technologies that can flex up and down to ensure that demand and supply match on a second-by-second basis. Some of the potential technologies create links between networks either of the same energy vector (as in the case of interconnectors linking GB to its neighbours) or between energy vectors (as in the case of electrolysers that convert electricity to hydrogen). Some are also looking at linking different industries, such as smart charging and V2G (mobility – energy) and braking energy (rail transport – energy), amongst others.

With a need to address both national and regional needs, generation and flexibility are likely to come from a range of assets including both large/centralised and smaller/decentralised distributed energy resources (DER). Determining which assets to build, where and when, will require further data sharing to reduce the potential risk of stranded assets and the cost associated with this.

Flexibility is seen as a key component for delivering value for consumers in a net zero economy. Cost-effectiveness will require large volumes of open data to extract the most value from flexibility and to create confidence that the system can overcome peaks and troughs.

Data will be required by both the owners of flexible assets but also other users of those assets. At times multiple stakeholder interactions with flexibility will need to be effectively resolved. During some periods, different users of the same flexibility asset may desire different outcomes and to resolve these, computational and data-intensive processes may be required (similar to how owners of the current generation assets assess how best to respond to the market, but this will need to work automatically for potentially hundreds of thousands of flexible assets).

3. A stakeholder-driven digitalisation strategy

3.1 Ongoing engagement

Engaging with a wide range of stakeholders, including current and potential service providers, generators, networks and network operators, academics and energy users has been central to the development of this Digitalisation Strategy and will be even more so in our future ones.

We refresh our digitalisation strategy every two years, so ongoing engagement is key to maintaining our understanding and alignment of our digitalisation activities to the ever-changing challenges they face. Our customers and stakeholders have also told us that they want us to develop improved communications channels that not only give them access to self-serve data but also enhance the effectiveness of our communications.

We will therefore build on the success of engaging our stakeholders through the mechanisms we employed to jointly develop our RIIO-2 business plan and work to maintain appropriate digital channels and establish the right end-to-end processes to improve our capabilities in stakeholder management, customer engagement and data management.

We have set up a team focused on enhancing our customer and stakeholder engagement experience, to ensure we continue to align our activities to their needs and identify new opportunities to improve and coordinate our co-creation efforts with other network companies and wider stakeholders.

We will also continue to seek input and feedback through the following existing channels and wider stakeholder forums:

- **Technical Advisory Council** - providing stakeholders with the opportunity to input into key design, development and testing phases of our solutions, as well as input into the ongoing development of our Digitalisation Strategy.
- **Open Innovation**[7] - an annual call for ideas providing parties with the opportunity to propose innovative solutions to address our priority areas including digital transformation, system stability and the whole electricity system.
- **Electricity Operational Forums** - regular meetings with our electricity customers to discuss the operation and performance of balancing services markets and collate feedback on how we are performing against our open data and digital market enablement goals.
- **Our Bridging the Gap, Data and Digital workstream –** engagement with a group of core stakeholders to discuss the new peaks/troughs we could see in our energy system, and how markets, technology and data and digitalisation can help to mitigate these challenges.
- **Energy Networks Association Data Working Group / National Energy System Map Sub-Group** - helping enable all geospatial data related to network infrastructure to be harmonised in terms of standard data classification, develop open data sets and enable them to be shared and exposed effectively to end consumers.
- **Ofgem's/BEIS Data & Digital Service Providers forum** - to seek wider stakeholder views on the development of our data strategy to inform our digitalisation strategy.

[7] ESO Open Innovation - https://www.nationalgrideso.com/innovation/news-and-events/open-innovation-event

3.2 Consumer and stakeholder priorities

Our customers and stakeholders span the electricity industry from generation to consumption, as can be seen in the figure below. We will build technology solutions that people – internal and external to the ESO – want to use and that maximise productivity and increase wellbeing.

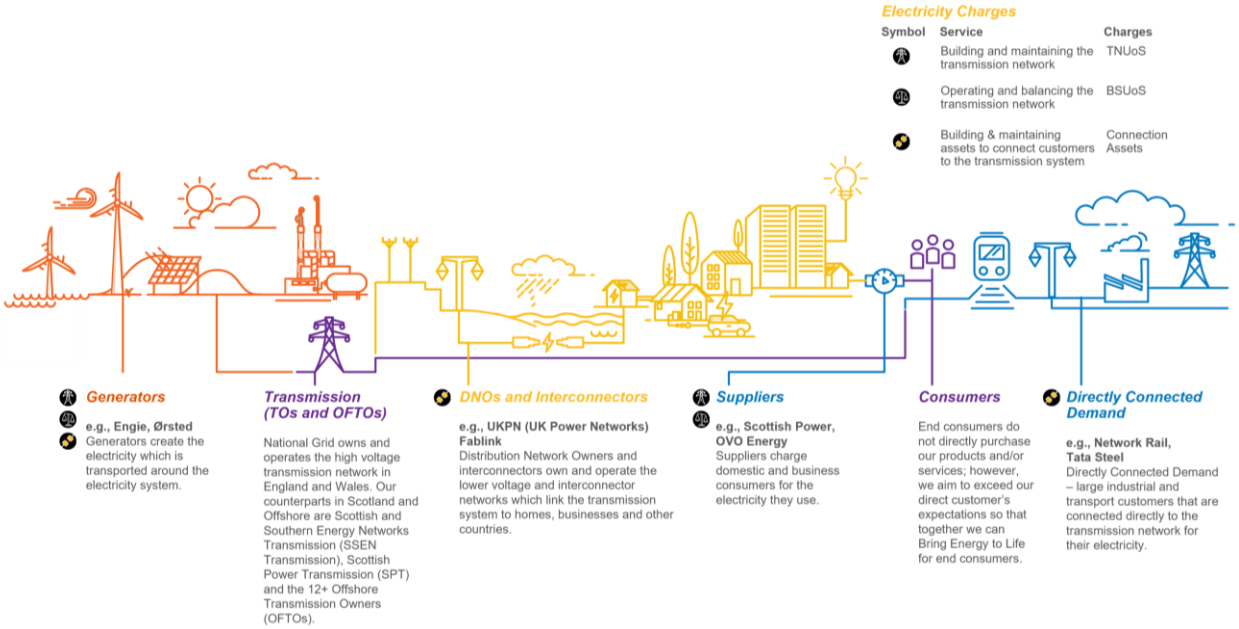

Figure 3 – Our customers and stakeholders explained

Our planned activities that will enable open data and digitalisation have been informed by significant inputs from a broad range of consumers and stakeholders, throughout our RIIO-2 business planning process. This approach has enabled us to establish both our user journeys; reflecting what they do now and what they want to be able to do in the future as well as identify and articulate our consumer and stakeholder priorities and tangible benefits. Further details of what our stakeholders have told us are set out in our RIIO-2 business plan Stakeholder Report[8].

Our digitalisation strategy aims to deliver the consumer benefits listed in the figure below, via our three strategic pillars, ensuring that there is a strong focus on consumer and stakeholder priorities throughout.

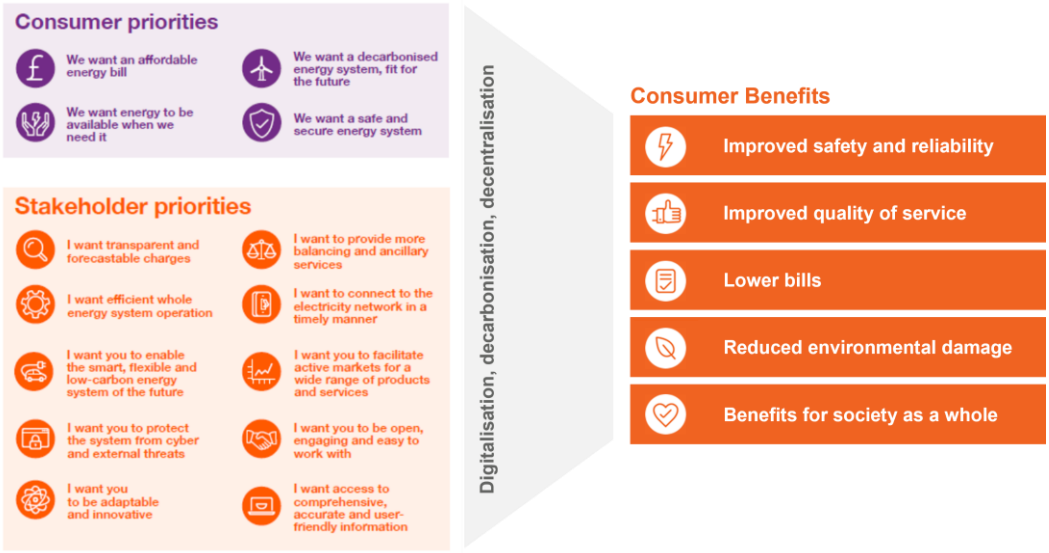

Figure 4 –Our digitalisation strategy aims to deliver benefits by focusing on consumer and stakeholder priorities

[8] ESO RIIO-2 Stakeholder Report - https://www.nationalgrideso.com/document/158066/download

4. Our ESO Digitalisation Strategy

The figure below illustrates the structure of our digitalisation strategy split across our three strategic pillars. The following chapter will detail the strategic enablers that underpin these three pillars and how they relate to the ESO's three core delivery roles.

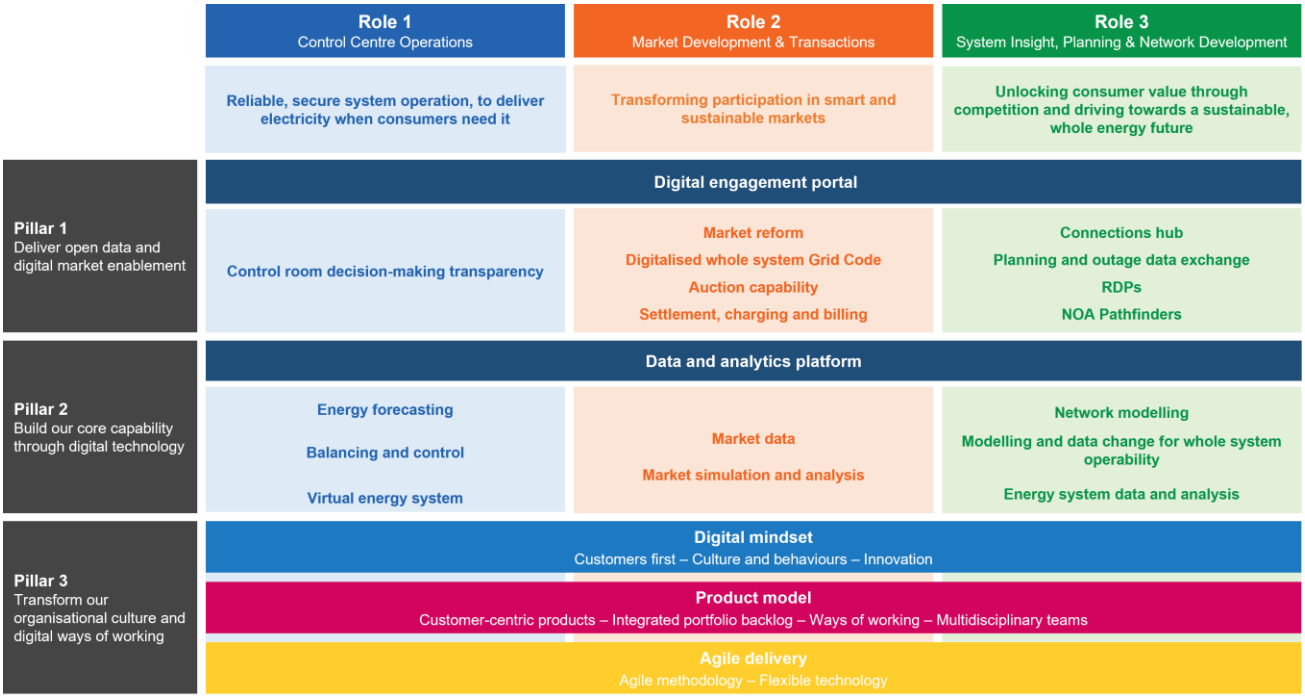

Figure 5 – Our digitalisation strategy is organised via the three strategic pillars and the ESO's three core delivery roles

4.1 Pillar 1 - Delivering open data and digital market enablement

Pillar 1 focuses on the customer-facing interface with the ESO, whereby our customers and stakeholders will be able to access services and data through the Digital Engagement Portal.

This pillar is key to maximising participation in efficient markets. Open data will enable efficient investment and operational decision-making and drive innovation across the industry, where digital market engagement will remove barriers to market participation, increasing market efficiency.

Sections 4.1.1 & **4.1.2** detail the ESO's plan to deliver open data and the underlying strategic enablers, whilst **Sections 4.1.3** & **4.1.4** focus on the plan to deliver digital market enablement and the strategic enablers.

4.1.1 Delivering open data

With ever-expanding digitalisation, the availability of quality data will be increasingly fundamental to developing new markets and empowering efficient decision-making. Understanding current and future trends, 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 shared how we should focus on a 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 manage operability challenges, thereby reducing costs for consumers. In addition to the raw data itself, we will also continue to provide analysis, insights and guidance to support and understand our data, sharing this to drive enhanced transparency and optimisation of operational and commercial decisions.

Along with delivering open data to our customers, we are also committed to receiving greater operational visibility of Distributed Energy Resources (DER) as DNOs transition to undertake Distribution System

Operation. As such, innovative technology enablers need to be embraced to facilitate the development of this ambition, which is critical to the DSO transition.

4.1.2 Strategic enablers to deliver open data

(i) Digital Engagement Portal (DEP)

We will provide a single point of access into the ESO data, content, and external-facing processes through our Digital Engagement Portal. It will make the experience of engaging with the ESO more intuitive and user friendly by providing a consistent and personalised user experience, including access to information and data, codes, connections, and market participation. We will also continue to work closely with other relevant data sharing projects, such as Icebreaker One[9] and the Energy Network Association's whole system asset register to inform our ongoing delivery.

The Digital Engagement Portal will replace the current NGESO website with a digital platform that will integrate with NGESO subsystems and portals. The DEP will provide a single place for hosting and visualisation of open and subscribed content and data. It will integrate with the Data and Analytics Platform, EMR and CfD Improvements, Digitalised Code, Market Reform, Auction Capability, Connections Hub and all other customer-facing platforms and services to provide a consistent and frictionless user experience.

The figure below illustrates how consumers will be able to access the ESO's open data via the Digital Engagement Portal which will also utilise the capabilities of the Data and Analytics Platform.

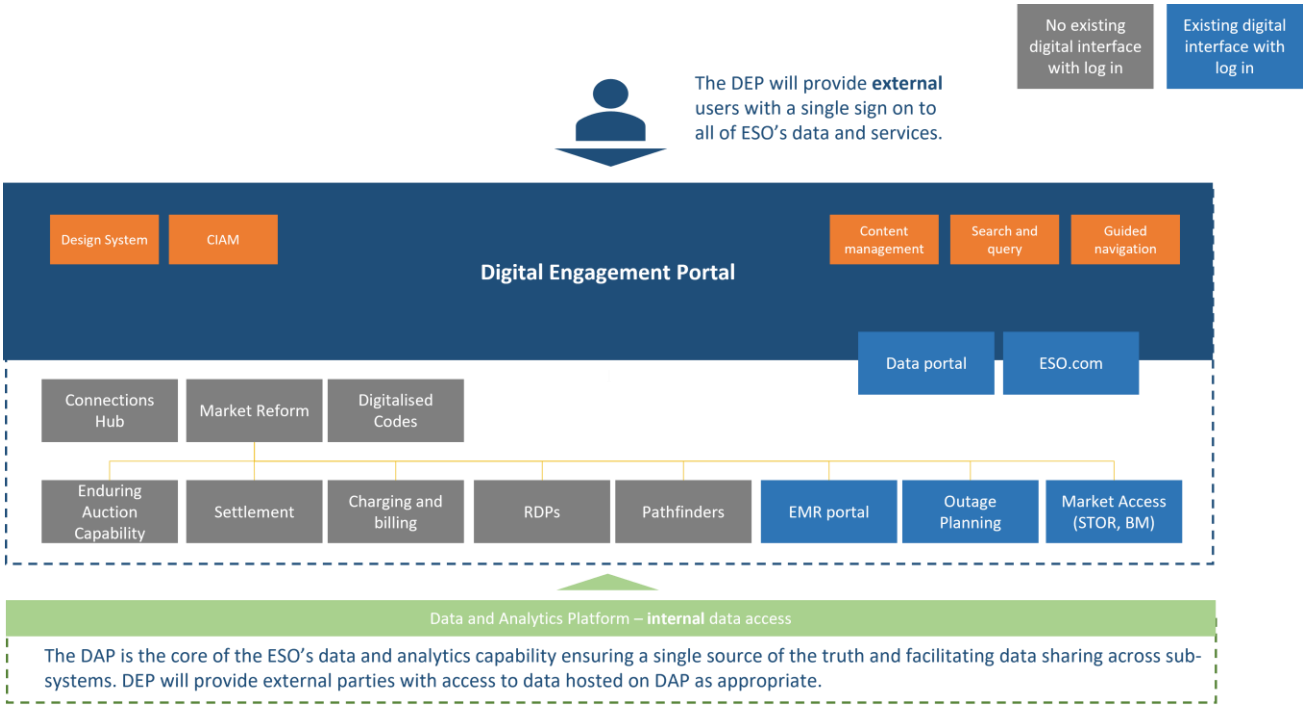

Figure 6 – The services and capabilities that will be accessible via the Digital Engagement Portal

(ii) Data Portal

We have delivered a foundational Open Data Portal with limited datasets. This is a proof-of-concept for the RIIO-2 Data Portal, which in the future, will be powered by the Data and Analytics Platform (DAP) and utilise the user interface of the Digital Engagement Portal (DEP). We intend to provide all published ESO data in a machine-readable format, and we are committed to making available an ESO data catalogue, publication schedule and to automating all published data to reduce publishing times.

As part of the Supplementary Questions process for the first RIIO-2 business plan, we have also committed to the following continuous deliverables to provide transparency and visibility into our delivery schedule:

- **Transparency Roadmap** – a roadmap published at 6-monthly intervals defining the outcomes, timescales, and steps to achieve the ESO's ambition to provide the highest level of transparency possible.

[9] Icebreaker One - icebreakerone.org

- **Transparency of operational decision-making** - provision of enhanced data to industry to deliver greater clarity and consistent information about the individual actions taken in the Balancing Mechanism (BM).
- **Trading Transparency** - provision of enhanced data to industry to deliver greater transparency of our trading decisions.
- **ESO Transparency Forum** – weekly webinars to answer transparency questions and help industry to understand the operational decisions that the ESO makes.

Through this portal we will create a centralised repository for all published ESO data, developing a clear and intuitive user interface for searching and querying our data. This is in line with resolving the challenges of data interoperability and ease of access and discoverability, as highlighted by the **Modernising Energy Data Programme[10].**

4.1.3 Delivering digital market enablement

The ESO manages markets, industry processes and frameworks that in turn influence the efficiency of market outcomes. We believe there is great potential to improve the efficiency of energy markets through the application of digital technologies to enhance the customer experience of interacting with us.

Our customers and stakeholders currently have many touchpoints 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 and are listed in the following section.

4.1.4 Strategic enablers to deliver digital market enablement

(i) Market Reform (previously known as the Single Markets Platform)

Market Reform is a key enabler of decarbonisation within electricity markets and underpins the reform of ESO's product markets which aim to lower barriers to entry, attract higher volumes or flexibility to facilitate decarbonisation and deliver consumer benefits that follow. Market Reform is critical to support this reform, enabling ESO to enact change more quickly, as well as to adapt to new markets and meet evolving needs.

Market Reform will deliver a single point of entry and a consistent, clear and engaging user experience for ESO customers and stakeholders to make it easier for them to participate in our markets. To make our markets work, we must ensure customers can access all the data they need conveniently and given the expected overlaps and interactions between products at transmission and distribution level, having one place to view and manage all market-related data will be crucial.

Market Reform will provide a full end-to-end customer journey allowing market participants to access data relating to several aspects including how to become a provider, contract tender, unit management, dispatch, performance monitoring and payment.

Following an iterative agile delivery approach, Market Reform will deliver prioritised functional capabilities based on value to the customer and informed by user research, industry consultation and stakeholder engagement. We will continue to mature our product model as we enhance our internal capabilities and tooling to deliver our products more efficiently across our platforms and services.

At the core of Market Reform will be an asset register identifying each unique asset on the transmission or distribution system that is participating in the market. Participants will be able to manage their portfolios by aggregating assets from these underlying components to participate in the markets, and we will seek opportunities to align other asset registers to support participation in ESO markets.

Finally, Market Reform will significantly reduce the time and effort required to participate in markets, with enhanced communications on processes including contracting, testing, procurement events, performance monitoring and reporting. Data input and management for processes including procurement events and performance monitoring will move from offline spreadsheets to more integrated components on the platform and messaging and validation rules will enable improved online decision support.

[10] Modernising Energy Data Programme - https://es.catapult.org.uk/impact/projects/modernising-energy-data-access/

(ii) 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.

We aim to transform the stakeholder experience of the code management process through AI-enabled navigation, and document and workflow management tools. The consumer benefits include having a more user-friendly and inclusive experience that will meet the diverse needs of our customers.

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

(iii) 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 coordination with other network organisations, a connections hub that provides a seamless connections experience to customers.

The customer connections hub will provide a single point of contact for connections to electricity networks that will guide customers through the connection process and provide online account management functionality for all live projects. The hub will enable customers to see regular updates on the progress of their applications to connect as well as information on those projects under construction, providing information directly from the relevant network companies to ensure regular and accurate information on build time and cost.

The hub will also facilitate enduring contract management during the operational phase of the project as well as provide a source of information for customers who are researching opportunities for connection and want to understand more about capacity opportunities on both the distribution and transmission networks. Being able to quickly understand where network capacity exists should help low carbon developers more quickly navigate the connections process. This will help to accelerate the decarbonisation of the energy sector.

We will need to work with other network organisations to develop the connections hub as it will feature information provided by different parties as well as links to the appropriate network organisation. 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.

(iv) Planning and outage data exchange

The ESO facilitates efficient access to the network by Transmission Owners (TOs) and connected parties for maintenance and construction activities. However, 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.

To address our customers' needs and stimulate potential DER markets we will improve and extend our outage notification system. We need to transform how we keep stakeholders informed of outages. We will introduce better digital communication with customers, stakeholders and the market, for example by using mobile apps, alerts, social media feeds and new digital enabler technologies. We will integrate with the Digital Engagement Portal to provide a seamless experience to customers and stakeholders.

The enhancement of outage planning and data exchange systems will enable a whole-system approach to access networks, manage significantly increased data volumes, and provide interactive stakeholder engagement. Investing in this area also aligns with the Energy Data Taskforce (EDTF) key finding around infrastructure and asset visibility, identifying system assets and infrastructure, where they are located and their capabilities, to inform system planning and management.

(v) Auction Capability

Regulatory and strategic changes to Ancillary Service markets are driving the ESO's procurement systems to procure daily. Whilst those changes are positive and will improve market access to a wider (and renewable) provider-base, it also means a significant increase in the volume of procurement contracts to be awarded, driving the need for investment in improved auction capabilities.

We aim to deliver a common Auction Capability for ancillary products to enable more efficient auction-based procurement activities and unlock closer to real-time procurement and co-optimisation of services where applicable. It will enable the ESO to procure services more flexibly, with greater granularity, through a platform that is fit for purpose offering a streamlined route to market for future designed services. This Auction Capability will be expandable to all types of auctions for reserve, response, and other services that will be gradually implemented on the platform.

The Auction Capability will integrate with Market Reform to optimise the user experience and will automate some market provider processes using APIs. We anticipate it will be a scalable and flexible solution to cater for all future day ahead market products and meet the needs of market participants including DSOs

(vi) Settlement, Charging and Billing

We will introduce a new Settlements, Charging and Billing system to replace both the legacy CAB and ASB systems. This will result in the increased ability to implement regulatory change in a timely and cost-efficient manner. This is particularly important given the number of complex and significant regulatory changes in the pipeline.

Our new system will support the need for increased calculation complexity, data and market demands from revenue streams. It will create greater flexibility and reduce the cost of change, removing manual processes and offline tools, thus reducing the risk of human error. We aim to provide a user-friendly system interface, meeting the ever-growing business demand for intuitive and easier to use tools. Our system must be scalable, to manage changes brought about by market disruption, for instance, significant increases in the number of market participants.

Once operational, we will continually enhance the system to add new services in response to evolving market requirements. We will ensure coordination is aligned across the regulatory portfolio for new modifications and services to ensure integration, testing, process development, communication and training all take place. We will also continue to extend and enhance our open data provision using standardised formats such as APIs, to provide greater levels of reports and insights harvested via our Digital Analytics Platform and published on the Digital Engagement Portal.

(vii) Regional Development Programmes (RDPs)

We will facilitate zero carbon operability through the continued roll-out of our Regional Development Programmes (RDPs) – a project or study that looks at the electricity network across Great Britain. They identify areas of development between transmission and distribution networks in areas with large amounts of distributed energy resources (DERs). A DER is a small-scale power generation that operates locally and is connected to a larger power grid at the distribution level. These can include solar panels or small wind farms.

RDPs are designed to unlock additional network capacity, reduce constraints, and open new revenue streams for market participants. They aim to introduce new ways of working that significantly enhance transmission and distribution systems coordination and control, and they provide new tools and resources to manage system constraints – ultimately reducing costs for consumers.

We will establish an integrated data exchange and situational awareness capability with all DSOs, enabling coordinated access to Distributed Energy Resources and management of service conflicts, via extension of Regional Development Programmes. This will grant the ESO greater visibility and control of parties connected to distribution networks. It will provide an integrated real-time data exchange, situational awareness and dispatch capability with DNOs thereby facilitating the RDP process. In the future, we will implement the output of the RDPs as enhancements to the overall network control and balancing solution.

Investing in this area aligns with the Energy Data Taskforce (EDTF) key finding in operational optimisation, enabling operational data to support system optimisation and facilitating multiple players to participate at all levels across the system.

(viii) Network Operator Assessment (NOA) Pathfinders

Pathfinders are projects that are looking for solutions to challenges in the electricity system, which is carrying increasing amounts of energy generated from renewable and low carbon sources. We will find innovative new ways to operate the electricity system of today and tomorrow, keeping costs down for consumers.

We will invest in enhancing the tools that our NOA Pathfinders depend on, such as our modelling capabilities, which enable us to unlock significant benefits and maintain a secure and operable network. These tools will

utilise the target platform architecture and integrate into cross-cutting platforms like the Data and Analytics Platform and the Digital Engagement Portal, for data and delivery channel services etc.

We need to be able to manage the rising number of scenarios and increased modelling complexity that are driven by the growing interaction between different network needs, such as voltage and stability. The better we understand likely needs, the better we can identify where and when to efficiently invest. Our current analytical tools focus on thermal needs and some voltage issues, so we need to expand our tools to cover all energy-related network issues.

4.2 Pillar 2 – Building our core capability through digital technology

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 digital 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 the 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.

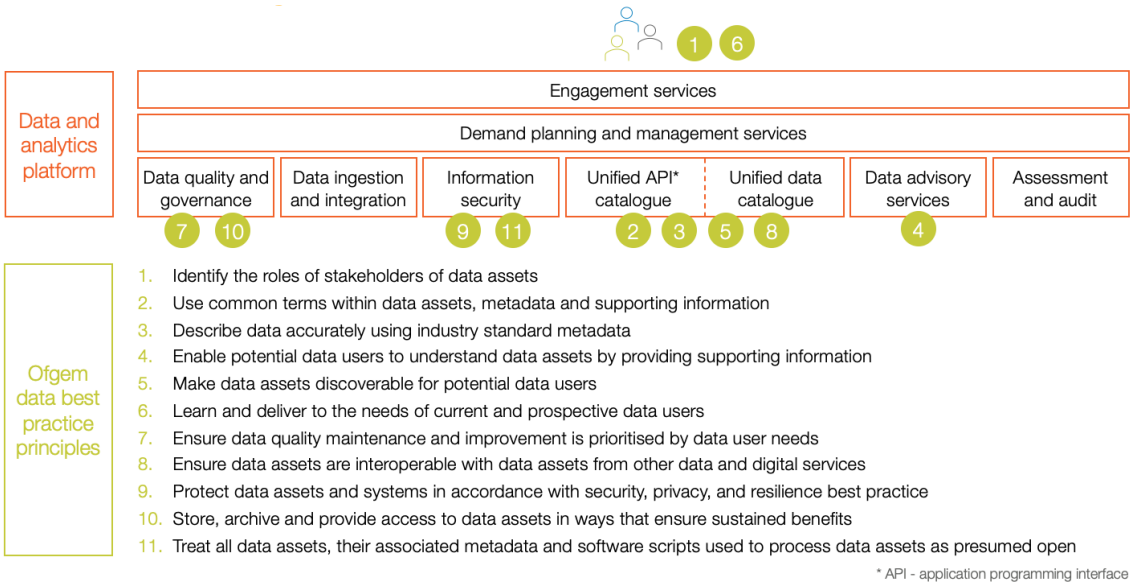

Figure 7 – Mapping between Ofgem's data best practice principles and our Data and Analytics Platform approach.

The Data and Analytics Platform (DAP) will act as a single version of the truth for our data, providing accessibility and transparency for stakeholders. It will provide the data to enable a consolidated graphical user interface for our Control Centre engineers, allowing them to better visualise and analyse operational data, and deliver data and analytics products for both internal and external stakeholder use-cases.

This solution will ultimately work to move all ESO data to a single platform and allow users to access it in the timescales they need. Externally, we will make agreed sets of data accessible via the Digital Engagement Portal, allowing stakeholders to make quicker and more accurate decisions, as well as extract and feed the data into their own analytics tools.

This single source of data approach requires a rigorous and well-managed process and culture, and it requires our infrastructure investment to support this increase in capability. To make the data accessible across the whole ESO we will invest in the required integration layer and associated APIs.

The Data and Analytics Platform will create a new communications architecture that allows new systems to be integrated seamlessly in a ‘plug-and-play’ or ‘app-like’ fashion. This allows our plan and future system upgrades to flex as needed to meet the challenges of facilitating the transition to net zero.

4.2.1 Strategic enablers to building digital technology capabilities

The Data and Analytics Platform will retire many of our data legacy systems and deliver a range of uses that will support our broader digitalisation strategy including:

- Energy forecasting
- Balancing and control
- The Virtual Energy System
- Market simulation and analysis
- Network modelling
- Modelling and data exchange for whole system operability
- Energy system data and analysis

(i) Energy forecasting

Our forecasts contribute to the decision making of market participants through operational and pricing decisions delivering more efficient markets. Better forecasts with less uncertainty will 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. Our plans are therefore to use modern digital technology to build a new platform for energy forecasting to replace our current forecasting system. Four digital enablers will support this new capability:

- **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.
- **Reporting & analytics** – data exploration and KPI reporting, embedding insights into operations and for market participants.
- **Modelling & automation** – wide enablement of automation and advanced modelling technologies, including machine learning, to streamline operations and deliver ongoing, sustainable improvements; and
- **Operational support & modelling** – round-the-clock support, maintenance and troubleshooting for data capabilities, ensuring system stability, robustness and compliance with Grid Code and licence obligations.

(ii) Balancing and control

Our core balancing systems enable the real-time balancing of electricity supply and demand and are classed as critical national infrastructure (CNI). A major failure of these systems would result in widespread loss of supply, which would lead to economic and societal damage to the UK and put ESO's licence at risk. It is essential that we invest in our core balancing systems to manage the rapidly evolving electricity market.

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.

Building on strategic design work and inertia forecasting and modelling in RIIO-1, we will apply automation, machine learning and AI to enable us to handle greater volumes of incoming data and balancing actions. We will be able to schedule and dispatch high volumes of renewable and distributed generation, and 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 costs. New situational awareness tools and upgrades to our control centre video walls and operator consoles will allow us to visualise 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 a lower cost to consumers.

We will make better use of data by integrating these capabilities with the Data and Analytics Platform and applying machine learning and automated control to transform system balancing. This will allow us to add balancing simulation into future training simulators and to generate valuable insights and analysis to be used across the ESO.

(iii) The Virtual Energy System

Our goal is to build a 'digital twin' of the UK power system and energy markets which can validate the benefits and impacts of changes to the market and physical network. Our Virtual Energy System will utilise machine

learning to run multiple, complex scenarios in a real-time training and simulation environment. This will inform the way we develop our new balancing and control tools, which will then be built offline in a modular and agile way. This will be a large programme of work, researching and testing different elements before starting to pull together the enduring system.

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. This benefits consumers, by making it easier for us to upgrade tools in the future and respond faster to change.

The development of the Virtual Energy System will begin with an open framework, with agreed access, operations and security protocols. Over time, this will be populated by existing and new digital twins – replicas of physical components of the energy system. Each digital twin will contribute to and access real-time data on the status and operation of other elements of the system. This layered data will generate insight, and a virtual environment through which to innovate ideas, with the potential to transform the system and support the transition to net zero.

Our use of digital twin technology is aligned with the vision for the UK national digital twin (NDT). We are actively engaging with stakeholders, such as via the Centre for Digital Built Britain Digital Twin Hub[11]. We envisage our Virtual Energy System as a 'federation' of organisations and educational institutions developing digital twins, sharing APIs and data across an entire network.

(iv) Market simulation and analysis

As we move through 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 the future, we will build digital replicas, using live data in an offline environment, allowing us to safely test new approaches, learn by doing and drive 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.

(v) Network modelling

As the generation mix moves towards more variable sources (e.g. wind and solar), the current business processes, based on estimates from historical data, will become unreliable and introduce higher system security risk. Greater volatility closer to gate closure means we need to run at least high-level network assessments closer to real-time. We are establishing new, more efficient ways to undertake more complex analyses and assess the growing number of interactions between different network issues.

We will enhance our network modelling capabilities by providing online analysis of voltage and power flow profiles closer to real-time. This will ensure the network is run securely and data exchanges with TOs and DNO / DSOs are timely and correctly assessed. We will also upgrade our offline modelling tools and use enhanced tools to allow more complex modelling arising from operability challenges, to support future network operation. The offline network modelling tools deliver the day-to-day analysis required to operate the transmission system safely and securely.

Both our online and offline network modelling capabilities rely heavily on the Data and Analytics Platform which will be the foundation to meet the needs of the RIIO-2 programme. The artificial intelligence and machine learning methods it enables will then be used to recommend or automatically execute actions. This will create an interchangeable suite of tools using a common dataset and seamless exchange of data between tools.

(vi) Modelling and data exchange for whole system operability

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

[11] Centre for Digital Built Britain Digital Twin Hub - https://www.cdbb.cam.ac.uk/DFTG/NDTHub

in modelling and are applying learnings from innovation projects to enhance our future operability analysis and planning.

Our support for cross-industry initiatives is also helping drive enhanced data sharing and collaboration. One example is the 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 the timely connection of DER through the Statement of Works process.

Our Enhanced Frequency Control Capability (EFCC)[12] project will enhance the visibility of frequency data at a regional level, facilitating the participation of demand-side response (DSR) providers in balancing markets, and the Investigation & Modelling of Fast Frequency Phenomena[13] project 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.

(vii) 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 Electric Vehicle (EV) charging behaviour[14], has brought a step-change in our modelling of EV electricity demand.

Our self-funded carbon intensity forecasting project[15], which uses machine learning and automation to provide more accurate forecasts. We publish these forecasts to enable consumers, academics and industry stakeholders to make more informed choices, and ultimately move the industry towards optimising the use of renewable electricity.

In the 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[16]. 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.

(viii) Distribution System Operation

Our work on operational visibility will affect many of the IT systems supporting the control room. In BP2 our investment will be initially focused on the installation of inter control room communication links to those DSO control centres in need of linkage. This real-time operational visibility will enable better decision-making capabilities by providing access to highly granular data that will allow parties to operate more efficiently.

[12] Enhanced Frequency Control Capability project - https://www.smarternetworks.org/project/ngeten03
[13] Investigation & Modelling of Fast Frequency Phenomena - https://www.smarternetworks.org/project/NIA_NGSO0007
[14] EVs' charging behaviour - https://www.smarternetworks.org/project/nia_ngso0021
[15] Carbon intensity forecasting - https://carbonintensity.org.uk/
[16] Spatial heat model - https://www.smarternetworks.org/project/nia_nggt0154

4.3 Pillar 3 - Transforming our organisational culture and digital ways of working

To achieve our digital ambitions, we will transform our organisation's capabilities, culture and ways of working, establishing a digital transformation programme that will implement our digital approach to operations. This will consist of three core elements: a **digital mindset, product model, and agile delivery methods**. The figure below shows our near-term roadmap.

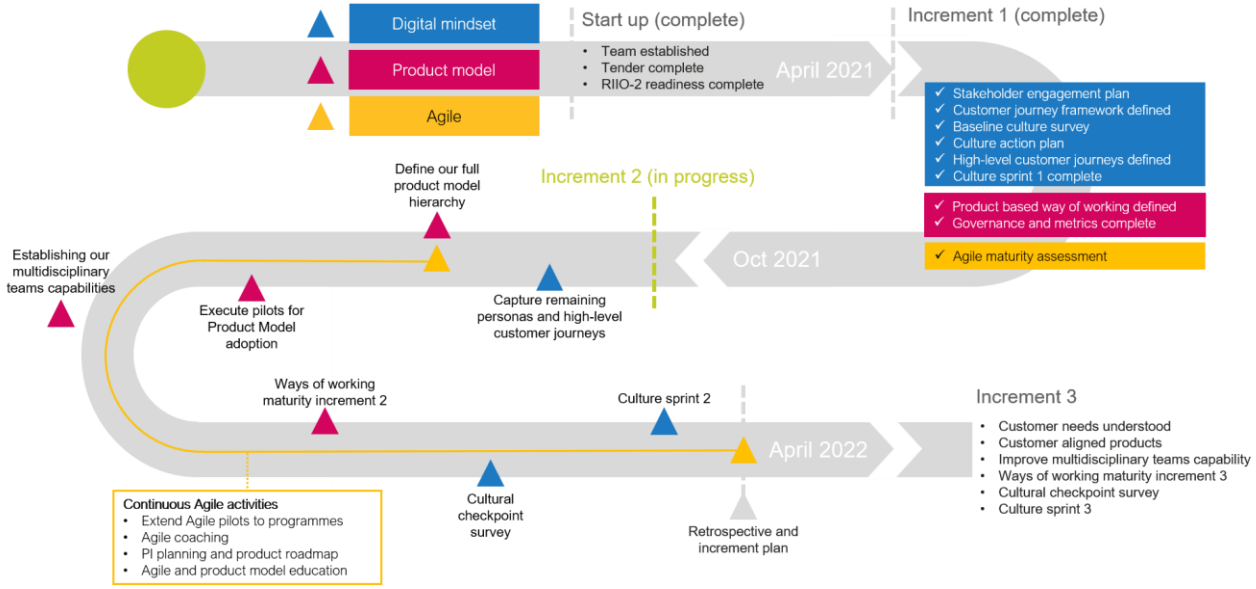

Figure 8 – Digital transformation (Ways of Working) roadmap

Our first phase will focus on understanding, defining, and early adoption, after which our next phases will scale our digital operations before moving into a period of continuous improvement. Thus far we have completed a series of activities to understand how we improve our emphasis on the customer, and how we bring the customer into the heart of our product development. This included understanding the products and services they want, and how they want to interact with us. We have now begun our second phase, adoption.

The adoption phase will support the implementation of the product model blueprint and will be a multiyear programme of change as we scale the product model, improving, and integrating our new ways of working. In parallel, we have defined a customer journey framework that allows us to consistently capture the needs and wants of our customers through personas and journey maps.

4.3.1 The digital mindset

We will generate a people-first mindset and put our customers, clients, stakeholders, suppliers, workforce, and users first in designing our end-to-end processes and technology solutions. Putting people first will enable us to think about what people really want to create value in the form of new products and services, or to create new user experiences, in the form of different more effective ways of doing things.

Our customers tell us that the experience of participation in energy markets is too complex, there is no step-by-step guidance on how to participate, information is diffuse, rules and frameworks are ambiguous requiring interpretation and discussion, and they don't know who to talk to.

They need a more seamless experience when interacting with the ESO – frictionless with minimal clicks to get what they need. Engaging with the ESO will become more intuitive and user friendly through the provision of a consistent and personalised user experience including access to information, data, codes, connections, and market participation. We want to make it fluent, easy, and actively engaging to take part in the energy market.

Customers want processes to be automated, data to be machine-readable, collected once and reused. They want an engaging experience with high levels of automation. This helps them to be more efficient, to be more proactive, and provide the value that consumers need. We will better understand the customer journey and the required products/services. Our vision is for this to be a co-creative process where together we will better understand their needs and improve the experience.

Digital mindset – customers first

We will build technology solutions that our customers – internal employees and external to the ESO – want to use and that seek to maximise productivity and increase wellbeing. Digital technologies are a piece of technology where the user's interaction or experience with the technology is paramount. Users don't care, and nor should they, about the actual underlying code or system – they want a personalised, friction-free, seamless start-to-finish experience that delivers the right outcome to them. It is important for us to provide digitalised products and services in an inclusive way. We intend that digitalisation of our products and services should not become a barrier to any of our stakeholders.

Core to this is the customer journey, which helps us to understand the needs of our customers and is a map of how and what people experience when they interact with ESO to achieve their outcome (see Figure 9). The usability of our systems for both internal and external users is critical for our success and is a key design principle for our products.

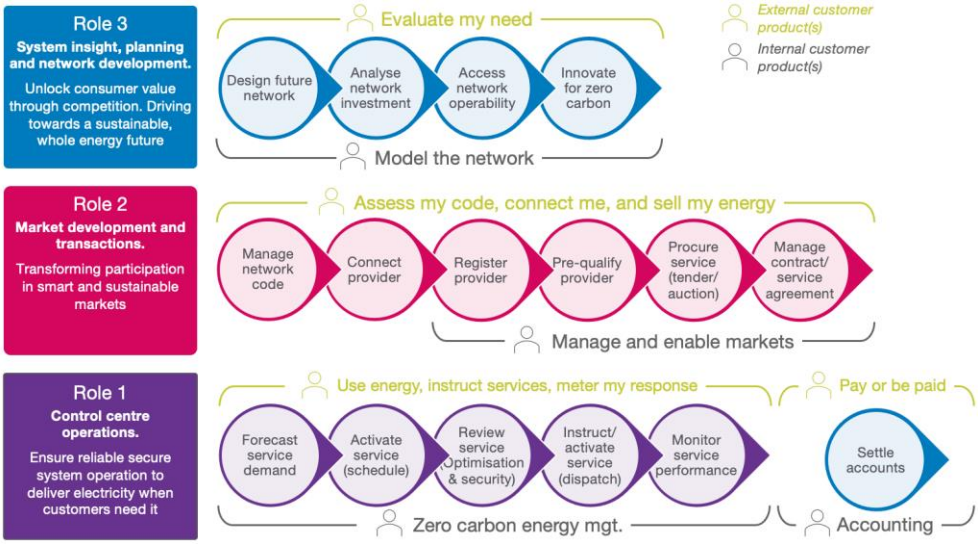

Figure 9 – A high-level example customer journey

Implementing design thinking and enabling customer engagement throughout the process will also be key to our customer-first approach. We will continue to carry out regular customer surveys using online tools to capture immediate feedback following events and key milestones, and we will run customer satisfaction surveys to gather feedback on our Role commitments and general performance, using these data points to deliver customer value. We will publish these insights and actions in 'you said/we did' documents, and following on from our work in 2021, we will continue to report our bi-annual independent survey scores and feedback against our three Roles as part of our incentives reporting, to meet our licence obligations.

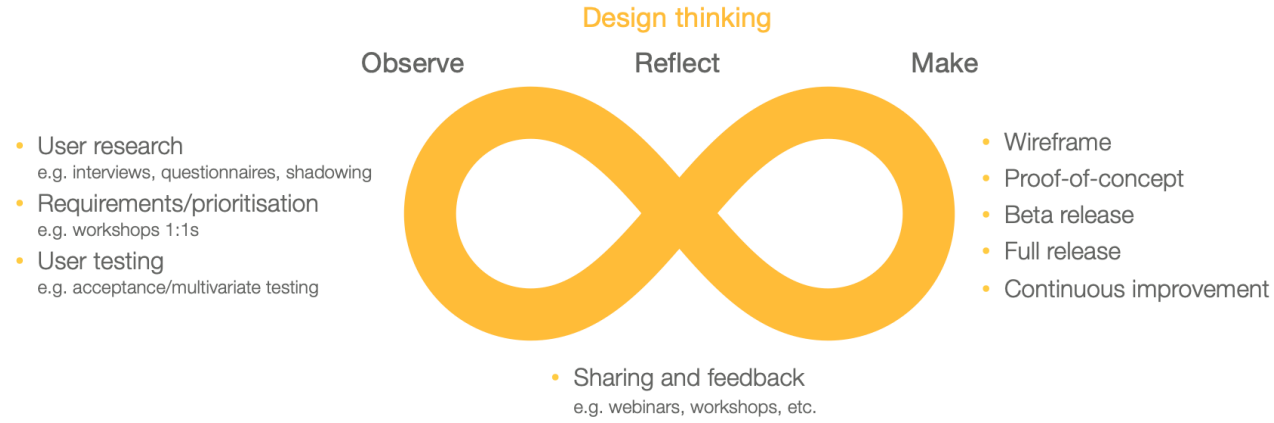

Figure 10 – Customer engagement and design thinking approach used in our Digital Engagement Portal development

Our Digital Engagement Portal is also one of our leading programmes to integrate the customer into our development lifecycle through interviews, questionnaires, and workshops. This is a model that we will embed in all our digital delivery. We will continue to share this insight more broadly through webinars to access further feedback, and a summary of this process is shown in Figure 10 above.

Digital mindset – culture and behaviours

Culture is a critical enabler of the digital mindset and fundamental to our success. There are characteristics of our culture that we want to encourage. Developing the right capabilities and skills in our workforce alongside a supporting culture and behaviours will foster a proactive, innovative, and collaborative operating environment.

Our enabling culture and behaviour principles are:

1. Open, transparent, and inclusive – so people can see what we're doing and be part of it.
2. Shared purpose and vision to give clarity and focus.
3. Empowered teams with defined roles and accountability that reflects and supports the way in which we create value.
4. Quick, efficient, and continuous decision making.
5. Coaching style leadership incentivised on purpose or mission.
6. Learning culture with a continual rapid iteration of thinking, doing, and learning to innovate and operate in a flexible and adaptable way.
7. Ask 'Why?' – create an inquisitive organisation that is connected to outcomes.

We are constantly considering how our approach to decision making, motivators, commitments, mindset, and our structure all contribute to our culture. We will run culture change sprints that aim to increase collaboration and empowerment as we see the cultural transition being fully embedded over the RIIO-2 period.

One of the ways we are encouraging internal collaboration across teams is by establishing communities of practice (CoP). Two examples are the data management/ advanced analytics (modelling) CoP and the Business Analyst CoP. Through these forums, we share best practices, educate and upskill others, and provide ad hoc project support. We plan to set up several other CoPs for product management, scrum masters, architects, DevOps etc. The introduction of a RAPID *(*Recommend, Agree, Decided, Input, Perform*)* decision-making framework has also been instrumental in helping to define clear roles and responsibilities and create a strong sense of accountability across the TechOps community.

Digital mindset – innovation

The Virtual Energy System is one of the ultimate aspirations listed in the ESO's 2021 innovation strategy and digital transformation and data will be key to enabling it. On a day-to-day basis, our technology will underpin the vision, whether that be through the building of operational digital twins, or the creation of scheduling and forecasting tools that will utilise artificial intelligence and machine learning. A case study of the Virtual Energy System can be seen in our recent Digitalisation Strategy and Action Plan.

4.3.2 Product model

Customer-centric products and services with an integrated backlog

Using the principles behind design thinking, we will develop customer-centric products and services that are built with the user in mind. Integrating our customers into the design and development of products allows us to develop a greater understanding of what they need and creates the 'golden thread' from customer to engineer. This insight will help us to offer better solutions, and when combined with agile delivery methods, will allow us to deliver value incrementally at speed and scale.

For us, a product delivers a distinct offering that is valued by customers and is managed as a distinct unit across its lifecycle. It might be made up of many applications or components but to the user, it is a single product. We have chosen to align our products to the customer journey rather than a technology platform or business capability. This will enable us to focus on the product as a whole and the value and benefits it delivers to customers as opposed to individual or groups of components or features delivered through a project.

Products can exist within products as part of a product family meaning our product model will be a hierarchy. This will ensure that the sub-products integrate within the product family and that the user experience is the same across all products and is simple, seamless and frictionless.

Figure 11 provides examples of potential customer-centric products that are being explored by the TechOps community. Each product and service will have a prioritised backlog of functionality and features with closely managed dependencies. The cross-cutting activities including innovation, customer and stakeholders,

regulation, assurance, and business change, will either be part of a product within our key product areas or have standalone products that suit their needs.

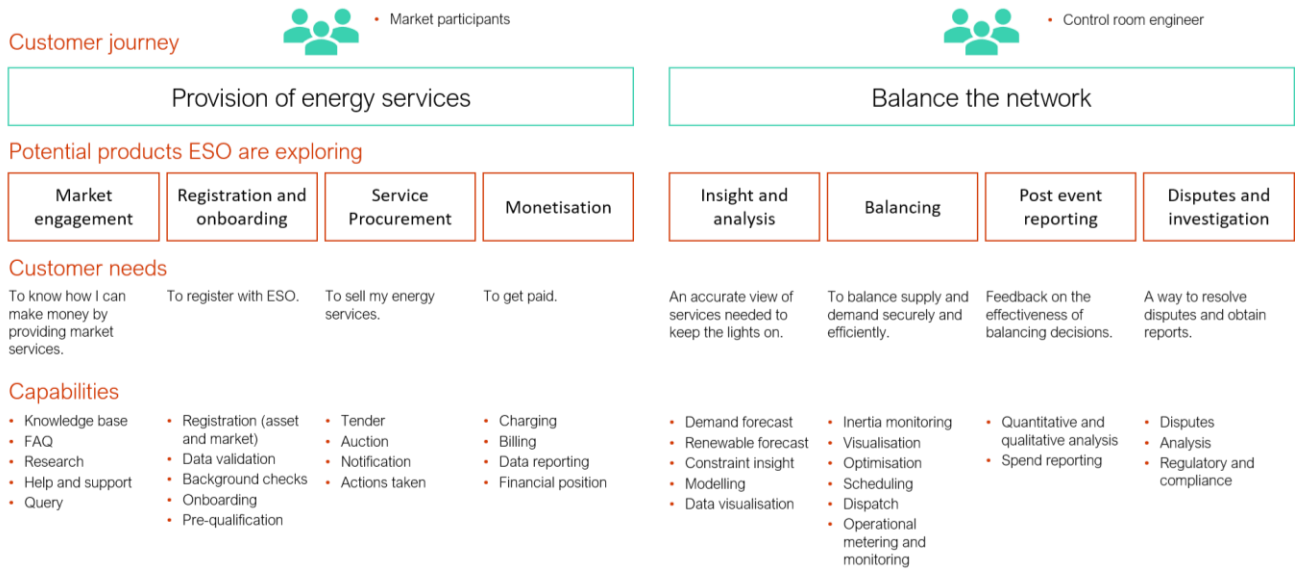

Figure 11 – Potential examples of customer-centric products that the ESO are currently exploring

Product model – ways of working

We will partner and collaborate with our customers and truly include them in the product development lifecycle. As we bring together our own team to operate with a one-team mindset, we will be able to innovate faster and reduce the time between an initial idea and a product launch, thereby enhancing the customer experience.

We are moving to a product approach and away from a project approach (see Figure 12), where possible, in how we govern and manage business initiatives.

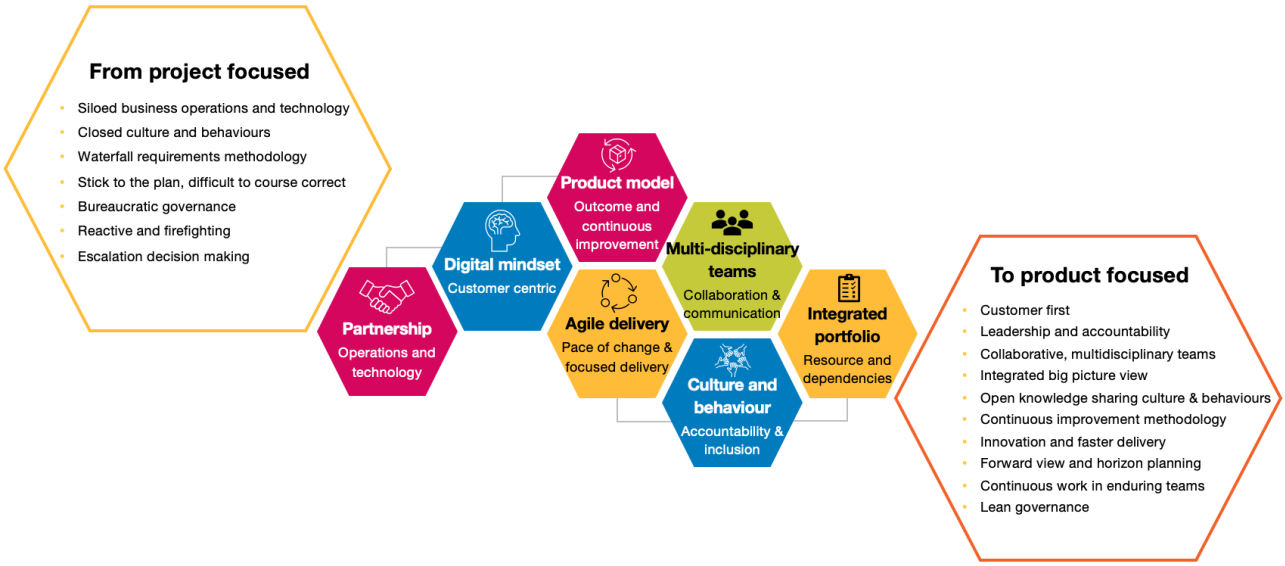

Figure 12 – What we are going to do differently, from project to product focus.

This transition from a project to product model will be phased as we evolve our capabilities, establish multidisciplinary teams, and incrementally add new products to cover our key end-to-end customer journeys (see Figure 13).

We will continue to develop our product management capabilities, and we will implement new ways of working with early adopters. These early adopters will trial our operating model, providing valuable feedback and lessons learnt. There will be engagement plans to take people on this journey from awareness to empowerment.

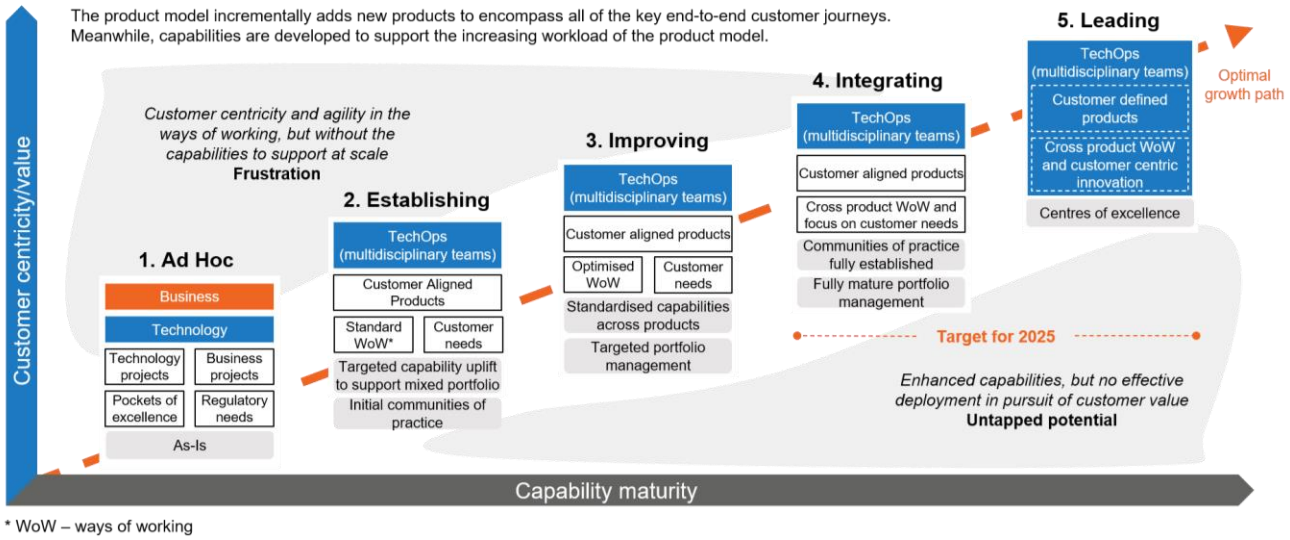

Figure 13 – Our phased approach to increasing our product model maturity.

A critical component of the new ways of working is the partnership between technology and operations (TechOps), building collaborative teams focused on outcomes. We will come together as equal partners in enduring, multidisciplinary teams to deliver this.

Product model – multidisciplinary teams

We are creating cross-functional teams that foster collaboration and inclusion. Involving the relevant people will connect the users to the people who design, develop and support our products and services, and will lead to higher quality outcomes.

Individual sprint teams will be purposefully built with ESO leadership and supported by high-calibre people from cross-functional teams (Figure 14), and we will draw on deep technical competencies from our own teams and those of our framework partners and niche suppliers as well. This will allow a core/flex model, increasing our own competencies while allowing flexibility for scaling or niche skills. Finally, we will move to a model where development, security, and IT operations (DevSecOps) are integrated into these multidisciplinary teams to give high performance and throughput.

Figure 14 – Example of a multidisciplinary team

4.3.3 Agile delivery

We want to delight our customers through early and continuous delivery of value. Agile and iterative development methodologies will enable us to cycle through the design thinking loop where we observe, reflect, and make. By integrating our customers into the design and development process, we can focus on high-value outcomes that meet the customer's needs (see Figure 15).

Using methodologies like SAFe[17] we will organise our delivery teams in value streams to focus on outcomes and people's experiences. Working in mixed discipline teams to achieve timeboxed (weeks, not months or years) results that enable stakeholders to continuously test against the relevant outcomes, user experience, and course correct the solution as required.

As part of our digital transformation, we are drawing on expertise from our agile transformation office. This team are focused on the practical implementation of agile methodologies including agile scrum ceremonies, backlog management and DevOps tools, and training.

We have conducted a delivery team agile maturity self-assessment to gauge the readiness of existing programmes to pivot to a product-focused model.

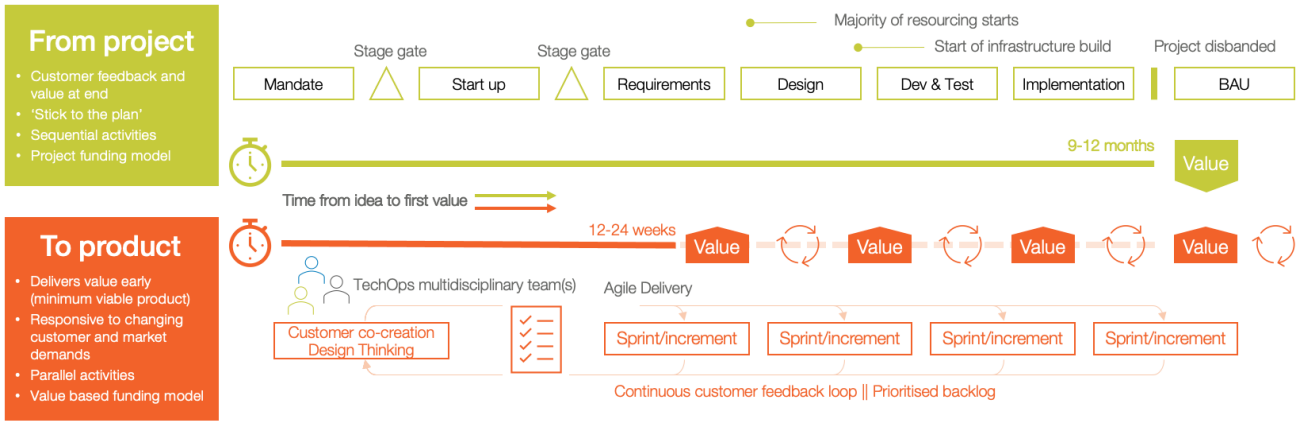

Figure 15 – From project to product. Prioritising the customer and delivering value sooner.

Our customer focussed product model will be delivered using iterative development methodologies (see Figure 16) and will combine elements of SAFe, Agile and Waterfall delivery frameworks.

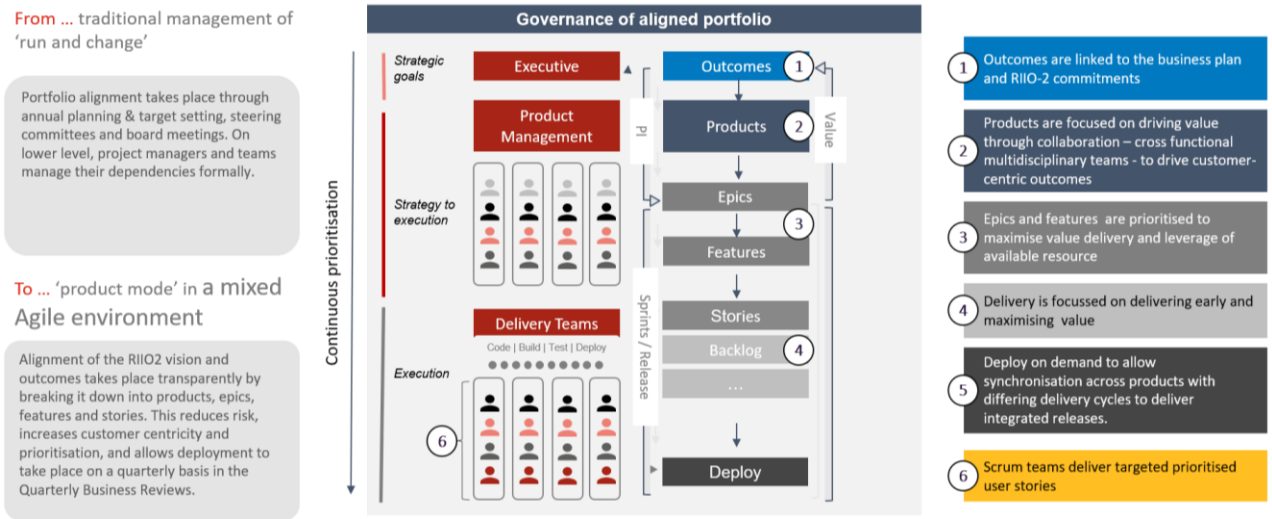

Figure 16 – Our customer-focused product model will be delivered using iterative development methodologies.

[17] See the Scaled Agile Framework website for more detail https://www.scaledagileframework.com

Agile delivery – flexible technology

We will use modern modular digital technologies, to enable flexibility so that we can upgrade or change parts of the solution more easily to meet changing needs. It will provide opportunities for a simplified, consistent, and accessible customer experience.

We will build solutions that facilitate and expedite change. Using a modular architecture approach will enable flexibility for change and growth – modules can be replaced/upgraded for more modern technologies without impacting other modules – and modules can be reused across the ESO, eliminating duplication (interoperability by design).

Our approach will be to consolidate applications and capabilities onto standard platforms. Creating these platforms will lay the foundations that move us away from interdependent systems and enable consistent adoption of digital initiatives.

This allows multiple enabling capabilities (activities) to be hosted on the same platform and consumed by customers via a product. For example, Market Reform will host registration, auction participation, and reporting – all exposed to the end-user through the Market Reform product.

The Data and Analytics Platform will create a new communications architecture that allows new systems to be integrated seamlessly in a ‘plug-and-play’ or ‘app-like’ fashion. This allows our plan and future system upgrades to flex as needed to meet the challenges of facilitating the transition to net zero.

For openness of information and interaction, we will enable application programming interfaces (API) through our Digital Engagement Portal.

Our non-CNI solution platforms will be hosted in the Azure cloud and CNI solution platforms will be hosted in the on-premise CNI data centre. All shared IT infrastructure investments (e.g. data centre, networks, and identity access management) take into consideration the possible separation of the ESO from National Grid Group.

Rationalisation and decommission of legacy applications and technologies is a key focus for the following two to three years. On an enduring basis, we will dedicate a proportion of our capacity to removing the technical debt that is a normal part of technology evolution and change.

5. Embedding data and digital practices across the ESO

5.1 Attracting and retaining technology talent

At the ESO, we consider our people to be our most important asset and we believe that building a diverse and digitally native workforce is the key to success in RIIO-2. Delivering our strategic intent will require a step-change in our capabilities and we will achieve this by continuing to invest heavily into growing and developing our people. Through this continued investment, our employees will be equipped with the skills required to thrive in their technology careers within ESO.

We will create an environment for our employees to continuously develop through a combination of curated programmes and self-serve learning. Our employees will be able to chart a clear career path in the ESO and we will nurture and promote them to develop their careers in their direction of choice. We will also continue to develop our successful trainee intake programme, thereby building a pipeline of future talent that will be highly skilled in modern technologies and will have the opportunity to work at the forefront of the energy sector.

To address the step-change in headcount and capabilities that we need to make in RIIO-2, our People & Capability team is constantly working to identify and mitigate against future workforce and capability gaps. Our blended sourcing strategy includes exploring multiple options to secure the right data and digital resources we need. The options include engaging with organisations that can help us accelerate this process and forming partnership arrangements to supplement our in-house capabilities. This will provide us with access to best practice, market-leading skills that will in turn help to develop our own people and capabilities.

The ESO has a unique opportunity in shaping the way we use and consume energy for generations to come. We want our employees to be empowered by a strong sense of purpose, as they leverage technology to play a key role in contributing to the nation's transition to net zero.

5.2 Promoting data literacy and digital skills

Our people are key to embedding data and digital practices across the ESO and will receive regular training to develop their data and digital skills, especially in the wake of the COVID-19 pandemic, which has accelerated the need for digital ways of working. We will continue to invest in training our existing workforce and will align our technology capabilities with a recognised industry-standard framework, such as The Skills Framework for the Information Age (SFIA). This will ensure our people are equipped with the requisite skills and competencies for delivering our digital transformation across the organisation.

From a digital perspective, we will upskill our workforce across several key capabilities to ensure that we can use more data more effectively and deliver the change projects that are a core component of our digital transformation. Data analytics and management, as well as stakeholder engagement and change management, will be increasingly important skills for all our employees to develop.

As we transition to a product model, we will ensure that our people receive the skills and qualifications required to fulfil their roles on agile delivery teams. Specialist training for roles such as scrum master, product owner and product manager will be provided to upskill existing employees and equip them with the skills required to excel in delivering continuous value for our customers.

To fully embed the Data and Analytics Platform into the day-to-day operations of the ESO, we will initiate a programme of upskilling our teams to adopt the new technologies deployed through the platform and defined and put in place a new Data and Analytics operating model, addressing the development, operation, and governance of data assets and products. By bringing together people, processes and technology, we will evolve our data capability to meet the challenges of planning and operating a fully decarbonised electricity grid, allowing us to, for example:

- Create new insights and tools to enhance the operation & planning of the grid, enabled by leading-edge machine learning and artificial intelligence capabilities and consistent data
- Enhance the Control Room's situational awareness by bringing together the data, visualisations and analytics to support real-time decision-making in an increasingly complex environment
- Promote collaboration and insight-sharing by standardising analytical, modelling, visualisation, and reporting tools across the ESO
- Create and deploy products and services via our Digital Engagement Portal based on a "single view" of our customers, driving innovation across the energy sector through Open Data and collaboration

5.3 A new data and analytics operating model

To fully exploit the technology delivered through our Data and Analytics platform and embed a data-driven culture across the ESO, a new Data and Analytics operating model is required, centred around the adoption of the TechOps approach to data product development and operation, underpinned by robust Data Governance that ensures **i)** data quality, **ii)** compliance with data policies, data management standards, privacy standards and regulations, and **iii)** drives standardisation and best practice across Data and Analytics activities.

Under this operating model, Data and Analytics activities will be orchestrated through a "Hub and Spoke" organisational construct, which seeks to balance:

1. **Centralisation**, to drive best practice, effective data governance and standardisation via a Hub team, and
2. **Decentralisation**, to promote self-serve innovation and data product creation in business Spoke teams under the TechOps model.

The activities orchestrated through the Hub and Spoke model are illustrated in the figure below. A key concept driving our operating model is that of "**Data as a Product**". Data products fulfil the specific needs of the business and provide the means by which data is managed, organised, presented, interpreted, and utilised to create insights. The goal of our operating model is to provide a structured framework for the development, operation and governance of the data products required to support the delivery of our mission.

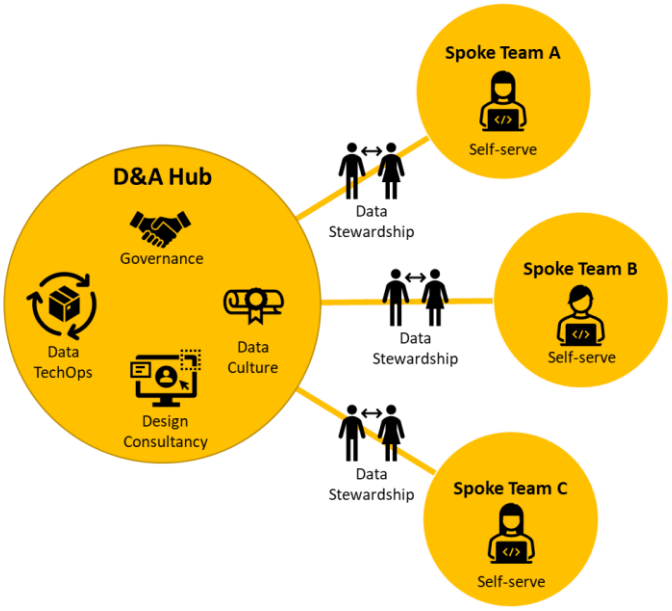

Figure 17 – Our Data & Analytics Hub and Spoke model

The characteristics of our target Data and Analytics operating model, serving both internal and external stakeholders, are set out below:

1. **Federated Data Governance:** An ESO Data Governance body creates and implements data quality standards and data governance and privacy policies, controls data access management, and has central visibility of data ownership to ensure consistent and compliant use of data across the ESO. Data Custodians[1] (previously referred to as "Data Owners") are supported by a team of embedded Data Stewards who ensure conformance with internal standards, compliance with regulations, run the Open Data Triage process, and maintain a forward view of the data needs of our organisation. Prioritisation of Epics/use cases will be done at the portfolio level by the TechOps community and presented to the Portfolio Review Board for agreement and approval. The Data Governance body makes recommendations to and takes direction from, the ESO's Portfolio Review Board with respect to other data initiatives.
2. **Self-serve Data & Analytics:** The "data as a product" approach is underpinned by our self-serve Data & Analytics platform (DAP), which abstracts the underlying technical complexity to enable users to focus on their individual data use cases within their business domains. A common data

management layer enables consistent governance and control and promotes data accessibility to internal and external stakeholders through a centrally maintained Data Catalogue.

3. **TechOps for Data Products:** The application of TechOps to the development and operation of data products draws on **i)** best practices from agile, DevOps and manufacturing, to enable extremely high-quality data pipelines and very low error rates, delivering timely, trusted, analytics-ready data to the point of use ("DataOps"), and **ii)** best practice from software application deployment to unify and automate the release cycle for machine learning /analytics data products ("MLOps"). In conjunction with the platform, the Data TechOps capability will enable efficient, robust and repeatable productionisation of machine learning /analytics applications, freeing data science resources to focus on innovation and continuous improvement of models.
4. **Design Consultancy:** In the early stages of adoption of the platform, a Design Consultancy capability within the Hub will work with business teams to advise and guide the development and embedding of data products.

Our Hub and Spoke model will enable the target Open Data customer experience which is illustrated in Figure 18. This experience will be enabled by our Digital Engagement Portal and Data and Analytics Platform and is underpinned by several processes:

- A transparent and user-friendly process for external customers and stakeholders to request access to datasets not yet published, exploiting our Open Data Catalogue[18] to discover new datasets and make these accessible.
- The Open Data Triage Process (already in operation), complying with the Data Best Practice Guidance published by Ofgem in November 2021. We will continue to engage with market participants to identify opportunities to enhance our open data service, in particular with respect to transparency of the triage process and managing sector-wide risks relating to inadvertent over-sharing of data.
- The data publication process, which currently requires a combination of manual effort and automation, will be increasingly automated through the integration of DEP and DAP in the BP2 period.

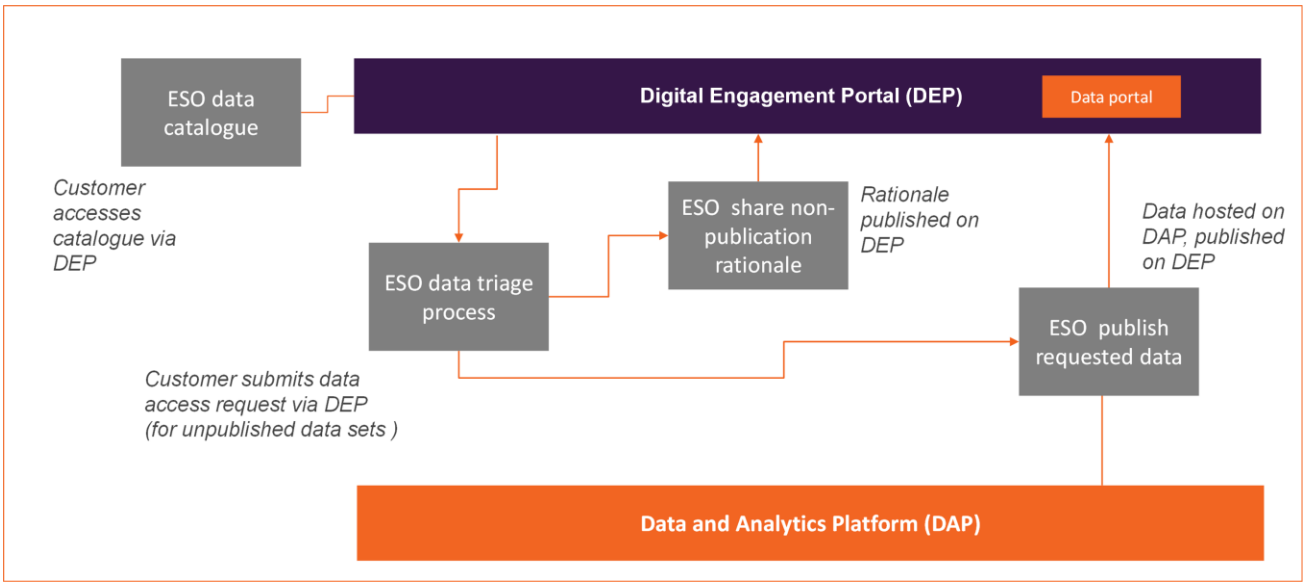

Figure 18 – The target Open Data customer experience

[18] The Open Data Catalogue is a list of data sets under management within ESO's systems and will be delivered by the end of the BP1 period.

5.4 Data management and security

Our data management policy is consistent with the principle of 'presumed open'. For **Open Data** we wish to provide:

1. Publication of open data with access via API and other formats
2. Advanced and filterable search options across both data and content enabling greater self-service and reducing the need for customers to contact ESO with business queries
3. Subscription to datasets and notifications of data updates and new datasets
4. Intelligent search to interact with ESO content, helping customers to identify appropriate detailed material or directing them to raise a business query with subject matter experts
5. An intuitive and easy to use the interface to raise, track and receive resolution of all queries
6. A way to discover and request datasets that are not yet published
7. Tools to manipulate and visualise published data (e.g. PowerBI)

To enable this, we will implement comprehensive data management tools and processes on the Data and Analytics Platform to manage shared data so that organisational goals are met, risks associated with data redundancy are reduced, higher data quality is ensured, and consequently, there is a reduction in the cost of data integration. This will bring about greater organisational data maturity and an unwavering trust in the data we consume and deliver.

We continue to mature as a data-enabled organisation; applying the data management standards we have established and that we continue to enhance. Our standards follow the Data Management Disciplines of the **Data Management Association (DAMA)**, summarised below and explained in their Data Management Body of Knowledge[19].

Figure 19 –Data Management Disciplines of the Data Management Association (DAMA)

1. & 2. our data is valued as an asset and managed, protected and appropriately exploited throughout its lifecycle. We ensure data is governed, assured and secure from unauthorised access with ownership and other key organisational roles and responsibilities clearly defined.

3. & 4. we unlock the value inherent in our data. Our data does not need to be perfect, but it must be fit for purpose, in terms of conforming to clearly defined quality characteristics. Our data also becomes inherently more valuable when it is made available in standardised formats and linkable to other data sources

5. we re-use data with a single authoritative (master) source of data

6. & 7. we provide transparency by opening up appropriate access to accurate and complete data to both our internal and external data users/stakeholders

We have designed our **Data Management BMS (Business Management Standard)** to ensure these principles are adopted. Ensuring we maintain our data quality (accuracy and completeness), effective governance and can mandate their application throughout ESO, including when enhancing and developing new services for our customers and wider stakeholders.

[19] DAMA Body of Knowledge - https://www.dama.org/cpages/body-of-knowledge

We have established **data standards**, including:

- Assigning publishing owners for all our data
- Confirming the use of verifiable sources for data we publish
- Validating format and quality for data prior to release

These standards ensure we continuously seek to improve our stakeholders' experience and increase the amount of data they can access, ensuring it is open to all as soon as it is appropriate. Our internal data users also benefit from this through increased operational efficiency, reduced risk of non-compliance, Improved strategical decisions and efficient management of growing data volumes.

In order to continuously improve our data standards, in all business areas, we will maintain our central **Data Quality and Governance team**. Their main purpose is to ensure effective data management, drive continuous improvement and greater data maturity.

We operate a three lines of defence model in the ESO. The first line (ESO business teams) can use measures provided to identify and remediate any gaps and assess their own control opinions. Our second line assurance team (ESO Assurance) audit against the data management standards we have defined using gap analysis to drive remediation actions. The third line (National Grid Group Assurance) ensure that we are appropriately adhering to data management standards and are utilising insights to drive our assurance and improvement activities.

We have introduced data management roles across the ESO, to ensure that data governance is managed at a local level, as well as supported centrally including:

- **Data Stewards**, who ensure conformance with Data Quality standards, compliance with regulations, run the Open Data Triage process with Governance oversight and curate the Open Data Catalogue. Data Stewards form part of the Hub team and are embedded in the business teams they support.
- **Data Custodians** are ESO staff in operational roles that provide data subject matter expertise and support Open Data and Transparency deliverables. They play a key role in the triage and publication process to ensure the right data is shared in the right way.

To achieve, assess and evidence adherence to these standards we maintain a **Data Management Library (DML).** This securely holds data relating to the ESO's systems and information flows, both internal and external, providing a view of our data landscape. All references of our business-critical data (both internal and external) are held within this library and ensure all data:

- Has an owner and a data steward
- Is assessed for criticality and confidentiality
- Has sources and destinations captured
- Has appropriate controls implemented and evidenced
- Is assessed for data quality

These standards have enabled us to ensure we are 'in control of our data. We will now focus on improving our data management capabilities and data culture by:

- Ensuring we have people who have the right skills and capability to pro-actively drive continuous improvement around how we consume, manage, share and use data
- Providing suitable tools and technology that enable ongoing optimisation of our data and data management related processes

We have embedded data management as a core capability across ESO and through the services we offer and develop, we will continue to focus on increasing our data quality, maturity and openness to enable the realisation of our Digitalisation Strategy. To further increase our data maturity and reduce risk we are implementing and will be compliant with two new data management standards, relating to unstructured data and external data publication.

We will continue to invest in becoming a more data-enabled, digitalised service delivery organisation through:

- Increasing data access to create additional value through its wider exploitation
- Comprehensive awareness and adoption of our data principles and standards across all levels and areas of ESO
- Embedding and optimising our data tools, resources and frameworks
- Establishing forward-looking metrics to drive further data management improvements.

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