ESO RIIO-2 Business Plan 2 Technology Investment

Annex 4

16 May 2022

BP2 Technology Investment

nationalgridESO

Executive Summary

Our IT delivery plan continues to evolve as the ESO's, and energy industry's ambitions and demands change. We continuously assess the best and most efficient way to meet them.

The need to fully digitalise how we design, develop, and provide the products and services in our business plan has been accentuated by the world's evolution, be it the COVID19 pandemic or increases in cyber-attack threat. Our customers now have new standards, and our plans have adapted to address these new realities.

The IT investments proposed in our original RIIO-2 Business Plan were part of a five-year roadmap. Our IT investments comprise of three components:

- Specific investments that directly support our outputs in this plan. These include both capex and opex expenditure.
- Shared investments in cyber security, IT infrastructure, and business services made by National Grid Group IT on our behalf and based on the universal cost allocation methodology (UCAM). These include both capex and opex expenditure.
- IT running costs, where the costs support our operational IT services. This also includes the increases to the base value following investment in technology change. These are allocated based on the UCAM methodology.

Our submission focuses primarily on the first category; ESO's specific investments and associated running costs. Since National Grid Group's shared IT investments and associated RtB IT costs were reviewed and approved for the five-year RIIO-2 period in Ofgem's RIIO-2 Final Determinations, these cost elements remain unchanged in this submission and are provided for information purposes only.

The objectives of our initial RIIO-2 investments remain valid and throughout the BP1 period we have made strides towards their delivery. We have already mobilised these investments as per our original plan (26 of 33) and will mobilise five more by the end of BP1, still on track to meet our main deliverables. These decisions are continuously reviewed as conditions evolve, such as the inclusion of new activities for the BP2 period which we have initially outlined as part of this submission.

When we developed our original RIIO-2 Business Plan we were working on a high-level set of assumptions of what the IT requirements may be to enable our zero-carbon operability ambition. At the time we based our estimates on past experience, alongside benchmarking, to challenge the robustness of our estimated costs. A year into the price control, we are clearer on the specific technology requirements for many parts of the business and have been able to test some of these requirements with the market, leading to a revision of our anticipated forecast IT costs. There is still some further work to do in this area and as such we are providing cost ranges in this submission, rather than specific point forecasts, for some of our major IT investment programmes whilst we continue to refine our forecasts for the final submission.

A summary of our new cost estimates can be seen below:

£ million (18/19 prices)		**2021/22**	**2022/23**	**2023/24**	**2024/25**	**2025/26**	**Total**
ESO specific investments (capex and project opex)	BP2	82.5	137.8	127.1	126.6	100.1	**574.2**
	BP1	76.5	80.3	92.4	82.4	75.8	**407.3**
	Variance	*6.0*	*57.5*	*34.7*	*44.2*	*24.3*	***166.9***
Shared investments (capex and project opex)	BP2	30.4	22.2	20.8	20.4	18.5	**112.2**
	BP1	40.1	25.9	20.8	20.4	18.5	**125.5**
	Variance	*(9.7)*	*(3.7)*	*0*	*0*	*0*	***(13.3)***
Cumulative IT incremental running costs	BP2	47.9	55.7	66.7	71.8	74.3	**316.3**
	BP1	47.1	49.6	53.7	59.6	64.2	**274.2**
	Variance	*0.8*	*6.1*	*13.0*	*12.2*	*10.1*	***42.1***
Total	BP2	160.8	215.7	214.6	218.8	193.0	**1,002.7**
	BP1	163.6	155.7	166.9	162.3	158.5	**807.1**

	Variance	*(2.8)*	*60.0*	*47.7*	*56.5*	*34.5*	***195.6***
2-yr total	BP2		376.5		433.4		
	BP1		319.3		329.2		
	Variance		*57.2*		*104.2*		

Table 1 – A summary of our full RIIO-2 cost forecasts for all portfolios

There are multiple drivers for the cost increases in our specific investments seen above. Depending on investment lifecycle, estimates are now based on known specific application software and hardware costs to meet specific use cases. We will continue to provide clarity on each of them and give confidence on their efficiency. External feedback and assurance are being sought for our August submission. The engagement model for this is currently being defined with our stakeholders.

Our updated plans show we have applied lessons learnt from RIIO-1 and are on a path of increased transparency, collaboration, and continuous improvement [See Appendix D]. As we adopt new ways of working and employ a customer centric view, we expect to keep sharing and validating our direction and ambitions to ensure they are beneficial for the whole industry and efficient.

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Part 1 – Technology overview

Our IT investments comprise a large proportion of our RIIO-2 proposals and we are committed to ensuring that these will effectively and efficiently enable the delivery of our Business Plan.

Over the course of 2021 and 2022 we have engaged extensively with Ofgem and are committed to continuing to work together to provide the information that is required to support their assessment and review of our proposed IT investments for BP2.

This section summarises ESO's Technology landscape at an overall portfolio level, outlining our underlying target architecture, technology capabilities we are seeking to deliver over the course of BP2, and the supporting governance and controls we will have in place to assure and monitor our delivery.

1.1. ESO Technology Architecture Overview

In our BP1 submission we explained how our planned architecture seeks to build on the foundation of distinct technology platforms that provide consistent customer experience across products and services. These platforms enable the delivery of modular capabilities year-on-year whilst providing a basis for the re-engineering of any functionality that will be carried forward.

Our target architecture therefore provides our stakeholders with a consistent user experience, self-service access to data, and the delivery of new outcomes in consistent, accelerated timescales. Each technology platform facilitates ease of change so digital services and components can be extended and/or superseded as new requirements evolve.

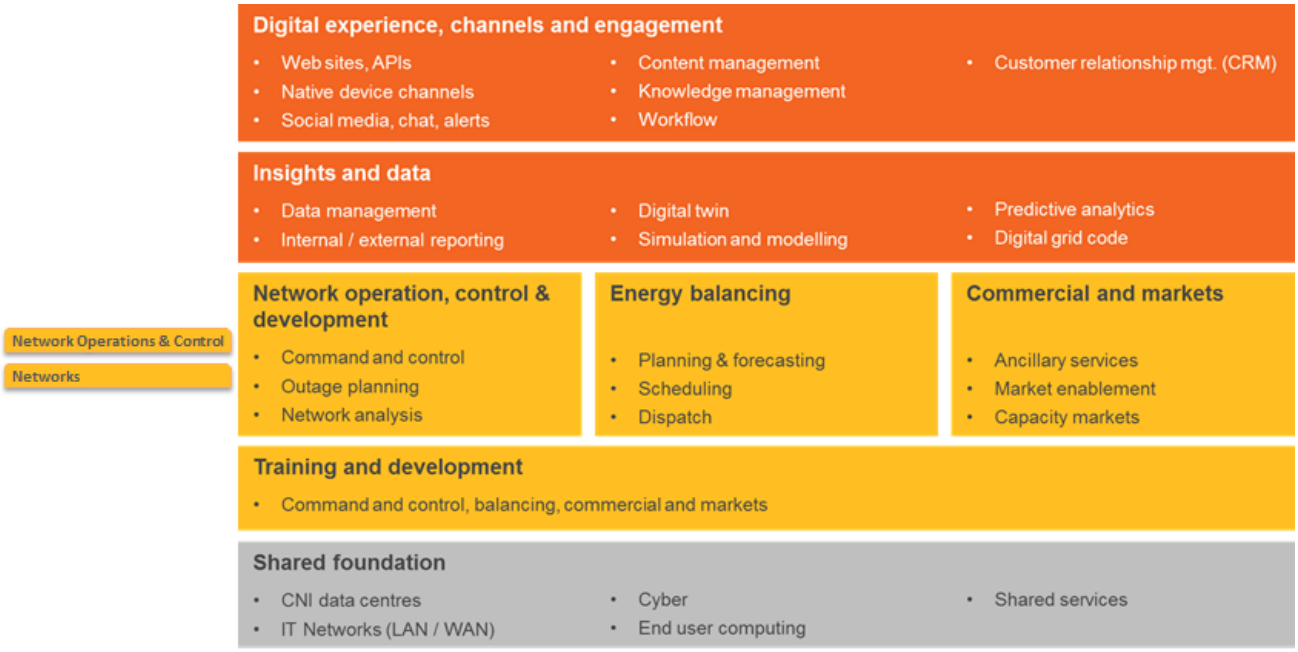

Figure 1 – A summary of our core business capabilities

During the BP1 period we consulted extensively with ERSG stakeholders, our internal Application Development & Maintenance (ADAM) teams, and Gartner to understand in further detail what a platforms architecture approach would entail, and we concluded from this exercise that this was the right target architecture approach for the ESO. Since that engagement exercise, we continued with our architecture definition work, developing a target architecture conceptual to illustrate how ESO IT capabilities will be enabled by our current and future technology platforms.

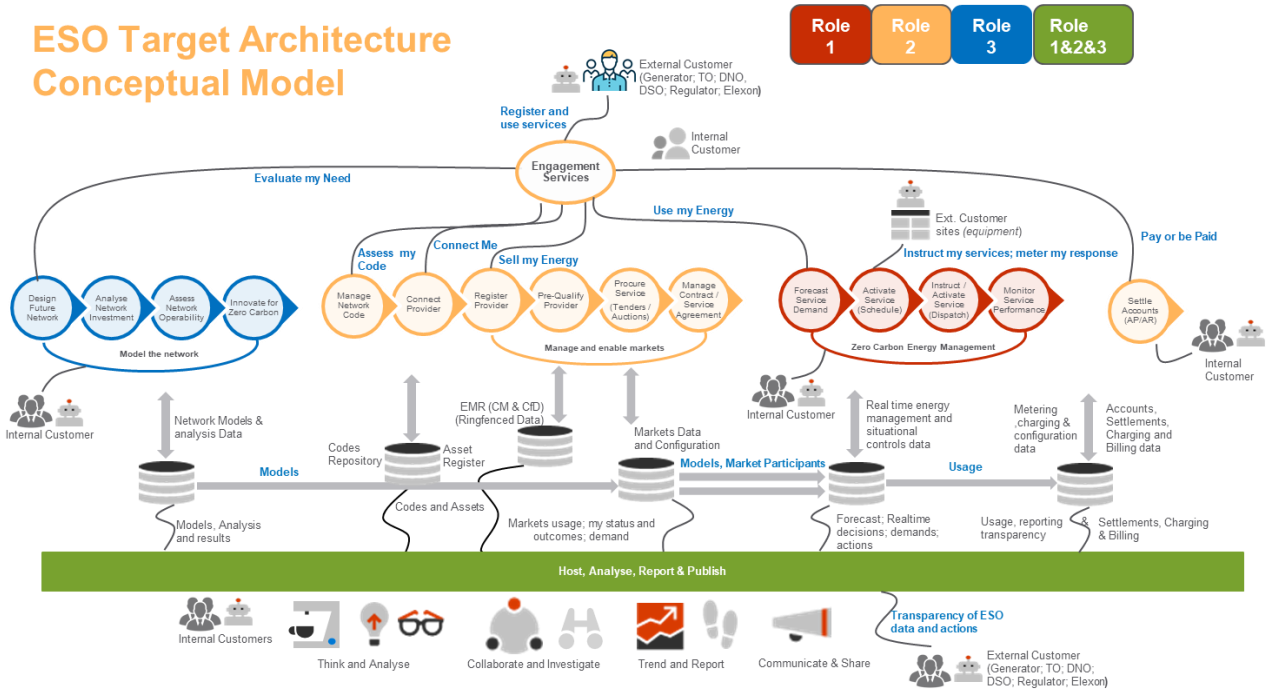

Figure 2 – An outline of our target architecture conceptual model

Since our BP1 submission we have also expanded our platform summary architecture view into a 'subsystems architecture', providing a blueprint of our future target state. This blueprint informs the design and build of our technology platforms and is informed and driven by our customer journeys and insights analysis, enabling the build and development of our target architecture in parallel to the delivery of our priority business and consumer outcomes.

A key design principle of our target architecture approach has been to allow ease of change and acceleration of delivery outcomes. We achieve this by developing solutions from discrete building blocks where features and functionality are rolled-in or rolled-out of service as required.

Our subsystem blueprint provides a 'system of systems' solution that promotes a ground-up build of new platforms, subsystems, technology and data services driven by customer outcomes. The architecture will accommodate legacy applications alongside new subsystem components through the use of integration technologies (Application Programming Interfaces – APIs) that minimise the disruption of transformation from legacy system and services to new solutions.

The key features of our subsystem architecture can be summarised as follows:

- A commitment to describing capability by the business purpose/function – to move away from internal IT system or application acronyms
- Logical groupings of capability into technology platforms to allow our product teams to re-use
- Data at the heart of all IT capability
- Positioning our digital engagement capability so internal users and external stakeholders benefit from a consistent user experience
- Ensuring our security compliance is embedded into all designs, with emphasis on granular CNI security levels driven by threat and risk analysis to group solutions by security, service, and operational attributes
- Adoption of the TBM methodology (in conjunction with Ofgem recommendations) to establish a clear relationship between the cost of IT and its target state architecture.

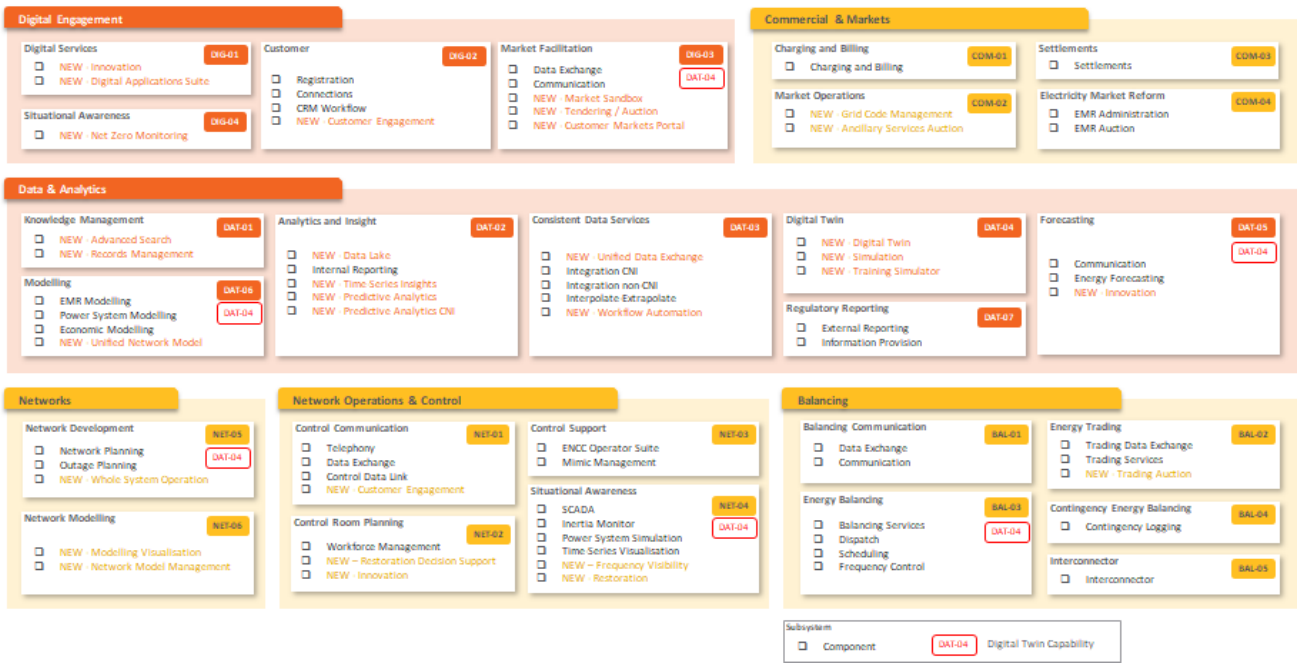

Figure 3 – A summary of our target Enterprise Architecture Framework – Subsystems and Components

	T2 Platform	T2 Subsystem Identifier	T2 Subsystem	Purpose
DIG	Digital Engagement	DIG-01	Digital Services	Provide digital app services to internal/external customers
		DIG-02	Customer	Engage and manage primary customer interactions
		DIG-03	Market Facilitation	Digital ESO.com and competitive market services
		DIG-04	Situational Awareness	Provide Net Zero operations visibility to internal/external
COM	Commercial & Markets	COM-01	Charging and Billing	Operate industry charging and billing services
		COM-02	Market Operations	Operate customer and market services
		COM-03	Settlements	Operate industry settlement services
		COM-04	Electricity Market Reform	Operate EMR independent body
DAT	Data & Analytics	DAT-01	Knowledge Management	Self-service access to ESO/industry data
		DAT-02	Analytics and Insight	Internal analytics and reporting services
		DAT-03	Consistent Data Services	Data Hub for all ESO connected data services internal/external
		DAT-04	Digital Twin	Digital representations of systems, models and markets
		DAT-05	Forecasting	Enhanced forecasting capabilities
		DAT-06	Modelling	Shared modelling capabilities – Unified Network Model
		DAT-07	Regulatory Reporting	Compliance reporting services for external / regulator
NET	Network Operations & Control	NET-01	Control Communication	Secure ENCC connectivity to internal/external
		NET-02	Control Room Planning	ENCC management capability
		NET-03	Control Support	ENCC services to support situational awareness
		NET-04	Situational Awareness	Net zero operations and restoration management
	Networks	NET-05	Network Development	Manage future networks and whole system design
		NET-06	Network Modelling	Maintain and model networks
BAL	Balancing	BAL-01	Balancing Communication	Secure Balancing connectivity to internal/external
		BAL-02	Energy Trading	Trade energy to support balancing operations
		BAL-03	Energy Balancing	Critical balancing operations, systems and services
		BAL-04	Contingency Energy Balancing	Contingency/emergency balancing services
		BAL-05	Interconnector	Interconnector balancing services

Figure 4 – Definition of our Enterprise Architecture Framework for IT Platforms

This structure represents a step-change and deviation from our previous T1 application architecture, shifting our thinking away from representing IT in silo application-only terms, and considering more the components that underpin the capabilities that support our overall platform architecture.

The platform and subsystem architecture (our "Enterprise Architecture / EA Framework") forms the basis for the Solutions Layer of our IT cost model submitted in the Technology Business Management (TBM) format. For further details on our TBM model and approach please refer to Part 5 of this document.

The EA Framework defines Solutions supporting Products and Services for Internal Business Units, Customers & Partners and Digital Platforms elements of our TBM model. Technology and delivery building blocks required to implement Solutions are provided in the IT Towers TBM model layer.

Further detail and linkage between TBM and our EA Framework is provided within Part 2 – Technology Investments.

To demonstrate how our platforms model relates to operational business processes and how our legacy application capabilities will be rationalised / modernised, we have compared our as-is/legacy business process landscape with our EA Framework target state.

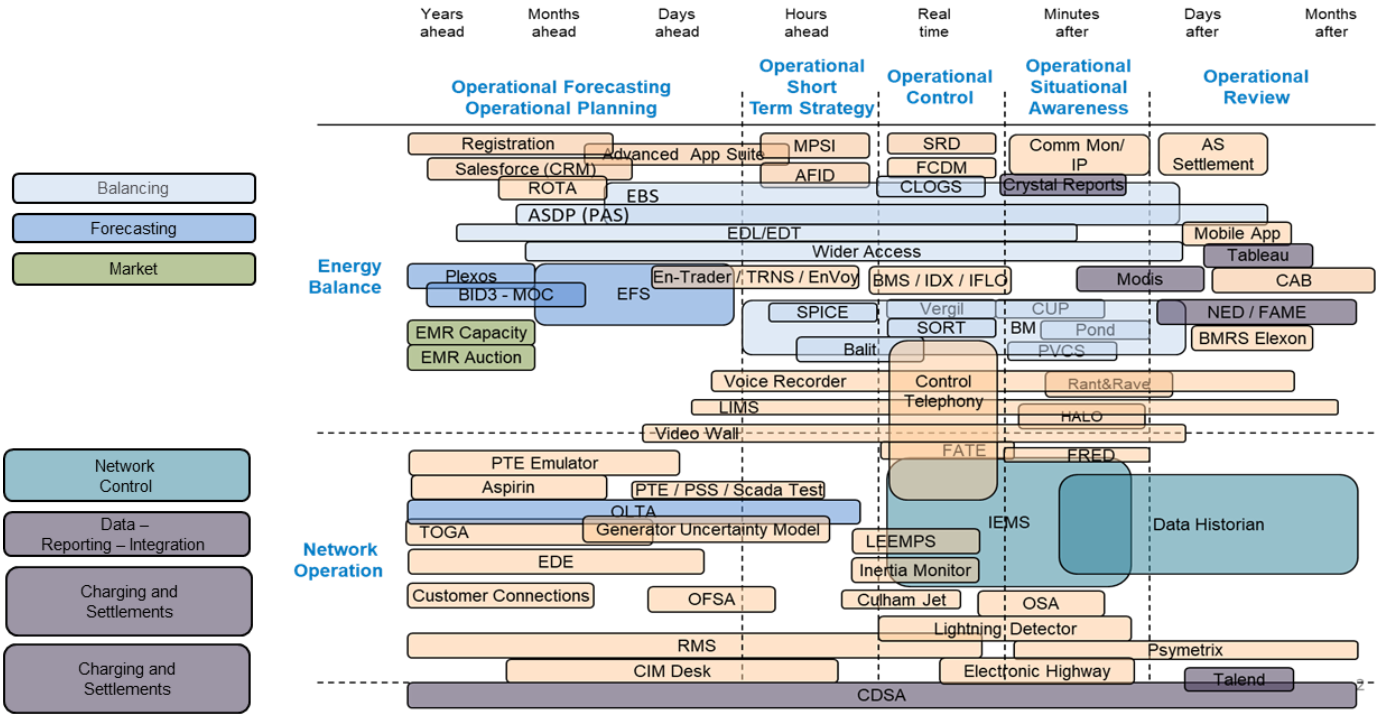

Figure 5 - An illustration of how our legacy applications support the business processes

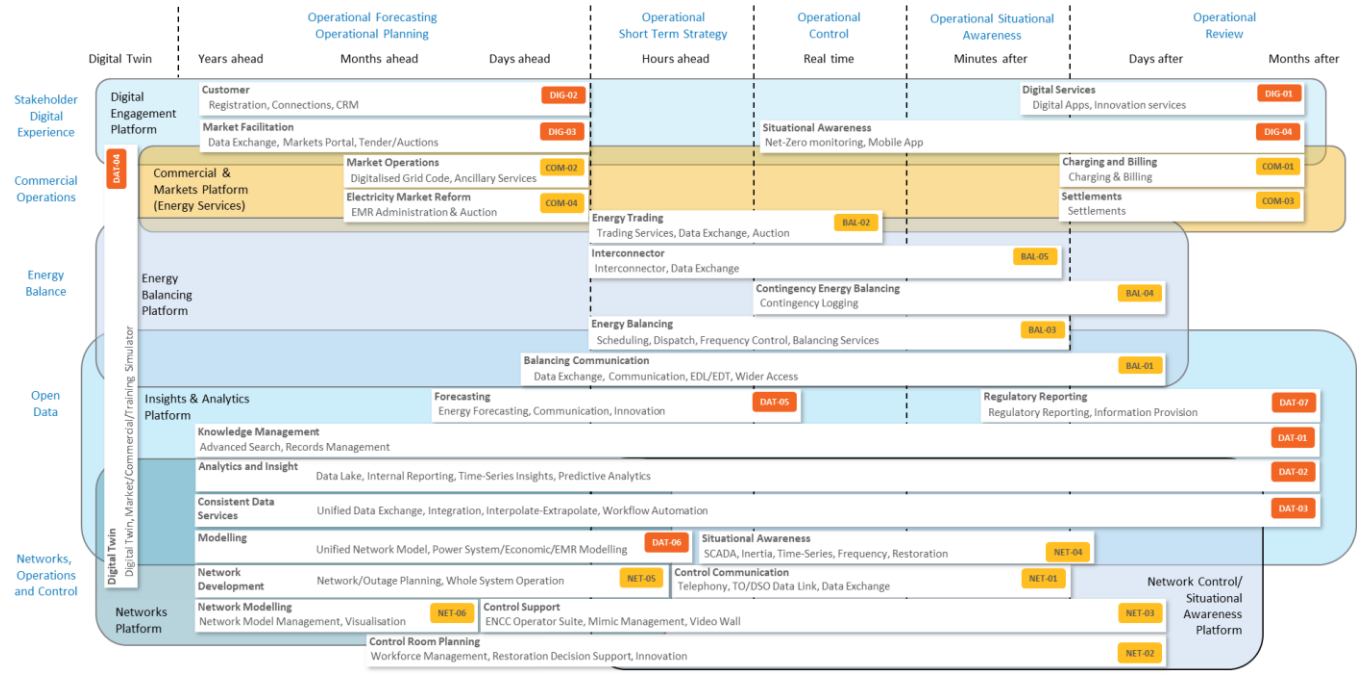

Figure 6 - An illustration of how our target EA Framework maps to the business processes

In conjunction with refinement of our target architecture we have also made significant progress in our technology platform delivery and operate model growth over the BP1 period, covering People, Process and Technology. During BP1 we have centred on the following component areas:

People:

- Leadership team recruitment for Product, Portfolio Management, Engineering/DevOps and User Experience
- Critical role recruitment in the areas of Product Management, Architecture, Business Analysis and Data Science
- Skills and training for Technology Business Management (TBM) model adoption to support regulatory and operational cost transparency requirements

Process:

- Established Product Ways of Working function to transition ESO IT delivery from Project to Product
- Implemented Product management model for transformation of Monetisation services (Settlements, Charging & Billing)
- Defined requirements for CNI Operate Model to support new Balancing and Network Control capabilities
- Defined requirements for Enterprise architecture tooling, data capture and operational process

Technology:

- Multiple procurement activities established and underway / nearing completion across the technology investments described in Part 2 of the IT Annex
- Data, insight and analytics foundations established on the Microsoft Azure cloud service
- Balancing technology platform technical blueprint established against CNI data centre and RedHat OpenShift service designs
- Digital engagement technology platform consisting of portal, design system and content management
- Network control/situational awareness technology platform in conjunction with solution providers (tender event)
- Markets technology platform in conjunction with software-as-a-service providers

1.2 Technology capabilities supporting our business ambition

Over the course of the BP2 period we intend to further build upon our key technologies and capabilities across design, build, operate and maintain as we progress with the delivery of our Business Plan, summarised in the below table.

ESO Domain	Scope	Technology **(*)** *ESO-delivered* ** *NG(Group)-delivered*	Capability
CNI highly critical	Data Centre, Networks, Compute, Storage	• CNI Data Centre ** • RedHat OpenShift **(*)** ** • VMWare **(*)** **	Restoration, Contingency Balancing and Emergency Control Room functions
CNI critical	Data Centre, Networks, Compute, Storage	• CNI Data Centre ** • RedHat OpenShift **(*)** ** • VMWare **(*)** **	Balancing, Situational Awareness and Zero Carbon Grid Operations

CNI Applications	Software	• COTS and bespoke software **(*)** • RedHat Integration **(*)** **	ESO IT critical applications
Business Applications	Cloud Infrastructure and Services – Compute, Storage and PaaS	• Microsoft Azure IaaS / PaaS subscription & service call-off **(*)** ** • External SaaS service contracts **(*)** • Azure and Mulesoft Integration ** • Business features and functionality **(*)**	Resilient and secure use of public cloud for Data & Analytics, Monetisation, Digitalised Grid Code, Energy Forecasting, Digital Engagement and Single Markets Portals
External Consumers	Internet	• Azure and Internet Gateway services **	Connectivity and secure internet traffic management between ESO and external data/service consumers
External Consumers	Private Links	• Microsoft Azure ExpressRoute ** • Optel and other WAN links **	Connectivity and secure private traffic management between ESO and external data/service consumers
Data Exchange	API, File, Data flows	• Microsoft Azure, Mulesoft, API Management **	Services to support all ESO IT investments and internal/external Open Data access
Legacy Applications / Data Migration	ESO IT estate pre transformation	• Legacy CNI Data Centre **(*)** ** • Legacy on-prem data centre ** • Legacy cloud service contracts ** • Legacy ESO applications (COTS, Bespoke, 3rd party technologies) **(*)** **	Operate and manage data for all legacy ESO IT applications whilst ESO target state architecture and technology platforms are delivered

Table 2 – A summary of the key ESO technologies and capabilities built upon during BP2

1.3 Governance and controls

In BP1 we explained that our organisational structure was going through significant transformation. We saw the introduction of an ESO Chief Information Officer (CIO); a member of the leadership team (as well as the UK IT leadership team), who directly reports into our ESO Director. A summary of our new leadership structure is provided below.

Figure 7 – An illustration of our ESO IT leadership structure and governance

Our new ESO IT leadership team that reports into our CIO, provides thought leadership into our short and long-term business and technology plans, and is collectively driving the transition of our IT function towards a product model way of working, and changing our culture to a TechOps one team mindset.

Alongside this structure we continue to use support services shared across all the National Grid Group. These include IT, Human Resources (HR), Finance, Corporate Affairs, Audit and Legal. This was agreed with Ofgem through the legal separation process and means we have benefited from economies of scale and utilisation of expertise in each of these areas.

Our leadership team owns our IT strategy and investment plans, and our ESO-specific IT investments are delivered by IT resources dedicated to ESO projects. More generic IT projects, such as infrastructure or cybersecurity, are delivered by a central IT function.

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 associated ways of working transformation across our TechOps community, working closely with the wider ESO IT Leadership team as part of this process.

We have control over our technology decisions and are able to prioritise based on our best interests. We have equal footing at a Group level and have a say in any shared investment decisions, always trading off against economies of scale for specific support services and solutions.

ESO's specific investments go through different levels of internal governance depending on their level of spend, with only investments above £150m going to National Grid PLC Board.

To ensure deliverability of all its commitments, ESO's monthly Portfolio Review Board reviews the integrated implementation plans between direct and shared approved, investments prioritising resources and deliverables, managing risks and dependencies.

All shared investments across the Group have to be approved by all functions (NG Gas, NG Electricity Transmission, NG Ventures and ESO), where their detailed solution plans are set annually and reviewed quarterly across the Group for decision making.

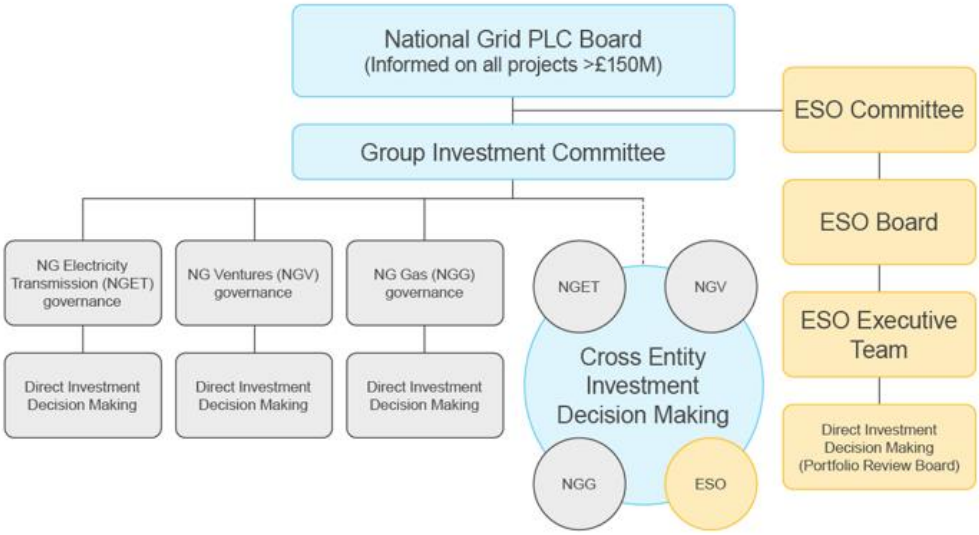

Figure 8 – An illustration of our internal governance structure and forum breakdown

Given the importance of the Cross Entity Investment Decision Making and Direct Investment Decision Making (Portfolio Review Board) forums to our IT investment decision making, we have included in Appendix B a summarised view of their terms of reference (ToR) relevant to IT investment decisions.

1.4 Stakeholder engagement

As outlined in our main business plan document, we have evolved our engagement strategy to an 'always on' approach to increase opportunities for all customers to engage through business as usual (BAU) touchpoints. We have used these to develop our BP2 proposals rather than adding additional engagement activities. You can find more information about this in our Stakeholder Engagement [Annex 3] document.

Our IT plans and in-flight work are reviewed and assessed through lenses reflective of the full range of our stakeholders: regulatory, operational, advisory and formal Business Plan content. Following our customer first principle, we want our stakeholders to be informed and come with us on this implementation journey. We already inform our stakeholders and will continue to do so via various forums, reports and publications, adapting the needs as the industry itself changes. The table below summarises our key engagement touchpoints.

Forum / Report/ Publication	Objective	IT investments in scope	Cadence
Incentives reporting	Outline of ESO performance against plan delivery, metric, stakeholder evidence, plan benefits and value for money.	Any that materially contributes to role cost increases or changes to delivery plans.	Main reports every 6 months RIIO-2 deliverables tracker updated quarterly
Technology Advisory Council	Ensure stakeholder input into the ESO transformation, guaranteeing the changes we make reflect wider market needs.	Any that materially contributes to role cost increases or changes to delivery plans. Any that is of interest to industry.	Every month
Digitalisation Strategy	Provide an overview of what our data and digital vision is	Any that forms part of the action plan.	Main strategy every 2 years

	and ensure alignment to industry needs.		Action plan every 6 months
Ofgem early view of ESO value for money reporting	Share an early indication of our cost updates and reasons for any deviations. Allowing further deep dive engagement.	Any that materially contributes to role cost increases or changes to delivery plans.	Every 6 months
RIIO-2 Business Plan	Give clarity on what is new / materially changed in our 5-year business plan (covering 2021-2026).	All	Every 2 years
Specific investment engagement	Allow clarification of external stakeholder needs and updates on delivery plans	Any that impact external stakeholders	Ad hoc based on each specific investment needs

Table 3 – A summary of our key engagement touchpoints across our stakeholders

On top of these we will continue to carry on with ad hoc engagement across the industry, providing clarity on the status of our portfolio or individual investments when through our internal governance we foresee material changes or if specific information is requested by our stakeholders. A yearly view of our engagement calendar can be seen below.

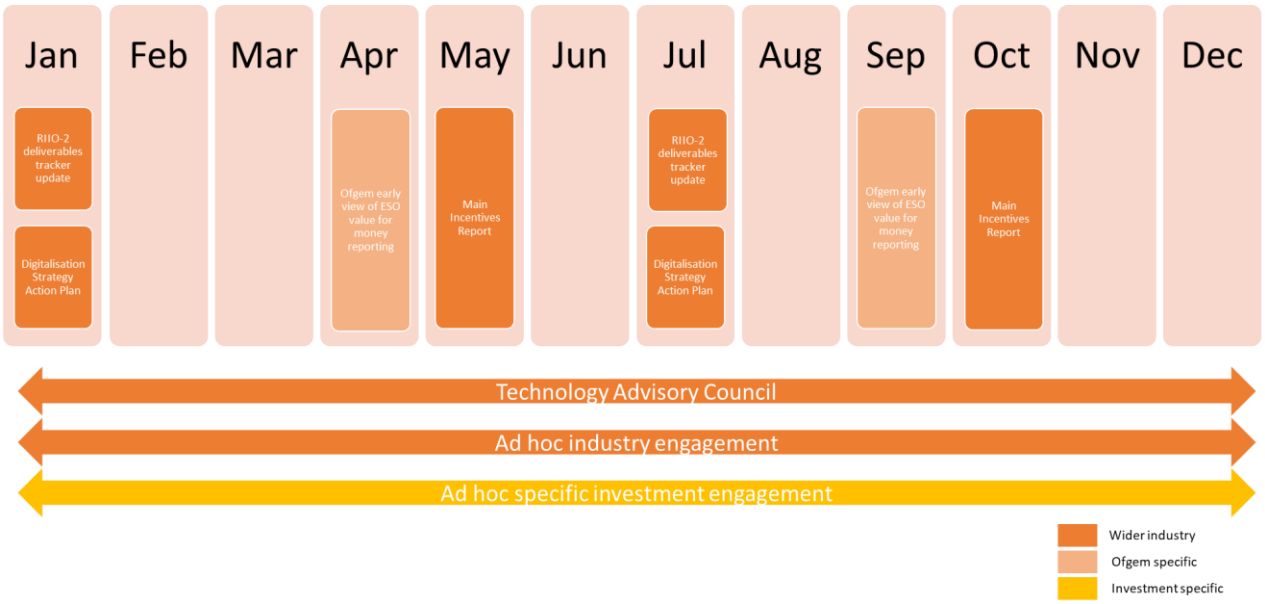

Figure 9 – An illustration of ESO's annual stakeholder engagement approach

We welcome feedback from the industry and Ofgem on our engagement levels and will review any engagement approach as necessary.

1.5 Portfolio Risks

We have identified a number of portfolio level risks that apply to some, or all of our technology investment lines. To avoid repetition these are listed below for reference. Risks that apply to a single investment are captured in the summary for that investment in Part 2 of this document.

The scoring mechanism that we have applied for both our portfolio and individual investment risks is based on a standard risk scoring methodology and is consistent with the methodology that was applied at BP1. An overview of this methodology can be found in Appendix A of this document.

To highlight how our risks align to our TBM cost model we have sought to map the most appropriate IT Tower to each risk. For our investment summary risks this Tower mapping is provided at Level 2 (Sub-tower detail), whereas in our portfolio risk summary (below) this is provided at Level 1 (Tower level detail) due to the overarching nature of our portfolio risks.

Risk	Related IT Tower	Mitigation(s)	Likelihood	Impact
The outcomes from the Balancing Capability Strategic Review prompts wider revision and refinement of associated investment lines causing corresponding impacts on time and complexity of integration to legacy and new ESO/external platforms	Delivery	• Expedite Balancing Capability Strategic Review and understand impacts with detailed impact assessment performed • Engage closely with Ofgem where material changes emerge to technology transformation strategy	3	3
Industry and Ofgem discussions result in new regulatory changes, additions to existing regulatory commitments, or continuous change which becomes incompatible with our defined business plans and strategic objectives impacting our delivery priorities and RIIO-2 commitments	Delivery	• Ensure regulatory team understands business plan and can align any new regulatory changes to it • Grow ESO IT regulatory team dedicated capability • The full end-to-end process is overseen by the design authority, ensuring market changes are aligned to business plan.	2	3
We develop tools with limited capability and/or shelf-life due to difficulty in predicting how modelling capabilities will need to evolve by the end of RIIO-2 given the pace of changing market needs and/or the implications from the Future System Operator delivery – leading to technical debt that requires further replacement during the BP2 period	Application	• Ensure continued review of requirements throughout remaining RIIO-2 period. • Deploy proof of concept tools where possible to gain understanding of requirements • Continue to use the product delivery principles and flexible, modular applications.	3	1
Delivery is slowed due to delays in identifying, sourcing and onboarding third party technical solutions and/or	Delivery	• Detailed third party solution requirements documented and	3	1

service providers leading to timescales slipping and potential additional costs		agreed as soon as possible • Market RFP (Request for Proposal) and procurement activities initiated as soon as possible so any delays and solution requirement / design revisions can be addressed in good time		
BP2 deliverables are impacted due to corresponding delays in interdependent investments leading to delay in overall business plan delivery and benefits realisation	Delivery	• Maintain up to date view of interdependencies between investments via portfolio planning with associated roadmap and actively manage over course of BP2	4	1
ESO is unable to source the right resource skills and quantity to match delivery demand (via internal or external means) due to current market competition for Digital and Data transformation skills, resulting in slower delivery pace	Application Delivery	• Continue to review and maintain resource capability requirements for IT Investments, identifying skills gaps quickly • Continuation of current internal staff development in line with Digitalisation Strategy to key address skill areas • Continue to utilise existing established partners and drive early engagement on resource support requirements	3	1
Infrastructure service delays including Azure PaaS, IaaS and CNI DC enablement	Platform Compute	• Continue to engage and influence NG Group infrastructure service / technology owners to prioritise ESO Azure Iaas/PaaS services and cost transparency data	2	4
Delay in data availability / provision from external providers leads to delays in delivery timelines and/or inability to achieve key data outcomes	Platform	• Continue to review and validate data needs and associated data strategies for projects where external data input is required	2	4

		• Continue to work with stakeholders, including the Government's Data Task Force to ensure the ESO has access to relevant data and in an agreed acceptable format for data population		
Poor data quality (both internal or external data sources) leads to reduced outcome value in data analytics and modelling	Platform	• Continue to work with stakeholder to define and agree data schemas, format and structure requirements to drive consistency • Utilise Data Analytics Platform cleanse and control capabilities to address data quality issues	2	1
FSO separation timescales may lead to impact on BP2 delivery plans	Delivery	• Impact assess BP2 and FSO delivery plans for areas of potential challenge • Identify delivery mitigations and agree with Ofgem maintaining close engagement throughout	4	2

Table 4 – A summary of our overarching portfolio level risks and corresponding likelihood and impact scoring

Part 2 – Technology investments

This chapter provides a summary of our RIIO-2 investments from an IT perspective. As our investments are all aligned to at least one of ESO's operational roles (see diagram below), our investment summaries are categorised and ordered according to this structure.

Our investment summaries outline the latest statuses and forecast BP2 delivery for our Direct and Indirect (Shared) investment portfolios, with high-level detail provided on the associated market and customer benefits that will be delivered. For further detail on this latter aspect, please refer to the corresponding ESO Role chapters within our overall BP2 submission document where further information can be found.

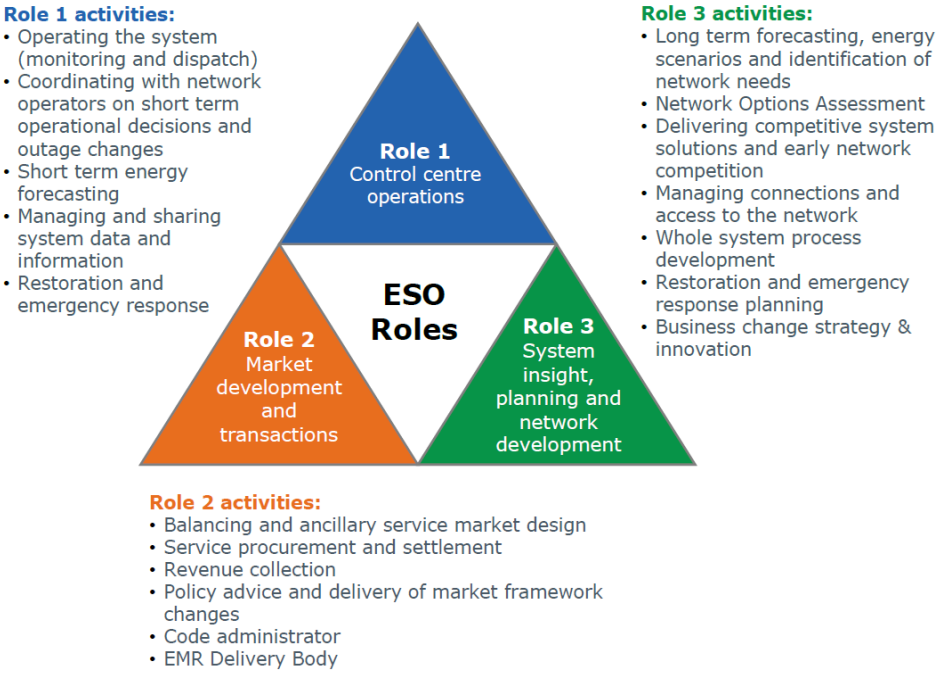

Figure 10 – A summary of our ESO roles

The IT investments proposed in our original Business Plan formed part of a five-year roadmap, where many investments were estimated to run beyond the original two-year business planning cycle, spanning across BP1 and BP2. In this submission, we therefore sought to update our forecast status for where we will be at the conclusion of the BP1 period (see 'Current State' narrative in our investment summaries) and where we will be at the end of BP2 (see 'Future State' summary).

Overall our IT investments can be categorised into three broad categories groups:

- Specific investments that directly support our outputs in this plan. These include both capex and opex expenditure and are referred to as our 'Direct' investment portfolio;
- Indirect investments in cybersecurity, IT infrastructure, and business services made by National Grid group IT on behalf of ESO and based on the Universal Cost Allocation Methodology (UCAM). These include both capex and opex expenditure and are referred to as our 'Indirect' investment portfolio; and
- Run the Business (RtB) costs. These are the opex spend to run our operational IT services, and reflects the increase in base RtB as a result of ESO's forecast technology transformation over the BP2 period.

Our submission focuses primarily on the first category; ESO's specific investments and associated running costs. Since National Grid Group's shared IT investments and associated RtB IT costs were reviewed and approved for the five-year RIIO-2 period in Ofgem's RIIO-2 Final Determinations, these cost elements remain unchanged in this submission and are provided for information purposes only.

Over the BP1 period we have mobilised all key enabling investments to support the whole RIIO-2 plan and to ensure we meet our deliverables. We have seen an increased demand from our Operations community as we have obtained a better understanding of the true needs of our internal and external customers, and this is

reflected in our updated forecasts for mobilised investments, where our estimates are now based on known specific application software and hardware costs.

During BP1 we have:

- Set strategic vision for main programmes with associated business and technology roadmaps plus user journeys
- Progressed main procurement events and completed POC (proof of concept) phases for main programmes
- Kept current systems compliant, supported, reliable and where required extended their life
- Met EU and GB regulatory deliverables plan
- Increased security compliance in operations and within our system designs
- Removed technical debt as part of asset health activities
- Enabled the connection and onboarding of DERs via digitisation of processes, via implementation of a customer portal for self-service on connections requests, data and process progression
- Increased the procurement frequency of one reserve product from monthly to day-ahead and implemented the auction capability to one new response service
- Introduced three new interconnectors and two inertia system management solutions
- Removed technical debt and grey IT, at least 10 applications
- Enabled better user experience for customers managing capacity market prequalification and registration

In areas where demand is expected to be consistent or growing year-on-year, we have also started adopting a product model approach compared to a project model approach. The diagram below illustrates the distinction between these delivery approaches and how the transition to a product focussed model allows us to keep technical debt to a minimum, and deliver the required improvements and enhancements to new capabilities much faster and more efficiently.

Figure 11 – A illustration of our project to product model transformation

All costs stated in this document are in 18/19 prices to allow for a like for like comparison with those that were stated at BP1. Our direct investment totex plan now ranges between £433m and £574m over RIIO-2, compared to £407.3m in our original Business Plan. Our IT running costs also increased to £79.5m from £50.3m. The range is reflective of the uncertainty regarding solution decisions and also excludes the four new business initiatives which we have identified over the course of BP1. These new business initiatives are as follows:

- Early Competition Onshore

- Offshore Coordination & Network Planning Review
- Distribution System Operation; and
- Net Zero Operability

As these four initiatives are all at an early definition stage, information is not yet available to develop a full investment summary and cost estimation on them. For the purposes of this draft submission a high-level summary on each initiative is provided at the conclusion of this chapter, and a full detailed summary and cost estimation will be provided as part of our final submission in August.

A summary of those investment where a cost range is provided due to a higher degree of cost uncertainty is provided below. These investments will go through additional external assurance between April and August to help give confidence on our final cost submissions.

Investment (Refs)	Whole RIIO2 FD	Whole RIIO2 BP2 data tables/TBM submission	Variance	Whole RIIO2 proposed range
Network Control (110)	30	50	(20)	45-50
Balancing Programme (180, 210, 260, 480)	58	142	(85)	83-142
Data and Analytics (220)	25	38	(13)	29-38
Interconnectors (120)	6	14	(8)	12-14
Single Markets (400)	18	33	(15)	23-33
Settlements, charging & billing (290, 300, 410, 610)	14	31	(17)	24-31
GB regulations (280)	15	21	(6)	19-21
EMR (320)	8	21	(14)	18-21
Connections Hub (380)	3	3	(0)	4-7
Total view	**177**	**353**	**(178)**	**257-357**

Table 5 – A summary of those investments where a cost range has been applied for our Draft BP2 submission

For each investment we provide a current high-level delivery status summary, its purpose and current and future state overview; investment roadmap with main milestones, investment delivery approach and solutions options, cost summary with accompanying narrative to explain any variance from our original Business Plan (2019) and associated risks. For the purposes of this summary the 'current state' refers to the status as of April 2023, and 'future state' refers to the status as of March 2025.

As stated in A1.2 of our overall Business Plan submission, investments 180 Enhanced balancing capability, 210 Balancing asset health, 260 Forecasting enhancements and 480 Ancillary services dispatch fall under the remit of the overall 'Balancing Programme' and are subject to the current ongoing Balancing Capability Strategic Review. For these, detailed investments summaries are not included within this submission but will be included in full as part of the August final submission. Cost tables are provided on these investments within Part 2. For clarity it is this data that is currently reflected in the draft TBM model submission.

In addition to providing a Capex and Opex cost breakdown for our investments, we also provide a summary of Incremental Cumulative Run the Business (iRtB) costs and their associated variance. It is worth noting that for this last cost component, in our original BP1 submission we used a calculation methodology based on the level of transformation of each investment. These have now been replaced with detailed forecasts from our delivery teams and as such any variance relative to BP1 is to be expected given our now improved forecasting approach. Further details on the RtB approach that was employed at BP1 can be found in Appendix B.

Role 1 Investments

2.1 110 Network control

Overview & Purpose

This investment will introduce a new real-time situational awareness capability giving control centre operators a better understanding of the changing network limitations, leading to a more efficient risk-based operation of the system.

This investment enables sub-activity **A1.3 Transform Network Control**. It also provides enhanced training simulation capabilities, and so benefits **A2.3 Training Simulation and Technology** as well.

This capability is classed as Critical National Infrastructure and as such is vital for the control of the grid network. It therefore primarily benefits the Electricity National Control Centre (ENCC). This investment also delivers enhanced training and database maintenance capabilities to enable the Operational Readiness and Performance Transformation & Control Systems teams to support the operation of the ENCC.

A summary of the key outcomes that will be delivered by this investment as well of the corresponding RIIO-2 sub-activities is included below.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A1.3 Transform Network Control	• Improved monitoring of network and understanding of operational limits
• A2.3 Training Simulation and Technology	• New training simulator

Table 6 – Summary of business outcomes and corresponding sub-Activities

The current Integrated Electricity Management System (IEMS) is shared with NGET, with access rules to ensure logical separation. The implementation of the Network Control Management System (NCMS) by ESO, and the corresponding replacement system by NGET will enable full separation of the systems.

There are strong synergies between this investment and IT investment 150 Operational awareness and decision support, and we will deliver these as a combined programme.

We envisage that the future situational awareness capability will comprise a core system, supplemented by modules providing enhanced situational awareness and modelling tools.

This investment will create the core system foundation architecture which will underpin the transformation of network control. The scope of this architecture includes:

- Resilient CNI infrastructure & networking.
- Enhanced data exchange, which will enable us to coordinate better with DNO/DSO Networks and integrate data more easily, thus increasing visibility of service providers connected at distribution level.
- Integration with the Data and Analytics platform, thus greatly enhancing sharing of data and insights within the organisation and enabling alignment of online and offline network models.
- Access to additional data sources to enable better running of the network.
- An improved state estimator to better understand the state of the electricity network.
- Basic alarm management & display capability.
- Contingency analysis.

Current State

As planned we have completed the detailed asset health assessment and technical options analysis for the existing Integrated Electricity Management System (IEMS). We have agreed the asset risk mitigation options and plan with NGET and have commenced the delivery of the asset health refresh, which will extend the life of the system until the replacement system goes live in 2025/26.

By March 2023 we will have completed the asset health refresh of the existing IEMS. A new support contract will have been instantiated, and tactical asset health and security enhancements will have been implemented.

We are currently in the procurement phase for the delivery of the new real time core situational awareness capability, now known as the Network Control Management System (NCMS). We are on track to deploy the core NCMS system into our data centres by April 2023. The core system will run initially in a non-operational sandbox environment alongside the existing iEMS. This will provide a basis for the testing of modules and the tuning of models. We will also have agreed a transition plan with NGET to enable system separation by 2025/26.

Roadmap

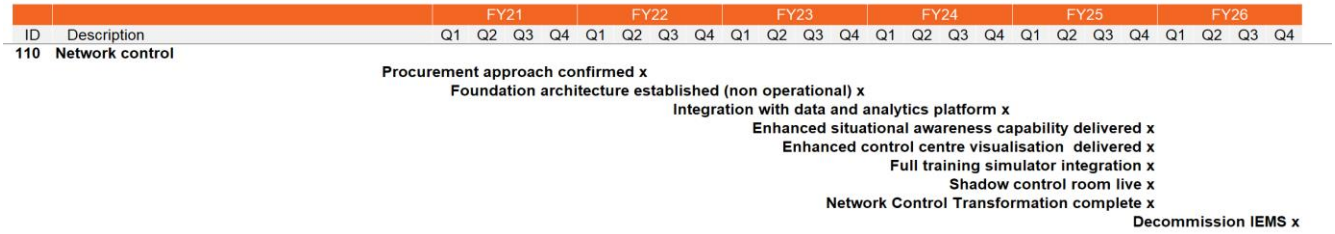

Figure 12 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Procurement approach confirmed	Business Units	Completion of the Procurement Request for Procurement (RFP) process. This identifies which vendor has been selected as delivery partner.
Foundation architecture established	Business Units	First tranche of infrastructure (Hardware and Software) along with Networking has been deployed within our new Data Centres.
Integration with data analytics platform	Business Units Customers & Partners	Initial integration with the Data and Analytics platform which will replace our long-term retention and analytics capability currently fulfilled by 'Data Historian'
Enhanced situational awareness capability delivered	Business Units Customers & Partners	Allows control room engineers to make more informed decisions and manage the network more effectively therefore providing higher confidence of running the system closer to agreed tolerances.
Enhanced control centre visualisation	Business Units Customers & Partners	Will allow control room engineers to access data from multiple discrete systems in a single platform to solve real time issues (in conjunction with the ENCC Operator Console).
Full training simulator integration	Business Units Customers & Partners	Allows control room engineers to run more realistic training scenarios across entire shift team with all new applications

Shadow control room live	Business Units Customers & Partners	Allows NCMS to test the new systems in a realistic control environment to feed back into the project backlog and real time operations
Network control transformation complete	Business Units Customers & Partners	The new Network Control Management System (NCMS) has been successfully accepted into Service, thus rendering the existing IEMS (Integrated Energy Management System) obsolete.
Decommission IEMS	Business Units	Decommissioning of the existing IEMS has been completed successfully with all infrastructure securely removed and disposed of.

Table 7 – Outcome summary descriptions

Future State

Network Control will largely replace the current Network Control solution and separate it from NGET. In addition, the new capabilities delivered via this investment will integrate with IT investment 220 Data and analytics platform, ensuring a single network model for control centre operators.

We will carry out an annual review of the status of the existing IEMS to determine if any additional actions are required to maintain the health of the system until the replacement system goes live in 2025/26.

Identifier	Target platform	Target Subsystem	Component	Future State
NET-01	Network Operations & Control	Control Communication	Data Exchange	NCMS operational, interoperating with TO and DNO/DSO SCADA systems.
NET-01	Network Operations & Control	Control Communication	Control Data Link	NCMS operational, interoperating with TO and DNO/DSO SCADA systems.
NET-03	Network Operations & Control	Control Support	Mimic Management	NCMS operational, including support for mimics
NET-04	Network Operations & Control	Situational Awareness	SCADA	NCMS operational, interoperating with TO and DNO/DSO SCADA systems.
NET-04	Network Operations & Control	Situational Awareness	Power System Simulation	NCMS Simulator configured, populated and operational
NET-04	Network Operations & Control	Situational Awareness	Time Series Visualisation	Situational Awareness suite implemented for 2025/26 System Operations. Modern Analytics and Numerical Modelling Frameworks in place to adapt to changing system rules and conditions.
DIG-04	Digital Engagement	Situational Awareness	Net Zero Monitoring	New Situational Awareness suite implemented for 2025/26 System Operations. Modern Analytics and Numerical Modelling Frameworks in place to adapt to

Identifier	Target platform	Target Subsystem	Component	Future State
				changing system rules and conditions.
DAT-02	Data & Analytics	Analytics and Insight	Predictive Analysis CNI	New Situational Awareness suite implemented for 2025/26 System Operations. Modern Predictive Analytic capability automating and underwriting System Operations.
DAT-02	Data & Analytics	Analytics and Insight	Predictive Analysis	New Situational Awareness suite implemented for 2025/26 System Operations. Predictive and forecast analytics blending local and cloud-based modelling, as demanded by models.
DAT-03	Data & Analytics	Consistent Data Services	Integration CNI	NCMS interfaces implemented as online APIs eliminating IT currency constraints.
DAT-04	Data & Analytics	Digital Twin	Simulation	See Power System Simulation state above. In addition, Network Control data available for emergent General Digital Twin framework.
BAL-01	Balancing	Balancing Communication	Data Exchange	Online interoperation with new Enhanced Balancing Capability.

Table 8 – Future state subsystem component summaries

Overall, by the end of the BP2 period our expectation is that the new Network Control solution will be in the final stages of parallel running with iEMS and moving towards full independent operations.

Approach

Our overall approach is to replace iEMS with an ESO-specific NCMS. In parallel and in coordination, NGET will select and implement a Transition Operator-specific EMS. By the beginning of BP2, NCMS will be selected and deployed in a pre-operational transitional form as outlined in our 'Current State' section above.

Across BP2 Network Control will invest in all ESO IT Towers being one of the two major occupants of the new CNI Data Centres. Data Centre establishment will include significant investments in the servers, storage and Operational Technology (OT) and IT networks. Network Control will also invest significantly in the deployment of a strategic integration platform for CNI.

NCMS is the central system in ESO Network Control and, once finalised, the surrounding system landscape will be evolved to complement it and complete the overall strategy, with key touchpoints including the Enhanced Balancing Capability, new WAMS system, and the new ENCC Control Room.

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP2	3.4	12.1	10.3	16.4	5.6	47.7

	BP1	2.9	5.2	6.5	7.9	4.5	27.0
	Variance	**0.4**	**6.9**	**3.8**	**8.5**	**1.1**	**20.7**
Opex	BP2	0.3	0.6	0.6	0.8	0.5	2.8
	BP1	0.3	0.6	0.7	0.9	0.5	3.0
	Variance	**0.0**	**0.0**	**-0.1**	**0.0**	**0.0**	**-0.2**
Cumulative RtB increase	BP2	0.0	0.0	0.0	0.8	0.8	1.5
	BP1	0.0	0.1	0.2	0.4	0.6	1.3
	Variance	**0.0**	**-0.1**	**-0.2**	**0.4**	**0.1**	**0.2**

Table 9 – Investment cost summary

There are strong synergies between this investment and IT investment 150 Operational Awareness and Decision Support, and we will deliver these as a combined programme. £400k expenditure in FY22 has been substituted from 150 Operational Awareness and Decision Support, as the functionality is being delivered by the Network Control Programme asset health workstream.

Since submitting our original plan for this investment, we now forecast an increase in delivery costs. In the main this has been due to our decision to incorporate additional cybersecurity resilience requirements within our overall solution design, along with increased CNI Data Centre costs. This was identified as a risk area within the programme and the decision was taken to mitigate this by aligning our solution design more fully with the latest market best practice guidance. In addition, further analysis has revealed a need to increase our RtB Opex costs associated with our CNI Data Centre spend.

Furthermore, the number of business resources have increased to ensure successful delivery. This is in response to stakeholder feedback (such as the Technology Advisory Council) and ensures the correct level of focus to complete our deliverables on time. Forecasts have also increased due to higher than inflation increases in the cost of IT resources and hardware.

As noted in the introduction to Part 3 – Technology Investments, this item is signalled as having higher uncertainty, and we are therefore providing a cost range. Make up of the cost range is detailed below, this investment will go through additional external assurance between April and August to help give confidence on the final cost submissions.

Investment	Whole RIIO2 FD	Whole RIIO2 BP2 data tables/TBM submission	Variance	Whole RIIO2 proposed range
Network Control	30	50	(20)	45-50

Table 10 – Investment cost range summary

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
We develop short-lived tools due to difficulty in predicting how modelling tools will need to evolve by the end of RIIO-2 given the pace of changing market needs and/or implications from Future System operator direction	IT Management & Strategic Planning	• Ensure continued review of requirements throughout remaining RIIO-2 period. • Deploy proof of concept tools where possible to gain understanding of requirements • Continue to use the product delivery principles and flexible, modular applications.	3	1

Full Integration to NGESO Future Balancing system may not be aligned to the NCMS delivery plan	Application Development	• Maintain Engagement with internal ESO product delivery teams • Periodic review of dependencies & programme interlocks • Review, impact assess and maintain fallback options	2	1
Full Integration with new NGET SCADA system may not be aligned to NGESO NCMS Delivery plan and may require the implementation of additional components (e.g Interfaces) to facilitate IEMS migration	Application Development	• Maintain engagement via formal 'Technical Working Group' forum • Periodic joint review & alignment of delivery schedules & dependent activities, Including contingency options • Planning & Alignment on cutover dates & pre-requisites to migrate away from the IEMS	2	2
Key internal SME/system user resource availability may impact the testing & implementation of the new system & toolset	Program, Product & Project Management	• Ensure early forecasting of resource requirements to business units • Timely recruitment for appropriately skilled resources where not already available	3	1

Table 11 – Investment risk summary

Solution Options

For the Network Control Programme, the main technical options debated at the outset and detailed in our original BP1 submission, focussed on whether ESO as an organisation should invest in upgrading its existing legacy tooling, develop its own proprietary and unique software solution, or whether a Commercial Off the Shelf (COTS) product should be sought and procured from the external marketplace.

Following an assessment of the relevant solution options, it has been concluded that a COTS product offers the most expeditious route to delivery. This has been decided based on the following factors:

- There are several established vendors in this marketplace which have a global reach and have extensive track records in delivering Situational Awareness toolsets, hence the product offerings will require the necessary capability, suitably backed with subject matter expertise within the relevant organisation.
- The cost of establishing a custom development team with the necessary skills and experience along with the longer-term cost involved with maintaining this team to cater for upgrades would exceed stated budgets
- By adopting a COTS product, the project is de-risked as the proprietary software is a known quantity (instead of being bespoke) and the focus is therefore orientated more towards following pre-existing integration and development pathways which the nominated vendor will be able to advise on.

The Network Control Programme is therefore proceeding on this basis and is currently pursuing the necessary procurement activities to source a new real time core situational awareness capability for ESO.

2.2 120 Interconnectors

Overview & Purpose

The amount of interconnection to other transmission systems and/or internal high voltage direct current (HVDC) links are expected to steadily increase throughout RIIO-2. To manage this, our current tools and processes will need to be extended to handle the additional capacity and data complexity.

This investment enables sub-activity **A1.1 Ongoing Activities**, whereby during RIIO-2 we expect to implement seven new interconnectors alongside delivering continuous functional, architectural and technical service improvements. This investment will maintain and improve the ability of the control room to manage GB system demand overnight through interconnector flows.

Standard interconnector architecture and designs are now in place. The existing Interconnector capabilities and standard interconnector design on NGESO systems will be re-used to accommodate all future new Interconnectors (with minimal changes).

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A1.1 Ongoing Activities	• Cross-border market, system and balancing services • New interconnector connections to ESO real-time systems • Maintenance and upgrade of control room systems

Table 12 - Summary of business outcomes and corresponding sub-Activities

Current state

The current supporting systems, Interconnector flow manager (IFLO), Electronic dispatch and Logging (EDL)/ Electronic data transfer (EDT) and Balancing Mechanism System (BM) continue to operate and deliver services and we anticipate this will continue for the next 18-24 months. The replacement for the legacy BM platform, termed the Open Balancing Platform (OBP), will gradually start to replace legacy services with a suite of newly developed microservices.

IFA Interconnector: We have completed an update to the trading patterns on the IFA interconnector with the implementation of the hourly intraday nomination gates thereby, providing market participants with more opportunities to carry out more efficient trading on this interconnector. Hourly gates provide the means to trade closer to real time, when there is a better view of network requirements.

IFA2 Interconnector: The delivery of the IFA2 Interconnector increased the capacity of the GB electricity market by an additional 1GW of electricity interconnector, further strengthening the security of energy supplies amidst growing economic needs. By March 2023 we will also have completed the standardisation of the Intraday Transfer Limit (ITL)/ Net Transfer Capacity (NTC) process on this interconnector to enable the electronic exchange and management of this process.

NSL Interconnector: The delivery of the North Sea Link (NSL) interconnector brought with it the additional capability to transport enough clean electricity to power 1.4 million UK homes. We are currently in the planning phase to deliver more services to this interconnector including the delivery of a SO-SO cross border services, which would enable NGESO modify the flow on the interconnector post the determination at the Day Ahead market at more efficient rates. This service is scheduled to be implemented by October 2022

Eleclink Interconnector: We are currently in the delivery phase of the Eleclink interconnector and are on track to deliver all functionality required by the ESO. Eleclink now has its final safety approval and we expect to deliver this interconnector before the end of the current financial year or by the start of the next financial year April 2022 at the latest.

Viking Link Interconnector: By March 2023, we will be well advanced in the delivery of the Viking link interconnector. By this time, we anticipate that we will have delivered the core functional and architectural features to manage the receipts of operational flows. We anticipate that beyond March 2023, we will be looking to implement all other outstanding functionality used to manage Reporting, Ancillary services, SO-SO services, and others; ahead of interconnector go live scheduled for January 2024.

Interconnector Service Improvements: We are currently improving our system architecture in line with a growing list of interconnectors and to increase resilience requirements withing our overall solution design. By March 2023, we would have completed a migration of all existing interconnectors from Energy Communication Platform ECP3 to ECP4, an upgrade of our .NET framework to the latest version, significant investments to migrate existing virtual machines to Critical Network infrastructure (CNI) consolidated platform, utilising Elastic Sky X (ESX), blades and shared storage. These upgrades help to provide resilience to localized hardware failures, support operational requirements to maintain hypervisor and underlying hardware with minimal service interruption. The upgrade of hardware will continue beyond March 2023 and well into 2025/2026.

Moyle TEC Increase: Moyle has requested an increase to their Transmission Entry Capacity (TEC), to return to 500MW, after several years of only having the right to import 80MW into GB. By March 2023, we will have commenced work for Moyle Interconnector updates which would include the migration of the management tools for this interconnector from BM to IFLO.

Roadmap

All interconnectors go-live dates are our estimations based on current information however some of these can move beyond the RIIO-2 period. Regardless, our main investment in interconnector management tools will continue to be integrated with our enhanced capabilities to deliver market benefits and efficiencies.

IC service improvement include upgrades and additional features on delivered Interconnectors to facilitate the expected increase in Interconnector capacity. Some examples of these upgrades are as follows:

- Interconnector Overview: Functionality to provide the users with a view of the current profiles for all selected interconnectors as well as a combined profile derived from a combination of the current profiles
- The creation of the user logins and access restrictions to be implemented in IFLO. Currently IFLO is only accessed by the Control room - this will ensure we can provide access to other teams based on their needs
- Comparison Functionality: Provides the control room with the ability to determine the change between a new Reference Programme just received and the previous one

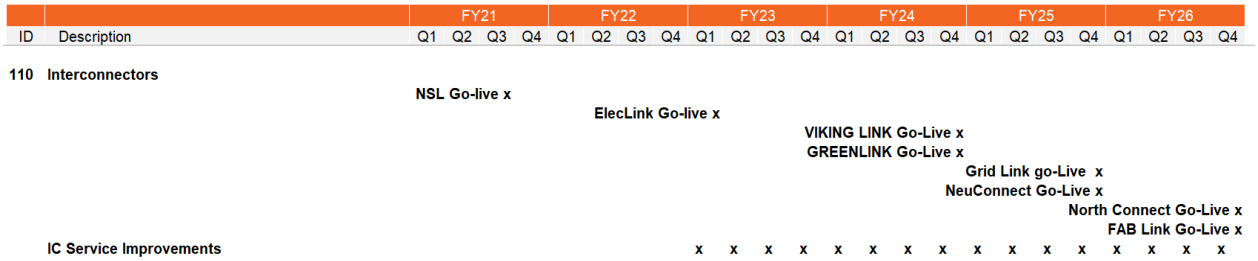

Figure 13 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
NSL Go-Live	Business Units & Customers & Partners	Onboarding of NSL interconnector will allow additional capability to transport enough clean electricity to power 1.4 million UK homes
EleckLink Go-live	Business Units & Customers & Partners	Eleclink which runs through the channel Tunnel thereby providing a low environmental impact will provide an additional transmission link between the UK and France with a capacity of a 1000MW in either direction of flow
Viking Link Go-Live	Business Units & Customers & Partners	Viking link is 1400MW HVDC link between the British and the Danish transmission systems. It will enable effective use of renewable energy,

		access to sustainable electricity generation and improved security of electricity supplies.
Green Link Go-Live	Business Units & Customers & Partners	Greenlink is a proposed subsea and underground electricity interconnector linking the power markets in Ireland and Great Britain. It brings significant benefits on both sides of the Irish Sea for employment, energy security and the integration of low carbon energy sources.
Grid Link Go-live	Business Units & Customers & Partners	GridLink interconnector is a proposed 1.4GW high voltage electricity interconnector between UK and France. Once operational, GridLink will transport sufficient electricity to supply 2.2 million households in France and the UK.
NeuConnect Go-live	Business Units & Customers & Partners	The NeuConnect Interconnector will create the first direct power link between Germany and Great Britain, connecting two of Europe's largest energy markets for the first time. When operational it will allow up to 1.4GW of electricity to move in either direction, enough to power up to 1.5 million homes over the life of the project.
North Connect Go-Live	Business Units & Customers & Partners	NorthConnect will provide an electrical link between Scotland and Norway, allowing the two nations to exchange power and increase the use of renewable wind and hydro power.
Fab Link Go-Live	Business Units & Customers & Partners	The FAB Link is an interconnector between France and Great Britain via the island of Alderney. This Interconnector will allow a maximum transmission of 1400MW, thus contribute to the energy transition in Europe. The project is also designed to provide a route to market for marine renewable energy planned to be constructed in the seas around Alderney.
Interconnector Service Improvements	Business Units & Customers & Partners	Some of major improvements will help control room users to better manage the energy flow through the interconnectors and deliver enhanced application & service with improved monitoring service level

Table 13 - Outcome summary descriptions

Future State

The existing iFLO platform will continue to provide pan-interconnection balancing services for the next ~24 months beyond which the Interconnector business processes will be gradually modernised during FY24-25. New micro-services will be developed, where required, using the OBP technology, to deliver Interconnector services. Where applicable we will reuse existing OBP micro-services to fulfil common functions required by the Interconnector functions e g. dispatch services. This maximises the business benefit gained from the OBP platform whilst avoiding duplication of services and the increased support effort and costs such duplication often incurs.

The Electronic Data Logging (EDL) and Electronic Data Transfer (EDT) interfaces and business processes services will also be replaced in time by services provided by new integration capabilities within ESO and by the Open Balancing Platform. The OBP will provide an Application Programming Interface (API)-based architecture, supported by Kubernetes technology, to enhance the functionality and security of data exchange services with external Interconnector data exchange gateways. We will implement this in a way such that

external Interconnector service providers encounter minimal disruption for their product interfaces and system designs.

Identifier	Target platform	Target Subsystem	Component	Future State
BAL-05	Balancing	Balancing Communication	Interconnector	The current iFLO services will be re-architected and new micro-services introduced in the new Open Balancing Platform (OBP). These will provide re-usable shared components to be adopted by the modernised Interconnector application.
BAL-01	Balancing	Balancing Communication	Data Exchange	The OBP will introduce a new integration platform in CNI and non-CNI environments as part of the drive towards common Consistent Data Services. This platform will provide common data exchange and orchestration services across platforms. Interconnector, EDL, and EDT will make use of these services to support modernisation of the end to end Interconnector service.

Table 14 - Future state subsystem component summaries

Approach

The approach adopted for deploying new Interconnector micro-services is an iterative, phased one which uses Agile methodologies to develop and deliver the services required. This approach enables ESO to deliver Interconnector functionality in a reliable, reusable, and rapid manner whilst minimising the risk associated with IT change. The tools and architecture selected for the OBP platform support this approach with alignment to the target DevSecOps tooling and capability for the Interconnectors subsystem.

Future Interconnector services will be developed as micro-services based on the tools and technologies used by the OBP. This modular approach of micro-service development enables ESO to transition the Interconnector platform over to the new technology estate in a controlled, phased manner which reduces the risk to the business and our customers.

This approach has been based on the following:

- The option of retaining the existing Interconnector platform and building upon it was eliminated as this would not make for cost effective use of the Open Balancing platform and would result in technical silos of functionality that would require separate development and support services being required.
- The option of retaining the Interconnector platform ‘as is’ and not developing it further was discounted as it would result in a platform that could not be extended to meet future market demands; this ‘do nothing’ approach was assessed as leading to an increased situation of technical debt with the platform being a constraint on our ability to meeting the future RIIO2 functional needs.
- The use of a COTS platform was eliminated due to their being no off-the-shelf platform being available that could meet our specific functional needs.

Cost

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP2	2.3	3.5	1.7	3.2	3.2	13.9
	BP1	1.5	1.5	0.7	0.7	0.5	5.0
	Variance	**0.8**	**2.0**	**1.0**	**2.5**	**2.7**	**9.0**
Opex	BP2	0.0	0.2	0.0	0.0	0.0	0.2
	BP1	0.2	0.2	0.1	0.1	0.1	0.6
	Variance	**-0.1**	**0.0**	**-0.1**	**-0.1**	**-0.1**	**-0.3**
Cumulative RtB increase	BP2	0.1	0.2	0.2	0.3	0.3	1.1
	BP1	0.0	0.1	0.1	0.1	0.1	0.5
	Variance	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.6**

Table 15- Investment cost summary

Since submitting the cost forecast on our original plan for these investments, we now estimate an increase in total delivery costs by £6.4m. In the main this has been due to:

- a shift in the timescales for onboarding Interconnectors and
- 2 new interconnectors being added to the delivery schedule for RIIO 2 period

This revised forecast includes retention and expansion of the IC Product team to enable the delivery of the interconnectors added to our scope in the new timescales. This is increase in number of interconnectors is in tally with the Ofgem published list, NGESO pipeline list and timeline commitments from the interconnectors themselves.

As noted in the introduction to Part 3 – Technology Investments, this item is signalled as having higher uncertainty, and we are therefore providing a cost range. Make up of the cost range is detailed below, this investment will go through additional external assurance between April and August to help give confidence on the final cost submissions.

Investment	Whole RIIO2 FD	Whole RIIO2 BP2 data tables/TBM submission	Variance	Whole RIIO2 proposed range
Interconnector	6	14	(8)	12-14

Table 16 - Investment cost range summary

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
The interconnector implementation dates are not under the control of the IC programme and could possibly change due to external factors.	Program, Product & Project Management	Monitor and review at agreed intervals, the scope of the interconnectors to be implemented during RIIO-2	4	1

Table 17 - Investment risk summary

Solution Options

With regards to the development options for iFLO, we have concluded that the optimum approach, for the BP2 timeline, is to continue developing the existing iFLO platform using the technologies upon which it built. This enables us to:

- Leverage the ESO architectural principle of loosely-coupled application services enabling us to expand the functionality of iFLO independently from the OBP and other initiatives.
- Enables us to continue building on the relatively modern iFLO architecture, so maximising the value from the original investment.
- Transition the functionality to a central capability such as OBP at a later date, when upgrading the iFLO platform may not be economically viable. The use of industry standard software and an API-centric design means the iFLO functionality can be subsumed by other BM-platforms such as OBP in the future, reducing the number of discrete platforms that have to be maintained and supported.

The options of either completely replacing the existing iFLO codebase vs reverse-engineering existing functionality is being kept open at this time and requires a feasibility study before a decision is made by ESO Architecture & Strategy – this will be completed by the start of the FY24 period. Irrespective of this outcome, we will modernise at least some of the existing iFLO application services to align to OBP during FY24-25.

Beyond the timescales of BP2, the iFLO functionality will be developed as new micro-services which can run on the OBP technology platform and the discrete iFLO functions migrated across in a phased manner. This ensures alignment of business functions with a common application landscape and enables us to more rapidly development and deploy new Interconnector-related services.

2.3 130 Emergent technology and system management

Overview & Purpose

This investment will ensure control centre users have the tools to manage operational issues and challenges highlighted in the operability strategy report, allowing them to monitor the system in real time and make decisions to counter any critical changes.

The operability strategy report explains the future challenges we face in maintaining an operable electricity system and what we are doing about them. Framed by our zero carbon 2025 ambition, it explains how our work aligns with our operability milestones.

The operability strategy report incorporates the concept of pathfinders, a key theme of which is learning by doing. This investment is designed to support this approach in a flexible manner.

This investment covers the IT changes required to implement solutions to manage these issues operationally. It benefits all 3 roles, as follows:

- Role 1 (National Control): This investment will deliver enhancements to the inertia monitoring and forecasting capabilities, as well as the ability for the Electricity National Control Centre(ENCC) to instruct new services arising from the pathfinders. It therefore enables sub-activity **A1.2 Enhanced Balancing Capability**.
- Role 2 (Markets): This investment will deliver the ability to register, settle, instruct, and report new services arising from the pathfinders, thus enabling sub-activity **A4.6 Balancing and Ancillary Services Market Reform**
- Role 3 (Networks): This investment delivers the IT changes required to implement the pathfinders, thus enabling sub-activity **A8.1 Rollout pathfinder approach and optimise assessment and communication of future needs**

A summary of the key outcomes that will be delivered by this investment as well of the corresponding RIIO-2 sub-activities is included below.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A1.2 Enhanced Balancing Capability • A4.6 Balancing and Ancillary Services Market Reform • A8.1 Rollout of pathfinder approach and optimise assessment and communication of future needs	• Inertia monitoring and forecasting • Registration, instruction, settlement, and reporting of new operability services

Table 18 - Summary of business outcomes and corresponding sub-Activities

Current State

This investment consists of 2 projects:

1: Inertia Monitoring and Forecasting:

By March 2023 we will have implemented two novel tools to measure system inertia in real-time to significantly improve the accuracy and optimise our real-time operation with the increasing number of embedded generators. These provide essential monitoring of both transmission and distribution side inertia, both in real-time and forecasting up to 24 hours ahead. These tools, from GE Digital (part of the General Electric Group) and Reactive Technologies, are the first major operational installation of tools that have arisen from innovation. They use very different methodologies and monitoring devices, and we continue to expand these tools to incorporate in our operational processes.

One of these tools, from GE (General Electric) Digital, has provided the initial interface to receive monitoring data from the TOs that are critical to the delivery of the monitoring and control system (MCS) being delivered by IT investment 500 Enhanced Frequency Control (previously Zero carbon operability) and the frequency and

oscillation monitoring capability being delivered by the IT investment 170 Frequency visibility. The Reactive Technologies solution has been installed and is undergoing operational testing.

2: Pathfinders:

The aim of the Pathfinder programme is to find the most economical way to operate a low-carbon system and preserve system security, whilst finding solutions (e.g., inertia & voltage support) which will lead to the lowest possible consumer bills while assisting in the reduction of the environmental impact of the electricity industry.

1. **Stability Pathfinder** - By March 2023, the Pathfinder programme will have delivered the ability to accommodate a wide range of units beyond just synchronous compensator units, for example grid forming technology.
2. **Voltage Pathfinder –** will have built upon earlier releases to accommodate the onboarding of the new Mersey & Pennines units (providers) and the system enhancements required to support ENCC functional processes.
3. **Constraint Management Pathfinder (CMP)** – supporting IT solution will have been delivered to support the ESO in disconnecting generation rapidly when a network fault occurs rather than pre-emptively reducing (buying off) generation in case the network fault occurred. This will be operational on the Scotland B6 Boundary.

Roadmap

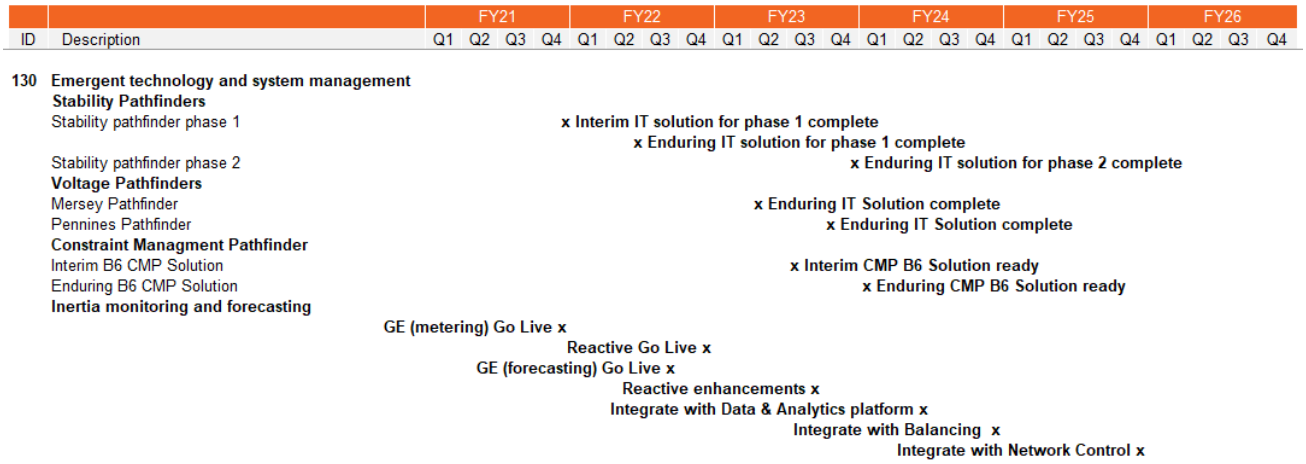

Figure 14 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Stability pathfinders: Interim IT solution for phase 1 complete	Business Units Customers & Partners	Ability to register, instruct, settle, and report initial stability service providers.
Stability pathfinders: Enduring IT solution for phase 1 complete	Business Units Customers & Partners	Ability to register, instruct, settle, and report additional stability service providers.
Stability pathfinders: Enduring IT solution for phase 2 complete	Business Units Customers & Partners	Ability to register, instruct, settle, and report further stability service providers, including those using novel grid forming technology.

Mersey Pathfinder: Enduring IT solution complete	Business Units Customers & Partners	Ability to register, instruct, settle, and report Mersey Pathfinder voltage service providers.
Pennines Pathfinder: Enduring IT solution complete	Business Units Customers & Partners	Ability to register, instruct, settle, and report Pennines Pathfinder voltage service providers.
Constraint Management Pathfinder: Interim CMP B6 Solution ready	Business Units Customers & Partners	Interim supporting IT solution will have been delivered to support the ESO in disconnecting generation rapidly when a network fault occurs rather than pre-emptively reducing (buying off) generation in case the network fault occurred. This will be operational on the Scotland B6 Boundary.
Constraint Management Pathfinder: Enduring CMP B6 Solution ready	Business Units Customers & Partners	Enduring supporting IT solution will have been delivered to support the ESO in disconnecting generation rapidly when a network fault occurs rather than pre-emptively reducing (buying off) generation in case the network fault occurred. This will be operational on the Scotland B6 Boundary.
GE Metering Go Live	Business Units Customers & Partners	Provision of real-time regional inertia monitoring capability capturing both transmission and distribution connected inertia. Initially configured to monitor the inertia contribution from Scotland, the system will monitor full GB contribution once NGET has installed the required monitoring devices. This will improve the information available within the Control Room for decision making and improve transparency to customers.
Reactive Go Live	Business Units Customers & Partners	Provision of real-time inertia monitoring for Great Britain using an ultracapacitor to trigger measurements. Alongside the GE metering this will improve our decision making in ensuring the system remains stable.
GE Forecasting Go Live	Business Units Customers & Partners	Extension of the GE real-time monitoring system to provide regional inertia forecasting 24 hours ahead. The inertia forecast will enable economic decisions to be made outside the BM to ensure sufficient inertia is available, optimising the operating plan.
Reactive Enhancements	Business Units	Improvements to the Reactive inertia monitoring system to improve user experience.
Integrate with Data & Analytics Platform	Business Units	Integrating the outputs from the Inertia Monitoring tools with our Data & Analytics platform to enable development of additional analytical tools and user data visualisation. This is also an enabler to integrate the tools with our balancing and Network Control tools
Integrate with Balancing	Business Units	Incorporate the inertia data into our Balancing tools to improve user experience with the Control

		Room and ensure that inertia analysis is included within optimising the operating plan.
Integrate with Network Control	Business Units	Improving user experience by integrating inertia data into situational awareness tools and our single operator console.

Table 19 - Outcome summary descriptions

Please note that as highlighted in the business Role 3 narrative for Activity **A8 Enable all solution types to compete to meet transmission needs**, we are currently reviewing the best approach of evaluation of needs and market structure for pathfinders and expect to provide more clarity on this in our August submission. This may therefore impact on the IT roadmap and costs.

Future State

This investment will implement our strategic Inertia Monitoring and Management solution, building on our upgraded Wide Area Monitoring System (WAMS) solution and new NCMS.

Attendant enhancements will be made to the Enhanced Balancing Capability and our settlement processes to accommodate the necessary dispatch and settlement changes to coordinate service providers.

The capabilities of DAP will be used for component integration and to provide analytics support. Partner interaction will be implemented using the DEP.

While the central software building blocks are well understood and in the process of being implemented, the interaction with partners is still emerging being subject to the outcome of the pathfinder projects. This will affect the solution model, particularly the network topology needed to support the distributed components of the solution.

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State
NET-02	Network Operations & Control	Control Room Planning	Innovation	New Inertia Monitoring and Management tools implemented for 2025/26 System Operations. Modern Network Analysis tools extended from NCMS or WAMS tools, built on DAP, or a hybrid of both.
NET-04	Network Operations & Control	Situational Awareness	Inertia Monitor	New Inertia Monitoring and Management capability integrated into overall Situational Awareness suite for 2025/26.
NET-04	Network Operations & Control	Situational Awareness	SCADA	New Inertia Monitoring and Management capability integrated into NCMS. Systems and processes enhanced to support these new system services.
COM-03	Commercial & Markets	Settlements	Settlements	Settlement systems and processes enhanced to support these new system services.
BAL-03	Balancing	Energy Balancing	Dispatch	Balancing systems and processes enhanced to support these new system services.

Table 20 - Future state subsystem component summaries

Approach

This programme is initially experimental, trialling different solutions for Inertia Monitoring and Management. ESO will continue to work with suppliers to determine the best scheme and tool.

The overall approach is to move ahead with the IT platform strategy, such that these new system services can be quickly integrated into it, as the pathfinders create them. At the business level that means implementing the new WAMS and NCMS and enhancing other supporting systems. At the IT level, implementing DAP and DEP. Creating a modern and adaptable network control architecture that will accommodate the final inertia monitoring and management solution.

Some variability is inherent as the pathfinders have adopted a learning by doing approach.

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP2	1.2	1.4	1.6	1.7	1.7	7.6
	BP1	0.0	1.5	1.7	1.9	1.9	6.9
	Variance	**1.2**	**-0.1**	**-0.1**	**-0.2**	**-0.2**	**0.7**
Opex	BP2	0.3	0.3	0.3	0.3	0.3	1.3
	BP1	0.0	0.2	0.2	0.2	0.2	0.8
	Variance	**0.3**	**0.1**	**0.1**	**0.1**	**0.1**	**0.6**
Cumulative RtB increase	BP2	0.3	0.3	0.5	0.7	0.9	2.7
	BP1	0.0	0.0	0.2	0.4	0.6	1.2
	Variance	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**1.5**

Table 21 - Investment cost summary

Since submitting our original plan for this investment FY22 expenditure has increased, primarily due to earlier than anticipated demand for stability and voltage pathfinders implementation, together with delays to inertia monitoring arising from external dependencies.

The delays to inertia monitoring have also led to the increase in RtB in FY22. At the time of the RIIO-2 submission, it was assumed that implementation would be complete in FY21 and that the RtB increase would have already been included in the starting baseline for BP2.

Furthermore, we have taken the opportunity to bring forward the implementation of inertia forecasting capability, which has led to a minor reduction in BP2 costs.

Please note that as highlighted in the business Role 3 narrative for Activity **A8 Enable all solution types to compete to meet transmission needs**, we are currently reviewing how best to take the Pathfinders programme forward and expect to provide more clarity on this in our August Final Business Plan submission. This may therefore impact on the IT roadmap and costs.

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
We develop short-lived tools due to difficulty in predicting how tools will need to evolve in future given changing needs and increased understanding of issues.	Business Software	• Ensure regular review of requirements throughout RIIO-2 period. • Deploy proof of concept tools as early as possible to gain understanding of modelling needs. • Employ agile delivery principles and flexible, modular applications. • Enable operability team to effectively prioritise investments based on likelihood and impact of system problems.	3	1
There is a risk/dependency that any delay to NGET and SSE timeline for completing	Program, Product & Project Management	• Maintain regular engagement with NGET and SSE with joint reviews of	2	1

their Phasor Data Concentrator (PDC) installation and commissioning work will affect the usability of the inertia monitoring tool		delivery plans and dependencies to track progress and mitigate any delays forecast		
Higher priority projects diverting required resources leading to a delay in the delivery of IT changes required to meet the release dates	IT Management & Strategic Planning	Solution Delivery Managers will be engaged throughout the project to keep them informed of upcoming resource needs so that resources can be booked in advance and any potential impacts to delivery will be communicated to the Project Board.	3	1
Changes to programme scope arise as new pathfinder service providers are identified and onboarded. This could result in additional / revised IT activities potentially impacting upon agreed costs and timescales	Program, Product & Project Management	To maintain agreed timescales and budgets a full impact assessment will be provided to the Project Boards to support an informed decision and approval on the priorities of the requirements following a Change Control Process. Financial impact considers time required to review requirements and carry out impact assessment	3	1

Table 22 - Investment risk summary

Solution Options

For this investment, the main solution options considered at the outset and detailed in our original BP1 submission have narrowed to the current plan. Suitable Inertia Monitoring and Management is essential as we move towards zero carbon operation. There are limited tools available in the market therefore we are procuring specialist software and hardware solutions, with bespoke development where necessary.

There is still optionality over which solution from the pathfinders will be carried forward to system-wide adoption. That will be dependent on our technical feasibility analysis and commercial arrangements.

2.4 140 ENCC operator console

Overview & Purpose

This item is for provision of the entire control room user interface/experience. It includes visualisation tools from control centre dashboards to the video wall plus infrastructure costs to update the silver command room.

Evolving control centre roles and increase in data sharing for a more complex network will require investment in user experience. This will take the shape of a single customisable graphical user interface (GUI), with the ability to interact across all relevant applications and present data from different networks.

This investment enables sub-activity **A1.3 Transform Network Control**. As part of this, it is also providing enhanced visualisation capability for training purposes, and so also provides benefits to **A2.3 Training Simulation and Technology.** By creating a common user experience and visualisation capability across the control room it also enables **A1.2 Enhanced Balancing Capability**.

This capability is classed as Critical National Infrastructure and as such is vital for the control of the grid network. It therefore primarily benefits the Electricity National Control Centre (ENCC). This investment also delivers enhanced training and database maintenance capabilities to enable the Operational Readiness and Performance Transformation & Control Systems teams to support the operation of the ENCC.

A summary of the key outcomes that will be delivered by this investment as well of the corresponding RIIO-2 sub-activities is included below.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A1.3 Transform Network Control • A1.2 Enhanced Balancing Capability • A2.3 Training simulation and technology	• Enhancements to user interface for ENCC control room • Data management automation • Inertia modelling capabilities • Integration between balancing and network control simulation

Table 23 - Summary of business outcomes and corresponding sub-Activities

Current State

Control centre users access many data sources and different applications to do their job. They use multiple individual displays and a video wall that shows a limited set of relevant operational data. As the control centre operational team is split over two sites some data is shared over phone or email, as is also the case with our silver command room (used to manage emergency situations).

By March 2023, the three main input programmes to 140 ENCC Operator Console will have refined their solution models and be in delivery (110 Network Control, 180 Future Balancing Capability and 220 Data and Analytics Platform), and requirements will have clarified. This will provide a basis for the solution design of Operator Console and the selection of any needed supporting systems.

Throughout FY23, the ENCC Operator Console delivery team will have been mobilised and a series of design thinking workshops would have been undertaken with key stakeholders with the intention to agree the scope of delivery and the approach (custom development vs COTS product deployment etc).

It is expected that a Request For Proposal (RFP) procurement event will be undertaken during BP2, whereby the external marketplace are invited to submit proposals in response to the requirements captured.

Roadmap

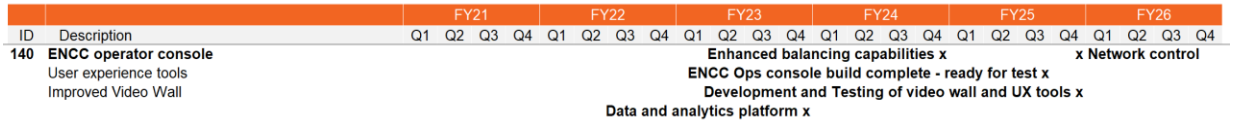

Figure 15 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Enhanced balancing capabilities	Business Units	New Enhanced Balancing capability is deployed and available for integration with the ENCC Operator Console.
ENCC Ops console Build complete and ready for test	Business Units	Newly designed and built infrastructure required for the ENCC Operator Console has been implemented and ready to start testing.
Development and testing of video wall and UX tools	Business Units	Newly delivered video wall and User Experience tooling has been delivered, tested and is ready for acceptance into service (AIS).
Integration with data analytics platform	Business Units	Initial integration with the Data and Analytics platform which will ultimately feed data through to our operator consoles and video walls.
Integration with Network Control	Business Units	Integration with the Network Control Tools streaming data to the video walls and allowing control access to the tools.

Table 24 – Outcome summary descriptions

Future State

Operator Console will replace and modernise the current control room software and hardware. Combining the GUIs of the new clutch of operational systems into a unified operator user experience.

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State
NET-03	Network Operations & Control	Control Support	ENCC Operator Suite	Operational new control room solution, combining the GUIs of NCMS, Enhanced Balancing Capability and other smaller operational systems into an efficient environment for all operator types. Console will consider a new Video Wall solution. Console will be extensible and flexible to adapt to new operator needs going forward as the grid decarbonises.

Table 25 – Future state subsystem component summaries

This will also give an overall view of the state of the power system in one place enabling control centre managers to rapidly make more informed decisions. In emergency cases, the silver command team will also be able to have faster reaction times and give the most up to date and relevant information to external stakeholders.

Control centre users will get data from NCMS, the Enhanced Balancing Capability and our IT investment 220 Data and analytics platform.

Approach

The overall approach is to allow the main input programmes to refine their solution models before designing and implementing a new Operator Console to combine them. This allows the new NCMS to be chosen and the wide range of GUIs and Situational Awareness tools it will provide to become clear.

The Enhanced Balancing Capability will deliver a modern Web UI that will integrate easily with other GUIs, UI frameworks, and with NCMS GUIs.

The investment will refresh the operating model of the ESO control room including people and process aspects to accommodate decarbonisation. Control room hardware will be refreshed, including supporting software platforms.

The video wall solution from the end of RIIO-1 will be extended to provide the switching and display mirroring function, using a range of control centre technologies at video signal, operating system, or application levels either individually or in combination.

In conjunction with this investment, there is an opportunity to assess and exploit Machine Learning techniques to advise or automate operator actions under the RIIO-2 Network Innovation Allowance (NIA) scheme.

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP2	0.0	0.7	0.5	1.7	2.0	5.0
	BP1	0.0	0.7	0.5	1.7	2.0	5.0
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Opex	BP2	0.0	0.1	0.1	0.2	0.2	0.6
	BP1	0.0	0.1	0.1	0.2	0.2	0.6
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Cumulative RtB increase	BP2	0.0	0.0	0.0	0.0	0.1	0.1
	BP1	0.0	0.0	0.0	0.0	0.1	0.1
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Table 26 – Investment cost summary

Since submitting our original plan for this investment, there has been no change in costs.

Risks

Risk	IT Tower	Mitigation	Likelihood	Impact
Market changes, changes in system conditions are faster than expected leading to further changes and increased costs .	Application Development	• Ensure IT tools are configurable and adaptable.	2	1
We may find compatibility issues between the various tools, leading to delay and increased costs.	Application Development	• Ensure tools being developed utilise industry standard protocols and are developed in line with best practice.	2	2

		• Undertake suitable due diligence in advance of procurement event award to ensure tooling fit for purpose end to end.		
Key internal SME/system user resource availability may impact the testing & implementation phases of the new system & toolset, leading to delay.	Program, Product & Project Management	• Ensure early forecast of resource requirements to business units • Timely recruitment for appropriately skilled resources	3	1
Global microchip shortage is affecting global supply chains for Hardware which could impact delivery timescales.	Program, Product & Project Management	• Place hardware orders as early as possible within delivery lifecycle	3	1

Table 27 – Investment risk summary

Solution Options

For the ENCC Operator Console, the main solution options have been set elsewhere in that NCMS, Enhanced Balancing Capability, and so on, combine to give the majority of the operator console. This section considers the options for the remaining components of the overall console, for example wall displays and their driver systems.

There are two basic option: (i) Enhance and upgrade existing supporting systems, and (ii) Procure new supporting systems. We will blend these options optimally. The current expectation is that we will procure a new wall display system, use the UI integration features of the new NCMS, and refresh or renew the remaining supporting components.

A key determinant of our actions is the choice of NCMS and the quality of its components pertinent to the console. these will only become visible at the right level of detail once detailed discussions and analysis with the vendor start. This consideration also applies to the NCMS capability to act as a UI integration framework. We expect it to perform this role based on our analysis so far but may need to reconsider if it falls short.

2.5 150 Operational awareness and decision support

Overview & Purpose

This investment will enhance our network modelling capabilities by giving online analysis of voltage and power flow profiles closer to real-time. This will ensure the network is run securely and data exchanges from TOs and DNO / DSOs are timely and correctly assessed.

With the increasing complexity of the transmission network and the need to consider at least part of DNO / DSO networks, we need new tools as well as upgrading existing ones to provide decision-making (e.g. machine learning). This investment is also required to enable whole-system simulation and modelling, both online and offline.

This investment enables sub-activity **A1.3 Transform Network Control.** As part of this, it is also providing enhanced modelling capabilities for training, and so also provides benefits to **A2.3 Training Simulation and Technology.**

This capability is classed as Critical National Infrastructure and as such is vital for the control of the grid network. It therefore primarily benefits the Electricity National Control Centre (ENCC). This investment also delivers enhanced training and database maintenance capabilities to enable the Operational Readiness and Performance Transformation & Control Systems teams to support the operation of the ENCC.

A summary of the key outcomes that will be delivered by this investment as well of the corresponding RIIO-2 sub-activities is included below.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A1.3 Transform Network Control • A2.3 Training simulation and technology	• Offline modelling capability improvements • Online modelling capability improvements • New training simulator

Table 28 - Summary of business outcomes and corresponding sub-Activities

There are strong synergies between this investment and IT investment 110 Network Control, and we will deliver these as a combined programme.

This investment will enable the transformation of network control through the delivery of new or enhanced business capabilities, which include:

- Greater visibility of current system conditions and predicted future conditions. As network conditions become more volatile, a ‘lookahead capability’ is vital to enable the ESO to manage risk on the network and take appropriate action.
- Voltage stability analysis and improved fault level analysis capabilities
- More intuitive display of alarms to speed up root cause analysis.
- Deeper analysis of the network, for example: Heatmaps of network issues and enhanced analytics, eg. contingency analysis enhancements.
- Assessing options to enhance the state estimator using techniques such as AI and machine learning
- Online Stability Analysis enhancements.

Current State

Our online and offline network analysis tools were designed to assess the transmission system at a time when its complexity and conditions were somewhat stable. Our offline tools can only study network conditions for specific time periods, a few times a day or for day-ahead purposes and are based on offline models, which, are often out of date due to ever changing market and network conditions. Our online tools currently only analyse

the current real-time situation, the IEMS (Integrated Energy Management System) along with OSA (Online Generator Stability Assessment tool) carry out real-time thermal, voltage and stability analysis and provide control engineers with vital information of current system conditions as well as any potential issues if contingency scenarios were to occur. These tools were developed as standalone functionality as data sharing with external parties and systems was not a priority.

By March 2023, several enhanced network analysis capabilities will have been delivered, these include:

- Voltage Stability Analysis (within the OSA (Online Generator Stability analysis) package)
- Fault Level Enhancements in place to align online and offline tools

The two main input programmes and analytics contributors (110 Network Control and 220 Data and Analytics Platform) to 150 Operational Awareness and Decision Support (OADS) will have refined their solution models and be in delivery having defined a clear delivery and integration strategy. This will provide the basis for the solution design & development of further Operational Awareness and Decision Support tools and the selection of any needed supporting systems.

The core Network Control Management system (NCMS) will have been established for testing and development, which will enable users to gain hands on experience of the new systems user interface to provide valuable early feedback and user testing.

Roadmap

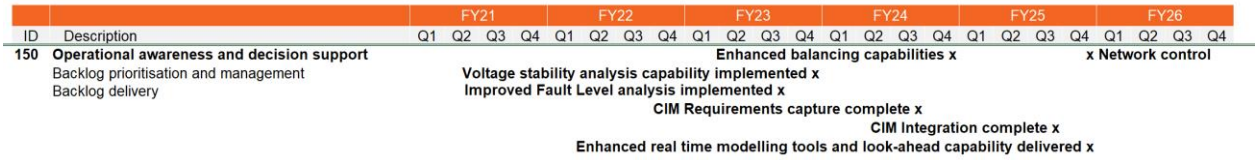

Figure 16 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Enhanced balancing capabilities	Business Units	New Enhanced Balancing capability is deployed and available for integration.
VSAT (Voltage Stability Analsis Tool) capability implemented	Business Units Customers & Partners	This will allow control room engineers to monitor and identify real-time voltage stability issues as well as potentially increasing constraint boundary limits based on thermal & voltage constraint calculations.
CIM requirement capture complete	Business Units	Completion of discovery and requirements capture in relation to the Common Information Model (CIM)
CIM integration complete	Business Units Customers & Partners	Leveraging CIM to unify our online and offline models, as well as potentially linking equipment/asset data between disparate internal and external systems (e.g., eNAMS, NGET (National Grid Electricity Transmission) SCADA (Supervisory Control and Data Acquisition)).
Enhanced real-time modelling tools and look ahead capability delivered.	Business Units Customers & Partners	Provides a more accurate representation of the network, allowing for all types of devices and dynamic tripping schemes to be represented. Look-ahead implementation will allow control room engineers visibility of any potential system

	issues they may encounter in the timeframe of 0-24hrs ahead

Table 29 – Outcome summary descriptions

Future State

ESO is seeking a focused Situational Awareness product set as outlined in our RIIO-2 price control business plan. The product needs to leverage several complex data sources and allow users to operate a heavily constrained electricity system securely, efficiently, and safely, bringing key issues into vision quickly and display them clearly to enable users to make informed decisions. The new product will deliver the following:

Enhanced look ahead capability will be required to predict transmission problems in a more volatile operating environment.

Enhanced network modelling capabilities to ensure we can adapt quickly to new power system elements and market products/systems.

Intelligent network analysis/alarming capabilities that leverage machine learning to alert control engineers to issues that may previously been missed during manual network analysis

Integrated Wide Area Monitoring (WAMS) functions will enable dynamic power system quantities to be monitored in real-time increasing situational awareness for control engineers. This investment will deliver further integration of WAMS in to NCMS, building on the WAMS capability being delivered by 130 Emergent Technology and System Management.

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State
DAT-02	Data & Analytics	Analytics and Insight	Predictive Analysis CNI	New Situational Awareness suite implemented for 2025/26 System Operations. Modern Predictive Analytic capability automating and underwriting System Operations. Modern Network Analysis tools extended from NCMS tools, built on DAP, or a hybrid of both.
NET-04	Network Operations & Control	Situational Awareness	SCADA	New Situational Awareness suite implemented for 2025/26. Suite will contain necessary power analytics tools, integrated into NCMS, for decarbonisation.
NET-04	Network Operations & Control	Situational Awareness	Time Series Visualisation	New Situational Awareness suite implemented for 2025/26. New power analytics tools integrated into NCMS using common data manipulation and presentation components.

Table 30 – Future state subsystem component summaries

Apart from new tools or enhancements to current tools, we will need greater alignment between real-time online and offline tools to allow for a more efficient control centre operation. These tools will be integrated via the IT investment 220 Data and analytics platform.

Approach

We will take a similar approach to IT investment 110 Network Control. The NCMS resulting from 110 Network Control will provide the basis of many of the OADS tools we need and will be completed by enhancement and customisation.

We will develop operational modelling and scenarios analysis tools. These will capture, store, analyse, and present data from multiple new sources in real time.

These rely heavily on IT investment 220 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.

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP2	0.0	1.7	3.4	3.8	1.7	10.6
	BP1	0.4	1.7	3.4	3.8	1.7	11.1
	Variance	**-0.4**	**0.0**	**0.0**	**0.0**	**0.0**	**-0.4**
Opex	BP2	0.0	0.2	0.4	0.4	0.2	1.2
	BP1	0.0	0.2	0.4	0.4	0.2	1.2
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Cumulative RtB increase	BP2	0.0	0.1	0.1	0.2	0.3	0.7
	BP1	0.0	0.0	0.1	0.2	0.3	0.5
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.2**

Table 31 – Investment cost summary

There are strong synergies between this investment and IT investment 110 Network Control, and we will deliver these as a combined programme. £400k expenditure in FY22 has been substituted in to 110 Network Control, as the functionality is being delivered by the Network Control Programme asset health workstream.

For the remainder of the cost forecast, since submitting our original plan for this investment, there has been no change in costs.

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
We develop short-lived tools due to difficulty in predicting how modelling tools will need to evolve by the end of RIIO-2 given the pace of changing market needs and/or implications from Future System operator direction (as per 110 Network control delivery)	IT Management & Strategic Planning	• Ensure continued review of requirements throughout remaining RIIO-2 period. • Deploy proof of concept tools where possible to gain understanding of requirements • Continue to use the product delivery principles and flexible, modular applications.	3	1
Delay to dependent NGESO platforms (NCMS+NGET SCADA Integration, Future Balancing & Data & Analytics) leading to delay to this investment.	Application Development	• Maintain Engagement with internal ESO product delivery teams • Periodic review of dependencies & programme interlocks • Review, impact assess and maintain fallback options	2	2
Key internal SME/system user resource availability may impact the testing & implementation phases of the new system & toolset, leading to delay.	Program, Product & Project Management	• Ensure early forecasting of resource requirements to business units • Timely recruitment for appropriately skilled resources where not already available	3	1

Table 32 – Investment risk summary

Solution Options

The overall solution option has been fixed, NCMS and DAP provide a base architecture for the OADS tools to snap into.

For the individual OADS tools, the solution options are to configure / enhance the corresponding NCMS component or to buy or build afresh.

These options are in play but the preferred and planned option, for those tools NCMS provides, is to consolidate on NCMS. The aim of the NCMS selection process is to select a product containing some of these tools. If individual tools within NCMS do not meet our needs or are not offered, buy or build will be considered. This information will only become fully visible at the right level of detail once detailed discussions and analysis with the vendor start in FY23 Q1-Q2.

The reasons for favouring innate NCMS tools is that it will give delivery lower costs and risks on multiple fronts (integration, operational, and commercial) and faster times to market. It also engenders a cohesive operator experience and a higher level of future proofing, as the overall NCMS advances as a suite.

2.6 170 Frequency visibility

Overview & Purpose

To maintain control of the power system, ESO must monitor system frequency at high resolution in real time. Frequency monitoring is also critical for system restoration.

As the amount of distributed generation increases, changes will be needed in the way the transmission system is monitored in real time. Purely monitoring frequency is no longer sufficient and we will need more information on regional conditions to maintain stability. We will also need better capability to monitor emerging issues such as harmonics and flicker. The TOs are continuing to roll out Phasor Measurement Units (PMUs) and accessing data from these will greatly enhance our capability to monitor the state of the system. We will be processing ever greater amounts of data.

This investment enables sub-activity **A1.1 Ongoing Activities.** This investment will maintain and improve the ability of the control room to manage frequency and inertia and understand the effects of system events with confidence.

This capability is classed as Critical National Infrastructure and as such is vital for the control of the grid network. It therefore primarily benefits the Electricity National Control Centre (ENCC). This investment also delivers enhanced monitoring capabilities to enable the Performance Transformation & Control Systems team to support the operation of the ENCC.

A summary of the key outcomes that will be delivered by this investment as well of the corresponding RIIO-2 sub-activities is included below.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A1.1 Ongoing activities	• Interconnectivity to stakeholders' phasor measurement data • Greater insight into power system dynamics • More reliable frequency visibility

Table 33 - Summary of business outcomes and corresponding sub-Activities

Current State

Our frequency monitoring capability is provided by a bespoke system, known as Frequency and Time Error (FATE). This system collects frequency information from a limited number of locations on the transmission network. Due to the critical nature of this data, FATE is a critical national infrastructure (CNI) system.

This is supplemented by GE Phasorpoint, part of the Wide Area Monitoring System (WAMS) product, which provides additional information and situational awareness of regional variations in frequency and stability. It receives information from phasor measurement units (PMUs), which are being rolled out by the TOs. This system is currently a standard business system.

There has been a change in the approach to maintain and upgrading frequency visibility systems. Following the incumbent vendor withdrawing support, we are replacing FATE with a new product during BP1 rather than keeping the existing system operational. The FATE Replacement system will align with our wide area monitoring (WAMS) strategy.

By March 2023 we expect to be in the final stages of replacing FATE with an updated WAMS platform (GE Digital's Energy Platform for Wide Area Monitoring) for our immediate frequency monitoring. We also plan to have installed communications links with Scottish and Southern Electricity Networks (SSEN) and National Grid Electricity Transmission (NGET) to receive PMU data.

Roadmap

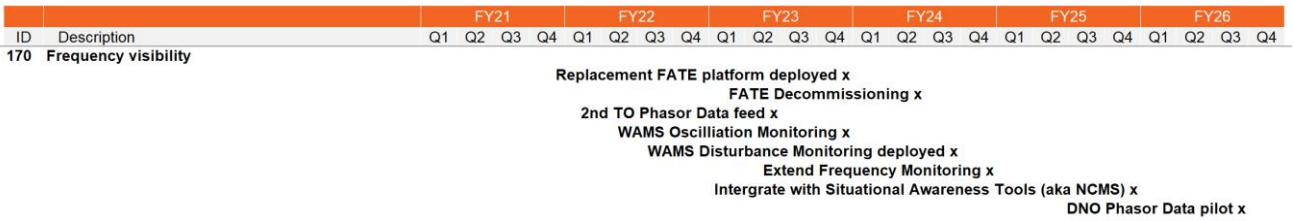

Figure 17 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Replacement FATE Platform deployed	Business Units Customers & Partners	The replacement Frequency and Time Error system has been successfully deployed and operational. This will replace the existing platform and provide enhanced visualisation and early warning of system issues.
2nd TO Phasor data feed	Business Units	Access to high resolution phasor measurement unit data for Northern Scotland to increase the area of the network we are monitoring
WAMS Oscillation Monitoring	Business Units Customers & Partners	Provision of analysis and visualisation to monitor the stability of the network to enable control engineers to be able to manage system issues.
WAMS Disturbance Monitoring deployed	Business Units Customers & Partners	Building on the oscillation monitoring to detect sudden disturbances in the network and provide awareness of the location that events have occurred.
Extend frequency monitoring	Business Units Customers & Partners	Increased coverage of the transmission network providing visibility for restoration
Integrate with Situational Awareness Tools	Business Units	Improved user experience by integrating WAMS tools into our single operator console
DNO Phasor Data pilot	Business Units Customers & Partners	Understanding of the requirements to obtain PMU data from the distribution networks

Table 34 – Outcome summary descriptions

Future State

We will enhance our capability to monitor and assess PMU data and address new challenges.

During BP2 we will be:

- Following a period of parallel running with the new solution, decommissioning the legacy FATE system.
- Completing replacement of our legacy PhasorPoint system to provide a strategic WAMS system for stability monitoring and post-event analysis, facilitating other investments including 500 Enhanced Frequency Control
- Expanding WAMS provision to provide additional stability monitoring and control systems determined by priorities identified from emerging Control Room challenges around stability monitoring, thus allowing remedial action to be taken. This will initially include oscillation and disturbance monitoring, depending on the availability of monitoring data from the TOs. We are also dependant on TOs rolling out Phasor Measurement Units across their networks in a timely manner as specified in the System

Operator Transmission Owner Code Procedure STCP 27-1 (which defines System Performance Monitoring Requirements).

- Enhancing the availability of PMU data by migrating our Gateway Phasor Data Concentrator (PDC) which receives PMU data from third parties to our new Data Centre to enable data to be available for our new Network Control tools.

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State
NET-04	Network Operations & Control	Situational Awareness	Frequency Visibility	GE WAMS operational with PMU monitoring and related Situational Awareness. NCMS operational, interoperating with GE WAMS.

Table 35 - Future state subsystem component summaries

This investment will also underpin IT investments 130 Emergent technology and system management and 500 Zero carbon operability, for inertia monitoring and wide area monitoring and control system respectively.

Approach

Our overall approach is to deploy the GE WAMS system, and supporting frequency/phase monitoring devices, and integrate it into NCMS and the wider network control solution.

Across BP2, Frequency Visibility will invest in most ESO IT Towers being a layer in the wider Network Control solution and having a similar but smaller footprint.

NCMS is the central system in ESO Network Control and, once finalised, surrounding systems such as WAMS will complement it and complete the overall strategy. Post initial deployment, developing Frequency Visibility requirements will be met with additional NCMS or WAMS modules or customisation.

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP2	0.4	2.3	0.6	0.4	0.1	3.8
	BP1	0.6	0.6	0.2	0.2	0.2	1.6
	Variance	**-0.2**	**1.7**	**0.4**	**0.2**	**0.0**	**2.1**
Opex	BP2	0.1	0.1	0.0	0.0	0.0	0.2
	BP1	0.1	0.1	0.0	0.0	0.0	0.2
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Cumulative RtB increase	BP2	0.0	0.2	0.2	0.3	0.3	1.1
	BP1	0.0	0.0	0.0	0.0	0.0	0.1
	Variance	**0.0**	**0.2**	**0.2**	**0.2**	**0.3**	**0.9**

Table 36 – Investment cost summary

Since submitting our original plan for this investment, our overall costs have increased. Following the incumbent vendor withdrawing support, we are now replacing FATE with a new product during BP1 rather than keeping the existing system operational. Costs have been lower than forecast in FY22 due to the need to reassess the plan, but are higher in FY23 when the new system will be delivered.

This change has necessitated a revision of the frequency roadmap and has pushed other work originally planned for BP1 into BP2, thus increasing BP2 spend. We also have a better understanding of delivery and RtB costs.

New requirements have emerged regarding the need for replacement of our tools that are used for Ancillary Service Monitoring and Dynamic System Monitoring. The changing generation profile is making this process harder, as the number of new, and smaller, providers we need to monitor increases. New tools are expected to be needed. These new requirements have not yet been solution assessed and are therefore not yet included in the costs for this investment. We will provide an update in our August submission.

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
There is a risk/dependency that any delay to Transmission Owner timelines for completing their Phasor Data Concentrator (PDC) installation and commissioning work will affect the delivery plan for Frequency Visibility	Program, Product & Project Management	• Maintain regular engagement with Transmission Owners with joint reviews of delivery plans and dependencies to track progress and mitigate any delays forecast	2	1
There is a risk that any delay to the implementation of FATE Replacement will impact the delivery of any additional enhancements as part of the Frequency Visibility project, impacting the ability of control room users to analyse frequency data	Program, Product & Project Management	• Regular reviews of delivery schedules and status reporting • Alignment of resources to ensure adequate business support during implementation and testing phases • Agile delivery methodology and re-prioritisation of backlog items to ensure continuous delivery	1	1
There is a risk the migrating the Gateway PDCs to the new CNI Data Centres and increasing their resilience is more complex and costly than envisaged as discovery work isn't planned until FY23	Program, Product & Project Management	• Regular engagement with ESO product delivery and technical teams	1	1
Key internal CNI/system user resource availability may impact the testing & implementation phases of the new system & toolset as result of unforeseen commitments	Program, Product & Project Management	• Ensure early forecasting of resource requirements to CNI resource team to agreed timescales	2	1

Table 37 – Investment risk summary

Solution Options

The range of solution options from the original Business Plan, i.e. No Investment, Upgrade Existing, or Buy New, have resolved to one. ESO has chosen to upgrade ("Upgrade Existing") and expand WAMS for frequency monitoring, replacing FATE in the process. Frequency Visibility will be enhanced to meet future needs on the base provided by WAMS and NCMS.

The extension of an existing modern COTS package, GE WAMS, minimises cost and delivery risk, effectively sharing these with the rest of GE's customer base around the world who are facing similar challenges. We will continue to monitor its market position and value proposition against our business strategy, as with all our major systems, under our normal Enterprise Architecture activities.

2.7 180 Enhanced balancing capability

Plans for this IT investment are not presented due to the ongoing Balancing Capability Strategic Review. Please see sub-activity A1.2 of the main business plan document for more information. The cost information provided in the table below is in line with the TBM data model submitted alongside this document.

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP1	1.3	1.3	1.3	0.0	0.0	3.8
Opex	BP1	0.1	0.1	0.1	0.0	0.0	0.4
Cumulative RtB increase	BP1	0.0	0.0	0.0	0.0	0.0	0.1

Table 38 - Investment cost summary

As noted in the introduction to Part 2 – Technology Investments, this item is signalled as having higher uncertainty, and we are therefore providing a cost range. Make up of the cost range is detailed below, this investment will go through additional external assurance between April and August to help give confidence on the final cost submissions.

Investment	Whole RIIO2 FD	Whole RIIO2 BP2 data tables/TBM submission	Variance	Whole RIIO2 proposed range
Balancing Programme	**58**	**142**	**(85)**	**83-142**

Table 39 - Investment cost range summary

As stated in A1.2 of our overall Business Plan submission, investments 180 Enhanced balancing capability, 210 Balancing asset health, 260 Forecasting enhancements and 480 Ancillary services dispatch fall under the remit of the overall 'Balancing Programme' and are subject to the current ongoing Balancing Capability Strategic Review.

2.8 190 Workforce and change management tools

Overview & Purpose

With the increased use of new technologies and more frequent updates to policies and standards, our current processes and tools will become inefficient and potentially introduce risks.

This investment will make learning and operational updates available on different platforms and adjusted to a user's profile, giving better training and operational decision-making. New tools will support shift, change, contract and document management, plus workforce planning.

The legacy tools used to manage change in the balancing mechanism system and shift management will require refresh or replacement during the BP2 period. This will give us the opportunity to automate our processes and ensure the right updates are given to our control centre users at the right time and in an appropriate format.

Our ambition for 2026 is to create a training repository system, which will allow training options to be drawn into personalised training plans in an automated fashion.

We will integrate these management tools with our IT investments 180 Enhanced balancing capability and 110 Network control tools to enable personalised updates. They will be linked to the rota and change management tools to allow for relevant updates to be given as required, for example, when a Control Centre user returns from a day off to perform a specific role. Automation of workforce related processes will allow for more flexible rota planning as well as ensuring all users have the most up to date information to do their job.

This investment enables sub- Activity A2.4 Workforce and Change Management tools

A summary of the ESO business areas that are supported by this investment and corresponding business activities below:

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A2.4 Workforce and Change management tools	• Integrated workforce and competency management system with data reporting capabilities • Digital workforce end user mobile app

Table 40 - Summary of business outcomes and corresponding sub-Activities

Current State

By March 23 we will have completed the rollout of central ota management system with end users accessing, reviewing and requesting shift changes through the mobile phone app. A single repository with advanced analytics capability will allow the workforce and change management team to develop better and more cohesive strategies based on working time and HR directives. We will also have completed the scoping and analysis stages of the next 2 phases which will include further automation of the rota systems and the document management improvements.

Roadmap

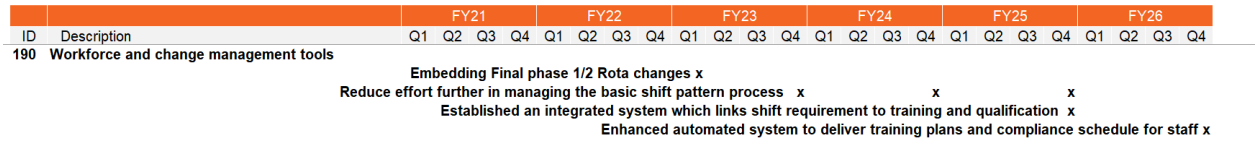

Figure 18 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Embedding Final phase 1 & 2 Rota changes	Business Units	Minor changes to support ongoing uptake and usage of the Rota System.

Reduce effort further in managing the basic shift pattern process	Business Units	Utilise lessons learned to optimise shift management process further through new reporting and small system changes.
Established an integrated system which links shift requirement to training and qualification	Business Units	Integrate training and qualification's tracking into shift management processes to further improve the rota management processes as well as establishing integration into other related systems such as HR and Payroll
Enhanced automated system to deliver training plans and compliance schedule for staff	Business Units	Deliver full compliance and automated training scheduling through a single tool, automated to such as degree that maintenance of data is located with the end user and minimal oversight is required by a central operations team

Table 41 - Outcome summary descriptions

Future State

We will integrate these management tools with our IT investments 180 Enhanced balancing capability and 110 Network control tools to enable personalised updates. They will be linked to the rota and change management tools to allow for relevant updates to be given as required, for example, when a control centre user returns from a day off to perform a specific role.

Subsystem Identifier	Target platform	Target Subsystem	Component	`Future State
NET-02	Network Operations & Control	Control Room Planning	Workforce Management	Enhanced and expanded core Salesforce SaaS system. Augmented with specialist SaaS or packages as needed.

Table 42 - Future state subsystem component summaries

Automation of workforce related processes will allow for more flexible rota planning, as well as ensuring all users have the most up-to-date information to do their job.

The aggregation of these changes will allow us to reduce the overall cost associated to the management of rota's and individual's training and authorisation processes.

Approach

We will extend and enhance the core Salesforce-based workforce management system. If appropriate we will continue to follow a best of breed approach based around the core, buying supporting tools and services to build a modern workforce management solution.

We will use the capabilities of the data and analytics platform to share data into the necessary directory, HR, and Enterprise Resource Planning (ERP) systems.

We will implement in the cloud where we can, building on the SaaS base offered by Salesforce.

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP2	0.0	0.2	0.0	0.0	0.0	0.2
	BP1	0.0	0.0	0.0	0.0	0.0	0.0
	Variance	**0.0**	**0.2**	**0.0**	**0.0**	**0.0**	**0.2**
Opex	BP2	0.0	0.0	0.8	1.2	1.6	3.6

	BP1	0.0	0.4	0.8	1.2	1.6	4.0
	Variance	**0.0**	**-0.4**	**0.0**	**0.0**	**0.0**	**-0.4**
Cumulative RtB increase	BP2	0.0	0.0	0.0	0.1	0.1	0.2
	BP1	0.0	0.0	0.0	0.1	0.1	0.2
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Table 43 - Investment cost summary

Further review of requirements has identified the need for customisation of the solution which has led to the minor CAPEX increase from BP1 forecasts. The cost forecast shows minor RtB increases since the original forecast. The RtB impacts have been aligned more closely to the expected increase in use of SAAS functionality and based on the assumption that we will continue to use of the already chosen SAAS solution and that the project will fund full uptake and normalization of usage and catch up on training / compliance to ensure the benefits are delivered.

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
Full confidence in the chosen Rota system has not been established due to supplier changes and circumstances out of NG control. If these uncertainties were to remain, there is a risk that an alternative solution may have to be sought.	Business Software	Reviews with the supplier are being undertaken on a regular basis	1	1
Future solution is envisaged to be on a single integrated platform, requirements have not been fully documented and matched and therefore a split of functionalities might occur leading to additional expense and time delays.	Program, Product & Project Management	• Close analysis of requirements and taking a cost vs value	1	1

Table 44 - Investment risk summary

Solution Options

The range of solution options from the original Business Plan, i.e. No Investment, Upgrade Existing, or Buy New, have resolved to one. ESO has chosen to implement the Rota system on Salesforce. Workforce Management is a core Salesforce module and the solution shares the benefits of our other investments in Salesforce.

The Rota system is a market leading and extensible SaaS system providing a low cost and low risk solution. It also aligns with our IT strategy for ERP systems and will, consequently, minimise our IT operations and support costs in the longer term.

2.9 200 Future training simulator and tools

Overview & Purpose

This investment covers the implementation of a control centre training simulator for both internal and external use, covering training for refresher and upskill sessions, special events, introduction of changes, feedback and authorisation exams.

Currently, training for Control Centre engineers is delivered on two disparate systems, our ambition is to link these systems together to deliver a true end-to-end training experience

This investment enables simulator and tools to accurately reflects the changing energy landscape allowing us to train Control Centre engineers on a range of past and future scenarios, including real-time data.

In our first business plan we committed to make upgrades to our current simulators to ensure they remain fit for purpose, including annual scenario snapshot refreshes, ahead of developing new simulation capability.

The new simulation capability could be facilitated by digital twin technology that includes end-to-end bespoke training scenarios and simulated operational systems using live data.

Further information on the current state can be found in the Role 1 narrative for sub-activity **A2.3 Training Simulation and Technology**.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A2.3 Training Simulation and Technology	• Online and e-learning training modules • New training simulator • Interface between balancing and network control simulation • Joint training and simulation sessions with DNOs

Table 45– Summary of business outcomes and corresponding sub-Activities

Current State

Upgrades to the current simulators will continue to be minor and only made, if necessary, to extend their life until the new simulation capabilities are ready.

By the end of the BP1 period the Network Control Management System (NCMS) Training Simulator requirements capture will be complete, enabled under sub- activity **A1.3 Transform Network Control**.

By the end of the BP1 period we would have also completed scoping of requirements for the Enhanced Balancing Training Simulator under **A1.2 Enhanced Balancing Capability** and scoping of requirements for an Integrated Network Control Simulator.

Roadmap

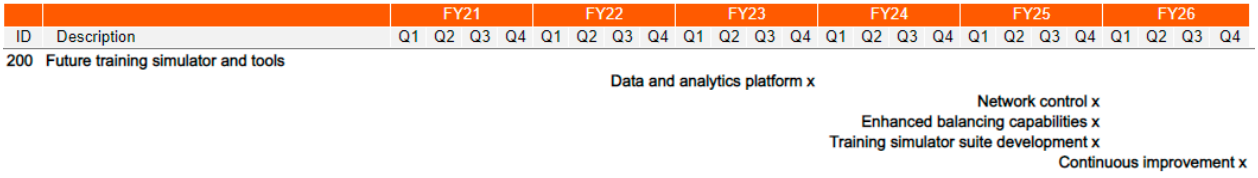

Figure 19 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Data and analytics platform integration	Business Units Customers & Partners	This will provide a platform to send NCMS outputs / receive data into the NCMS (e.g. CIM network files, network outage information etc.)
Network control future training simulator	Business Units Customers & Partners	Allows control engineers to run end to end training scenarios to mimic real system events
Enhanced balancing capabilities	Business Units Customers & Partners	Provide access to an accurate representation of future scenarios (i.e. Generation and Demand predictions) Allows to integrate the NCMS training simulator with Enhanced Balancing Simulator for an engineers to run end to end training scenarios to mimic real system events
Training simulator suite development	Business Units Customers & Partners	Link disparate training simulators to enable a true end to end training experience for control engineers
Continuous improvements	Business Units Customers & Partners	Future training simulator should be capable of incorporating new network and market technologies/products

Table 46 – Outcome summary descriptions

Future State

An Integrated Network Control Simulator built on the simulation and training component procured with NCMS and extended to cover Balancing, customisation of NCMS, and other integrated control systems. This will provide an end to end simulation and training capability that is representative of our live operational systems.

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State
DAT-04	Data & Analytics	Digital Twin	Training Simulator	Integrated Network Control Simulator built on the simulation and training component procured with NCMS.

Table 47 – Future state subsystem component summaries

Development of the new simulator has a key dependency on delivery of the transformational Network Control and Balancing systems. Due to the ongoing Balancing Capability Strategic Review the costs, milestones, and scope of this deliverable may be different in our final business plan due to the uncertainty around the impacts of the review on the required interface between Network Control & Balancing Simulator Tools.

Overall, by the end of the BP2 period our expectation is that the new integrated training simulation capability, developed by bringing together new Network Control and Balancing simulator tools would be available for use both internally and externally, ensuring they interface seamlessly, as they would in real-time operation.

Approach

We will configure and extend the simulation and training component of NCMS. This component will provide the command and control and new or customised components will be amended to process simulation commands from the central component.

Automated simulation tools to allow trainers to control the scenario presented to trainees and to measure their performance.

We will use cloud technology to provide the capacity to deploy multiple separate instances and datasets simultaneously on demand. New operational systems will be cloud native (e.g. the new optimisers) to simplify and lower their cost. Where applicable, we will leverage the Kubernetes capabilities deployed by the Open Balancing Platform to spin-up training environments on an as-needs basis, thereby reducing the capex spend on hardware and maximising the use of the existing physical platforms. We will also leverage the new integration platform (deployed on the Red Hat Integration platform) to enable connectivity between balancing and NCMS training and simulation platforms.

Security policies will be defined in line with NIS-D and ESO information security requirements to ensure appropriate levels of protection as data is curated throughout the ESO business process. These policies will apply equally across CNI and Cloud data centre operating environments and will ensure data sets are correctly protected as they move through the data lifecycle, with the focus on promoting Presumed Open Data as early in the lifecycle as possible.

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP2	0.0	0.0	1.2	2.3	2.3	5.8
	BP1	0.0	0.0	1.2	2.3	2.3	5.8
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Opex	BP2	0.0	0.0	0.3	0.6	0.6	1.5
	BP1	0.0	0.0	0.3	0.6	0.6	1.5
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Cumulative increase RtB	BP2	0.0	0.0	0.0	0.1	0.2	0.3
	BP1	0.0	0.0	0.0	0.1	0.2	0.3
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Table 48 – Investment cost summary

BP2 forecast remains the same as originally forecast and this is based on identified high level requirements. Assumptions and requirements will be defined in a workshop early in FY23 to explore milestones, deliverables and forecast and are therefore not yet included in the costs for this investment. We will provide an update in our August submission.

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
We develop short-lived tools due to difficulty in predicting how modelling tools will need to evolve by the end of RIIO-2 given the pace of changing market needs and/or implications from Future System operator direction	IT Management & Strategic Planning	• Ensure continued review of requirements throughout remaining RIIO-2 period. • Deploy proof of concept tools where possible to gain understanding of requirements • Continue to use the product delivery principles and flexible, modular applications.	3	1
Delivery plans for the corresponding balancing &	Application Development	• Maintain Engagement with internal ESO product delivery teams	2	1

network control systems may impact the integration of the new training simulator		• Periodic review of dependencies & programme interlocks • Review, impact assess and maintain fallback options		
Key internal SME/system user resource availability may impact the testing & implementation phases of the new system & toolset	Program, Product & Project Management	• Ensure early forecasting of resource requirements to business units • Timely recruitment for appropriately skilled resources where not already available	3	1

Table 49 – Investment risk summary

Solution Options

Notwithstanding the risks above, the macro-scale solution options considered at the outset and detailed in our original BP1 submission (i.e. No Investment, Upgrade Existing, or Buy New) have narrowed to the approach detailed above.

The preferred and working solution option is to buy the core training and simulation capability as part of NCMS and then extend it to future balancing and other operator systems. This option will be the lowest cost, lowest risk and fastest to market because it will be integrated into NCMS by design.

Initial analysis during the NCMS selection process shows that the training and simulation capabilities of the remaining NCMS candidates are good bases to use. More detailed functional and feasibility analysis work will be carried out on the winning NCMS, post selection. If the costs of extending the native training and simulation system are higher than expected, we will consider our options.

The other major component of the overall operator experience is the Open Balancing Platform. It is a bespoke solution and extending the NCMS training and simulation system to cover it will give a unified training and simulation solution and avoid the cost of developing the required generic training and simulation control and dataset management capabilities.

There will be low level optionality in the coverage of the simulator. Amending systems fully to operate in a simulation is non-trivial and trade-offs may have to be made e.g. manual work arounds. These will clarify as the systems are planned, built and rolled out.

For data management, data sharing, and data analytics use cases the full solution will use the capabilities of the DAP.

2.10 210 Balancing asset health

Plans for this IT investment are not presented due to the ongoing Balancing Capability Strategic Review. Please see sub-activity A1.2 of the main business plan document for more information. The cost information provided in the table below is in line with the TBM data model submitted alongside this document .

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP1	8.1	10.1	12.2	6.1	4.1	40.5
Opex	BP1	0.9	1.1	1.4	0.7	0.5	4.5
Cumulative RtB increase	BP1	0.2	0.2	0.3	0.4	0.4	1.5

Table 50 – Investment cost summary

As noted in the introduction to Part 2 – Technology Investments, this item is signalled as having higher uncertainty, and we are therefore providing a cost range. Make up of the cost range is detailed below, this investment will go through additional external assurance between April and August to help give confidence on the final cost submissions.

Investment	Whole RIIO2 FD	Whole RIIO2 BP2 data tables/TBM submission	Variance	Whole RIIO2 proposed range
Balancing Programme	**58**	**142**	**(85)**	**83-142**

Table 51 - Investment cost range summary

As stated in A1.2 of our overall Business Plan submission, investments 180 Enhanced balancing capability, 210 Balancing asset health, 260 Forecasting enhancements and 480 Ancillary services dispatch fall under the remit of the overall ‘Balancing Programme’ and are subject to the current ongoing Balancing Capability Strategic Review.

2.11 220 Data and analytics platform

Overview & Purpose

The Data and Analytics Platform (DAP) will

- create a new architecture that allows new systems to be integrated seamlessly in a ‘plug-and-play’ or ‘app-like’ way. This allows our plan, and future system upgrades, to flex as needed to meet the challenges of facilitating the transition to net zero. The platform will provide a primary source of data for analysis and publication, providing accessibility and transparency for stakeholders.
- provide the technology underpinning the management of all of our data, making it discoverable and accessible to internal and external stakeholders. Cloud-based data management and analytics are now universal and essential for modern data analysis approaches and even more so for artificial intelligence implementations. This investment will evolve ESO’s traditional data management and analytics to the cloud. It is indispensable for much of the RIIO-2 change programme.
- retire many of our data legacy systems. It will include an analytical capability, so we can access, share and shape any type of data we store. This is critical to allow quicker, accurate operational decisions and give our customers value added information.
- act as a foundational component for our new Control Centre architecture. It will provide a common platform for internal systems and provide a single access for data searching, analysis and publication. Our ambitions, strategy and capability plan for data and analytics are described in A19 Data and Analytics Operating Model to provide the capability for efficient and effective development, operation, and governance of the data products necessary to fulfil our mission. This model has a key dependency on the Data and Analytics Platform implementation.

A summary of the ESO business areas that will be improved as a result of this investment, as well as some corresponding activities is included in the table below. Note that although DAP sits within role 1, the platform supports investments across all roles and activities. For the purposes of the submission, it is assumed A1.4 Control Centre Architecture delivers the considerable proportion of business outcomes for National Control, and A5.3 and A11.1 deliver a considerable proportion of business outcomes for Networks and Strategy and Regulation.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A1.4 Control Centre Architecture • A5.3 Improve our security of supply modelling capability • A11.1 Refresh and integrate economic assessment tools to support future network modelling needs	• Data consolidation and integration from internal and external sources • Data processing and productionisation of advanced analytics • Open data catalogue • Integration with data sharing portal (Digital Engagement Platform) • Data security and compliance standards

Table 52 – Summary of business outcomes and corresponding sub-Activities

The Data and Analytics platform touches on a significant number of activities beyond the five items shown in the above table. These include some of the user stories shown below where DAP will provide the platform for individual investments to build capability to support the user stories under a self-serve delivery model:

- A11.2 Implement probabilistic modelling
- A11.4 Build stability assessment techniques into an optimisation tool
- A13.1 Carry out analysis and scenario modelling on future energy demand & supply
- A13.5 FES: Integrating with other networks and supporting DNOs to develop their own DFES processes
- A16.3 Work more closely with DNOs and DER to facilitate network access

This investment will lower costs to consumers through more efficient receipt and management of data, enhanced data quality and system consolidation, without increasing system security risks. The Data and

Analytics platform will provide greater transparency of ESO data & data lineage, enhanced data quality and analytics capability.

Current State

As planned, we have completed several steps in the design and Implementation of the Data and Analytics Platform:

a) Implementation of Microsoft Power BI Service as the strategic reporting and BI platform for ESO
b) Appointed a core Data and Analytics implementation partner
c) Created and implemented design patterns on Azure and used for proof of concept demonstrated to users.
d) The Conceptual Solution Architecture has been defined, providing the starting point for the physical implementation
e) Re-usable design patterns for the ingest of data from various sources delivered
f) POCs executed to prove out data ingest and BI/reporting capabilities (NED, Data Historian and Inertia Monitoring)
g) A Compilation of comprehensive backlog of user stories, spanning strategic programmes, other RIIO2 deliverables.

By March 2023 we will have completed the following.

a) Implementation of an ESO Data Catalogue
b) Implementation of Consistent Data Services for CNI workloads via RedHat Integration.
c) Finalisation of the DAP solution model for ESO Meter Data and Time Series
d) Expanded the range of ESO data sets available on DAP
e) Implementation of a TechOps model for data products
f) Containerised standalone (Python and R) analytics processes as per PEF (Platform for Energy Forecasting) requirements.
g) MVP will be implemented within an ESO controlled subscription in the National Grid tenancy on the Azure public cloud. Note that appropriate DAP services and solutions, designed and operated by DAP, may need to be deployed within the CNI landscape, the design of which will be dependent upon use case definitions, and a detailed architecture and strategy review

The TechOps model for data products will continue to evolve over the BP2 period in line with more applications utilising the Data and Analytics platform. This will include the application of TechOps for Data Products to enable extremely high-quality data pipelines and very low error rates, delivering timely, trusted, analytics ready data to the point of use (“DataOps”), It will also unify and automate the release cycle for Machine Learning (ML)/analytics data products (“MLOps”). In conjunction with the platform, the Data TechOps capability will enable efficient, robust and repeatable productionisation of ML/analytics applications, freeing data science resources to focus on innovation and continuous improvement of models. We will also initiate a programme of upskilling of our teams to adopt the new technologies deployed through the platform.

Further information on the current state can be found in the Role 1 narrative for sub- activity A1.4 and the narrative for sub - activity A19.1

Roadmap

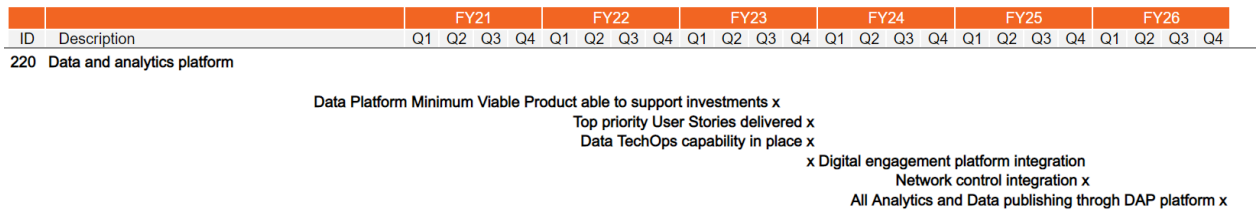

Figure 20 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Data platform minimum viable product able to support investments	Business Units / Customers & Partners	Foundational architecture deployed aligned to conceptual solution architecture and initial user stories (requirements)
Top priority user stories delivered	Business Units Customers & Partners	1st tranche of priority user stories delivered and operational on the DAP platform. These user stories will be suitably prioritised within the broader DAP backlog.
Data tech ops capability in place	Business Units Customers & Partners	Full DAP capability operational with CI/CD pipelines in place.
Digital Engagement Platform Integration	Business Units Customers & Partners	Integration with Digital Engagement platform complete which provides front end access to data held with the Data and Analytics Platform.
Network Control Integration	Business Units Customers & Partners	Integration with the operational Network Control Management System (replacement IEMS)
All analytics and data publishing through DAP platform	Business Units Customers & Partners	All targeted analytics and data publishing functions across ESO have been onboarded to the DAP platform

Table 53 – Outcome summary descriptions

Future State

DAP will provide a capability to capture, curate and consume our data to drive insight and value creation. The key capabilities that the platform will deliver are:

- The Data Supply Chain – to ingest data from various sources and deliver trusted analytics through a choice of access channels
- Data Governance and Management – to manage access, ensure compliance with standards and regulations, track lineage, implement automated data quality checks, classify data and automate governance workflows
- Self-Service –a Data Catalogue will enable users to discover and access data, and a sandbox environment will offer access to data and tools and allow users to ingest, manipulate, visualise and analyse data sources without requiring IT support
- Machine Learning & Advanced Analytics – to productionise advanced analytics and machine learning data products, such as those used to support the Future Energy Scenarios (FES) and Network Options Assessment (NOA).

Internally, this investment line will move the large mass of ESO data to a single platform and allow downstream users to access it in the timescales they need.

We will have an MVP stood up by end of 2022, delivering foundational architecture and the priority business requirements.

Future phases of the DAP programme will deliver incremental build out of the physical platform via a use-case led approach. In this way, the deployment of new capabilities is always aligned with business priorities and value creation.

The data and analytics platform will utilise the ESO API Architecture to standardise and automate access for the RIIO-2 business service. We will extend the ESO API Architecture to participants as managed APIs

permitting access to ESO (tightly controlled) data and analytics services in the most cost-efficient way that meets industry standards.

DAP will provide the means to deliver on our regulatory reporting requirements, both to the GB and European markets. We need to maintain the appropriate systems and expand them to accommodate the increased number of participants. Accurate and timely information is vital to the market for customers to manage their positions and DAP will be at the heart of regulatory reporting.

The following table maps the Data and Analytics Platform's delivery to ESO's overall Target Platform Architecture. The principal subsystems and components to be delivered by this investment are listed along with a specification of the expected target state for each by the end of BP2 delivery period.

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State
DAT-01	Data & Analytics	Knowledge Management	Records Management	DAP will be the default data store for ESO data. DAP will make these records accessible to the rest of the sector.
DAT-02	Data & Analytics	Analytics and Insight	Data Lake	DAP will provide several data lakes for its own usage and for analytics teams. DAP will provide external access to its internal data lake to fulfil the ESO open data requirement.
DAT-02	Data & Analytics	Analytics and Insight	Internal Reporting	DAP will implement Microsoft Power BI service as the strategic reporting service for internal and external consumers. Human readable and API data services will be available.
DAT-02	Data & Analytics	Analytics and Insight	Time-Series Insights	DAP will implement cloud analytics frameworks for the manipulation and analysis of time series data (primarily meter data) for consumption by ESO and external processes.
DAT-02	Data & Analytics	Analytics and Insight	Predictive Analysis	DAP will provide analytics services for use in Predictive Analysis and forecasting.
DAT-03	Data & Analytics	Consistent Data Services	Unified Data Exchange	DAP will implement data services for the provision of data to ESO and external processes and consumers. The services will cover API and bulk data access. The services will include data catalogue and metadata services to enable real world usage.
DAT-03	Data & Analytics	Consistent Data Services	Integration non-CNI	DAP and services primarily live outside CNI but they will extend to CNI-sourced data, either by providing API access or in publishing replica CNI data. Significant ESO data originates in CNI.
DAT-03	Data & Analytics	Consistent Data Services	Interpolate-Extrapolate	DAP will implement cloud analytics frameworks offering common data operations adjacent to the raw data and hiding unnecessary implementation detail from consumers, ESO and external.
DAT-03	Data & Analytics	Consistent Data Services	Workflow Automation	DAP will automate the data analytics life cycle to bring Data TechOps practices to data consumers.
DAT-07	Data & Analytics	Regulatory Reporting	External Reporting	See Internal Reporting above. Reporting services will apply to external parties too, in multiple forms.
DAT-07	Data & Analytics	Regulatory Reporting	Information Provision	DAP will provide a range of data services to internal Regulatory Reporting processes and to regulators directly.

Table 54 – Future state subsystem component summaries

Approach

To accelerate delivery of our target state, we will implement a "Minimum Viable Product" (MVP) of the DAP platform, providing the foundations of the capabilities set out above, centred around delivery a concrete user-story of relevance to the business. Future phases of the DAP programme will deliver incremental build out of the physical platform via a use-case led approach. In this way, the deployment of new capabilities is always aligned with business priorities and value creation.

We will leverage established design patterns for big data/big compute via an experienced implementation partner to adapt and implement their proven architecture for cloud data and analytics in ESO.

The platform will be primarily cloud-based with deployment to CNI-compliant hybrid cloud elements as well as public cloud for less critical workloads. Public cloud opens further options for participants to ESO datasets.

Major component technologies will be subject to detailed selection processes to ensure that all requirements are met reliably i.e. we will buy where we can. Careful selection will avoid unnecessary re-invention or duplication of capabilities and reduce build and run cost. We will go cloud-native in the first instance, and review technology choices as and when required, subject to use-case requirements.

Costs

Investment (£m)		**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**Total**
Capex	BP2	4.2	8.6	10.0	6.6	3.8	33.2
	BP1	3.1	5.8	5.8	3.1	2.2	20.0
	Variance	**1.1**	**2.7**	**4.2**	**3.5**	**1.7**	**13.2**
Opex	BP2	0.3	1.9	1.3	0.7	0.5	4.7
	BP1	0.8	1.5	1.5	0.8	0.5	5.0
	Variance	**-0.5**	**0.5**	**-0.1**	**-0.1**	**0.0**	**-0.2**
Cumulative RtB increase	BP2	0.0	0.1	0.5	0.5	0.5	1.7
	BP1	0.0	0.1	0.3	0.5	0.6	1.4
	Variance	**0.0**	**0.0**	**0.2**	**0.1**	**0.0**	**0.3**

Table 55 – Investment cost summary

The cost forecast since the original submission has increased. £13.2M has been included within BP2 caters for:

- Data Centre and Networking uplifts - The current forecasts accounts for some form of network capacity uplift that will be required during BP2 period, especially if no CNI DC presence is deployed - we are analysing the requirements to determine a solution including what size CNI DC environment it will require and when this will be delivered.
- any capability that might be required in case of a network breach by DAP, given the potential data volumes we would be transiting across the network.
- Grey IT Remediation cost - In BP1, as part of transformational investments, we have assessed the ESO Grey IT estate and have identified several tools which will need to be productionised. These could end up as projects or options within several different solutions including:
    - Data and Analytics Platform
    - Other transformation investments (such as Network Control or Balancing)
    - A proposed new investment: Grey IT Remediation
    - Sunset the existing tool or choose not to productionise if it would add no value to customers

All option analysis will need to go through a formal tactical or strategical decision-making process. Until full analysis of the options is carried out, anticipated costs for Grey IT Remediation have been added to the DAP forecast but this forecast will be broken out into the correct areas for the August submission of the BP2 IT investment report.

It is conceivable that we may need to revisit the forecasts around the above between April and August following the onboarding of a design partner (3rd party) who are due to join the team in April.

As noted in the introduction to Part 3 – Technology Investments, this item is signalled as having higher uncertainty, and we are therefore providing a cost range. Make up of the cost range is detailed below, this investment will go through additional external assurance between April and August to help give confidence on the final cost submissions.

Investment	Whole RIIO2 FD	Whole RIIO2 BP2 data tables/TBM submission	Variance	Whole RIIO2 proposed range
Data and Analytics	25	38	(13)	29-38

Table 56 – Investment cost range summary

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
There is a risk that data storage remains highly fragmented leading to much effort expended on sourcing rather than analysing data.	Program, Product & Project Management	• On-board key ESO data repositories onto DAP guided by data roadmap.	3	1
There is a risk that lack of transparency of our data assets leads to confusion and inefficiency in data processing by our external and internal stakeholders.	Application Support & Operations	• Publish and maintain API and Data catalogues.	3	2
Incomplete, late, inaccurate, and inconsistent data impacts the quality of analysis and business information.	Business Software	• Review legacy data systems before onboarding as data products onto DAP	3	2
There is a risk that obsolete, fragmented, and islanded data repositories cannot be scaled leading to inability in meeting the challenges of ever-growing datasets and demands for advanced analytics.	Application Support & Operations	• Implement DAP platform in the cloud using horizontally and vertically scalable PaaS services.	3	2

Table 57 – Investment risk summary

Solution Options

We have implemented DAP on Microsoft Azure (generally using native Azure services) and will continue to expand DAP to service our business strategy. This includes the necessary operating model changes to embed DAP in our IT and business processes.

The choice of Azure was the subject of a National Grid selection process. In terms of general cloud platforms there is an emerging duopoly of Azure and Amazon Web Services, ESO has no plans to revisit this decision. Azure is future proofed by being part of this duopoly, with investment, innovation, and available skill base gravitating to these two, and Azure has established a dominant position in the UK energy sector.

At a lower level, there are still solution options to be considered as the RIIO-2 programme unfolds. There we will follow our usual Enterprise Architecture and project processes to re-use, buy, or build the correct solution, while being guided by our overall IT Strategy. For example, we are currently running a selection process for a data catalogue tool. Data Catalogues are an established software category and buying rather than building one is the obvious option. Elsewhere, we have selected and implemented a range of Azure native tools for different roles on DAP, e.g. Azure Data Factory, Azure Data Lake, and Azure SQL Server. To date, we have used these to implement an expanding set of DAP services.

2.12 240 ENCC asset health

Overview & Purpose

To operate the grid system, to handle unforeseen events and to ensure we can continue to operate the system safely, economically, and efficiently, we need to invest in maintaining our stand-alone specific tools and resilient bespoke communication links. It is necessary to periodically invest in these tools to maintain their reliability and usability, and to keep them up to date to minimise cyber security risks. We must maintain the health of our control room IT systems. As the market continues to evolve, we need to be able to respond to this quickly, without waiting for our new capabilities to arrive.

Failure to undertake these types of investment would put our capability to maintain grid system security at risk, put our ability to exchange real time data with other parties at risk, increase cyber security risk and would leave operational critical tools un-supported.

This investment enables sub - activity A1.1 Control Centre Architecture and Systems – Ongoing Activities

ENCC Asset Health is a role 1 aligned investment although there is some focus on Markets which relate to market participants and the onboarding team.

A summary of the ESO business areas that are supported by this investment and corresponding business activities below:

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A1.1 Ongoing Activities	• Maintenance and end of life services for non-investment defined control room systems • Onboarding and data integration of new balancing service suppliers • Security resilience for non-investment defined control room systems • Small change support and maintenance enhancements to non-investment defined control room systems

Table 58 - Summary of business outcomes and corresponding sub-Activities

Current State

The ENCC utilises several specialised tools and resilient communication links to operate the grid system. By March 2023 we will have completed 20+ projects under the ENCC Asset health investment line. These projects delivered the following:

- 18 cases of removing grey IT and bespoke systems from our environment
- Replacing / upgrading 10 applications with upgraded and supported applications
- Re-platforming 4 hardware platforms to address software/ hardware constraints

We are continuing to develop, evolve and prioritise a list of asset health priorities which we will continue to mobilise on a quarterly basis. We will also be replacing, upgrading, or taking maintenance actions for systems as required.

We will be mobilising to meet requirements for updates to meet external demands, such as increased numbers of market participants or new performance reporting requirements, or general software and hardware patching maintenance while reducing security and technical debt risk where applicable.

BP1 has proved that flexibility in delivery is important to maintaining and upgrading our ENCC systems. Though we have a strong understanding of our application landscape it is impossible to predict precisely which requirements will arise over the BP2 period.

Further information on the current state can be found in the Role 1 narrative for sub - Activity A1.1.

Roadmap

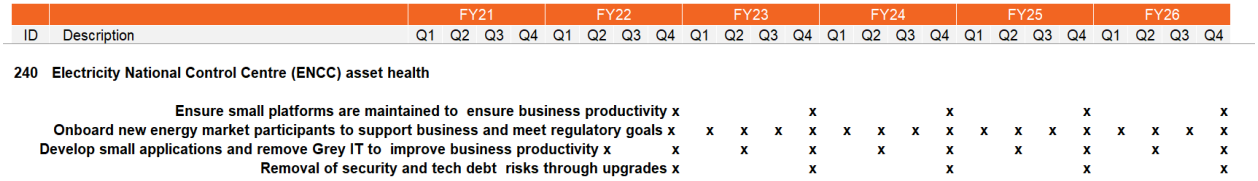

Figure 21 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Ensure small platforms are maintained to ensure business productivity	Business Units	Operational impacts from maintenance or end of life are reduced to zero for systems outside of mainline investments
Onboard new energy market participants to support business and meet regulatory goals	Business Units Customers & Partners	New participants receive the correct levels of support and can connect technical to participate in the market
Develop small applications and remove Grey IT to improve business productivity	Business Units	Small business-built tools and information management sources can be brought into full support once they have developed to a sufficient degree of maturity and importance
Removal of security and tech debt risks through upgrades	Business Units.	Patches and updates are applied to ensure continued security standards and application currency

Table 59 - Outcome summary descriptions

Future State

This investment industrialises a set of additional network control tools fit for the future. These changes will make full use of the target platform architecture benefitting from cross-cutting platforms like DAP and DEP. This investment will ensure the ongoing reliability, usability, and cyber security of these tools.

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State
NET-01	Network Operations & Control	Control Communication	Data Exchange	NCMS and DAP operational. Data exchange implemented and managed by DAP or services provided by DAP,
NET-01	Network Operations & Control	Control Communication	Control Data Link	NCMS and DAP operational. Additional network control tools will use data and data services provided by NCMS and DAP.
NET-02	Network Operations & Control	Control Room Planning	Workforce Management	Additional network control tools consolidated into seamless reliable IT managed system.
NET-03	Network Operations & Control	Control Support	ENCC Operator Suite	As above. Additional network control tools will be industrialised, integrated with, and use data and data services from, NCMS and DAP.
NET-04	Network Operations & Control	Situational Awareness	Power System Simulation	System simulation capabilities extended to additional network control tools.

NET-04	Network Operations & Control	Situational Awareness	Time Series Visualisation	As above. Additional network control tools will be integrated with, and use data visualisation services from, NCMS and DAP.
DIG-01	Digital Engagement	Digital Services	Digital Application Suite	Automation of network changes will use DEP features to extend automated handling of network and CIM changes to partners and customers.
DAT-02	Data & Analytics	Modelling	Power Systems Modelling	As above. Additional network control tools will use data and data services provided by DAP.

Table 60 - Future state subsystem component summaries

Our focus through BP2 will continue to:

- Maintain and/or decommission specific tools that support ENCC activities
- Ensure system solutions maintain resilience in our business processes.
- Implement solutions to mitigate risks associated with legacy and new unsupported user written tools.
- Create smaller solutions and address minor enhancements via Rapid Development Team.

Approach

The overall approach is to run a delivery programme to address a backlog of known improvements. Entry onto the backlog will follow standard processes of business consultant engagement, mandate creation and sign off approval through QRF processes.

Where possible, we will look to modernise and simplify the tools, using a platform-based approach, rather than making like for like refreshes. Architectural oversight will ensure that the improvement of each tool will be considered against the wider Business and IT strategies, this will identify any synergies that can be exploited to give a better solution.

Costs

Investment (£m)		**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**Total**
Capex	BP2	1.9	2.1	2.0	2.0	2.0	10.2
	BP1	2.0	2.0	2.0	2.0	2.0	10.2
	Variance	**-0.1**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**
Opex	BP2	0.7	0.9	0.9	0.9	0.9	4.2
	BP1	0.9	0.9	0.9	0.9	0.9	4.4
	Variance	**-0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**-0.1**
Cumulative RtB increase	BP2	0.1	0.6	0.6	0.6	0.6	2.5
	BP1	0.0	0.0	0.0	0.1	0.1	0.2
	Variance	**0.1**	**0.5**	**0.5**	**0.5**	**0.5**	**2.2**

Table 61 – Investment cost summary

Minor RtB increases have been included in the forecast for BP2. Initial forecasts failed to consider small cost increases associated with refreshing software/hardware contracts and technology platforms as well as bringing grey IT into support leading to RtB increase in FY22-23. These RtB increases are to consider increased volumes of MS Access databases and MS Excel spreadsheets being productionised

Capex/Opex underspend due to delays of work into FY23.

The forecast assumes demand for ENCC Asset Health remains broadly the same as the last couple of years and that the pipeline of work is consistent in terms of size and complexity.

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
Investment may commence on work which is inaccurately scoped which may lead to non-maintenance or over/under spend	Program, Product & Project Management	Close analysis of requirements Maintenance updates to systems being replaced will be closely monitored to avoid regret spend.	1	1

Table 62 – Investment risk summary

Solution Options

This investment industrialises a set of additional network control tools.

Feasibility analysis, including third party software market analysis, during the BP1 period determined that developing bespoke tools and consolidating the bespoke tools currently in use offered the best fit to our strategic requirements for RIIO-2.

This pragmatic solution will exploit the target platform architecture, benefitting from cross-cutting platforms like DAP and DEP, to achieve this.

Building our own models means that we retain the intellectual property in house and maximise our flexibility to adapt to GB specific conditions.

2.13 250 Digital engagement platform

Overview & Purpose

This investment is key to enabling greater participation in energy markets for an increasingly diverse marketplace as well as facilitating solutions to energy challenges. Enhanced digital engagement capabilities are an essential element in the ESO's toolkit for becoming the System Operator of the future leading the transition to net zero.

We will deliver the digital engagement platform (DEP) which will replace the current nationalgrideso.com website and create a single point of access into the ESO systems and external facing processes, providing secure, open access to data, compliant with data classification policies and standards.

DEP will enable external customers and stakeholders to access ESO data and services in a simple, intuitive, predictable, personalised, and seamless manner, making it easier to do business with the ESO. It will serve as a "digital concierge" providing accessibility to our markets, data and new insights as well as enabling more engaging ways to collaborate and participate in our journey to net zero.

It sits at the heart of our vision for digital capability, and despite sitting within role 1, and primarily enabling activity **A17 Open data and transparency**, the platform supports investments across all roles, providing a common engagement experience for all stakeholders.

A summary of the key outcomes that will be delivered by this investment as well of the corresponding RIIO-2 sub-activities is included below.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A17 Open data and transparency	• Singular data, insights and engagement portal for all customers and stakeholders

Table 63 – Summary of business outcomes and corresponding sub-Activities

Current State

In BP1, we conducted user research to set the initial vision and scope for the future platform, before running a procurement activity to select a vendor which could deliver our digital platform and its core capabilities required by our users and stakeholders.

By the end of BP1, we will have selected vendors and commenced the delivery of the Digital engagement platform and its core components.

One of the components delivered as part of DEP will be a common Design System to enable a consistent user experience across our customer facing portals and websites, aligned to the NGESO brand and style guidelines. The new DEP Design System will also be used to ensure consistent development of user interfaces across all customer-facing applications. This will require new ways of working to be embedded in our design and development teams, which we anticipate will start to come into place by the end of BP1.

The main component of DEP to be delivered by the end of BP1 will be the Digital Experience Platform (DXP) that will provide content management, advanced search, personalisation, digital integration and other customer enhancements. We will have delivered a Minimum Viable Product (MVP) release of the new nationalgrideso.com website, which will include the core elements of the content management suite.

DXP will be delivered along with foundational capabilities for customer identity management. This customer identity and access management (CIAM) solution will manage customer identities in a consistent and secure way, and will ultimately provide a single sign-on experience across all constituent platforms and services accessed via DEP.

We will also have initiated the integration of DEP with the new Data & Analytics Platform (DAP) to enhance the provision of open data with a structured approach to publishing new data sets.

Roadmap

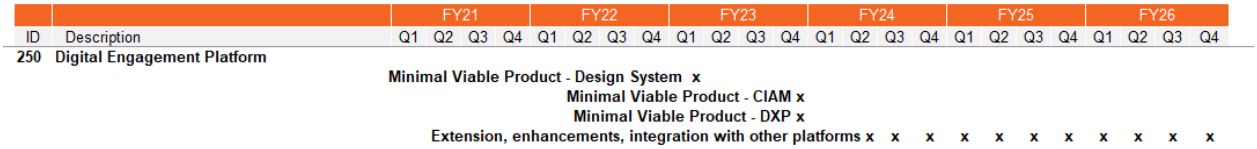

Figure 22 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Digital Engagement Platform MVP implemented • Design System • CIAM • DXP	Customers & Partners Business units	ESO customers and stakeholders will find it much easier to locate and access relevant insight, data and support to enable them to achieve desired outcomes with ESO. DEP will make the experience of engaging with the ESO more intuitive and user friendly through providing a consistent and personalised user experience including access to data and information, codes, connections, and market participation. The MVP will provide the foundations for this transformation including provision of personalised content as well functionality that enables users to manage their digital interactions with ESO from one account space and stay up to date with the latest ESO publications and events.
Extensions, enhancements, integration with other platforms*	Customers & Partners Business units	Customers and stakeholders will be able to engage with the ESO and access open data through one account and user interface as part of a holistic digital experience, making it easier to do business with the ESO. DEP will seamlessly join up insight, data, and operational processes to facilitate greater market engagement, participation, and decarbonisation. Further enhancement of the DEP will provide users with integrated search and query management capability across the whole ESO digital estate; personalised account dashboards that are fully integrated with other ESO systems such as Single Markets Platform and Connections Portal; personalised notifications and recommendations for content; contextual guidance and next best action through ESO business processes.

Table 64 – Outcome summary descriptions

**Timelines for integration with downstream systems such as DAP and SMP are dependent on progress of those programmes*

Future State

The Digital Engagement Platform will replace the current NGESO website with a digital platform which will provide a secure, single place for the hosting and visualisation of open and subscribed content and data, and will provide a consistent and frictionless user experience by integrating with NGESO customer-facing subsystems and portals including:

- 220 Data and analytics platform
- 320 EMR and CfD Improvements
- 330 Digitalised code management
- 350 Planning and outage data exchange
- 400 Single markets platform
- 420 Auction capability
- 380 Connections platform

Having implemented the MVP release on our selected digital engagement platform in BP1, we will further develop the platform and introduce functionalities to enrich the end-user experience with more personalised access to data and insights. This will include greater integration of platforms and services into our CIAM service for centralised customer identity and personalisation.

Further work will include enhancements and extensions to our digital codes service and integration with our new balancing services as they start to get rolled out in BP2.

We also foresee much greater provision of open data, harvested from multiple subsystems, and hosted in the Data and Analytics Platform, via the DXP data portal This will provide improved visualisation of our data sets in charting and graphical forms.

The following table maps DEP's delivery to ESO's overall Target Platform Architecture. The principal subsystems and components to be delivered by this investment are listed along with a specification of the expected target state for each by the end of BP2 delivery period.

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State
DIG-01	Digital Engagement	Digital Services	Innovation	AI enabled search, guided navigation
DIG-01	Digital Engagement	Digital Services	Digital Applications Suite	Content, Document, Visualisation and API capabilities
DIG-02	Digital Engagement	Customer	Customer Engagement	Integration with our customer engagement channels
DIG-03	Digital Engagement	Market Facilitation	Communication	Access and integration into our communications channels
DAT-02	Data & Analytics	Analytics and Insight	Predictive Analytics	Publishing of analytical reports for various use cases
DAT-03	Data & Analytics	Consistent Data Services	Integration Non-CNI	Integration with 3rd party data sources, if required
DAT-07	Data & Analytics	Regulatory Reporting	External Reporting	Publishing of external reporting provisioned via DAP
DAT-07	Data & Analytics	Regulatory Reporting	Information Provision	Publishing of open data provisioned via DAP, replacing the current data portal

Table 65 – Future state subsystem component summaries

Approach

Once the foundation platform is in place, our overall approach in BP2 is to further extend and enrich the functionalities and integration of the platform:

- Guided by user research, we will continually enhance the user experience of DEP by including capabilities such as advanced search, guided navigation, visualisation and single sign-on, offering greater levels of personalisation across platforms,

- We will enable deeper integration with subsystems and platforms such as the markets platform, DAP and other communication channels to provide seamless navigation across systems.

The chosen vendors will work with the project team over BP2 to deliver the platform and its capabilities, whilst the team transitions from project to product:

- As we anticipate a regular pipeline of enhancements to the platform to enhance end-user experience, facilitate access to data and insight and meet the strategic directions of the future ESO, an enduring 'product core team' will be set-up from the end of BP1 to manage the backlog of requirements and oversee the developments and enhancements to the platform. During BP2, we will set up an internal delivery team which will eventually manage the delivery of enhancements to the platform, taking over from the vendor(s), who will progressively ramp down.
- The internal core product team will also provide support and oversight to other customer-facing platforms, to ensure consistency across the estate.

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP2	1.1	2.3	2.9	2.1	2.0	10.4
	BP1	1.3	1.3	1.1	0.6	0.0	4.2
	Variance	**-0.1**	**1.1**	**1.8**	**1.5**	**2.0**	**6.2**
Opex	BP2	0.4	0.3	0.4	0.4	0.4	1.7
	BP1	0.8	0.8	0.7	0.4	0.0	2.8
	Variance	**-0.5**	**-0.5**	**-0.3**	**-0.1**	**0.4**	**-1.1**
Cumulative RtB increase	BP2	0.0	0.2	0.5	0.5	0.5	1.8
	BP1	0.0	0.1	0.2	0.3	0.3	0.9
	Variance	**0.0**	**0.1**	**0.3**	**0.3**	**0.2**	**0.9**

Table 66 – Investment cost summary

The forecast for DEP is showing an increase in the required funding as we now have a better understanding of the foundational scope of DEP and its future enhancements.

When original BP1 plans were drafted in 2019 the programme had limited understanding of the scope and deliverables. Over the past two years the scope has been developed and defined with all stakeholders leading to better understanding of the deliverables which is now reflected in the forecast.

The programme is undergoing an RFP process to identify the vendor for the DXP and CIAM platforms. This process is due to conclude in June 2022, at which point, we will be able to refine this forecast further.

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
Constituent customer-facing platforms and services are not ready to be integrated with CIAM and DXP leading to delays in the roll out of the CIAM capability	Application Development	Deliver CIAM integration in a phased manner using standard design patterns, aligned to other release plans of constituent platforms	2	1

Customer's data insight and reporting may be limited until the full capability of DAP is operational.	Application Development	DEP to work closely with DAP to ensure data requirements are prioritised.	2	1
Lack of clarity as to the direction of DNO and DSO data exchange requirements and its impact on DEP leading to potential increased costs to meet digital any future integration capabilities.	Application Development	DEP to work closely with Planning and Outage data exchange investment, business stakeholders and DNOs to ensure technical integration requirements can be met.		

Table 67 – Investment risk summary

Solution Options

The current nationalgrideso.com website is the main point of external user access to ESO corporate content as well as routes to subsystems for transactional processes for our customers. The website is built on a National Grid owned and managed shared service under a contract with a third-party which comes to an end in December 2022. As part of this investment, NGESO has initiated procurement activities to replace the current service with a new website hosted on an NGESO owned and managed Digital Engagement Platform (DEP). National Grid Group will pursue its own separate web strategy.

As part of this exercise four options have been considered:

- Build DEP capabilities on existing National Grid shared corporate platform
- Spin off an instance of National Grid's corporate platform for ESO
- Build DEP as part of future National Grid shared corporate platform
- Build separate ESO DEP and migrate off National Grid Group corporate platform

The option to proceed with a dedicated ESO DEP platform was chosen as it best aligned with the ESO strategic goals of delivering its own digital platform capability. It also allows for the procurement exercise to proceed on ESO timescales, reduce dependency on NG Group and align to our platform architecture strategy.

The DEP programme is therefore proceeding on this basis and is currently pursuing the necessary procurement activities to source a platform to deliver value to ESO customers.

2.14 260 Forecasting enhancements

Plans for this IT investment are not presented due to the ongoing Balancing Capability Strategic Review. Please see sub-activity A1.2 of the main business plan document for more information. The cost information provided in the table below is in line with the TBM data model submitted alongside this document.

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP1	0.0	0.3	0.0	0.3	1.4	2.0
Opex	BP1	0.0	0.2	0.0	0.2	0.9	1.3
Cumulative RtB increase	BP1	0.1	0.1	0.1	0.1	0.1	0.4

Table 68 – Investment cost summary

As noted in the introduction to Part 2 – Technology Investments, this item is signalled as having higher uncertainty, and we are therefore providing a cost range. Make up of the cost range is detailed below, this investment will go through additional external assurance between April and August to help give confidence on the final cost submissions.

Investment	Whole RIIO2 FD	Whole RIIO2 BP2 data tables/TBM submission	Variance	Whole RIIO2 proposed range
Balancing Programme	**58**	**142**	**(85)**	**83-142**

Table 69 - Investment cost range summary

As stated in A1.2 of our overall Business Plan submission, investments 180 Enhanced balancing capability, 210 Balancing asset health, 260 Forecasting enhancements and 480 Ancillary services dispatch fall under the remit of the overall 'Balancing Programme' and are subject to the current ongoing Balancing Capability Strategic Review.

2.15 450 Future innovation productionisation

Overview & Purpose

This investment supports future digital ESO innovation projects that have been recognised has having a wider benefit to the Business and/or Industry and as a result require formal IT “productionisation” to ensure it aligns with National Grids IT strategy, fits within our commercial terms, is properly supported according to business requirements, and meets the desired security standards.

The ESO Innovation function will typically deliver innovation projects (see list of current proposed projects below) in an agile manner and seek to test the success criteria of a given project through a “Proof of Concept” (POC) process.

This investment allows for IT to:

- help identify and advise upon early innovation projects specifically with common system/interface and security dependencies or constraints which may help to define the benefit of the POC
- plan a project to deliver a successful POC candidate into the wider IT infrastructure
- resource a team to deliver candidate POC projects into IT service Delivery framework to meet the desired business/industry need

Current State

To date no Innovation project has been passed over to IT for “productionisation”. Some candidate projects identified in BP1 did not meet the success criteria for further development or are still under evaluation.

The current list of 18 innovation projects (detailed below) are continually being evaluated to better understand timelines and scope should productionisation be required.

Roadmap

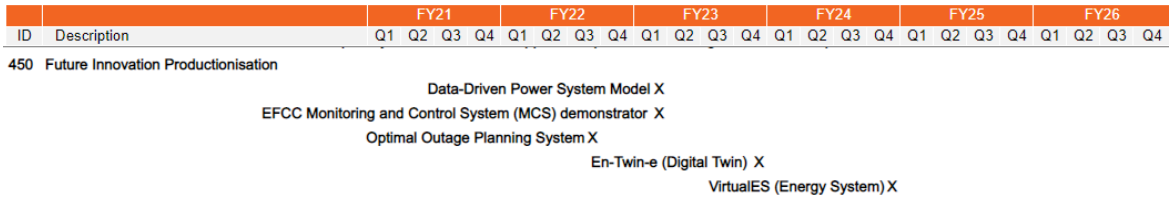

Figure 23 – Outcome roadmap

Roadmap indicates estimated innovation project POC end dates that have been earmarked for further IT productionisation. They are not indicative of the actual productionisation timescales or output dates.

Milestone	Outcome recipient	Outcome description
Date Driven Power System Model	Customers & Partners Business units	To develop advanced tools for obtaining accurate grid dynamic models, which doesn’t reveal confidential system data and can be shared with outside stakeholders.
EFCC Monitoring & Control System (MCS) demonstrator	Customers & Partners Business units	This project aims to: Demonstrate how the MCS can be installed and integrated within the existing National Grid IS communications network, and connect to commercial

		generation sites (one embedded, one transmission connected). Establish the cyber security risks and challenges
Optimal Outage Planning System	Customers & Partners Business units	The outage planning process at the ESO involves collecting information from multiple systems and using it to make decisions on system access (who can do what, where and when) The ultimate objective of this project is to develop a tool that: (1) facilitates the most efficient economic decision-making from the year-ahead plan to three-weeks ahead, and (2) tracks risks from year-ahead to day-ahead
En-Twin-e (Digital Twin)	Customers & Partners Business units	The project aims to provide the system operator, NGESO, and SPT with unprecedented levels of visibility into the real-time state of distribution network through creation and access to a digital twin of the transmission and distribution system
VirtualES (Energy System)	Customers & Partners Business units	This world first, real-time replica of our entire energy landscape will work in parallel to our physical system. A shared industry asset, the Virtual Energy System will improve our simulation and forecasting abilities to support the long-term vision to operate a zero-carbon electricity system

Table 70– Outcome summary descriptions

Future State

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State
DAT 05	Data & Analytics	Forecasting	Innovation	Capability to deliver rapid amendments to Forecasting services based on new data, models, and algorithms to complement all types of Forecast
DAT 04	Data & Analytics	Digital Twin	Digital Twin	Digital Twin (VES) will be extended to accommodate new types of market participant and expose models/data sets to the control room for enhanced digitised versions of the energy network/markets
DIG 01	Digital Engagement	Digital Services	Innovation Digital Application Suite	Small, high value application requirements will be brought under IT support into the Digital Applications Suite (future version of RDT) – specifically where there is no wider IT estate impact for the Innovation functionality required. If the proposed Innovation capabilities are more suited to another Subsystem/Component, they will be diverted to the product backlog for that systems area.

Table 71 – Future state subsystem component summaries

This funding is needed to enable us to respond to challenges as they appear. The new SIF (Strategic Innovation Fund) is a mechanism that will offer a route for larger, long-term projects to be funded (replacing NIC funding), provided they meet the criteria and timescales for this process (and are successfully awarded). We aim to utilise this funding as much as possible, in coordination with ongoing NIA activities.

The ongoing nature of the Innovation pipeline requires funding to be available for NIA and SIF productionisation. We are evaluating several projects that may require funding in RIIO-2. Due to the nature of Innovation POC (Proof of Concept) trials productionisation candidates are dynamic by nature and subject to change.

This investment also includes an opex element to cover initial IT support for new innovation projects.

Some projects are covered by their own investment or shared investment lines, included elsewhere in the BP2 submission:

- EFCC Monitoring and Control System (MCS) demonstrator covered under investment 500 EFC
- Optimal Outage Planning System covered under 360 Offline Network Modelling
- En-Twin-e (Digital Twin) various -Investments 110,190,220 and 460

At present there are 18 innovation projects in the innovation portfolio that are estimated to fall inside the BP2 funding period, which are summarised below. Many are at the early stages of research and development; it is therefore too difficult at the present time to confirm which of these projects will progress to productionisation. A probability column has been included below to better visualise current innovation projects and to indicate the likelihood that productionisation will be required. It also details the planned start and end date of the Innovation POC (not the productionisation dates) where currently known.

Where investments are covered elsewhere in the RIIO-2 business plan, this is highlighted in blue in the probability column with the investment line indicated in brackets.

Legend

Probability of IT implementation	Description
	Innovation project identified as requiring Productionisation in RIIO-2. Funding request is included in other IT investment items (reference in brackets)
	High probability that budget for IT implementation is required within next two years of RIIO-2 BP2
	May require some budget for IT implementation within next two years, dependent on project delivery or final implementation decision.
	Unlikely to require budget for IT implementation

Project Status	Description
Proposal	An innovation opportunity has been identified and going through viability studies, and contract negotiations where applicable. Trial/POC dates and exact scope not yet confirmed. IT Productionisation candidates are identified and monitored.
Project	The Innovation project is live and in delivery – IT Productionisation candidates' criteria can start to be developed further as the POC develops.
Completed	The Innovation trial/POC has completed and being evaluated with the business owner. It Productionisation is finalised and delivered where merited.

Title	Project Status	Probability of IT implementation	Estimated Innovation project Start Date	Estimated Innovation project End Date	Role
Gas and Electricity Transmission Infrastructure Outlook	Proposal		TBC (BP2 Period)	TBC (BP2 Period)	Role 3
NIC_QUEST	Proposal		Apr 2021	Jul 2025	Role 3
Future of Reactive Power	Project		Sep 2021	Jul 2022	Role 2
Operational Planning under New Technologies (OpNet)	Proposal		TBC (BP2 Period)	TBC (BP2 Period)	Role 3
Stability Market	Proposal		Jun 2021	Mar 2022	Role 2
Data-Driven Power System Model Development for Control Interaction Studies (D3)	Proposal		TBC (BP2 Period)	TBC (BP2 Period)	Role 3
Interoperability Metrics	Proposal		TBC (BP2 Period)	TBC (BP2 Period)	Role 2
EFCC Monitoring and Control System (MCS) demonstrator	Proposal	(500 EFC)	TBC (BP2 Period)	TBC (BP2 Period)	Role 3
Interconnectors – 2035 ESO Cross-Border Strategy	Proposal		TBC (BP2 Period)	TBC (BP2 Period)	Role 2
Dynamic reserve calculation	Project		May 2021	May 2023	Role 2
Resilient Electric Vehicle charging (REV)	Project		Jul 2021	Dec 2022	Role 3
Optimal Outage Planning System	Project	(360 Offline Network Modelling)	Dec 2020	Oct 2022	Role 3
Balancing Costs Forecast	Proposal		TBC (BP2 Period)	TBC (BP2 Period)	Role 2
Market Monitoring	Proposal		TBC (BP2 Period)	TBC (BP2 Period)	Role 2
Exploring cross border participation in Dynamic Containment	Proposal		TBC (BP2 Period)	TBC (BP2 Period)	Role 2
En-Twin-e (Digital Twin)	Proposal	(multiple)	TBC (BP2 Period)	TBC (BP2 Period)	Role 1
VirtualES (Energy System)	Proposal		TBC (BP2 Period)	TBC (BP2 Period)	Role 3
Solar PV Phase 3	Completed		TBC (BP2 Period)	TBC (BP2 Period)	Role 3

Table 72 - Innovation portfolio

The list above is not exhaustive. New projects could be added to the portfolio during the BP2 period.

Approach

Unless an exceptional change to the target state architecture is required for productionising an Innovation solution, the Innovation features, functionality, data, security and infrastructure design will fit into the standard approach for our platform-based architecture.

The capabilities added by the data and analytics platform and the digital engagement platform will be fully used to integrate, extend, or build new services and/or application functionality representing the output of the selected innovations.

Innovation projects to be productionised are still to be determined. Where possible we would seek to utilise an agile methodology for implementation.

The delivery phase for productionisation can generally be broken down into the following

1. Innovation Proposal

    - *Engagement with IT identify productionisation candidates*
    - *Business Sponsor identified to productionise*
    - *Early fit to product Model identified*
    - *Challenge via Strategic IT Architecture vision*

2. Innovation Project

    - *Innovation POC trial informs productionisation needs, including but not limited to:*
    - *Security consultancy*
    - *Business Impacts*
    - *Business Support requirements*
    - *Service transition*
    - *IT commercial*
    - *Architectural fit*
    - *Process and Data requirements*

3. Completion

    - *The Innovation team close the POC (the Innovation trial is complete)*
    - *Learnings inform productionisation decision*
    - *Productionisation delivery is triggered*
    - *Delivery*

Funding for stages 1 & 2 would be sought from the £100k initial Opex IT support pot with full productionisation post stage 3 sought from the main fund (see below)

Costs

Investment (£m)		**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**Total**
Capex	BP2	0.0	0.6	1.2	1.2	1.8	4.8
	BP1	0.6	0.6	1.2	1.2	1.8	5.4
	Variance	**-0.6**	**0.0**	**0.0**	**0.0**	**0.0**	**-0.6**
Opex	BP2	0.1	1.3	0.8	0.8	0.8	3.8
	BP1	0.4	0.4	0.8	0.8	1.2	3.6
	Variance	**-0.3**	**0.9**	**0.0**	**0.0**	**-0.4**	**0.2**
	BP2	0.0	0.0	0.1	0.1	0.2	0.3

Cumulative RtB increase	BP1	0.0	0.0	0.1	0.2	0.3	0.6
	Variance	**0.0**	**0.0**	**0.0**	**-0.1**	**-0.1**	**-0.2**

Table 73 – Investment cost summary

Given the uncertainty around innovation projects there are no reasons to deviate from the original BP1 submission. We will seek to update Ofgem through the six-monthly reporting.

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
Future strategic system/components/IT architecture is not aligned to support future unknown innovation needs, leading to a delay or incompatibility that could result in Innovation benefits not being fully realised.	Program, Product & Project Management	• Regular engagement and forward planning on the solution/industry options available, and engagement and visibility of innovation portfolio to allow for future proofing of IT architectural decisions	2	1
Level of activity and deliverables in the IT portfolio taking priority over innovation activity leading to a delay in productionisation of innovation projects.	Program, Product & Project Management	• Innovation Sponsors must make the case for their ideas requirements where consumer / stakeholder benefits can be realised. • ESO product owners to prioritise Innovation productionisation demand based on the value it brings to business and consumers compared to other backlog items.	3	1
Cost to productionise is found to be too high compared to the value achieved too late in the innovation process, leading to wasted time and efforts.	Program, Product & Project Management	• Early engagement (exactly as this investment describes in the list of future projects) helps ESO enterprise architecture and engineering teams identify areas of the target architecture where high cost could be encountered, in line with the “Fail Fast” innovation ethos.	2	2

Table 74 – Investment risk summary

Solution Options

The overall principle for Future Innovation Productionisation is to align to the target state ESO platform architecture and enterprise architecture framework. This means that Innovation requirements prioritised for IT supported status will follow the solution design, build, and release approaches as with our other Product teams to ensure the end functionality aligns to application support standards.

The option of defining a separate architecture framework to handle productionise of Innovation scope was rejected as there is no IT operational or consumer/stakeholder benefit of treating this scope differently. Our ESO target architecture already includes capability for exposing small and large solutions to our teams and external stakeholders and Innovation solutions will fit into this approach.

The option of exploring separate/different technology stacks was rejected as this does not align with our enterprise architecture approach for cloud-native applications – the Innovation solutions will broadly align to all of our other non-CNI applications estate using Microsoft Azure technologies when outside of CNI. Inside CNI the Innovation solutions will re-use the modular frameworks and APIs being defined by Balancing and Network Control products/solutions.

2.16 460 Restoration

Overview & Purpose

This investment covers changes to systems and communication methods on the back of the findings from the Distributed Restart project started in RIIO-1.

Currently we have around 20 black start providers, mostly large traditional generators connected to the transmission network. As larger traditional generation units close, black start capability is expected to be extended down into the distribution networks. We are considering options to achieve this through the restoration innovation project.

The innovation project will change how black start is modelled, commercially and technically assessed, and controlled, and we will need to update our systems to facilitate this. There are three main areas of change: communications, control, and visibility. They can impact various systems with different levels.

This investment enables sub-activity A3.3 Innovation project in restoration

A summary of the ESO business areas that are supported by this investment and corresponding business activities below:

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A3.3 Innovation project in restoration	• Restoration assessment tender tool for distributed generators • Resilient communication connections with distribution restoration providers

Table 75 – Summary of business outcomes and corresponding sub-Activities

Current State

The Distributed Restart NIC (Network Innovation Competition) project will be complete by December 2022 and the closedown report published including a roadmap for productionising the recommendations of the project and evidence of the project's engagement with industry.

Most of the automation and control systems recommendations of the Distributed ReStart project are for DNOs. However, the ESO will need visibility of the information held by DNOs and new communications infrastructure is proposed to incorporate new distribution-connected Restoration providers into ENCC system and to feed data from the new DNO control systems to the ENCC. Only one DNO is currently linked in such a way to the ENCC.

At the time of writing the Distributed ReStart project recommendations are pre-publication and it is possible that stakeholders will decide against adopting some or all recommendations. We will modify and drop the milestones and IT investment planned for this deliverable as necessary to meet the needs of stakeholders.

IT investments needed to provide resilient communication infrastructure to new distribution-connected generators contracted for Restoration services following upcoming regional tenders will be made via 460 Restoration. In addition to this, if the ESO and stakeholders adopt all recommendations of the Distributed ReStart project, such as new DNO control systems, any associated IT investments will be made via 460 Restoration.

Roadmap

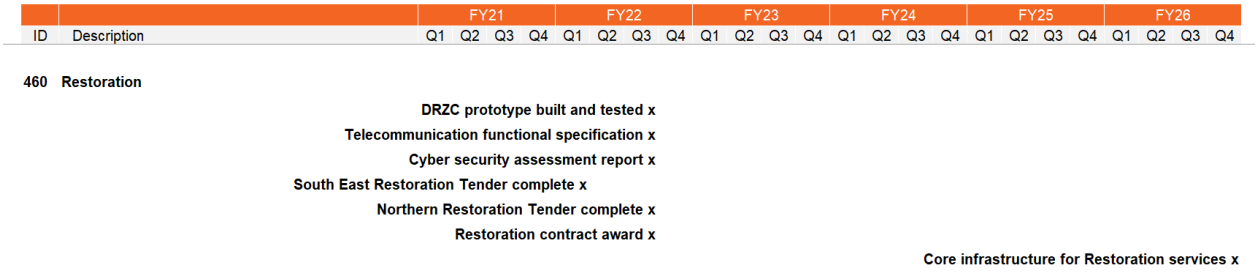

Figure 24 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
DRZC prototype built and tested	Business Units / Customers & Partners	Distributed Restart Zonal Controller tested. Demonstration to DNOs that design concept is feasible.
Telecommunication functional specification	Business Units / Customers & Partners	Vendor agnostics functional specification document detailing the requirements to support the infrastructure for data, voice, and automated distribution restoration controller system
Cyber security assessment report	Business Units / Customers & Partners	End-to-end cyber security assessment report of best practice for communications strategies and cyber-resilience for multi-party end-to-end system requirements
South East Restoration Tender complete	Business Units/Customers	Generators in South East region of England have submitted their capability to provide a contracted Restoration service.
Northern Restoration Tender complete	Business Units/Customers	Generators in Northern region of GB have submitted their capability to provide a contracted Restoration service.
Restoration contract award	Customers & Partners	Technical assessment of generators and networks to meet the requirements of the Restoration Service has been completed. Contracts awarded.
Core infrastructure for resilient communication and control of distribution generation for Restoration services	Business Units / Customers & Partners	New restoration service providers have resilient communication and control infrastructure put in place with NGESO and/or relevant network owners to ensure Restoration service can be provided during a National Power Outage.

Table 76 - Outcome summary descriptions

Future State

The final solution is to take the Distributed ReStart from this investment and integrate it into the new Restoration functions of the new NCMS delivered by investment 110 Network control.

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State

DAT-02	Data & Analytics	Analytics and Insight	Predictive Analysis CNI	New Situational Awareness suite implemented for 2025/26 System Operations. Predictive Analytic capability used to automate restoration.
DAT-02	Data & Analytics	Analytics and Insight	Predictive Analysis	New Situational Awareness suite implemented for 2025/26 System Operations. Predictive Analytic capability used to support restoration.
DAT-03	Data & Analytics	Consistent Data Services	Integration CNI	NCMS DNO restoration interfaces implemented.
DAT-07	Data & Analytics	Regulatory Reporting	External Reporting	Custom reporting for restoration service providers and regulator.
DIG-02	Digital Engagement	Customer	Customer Engagement	Customer administration processes enhanced to manage restoration service providers.
DIG-03	Digital Engagement	Market Facilitation	Communication	Non-operational B2B interfaces with restoration service providers implemented using DEP and DAP capabilities.
DIG-03	Digital Engagement	Market Facilitation	Data Exchange	Non-operational B2B interfaces with restoration service providers implemented using DEP and DAP capabilities.
NET-01	Network Operations & Control	Control Communication	Telephony	Upgraded operational telephony supporting new restoration systems.
NET-01	Network Operations & Control	Control Communication	Control Data Link	Upgraded OpTel network supporting new distributed restoration system.
NET-04	Network Operations & Control	Situational Awareness	Restoration	NCMS operational. Restoration functions extended and configured to support new distributed restoration system.
NET-04	Network Operations & Control	Situational Awareness	Power System Simulation	NCMS Simulator extended and configured to support new distributed restoration system. Enabling operational simulations and operator training.

Table 77 - Future state subsystem component summaries

The new restoration solution derived from the initial innovation project will be continued and integrated into the central restoration solution purchased as part of NCMS. We will reuse the rest of the system e.g. secure communication links to DERs, models and systems for restoration services tendering.

Approach

Our overall approach is to use the restoration management capabilities of the new NCMS. This facility will be customised to implement the solution including extending or customising situational awareness components, provider management components, and restoration operations components.

Other ESO systems will be enhanced to support restoration, ranging from provider registration and management functions to balancing and settlement.

Implementation is expected to entail enhancement of our Optel and general data networks throughout the country. We will work with our TO and DSO partners to roll this out.

We will use a dedicated control data network (provided by the TO) with guaranteed performance and service levels to communicate with restoration service providers.

We will exploit the target platform architecture, benefitting from cross-cutting platforms like DAP and DEP, to achieve this integration between systems will use the capabilities of the data and analytics platform.

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP2	0.0	1.8	6.3	6.3	5.4	19.8
	BP1	0.9	1.8	6.3	6.3	5.4	20.7
	Variance	**-0.9**	**0.0**	**0.0**	**0.0**	**0.0**	**-0.9**
Opex	BP2	0.0	0.1	0.7	0.7	0.6	2.1
	BP1	0.1	0.2	0.7	0.7	0.6	2.3
	Variance	**-0.1**	**-0.1**	**0.0**	**0.0**	**0.0**	**-0.2**
Cumulative RtB increase	BP2	0.0	0.0	0.1	0.9	1.7	2.7
	BP1	0.0	0.1	0.3	1.1	1.9	3.4
	Variance	**0.0**	**-0.1**	**-0.2**	**-0.2**	**-0.2**	**-0.7**

Table 78 – Investment cost summary

Since submitting our original plan for this investment FY22 expenditure has decreased, primarily due to a delayed start in the project due to resource constraints.

BP2 forecast remains the same as forecasted in our original plan and this is based on identified high level requirements. Assumptions and requirements will be defined in a workshop early in FY23 to explore milestones, deliverables and forecast. It is conceivable that we may need to revisit the forecasts around the above between April and August following the outcomes of the workshop mentioned above.

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
Cost of providing sufficient resilience in telecommunications for distributed restoration is higher than projected or new tools are required to achieve its benefits.	IT Management & Strategic Planning	• The Network Innovation competition (NIC) DER project will provide a working (albeit small scale) proof of concept solution for resilient telecommunications which can be suitably scaled for GB wide use. • Monitor closely project findings and plans	2	3

Table 79 – Investment risk summary

Solution Options

The solution for Restoration and Restoration Decision Support are intertwined. The preferred and working solution option is to buy the core restoration capability as part of NCMS and then extend it to manage distributed providers as per the investigative aspects of this programme as laid out above. The NCMS will have a native restoration management capability, and our preference is to configure and extend this. This option will be the lowest cost, lowest risk and fastest to market because it will be integrated into the NCMS by design.

- Initial analysis during the NCMS selection process shows that the restoration management capabilities of the remaining NCMS candidates are good bases to use. More detailed functional and feasibility analysis work will be carried out on the winning NCMS, post selection. If the costs of configuring and customising the native Restoration Decision Support are higher than expected, we will consider our options.
- Our analysis of the EMS vendor market is that the restoration capabilities of EMS are developing towards distributed restart in parallel in response to market demand. A further variant may be co-development or exploiting new distributed restart features supplied by the vendor as part of the ongoing modernisation of their product.
- For data management, data sharing, and additional analytics use cases the full solution will use the capabilities of the DAP. For engagement with customers the full solution will use the capabilities of the DEP.

2.17 480 Ancillary services dispatch

Plans for this IT investment are not presented due to the ongoing Balancing Capability Strategic Review. Please see sub-activity A1.2 of the main business plan document for more information. The cost information provided in the table below is in line with the TBM data model submitted alongside this document.

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP1	2.3	1.8	0.5	0.0	0.0	4.5
Opex	BP1	0.3	0.2	0.1	0.0	0.0	0.5
Cumulative RtB increase	BP1	0.4	0.7	0.9	0.9	0.9	3.8

Table 80 – Investment cost summary

As noted in the introduction to Part 2 – Technology Investments, this item is signalled as having higher uncertainty, and we are therefore providing a cost range. Make up of the cost range is detailed below, this investment will go through additional external assurance between April and August to help give confidence on the final cost submissions.

Investment	Whole RIIO2 FD	Whole RIIO2 BP2 data tables/TBM submission	Variance	Whole RIIO2 proposed range
Balancing Programme	**58**	**142**	**(85)**	**83-142**

Table 81 - Investment cost range summary

As stated in A1.2 of our overall Business Plan submission, investments 180 Enhanced balancing capability, 210 Balancing asset health, 260 Forecasting enhancements and 480 Ancillary services dispatch fall under the remit of the overall 'Balancing Programme' and are subject to the current ongoing Balancing Capability Strategic Review.

2.18 510 Restoration decision support

Overview & Purpose

This investment will provide a decision support tool based on real-time data to deliver a dynamic, feasible restoration plan to Government standards. The tool will support the informed decision making of the control centre engineers in a national power shutdown scenario on the best restoration route to implement based on a number of factors such as MW (Mega Watt), MVAr(megavolt ampere of reactive power), SCL (Short circuit level) etc of the network, availability and response time of the restoration providers.

Restoration standards are issued in October 2021 This, allied to the increase in technologies able to provide black start services, means the number of restoration scenarios and options will grow exponentially, making our current methods of creating restoration plans inefficient.

We will implement a tool that runs live with the latest network configuration, providing a dynamic decision tree for the best route to restoration. It will change its output every time the network configuration changes, and update live in a restoration situation if the initial recommendation is overruled.

Depending on market participation response, the tool will be flexible to accommodate learnings from restoration innovation project and meet Government restoration standards, including user defined scenarios for multiple restoration strategies.

A summary of the ESO business areas that are supported by this investment and corresponding business activities below:

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A3.2 Restoration Standard	• Real-time options for supply restoration to meet electricity system restoration standard (ESRS) • Visibility of compliance to ESRS standard

Table 82 – Summary of business outcomes and corresponding sub-Activities

There is no change to the scope of this deliverable, and we are on-track to deliver the milestones as described in the first business plan submission including go-live in March 2025 within the control room.

Current State

By March 2023, we forecast to have completed the following:

- Defined the scope of the restoration decision support tool in conjunction with IT
- Identified software for the tool
- Decided on fully inhouse build or off the shelf tool for modification/reconfiguration
- Commenced tool development

We expect to have:

- significantly progressed the development of the restoration decision support tool incorporating requirements from across the industry to allow ESO oversight and control of the restoration process.
- completed the ‘automation prototype testing’ of the outcome from the Distributed ReStart project.

There are no changes from BP1 and we expect to commence project in Q1 2022/23 and deliver the Restoration decision support tool by end of 2024/25.

Roadmap

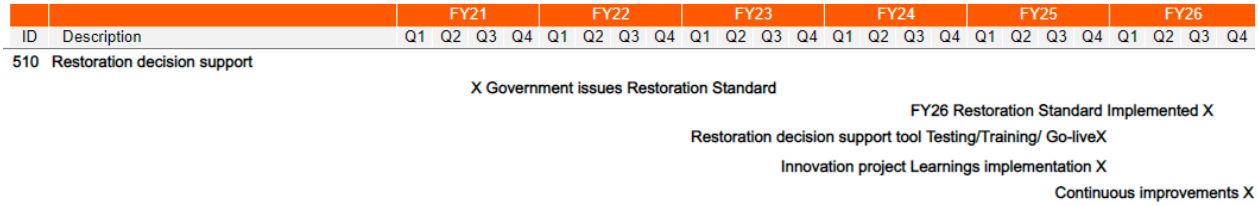

Figure 25 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Government restoration standards issued	Business Units	ESO Licence Change to include the ESRS obligation to restore 60% demand within 24hrs and 100% within 5days
NCMS integration	Business Units	Restoration tool access to real time data
Restoration decision support tool testing	Business Unit & Stakeholders	Recommends quick and efficient restoration routes to Control Engineers, supporting ESO's capability of meeting the ESRS standard
Restoration decision support tool training	Business Unit & Stakeholders	Ability to use the Restoration tool as expected.
Restoration decision support tool Go-live	Business Unit & Stakeholders	Recommends quick and efficient restoration routes to Control Engineers, supporting ESO's capability of meeting the ESRS standard.
Restoration Standards implemented	Business Unit, Customers & Stakeholders	Quicker system restoration with limited impact on the society following a partial or total shutdown
Continuous Improvements	Business Unit & Stakeholders	Quicker system restoration with limited impact on the society following a partial or total shutdown

Table 83 – Outcome summary descriptions

Future State

We will implement a Restoration Decision Support (RDS) tool that runs live with the latest network configuration, providing a dynamic decision tree for the best route to restoration. It will change its output every time the network configuration changes, and update live in a restoration situation if the initial recommendation is overruled. It will update the decisions log explaining why and initial recommendation is overruled.

It will be flexible to accommodate learnings from restoration innovation project and meet Government restoration standards, including user defined scenarios for multiple restoration strategies.

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State
DAT-02	Data & Analytics	Analytics and Insight	Predictive Analysis CNI	New Situational Awareness suite implemented for 2025/26 System Operations. Predictive Analytic capability used to automate or guide operator decision making.

DAT-02	Data & Analytics	Analytics and Insight	Predictive Analysis	New Situational Awareness suite implemented for 2025/26 System Operations. Predictive Analytic capability used to automate or guide operator decision making.
DAT-03	Data & Analytics	Consistent Data Services	Integration CNI	Integration of new RDS tool into NCMS and overall Situational Awareness suite. Access to necessary data sources and streams.
DAT-03	Data & Analytics	Consistent Data Services	Integration non-CNI	Integration of new RDS tool into NCMS and overall Situational Awareness suite. Access to necessary data sources and streams.
DAT-06	Data & Analytics	Forecasting	Power System Modelling	Integration of new RDS tool into network modelling software.
NET-02	Network Operations & Control	Control Room Planning	Restoration Decision Support	New RDS tool fully operational.

Table 84 – Future state subsystem component summaries

Approach

We will custom develop the new Restoration Decision Support (RDS) tool using the analytics frameworks, visualisation tools, data, and data services of the DAP.

The integration platform provided by DAP will provide the means of integrating the RDS tool into NCMS and the wider Situational Awareness suite.

We will exploit the target platform architecture, benefitting from cross-cutting platforms like DEP, to achieve this Integration between systems will use the capabilities of the data and analytics platform.

Costs

Investment (£m)		**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**Total**
Capex	BP2	0.0	0.5	1.4	1.8	0.9	4.5
	BP1	0.0	0.5	1.4	1.8	0.9	4.5
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Opex	BP2	0.0	0.0	0.2	0.2	0.1	0.5
	BP1	0.0	0.1	0.2	0.2	0.1	0.5
	Variance	**0.0**	**-0.1**	**0.0**	**0.0**	**0.0**	**-0.1**
Cumulative RtB increase	BP2	0.0	0.0	0.0	0.0	0.0	0.0
	BP1	0.0	0.0	0.1	0.2	0.4	0.7
	Variance	**0.0**	**0.0**	**-0.1**	**-0.2**	**-0.4**	**-0.7**

Table 85 – Investment cost summary

BP2 forecast remains the same as originally forecast at £4.5m although further exploration is needed.

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
Delay in delivery of tool dependencies. (NCMS and Restoration Decision Support Tool are hard dependencies)	Program, Product & Project Management	• Ensure NCMS Programme and Restoration Programmes are closely aligned, if not co-delivered • Maintain engagement with internal ESO product delivery teams • Review, impact assess and maintain fallback options	4	4
Difficult to predict how modelling tools will need to evolve in future due to changing needs and increased understanding of issues.	Application Development	• Ensure regular review of requirements throughout RIIO-2 period. • Deploy proof of concept tools as early as possible to gain understanding of modelling needs. • Employ agile delivery principles and flexible, modular applications.	3	1
Requirements from restoration innovation project and Government standards are of higher complexity than anticipated.	Program, Product & Project Management	• Monitor closely innovation project findings and plans from restoration innovation project. • Prioritise delivery plan based on compliance regulations and consumer value.	2	2
Delays to project delivery timelines	Program, Product & Project Management	• Commence engagement as soon as possible	4	4

Table 86 – Investment risk summary

Solution Options

The high-level solution options are to buy or build. The NCMS has a restoration management capability and our preferred option is to configure and extend this to meet our requirements. This option will be the lowest cost, lowest risk and fastest to market because it will be integrated into the NCMS by design.

Initial analysis during the NCMS selection process shows that the restoration management capabilities of the remaining NCMS candidates are good bases to use. More detailed functional and feasibility analysis work will be carried out on the winning NCMS, post selection. If the costs of configuring and customising the native Restoration Decision Support are higher than expected, we will consider our options.

For data management, data sharing, and additional analytics use cases the full solution will use the capabilities of the DAP. For any engagement with customers we will use the capabilities of the DEP.

Role 2 Investments

2.19 270 EU Regulation / Role in Europe

Overview & Purpose

With the UK leaving the European Union (EU) and European Network of Transmission System Operators For Electricity (ENTSO-E), the ESO relationship with our European counterparts has fundamentally changed. The Trade and Cooperation Agreement (TCA) now provides the framework governing our future energy trading relationship with Europe.

This investment enables ESO technology to support the work required by the ESO business in developing, designing, and eventually implementing all IT impacting changes born out of our TCA obligations.

This includes:

- Resource required to support options development, planning, design, and eventual implementation of solutions for:
  - A Cross Border Balancing strategy, both for interim and enduring.
  - Technical procedures for Intra-Day, Long-term and Day-Ahead Capacity Calculation.
  - Coordinated process for remedial actions including Redispatch and Countertrading (RD CT)
- Analysis and implementation of system changes required as a result of regulations that are retained within UK law such as Clean Energy Package (CEP) and SOGL 118/9 (GC0154).
- Funding for initiatives that enable future integration and collaboration with European TSOs and ENTSO-E such as Physical Communications Network (PCN).
- Maintenance of current Regional Security Coordination (RSC) services integration to maintain security and adequacy reporting and to enable options for coordinated capacity calculation.

This investment aligns and supports the delivery of cross-role activity **A21 Role in Europe** and sub-activity **A6.2 European Union (EU) code change and relationships**.

A summary of the key outcomes that will be delivered by this investment as well of the corresponding RIIO-2 sub-activities is included below.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A6.2 European Union (EU) code change and relationships • A21 Role in Europe	• Management and delivery of EU regulatory change retained in UK law and TCA obligations

Table 87 – Summary of business outcomes and corresponding sub-activities

Current State

The UK withdrawal from the European Union has caused uncertainty, not only for the ESO but also the industry at large and BP1 proved to be a transitional period where the ESO has sought to understand the implications of Brexit and the obligations under the TCA. Changes delivered in BP1 include:

- Clean Energy Package article 6.9 Day Ahead Short-Term Operating Reserve (STOR), which allowed greater competition in the STOR market, by enabling one day duration Day Ahead contracts, this has reduced the cost of availability payments to suppliers, which is passed on to the end consumer.
- The Physical Communications Network (PCN) - a secure wide-area communications network used to exchange data securely between European TSOs. This network will go-live during BP1, but work will continue into BP2 (see Future state section).
- Impact assessments for Clean Energy Package Articles have been completed and submitted with accompanying documentation to ESO European Code team to be communicated to the relevant working groups and Ofgem respectively and to support a decision on potential implementation dates.

- Initial discovery for SOGL 118 impact has been completed.
- The ENTSO-E Common Grid Model programme has gone live. However, service packs and additional modelling requirements are expected to be needed for the remainder of BP1 and during BP2.
- Produced early analysis and contributed to options development on the technical elements of the TCA such as Cross Border Balancing and Day Ahead Capacity Calculation.
- Although the ESO has driven discussions on options for interim and enduring Cross Border Balancing arrangement and Day Ahead Capacity Calculation work during the BP1 period, there is still a significant degree of uncertainty on the outcomes of discussion with Interconnector operators, TSOs, EU TSOs and ENTSO-E.

Roadmap

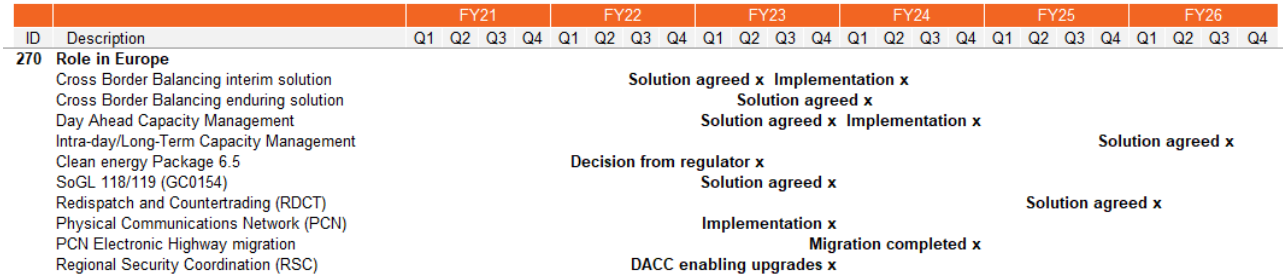

Figure 26 - Outcome roadmap

**Solution agreed and implementation dates are estimates. These are wholly dependent on multilateral agreements with EU TSOs and guidance from GB and EU regulatory bodies and as such are subject to change. The term implementation in this plan refers to ESO implementation. It does not consider third party implementation timeframes.*

Milestone	Outcome recipient	Outcome description
Cross border Balancing interim solution Cross Border Balancing enduring solution Cross Border Day Ahead capacity management Cross Border Intra-day/long-term Capacity Management Redispatch and Countertrading (RDCT)	Customers & Partners Business units	Establish technical procedures, processes and systems that enable the operationalisation of cross border balancing and capacity management processes aligned to the core principles of the TCA, providing UK customers with security of energy supply at the lowest possible costs and ensuring the ESO remain compliant with the terms of the TCA.
Clean Energy Package 6.9 MFR SoGL 118/119 (GC0154)	Customers & Partners Business units	Ensure ESO remains compliant to European codes that have been retained in UK law post Brexit.
Physical Communications Network (PCN) PCN Electronic Highway migration Regional Security Coordination (RSC)	Customers & Partners Business units	Control room users are provided with accurate network security analysis and better awareness of system conditions affecting EU TOs. In addition, PCN supports compliance to TCA by providing the ESO with the ability to securely connect to European partners.

Table 88 – Outcome summary descriptions

Future State

At the time of writing there are high levels of uncertainty relating to the implementation of TCA technical procedures as those are still being agreed with the EU TSOs, ENTSO-E and Interconnector operators.

Certain elements of the TCA related obligations have already started during BP1, and we would expect those to be completed or significantly progressed by the end of BP2:

- Implementation and operation of a Cross Border Balancing interim solution and an implemented Cross Border Capacity Management technical procedure across all relevant timescales
- A defined solution and delivery plan for a Cross Border Balancing enduring solution – this will be achieved by embedding IT regulatory team resources within the Balancing Transformation Programme to understand and influence the design of short-term reserve energy position. This will facilitate further design for the enduring solution during FY24, which is assumed to be agreed by all parties by Q1 of that financial year.
- Completion of PCN service and migration from the legacy Electronic Highway network (EH) enabling the ESO to continue to exchange data securely with our TSO partners. Pending the completion of a costs benefit analysis to be completed in FY23, we may also deliver a satellite based out-of-bound service to make the PCN based hosted exchanges more resilient.
- Maintenance of current Regional Security Coordination (RSC) services integration to enable options for coordinated capacity calculation. This work will ensure the ESO continues to supply and receive accurate network models to and from Coreso, enabling highly valuable security analysis to the Electricity National Control Centre (ENCC), and reducing the risk of high-cost remediation actions on the network.
- Implementation of relevant IT changes to support the delivery of EU Network Codes retained in UK law i.e. CEP 6.5 and SOGL.
- Over the BP2 period we plan to continue to extend the regulatory response capability within ESO technology to support this work by embedding IT regulatory team resource in ESO strategic product teams, influencing outcomes, producing options analysis where required and ensuring that regulatory obligations are considered during solution design of strategic platforms.

It is important to highlight that the delivery of TCA obligations during the BP2 period are heavily influenced by external factors beyond the ESO and UK TSOs control, bringing a significant level of uncertainty to timescales, costs and deliverability of all TCA-related projects.

This investment plan acknowledges the level of uncertainty and is based on assumptions discussed and agreed with business SMEs and built with flexibility in mind to allow ESO technology to scale up or down and respond to the business requirements as multi-lateral negotiations advance throughout the BP2 period.

Due to the uncertainty around all TCA deliverables, we must accept that there is a significant chance that this investment plan may have to change over the BP2 period.

On this basis the investment requested here may reduce, or increase, in which case the ESO may be required to trigger Ofgem's pass-through funding mechanism to deliver the required changes that will enable compliance to TCA obligations over the BP2 period.

Approach

From a process perspective the overall approach is to grow the existing IT regulatory change team with resource and capabilities to support the ESO business with option development, solutioning and implementation of the deliverables as outlined in the business plan.

We must acknowledge the subtle differences in the required approach for each work package to deliver maximum value at the lowest possible costs:

- Physical Communications Network and RSC services - we will maintain the existing project team to continue to work with our suppliers and partners to deploy and enhance our connections to European TCOs.
- For TCA related initiatives - we will leverage the enhanced IT regulatory change team to continue to input into recommended options and working alongside the ESO European Frameworks Team providing support with plans, costs and assumptions. As mentioned earlier we will embed resources within the strategic teams to represent these changes within the relevant Product Teams during design as well as implementation with the objective of increasing visibility and communication of regulatory requirements.

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP2	2.9	9.6	2.2	3.1	2.7	20.3
	BP1	9.0	7.2	7.2	7.7	7.7	38.7
	Variance	**-6.1**	**2.4**	**-5.0**	**-4.6**	**-5.0**	**-18.4**
Opex	BP2	0.3	1.1	1.5	1.5	1.5	6.0
	BP1	1.0	0.8	0.8	0.9	0.9	4.3
	Variance	**-0.7**	**0.3**	**0.7**	**0.7**	**0.7**	**1.7**
Cumulative RtB increase	BP2	0.5	0.8	1.0	1.2	1.5	5.1
	BP1	0.8	1.0	1.2	1.4	1.6	6.1
	Variance	**-0.3**	**-0.2**	**-0.2**	**-0.2**	**-0.2**	**-1.0**

Table 89 – Investment cost summary

The original numbers were based on historical regulatory change against a very different political background, i.e., Brexit had not yet happened. Since then, the UK / EU relationship has changed significantly and as such so has this investment. Regulations such as the Trans-European Reserves Replacement Market (TERRE) and Manually Activated Reserves Initiative (MARI) have been withdrawn and replaced by the deliverables set out in the Trade and Cooperation Agreement (TCA).

To produce this forecast a bottom-up review of all EU activity has been done in partnership with the ESO European Frameworks team. These included all TCA related activities and any EU regulation retained in UK law following Brexit.

A key factor in producing this forecast is that at present, most European activity going forward is subject to collaborative work firstly with all UK TSOs to agree a UK position and then engagement with EU TSOs. The IT regulatory change team worked with the ESO EU frameworks team to agree on the probable direction of each TCA activity and a forecast has been produced based on documented assumptions. For example, with the Cross Border Capacity Management activity we assume that Long-Term and Intra-Day IT work will be smaller in scale compared to Day-Ahead as we expect to leverage much of the same technology already developed for that specific timescale.

Any deviation from those assumptions during the BP2 period could result in costs variances. As we work through each activity, our understanding of it improves and more accurate numbers can be produced. Before August we expect the following changes:

- A significant reduction of FY23 forecast following the pricing proposal application for CEP article 6.4 and derogation of article 6.9.
- Better understanding of the requirements around redispatching and counter trading (RDCT), which at the time of writing have not been included in this forecast.

As such expect that there will be further forecast changes ahead of the final submission in August.

Risks

Risk	Relevant IT Tower Component	Mitigation(s)	Likelihood	Impact
There is risk that this investment plan may need to significantly change over the BP2 period should there be any significant deviations from assumptions on the timescales & scope, leading to potential increases or reductions in costs.	Program, Product & Project Management	• To invest sensibly and avoid committing resources until a direction of travel on each regulatory change becomes clearer. • To work closely with ESO European Frameworks Team	5	1
Changes to existing or new regulatory commitments are incompatible with the wider ESO technology change roadmap leading to potential additional costs to implement major regulatory changes in legacy platforms diverting resource from planned RIIO2 investments.	Application Development	• Ensure IT regulatory team and ESO European Frameworks Teams work "hand in glove" so ESO IT strategy and long-term commitments are taken considered by industry and Ofgem when making decisions on regulatory change. • Work closely with Ofgem to understand and respond to their intentions for change	4	1

Table 90 – Investment risk summary

Solution Options

Each regulatory change that has the potential to impact the ESO technology estate goes through an investigation and analysis process to establish, at an early stage how it could impact ESO IT systems. This analysis is produced and fed back to the ESO Code Change Delivery team, which in turn uses the information in workgroup discussions with industry participants and Ofgem.

This is to ensure that any decisions made, or options chosen by industry participants at workgroup level consider the overall impact to the ESO technology landscape. Where possible, the ESO may recommend for a regulatory change to be delivered later to minimise impact to legacy platforms, thus reducing the total costs of delivering the change. This investment also enables earlier visibility by strategic platform programmes of upcoming regulatory changes so those can, where possible, be considered of future systems design.

2.20 280 GB Regulations

Overview & Purpose

This investment exists to support the analysis, planning, and implementation of mandatory GB regulatory and market-driven change across the ESO technology estate. This includes but it's not limited to Grid Code, Balancing and Settlement Code, Connection and Use of Systems Code changes.

The exception to the above are regulatory changes that affect the ESO Settlements and Charging system exclusively, which are captured under investment 610 Settlements, Charging and Billing.

We anticipate that over the BP2 period the volume of regulatory driven change will continue to increase, underpinned by the ESO and Energy Industry's drive to reform markets and to support the UK government commitment to a fully decarbonised power system by 2035.

This investment enables sub-activity **A6.1 Code management / market development and change** in the ESO business plan.

A summary of the key outcomes that will be delivered by this investment as well of the corresponding RIIO-2 sub-activities is included below.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A6.1 Code management / market development and change	• Management and delivery of UK code changes

Table 91 – Summary of business outcomes and corresponding sub-activities

Current State

Regulatory driven change is characterised by its wide impact across the ESO processes, IT systems, products, and teams.

Over the BP1 period, ESO technology has developed a process and set up a team to manage the backlog of regulatory change and to better understand the impact of the proposed changes in the existing and future ESO systems, platforms, and products.

The process includes early Discovery Analysis and Impact Assessment Analysis to understand how a proposed change may (or may not) impact ESO technology systems, processes, and services.

Initial discovery analysis is carried out as early as practicably possible during the consultation process for a proposed modification or regulation. A Discovery Analysis document provides early investigation of a proposed modification or regulation, and its likely impact on ESO technology assets, including what systems the change is likely to affect. This data is compared against the RIIO-2 product roadmaps to provide an indication of when the ESO technology changes could be delivered if compliance could be deferred until the strategic product backlogs are able to prioritise them, post-delivery of their minimum viable products (MVP).

The discovery documents are refined to provide indicative delivery timescales to help the business understand the potential IT implications of a proposed regulatory modification, and often to assist discussions with the working group and/or regulator during the code modification process.

An impact assessment goes a step further than discovery. It is completed when there is an expectation that the proposed regulatory change is proceeding towards a consensus to its implementation. It provides the business with a proposed high-level solution design(s) for the modification and associated costs to deliver the change. Depending on the modification, an impact assessment may be required to input to the industry consultation process, for example, if the regulator needs to understand the costs of a change so a decision can be made in terms of cost benefit. Impact assessments tend to be more costly because it often will involve multiple IT delivery teams and partners to assess the changes and provide cost and time estimates.

This work is done in partnership with the ESO Code Change Delivery function, and it provides a better understanding of proposed regulatory change early on in its lifecycle. It also provides the ESO with quality analysis to inform the ESO's participation in regulatory workgroups and facilitate discussions with industry participants.

GB regulatory and market driven regulatory change delivered over BP1 include:

- P399 BSAD Identity Visibility
- P375 Metering behind the Boundary Point
- P402 Enabling reform of residual network charging as directed by the Targeted Charging Review
- GC0109: Publication of the various GB electricity Warnings or Notices or Alerts or Declarations or Instructions or Directions etc.

This approach has worked well over the BP1 period, making the process of regulatory change pipeline management more transparent because business and IT stakeholders have a clearer understanding of the impact of regulatory change earlier in the change lifecycle. We will continue to evolve the process and team over the BP2 period by funding dedicated embedded regulatory resources within the ESO technology product groups, which will enable regulatory change representation during design and backlog prioritisation, reducing potential rework and cost as the regulatory changes have been considered early in the product roadmap.

Roadmap

The roadmap for individual regulatory changes will be refined on an ongoing basis over the RIIO-2 period.

		FY21				FY22				FY23				FY24				FY25				FY26			
ID	Description	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
280	**GB Regulation**																								
	Issue 98							**Workgroup conclusion x**																	
	GC0117											**Ofgem decision x**													
	P376					**Change approved x**				**Implementation x**															
	P419									**Implementation x**															
	P415							**Workgroup conclusion x**																	
	Issue 95							**Workgroup conclusion x**																	
	GC0139							**Workgroup conclusion x**																	
	Consequential Changes to Residual Cashflow Reallocation Cashflow (RCRC)									**Workgroup conclusion x**															
	Market wide half hour settlement					**Discovery and analysis of IT impact x**				x		x		x											
	Discovery and Impact assessments for all upcoming regulatory changes					**Assessment of IT impacting regulatory change x**				x		x		x		x		x		x		x		x	

Figure 27 – Outcome roadmap

***Regulatory change is a continuous activity by nature. In BP2 we will continue to assess all IT impacting change proposals and market wide initiatives and implement those changes in ESO IT systems as they are approved by industry and regulator.*

Milestone	Outcome recipient	Outcome description
Issue 98 'Review of the current practice of setting Dynamic Parameters within the Balancing Mechanism'	Customers & Partners	This workgroup aims to find a solution for a balance between market manipulation rules and economic efficiency.
GC0117 'Improving transparency and consistency of access arrangements across GB by the creation of a pan-GB commonality of PGM requirements'	Customers & Partners	This is a mod proposal to Grid Code and it aims to review the thresholds and harmonize the definitions of small and large generators across England and Scotland.
P376 ‘Utilising a Baselining Methodology to set Physical Notifications’	Customers & Partners	This mod sets a baseline methodology option BMUs who struggle to accurately predict their PNs. This targets complex customer sites with numerous assets.
P419 ‘Enhanced Reporting of Demand Data to the NETSO to facilitate BSUoS Reform’	Customers & Partners	This Modification seeks to enable BSC Systems to aggregate the

		Import data of all non-Final Demand sites for exclusion from Balancing Services and Use of System (BSUoS) charges. It enables the introduction of CMP308.
P415 ‘Facilitating access to wholesale markets for flexibility dispatched by Virtual Lead Parties’	Customers & Partners	P415 proposes to amend BSC systems and processes to allow flexibility delivered by a secondary BM Unit to be allocated to that VLP’s energy account to facilitate an electricity consumer’s participation in wholesale markets with no involvement from their Supplier
Issue 95 'Assessing the continued use of TIBCO service as a source of data for market participants'	Customers & Partners	This Issue Group seeks to establish the future of the TIBCO messaging service with the migration of BMRS as part of Elexon’s transformation programme.
GC0139: Enhanced Planning-Data Exchange to Facilitate Whole System Planning	Customers & Partners	This modification seeks to increase the scope and detail of planning-data exchange between DNOs and National Grid ESO to help facilitate the transition to a smart, flexible energy system by aligning certain data exchange processes, providing greater granularity of data at a wider range of operating condition
Consequential Changes to Residual Cashflow Reallocation Cashflow (RCRC) following BSUoS Reform	Customers & Partners	Review of Residual Cashflow Reallocation Cashflow (RCRC)
Discovery and Impact assessments for all upcoming regulatory changes	Customers & Partners Business units	Ongoing delivery of analysis to support industry discussions for regulatory change over the BP2 period. This includes industry wide projects such as Market Wide Half Hour Settlement, Early competition, Net Zero Market Reform and TNUOS reform.

Figure 28 – Outcome summary descriptions

Key benefits that will be delivered to the business by this investment:

- Timely and efficient response to regulatory demand
- Realise efficiency benefits resulting from the ESO TechOps product model
- Early feedback on technical, implementation options, timescales, and costs to working groups and regulators
- Regulatory alignment with ESO strategic roadmap enabling best outcome for end consumers

Future State

Over the BP2 period we plan to continue to extend the regulatory response capability within ESO technology to manage the increasing backlog of regulatory change.

The overarching assumption is that the volume of regulatory change will increase driven by the UK government commitment to decarbonise the UK energy sector by 2035. Over the BP2 period we expect regulatory changes resulting from:

- Industry wide, transformation initiatives such as:
  - Market Wide Half Hour Settlement – The proposed change to settlement period is likely to have an impact on ESO Strategic Settlement and revenue products, along with possible changes to reporting and Forecasting platforms.
  - Early Competition - This could affect IT in several ways, primarily in the registration and onboarding of the new asset to ESO IT network management, forecasting, settlement, and revenue products/Platforms.
  - Net Zero Market reform – By opening new products, markets and increasing competition with smaller low carbon suppliers. Reducing the attractiveness of carbon intensive suppliers through carbon pricing.

- Ad-hoc, industry participant led initiatives:
  - GC0117: Improving transparency and consistency of access arrangements across GB by the creation of a pan-GB commonality of PGM requirements
  - P419: Enhanced Reporting of Demand Data to the NETSO to facilitate BSUoS Reform CMP308 Removal of BSUoS charges from Generation
  - P376: 'Utilising a Baselining Methodology to set Physical Notifications'
  - P415: 'Facilitating access to wholesale markets for flexibility dispatched by Virtual Lead Parties'
  - GC0139: Enhanced Planning-Data Exchange to Facilitate Whole System Planning
  - GC0154: Incorporation of interconnector ramping requirements into the Grid Code as per SOGL Article 119
  - P402: Enabling reform of residual network charging as directed by the Targeted Charging Review
  - Issue 95 - Assessing the continued use of TIBCO service as a source of data for market participants
  - Issue 98 - Review of the current practice of setting Dynamic Parameters within the Balancing Mechanism

The nature and impact of regulatory change is difficult to predict and plan for. The purpose of the investment line is to manage the uncertainty that exists within the regulatory space.

Most of the regulatory changes outlined in the plan are in discussion with industry and Ofgem. Acknowledging the fluid nature of regulatory change, this investment line is based on a number of assumptions of the potential solutions for each regulatory change, using the best information available at the time of writing. As such we expect that depending on the nature of the change and including any deviations to those assumptions, the ESO may be required to trigger Ofgem's pass-through funding mechanism to deliver regulatory change over the BP2 period.

For example, GC0117 is a change that, depending on agreed implementation timescales, could require IT investments to the existing legacy Balancing IT platform, and more widely across various existing processes and systems such as Registration, Network modelling and Settlements, which inevitably will be costly. Conversely, if timescales allow for implementation in the ESO Future of Balancing strategic platform, costs could be reduced.

Approach

As with EU Regulation, there are no specific systems, processes, technologies, or practices associated with this investment. We will look to implement regulatory changes on existing capabilities and where possible align them to our new and emerging platforms as they develop.

From a delivery process perspective the overall approach is to augment the existing IT regulatory change team to support the ESO business with option development, solutioning and implementation of the deliverables as outlined in the business plan.

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP2	1.1	2.0	2.9	4.2	4.6	14.8
	BP1	2.7	2.7	2.7	2.7	2.7	13.5
	Variance	**-1.6**	**-0.7**	**0.2**	**1.5**	**1.9**	**1.3**
Opex	BP2	0.3	0.6	1.6	1.7	1.7	5.8
	BP1	0.3	0.3	0.3	0.3	0.3	1.5
	Variance	**0.0**	**0.3**	**1.3**	**1.4**	**1.4**	**4.3**
Cumulative RtB increase	BP2	0.0	0.0	0.1	0.2	0.3	0.7
	BP1	0.0	0.1	0.2	0.2	0.3	0.8
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**-0.1**

Table 92 – Investment cost summary

As with 270 Role in Europe BP2 forecast, a bottom-up review of all regulatory changes in the IT backlog has been done in partnership with the ESO Code Change Delivery team and assumptions have been made and documented as to the direction we expect each of the changes to go. Each option was costed and agreed.

The original numbers were set two years ago based on historical regulatory change against a significantly different background. For the BP2 submission we reviewed all known regulatory change items in the backlog and worked through the possible outcomes for each, costing the most likely outcome for each change (validated with the business).

Activities such as GC0117 are included in this forecast and are key items that drive the variance to original numbers.

- For regulatory changes that, at point of writing, we had impact assessments completed with costs provided by the affected IT towers, those numbers were used to produce a forecast.
- Where no impact assessments had been completed, either due to change being due in a few years away or as a result of work prioritisation, we applied experience and comparison to similar changes in the past to base our forecast.
- This forecast is based on assumptions made in partnership with ESO Code Change Delivery team as to the direction each regulatory change might go in the coming years. Any deviation from those assumptions during the BP2 could result in costs variances.
- In addition, as we work through each regulatory change, our understanding of it improves and more accurate numbers can be produced.

This forecast is a snapshot in time, with the best information available at the time of writing, and we expect that there will be further changes ahead of the final submission in August as we progress our understanding of each proposed change, or new changes are put forward by the industry in the intervening period.

As noted in the introduction to Part 3 – Technology Investments, this item is signalled as having higher uncertainty, and we are therefore providing a cost range. Make up of the cost range is detailed below, this investment will go through additional external assurance between April and August to help give confidence on the final cost submissions.

Investment	Whole RIIO2 FD	Whole RIIO2 BP2 data tables/TBM submission	Variance	Whole RIIO2 proposed range
GB regulations	15	21	(6)	19-21

Table 93 – Investment cost range summary

Risks

Risk	Relevant IT Tower Component	Mitigation(s)	Likelihood	Impact
There is risk that this investment plan may need to significantly change over the BP2 period should there be any significant deviations from assumptions on the timescales & scope, leading to potential increase in costs which could result in the ESO being required to trigger Ofgem's pass-through funding mechanism.	Program, Product & Project Management	• To invest sensibly and avoid committing resources until a direction of travel becomes clearer • To work closely with ESO European Frameworks Team • Maintain flexibility as the focus of the IT regulatory change team.	5	1
There is risk that changes to existing or new regulatory commitments are incompatible with the wider ESO technology change roadmap, leading to potential additional costs to implement major regulatory changes and prevention of planned delivery investments reducing benefits of new tools	Program, Product & Project Management	• Ensure IT regulatory team and ESO European Frameworks Teams work "hand in glove" so those risks are highlighted early in the change process • Work closely with Ofgem to understand and respond to their intentions for change	4	1

Table 94 – Investment risk summary

Solution Options

Each regulatory change that has the potential to impact the ESO technology estate goes through an investigation and analysis process to establish, at an early stage how it could impact ESO IT systems. This analysis is produced and fed back to the ESO Code Change Delivery team, which in turn uses the information in workgroup discussions with industry participants and Ofgem.

This is to ensure that any decisions made, or options chosen by industry participants at workgroup level consider the overall impact to the ESO technology landscape. Where possible, the ESO may recommend for a regulatory change to be delivered later to minimise changes to legacy platforms, thus reducing the total costs of delivering the change and aligning to strategic platform where possible.

2.21 290 Charging and billing asset health

This investment is now superseded by **610 Settlements, Charging & Billing**

2.22 300 Charging regime and CUSC changes

This investment is now superseded by **610 Settlements, Charging & Billing**

2.23 320 EMR and CfD Improvements

Overview & Purpose

This investment will enable the ESO to continue to advance the enhancement, user experience optimisation, and delivery of regulatory change in the new, Salesforce-based Electricity Market Reform (EMR) portal system and a reporting capability, following its foundational implementation in BP1.

The Salesforce platform has been designed to provide a step change in user experience, cost, and speed to implement change, supporting the Capacity Market registration, pre-qualification, and agreement management processes. This will also include functionality to manage Contracts for Difference (CfD), which will be delivered in early BP2.

The Power BI reporting tool will enable greater analytics capability for external users to self-service as well as the business, generating insightful reports to better inform business decisions.

In the BP2 period this investment will allow the ESO, in its capacity as the EMR Delivery Body, to continually enhance the platform in response to stakeholder feedback, deliver regulatory change at greater speed and lower costs and automate manual processes. This will allow the business to focus increasingly on higher value-add activities and better supporting our customers.

It is worth noting that the regulatory change process for EMR differs from regulatory code changes outlined in previous chapters. BEIS and Ofgem own the Regulations and Rules that govern EMR, and they are responsible for making regulatory changes. Ofgem are also in the process of setting up a Capacity Market Advisory Group. The ESO plays a key role in advising BEIS and Ofgem on regulatory changes and in the delivery of such change. As part of that, the regulatory change requirements are assessed by the ESO and those requirements that require system modifications are added to the product backlog and implemented through quarterly releases.

Those changes are specific to Capacity Market and Contracts for Difference and as such its impact is contained to the EMR auction platform. Those changes are therefore accounted for specifically within the EMR and CfD improvements investment line, rather than the GB regulatory change investment.

It is also in scope of this investment to integrate the new EMR platform into the ESO strategic digital and data platforms, providing customers with a streamlined point of entry into ESO services.

This investment supports and aligns to sub-activity **A5.2 Deliver an enhanced platform for EMR** in the business plan.

A summary of the key outcomes that will be delivered by this investment as well of the corresponding RIIO-2 sub-activities is included below.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A5.2 Deliver an enhanced platform for EMR	• Capacity market & CFD market participation and end-to-end seamless user experience • Capacity market & CFD regulatory compliance and fit for future change

Table 95 – Summary of business outcomes and corresponding sub-activities

Current State

In BP1, the EMR Delivery Body completed a comprehensive internal and external stakeholder engagement exercise to set the direction for the proposed new EMR platform. The feedback provided clarity of requirements and set the foundation for the decision to seek a new platform to manage the Capacity Market (registration, prequalification, and agreement management) process.

We selected Salesforce as our platform of choice to deliver the new EMR portal as it can meet all of the functional, workflow and technical integration requirements as well as allowing us to leverage the existing Salesforce support function. Power BI was selected as our self-service reporting solution, as it aligned to our Data & Analytics Platform (DAP) strategy.

Also, during BP1 we adopted a product model using agile sprints to deliver functional products on a quarterly release basis, with a particular focus on user experience and customer outcomes.

By the end of BP1, we anticipate the following capabilities to have been delivered:

- User and company registration
- Creation and management of capacity market units
- Manage pre-qualification and pre-auction processes
- Manage agreements through their lifecycle
- Foundational integration with our capacity markets auctions platform
- Publish capacity markets register
- Introduce self-service reporting
- Foundational integration with the strategic Digital Engagement platform.

The above will be achieved using optimised user journeys, with intuitive workflows, much improved data validation and reduced workarounds and manual checks. We will also continue to support the delivery of prioritised regulatory changes during this stage, alongside continuous enhancements of the new EMR solution.

Roadmap

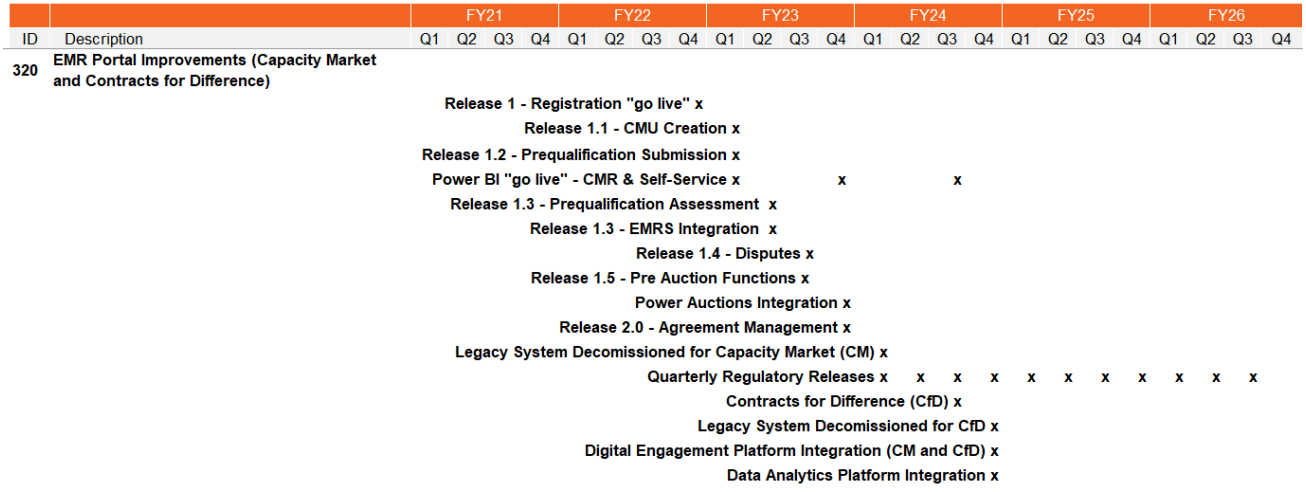

Figure 29 – Outcome roadmap

Milestone	Outcome recipient	Outcome description
Registration “Go live”	EMR Business Unit Customers	Provides capability for registration and management of companies and users.
CMU creation	Customers	Provides capability for customers to create and manage Capacity Market Units.
Pre-qualification submission	Customers	Provides capability and an improved experience for customers to create, manage and submit prequalification applications for auctions.

CMR & Self Service	EMR Business Unit	Capability to create and publish capacity markets register and provision of user self-service reporting.
Pre-qualification Assessment	EMR Business Unit Customers & Delivery Partner	Provides enhanced capability for business unit to assess prequalification applications and release results to customers and delivery partner.
EMRS integration	EMR Business Unit Delivery Partner	Foundational integration with the strategic Digital Engagement platform.
Disputes	EMR Business Unit Customers	Provides enhanced capability and an improved experience for customers and the EMR Business Unit to manage disputes.
Pre-Auction functions	EMR Business Unit Customers	Provides enhanced capability and an improved experience for EMR Business Unit and customers to manage and track pre-auction activities.
Power Auctions integration	EMR Business Unit	Provides automated integration with the Power Auctions system to enable seamless transfer of data between the systems and reduce assurance overheads.
Agreement management	EMR Business Unit Customers & Delivery Partner	Provides enhanced capability and an improved experience for EMR Business Unit, Customer and Delivery Partner users to manage and track agreements, milestones, and associated activities.
Legacy System decommissioned for Capacity Market (CM)	EMR Business Unit Customers & Delivery Partner	Disablement of Capacity Market related processes on legacy system and move to a single system for all processes.
Quarterly Regulatory releases	EMR Business Unit Customers & Delivery Partner(s)	Enables any regulatory changes and user enhancements on a quarterly basis in line with the operational timelines required.
Contracts for Difference (CfD)	EMR Business Unit Customers	Provides enhanced capability and an improved experience for EMR Business Unit, Customer and Delivery Partner users to manage CfD related activities.
Legacy System decommissioned for CfD	EMR Business Unit	Disablement of CfD related processes on the legacy system and move to a single system for all processes.
Digital Engagement Platform integration (CM) and (CfD)	EMR Business Unit Customers & Delivery Partner(s)	To enable a seamless ESO user experience for customers and delivery partner(s).
Data and Analytics Platform integration	EMR Business Unit Customers & Delivery Partner(s)	To enable an enhanced strategic reporting and analytics capability for users.

Table 96 – Outcome summary descriptions

Future State

In BP2, we will move to a quarterly release strategy for the implementation of functional enhancements to the EMR platform. These will deliver changes to support both regulatory and customer requested changes throughout BP2.

We will also align our front-end user interface to the design system delivered by 250 Digital Engagement Platform (DEP) and integrate the EMR Single Sign-On (SSO) functionality using the new customer identity and access management (CIAM) solution, also delivered by DEP. Taken together this will provide an enhanced and frictionless customer experience for EMR portal users.

We will continue to improve and enhance our self-service reporting functionality developed in BP1, aligning more closely to our DAP platform. Further work will include exploration and potential implementation of new API-driven interfaces with external parties.

The following table maps the EMR delivery and alignment to ESO's overall Target Platform Architecture. The principal subsystems and components to be delivered by this investment are listed along with a specification of the expected target state for each by the end of FY25 in BP2 delivery period.

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State
DIG 02	Digital Engagement	Customer	CRM Workflow	Managing workflows in SMP
DIG 02	Digital Engagement	Customer	Customer Engagement	Core markets platform capability in Salesforce CRM
DIG 03	Digital Engagement	Market Facilitation	Data Exchange	Management of data exchange with internal systems and 3rd party systems
DIG 03	Digital Engagement	Market Facilitation	Communication	Managing communication channels with our customers
DIG 03	Digital Engagement	Market Facilitation	Market Sandbox	A sandbox capability to simulate or train market participants
DIG 03	Digital Engagement	Market Facilitation	Tendering / Auction	Alignment with our existing CM auctions platform
DIG 03	Digital Engagement	Market Facilitation	Customer Markets Portal	Portal functionality for markets
COM 03	Commercial & Markets	Settlements	Settlements	Integration with EMRS
BAL 02	Balancing	Energy Trading	Trading Auction	Integration with future trading platforms
DAT 02	Data & Analytics	Analytics & Insight	Internal Reporting	DAP reporting for insights and market reports
DAT 02	Data & Analytics	Analytics & Insight	Predictive Analytics	Analytical reporting from our DAP for market participants
DAT 03	Data & Analytics	Consistent Data Services	Integration Non-CNI	Integration services with auctions and LCCC
DAT 07	Data & Analytics	Regulatory Reporting	Information Provision	Provision of CMR regulatory reports

Table 97 - Future state subsystem component summaries

Approach

At the end of BP1, we will have largely completed the transition of the Capacity Market from the legacy EMR portal to our new solution on Salesforce. In BP2, the residual elements of decommissioning the legacy portal, as well as development of integration with Electricity Market Reform Settlements (EMRS), Low Carbon Contracts Company (LCCC), Digital Engagement Platform (DEP) and Data and Analytics Platform (DAP) services, will be implemented.

These will provide for greater levels of alignment with our design system, customer identity management, analytics platform and API based data exchange.

In BP1, we introduced the product model approach to delivering new functions and features, using an agile iterative delivery model. Customer engagement and market testing will continue to be intrinsic elements of the EMR delivery model in BP2.

We intend to extend and expand this model to deliver customer as well as regulatory driven changes to the EMR portal. The product model will enable us to focus and iterate discrete product development for these changes.

We will continue to extend our self-service reporting capability in FY24 using our DAP platform, building on the work initiated in BP1.

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP2	5.4	5.5	4.1	3.1	3.1	21.1
	BP1	1.2	0.9	0.9	0.9	0.9	4.7
	Variance	**4.1**	**4.6**	**3.2**	**2.2**	**2.2**	**16.4**
Opex	BP2	0.0	0.0	0.2	0.0	0.0	0.3
	BP1	0.8	0.6	0.6	0.6	0.6	3.1
	Variance	**-0.8**	**-0.6**	**-0.4**	**-0.5**	**-0.5**	**-2.9**
Cumulative RtB increase	BP2	0.0	0.4	0.5	0.3	0.3	1.4
	BP1	0.0	0.1	0.1	0.1	0.2	0.5
	Variance	**0.0**	**0.3**	**0.3**	**0.1**	**0.1**	**0.9**

Table 98 – Investment cost summary

The original numbers were set before we had full understanding of what the new EMR portal replacement solution was going to be. In addition, the narrative in the final determination stated the EMR roadmap was in development to provide clarity of the solution, delivery approach and timescales and thus there was a level of uncertainty in the original estimates. Finally, there have also been further policy and regulatory changes such as BEIS's announcement to increase the frequency of CfD allocations to annual rounds.

The updated BP2 forecast benefits from a defined platform solution in Salesforce and a much clearer understanding of the required reporting capabilities and importantly, a better understanding of the requirements of integration with the Digital Engagement (DEP) and Data and Analytics (DAP) platforms, which in the original submission was an unknown as neither DAP nor DEP investments had been scoped in detail.

The variance in costs is largely driven by the Salesforce delivery for regulatory changes, reporting capability development and the dependencies on DEP and DAP. Additional investment is also required for FY24-26 as we couldn't anticipate the level of change required post the new portal implementation in the original submission. Also, the need to shift the delivery of the platform from RIIO-1 into RIIO-2 meant that Capital Expenditure costs that were expected to incur in RIIO-1 were incurred in RIIO-2.

This updated forecast accounts for:

- Ongoing functional and user experience changes as well as degree of regulatory change required.
- Costs for integration on to strategic platforms.
- Transition of CfD processes onto Salesforce.
- Ongoing development and support of the new reporting solution.
- Decommissioning of the legacy solution in FY24.
- In producing this forecast we made the following assumptions:
- We have assumed DAP will support the EMR reporting functionality and infrastructure.
- Reporting scrum team based on agile delivery model for the development of reports.

- We expect to use Conga for generating exhibits and digital signatures.
- Review of Salesforce delivery costs and comparison to other deliveries in the ESO portfolio may result in cost reduction.

As noted in the introduction to Part 3 – Technology Investments, this item is signalled as having higher uncertainty, and we are therefore providing a cost range. Make-up of the cost range is detailed below; this investment will go through additional external assurance between April and August to help give confidence on the final cost submissions.

Investment	Whole RIIO2 FD	Whole RIIO2 BP2 data tables/TBM submission	Variance	Whole RIIO2 proposed range
EMR	8	21	(14)	18-21

Table 99 – Investment cost range summary

Risks

Risk	Relevant IT Tower Component	Mitigation(s)	Likelihood	Impact
New EMR portal developments cannot keep pace with the regulatory as well as customer driven changes, leading to delays in adoption of these services.	Application Development	• Work closely with customers and stakeholders including BEIS and Ofgem to continue to refine and prioritise the EMR change backlog and to provide an appropriate forward look of agreed change requirements throughout the RIIO-2 period. • Continuous improvement in our agile delivery strategy, increasing speed of change delivery with more flexibility to adapt to changes.	3	1
Strategic platforms and solutions (such as API/integration middleware, DAP, DEP) are not available and changes need to be completed on legacy platforms, leading to regret spend	Application Support & Operations	• Align product roadmap to IT strategic platform roadmap	2	1
CfD implementation on the new EMR portal may be delayed due to delays in completion of CM releases in BP1, leading to manual workarounds	Application Development	• Prioritise functional releases in BP1 and BP2 to ensure CfD implementation can be delivered in time • Continued use of the legacy system for CfD as a last resort until new functionality is in place	2	1
Market influences could impact resourcing and cost structure creating a shortage of supply of critical resources,	Program, Product & Project Management	• Stay abreast of market influences • Seek flexible resource options from our partners. • Ensure ESO remains an attractive career path with a competitive pay structure	2	1

	leading to increase in costs.

Table 100 – Investment risk summary

Solution Options

In BP1, we undertook a series of steps to determine the future solution for the EMR portal:

- A detailed review of the options for re-engineering the current platform to address existing pain points
- An RFI with our ADAM partners to propose alternative solution options that would address existing pain points as well as provide flexibility for future changes. These included CRM solutions such as Salesforce, MS Power Platform as well as low-code alternatives.
- Undertook a detailed assessment of the solution options, based on the above analysis

Following an assessment of the relevant solutions, Salesforce was chosen as it best aligns with ESO's goals of delivering customer-centric user experience, cost efficiency and speed of change. It was concluded that:

- Salesforce is National Grid's strategic CRM tool for customer centric digital solutions, it has strong workflow capability, enabling us to build joined up end to end customer-centric solution.
- Some external market participants already interact with Salesforce and hence are familiar with the service.
- We already have demonstrable internal team delivery experience on Salesforce in NG which will provide predictability in sprint planning and costs
- Lower cost of provisioning infrastructure (SAAS model), with focus on building applications. Other options would have higher initial setup costs
- Contractual/Commercial relationships already exist, reducing RFP lead time.

We anticipate that the Salesforce platform, augmented by its partner eco-systems apps, available on the App Exchange will meet support the ESO and its customers to continue.

2.24 330 Digitalised code management

Overview & Purpose

This investment aims to transform the stakeholder experience of the code management process through enhanced navigation capabilities, automated version control, greater clarity on relevant sections using metadata tagging, document and workflow management tools.

In the original IT investment plan, this activity was due to start in FY24. It has been agreed with business and IT stakeholders to bring this investment forward by one year, this will leverage the current ongoing activity relating to Energy Code Review where customers are being actively engaged on how to manage, visualise and amend/maintain code in the future. In addition, bringing the investment forward ensures that the solution meets Customer expectations and improves their experience.

This investment line supports sub-activity **A6.8 Digitalisation of Codes** in the ESO business plan.

A summary of the key outcomes that will be delivered by this investment as well of the corresponding RIIO-2 sub-activities is included below.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A6.8 Digitalisation of Codes	• Improved Industry Code accessibility and end user experience • Management and development of Industry Codes

Table 101 – Summary of business outcomes and corresponding sub-activities

Current State

In the original RIIO-2 plan, this investment line supported the delivery of the business plan activity A6.5 Work with all stakeholders to create a fully digitalised, whole system Grid Code by 2025. Originally there were two key commitments under this activity:

- Develop a single technical code for distribution and transmission that focussed on providing minimum standards to allow safe and secure operation of the electricity systems. This is a business led activity working with industry participants generating inputs and insights.
- Digitalise and transform the external user experience through guided navigation and search capability, guiding stakeholders to the provisions that apply to them, based on their characteristics.

Within the BP1 period the ESO business has engaged with stakeholders in the industry to seek their view on the development of a single technical code for distribution and transmission and a consultation to industry participants was issued in September 2021.

Through the work above it has become clear that the consolidation of the distribution and transmission code has a number of dependencies, particularly with the outcome of Energy Codes Review (ECR) and the timescales for completion are likely not to align with the digitalisation of code workstream.

Conversely, the digitalisation workstream is considered a no-regrets option that is independent of the outcome of the code consolidation workstream and ECR outcome. It will drive consumer benefit regardless of the code it is applied to.

As such this investment line will continue and is now aligned to A6.8 Digitalisation of code, which is concerned primarily with looking at digital solutions to enable easier access to code. In addition, the ESO has agreed to bring forward this activity by 1 year compared to the original RIIO-2 plan.

In BP1 we have started working on defining the scope of the digitalisation work by bringing users to the forefront of the solution design work. To follow on from the ESO business led activity a technical team has been established to create a design thinking period that allows the inputs to be captured and requirements validated, during this period a prototype will be constructed, and feedback requested prior to mobilising a delivery team. This customer focused team comprises of a Product Owner, UX Designer and Business Analyst.

Roadmap

Our proposed roadmap takes a pragmatic, iterative development approach to build the digitalised code solution, supported by ongoing user research and stakeholder feedback and takes into consideration the ongoing codes reform programme.

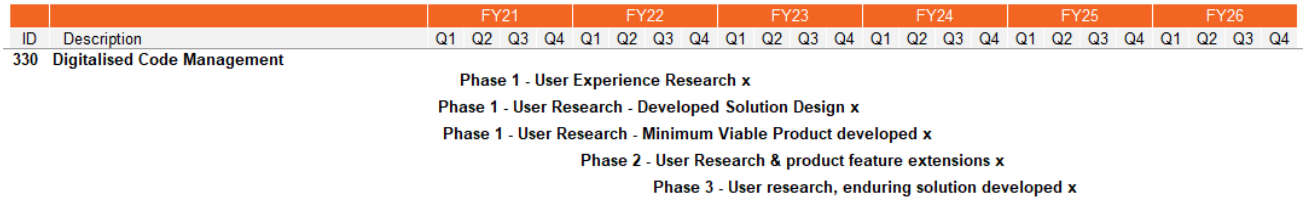

Figure 30 - Outcome roadmap

As these investments have recently started the outcome dates are still to be fully determined, they will need to be agreed and prioritised through the work in Business Plan 1

Milestone	Outcome recipient	Outcome description
Phase 1 – User Experience Research	Business units	Understand and define the problem. To validate Stakeholder groups and forums
Phase 1 – User research – developed solution design	Business units	Review vanilla products Develop Wireframes High Level Requirements Define success criteria
Phase 1 – User research – minimum viable product developed	Business units Customers & Partners	Develop MVP Test and iterative improvements on core design
Phase 2 – User research & product feature extensions	Business units Customers & Partners	Deliver added functionality Test with Business Stakeholder Define BAU process
Phase 3 – User research, enduring solution developed	Business units Customers & Partners	Launch product Refine via BAU process

Table 102 – Outcome summary descriptions

Future State

This investment will digitalise and transform the external user experience through enhanced guided navigation and search capability, which will mean stakeholders are guided to the provisions that apply to them, based on their characteristics.

This will be provided for the whole-system grid code and will be scalable to other codes in an agile phased manner. It will build on our investments in open data and digital engagement. We believe this investment will use a cloud infrastructure to make it easy to extend and scale. The IT architecture build will take place in parallel with the restructuring of the codes.

The code modification process will also be enhanced by the provision of web-based document workflow, to make the change process more efficient and accessible to stakeholders.

The following table maps Digitalised Code Management delivery and alignment to ESO's overall Target Platform Architecture. The principal subsystems and components to be delivered by this investment are listed along with a specification of the expected target state for each by the end of FY25 in BP2 delivery period.

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State
DIG-01	Digital Engagement	Digital Services	Innovation	Enhanced search, guided navigation
DIG-01	Digital Engagement	Digital Services	Digital Applications Suite	Content, Document, Visualisation and API capabilities
DIG-02	Digital Engagement	Customer	Customer Engagement	Integration with our customer engagement channels
DIG-03	Digital Engagement	Market Facilitation	Communication	Access and integration into our communications channels
DAT-03	Data & Analytics	Consistent Data Services	Integration Non-CNI	Integration with 3rd party data sources, if required

Table 103 – Future state subsystem component summaries

By the end of BP2, our expectation is that the new Digitalised Code Management solution will be in place, integrated with our Digital Engagement Platform and the mechanism for ongoing enhancements will be established.

Approach

We will build an enhanced code management hub integrated with the digital engagement platform for customers, providing a consistent user experience.

The investment will explore appropriate digital solutions to enable users to search, interpret and better understand market codes with much less manual intervention.

We propose a phased rolling out the digitalised code capability in an iterative manner:

- Phase 1 (FY23) – Market user research, development, and piloting of a Minimum Viable Product (MVP) and market testing with refinements based on pilot feedback
- Phase 2 (FY24) – Enhancements of the MVP to include additional features such as advanced navigation capabilities, meta tagging and cross-linking functionality and API capability where appropriate
- Phase 3 (FY25) – Further enhancements to code management and extensions to provide the capability to digitalise all codes as required by the business.

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP2	0.0	0.3	0.8	0.5	0.0	1.6
	BP1	0.0	0.0	0.3	0.8	0.5	1.6
	Variance	**0.0**	**0.3**	**0.5**	**-0.3**	**-0.5**	**0.0**
Opex	BP2	0.1	0.2	0.5	0.3	0.0	1.1
	BP1	0.0	0.0	0.2	0.5	0.3	1.0
	Variance	**0.1**	**0.2**	**0.3**	**-0.2**	**-0.3**	**0.0**
Cumulative RtB increase	BP2	0.0	0.0	0.0	0.0	0.1	0.1
	BP1	0.0	0.0	0.0	0.0	0.1	0.1
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Table 104 – Investment cost summary

The activity has been brought forward as it is considered by the business as a no-regrets option that is independent of the outcome of the code consolidation workstream and ECR outcome. It will drive consumer benefit regardless of the code it is applied to.

The BP2 forecast for this activity has not changed since the original RIIO2 submission, as the project is still in the very early stages of defining the scope of the digitalisation work.

The investment has been brough forward by one year, however there are no changes to the total cost of this project compared to the original BP1 plan.

The project is at the very beginning of the problem definition phase, working with users to understand the key pain points. As such the decision has been made with IT and business stakeholders to maintain the total 2.6m forecast for the BP2 submission.

For this investment we assume that the consolidation of the distribution and transmission codes will continue to progress over the BP2 period, independently of the digitalisation activity as stated in the business plan. Problem definition, scoping and end user research are starting in the first half of 2022. We expect that before final submission in August, enough progress will have been made for the project to have an outline of a solution design that can then be used to refine costs, so we do expect the forecast to be updated.

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
The capabilities identified from the design thinking cannot be met with what is available from the Digital Engagement Platform, leading to potentially separate solution and additional integration requirements	Application Development	• Clarity of requirements defined as part of the design thinking process and stakeholder feedback • Conduct a market assessment of relevant comparable tools available in the industry and their alignment to our digital strategy	3	1
Dependency on codes reform and 3rd party data sources may impact the level and extent of what can be rolled out in extension phases, leading to potential delays in delivering the complete capability.	Application Development	• Maintain Engagement with internal ESO product delivery teams • Periodic review of dependencies & programme interlocks • Review, impact assess and develop fallback options	2	1

Table 105 – Investment risk summary

Solution Options

In BP1, we will have completed the user research, outline design, epics and features required for the digitalised code solution. The following solution options will be considered for this investment:

- Extent to which we can utilise the content, visualisation, and AI capabilities from our Digital Engagement Platform, though some advanced document versioning and control capabilities may be delivered outside of this
- Review market leading COTS or SaaS solutions that may support these requirements
- Leverage or extend existing document management and visualisation tools that may provide some of these capabilities
- If the above are exhausted, then bespoke options will be considered

2.25 400 Single markets platform

Overview & Purpose

The Single Markets Platform (SMP) 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.

SMP is critical to support this reform, enabling ESO to enact change more quickly, as well as adapt to and stand-up new markets to meet the needs of the evolving industry:

- As part of a wider strategy to utilise digital ways of working to make it easier for market participants to do business with the ESO, the SMP investment will deliver a single point of entry for all market participants to undertake their end-to-end processes with ESO.
- This SMP investment will also manage and optimise the changes and integration required to upstream and downstream systems to underpin the introduction of new reformed services onto the market.

During BP2, SMP will also enable alignment and interaction with wider DSO and flexibility markets as they develop with greater levels of data exchange.

This investment line enables sub-activities **A4.3 Deliver a single day ahead response and reserve market**, **A4.4 Deliver a single integrated platform for ESO markets** and supports **A4.6 Balancing and ancillary services market reform** in the ESO business plan.

A summary of the key outcomes that will be delivered by this investment as well of the corresponding RIIO-2 sub-activities is included below.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A4.3 Deliver a single day-ahead response and reserve market • A4.4 Deliver a single, integrated platform for ESO Markets • A4.6 Balancing and ancillary services market reform	• Participation in new and enduring day-ahead response and reserve markets • Single, seamless user experience for providers of balancing services • Initial integration with DSO and flexibility markets

Table 106 – Summary of business outcomes and corresponding sub-activities

Current State

The original RIIO-2 business plan for SMP considered the development of customer-facing services such as user and asset onboarding, contract tendering as well as performance monitoring. The intention was to onboard all new reformed market services (such as new dynamic response products) via SMP and to integrate these with downstream processes and systems to provide control room availability and dispatch where appropriate.

Within the first year of BP1 we have commenced the development of the Single Markets Platform (refer to A4.4 for greater detail). The foundational release of the SMP went live in Q4 FY 22 in support of the onboarding process for new and existing day-ahead Frequency Response Markets, Dynamic Containment (DC), Dynamic Regulation (DR) and Dynamic Moderation (DM). Following its launch, developments were made to the DC service, launching DC high frequency, and permitting stacking with the Balancing Market (BM). The two other new services will see both low and high frequency products launched and stacking with the BM available to providers from "day one".

With the introduction of the first set of reformed response services (Dynamic Containment, Dynamic Moderation and Dynamic Regulation) and early impact assessment of introducing reserve services in the BP1 period, the need to make changes to downstream systems became evident. This was not factored in the original RIIO-2 submission.

We have therefore split our SMP investment line into two segments to provide for both customer-facing developments as well as changes to support new reformed services in downstream systems:

- Single Markets Platform (SMP) – will continue to provide ongoing changes and development of customer-facing systems to provide a single point of entry for market participants to transact on all ESO markets. All market related processes, including onboarding, procurement and settlement positions will be accessible through this platform
- Ancillary Services Reform (ASR) – this project will continue to deliver the necessary changes required to downstream systems and our control room processes to support the introduction of new services onto the market.

This realigned structure provides for a bimodal delivery approach, allowing faster rates of development for front-end customer-facing processes, whilst working with downstream system teams to deliver market and regulatory changes in structured releases.

From a SMP perspective during the BP1 period, we successfully selected Salesforce as our preferred platform for customer facing interactions for market participants. By the end of BP1 we expect to have established the foundational aspects of SMP, including:

- User registration
- Asset and unit registration
- Pre-qualification portal, including e-signature capability
- Service configuration to enable flexible onboarding of future ancillary products
- Maintenance of the contract lifecycle
- Reporting capability
- Support for downstream integration with balancing and settlement systems
- Foundational work to integrate our enduring auctions platform

During the later stages of BP1, we will start to align SMP with our Design System (delivered by DEP), which will provide a set of common UI component libraries, to enable the development of consistent customer facing user interfaces. We will also have started to transition to a product model of delivery, using agile iterative scrum teams and defined release trains delivering a prioritised backlog of features.

From an ASR perspective, during BP1 we initiated the introduction of new response products, Dynamic Containment, followed by Dynamic Moderation and Dynamic Regulation. These new products are procured daily using the EPEX SPOT auctions platform, a tactical solution, also sourced and implemented in BP1 which had been trialled for Firm Frequency Response (FFR) auctions.

We expect the introduction of new reserve products to be initiated in the later stages of BP1 and likely to continue into BP2. We will aim to align the product release timelines with the delivery of strategic platforms for the settlements, auction, and balancing services.

Roadmap

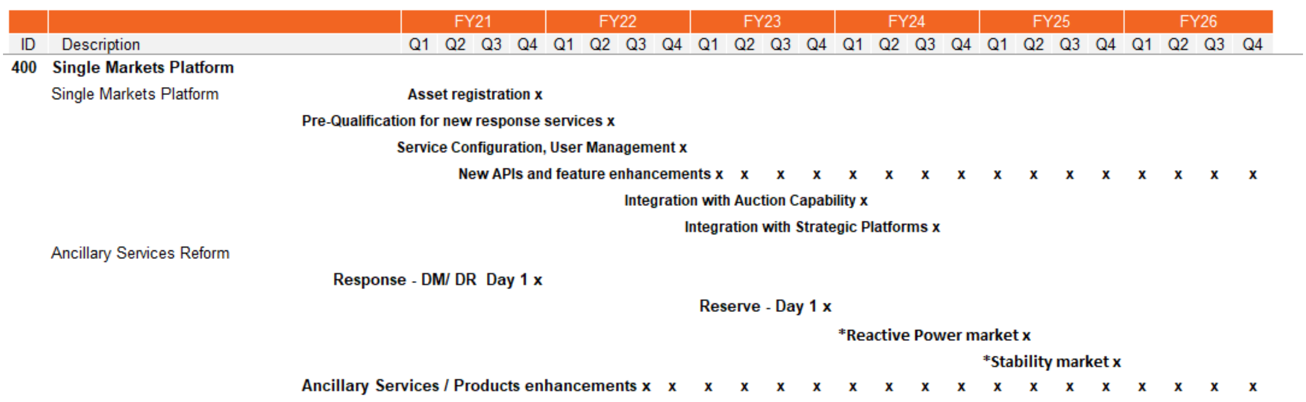

Figure 31 – Outcome roadmap

Milestone	Outcome recipient	Outcome description
SMP		
Asset Registration Pre-qualification	Customers & Partners Business units	End users can benefit from one time, one place automated self-registration and pre-qualification Reduced manual processes for business units
Service configuration, user management and Contract management.	Customers & Partners Business units	Users can manage their access in a single Portal. Reduced manual/duplication of processes. Single portal facilitates seamless end to end journey for external Market providers. Supports Internal processes Integration.
New APIs and feature enhancements	Customers & Partners Business units	Ease of access to create and manage Multiple units and Assets across services which will save time for external Market providers.
Integration with Auction Capability	Customers & Partners Business units	Market Providers will have single platform to access auction capability by facilitating bid process and access the bid results. API is built for E-Contracts to be consumed by downstream systems (Internal Users).
Integration with Strategic Platforms	Customers & Partners Business units	Market Providers have Single platform to access other functionalities like Query Management, Invoice Visibility, and performance Monitoring.
ASR		
Response DM/DR Reserve Day 1 *Reactive Power Market *Stability	Customers & Partners Business units	Customers - The introduction of new standardised products supported by automated process will grow market participation and increase competition and driving prices down in the long term. Business units - automation will remove the risk of manual error, increase operational effectiveness and data driven decision making, as systemised solutions will provide greater visibility of market data, allowing for more educated decisions to be made.
Ancillary services enhancements E.g., Response DM/DR day 2		Investment in IT will deliver new features and enhancements that will ensure ease of delivery for business and ease of use for the market participants, who can interact with the same system across the product suites with common and replicable customer experience for the various ancillary services.

Figure 32 – Outcome summary descriptions

**Reactive Power Market and Stability Market timelines are dependent on the outcome of ESO business feasibility studies.*

Future State

We anticipate a regular need for changes to SMP and back-end systems to support the introduction of new reformed products in response, reserve, stability, and reactive power markets as well as further enhancements to these products throughout BP2.

These changes will need to be managed in legacy upstream and downstream systems which are themselves being transformed in BP2. This means that changes made in legacy platforms will need to be migrated to new strategic platforms when they become available. These include:

- the new auctions platform which will provide the flexible procurement engine for new products,
- the digital and analytics platform for self-service reporting and performance monitoring of metered services,
- the digital engagement platform for managing customer identities as well as publishing open data.
- the new balancing suite used in the control room for situation awareness and near-to-real time decision-making
- the new settlement platform for handling settlements related to new reformed services

We anticipate that by end of BP2, all relevant ancillary services will be run from those strategic platforms and that any legacy/interim platform will be decommissioned where possible.

We anticipate closer integration with the upstream Connections platform, allowing us to optimise the wider Balancing Mechanism registration process, and will complete the integration with our downstream systems such as the new balancing and dispatch systems as well as the Oracle Market Settlements Manager (MSM) system. Integration will be achieved using APIs deployed via our integration middleware services.

Whilst the current focus is on the foundational functionality to support optimising across new and existing ESO markets, it is acknowledged that through RIIO-2 greater interaction with wider Distribution System Operator (DSO) markets will be required to facilitate optimised markets across distribution and transmission requirements. Industry platforms will need to integrate more closely over time to ensure that there is visibility across ESO and DSO / Flexibility markets to optimise participation and facilitate real time transparency of what assets are participating in which markets at any time. SMP will have a key role to play in providing visibility of these assets as markets evolve and as we better understand the nature of data exchange between ESO, DSO and market operators.

The following table maps the Single Market Platform delivery and alignment to ESO's overall Target Platform Architecture. The principal subsystems and components to be delivered by this investment are listed along with a specification of the expected target state for each by the end of FY25 in BP2 delivery period.

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State
DIG 02	Digital Engagement	Customer	CRM Workflow	Managing workflows in SMP
DIG 02	Digital Engagement	Customer	Customer Engagement	Core markets platform capability in Salesforce CRM
DIG 03	Digital Engagement	Market Facilitation	Data Exchange	Management of data exchange with internal systems and 3rd party systems
DIG 03	Digital Engagement	Market Facilitation	Communication	Managing communication channels with our customers
DIG 03	Digital Engagement	Market Facilitation	Market Sandbox	A sandbox capability to simulate or train market participants
DIG 03	Digital Engagement	Market Facilitation	Tendering / Auction	Alignment with our enduring auctions platform
DIG 03	Digital Engagement	Market Facilitation	Customer Markets Portal	Portal functionality for markets
COM 03	Commercial & Markets	Settlements	Settlements	Integration with our Oracle MSM service
BAL 02	Balancing	Energy Trading	Trading Auction	Integration with future trading platforms
DAT 02	Data & Analytics	Analytics & Insight	Internal Reporting	DAP reporting for insights and market reports

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State
DAT 02	Data & Analytics	Analytics & Insight	Predictive Analytics	Analytical reporting from our DAP for market participants
DAT 02	Data & Analytics	Analytics & Insight	Data Lake	Data harvesting for the DAP
DAT 02	Data & Analytics	Analytics & Insight	Workflow Automation	Managing workflows between SMP and DAP
DAT 03	Data & Analytics	Consistent Data Services	Integration CNI	Integration with downstream control room systems
DAT 03	Data & Analytics	Consistent Data Services	Integration Non-CNI	Integration services with auctions and other business applications
DAT 06	Data & Analytics	Modelling	Economic Modelling	Data modelling within DAP for markets
DAT 07	Data & Analytics	Regulatory Reporting	Information Provision	Provision of regulatory reports
BAL 01	Balancing	Balancing Communications	Data Exchange	Transfer of contract and availability information to control room balancing systems
BAL 03	Balancing	Energy Balancing	Balancing Services	Changes required in balancing service to deliver changes for ASR

Figure 33 – Future state subsystem component summaries

Approach

Through BP2, we anticipate continued development of SMP and back-end system changes with process rationalisation, as new reformed products in response, reserve, stability, and reactive power markets are introduced and further enhanced.

In BP2, we intend to exploit this platform to deliver significant enhancements and greater levels of integration with our platform eco-system. Functional changes will largely focus on providing a harmonising the market providers experience by ensuring easy and efficient access to onboarding, market operations and reporting services. This will be supported by customer-centric developments, building on our foundational releases in BP1. We will leverage our strategic integration middleware platform to develop API-driven integration with subsystems (such as DEP, DAP, Settlements, and other downstream systems).

We will also leverage Salesforce's out of the box connectors and integration patterns, as well as their application exchange to deliver new functional and technical capabilities in BP2.

Adopting the product model for SMP, we have set up an enduring product team to manage and deliver functional developments of defined products over the course of BP1 and BP2, in alignment with market reform activities and the introduction of new market products.

Following an iterative agile delivery approach, SMP will deliver prioritised functional capabilities based on value to the customer and informed by user research, industry consultation and stakeholder engagement (e.g., show and listen seminars), through each release. 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.

The ASR workstream will manage the delivery of required changes to the downstream systems including auctions, settlements, balancing and reporting system. The impact on these systems will be assessed, prioritised alongside other changes that are managed by downstream system backlogs, and delivered as part of downstream system releases. Given that our downstream systems themselves are being transformed (e.g., settlements, balancing suite), we will prioritise developments onto strategic platforms where possible, but recognise that some changes, will of necessity, need to be delivered in legacy platforms.

We will work closely with the relevant delivery teams to align our delivery approach, taking into consideration timing of new capability commissioning as well as prioritising backlog to align to our delivery schedules. Wherever possible, technical options for delivery will aim to minimise technical debt on legacy platforms.

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP2	4.6	6.4	6.4	6.3	6.3	29.9
	BP1	3.1	3.1	2.2	1.2	1.3	11.0
	Variance	**1.5**	**3.3**	**4.2**	**5.0**	**5.0**	**19.0**
Opex	BP2	0.6	0.7	0.8	0.5	0.5	3.1
	BP1	2.1	2.1	1.5	0.8	0.9	7.3
	Variance	**-1.5**	**-1.4**	**-0.7**	**-0.3**	**-0.3**	**-4.2**
Cumulative RtB increase	BP2	0.2	0.8	1.3	1.4	1.4	5.1
	BP1	0.0	0.6	1.1	1.5	1.8	5.0
	Variance	**0.2**	**0.2**	**0.2**	**-0.1**	**-0.4**	**0.1**

Figure 34 – Investment cost summary

Since the original RIIO2 submission, the following work has been completed which has allowed the programme to refine its forecast:

- A bottom-up review of the SMP backlog of requirements has taken place, justifying the sustained use of 2 scrum teams to deliver backlog from FY23.
- For ASR, learnings from the Dynamic Moderation and Dynamic Regulation launches have provided better understanding and visibility of the backlog of change across the user journey downstream of the onboarding process, including interactions with auctions, performance reporting and settlement, increasing forecasts and estimates for implementation.
- Original ASR numbers did not reflect costs of change relating to Balancing Mechanism (BM), to support the introduction of Response and Reserve products in FY23. Those changes are required in the legacy platform attracting a higher cost of change. If cost of change on the new strategic Balancing platform are still unknown, forecast assumes a lower cost compared to legacy BM/non-BM costs.

In addition, the original forecast has been updated to reflect additional considerations. Specifically:

- Consideration of wider set of products, including contract management
- This forecast also now includes integration with downstream systems that are needed to provide the E2E user experience for market participants who engage in ancillary services

Finally, this investment forecast includes migration/decommissioning of legacy systems, previously were not accounted for in original numbers. Our working assumptions are:

- This forecast assumes strategic platforms (Auction capability, Settlement, Charging and Billing platform, Enhanced Balancing Capability, Data and Analytics Platform) will be in place from end of FY24 – Additional costs will be incurred if changes are to be conducted on legacy platform (e.g., EBS)
- The current assumption is that this investment will perform the development and delivery of at least 2 new products per year, with regular enhancements to these products thereafter.
- FY24 – Delivery of Reserve and Development of Reactive powers + enhancement to launched services + migration from legacy systems to strategic platforms. Reactive powers and Stability are subject to the outcome of feasibility study carried out by the ESO business during the BP2 period.
- FY25 – Delivery of Reactive power and Development of Stability + enhancement of launched services.

- FY26 – Delivery of Stability and any new projects (issued from Pathfinders or other requirements) + enhancement of launched services
- This forecast assumes Auctions changes are covered by 420 Auction capability investment line.

The forecast is a snapshot in time, with the best information available at the time of writing, and we expect that there could be further changes ahead of the final submission in August as we progress our understanding of each proposed change or as decisions are made at industry level. We identified the following dependencies when producing this investment forecast:

- The ESO business further clarifying their requirements, which may lead to further system changes
- The ESO business further updating their Product release roadmap, which may shift the cost of development and delivery earlier or later to support the product release
- The IT organisation further updating their strategic platform delivery timelines. Any delay to the delivery of underpinning strategic system will either delay costs or add additional costs of implementation on and migration from legacy platforms.
- Additional projects may be added as part of this investment (e.g., Interconnectors for Dynamic Containment could be considered as an Epic to add on the Ancillary Services Reform backlog) to either deliver new products or specifics requirements to these products – if so, an impact assessment will be conducted, and forecasts will be increased to reflect the additional budget requirements to deliver accordingly.

As such we expect this forecast to change before August 22, particularly for FY23.

As noted in the introduction to Part 3 – Technology Investments, this item is signalled as having higher uncertainty, and we are therefore providing a cost range. Make up of the cost range is detailed below. This investment will go through additional external assurance between April and August to help give confidence on the final cost submissions.

Investment	Whole RIIO2 FD	Whole RIIO2 BP2 data tables/TBM submission	Variance	Whole RIIO2 proposed range
Single Markets	18	33	(15)	23-33

Figure 35 – Investment cost range summary

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
Single Markets Platform development cannot keep pace with the changes required to support new reformed market services. Leading to delays in adoption of these services	Application Development	• Continued refinement and prioritisation of SMP backlog throughout RIIO-2 period • Ensure SMP backlog is integrated with other backlogs to ensure dependency alignment. • Employ flexible and adaptable release strategy based on agile delivery principles to align with new market service requirements. • Enable Salesforce support team to effectively prioritise investments based on likelihood and impact of system problems.	3	2

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
Strategic platforms are not available, and changes need to be completed on legacy platforms, leading to regret spend and increase in use of grey IT solutions.	Application Support & Operations	• Align product roadmap to IT strategic platform roadmap • Align product feature release roadmap (Day 1, Day 2 release) to IT Strategic roadmap.	1	2
Electricity Balancing Guidelines (EBGL) and Ofgem consultations may delay the launch of new services	Program, Product & Project Management	• Work closely with business SMEs to understand lead times for consultation outcomes.	1	1

Figure 36 – Investment risk summary

Solution Options

In BP1, we reviewed our requirements for SMP and recognised that they can be met with market leading Customer Relationship Management (CRM) platforms. We assessed several best of breed products, including low-code platforms, fully formed CRM platforms, including our own Salesforce platform. Salesforce was selected as our preferred platform based on the following factors:

- Salesforce is one of the leading market products for CRM and can meet most of the requirements identified by SMP customers and stakeholders
- A CRM Salesforce development and support capability is already established within NGESO that can be leveraged at pace and scale to meet future needs.
- Establishing a custom solution with a dedicated team with the necessary skills and experience to maintain the platform would be prohibitively costly, representing poor value to industry and consumers.

We anticipate that the CRM Salesforce platform will provide capabilities identified in this investment through BP2.

2.26 410 Ancillary services settlements refresh

This investment has been superseded by **610 Settlements, Charging & Billing**

2.27 420 Auction capability

Overview & Purpose

This investment aims to deliver an enduring auction capability to unlock more efficient auction-based procurement activities and facilitate closer to real time procurement whilst co-optimising across our products. This auction capability will improve the procurement experience of how parties participate in our markets and provide ESO with much greater flexibility and support changes such as enhanced bidding granularity and the ability to expand and facilitate new services to be integrated in a timely efficient manner.

In selecting the right partner, we will ensure sound integration with wider IT projects such as the single markets platform to deliver a great user experience for both our internal and external stakeholders.

This investment enables sub-activity **A4.3 Deliver a single day ahead response and reserve market**, specifically aligning with deliverable **D4.3.5 Auction capability**.

A summary of the key outcomes that will be delivered by this investment as well of the corresponding RIIO-2 sub-activities is included below.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A4.3 Deliver a single day-ahead response and reserve market	• Single platform for the procurement of response and reserve ancillary services on an enduring basis

Table 107 – Summary of business outcomes and corresponding sub-activities

Current State

Under BP1 we enabled the day-ahead procurement of Short-Term Operating Reserve (STOR) on the cloud-based software Salesforce and Dynamic Containment on the EPEX platform. Procuring these services much closer to real time and operating the supporting business activities for day-ahead auctions compared to our traditional weekly, monthly, or annual manual procurement routes, has provided greater flexibility to market participants and ability for ESO to be more dynamic in our procurement strategies to meet operational scenarios.

We are in the process of running an open tender procurement event to select a partner for our enduring auction capability and the project is on track to select this partner in Q1 FY23. Part of this process is ensuring we select a partner with the right capabilities that will enable us to expand on the functionality and opportunities identified through the early operation of day-ahead markets.

To help support this activity we have bought in a supplementary FTE to be the product owner of the enduring solution. Whilst this enduring work is underway, ESO will continue to procure our new services via day-ahead mechanisms and make appropriate improvements to ensure we continue to realise the benefits of closer to real time procurement. Learnings from running daily auctions on both Salesforce and EPEX SPOT will continue to be embedded in the enduring auction tender work.

Roadmap

		FY21				FY22				FY23				FY24				FY25				FY26			
ID	Description	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
420	**Auction Capability**																								
	Vendor selected x																								
	Response products on Auction capability MVP x																								
	Reserve products running on Auction Platform x																								
	Integration with SMP x																								
	Capability enhancements to support new products and integration with other platforms x																	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**

Figure 37 – Outcome roadmap

Milestone	Outcome recipient	Outcome description
Vendor selected	Business units	Partnership with an experienced, market leading provider of auction platform, algorithm development and consultancy services.
Response products on Auction Capability MVP	Customers & Partners Business units	Customers - The introduction of a new single solution supported by automated process will provide a co-optimised algorithm to procure day ahead response services. Business units - automation will remove the risk of manual error, increase operational effectiveness and data driven decision making, as systemised solutions will provide greater visibility of market data.
Reserve products on Auction Platform	Customers & Partners Business units	Customers - The introduction of a new single solution supported by automated processes and an efficient algorithm to procure day ahead reserve services.
Integration with SMP	Customers & Partners Business units	Market participants are able to benefit from one time, one place to view auctions they are eligible for, submit bids and view auction results. NGESO will benefit from reduced manual processes for business units, using APIs built to be consumed by downstream systems.
Platform capability enhancements to support new products and integration with other platforms	Customers & Partners Business units	Replacement of interim solutions for the procurement of day-ahead ancillary services, to provide a single route to market. Increased automation of existing manual processes.

Table 108 – Outcome summary descriptions

Future State

As we develop our new response and reserve services, we are exploring a range of solutions to deliver an efficient frequency market. Part of this work is creating a longer-term procurement strategy which spans response and reserve looking at how the products interact with each other operationally and commercially, and the wider market. For example, in BP2 we will be looking at auction timings and the order in which we buy these services. A large part of deciphering how these services interact, and how the market rules/algorithms are designed to ensure maximum co-optimisation and market efficiency will be a key output from the work with our enduring auction partner.

As we transition into BP2 the enduring auction project will be moving into delivery phase. The implementation of the enduring capability functionalities and the enrolling of markets onto the platform will take place in a phased approach, starting with the newly introduced services during the BP1 period.

As we move all of these new markets onto the enduring auction capability, we will introduce, where appropriate, enhanced features to improve user experience and enhance automation and system integration with Single Markets Platform. This will enable ESO to procure services more flexibly whether, this be through enhanced granularity (e.g., such as procuring by settlement period), requirement setting or streamlined route to market. Those features will overall unlock additional value for both ESO, industry and the end consumer.

By the end of the BP2 period, this investment will be aiming to deliver the following benefits:

- Facilitate closer to real-time-procurement-events.

- Increased market efficiency, reducing barriers to entry, improved market pricing signals and additional product options.
- More efficient and transparent auction-based procurement activities.
- Transitioned to more complex forms of co-optimisation to continue to drive value for the end consumer.
- An enhanced user experience for both our internal and external stakeholders making it easier and more effective to participate in our markets.
- A flexible solution that can accommodate change and addition of new services.

In BP2, we will align the delivery of enhancements to the auction platform to the SMP and Ancillary services product roadmap.

Continued development of auction algorithms and enhancements to the capability during BP2 will be achieved by our product teams using a coordinated release strategy for both upstream (participant onboarding) and downstream (balancing and settlement) processes.

The following table maps the new Auctions capability delivery with ESO's overall Target Platform Architecture. The principal subsystems and components to be delivered by this investment are listed along with a specification of the expected target state for each by the end of FY26 in BP2 delivery period.

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State
DIG 03	Digital Engagement	Market Facilitation	Tendering / Auction	Alignment with our enduring auctions platform
DIG 03	Digital Engagement	Market Facilitation	Communication	Managing communication channels with our customers
DIG 02	Digital Engagement	Customer	Customer Engagement	Integrate with SMP for bid submission and auction results
DIG 03	Digital Engagement	Market Facilitation	Data Exchange	Management of data exchange with internal systems and 3rd party systems
DIG 03	Digital Engagement	Market Facilitation	Market Sandbox	A sandbox capability to simulate or train market participants
COM 03	Commercial & Markets	Settlements	Settlements	Integration with our Oracle MSM service via SMP and DAP
DAT 02	Data & Analytics	Analytics & Insight	Internal Reporting	DAP reporting for insights and market reports
DAT 07	Data & Analytics	Regulatory Reporting	Information Provision	Provision of regulatory reports

Table 109 – Future state subsystem component summaries

Approach

Building on from the foundation auction capability (MVP) delivered at the early stages of BP2, the programme will continue to future-proof and enhance ESO enduring auction capability considering user research at every step of the development.

We will continue to work with the selected vendor to expand and scale the platform to accommodate for the procurement of further ancillary services, such as reserve or reactive.

As the organisation moves to a Product Model, a core Product Team will capture and manage and prioritise the backlog of requirements for changes to be delivered by the vendor on the platform

This approach will give the programme the required flexibility to deliver customer value faster and earlier in the lifecycle.

As more products are procured through the platform, we will collaborate with strategic programmes and product teams such as '180 Enhanced balancing capabilities' and the '610 Settlements, Charging and Billing' ultimately integrating the auction capability with:

- The Single Markets Platform to provide a common participant experience across common processes such as market registration, settlement, and billing.
- The Settlement system
- The Data and Analytics Platform to deliver advanced reporting capability
- The Future of Balancing modules

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP2	0.0	2.5	1.7	1.3	1.1	6.7
	BP1	0.0	0.0	0.0	0.0	0.0	0.0
	Variance	**0.0**	**2.5**	**1.7**	**1.3**	**1.1**	**6.7**
Opex	BP2	0.6	0.2	0.1	0.1	0.1	1.1
	BP1	4.0	2.0	2.0	0.0	0.0	8.0
	Variance	**-3.4**	**-1.8**	**-1.9**	**0.1**	**0.1**	**-6.9**
Cumulative RtB increase	BP2	0.0	0.0	0.7	0.9	1.0	2.7
	BP1	0.1	0.5	0.8	1.0	1.0	3.4
	Variance	**-0.1**	**-0.5**	**0.0**	**-0.1**	**0.0**	**-0.7**

Table 110 – Investment cost summary

The forecast for this programme has been revised, based on two key factors:

- The programme is at RFP stage, however in January 2022, the programme received initial high-level quotes from 4 shortlisted vendors, which have allowed a clearer view of potential costs.
- In the original numbers anticipated that the project would close in FY24. Subsequently the business agreed the requirement to maintain a capability to continuously deliver the enhancements to the platform throughout the BP2 period. The new forecast accounts for that requirement.

In producing this forecast we made the following assumptions:

- Auction platform MVP is delivered in March 23 or Q1 FY24. We assume that the initiative will continue post 2024 (initial closure date for the project) despite a slight decrease in activity, to support the delivery of any regulatory-related change, and the necessary changes related to the implementation and auctioning of new Products onto the market.
- This forecast accounts for changes required for the procurement of reformed products on the platform (e.g. response, reserve, reactive, stability…), and further integration with SMP, DEP and DAP. It will also fund any changes required to algorithm to keep the currency, regulatory compliance, and performance of the platform.
- An enduring team has been set up around a product model to manage change. In the event the backlog of requirements exceeded the capacity of the team, additional costs would be incurred to be able to deliver those.

We expect the costs to be further refined prior to the August final submission pending the outcome of the procurement activities due to be finalised in May 2022 as the vendor get selected.

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
API capabilities required to support SMP integration are not available in time for the auction's MVP release leading to an incomplete product / delay in launch	Application Development	• Ensure early engagement with API and SMP teams to ensure alignment with delivery timescales • Include API capabilities in SMP and Auction's backlog	2	1
Algorithm requirements in the Auction platform are too complex to deliver within the agreed MVP timescales leading to an incomplete product / delay in launch and complex support model	Application Support & Operations	• Collaborate with product team to establish clarity of scope for MVP release • Engage early on with business SMEs to design required algorithms	2	1
Electricity Balancing Guidelines (EBGL) and Ofgem consultations may delay or request enhancements to the auction's capability	Program, Product & Project Management	• Work closely with business subject matter experts (SMEs) to understand and manage lead times for consultation and reflect those into the delivery plan	2	1
There is a risk that market evolution creates additional requirements that programme backlog is unable to absorb, leading to delays to meet those needs or additional costs to increase capacity.	Program, Product & Project Management	• Build programme delivery roadmap in partnership with business to ensure alignment and synergies can be leveraged throughout • Work with business SMEs to ensure early visibility of market trends and build those in the contingency plan	2	1

Table 111 – Investment risk summary

Solution Options

In BP1, a number of tactical solutions were implemented to support the launch of new market services, delivering value to our customers, and meeting our RIIO-2 commitments. These included:

- a day ahead solution in Salesforce for Short Term Operating Reserve (STOR) in response to regulatory changes resulting from Clean Energy Package (CEP6.9).
- a solution for weekly Firm Frequency Response (FFR) auction trials, based on EPEX SPOT
- early developments of a day ahead solution for response products (Dynamic Containment, Regulation and Moderation), delivered using EPEX SPOT, building on the work from FFR.

Given the continued need for greater levels of flexibility for closer to real-time procurement, we examined solution options for an enduring auctions capability that could meet future needs. The following options were reviewed:

- Build bespoke day ahead algorithms using Salesforce
- Build bespoke solution using low-code alternatives
- Extend and enhance EPEX SPOT for future needs
- Undertake a tendering event to procure a leading day ahead solution that could be adapted to market evolution.

The tendering option was chosen as market research indicated that flexible and scalable products were available which could meet future functional needs but also provide a strong api-driven architecture, that will support integration with our strategic platforms.

We have commenced this exercise via open tender and plan to complete vendor selection by Q1 FY23, with an MVP release planned for Q1 FY24. Further enhancements releases will be planned for delivery during BP2.

2.28 610 Settlement, Charging & Billing

Overview & Purpose

This investment has replaced 3 investment lines in the original RIIO-2 business plan:

- 290 Charging and billing asset health
- 300 Charging regime and CUSC changes
- 410 Ancillary services settlements refresh

Investment lines 290 and 410 key deliverables were to replace and decommission the legacy Charging and Billing System (CAB) and Ancillary Services Business (ASB) systems during the BP1 period. Additionally, investment 300 was created to make funds available for "in year" impact assessment and minor system changes, relating to Connection and Use of System Code (CUSC) regulatory changes within the legacy CAB and ASB systems, until the strategic replacement platform could be sourced and implemented as per plan outlined in investments 290 and 410.

This updated investment line, 610 Settlements, Charging and Billing, rationalises the previous submission by aligning it with the new Settlements and Charging business landscape, supporting the NGESO transition to a product model methodology designed to deliver continuous and sustained changes to the Oracle MSM system more efficiently.

This includes upgrades, fixes and impact assessments to the platform as required by business users as well as regulatory change, which is set to increase over the BP2 period as a result of industry wide initiatives such as BSUoS and TNUoS reform. The costs are based on an assumed level of change during the timeframe therefore a level of estimation was used to outline the size of the continuous delivery team.

The 610 Settlements, Charging and Billing is aligned to business sub-activities **A6.3 Industry Revenue Management**, **A6.1 Code management / market development and change**, **A6.7 Fixed BSUOS tariff setting**, with secondary benefits to **A4.1 Manage balancing services and markets** and **A4.3 Deliver an integrated single day-ahead response and reserve market**.

A summary of the key outcomes that will be delivered by this investment as well of the corresponding RIIO-2 sub-activities is included below.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A6.3 Industry revenue management • A6.1 Code management / market development and change • A6.7 Fixed BSUOS tariff setting • A4.1 Manage balancing services and markets • A4.3 Deliver a single day-ahead response and reserve market	• Management, collection, and dispersal of charges to operating system (Revenue Management) • Ancillary services settlements for existing and new services

Table 112 – Summary of business outcomes and corresponding sub-activities

This investment will support the delivery of the following business outcomes over the BP2 period:

- 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.
- Support the need for increased calculation complexity, data and market demands from revenue streams.
- Greater flexibility and reduced cost to change, removing manual processes and offline tools, thus reducing the risk of human error.
- A user-friendly system interface, meeting the ever-growing business demand for intuitive and easier to use tools.
- Scalability, delivered by a modular platform architecture - important to manage changes brought about by market disruption, for instance, significant increases in the number of market participants.

- Continuous enhancement of the system to add new services in response to evolving market requirements

Current State

In the BP1 period, the programme completed the tender process and selected Oracle MSM as the system of choice to replace ASB and then later confirmed to replace CAB rather than enhancing the existing system.

To reduce overall costs and gain synergies the two programmes were amalgamated into one product team, furthermore we invested in pivoting the delivery into a product team during FY22.

Having now fully onboarded the required suppliers, the product team is progressing towards delivering its phased first go live in FY23.

In the final year of the BP1 period the programme will migrate two ancillary services onto the new system: Short Term Operating Reserve (STOR) and Assistance for Areas with High Electricity Distribution Costs (AAHEDC).

By March 2023 the programme's product team will have completed the implementation of STOR and AAHEDC and deliver a number of significant regulatory changes arising from the BSUoS charges reform and Ofgem's Targeted Charging Review (TCR) concerning the Transmission Demand Residual (TDR) such as CMP 343 and 335/336. A detailed list of all regulatory changes due to be implemented during the BP1 period can be found in the roadmap section of this chapter.

By the end of the BP1 period the programme will also have established its Product team composed of 4 enduring Agile development teams to continue to migrate the remaining existing ancillary services and deliver regulatory change. This will transition the team to a continuous delivery model.

Roadmap

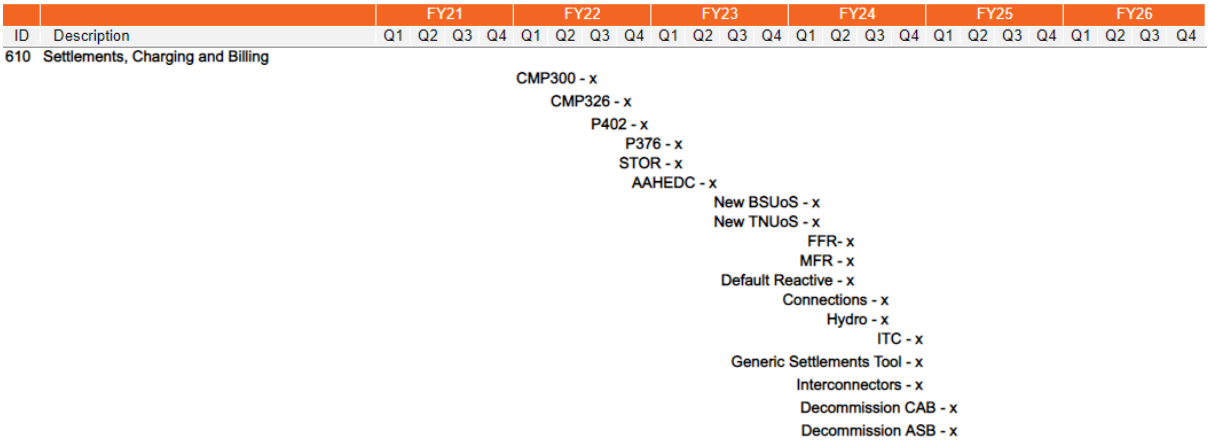

Figure 38 – Outcome roadmap

Milestone	Outcome recipient	Outcome description
CMP300	Customers & Partners	Seeks to improve the cost reflectivity of the Response Energy Payment ("REP") for Balancing Mechanism Units ("BMUs") with low or negative marginal costs, as a consequence of having a Contract for Difference ("CfD")
CMP326	Customers & Partners	To introduce a 'Turbine Availability Factor' into the CUSC to enable accurate calculation by the NGESO Control Centre and consequently accurate settlement of the Frequency Response

		capability of PPMs when some of the turbines on site are unavailable.
P376	Customers & Partners	This will decouple the expected volume used in Settlement from the Physical Notification used by the NETSO for dispatch. This change will allow Balancing Service Providers to be fully recompensed for their actual change from normal usage and the impact this change has on the system, thus enabling greater participation.
P402	Business units Customers & Partners	Ability to directly ingest and store LSDO and BSCCo data within ESO, this solution does not require Elexon and is a first step in open data exchanges, this data is required for New TNUoS
New BSUoS and New TNUoS	Business units Customers & Partners	Creation of a new service from legacy CAB to Oracle MSM, integration of data and enhanced reporting outputs leveraging Oracle Analytics and PowerBI, allowing the business to automatically share reports with customers. This milestone also delivers the changes required for the ESO to comply with regulatory changes for TDR/TGR and BSUoS and TNUoS reform CMP334, CMP343 &CMP335, CMP369/368 plus CMP362, CMP361 and P419
Short term operating reserve (STOR) Assistance for Areas with High Electricity Distribution Costs (AAHEDC) Firm frequency response (FFR) Mandatory Frequency Response (MFR) Default Reactive Connections Hydro ITC Interconnectors	Business units Customers & Partners	Migration of ancillary services settlement process from legacy ASB to new Oracle MSM system, data integration, resulting in reduction in business manual processes. Enhanced reporting outputs using Oracle Analytics and Power BI will allow business to automatically email customers
Generic Settlements Tool	Business units	Functionality to replace manual processes within the Settlements team and ensure controls are in place to collate and extract data over 7 processes
Decommission CAB and ASB	Business units	Removal of interfaces, data exchanges and physical servers/hardware.

Table 113 – Outcome summary descriptions

Some epics listed above may not yet be approved or have cost estimates and others are likely to be broken into a suite of sub modifications that will have independent delivery forecasts, this activity will look to reduce overall costs and delivery complexity where possible.

Future State

In BP2, we will build on our foundational releases of Oracle MSM in BP1, by extending functional features to support statutory, regulatory, customer and market-driven changes. We will also integrate MSM with our digital platforms such as DEP and SMP. Further integration with our DAP platform will allow us to enhance our reporting and analytics functionality which is commencing in FY23

Our product model approach will put in place a dedicated delivery team to improve cadence and reduce overall costs, by removing the need to mobilise and demobilise resource, reducing waste associated with sanctioning, onboarding people, outlining requirements and the delays around such activities.

Throughout BP2 the team will continue to migrate ancillary services settlement processes into the Oracle MSM platform including Firm frequency response (FFR), Mandatory Frequency Response (MFR) as outlined in the roadmap section.

By the end of BP2, we will be using an efficient, agile driven release strategy to deliver functional and technical changes to the MSM platform as well as API integration.

The following table maps the Settlements, Charging and Billing delivery and alignment to ESO's overall Target Platform Architecture. The principal subsystems and components to be delivered by this investment are listed along with a specification of the expected target state for each by the end of FY26 in BP2 delivery period.

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State
COM 01	Commercial & Markets	Charging & Billing	Charging & Billing	Core Oracle MSM
COM 03	Commercial & Markets	Settlements	Settlements	Core Oracle MSM
DAT 02	Data & Analytics	Analytics & Insight	Data Lake	Harvesting data from Oracle MSM
DAT 02	Data & Analytics	Analytics & Insight	Internal reporting	Self-service advanced analytics & reporting
DAT 02	Digital Engagement	Analytics & Insight	Predictive Analytics	Analytical reporting
DAT 03	Digital Engagement	Consistent Data Services	Integration – CNI	Integration with downstream systems
DAT 03	Digital Engagement	Consistent Data Services	Integration – Non-CNI	Integration with downstream systems
DIG 01	Digital Engagement	Digital Services	Digital Applications Suite	Integration with DEP
DIG 02	Digital Engagement	Customer	CRM Workflow	Workflows with SMP
DIG 02	Digital Engagement	Customer	Customer Engagement	To manage customer queries
DIG 03	Digital Engagement	Market Facilitation	Customer Markets Portal	Integration with SMP
DAT 06	Data & Analytics	Modelling	Economic Modelling	Analytical modelling
DAT 07	Data & Analytics	Regulatory Reporting	Information Provision	Provision of reporting to the regulator

Table 114 – Future state subsystem component summaries

Approach

Our overall approach is, once implemented, is to maintain the currency of the Oracle MSM system to ensure it supports statutory as well as regulatory requirements. This investment will also maintain the asset health of the system throughout the BP2 period with periodic upgrades and service enhancements.

We will use a product model to maintain pace on delivering changes, using an agile iterative approach, to support regulatory, customer-driven and maintenance requirements.

Regulatory change will be delivered in line with Ofgem and industry demand but remains challenging to forecast due to the naturally dynamic nature of the modification engagement process. A process has been set up to review and assess proposed modifications at the earliest opportunity with a view to reaching a consensus on our delivery pipeline with all stakeholders.

In some instances, regulatory modifications may be referenced in more than one part of this submission. This reflects the wider impact of regulatory change across the entire ESO IT infrastructure.

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 the ESO Data and Analytics Platform (DAP) and published on the Digital Engagement Platform (DEP).

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP2	8.5	7.0	4.8	4.8	4.8	29.9
	BP1	4.7	0.7	0.7	0.7	1.9	8.5
	Variance	**3.9**	**6.3**	**4.2**	**4.2**	**2.9**	**21.4**
Opex	BP2	0.3	0.8	0.1	0.1	0.1	1.4
	BP1	3.1	0.4	0.4	0.4	1.3	5.7
	Variance	**-2.8**	**0.4**	**-0.3**	**-0.3**	**-1.2**	**-4.3**
Cumulative RtB increase	BP2	0.3	1.4	2.0	2.1	2.3	8.2
	BP1	0.5	0.7	0.7	0.7	0.7	3.3
	Variance	**-0.2**	**0.8**	**1.4**	**1.4**	**1.5**	**4.9**

Table 115 – Investment cost summary

As indicated earlier in this chapter, this investment line is the product of the consolidation of 3 activities in the original BP1 plan: 290 Charging and Billing Asset Health – primarily concerned with the maintenance of the SAP-based Charging and Billing System (CAB) ; 410 Ancillary Services refresh – primarily concerned with replacement of the Ancillary Services Business system and 300 Charging Regime and CUSC changes – put in place to ensure funding was available over BP1 to deliver regulatory change.

The ESO Settlements and Revenue landscape has changed considerably since the original BP1 plan was drafted and as a result, so have the costs for this particular investment. The overall investment has increased by £22m overt the full 5 years of the RIIO2 period.

Our cost change drivers can be summarised as follows:

- **The decision to replace CAB** – the original BP1 plan, and its forecast, assumed that the ESO would re-engineer of the legacy CAB system and continue to run it for the foreseeable. During BP1, the decision was made, with the ESO Settlements and Revenue leadership team, to completely replace the legacy CAB system with Oracle MSM instead, which had already been sourced as the ASB replacement system. The complete replacement of CAB represented an opportunity to

rationalise ASB and CAB under a single delivery and eventually product team and future proof the ESO against the increasing pace of regulatory and market change.

As a result, the costs of replacing CAB in its entirety were not accounted for in the original submission, which has caused a significant delta between BP1 the BP2 forecast.

- **Increased regulatory change demand** – The regulatory change landscape has also changed in the past two years. We have seen an increase in the number of regulatory changes impacting settlements and revenue processes, requiring the ESO to dedicate more resources for the delivery of those changes, whilst maintaining the required team to deliver the implementation of the new system and the migration of ancillary services settlement processes. Please refer to the roadmap section for details of those changes.

As noted in the introduction to Part 3 – Technology Investments, this item is signalled as having higher uncertainty, and we are therefore providing a cost range. Make up of the cost range is detailed below, this investment will go through additional external assurance between April and August to help give confidence on the final cost submissions.

Investment	Whole RIIO2 FD	Whole RIIO2 BP2 data tables/TBM submission	Variance	Whole RIIO2 proposed range
Settlements, charging and billing	14	31	(17)	24-31

Table 116 – Investment cost range summary

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
Regulatory changes may impact our ability to deliver functional changes to support reform of new ancillary services leading to delays bringing online new reformed services in line with our published roadmaps	Program, Product & Project Management	• Develop detailed release plan to align with regulatory changes alongside reform driven changes and customer enhancements backlog	5	2
Resources delivering within BP1 leave leading to disruption to cadence and ability to deliver	Program, Product & Project Management	• Building core Product team • Assessing Perm vs Contractor roles to ensure roles are filled to support maturing the continuous delivery team	3	2
Additional Regulatory and non-Regulatory activity is added to the backlog leading to the possibility of ESO triggering pass through funding mechanism to deliver all regulatory change	Program, Product & Project Management	• Business and strategy prioritisation and alignment	5	3

Table 117 – Investment risk summary

Solution Options

The ESO utilises two legacy systems in its Revenue and Settlements function: SAP-based Charging and Billing (CAB) and Ancillary Services Business (ASB).

The Settlements, Charging and Billing Programme, along with business stakeholders considered the following options when assessing the needs and potential routes to deliver the maximum value to ESO and its customers:

- To remediate and address critical paint points in legacy SAP-based system
- To re-engineer legacy system though major architectural changes and re-use of National Grid apps to fulfil business requirements
- To procure a best of breed product through open tender event

The tender route was chosen, and the preferred solution was narrowed down to Oracle MSM through various stages of options analyses including a feasibility analysis (F&A) study, RFI and full RFP process. A deep dive of Oracle MSM capabilities was then undertaken to determine whether it could meet the business requirements.

Oracle MSM was then selected as the strategic settlements and revenue processing system as it could meet the functional flexibility to quickly adapt to market rule changes as well as self-service automation. The shared MSM solution will leverage ESO strategic platforms such as Data & Analytics Platform (DAP) and Salesforce, to meet all the ESO revenue, charging and billing needs. This option was chosen as it also provided value through cost avoidance and risk reduction including:

- savings from avoiding a separate tender process for each of the existing legacy platforms - Charging and Billing (CAB) and Ancillary Services Business (ASB)
- savings from design, build and delivery on a common platform rather than two separate ones
- savings in operating both services (Settlement and Charging and Billing) on a single platform
- Sarbanes Oxley (SOX), GDPR and security standards compliance

As a result, programme is proceeding with the implementation of the Oracle MSM system and the set-up of its Product Team to deliver quarterly system enhancements and regulatory change throughout the BP2 period.

Role 3 Investments

2.29 340 RDP implementation and extension

Overview & Purpose

This investment will establish an integrated data exchange and situational awareness capability with DSOs, enabling coordinated access to Distributed Energy Resources (DER) and management of service conflicts, via extension of regional development programmes (RDPs).

As the number of service providers embedded in the distribution networks increases, this can create more issues at the transmission/distribution interface. This in turn can delay the connection of DER to the network. The proposed approach allows RDPs to be developed in response to specific network issues as they arise.

It will also become increasingly difficult to coordinate actions manually. Greater interaction with TOs and DSOs is expected, necessitating greater sharing of information to enable operation across boundaries and understanding the impacts of actions on other parties.

Investing in this area also 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.

This investment will provide the ESO with 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. We will look to implement common processes where possible across the RDPs. However, each DNO / TO will have different control systems and interfacing requirements. A separate IT design stage for each RDP will therefore assess requirements to achieve a co-created design.

It primarily benefits the Whole Electricity System team within Networks, and it enables sub-activity **A15.5 Develop Regional Development Programmes (**RDPs). This investment provides enhanced capability to the Electricity National Control Centre so therefore also enables **A1.1 Ongoing Activities.**

It is expected that this investment will be impacted by the new cross-role activity **Facilitating distributed flexibility**, and consequent changes to sub-activity **A15.8 Facilitate distributed flexibility and whole electricity system alignment**. These changes have not yet been solution assessed and are therefore currently out of scope of this investment. We will provide an update in our August submission.
A summary of the key outcomes that will be delivered by this investment as well of the corresponding RIIO-2 sub-activities is included below.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A15.5 Develop Regional Development Programmes (RDPs)	• Registration, instruction, procurement settlement, and reporting of regional constraint services • Automated constraint management system (GEMS)

Table 118 - Summary of business outcomes and corresponding sub-Activities

Current State

In BP1 we have enhanced our activities through the regional development programmes which are looking across the whole-system landscape to identify opportunity for additional network capacity, reduced constraints, and to open up new revenue streams for market participants. These are developed on a need's basis, and we continue to work with other network organisations to proactively identify their need.

N-3 intertripping functionality go live for UK Power Networks (UKPN) as part of BP1 has been delivered. N-3 Intertripping is a capability that has been introduced to ensure that the transmission network remains operable by reduction of load during an N-3 event which is a post fault scenario of a planned transmission outage (N-1) followed by a double circuit fault (N-3). During planned outages pre-fault measures are set with the DNO to ensure the appropriate amount of Distributed Energy Resource (DER) is removed from the distribution network

therefore managing thermal overloads on the transmission system at DER level and ensuring safety of the network at all times, should the fault event occur.

By March 2023 we aim to achieve:

- N-3 intertripping functionality - Delivery of the systems and processes required for the continued release of transmission outages compliant with Security and Quality of Supply Standards (SQSS), whilst providing a means to control the increasing amount of DER on the south coast. This will be implemented within the Distribution Network Operators (DNO) networks of Scottish and Southern Electricity Networks (SSEN) and Western Power Distribution (WPD).
- MegaWatt (MW) Dispatch – to provide the ENCC with the ability to manually select the volume of Distributed Energy Resources (DERs) to manage thermal boundary constraints. This will be implemented within the Distribution Network Operators (DNO) networks of UKPN and WPD as initial MVP releases.
- Generation Export Management System (GEMS) – Proceeding to take forward the conceptual design to an agreed detailed solution with Scottish Power Energy Networks (SPEN's) chosen vendor and commence system build activities of the end to end GEMS system.

Roadmap

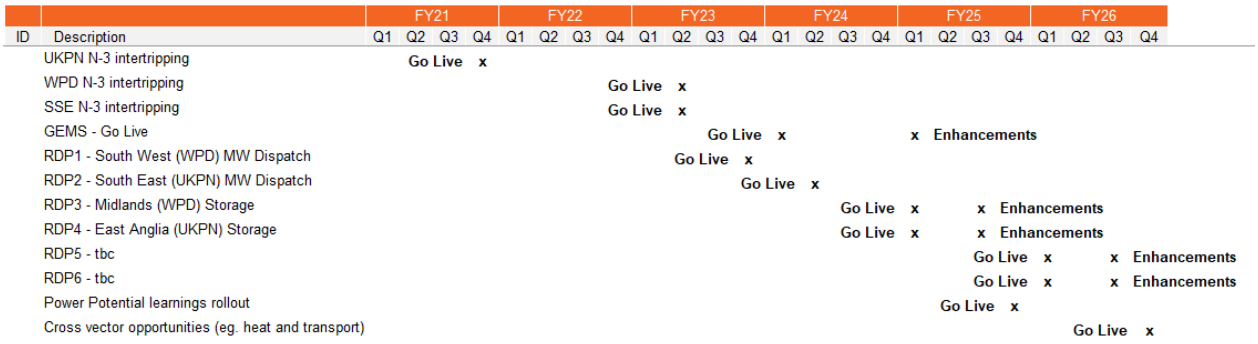

Figure 39 - Outcome roadmap

The RDPs will be delivered in an agile manner, with an MVP being delivered for go live, with further enhancements over the following 6-12 months as appropriate.

Milestone	Outcome recipient	Outcome description
UKPN N-3 Intertripping	Business Units Customers & Partners	N-3 Intertripping is a capability that has been introduced to ensure that the transmission network remains operable by reduction of load during an N-3 event which is a post fault scenario of a planned transmission outage (N-1) followed by a double circuit fault (N-3).
WPD N-3 Intertripping	Business Units Customers & Partners	N-3 Intertripping is a capability that has been introduced to ensure that the transmission network remains operable by reduction of load during an N-3 event which is a post fault scenario of a planned transmission outage (N-1) followed by a double circuit fault (N-3).
SSE N-3 Intertripping	Business Units Customers & Partners	N-3 Intertripping is a capability that has been introduced to ensure that the transmission network remains operable by reduction of load

		during an N-3 event which is a post fault scenario of a planned transmission outage (N-1) followed by a double circuit fault (N-3).
GEMS Go Live	Business Units Customers & Partners	This deliverable enables transmission and distribution parties to connect in lieu of physical transmission build works, with the implementation of automated dispatch capability between the ESO and SPEN.
RDP1 - South West (WPD) MW Dispatch	Business Units Customers & Partners	A new thermal transmission constraint management service will have been delivered in the South West of England in co-ordination with Western Power Distribution (WPD). The service will be instructable from the ESO control room via the DNO's Distribution Energy Resource Management System. This service will enable us to manage regional export constraints in the area.
RDP2 - South East (UKPN) MW Dispatch	Business Units Customers & Partners	`A new thermal transmission constraint management service will have been delivered in the South East of England in co-ordination with UK Power Networks (UKPN). The service will be instructable from the ESO control room via the DNO's Distribution Energy Resource Management System. This service will enable us to manage regional export constraints in the area.
RDP3 - Midlands (WPD) Storage	Business Units Customers & Partners	Economic and operable solution/s delivered, in co-ordination with the DNO, to manage growth of distribution storage in the Midlands.
RDP4 - East Anglia (UKPN) Storage	Business Units Customers & Partners	Economic and operable solution/s delivered, in co-ordination with the DNO, to manage growth of distribution storage in East Anglia.
RDP5 - tbc	Business Units Customers & Partners	Economic and operable solution/s delivered, in co-ordination with the DNO, to manage a regional issue. Location / DNO partner to be confirmed (Heysham GSP, North of Scotland, South West/South Wales, North East)
RDP6 - tbc	Business Units Customers & Partners	Economic and operable solution/s delivered, in co-ordination with the DNO, to manage a regional issue. Location / DNO partner to be confirmed (Heysham GSP, North of Scotland, South West/South Wales, North East)
Power Potential learnings rollout	Business Units Customers & Partners	The Power Potential innovation project investigated how DER could help provide reactive power services. We are continuing to review

		learnings from this project and the potential IT investment requirements.
Cross vector opportunities (eg. heat and transport)	Business Units Customers & Partners	The plan currently includes consideration of opportunities and needs arising from the electrification of heat and transport and we have included investment towards the end of the RIIO-2 period, as per our original submission. However our current thinking is that these activities now fall within scope of the new cross-role activity Net Zero Operability. We will therefore be reviewing this position for our August submission and we expect that these costs will be revised, and potentially moved to a new Net Zero Operability investment.

Table 119 – Outcome summary descriptions

Discussions are ongoing with DNOs regarding RDP5 and RDP6, and potentially an RDP7. The plans for these are therefore fluid until discussions are complete and a go/no go decision is made.

Future State

This investment will implement the output of the RDPs as enhancements to the overall network control and balancing solution.

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State
NET-05	Network Operations & Control	Network Development	Whole System Operation	Situational Awareness suite implemented for 2025/26 System Operations. Modern Analytics and Numerical Modelling Frameworks in place to adapt to changing system rules and conditions. Complemented with necessary balancing and dispatch enhancements.

Table 120 – Future state subsystem component summaries

The overall solution is a moving target with all the major network control and balancing systems being replaced or renewed under RIIO-2 e.g. NCMS, Enhanced Balancing Capability. The RDP changes will move with it, such that RDP resultant services are maintained during transition and in the final solution.

The enhancements will be implemented in the local technologies of the relevant platform.

Approach

We will continue the general approach followed in BP1, enhancing and extending our operational systems to support the RDP outputs. We will use our usual project management and change delivery processes to do this safely in the context of a transforming technology landscape. The parent systems will dictate the technology stack and run-time location of each RDP change.

Implementation is expected to require enhancement of our Optel and general data networks throughout the country to allow us to reach the necessary RDP sites. We will work with our partners to roll this out.

RDP changes will utilise the RIIO-2 target platform architecture and integrate into cross-cutting platforms like DAP and DEP, for data and delivery channel services etc.

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP2	1.4	4.6	3.8	5.0	9.2	24.0
	BP1	2.9	3.2	3.2	5.4	9.9	24.5
	Variance	**-1.5**	**1.5**	**0.6**	**-0.4**	**-0.7**	**-0.5**
Opex	BP2	0.1	0.2	0.3	0.6	1.0	2.2
	BP1	0.3	0.4	0.4	0.6	1.1	2.7
	Variance	**-0.2**	**-0.1**	**0.0**	**0.0**	**-0.1**	**-0.5**
Cumulative RtB increase	BP2	0.1	0.6	1.0	1.4	2.1	5.2
	BP1	0.3	0.6	1.0	1.4	2.1	5.4
	Variance	**-0.2**	**0.0**	**0.0**	**0.0**	**0.0**	**-0.2**

Table 121 – Investment cost summary

Since submitting our original plan for this investment, expenditure has shifted from FY22 to FY23, primarily due to delays to the GEMS workstream arising from external dependencies. There has also been a minor reduction in BP2 costs arising from an update to the delivery plan.

As noted in the Overview and Purpose section above, it is expected that this investment will be impacted by the new cross-role activity **Facilitating Distributed Flexibility**, and consequent changes to sub-activity **A15.8 Facilitate distributed flexibility and whole electricity system alignment,** regarding operational visibility and primacy. These changes have not yet been solution assessed and are therefore currently out of scope of this investment. We will provide an update in our August submission.

The plan currently includes consideration of opportunities and needs arising from the electrification of heat and transport and we have included investment towards the end of the RIIO-2 period, as per our original submission. However our current thinking is that these activities now fall within scope of the new cross-role activity **Net Zero Operability**. We will therefore be reviewing this position for our August submission, and we expect that these costs will be revised, and potentially moved to a new Net Zero Operability investment.

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
We have assumed that we will deliver six RDPs in the RIIO-2 period. Costs could vary up or down if this assumption proves to be incorrect.	Program, Product & Project Management	Engage closely with the business and industry and monitor development of the whole system approach.	3	1
Misalignment with DSOs regarding objectives, timescales, technical design standards and ability to fund investments, leading to delays in realisation of benefits and increased costs to deliver solutions.	Program, Product & Project Management	Engage closely with DSOs and progressively develop ways of working and agreed standards	3	1

Missed milestones due to the need to deliver across multiple ESO technology platforms, with potential for conflicting priorities, leading to delays in realisation of benefits.	Program, Product & Project Management	Build integrated delivery plans and seek synergies to create delivery efficiencies	1	1

Table 122 – Investment risk summary

Solution Options

The macro-scale solution options considered at the outset and detailed in our original BP1 submission, i.e. No Investment, Upgrade Existing, or Buy New, have narrowed to the approach detailed above. Extending and enhancing current operational systems being the lowest cost and the lowest risk option.

Our analysis, including third party software market analysis, during the RIIO-1 and BP1 periods determined that new software packages would be high cost and high risk relative to customising our existing systems.

There will be low level optionality in the application and data network designs implementing the RDP changes. These will clarify as the changes are planned, built, and rolled out.

For data management, data sharing, and data analytics use cases the full solution will use the capabilities of the DAP. For engagement with customers the full solution will use the capabilities of the DEP.

2.30 350 Planning and outage data exchange

Overview & Purpose

This investment enhances outage planning and data exchange systems to enable a whole-system approach to access networks, manage significantly increased data volumes, and provide interactive stakeholder engagement.

It primarily benefits the Network Access Planning and Network Capability teams within Networks. It consists of 3 workstreams:

- Enhancements to the new eNAMS (electricity Network Access Management System) to further improve and extend the outage planning process. These enhancements enable sub-activities **A16.1 Manage access to the system to enable the TOs to undertake work on their assets, liaising with customers where access arrangements impact them**, and **A16.4 Whole system outage notification.**
- Delivery of IT capabilities to enable Deeper Access Planning with Distribution Network Operators (DNOs) as they transition to become Distribution System Operators (DSOs). These capabilities will enable sub-activity **A16.3 Work more closely with DNOs and DER to facilitate network access**. They will give all parties greater visibility of changes on other networks, thus facilitating better account to be taken of those changes, and also enabling DER to provide services to facilitate outages.
- Replacement of the legacy External Data Exchange (EDE) system with a modern system that is integrated with the Data and Analytics Platform. It will handle significantly increased volumes, types, and frequency of data, and will enable 2-way data exchange and automated data checking. It will also enable the implementation of the Common Information Model (CIM) standard for planning data exchange, arising **from** Grid Code Modification GC0139 (Enhanced Planning-Data Exchange to Facilitate Whole System Planning). These capabilities will enable sub-activities **A15.4 Manage our operational data and modelling requirements** and **A15.6 Transform our capability in modelling and data management** and also supports **A16.3 Work more closely with DNOs and DER to facilitate network access.**

This investment also indirectly benefits Role 1, National Control, by providing outage information to enable short term planning and analysis of the network.

A summary of the key outcomes that will be delivered by this investment as well of the corresponding RIIO-2 sub-activities is included below.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A16.1 Manage access to the system to enable the TOs to undertake work on their assets, liaising with customers where access arrangements impact them • A16.3 Work more closely with DNOs and DER to facilitate network access • A16.4 Whole system outage notification • A15.6 Transform our capability in modelling and data management • A15.4 Manage our operational data and modelling requirements	• Outage planning workflow optimisation and user interface improvement • Optimised outage management across networks • Automated network system data transfer

Table 123 - Summary of business outcomes and corresponding sub-Activities

Current State

As planned, we have developed and implemented new products Electricity Network Access Management System (eNAMS) and Electricity Generator Availability and Margin Analysis (eGAMA) to replace the Transmission Outage and Generator Availability (TOGA) system.

Building on the first release of eNAMS and eGAMA products, as part of the “Planning and Outage Data Exchange” RIIO-2 investment, we have initiated 3 key workstreams to address the future capabilities for Outage Management as per below.

Workstream -1: Enhancing the outage planning and reporting process within eNAMS further to address customer needs. By the end of March 2023, we would have addressed the following key functional and technical enhancements:

- Advanced key performance indicator (KPI) reporting requirements and improvements to operational reporting to provide better visibility of data and enable more effective planning of outages
- Workflow optimisation and user interface improvements to reduce operational risks
- Enhanced data provisioning for future operational needs
- ESO platform separation from the common National Grid platform, to align with other ESO Customer Relationship Management solutions and simplify platform management and increase separation of ESO services

Workstream -2: Initiated to capture IT capabilities required to enable Deeper Access Planning with Distribution Network Operators (DNOs) as they transition to become Distribution System Operators (DSOs). By end of Mar 2023, we are planning to deliver the following

- Establishing ways of working with customers / industry to streamline DSO process by forming a working group with suitable governance model
- Identify required new capabilities to be built or existing capabilities to be changed
- Capturing end to end customer journeys and personas for the identified capabilities
- Publishing IT solution blueprint and roadmap for solution delivery
- Completing IT solutions enablement work within ESO landscape this would enable DNO/DSOs to start their development work for end-to-end systems integration

Workstream 3: Replacement of the legacy External Data Exchange (EDE) system with a modern system that is integrated with the ESO IT Strategic platforms to provide an intuitive experience for our customers. The replacement solution will be designed based on CIM (Common Information Model) standards. The following activities will be completed by end of March 2023:

- Establishing a strategy and roadmap to replace External Data Exchange (EDE)
- Delivery of interim solution to address current customer pain points whist we are waiting for the final conclusion of CIM Standards as part of GC0139 grid code change
- Developing an enduring solution blueprint

Roadmap

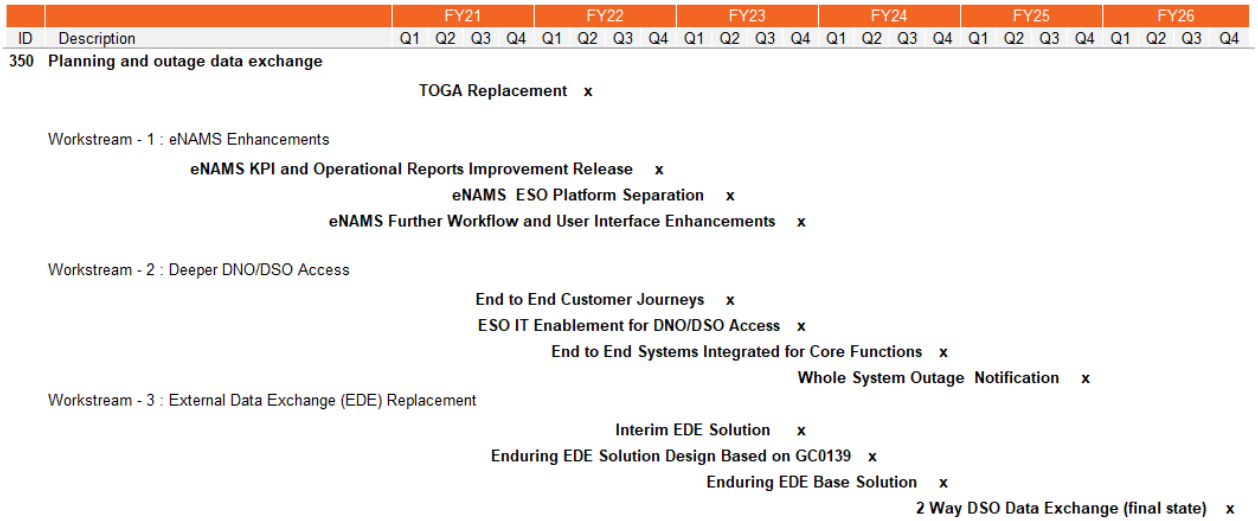

Figure 40 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
TOGA Replacement	Business Units Customers & Partners	Go live of the eNAMS system.
eNAMS KPI and Operational Reports Improvement Release	Business Units Customers & Partners	Iterative productivity and user experience improvements.
eNAMS ESO Platform Separation	Business Units	Complete migration of Salesforce from the corporate to ESO network.
eNAMS further workflow and User Interface Enhancements	Business Units Customers & Partners	Iterative productivity and user experience improvements.
Deeper DNO/DSO Access: End to End Customer Journeys	Business Units Customers & Partners	High level requirements for DNO/DSO access agreed with external stakeholders.
Deeper DNO/DSO Access: ESO IT Enablement for DNO/DSO Access	Business Units Customers & Partners	Extension of outage planning systems to initial DNOs & integration of systems to trial data exchange.
Deeper DNO/DSO Access: End to End Systems integrated for core functions	Business Units Customers & Partners	Extension of outage planning systems to all DNOs.
Whole System Outage Notification	Customers & Partners	Stakeholders better informed of outages, through enhanced digital communication.
EDE Replacement: Interim EDE Solution	Business Units Customers & Partners	Productivity and automated data validation improvements to existing EDE system.

EDE Replacement: Enduring EDE Solution design based on GC0139	Business Units Customers & Partners	Design for enduring EDE system agreed with external stakeholders
EDE Replacement: Enduring EDE Base Solution	Business Units Customers & Partners	Replacement EDE base solution integrated with the Data & Analytics Platform and Digital Experience Platform and available for DNOs to connect to.
EDE Replacement: 2-way DSO Data Exchange (final state)	Business Units Customers & Partners	As the DSO transition is better understood, implement 2-way data exchange, and add functionality to get to final state.

Table 124 – Outcome summary descriptions

Future State

We expect a significant increase in the frequency, complexity and volumes of data exchanged between the ESO, DSOs and TOs as the need for whole-system coordination increases and competition emerges in transmission. We will move from simply collecting winter peak data to exchanging data more frequently. We will need greater volumes of information about distributed energy resources, e.g. their capacity, location, and type.

The following table maps PODE delivery to ESO's overall Target Platform Architecture. The principal subsystems and components to be delivered by this investment are listed along with a specification of the expected target state for each by the end of BP2 delivery period.

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State
DIG 03	Digital Services	Market Facilitation	Data Exchange	Expanded set of APIs for customers and partners. Integration of API access with ESO common API platform. Self-service API management.
NET 05	Network Operations & Control	Network Development	Network Planning	Streamlined and automated Network Planning processes.
NET 05	Network Operations & Control	Network Development	Outage Planning	Streamlined and automated Outage Planning processes. Timely availability of outage data via data APIs.

Table 125 – Future state subsystem component summaries

The way network data, regional models and outage planning data is exchanged will need to be transformed. The legacy methods of file transfer and faxing are not fit for the future and will be replaced with new flexible digital channels. Access to systems will be extended to a wider range of stakeholders with differing business models and needs.

To manage the greatly increased future workload, we will continue to build on eNAMS and the PODE investment to further improve the outage planning process. Proposed enhancements in the RIIO-2 period include:

- Outage visualisation capability.
- Tools to optimise system access in the long and short term.
- Machine learning for outage planning.
- Implementation of common information model (CIM) compliant outage data.
- Automation of data exchange.

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 '250 Digital Engagement Platform' to provide a seamless experience to customers and stakeholders.

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.

Approach

Our overall approach is to build on the platform provided by eNAMS and the PODE investment, utilising cross-cutting capabilities provided by the Data & Analytics Platform (DAP) and Digital Engagement Platform (DEP) to provide a modern, highly efficient, and low latency set of services to the industry.

Planning and Outage Data Exchange will invest in the cloud components of the ESO IT Towers, principally Servers and Online Storage.

These services will be based on the enterprise data and analytical platforms and the digital experience platform. They will be developed to meet the needs of the RIIO-2 programme.

The enterprise data and analytical platforms and the digital experience platform provide for the widest range of application and data integration styles, and these will be used to exchange situational data with participants, DSOs, the TSO and Ofgem.

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP2	2.0	1.4	1.2	1.4	1.4	7.4
	BP1	0.4	0.4	1.2	1.4	1.4	4.8
	Variance	**1.6**	**1.0**	**0.0**	**0.0**	**0.0**	**2.6**
Opex	BP2	0.1	0.0	0.3	0.4	0.4	1.1
	BP1	0.1	0.1	0.3	0.4	0.4	1.2
	Variance	**0.0**	**-0.1**	**0.0**	**0.0**	**0.0**	**-0.1**
Cumulative RtB increase	BP2	0.3	0.6	0.7	0.7	0.7	3.1
	BP1	0.0	0.0	0.0	0.1	0.1	0.2
	Variance	**0.3**	**0.6**	**0.6**	**0.6**	**0.6**	**2.8**

Table 126 – Investment cost summary

Since submitting our original plan for this investment, our costs have increased, due to the later than planned delivery of the eNAMS system. However our BP2 costs are unchanged.

The delays in eNAMS implementation have also led to the increase in RtB. At the time of the RIIO-2 submission, it was assumed that implementation would be complete in FY21 and that the RtB increase would have already have been included in the starting baseline for BP2. Further RtB increases are also anticipated to arise from extended support requirements. 24 X 7 support is expected to be needed post deployment of Deeper Outage Planning together with an increase in Salesforce licences for external users.

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
Delay in concluding GC0139 will have an impact on EDE final solution delivery due to the dependency of CIM standards, leading to delays in transforming our capability in modelling and data management and enabling deeper access planning.	Program, Product & Project Management	Ensure regular review of requirements throughout RIIO-2 period. Employ agile delivery principles and flexible, modular applications.	3	1
As the DSO transition matures over a period, and responsibilities arising from GC0139 become clearer, frequent, or fundamental changes may be expected to our existing ESO solutions, or our initial solution design assumptions may need to change, leading to an overall solution delivery delay and further budget impact.	Program, Product & Project Management	Ensure regular review of requirements throughout RIIO-2 period. Employ agile delivery principles and flexible, modular applications. Cross Industry working group to be established to ensure frequent communication and alignment on requirements and design	3	1
Delay in delivery of strategic IT Data Platforms (DEP/DAP) will impact enduring EDE solution delivery, leading to delays in realising the benefits of seamless data exchange between tools.	Program, Product & Project Management	Early engagement and regular review with platform delivery teams to Identify any delay/Impact as early as possible and agree a tactical workaround where required to deliver objectives	2	1

Table 127 – Investment risk summary

Solution Options

For the BP2 period there is only one solution remaining, to build on the platform provided by eNAMS and the PODE investment, utilising cross-cutting capabilities provided by the Data & Analytics Platform (DAP) and Digital Engagement Platform (DEP).

This is by design, eNAMS (i.e. customised Salesforce SaaS) (together with DAP and DEP) is our strategic target and is confirmed as the best means to meet our business strategy: Deeper Access Planning, External Data Exchange, and to give customers a consistent experience by harmonising network planning B2B processes with other B2B interactions.

Salesforce was previously selected as the National Grid strategic platform for customer centric processes. Salesforce is the market leading Customer Relationship Management (CRM) and using it means that our customers can enjoy a high-quality consistent experience when dealing with ESO. Many CRM processes are

not specific to electricity system operation making a third-party solution the lowest cost, lowest delivery risk, and fastest time to market solution.

2.31 360 Offline network modelling

Overview & Purpose

Transmission analysis is carried out from 10 years ahead through to real-time and post event to help design and run the network as securely and economically as possible. The offline network modelling tools deliver the day-to-day analysis required to operate the transmission system in a safe and secure manner, as well as deliver the electricity 10-year statement and ENTSO-E reporting. This investment includes:

Delivery of major upgrades to our offline modelling tools, which will allow us to model a more complex system:

- Upgrade offline modelling tools and use enhanced tools to allow more complex modelling arising from operability challenges, to support future network operation.
- Ensure integration of our offline modelling tools with IT investment 220 Data and analytics platform, that will facilitate an interchangeable suite of tools using a common data set, and seamless exchange of data between tools.

Development & ongoing maintenance of Electromagnetic Transient (EMT) Capabilities

- Increase ESO Networks capability to carry out system analysis using EMT tools, which in turn will provide greater confidence and forward planning with regards to voltage oscillations, system interaction and power quality issues as the system moves towards zero carbon operation. After development and initial implementation, deliverable becomes ongoing for the maintenance.

Co-simulation analysis

- Engage with wider industry (all TOs) and develop capability to carry out co-simulation using Root Mean Square (RMS) and EMT packages
- Develop ability to carry out co-simulation analysis using RMS and EMT tools (such as Digsilent Powerfactory, and Power Systems Computer Aided Design (PSCAD)) that could reduce the simulation time and at the same time has the ability to analyse both small and large signal behaviour of the system. (expected to complete in FY24).

Other enhancements for BP2 include:

- Develop automation capabilities to enhance data validation and enable studies to run quickly for multiple scenarios in order to be able to understand the operating envelope at more time points.
- Enhance modelling in to the DNO networks to support Deeper Access Planning, thus facilitating better account to be taken of changes in those networks.

This investment enables sub-activities **A15.6 Transform our capability in modelling and data management**, **A16.3 Work more closely with DNOs and DER to facilitate network access**, and the new sub-activity **A16.5 Network Access Planning Automation**. The main users of these capabilities are the Network Operability, Network Access Planning and Network Development teams.

These capabilities are also used by the Electricity National Control Centre, so this investment supports **A1.1 Ongoing Activities.**

A summary of the key outcomes that will be delivered by this investment as well of the corresponding RIIO-2 sub-activities is included below.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A1.1 Ongoing activities • A15.6 Transform our capability in modelling and data management	• Maintenance and upgrade of existing networking modelling tooling • Enhanced network analysis

• A16.3 Work more closely with DNOs and DER to facilitate network access • A16.5 Network Access Planning Automation	• Deeper outage planning • Network Access Planning Automation

Table 128- Summary of business outcomes and corresponding sub-Activities

Current State

By March 2023 we will have delivered a major upgrade to our offline modelling tools, which will allow us to model a more complex system. Both hardware and software upgrade for OLTA offline analysis tool will be carried out in BP1 that increases our capability for enhanced short circuit analysis, and the offline modelling roadmap will be developed.

Furthermore, the Networks teams will have built an Electromagnetic Transients (EMT) Modelling proof of concept by using the PSCAD Simulation Software for system transient simulation package.

Roadmap

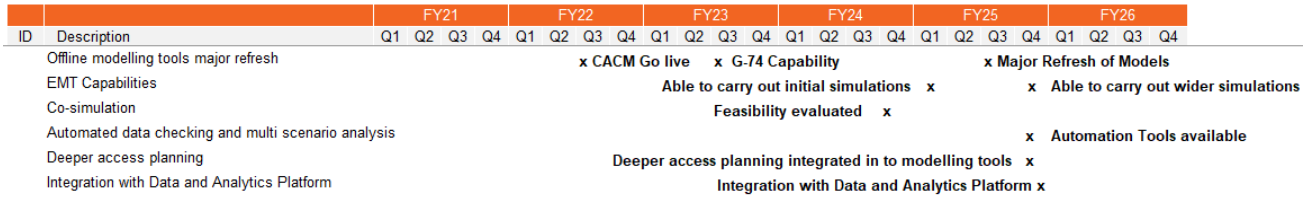

Figure 41 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
CACM Go Live	Business Units Customers & Partners	Compliance with the European Capacity Allocation and Congestion Management guideline, which sets out the methods for calculating how much space can market participants use on cross border lines without endangering system security.
G74 capability	Business Units Customers & Partners	Enhanced ability to calculate short circuit fault levels, thus improving system security.
Major refresh of models	Business Units Customers & Partners	Upgrades to offline modelling capability to analyse the more complex power system, address operability challenges and enable more efficient exchange of data.
EMT Capabilities: able to carry out initial simulations	Business Units Customers & Partners	Increase ESO Networks capability to carry out system analysis using Electromagnetic Transient tools, which in turn will provide greater confidence and forward planning with regards to voltage oscillations, system interaction and power quality issues as the system moves towards zero carbon operation. Initially for specific parts of the grid system.
EMT Capabilities: able to carry out wider simulations	Business Units Customers & Partners	Extension of above to other parts of the GB system.

Co-simulation: Feasibility evaluated	Business Units Customers & Partners	Confirm the feasibility of combining standard & EMT modelling techniques to enhance the ability to analyse the complex system efficiently with less time to simulate.
Automation tools available	Business Units	Develop automation capabilities to enhance data validation and enable studies to run quickly for multiple scenarios in order to be able to understand the operating envelope at more time points.
Deeper access planning integrated in to modelling tools.	Business Units Customers & Partners	Enhance modelling in to the DNO networks to support Deeper Access Planning, thus facilitating better account to be taken of changes in those networks.
Integration with Data and Analytics Platform	Business Units	Ensure integration of our offline modelling tools with the Data and analytics platform, that will facilitate an interchangeable suite of tools using a common data set, and seamless exchange of data between tools.

Table 129 – Outcome summary descriptions

Future State

Offline Network Modelling will implement EMT and additional network modelling tools by extending and enhancing PowerFactory and PSCAD to complete our modelling capability.

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State
NET-06	Network Operations & Control	Network Modelling	Modelling Visualisation	Expanded set of modern network modelling tools, configured and customised to ESO requirement.
DAT-06	Data & Analytics	Modelling	Power System Modelling	PowerFactory, PSCAD and custom tools or derivatives, augmented with DAP analytics development tools to make modelling processes robust and enable B2B data access.

Table 130 – Future state subsystem component summaries

The tools will utilise the RIIO-2 target platform architecture and integrate into cross-cutting platforms like DAP and DEP, for data and delivery channel services etc.

These platforms will be used to provide an enhanced digital experience platform to allow internal and external stakeholders to view and interact with the outputs of our models.

Approach

This investment line continues to follow a best of breed approach, combining commercial software and inhouse developed analytic software using the same set of data science tools supplied by the data and analytics platform, DAP.

Specifically, we will consolidate on the PowerFactory and PSCAD applications. Modernising them and deploying them in line with our wider IT Strategy. We will build out, configure, integrate, and extend these core applications to our requirement.

We will build upon IT Investment 220 Data and analytics platform to augment PowerFactory and PSCAD and enable an interchangeable suite of tools to utilise common datasets, share data, etc.

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP2	0.9	2.0	0.8	2.0	0.8	6.5
	BP1	1.2	0.8	0.8	2.0	0.8	5.6
	Variance	**-0.3**	**1.2**	**0.0**	**0.0**	**0.0**	**0.9**
Opex	BP2	0.1	0.9	0.2	0.5	0.2	1.9
	BP1	0.3	0.2	0.2	0.5	0.2	1.4
	Variance	**-0.2**	**0.7**	**0.0**	**0.0**	**0.0**	**0.5**
Cumulative RtB increase	BP2	0.0	0.1	0.2	0.2	0.2	0.7
	BP1	0.0	0.0	0.1	0.1	0.2	0.3
	Variance	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.4**

Table 131 – Investment cost summary

Since submitting our original plan for this investment, our costs have increased, due to the later than planned delivery of the hardware upgrade for the OLTA offline analysis tool. However our BP2 costs are unchanged.

The delays in eNAMS implementation have also led to the increase in RtB. At the time of the RIIO-2 submission, it was assumed that implementation would be complete in FY21 and that the RtB increase would already have been included in the starting baseline for BP2.

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
EMT Modelling Requirements may not be available with the current toolsets (OLTA and PSCAD), along with uncertainty around the viability of co-simulation, leading delay in achievement of zero carbon operation.	Business Software	Establish an Innovation Project to validate the modelling capabilities. Further co-simulation implementation options to be considered.	3	1
Delay in delivery of strategic IT Data Platforms (DAP) will impact enduring OLTA Modelling capability, leading to delays in realising the benefits of seamless data exchange between tools.	Program, Product & Project Management	Early engagement and regular review with platform delivery teams to Identify any delay/Impact as early as possible and agree a tactical workaround with architecture board.	2	1

Table 132 – Investment risk summary

Solution Options

For BP2 the range of macro-level solution options, i.e. No Investment, Upgrade Existing, or Buy New, have effectively resolved at the individual tool level under the Offline Network Modelling investment.

As described above we will complete productionisation of PSCAD and build out the additional tools we need around PSCAD and OLTA (PowerFactory).

Our feasibility analysis, including third party software market analysis, during the RIIO-1 and BP1 periods have confirmed that this combination of third-party package and bespoke software meets our strategic requirement and gives the lowest delivery cost and risk overall.

2.32 380 Connections platform

Overview & Purpose

The changes in UK Government environmental targets have meant that over the last few years we have seen significant changes in the types of customers seeking connection or use of the electricity network in GB. The shift towards smaller and more flexible generation has seen an unprecedented increase in the number of connection applications coming into the ESO.

As the number of connection applications increases, it is becoming increasingly important to streamline the process of managing them. Phase 1 of the portal, implemented in BP1, will have digitised the connection application process`s, and introduced process efficiencies and automation, for both the ESO and the customer. This will lead to more efficient use of industry resources, saving costs for consumers. Phase 2 of the portal which will begin early in BP2, will bring increased automation and self-service functionality.

The customer connections platform 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. This 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 platform will also facilitate enduring contract management during the operational phase of the project as well as providing 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.

This investment enables sub-activities **A14.4 Facilitate development of the customer connections portal** and **A14.3 Further enhance the customer connections experience, including broader support for smaller parties**. As part of this, it is also providing enhanced training simulation capabilities, and so also provides benefits to **A2.3 Training Simulation and Technology.**

A summary of the key outcomes that will be delivered by this investment as well of the corresponding RIIO-2 sub-activities is included below.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A14.4 Facilitate development of the customer connections hub • A14.3 Further enhance the customer connection experience, including broader support for smaller parties	• Singular customer engagement portal for connections request management and tracking • Digitised connections processes and automation

Table 133 - Summary of business outcomes and corresponding sub-Activities

Current State

The improvements we have made so far, and those we are proposing, are a direct result of customer feedback. Industry stakeholders have told us that the ESO should take a lead role in developing a customer connections portal, and their detailed feedback informed the scoping of the Minimum Viable Product. Customers also felt that the applications process is complex and outdated. The portal will look to address these points by digitising the process and making it more transparent, guiding the customer through each of the steps.

We will deliver foundational Minimum Viable Product (MVP) releases in July, October, and December 2022 respectively. These focus on digitizing the connection application process and will deliver the following functionality:

- Self-service account registration
- Requesting pre-applications
- Submitting applications
- Automating the fee calculation process

- Tracking the lifecycle of their application
- New e-signature functionality to allow applicants to electronically sign agreements.

In FY23 we will pilot the use of our new Design System, developed by the Digital Engagement Platform (DEP), and look to refactor the user interface using a React based front-end development framework. Subject to a successful pilot, we will align our user interface development to the Design System by early FY24 alongside our feature releases.

Following this foundational phase, incremental improvements will be added in subsequent releases, including process efficiencies and automation which continue into BP2.

Roadmap

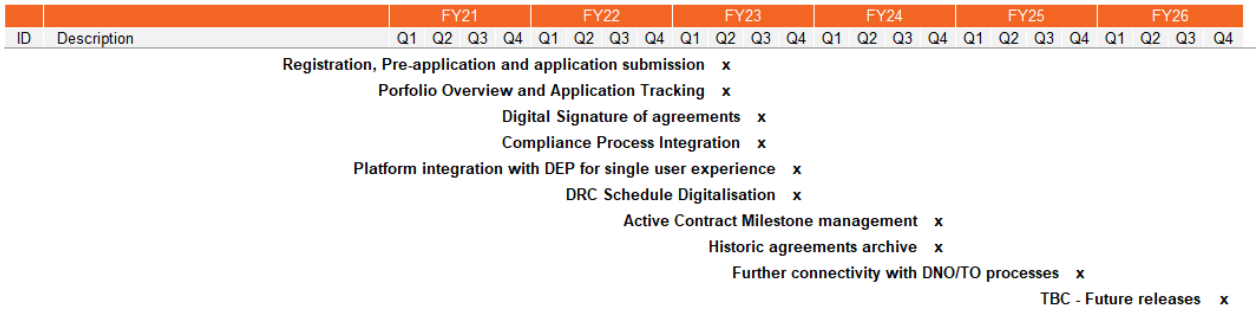

Figure 42 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Registration, Pre-application, and application submission	Business Units Customers & Partners	Customer ability for self-service account registration, requesting pre-applications and submitting applications
Portfolio Overview and Application Tracking	Customers & Partners	Customers can track the lifecycle of their application
Digital Signature of agreements	Customers & Partners	New e-signature functionality to allow applicants to electronically sign agreements.
Compliance Process Integration	Business Units Customers & Partners	Enablement of Compliance data for generators
Platform integration with DEP for single user experience	Business Units Customers & Partners	Pilot of integration with the Digital Experience Platform for a single user experience
DRC Schedule Digitalisation	Business Units Customers & Partners	Easier access and navigation of the Data Registration Code schedule.
Active Contract Milestone management	Customers & Partners	Customers can update their progress milestones
Historic agreements archive	Business Units Customers & Partners	Deliver a centralised document storage solution to manage customer contracts, documents including archival management

Further connectivity with DNO/TO processes	Business Units Customers & Partners	Seamless connection process with TOs and DNOs
TBC - Future releases	Business Units Customers & Partners	User experience enhancements

Table 134 – Outcome summary descriptions

Future State

In BP2, we will extend the Connections Hub self-service capability to include:

- Integrate with DAP and provision APIs allowing data accessibility to the customers
- Deliver a centralised document storage solution to manage customer contracts, documents including archival management
- Allow customers to update their progress milestones
- Digitalisation of the Data Registration Code (DRC) schedule. The DRC presents a unified listing of all data required from time to time under the Grid Code.
- Enablement of Compliance data for generators
- Seamless connection process with TOs and DNOs
- User Experience enhancements
- Explore the feasibility of interactive and integrated rich UI based features like Heatmaps and interactive maps
- Explore opportunities to integrate with other portals in the organisation enabling seamless uninterrupted rich experience for the customer in the digitised portal journey

We will use standard functions and features of the Salesforce CRM platform where possible, augmenting with niche capabilities where required using applications from the Salesforce eco-systems and our strategic platforms and services. These will include for instance:

- Use of the Design System, developed by DEP, to ensure we build consistent user interfaces aligned to our brand and style guidelines
- Integrate with the Customer Identity and Access Management (CIAM) solution, delivered by DEP, to provide a Single Sign-On (SSO) experience for all customer interactions
- Integrate with the Single Markets Platform (SMP) to optimise the wider BM registration process and to provide seamless access to ancillary markets.
- Integrate with the Data and Analytics Platform (DAP) to develop internal reports as well as leverage consistent data services to handle data exchange with third parties.

The following table maps the Connections platform delivery aligned to ESO's overall Target Platform Architecture. The principal subsystems and components to be delivered by this investment are listed along with a specification of the expected target state for each by the end of FY26 in BP2 delivery period.

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State
DIG 02	Digital Engagement	Customer	Connections, CRM Workflow	Customer Connections self-service application process on Salesforce CRM
DIG 01	Digital Engagement	Digital Services	Digital Applications Suite	Integration with and use of the DEP Design System
DIG-03	Digital Engagement	Market Facilitation	Customer Markets Portal	Alignment with SMP during BP2
DAT-02	Data & Analytics	Analytics and Insight	Internal Reporting	Reporting capability delivered by DAP

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State
DAT-02	Data & Analytics	Consistent Data Services	Integration non-CNI	Integration with downstream systems and TOs and DNOs

Table 135 – Future state subsystem component summaries

Approach

Through BP2, we anticipate continued development of the Connections Hub and back-end system changes with process rationalisation, as new functional enhancements are introduced.

Adopting the product model, we have set up an enduring product team to manage and deliver functional developments of defined products over the course of BP1 and BP2, in alignment with customer-driven and regulatory changes.

Following an iterative agile delivery approach, Customer Hub will deliver prioritised functional capabilities based on value to the customer and informed by user research, industry consultation and stakeholder engagement (e.g., show and listen seminars), through each release. 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.

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP2	0.9	1.6	0.2	0.1	0.1	2.8
	BP1	0.7	0.7	0.2	0.1	0.1	1.8
	Variance	**0.2**	**0.8**	**0.0**	**0.0**	**0.0**	**1.0**
Opex	BP2	0.0	0.1	0.1	0.1	0.1	0.3
	BP1	0.5	0.5	0.1	0.1	0.1	1.2
	Variance	**-0.4**	**-0.4**	**0.0**	**0.0**	**0.0**	**-0.9**
Cumulative RtB increase	BP2	0.0	0.0	0.1	0.1	0.1	0.4
	BP1	0.0	0.1	0.1	0.1	0.1	0.4
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Table 136 – Investment cost summary

The discrepancy in the phasing and capex/opex split in the BP1 period arises from more detailed planning now that the project is in delivery.

The current forecast numbers for the BP2 period shown in the table above are taken from the original estimates submitted as part of the BP1 submission. These do not reflect the increased ambition and scope detailed within this narrative.

A detailed scope and cost benefit analysis will be conducted on the Connections platform to determine phase 2 deliverables balanced with an associated cost forecast that will be acceptable to the business. This will be carried out over the next few months and will be completed prior to the final August submission of the IT narrative document which will be updated with a more accurate forecast.

Therefore, as noted in the introduction to Part 3 – Technology Investments, this item is signalled as having higher uncertainty, and we are therefore providing a cost range, as detailed below. This investment will go through additional external assurance between April and August to provide confidence on the final cost submissions.

Investment	Whole RIIO2 FD	Whole RIIO2 BP2 data tables/TBM submission	Variance	Whole RIIO2 proposed range
Connections Hub	3	3	(0)	4-7

Table 137 – Investment cost range summary

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
Refactoring the user interface aligned to the Design System may be more complex than anticipated leading to delays in delivering future releases.	Application Development	• Pilot in BP1 will inform the level of risk associated with refactoring • Early engagement with front and backend development teams to ensure technical delivery Is feasible	2	1
Approach to integration with the Digital Engagement Platform customer identity and access management solution (DEP(CIAM)) for single sign on, and with the Single Markets Platform (SMP) for market services may be delayed leading to poor customer experience.	Program, Product & Project Management	• Align Connections Hub delivery with DEP (CIAM) and SMP roadmaps and backlog • Determine technical integration approach early in BP2 • Align common products where possible with SMP	2	1
Integration with other applications may be more complex than envisaged leading to additional costs and delays to delivery.	Application Development	• Engagement with third parties to ensure alignment of integration and access requirements • Align with data platform and integration services tower	2	1

Table 138 – Investment risk summary

Solution Options

The choice of Salesforce to develop the self-service Connections Hub was taken early in BP1, primarily because existing internal connections processes already operate on Salesforce and to build out the externally facing portal can be easily supported by the platform. We believe that Salesforce still provides the best platform for developing our BP2 Connections portal capabilities and alternative options at this stage would not be cost-effective or provide the functions and features for the future. Through BP2, a number of extensions to the platform will therefore be undertaken. These will largely utilise Salesforce components and augmented with suitable products from the Salesforce partner eco-system, where appropriate. In BP2, we anticipate further integration with our strategic platforms for API/integration management, DEP and DAP.

2.33 390 NOA enhancements

Overview & Purpose

Our modelling capabilities underpin what we intend to deliver in Role 3, enabling us to unlock significant benefits and maintain a secure and operable network. 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.

The innovative techniques currently being explored will need to be implemented in RIIO-2 and we expect further consumer benefits can be gained as we build on these techniques. For example, greater integration between the different modelling tools will allow us to better understand the interactions between different network needs and optimise our economic decision-making.

This investment implements the enhancements to the Network Options Assessment (NOA) tools required to deliver the sub-activities below. However, these are enablers for other business activities, therefore these have not been included in the TBM cost model spreadsheet:

- **A11.1 Refresh & integrate economic assessment tools to support future network modelling needs**
- **A11.2 Implement Probabilistic modelling**
- **A11.3 Build voltage assessment techniques into an optimisation tool**
- **A11.4 Build stability assessment techniques into an optimisation tool**

By delivering enhancements to modelling tools used for the NOA, Electricity Ten Year Statement (ETYS) processes, ad-hoc analysis processes, this investment enables sub-activities **A7.1 Analyse and communicate future network needs, A7.2 Advise on economically efficient ways to address network needs, and A7.3 Undertake ad hoc analysis in response to external requests.**

This investment will also deliver the enhancements required for the Connections Wider Works and end-of-life asset replacement processes. It therefore enables sub-activities **A9.3 Expand to all Connections Wider Works (CWW) and A9.4 Develop process with TOs to input into ESO analysis of end-of-life asset replacement decisions**

These modelling capabilities also support the Future Energy Scenarios (FES) process; therefore this investment also enables sub-activity **A13.1 Carry out analysis and scenario modelling on future energy demand and supply**

A summary of the key outcomes that will be delivered by this investment as well of the corresponding RIIO-2 sub-activities is included below.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A7.2 Advise on economically efficient ways to address networks needs • A9.2 Trial assessment of all connection wider works in one region • A13.1 Carry out analysis and scenario modelling on future energy demand and supply	• Economic Efficiency Advice Services • Network options economic evaluations • Modelling and Data Management

Table 139 - Summary of business outcomes and corresponding sub-Activities

Current State

By the end of BP1 we will have completed delivery of Economic Assessment Tool implementation and leading into future enhancements. The Thermal Probabilistic tool (POUYA) will also be integrated into the NOA process by Q4 FY23.

The Voltage Optimisation proof of concept work will be extended through to the summer of 2022 leading into formal project. Additional resources are being assigned to maintain the delivery timetable. With the Stability Assessment tool within the innovation project has highlighted issues with data quality in modelling within our current systems which requires resolving to achieve value from the tools.

Roadmap

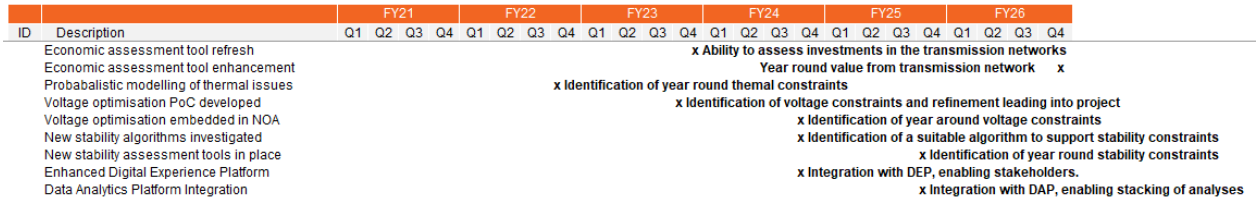

Figure 43 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Economic assessment tool refresh	Business Units	Implementation of a new EA tool, which reflects the latest modelling approach and technologies, and therefore enables: • Quicker evaluations and issues identification • At lower cost. • More networks being evaluated • Evaluation of additional quantities, and/or on additional boundaries.
Economic assessment tool enhancement	Business Units	Enhancement to EA tool, to reflects the latest modelling approach and technologies.
Probabilistic modelling of thermal issues	Business Units	Identification of year-round thermal constraints. This will allow for planning to consider how often and under what prevailing conditions circuit overloads are expected.
Voltage optimisation PoC developed	Business Units	We understand which optimisation model and algorithm will be best suited to the *NOA* process for voltage assessment.
Voltage optimisation embedded in NOA	Business Units	Model implemented that enables year-round assessment of voltage needs. Needs identified across multiple year-round snapshots rather than single summer minimum snapshot.
New stability algorithms investigated	Business Units	Stability proof of concept tool works on our existing model structures
New stability assessment tools in place	Business Units	Year-round screening of different network conditions for stability conditions is available and is used in ad-hoc studies working towards full use within the NOA methodology.

Enhanced Digital Experience Platform	Business Units Customers & Partners	Integration with Digital Experience Platform to allow stakeholders to view network needs and see the impact of selected generic options.
Data Analytics Platform Integration	Business Units	Economic assessment tool can fully integrate with network assessment tools to provide a stack for investment assessment Cost Benefit Analysis and the NOA. Nodal modelling is used to assess requirements where boundary methodology is insufficient.

Table 140 – Outcome summary descriptions

Future State

We will design and build analytical tools providing:

- Voltage optimisation
- Stability assessment

These tools will be built in Python and use common Python libraries and, potentially, using components of the new Economic Assessment Tool. They are expected to run locally on analyst workstations or will be ported to the Azure cloud as appropriate.

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State
DAT-06	Data & Analytics	Modelling	Economic modelling	Strategic Economic Assessment, Probabilistic Modelling, Voltage Optimisation, and Stability Assessment tools implemented and integrated into the RIIO Platform Architecture.

Table 141 – Future state subsystem component summaries

The tools will utilise the RIIO target platform architecture and integrate into cross-cutting platforms like the Data and Analytics Platform (DAP) and the Digital Engagement Platform (DEP), for data and delivery channel services etc.

These platforms will be used to provide an enhanced digital experience platform to allow stakeholders to view network needs and see the impact of selected generic options.

Approach

By the start of the BP2 period we will have completed implementation of our strategic Economic Assessment Tools. For the BP2 period we will build out the complete solution using the same architecture as the Probabilistic Modelling tool and using the data and services of the DAP.

Costs

Investment (£m)		FY22	FY23	FY24	FY25	FY26	Total
Capex	BP2	-0.1	3.2	3.2	1.6	1.2	9.1
	BP1	3.0	3.0	3.2	1.6	1.2	12.1
	Variance	**-3.1**	**0.2**	**0.0**	**0.0**	**0.0**	**-2.9**
Opex	BP2	0.5	1.4	0.8	0.4	0.3	3.3

	BP1	0.8	0.8	0.8	0.4	0.3	3.0
	Variance	**-0.3**	**0.6**	**0.0**	**0.0**	**0.0**	**0.3**
Cumulative RtB increase	BP2	0.2	0.5	0.6	0.8	0.9	3.0
	BP1	0.0	0.2	0.3	0.5	0.6	1.6
	Variance	**0.2**	**0.3**	**0.3**	**0.3**	**0.3**	**1.4**

Table 142 – Investment cost summary

Since submitting our original plan for this investment, our capex costs have reduced. This is due to savings in the development of the probabilistic modelling tool, together with a more informed view of the split between capex/opex and RtB (see below). Furthermore some expenditure has been moved from FY22 to FY23 due to procurement timescales deferring the license purchase for the economic assessment tool. However our BP2 costs are unchanged.

RtB costs have increased due to a more informed view from initial costings from the Economic Assessment tool procurement event. Assumptions made for similar cost base for additional tools to be delivered through BP2. These increases are offset by the reduction in capex expenditure noted above.

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
Delay in delivery of strategic IT Data Platforms (DEP/DAP) will Impact enduring solution delivery, leading to delays in realising the benefits of seamless data exchange between tools.	Program, Product & Project Management	Early engagement and regular review with platform delivery teams to Identify any delay/Impact as early as possible and agree a tactical workaround where required to deliver objectives	2	1
Delay in proof of concept (POC) activities leading to delay in formal project delivery for Voltage Optimisation and Stability Assessment	Program, Product & Project Management	Make improvements to the dynamic ETYS model. Resource POC activities with new appointments of skilled staff and baseline plan communicating this with Ofgem	2	1

Table 143 – Investment risk summary

Solution Options

The BP1 range of solution options i.e. No Investment, Upgrade Existing, or Buy New have effectively resolved for BP2. As laid out above, we will procure a new Economic Assessment Tool. For the other tools, we will build the tools we need following the same approach used in BP1 to implement the Probabilistic Modelling tool, custom build reusing various 3rd party frameworks.

Other than for the Economic Assessment Tool, our feasibility analysis has confirmed that industrialising our own bespoke software meets our strategic requirement and gives the lowest delivery cost and risk overall. Building

our own models means that we retain the intellectual property in house and maximise our flexibility to adapt to GB specific conditions.

Our analysis rejected finding and procuring third party software for these systems as being too expensive and carrying more risk.

2.34 500 Enhanced Frequency Control (formerly Zero Carbon Operability)

Overview & Purpose

This investment was formerly named “Zero carbon operability”, however as the deliverables are specific to delivery of the Enhanced Frequency Control tool it has been renamed to reflect this specificity, in line with the corresponding change to the business narrative. This change more accurately demonstrates that this investment intends to deliver a Monitoring and Control System (MCS) to provide fast and coordinated frequency response for the low inertia system that is required to achieve the bigger zero carbon and net zero ambitions.

With the decrease in inertia of the system and the rise in the maximum infeed loss risk, there is an increase in the likelihood of events that could cause risk of system frequency instability. Through implementation of the MCS system we will be able to monitor the electricity network at a regional level and coordinate regional frequency response from a range of service providers to maintain the frequency stability of the system.

A phased approach to any potential implementation of the monitoring and control system (MCS) is needed which can take account of the development and performance of stability related balancing services. This will include a full assessment of the how the MCS will operate on the live electricity system which will help to increase the technical readiness of the system before any potential roll-out. Consideration must also be given to the new commercial framework and IT interfaces with National Grid Electricity System Operator's (NGESO) systems before any implementation to understand the impact and necessary interfaces.

This phased approach will help the transition of this complex scheme to be carefully managed and coordinated with other industry strategies. In order to mitigate risk, the implementation project will follow a 6-phase approach, as follows:

0) Strategy and Roadmap
1) NIA demo (non-operational)
2) Develop an operational demo
3) Operational demo
4) First stage rollout
5) Second stage rollout.

This investment enables sub-activity **A15.7 Deliver Enhanced Frequency Control by 2025**. As part of this, it will also be creating new market services, and providing the capability for the Electricity National Control Centre to better manage frequency. It therefore also supports sub-activities **A4.6 Balancing and Ancillary Services Market Reform, A1.2 Enhanced Balancing Capability and A1.3 Transform Network Control**, but these have not been included in the TBM data model.

A summary of the key outcomes that will be delivered by this investment as well of the corresponding RIIO-2 sub-activities is included below.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A15.7 Deliver Enhanced Frequency Control by 2025	• Coordinated frequency response control • Wide area monitoring and control system

Table 144 - Summary of business outcomes and corresponding sub-Activities

Current State

During the BP1 period, a “Phase Zero” milestone was introduced, which was not in the original five-year plan. Its purpose was to develop requirements and a technical design for the programme and mobilise the participants for the Phase One non-operational demonstration. This meant that the Phase One commencement was deferred, however it is expected to be completed within BP1 timescales.

The current status of the project is that we have identified and engaged with industry parties to participate in the Phase One non-operational demonstration and completed Phase One design and requirements. Network

Innovation Allowance (NIA) funding for the Phase One non-operational demonstration has been sanctioned and the project team is working on implementing and testing the Phase One MCS system.

The subsequent milestones of operational demonstration (Phase Two and Phase Three) are now planned to be delivered during BP2. The rollout of the first stage (Phase Four) itself however is still planned for delivery in 2024/25 as specified in BP1.

By March 2023 the Enhanced Frequency Control (EFC) team will have

- Completed the Phase 0 – Strategy, which will provide a roadmap to implement the EFC for Phases 2-5
- Completed the Phase 1 NIA Project to run the Non-Operational Demonstration, and published the completion report
- Completed the Phase 1 non-operational demo which will have gathered sufficient analysis to implement the Phase 2 Operational Demo Design. This will confirm the business case for the EFC / MCS services and deployed technology

Roadmap

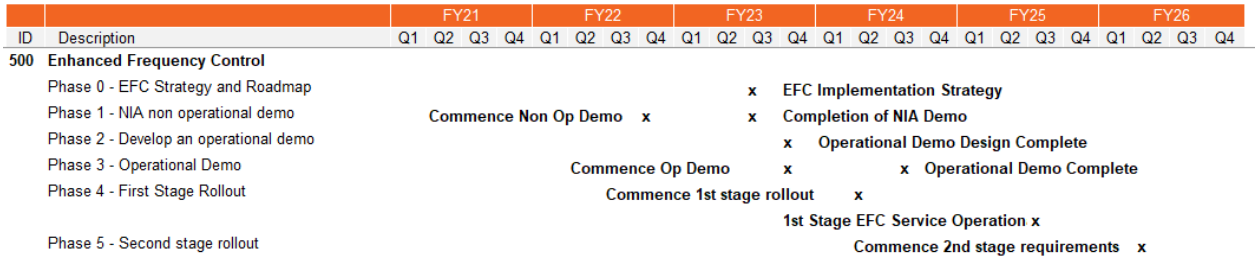

Figure 44 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Phase 0 – EFC Implementation Strategy	Business Units Customers & Partners	Requirements and a technical design for the programme developed, and participants mobilised for the Phase One non-operational demonstration.
Phase 1 – NIA non-operational demo: Commence Non-Op demo	Business Units Customers & Partners	Trial MCS in place and connected to a small number of participants. The MCS will be able to detect real grid system events and issue dummy instructions.
Phase 1 – NIA non-operational demo: Completion of NIA demo	Business Units Customers & Partners	Communications trialled with a small number of participants and the response of the MCS to real grid system events has been validated.
Phase 2 – Develop an operational demo: Operational demo design complete	Business Units Customers & Partners	The MCS algorithm will be in place, with required equipment installed on the system; Basic integration with existing control systems will be achieved.
Phase 3 – Operational Demo: Commence Op demo	Business Units Customers & Partners	This phase is the enactment of the activities from Phase 2. The MCS deployment is limited, and our control room can directly instruct some service providers via the MCS.

Phase 3 – Operational Demo: Operational Demo Complete	Business Units Customers & Partners	MCS trialled with a larger number of participants, and response to instructions tested. Integration with control systems trialled and interactions with the grid system evaluated.
Phase 4 – First Stage rollout: Commence 1st stage rollout.	Business Units Customers & Partners	Design of enduring MCS system complete and ready for rollout on the grid system.
Phase 4 – First Stage rollout: 1st stage EFC Service Operation	Business Units Customers & Partners	The MCS will be fully integrated with the new capabilities being delivered by IT investments 110 Network control, 220 Data and analytics platform, and 180 Enhanced balancing capability. The MCS will be fully launched as an operational tool with an increased number of response providers delivering response within the commercial response framework.
Phase 5 – Second Stage Rollout: Commence 2nd Stage requirements	Business Units Customers & Partners	Requirements commenced in to extending the functionality of the MCS.

Table 145 – Outcome summary descriptions

Further information on the scope and objectives of phases 1-5 can be found in the ESO RIIO-2 Business Plan: Annex 4 - Technology Investment report: https://www.nationalgrideso.com/document/158071/download

We will be working closely with the Markets team to develop complementary frequency services.

Timely delivery of the MCS is dependent on consideration and assessment of how it will operate in conjunction with/interface with the ongoing developments to the Enhanced Balancing Capability.

Future State

Enhanced Frequency Control will implement the full MCS resulting from the programme above and integrate it into our other control systems, primarily the Wide Area Monitoring System (WAMS) and Network Control Management System (NCMS). The new system will use the capabilities and form part of the ESO platform architecture.

Subsystem Identifier	Target platform	Target Subsystem	Component	Future State
NET-01	Network Operations & Control	Control Communication	Control Data Link	Control network enhancements made to support MCS traffic, sharing links with other operational control systems where possible.
NET-04	Network Operations & Control	Situational Awareness	Frequency Visibility	MCS will complement the strategic WAMS solution, sharing infrastructure where possible.
NET-04	Network Operations & Control	Situational Awareness	Power System Simulation	MCS based operational processes will be extended to simulation and operator training. NCMS Simulator configured, populated and operational
DIG-04	Digital Engagement	Situational Awareness	Net Zero Monitoring	MCS will feed data and contribute to the Situational Awareness suite implemented for 2025/26 System Operations. Modern Analytics and Numerical Modelling Frameworks in place to adapt to changing system rules and conditions.

BAL-03	Balancing	Energy Balancing	Frequency Control	Online interoperation with new Enhanced Balancing Capability. The new balancing system will be adapted to support frequency control operations controlled by MCS.

Table 146 – Future state subsystem component summaries

Additionally, the MCS will engage with the RIIO-2 target platform architecture and integrate into cross-cutting platforms like the Data and Analytics Platform (DAP) and Digital Engagement Platform (DEP), for data and delivery channel services etc.

Approach

The overall approach is to work with a partner vendor to develop a prototype MCS. Once a working prototype exists and is proven, we plan to run an open procurement cycle to select an MCS solution ensuring that we are getting market value. We will then implement the selected MCS to deliver enhanced frequency control to our wider new network control solution.

Implementation is expected to entail enhancement of our Optel and general data networks throughout the country and the deployment of frequency control appliances around the power networks. We will work with our TO and DSO partners to roll this out.

The MCS will be integrated with WAMS and NCMS to provide a complete operational solution. Implementation of the MCS will snap into the target platform-based application architecture utilising the capabilities of the cross-cutting platforms within it, the DAP primarily.

Costs

Investment (£m)		**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**Total**
Capex	BP2	0.3	3.2	8.1	8.4	1.3	21.3
	BP1	4.0	5.2	7.0	3.9	2.3	22.4
	Variance	**-3.7**	**-2.0**	**1.0**	**4.5**	**-1.0**	**-1.0**
Opex	BP2	0.6	0.9	0.8	0.4	0.3	3.0
	BP1	0.4	0.6	0.8	0.4	0.3	2.5
	Variance	**0.2**	**0.3**	**0.0**	**0.0**	**0.0**	**0.5**
Cumulative RtB increase	BP2	0.0	0.2	0.8	1.6	2.1	4.7
	BP1	0.0	0.5	1.1	2.0	2.5	6.0
	Variance	**0.0**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-1.3**

Table 147 – Investment cost summary

Since submitting our original plan for this investment, there has been an increase of £5.58m in BP2 costs.

This has arisen from replanning of the later phases due to the introduction of a 'Phase Zero' in to BP1. However, overall estimates across the 5-year RIIO-2 period are unchanged and the rollout of the first stage (Phase Four) itself is still on track for delivery in 2024/25 as specified in BP1.

Cumulative RtB increases have been delayed due to the same reason.

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
The system requires fast communications, and we are dependent on a third party to deliver these, leading to not being able to achieve the objective of response to a system event with 0.5 seconds.	LAN / WAN	The network communication requirements will be assessed and agreed in phases 1 and 2. Delay rollout and rely on balancing services at higher net cost.	2	1
Cyber security vulnerability, leading to unauthorised operation impacting electricity system security.	LAN / WAN	Phase 0 undertaking a security architecture risk review including the use of 4G and 5G technology. This will be continually assessed as the system is scaled up. If cyber issues could not be resolved, we would delay rollout and rely on balancing services at higher net cost.	2	1
While the technology has been tested through the EFCC innovation project, it has not been implemented on a larger scale and with increased complexity. Costs and timescales may therefore increase.	Program, Product & Project Management	There will be project check points following the end of each phase of the project to assess whether it should progress to the next phase.	3	2
The current design of the MCS could require a significant volume of data transfer, leading to additional investment in the communications network.	LAN / WAN	Phased approach and rollout strategy will seek to minimise data volumes. Full capability will only be deployed in Phase 5, based on learnings from the first 4 phases.	3	3
Demand side participation is higher than estimated. If the number of distribution connected providers is greater than the assumed 20%, costs could increase significantly.	LAN / WAN	Utilise the phased approach and monitor types of participants wishing to connect and carefully manage onboarding	2	2
Commercial arrangements for use of the system cannot be agreed with sufficient providers, leading to reduced benefits.	Business Software	Include development of commercial terms in the criteria for project progression.	2	2
The system measurements (e.g. inertia monitoring) required for effective system performance cannot be delivered, leading to inability to effectively respond to system events.	Business Software	Include development of inertia monitoring in the criteria for project progression. Phase 1 NIA prototype will evaluate monitoring capability. If issues could not be resolved, we would delay	2	1

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
		rollout and rely on balancing services at higher net cost.		

Table 148 – Investment risk summary

Solution Options

For EFC, which is taking a prototyping approach, there are two main solution options. Implement the prototype or use the learnings from the prototyping activity to select another product and implement that.

There will be further optionality in the data network design and device deployment. These will be clarified and decided upon as the prototyping converges on the final solution. The learnings from the phased approach will help determine the eventual solution.

For data management, data sharing, and data analytics use cases the full solution will use the capabilities of the DAP

Part 3 - New business initiatives

- As part of our portfolio review and assessment as part of BP2, we have identified the following new cross-role activities which may develop into formal investment lines as part of our submission. As these are currently at a formative stage, we have not provided a detailed summary or cost forecast for these items at this stage. For now we have provided a high-level summary of these potential investments, and should we determine that these require full investments during the BP2 period we will provide a full breakdown and summary of these, both in our IT Annex and TBM mode, as part of our Final BP2 submission. Alternatively, following assessment, these may result in scope and cost changes to existing investment lines instead.

3.1 Early Competition Onshore

- This potential new investment area arises from the new sub-activity **A8.4 Early Competition Onshore**.
- Roles and responsibilities for running early competitions have not yet been fully determined by BEIS and Ofgem. In particular, it is not yet decided who will become the procurement body that administers the competition. IT investment associated with the procurement body is therefore not included here.
- We do, however, expect that the ESO will be asked to undertake activities to support the procurement body, regardless of who becomes that body. IT work will be required to help develop bespoke network models; however these costs are expected to be minimal and will not require specific IT investment.
- Further IT costs are expected to be incurred after the Business Plan 2 period once the competition has concluded. These will be the costs required to integrate a new TO and network solution into various IT systems within the ESO.

3.2 Offshore Coordination and Network Planning Review

- This potential new investment area arises from the new activity **A22 Offshore Coordination and Network Planning Review.**
- Both our Network Planning Review (NPR) and Offshore Coordination (OC) projects are expected to have a significant impact on our ongoing Role 3 activities. Further work is planned for 2022 to investigate the more detailed enduring requirements from the NPR and OC projects, and IT requirements and timescales will become clearer as this work proceeds. Our initial view is as follows:
- **Model Supply and Demand:** We need to ensure our systems can model sensitivities effectively. Disparate, new (and existing) data sources will need to be managed/converted so that they are compatible with existing and new systems. There are links here to existing RIIO-2 deliverables such as the Data and Analytics Platform, which is expected to be required to support efficient running of multiple scenario sensitivities.
- **Identify System Needs**: Adopting a more systematic approach to the identification of system needs is expected to require new ways of assessing the impact of scenarios on the network, as the current more targeted approach presents an intensive call on engineers' time. The exact needs will be worked through in detail as the projects progress.
- **Identify System Options:** New tools will be needed to enable these new design activities. This are expected to include (but not be limited to) software to assist with onshore and offshore route planning for high-level strategic investment options, and to manage visual amenity. Existing tools will also need to be augmented or supplemented to enable these activities to be delivered. Further resources may be identified as necessary to manage whole system interactions, including electricity distribution and, in future, across other energy vectors.
- **Options Appraisal Process:** Existing tools may need to evolve to be able to deal with the consequences of a revised options appraisal process that incorporates both strategic and non-strategic developments in a suitable way.

- **Multi-Purpose Interconnectors (MPIs):** At this point in time, the potential impacts our systems are yet to be identified; a further assessment would be required to understand them in detail once the changes to the treatment of MPIs are known.

3.3 Facilitating Distributed Flexibility

This potential new investment area arises from the new cross role activity **Facilitating Distributed Flexibility**, which has resulted in new deliverables across all 3 roles with IT impacts:

- A new sub-activity in Role 1 A1.5 Operational coordination with DER and DSO. This reflects the growing impact of DER on our real-time operations. We will ensure our control room systems and processes account for increased operational visibility, and operational coordination.
- New Role 2 deliverables within the existing sub-activity A4.5 Facilitate whole electricity system market access for DER (formerly Transform access to the Capacity Market). These deliverables investigate how our markets can be designed and implemented in a way that will unlock the potential of distributed flexibility.
- In Role 3, we are proposing new work to enable greater procurement of services from DER. This includes IT solutions to ensure continued system operability through greater visibility of DER and operational coordination of DER services. Building on our work to review BM operational metering standards we will work with stakeholders to review our technical requirements for service provision to ensure these remain appropriate for smaller distribution assets. Further details are under A15.8 Facilitate distributed flexibility and whole electricity system alignment. This is in addition to our work on DSO policy and RDPs.

In addition to our work on **A15.5 Regional Development Programmes** that were highlighted in the original Business Plan we have identified the following new investments in BP2:

- For our increased operational visibility, we propose to have operational data exchanges or ICCP links with all DNOs. There will also potentially need to be updates to existing control centre systems to accommodate additional data requirements. These will be scoped at the start of BP2.
- Implementation of operational co-ordination systems into our control room will require new IT functionality to be developed and delivered.
- In Role 2 we can see a need for IT system changes to share service provider information more efficiently with DSOs to ensure overall co-ordination.
- These requirements may impact on the 110 Network Control, 180 Enhanced Balancing Capability and 340 RDP Implementation and Extension investments. Furthermore, as the requirements for working more closely to facilitate network access evolve, this may impact on the 350 Planning and Outage Data Exchange and 360 Offline Network Modelling investments.
- We can also see a need for enhancements to our Single Market Platform (investment 400) and Digital Engagement Platform (investment 250) to ensure interoperability with DSO platforms described in their RIIO-ED2 Business Plans.

Relevant sub-activities are not yet aligned directly to an IT investment, as they are still to be solution assessed, however we will provide further detail in our final Business Plan in August 2022.

3.4 Net Zero Operability

- This potential new investment area arises from the new activities Net Zero Operability, A20 Net Zero Market Reform, and the revised sub-activity A15.9 Zero Carbon Operations.
- The UK Government has committed to fully decarbonising the UK electricity system by 2035. This brings with it a raft of operational challenges to the electricity system, which we anticipate will impact our IT systems across all 3 ESO roles.
- The strategy will be taken forwards and explored in early 2022, with additional development expected for the August plan. IT requirements and timescales will become clearer as this work proceeds.

- Our plan for 340 RDP Implementation and Extension currently includes consideration of opportunities and needs arising from the electrification of heat and transport and we have included investment towards the end of the RIIO-2 period, as per our original submission. However our current thinking is that these activities now fall within scope of the new cross-role activity Net Zero Operability. We will therefore be reviewing this position for our August submission, and we expect that these costs will be revised, and potentially moved to a new Net Zero Operability investment.

Part 4 – Shared investments

Throughout the BP1 Period, National Grid has continued to invest in core IT capabilities maintaining the asset health of the estate and modernising capabilities such as our access to cloud services. By maintaining the asset health of our core infrastructure and investing to modernise our capabilities we ensure the reliable and secure provision of service in the most cost-efficient manner in terms of total cost of ownership. Modern, secure, and reliable IT services are at the core of the technology solutions National Grid ESO will bring forward during the BP2 period, enabling the energy shift to Low Carbon and delivering value to the consumer.

The following chapters outline our continuing ambition and key focus areas for the remainder of RIIO-2.

4.1 Business Services

As outlined in BP1, National Grid (NG) will invest £75.5 million (of which £12million will be allocated to ESO) for the purposes of maintaining and evolving our IT systems that support key business service areas. The below table categorises these services into: Digital web applications, Finance, HR, Other core applications, and Procurement, summarising the total investment per annum across the full RIIO-2 period.

The purpose of these investments is to continue to maintain and evolve ESO's digital eco-system, equipping ESO with the building blocks and functionality to drive a positive shift towards Net Zero 2050, further enhance our cybersecurity capabilities and resilience and continue to empower our people through digitisation.

	2021/22	2022/23	2023/24	2024/25	2025/26	Group Total
Digital and web	0.5	1.9	0.0	0.0	1.5	3.9
Finance	9.6	10.1	7.9	8.1	10.9	46.7
HR	2.1	1.6	2.2	2.0	1.6	9.4
Procurement	2.5	1.2	0.9	0.7	2.9	8.3
Other apps.	1.2	3.5	1.3	0.4	0.8	7.1
Total	**15.9**	**18.3**	**12.3**	**11.3**	**17.7**	**75.5**

Table 149 – Group capex investment in business services – 18/19 prices

The below sections summarise our investments across each of these business service areas, outlining our current and forecast future state by the end of the BP2 period, as well as our summary cost positions.

Finance

National Grid will continue to invest in the S4/HANA ERP platform and connected applications to maintain the platform in accordance with the SAP product roadmap. Application of product updates and patches is integral in maintaining the security of the platform through vulnerability updates. Maintaining the product in line with the Product roadmap significantly reduces the complexity and cost of product update and refresh over the long term, making it efficient in terms of total cost of ownership over the lifetime of the product.

Throughout BP1 ESO has invested in several areas within IT Finance. During 2018-20, a major business transformation programme, Project One, delivered a refreshed platform and suite of applications. This core ERP platform has been transitioned from SAP ECC to SAP S/4HANA, delivering better efficiency and oversight across a number of areas. as well as overall improved data quality.

The diagram below details the sub-sections where ESO has benefited from this implementation.

Figure 45 - S/4HANA benefits summary

In conjunction with this ERP investment, ESO payroll has transitioned to a managed service, SAP Concur, which has delivered additional functionality of travel booking and expenses. This consolidation of systems across finance has given us a solid foundation and basis upon which to drive further digital improvement within RIIO-2.

Throughout BP2 our primary focus will be on continuing to mature our S/4HANA ERP solution. Our ERP solution was implemented during BP1, we will continue to refine and mature our solution, working to build in further efficiencies as we progress. This will focus on the maturity of our data, streamlining processes and efficiency across Finance. Across all business services areas not just those specifically related to Finance, our ambition throughout BP2 is to continue to reduce manual processes as much as possible by the use of automation, machine learning and RPA. This will make us much more efficient and further support our transition towards our Net 2050 target.

As a deliverable of the ESO's legal separation, ESO ERP Data is now independent of National Grid. Maturing our data is an ongoing journey, and across BP2 we will continue to invest in our cybersecurity to protect both our client's and our own data. Our portfolio of Shared Investments will continue to support the maintenance of our systems to ensure seamless integration and data security, and this integration will also help ensure ongoing stability and access in day-to-day operations.

Whilst our digital journey moving into BP2 will be predominately focussed on our ERP capabilities and data maturity, our intention is also to establish and bring new wider technologies to life, setting the foundation and precedence for fiscal years 25/26.

Costs

	2021/22	2022/23	2023/24	2024/25	2025/26	Group Total
Banking upgrade	0.0	0.0	0.0	0.0	0.0	0.0
Business planning	0.0	3.0	0.0	0.0	0.0	3.0
Process improvement	0.0	0.0	0.0	0.0	0.0	0.0
Tax reporting and analysis	0.0	0.0	0.0	0.0	0.0	0.0
Enterprise content mgt.	1.0	0.0	0.0	0.0	3.0	4.0
ERP S/4HANA	6.9	6.9	6.9	6.9	6.9	34.5
Making tax digital	0.0	0.0	0.0	0.0	0.0	0.0
Payroll	0.0	0.0	0.0	1.0	0.0	1.0
Portal	0.0	0.0	0.0	0.0	0.0	0.0
RPA platform	1.0	0.3	0.3	0.3	1.0	2.8
SAP analytics cloud	0.0	0.0	0.0	0.0	0.0	0.0
SAP group financial controls	0.0	0.0	0.0	0.0	0.0	0.0
Service management tool	0.0	0.0	0.0	0.0	0.0	0.0
Compliance activities	0.0	0.0	0.0	0.0	0.0	0.0
Treasury mgt. enhancements	0.8	0.0	0.8	0.0	0.0	1.5
Total	**9.7**	**10.2**	**8.0**	**8.2**	**10.9**	**46.6**

Table 150 – Group capex investments in finance systems, 18/19 pricing

Procurement

National Grid will invest within the procurement business service area over the course of BP2. This investment so far has helped maintain the ESO's asset health and enabling technologies, ensuring the continued efficient operation of our procurement solutions.

We have replaced our legacy procurement purchase to pay system, SAP SRM5, with a new cloud solution, Coupa, which has helped to provide continued improvements to data, mobility, and end-user experience. We have also invested in the SAP Ariba platform to manage our source to contract and tendering processes, enabling us to build and drive greater efficiency and compliance within our procurement activities going forwards.

Within purchase to pay, across BP2 investments will focus on upgrades and refresh of systems to integrate the purchasing and accounts payable functions. Additional capabilities will be delivered during BP2 including supply management, purchase requisition, purchase order, receiving, invoice reconciliation, and accounts payable.

This will also be supported by investment in AI and robotics to automate our contract awards processes, reducing manual human input and further increasing operational efficiencies.

We will also continue to invest in upgrades and refresh of systems within our source to contract process area, enabling maximum benefit and management of our procurement spend on goods and services. There are a number of capabilities expected to be delivered during BP2, some of which are digital contract management that provides easy access and real-time alerts to vendor performance; supplier relationship management to track vendor interactions and drive consistency in interactions with suppliers; and finally benefits management to accurately track value from strategic contracts and category management activities.

Costs

	2021/22	2022/23	2023/24	2024/25	2025/26	Group Total
ARIBA replacement	0.5	1.0	0.4	0.4	0.4	2.8
Fieldglass replacement	0.0	0.2	0.0	0.0	0.0	0.2
Procurement supplier relationship mgt.	0.0	0.0	0.0	0.0	0.0	0.0
Purchase-to-pay upgrade and enhancements	2.0	0.0	0.0	0.0	2.0	4.0
SAP concur upgrade and enhancements	0.0	0.0	0.5	0.0	0.5	1.0
Travel and booking	0.0	0.0	0.0	0.3	0.0	0.3
Total	**2.5**	**1.2**	**0.9**	**0.7**	**2.9**	**8.2**

Table 151 – Group capex investment in procurement systems, 18/19 pricing

HR & Workforce

There will be investments made which will be dedicated to HR-related functions during BP2. During BP1 we have seen our cloud-based Human Capital Management (HCM) system, SuccessFactors, successfully delivered into live operation. The digital landscape continues to change at an exponential rate, and as the COVID-19 pandemic has poignantly shown, the demand for greater connectivity and collaboration among our people is substantial. SuccessFactors will become the core foundation for ESO's HR needs going forwards, and we will continue to build upon this delivery over the coming years.

These unprecedented changes in workforce balance have prompted us to redefine our corporate culture and expectations of our people. As an organisation, we have shifted to a mobile-first approach and across the business, our systems now support flexible working, a more open and social approach to collaboration, and are increasingly automated, intelligent, and data-centric. This has led us to continue our investment in SuccessFactors, to maintain the platform and align it to the product roadmap. We will ensure that the platform continues to support our evolving organisational culture by ensuring key patches and vulnerability updates are applied.

Building on our SuccessFactors platform implementation, we have also further increased data functionality within the platform. This has helped deliver the data foundations needed for a data-centric HR function, with all employee data in a single system. This has transformed our ways of working and we will continue to invest in the years ahead and ensure continued compliance around data risk, control, security, and enablement.

The continued rise of digital technologies and shifting workforce dynamics are fundamentally changing how HR functions work today. As we move into BP2, we will continue on our digital journey with our people to develop

SuccessFactors that empowers digitally led, self-enablement services. These investments are made and will continue to be made to empower attraction, retention and develop the best people. Further investment into SuccessFactors will benefit the businesses we serve, driving lower costs through incremental efficiencies and effectiveness, as well as streamlining processes and creating further autonomy for our people.

Costs

	2021/22	2022/23	2023/24	2024/25	2025/26	Group Total
Case management	0.3	0.0	0.0	0.0	0.0	0.3
Data archiving	0.0	0.0	0.0	0.0	0.0	0.0
Digitising learning	0.1	0.1	0.1	0.1	0.1	0.4
HR policy compliance	0.0	0.0	0.0	0.0	0.0	0.0
SuccessFactors upgrade and enhancements	1.6	1.6	2.0	1.9	1.6	8.7
Total	**2.1**	**1.6**	**2.2**	**2.0**	**1.6**	**9.4**

Table 152 – Group capex investment in HR systems, 18/19 pricing

Digital & Web Systems

Our digital communication channels sit at the heart of how we connect with our stakeholders, customers, and colleagues. As we move into BP2 our increasing demand to be digitally present for our customers and our people is where we will place our attention and investment. We will be focusing on self-serve data and enhancing the communication methods that will set us apart in the energy sector.

As a group, we will invest £4 million in Digital & Web Systems. This will ensure the maintenance, product updates and patch deployments of valued digital channels that provide stakeholder management, customer management and data management. Asset health lies at the core of our investments with incremental capability built on those foundations.

The greater adoption of digital channels has embedded collaboration and inclusion across our organisation, enabling us to involve the relevant people at the right time throughout the system development lifecycle to support our ongoing products and service development activities. This has helped drive efficiencies across our transformation delivery, ensuring development teams remain connected, and close collaboration exists between delivery teams and business customers, ensuring requirements are fully understood and solutions built which are fit for purpose.

Efficiency benefits that we will continue to drive within this area include:

- Less wasted time (quick to find or access things that matter).
- Targeted news and communications giving an effective internal voice.
- Reduction in the number of systems.
- Increased productivity (self-service, increasing ability to complete tasks).
- Employee awareness - access to expertise.
- Enables us to work faster, bringing alignment and visibility between departments.

Throughout BP2 we will also continue to invest in innovative technologies so we can grow in line with our customer, supplier and stakeholder needs. Innovative technologies such as simulation using digital twin and artificial intelligence technologies will improve our service capability and efficiency, and we intend to use a blend of cloud computing and on-premises services to achieve this.

Investment into new functionality will bring new capabilities including artificial intelligence, robotic process automation, machine learning and data analytics. These types of tools will create better business insights that will create both efficiency and new opportunity for ESO.

Costs

	2021/22	2022/23	2023/24	2024/25	2025/26	Group Total
Analytics	0.0	0.0	0.0	0.0	0.0	0.0
Digital service integration	0.0	0.0	0.0	0.0	0.0	0.0
Ext. channels improvement	0.0	0.0	0.0	0.0	0.0	0.0
InfoNet refresh	0.0	0.0	0.0	0.0	1.5	1.5
Int. channels improvement	0.0	0.0	0.0	0.0	0.0	0.0
NG.com refresh	0.0	1.9	0.0	0.0	0.0	1.9
Stakeholder/internal apps.	0.5	0.0	0.0	0.0	0.0	0.5
Web minor works	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.5**	**1.9**	**0.0**	**0.0**	**1.5**	**3.9**

Table 153 – Group investment in digital and web systems, 18/19 pricing

Other Core Functions

We are investing £7 million to refresh, sustain and/or implement new capabilities and functionality for our core functions, covering safety, Internal Audit, Enterprise Risk Management, Legal and IT.

Safety is and always will be National Grid's number one priority, and during BP1 we have invested in our incident management systems to ensure they remain fit for purpose and reflect the increasingly mobile nature of our workforce. We have also invested in increasing the capability of our health and sustainability systems with a number of initiatives, including safe driving, health dashboards and sustainability management. We will continue to invest in our incident management systems to ensure they remain fit for purpose and support the safety of our people and our customers. We will also invest in increasing the capability of our health and sustainability systems with a number of initiatives, including safe driving, health dashboards and sustainability management.

We have maintained our investment in RSA Archer to provide an integrated governance risk and compliance platform connecting the first, second and third line of audit and assurance defence and consolidating all risk-related data onto one platform. RSA Archer will continue to be developed throughout BP2, enhancing integrated governance risk. This compliance platform connects the first, second and third line of audit and assurance defence and consolidating all risk-related data onto one platform.

Throughout BP1 we have invested in our legal document management, contract automation, and spend tracking platforms to maintain the asset health and update in line with the product road maps ensuring the products remain current and patched against potential vulnerabilities ensuring the effective operation of our legal function.

During BP2 we will continue to maintain our legal document management, contract automation, and spend tracking platforms. In addition, we will invest in our IT for IT tooling to ensure we have effective and integrated platforms to support software and project delivery. This has been and will be an investment focus for BP2. This will enable our IT organisation to effectively manage cost, vendors, and contractual agreements in addition to providing cost and service transparency. This will reduce operating costs across the business, supporting the IT strategy for application rationalisation and minimisation.

Costs

	2021/22	2022/23	2023/24	2024/25	2025/26	Group Total
Global travel mgt.	0.0	0.0	0.0	0.0	0.0	0.0
Identity and access mgt.	0.0	0.0	0.0	0.0	0.0	0.0
Safety incident mgt. and related SHE systems	0.4	0.8	0.3	0.2	0.2	1.8
Upgrade of UK IMS system	0.0	0.0	0.0	0.0	0.0	0.0
Employee digital workplace	0.0	0.0	0.0	0.0	0.0	0.0
RSA Archer upgrade	0.5	2.0	0.5	0.0	0.3	3.3
Analytics and visualisation	0.3	0.0	0.0	0.1	0.0	0.5
Investor relations web	0.0	0.0	0.0	0.0	0.0	0.0
IT provisioning and software licence asset mgt.	0.0	0.0	0.3	0.1	0.0	0.4
IT tools for planning and delivery	0.0	0.4	0.0	0.0	0.2	0.6
Agile development tooling	0.0	0.0	0.3	0.0	0.0	0.3
Boardvantage	0.0	0.0	0.0	0.0	0.0	0.0
Legal analytics and visualisation	0.0	0.0	0.0	0.0	0.0	0.0
Legal matter mgt. upgrade	0.0	0.0	0.0	0.0	0.0	0.0
Legal support systems	0.0	0.3	0.0	0.0	0.2	0.5
Corporate regulated minor works	0.0	0.0	0.0	0.0	0.0	0.0
Total	**1.2**	**3.5**	**1.3**	**0.4**	**0.8**	**7.2**

Table 154 – Group capex investment in other systems, 18/19 pricing

Risks

Description	Mitigation
We incur cyber and security breaches.	Ensure systems are maintained to latest vendor released versions. Maintain a strong cyber capability within National Grid which regularly assesses the IT landscape for vulnerabilities
We incur cost to reimplement systems delivered in RIIO-1.	Ensure systems are maintained to latest vendor-released versions to avoid systems becoming obsolete and incurring more significant investment or replacement.
We are unable to unlock new value.	Maintain systems at the latest vendor released versions to reduce the time to value in enabling task automation functionality that releases HR to focus on higher value activity.
We suffer controls and compliance failures.	Ensure both IT systems and business support teams supporting the GRC space are maintained.
We lose talent from the organisation.	Ensure a program of continual improvement is implemented to help retain talent and knowledge within National Grid and avoid a famine and feast mentality in application lifecycle management.
The efficiencies made in the past are eroded.	Ensure the IT systems evolve with the business requirements over time to prevent the formulation of offline processes.
We are unable to fully digitalise the support functions.	Maintain a strong enterprise architecture capability to ensure the strategy is adopted and matured in line with evolving aspirations.
Vendors release exceptional updates (re-platformed or re-architected solutions) which require major migration activity to continue using the product.	Funding may need to be diverted from enhancements that maintain or improve business efficiency to fund an exceptional upgrade activity.
A failure to keep the whole ecosystem current could seriously impact the value chain due to interconnected nature of systems.	Ensure all applications in the estate are maintained in a consistent manner. For systems on the perimeter, ensure they are integrated through centralised API management rather than point-to-point.

Table 155 – Business services risk summary

4.2 End User Computing

As confirmed in BP1, National Grid will invest £24million towards end user computing. End user computing covers a variety of support within ESO IT Operations including Modern Workplace End-User Service. For an end user to be able to be online and productive it requires that both software and device are up-to-date and secure to allow mobility.

Device Refresh

In BP2 we will continue to invest in the end-user experience ensuring access to collaboration technology and tooling to enable the post-pandemic hybrid working proven effective during BP1. Maintain our end-user device estate in accordance with asset heath policy ensuring users have access to the technology and applications to work seamlessly in the office or remotely. Maintaining platforms, operating systems and applications to ensure updates and vulnerability patching are tested and applied to protect the integrity of the overall estate.

As demand for a more diverse selection of devices grows and cloud services evolve, the management of these devices and services becomes more complex, requiring new tools and services. An enterprise mobility management solution to manage tablets, mobiles, and laptops on a common platform.

Service Upgrade / Refresh

An ongoing programme has been to maintain service access to our core services. These core services include Microsoft O365 and Windows 10 as they both provide critical access in how we have managed our business in recent years.

As more cloud-based services dictate the pace of change, we will need new capability to manage updates and refreshes. Due to the volume of changes that Microsoft push (343 updates in the past 12 months) we must develop a system / process that enables us to deal with these quickly and efficiently. The inability to evaluate future changes will at best prevent efficiency improvements and at worse disrupt services to end-users. Examples of recent changes during BP2 include:

- Secure biometric login of Windows 10 requires appropriate hardware support outside our device estate. With the right hardware these features provide a more secure and efficient log-in
- Microsoft has added a new mobile messaging service (Kaizala) to Office 365. Potentially this application can provide significant safety and productivity improvements through the digitalisation of field process, such as recording job progress or providing remote expert support.

We will invest in our ability to consume updates from the likes of Microsoft and Windows. The complexity is the volume of updates annually and the impact of those, whilst reducing risk to implementation.

Security and Management of Devices

As demand for more diverse selection of devices grows and cloud services evolve the management of these devices and services becomes more complex and tools and services are required to ensure efficient management of these devices and services. An Enterprise Mobility Management solution will be deployed to manage tablets, mobiles, and laptops on a common platform

Fixed Video

National Grid supports 86 videoconference units. These have a lifespan of five years, and we aim to replace each device over the RIIO-2 period and increase the number to 110. We also have two telepresence units in the UK which will need refreshing in year three of RIIO-2.

SharePoint Refresh

SharePoint remains central to efficient collaboration allowing users to share and collaborate on the development of documents and ideas. During BP1 we began the migration from legacy SharePoint to SharePoint online unlocking the full potential of Office 365. Throughout BP2 we will continue this migration providing users with great collaboration experience, while reducing exposure to legacy technology and reducing cost.

API Integration

As we move our technology forward, we must consider the connectivity theme across all areas of our IT Operations. For our customers, stakeholders, and people, they each require easier access and connectivity with minimal data input.

The ESO has a number of applications, systems and software and moving forward we would like to consolidate our applications and capabilities into standard platforms. Where we see the potential is opening an API, this will allow for seamless integration and the movement of data reducing input multiple times by our customers, which we have already identified as a requirement.

Costs

	2021/22	2022/23	2023/24	2024/25	2025/26	Group Total
Customer experience	0.0	0.0	0.0	0.0	0.0	0.0
Emerging technologies	0.5	0.5	0.5	0.5	0.5	2.5
End user computing	5.0	4.0	4.5	4.0	4.0	21.5
Unified communications and collaboration	0.0	0.0	0.0	0.0	0.0	0.0
Total	**5.5**	**4.5**	**5.0**	**4.5**	**4.5**	**24.0**

Table 156 – Group capex investment in end user computing, 18/19 pricing

Risks

Description	Assumption
Most of the investment is driven by device refresh which is dependent on user numbers and device-to-user ratio. A significant change in device numbers would result in a corresponding change in investment.	User numbers remain broadly flat.
Most of the investment is driven by device refresh. Technology hardware is typically priced in US dollars. A significant change in exchange rate due political events may impact hardware purchase costs (as seen during RIIO-1).	It is assumed that GBP: USD currency rates remain stable, and vendors don't realign to UK pricing.
RIIO-2 covers a long time period from a technology development perspective. New technologies or methods of working may change investment profile. Split between	Current planned solutions will not change unless there is a financial/efficiency benefit.

opex and capex may change but totex will remain same or be reduced.

Table 157 - End User Computing risk summary

4.3 Hosting

National Grid will invest £106M in modernising hosting capabilities to ensure that core infrastructure supports user productivity and efficiency, delivering excellent customer satisfaction while maintaining a secure cyber environment.

Hosting Infrastructure

National Grid has adopted a Hybrid Public / private cloud strategy for hosting, enabling the leverage of scalable and efficient public cloud services for common business solutions, while maintaining Private infrastructure for operationally critical services.

Public Cloud

These are computing services offered by third-party providers over the public internet. Customers typically pay only per usage for the CPU cycles, storage, or bandwidth they consume; pre-buying is an alternative option. Examples include Microsoft Azure, AWS, and Google.

Public cloud providers buy, manage, and maintain the infrastructure. They have virtually infinite scale customers. The public cloud is secure if the provider uses proper security methods.

Cloud-based data management and analytics are now universal and essential for modern data analysis approaches and even more so for artificial intelligence implementations. This investment will evolve ESO's traditional data management and analytics to the cloud. It is indispensable for much of the RIIO2 change programme, including unlocking the value of our digital twin technology investments and hosting data from the asset register which is fundamental for our Single Markets Platform.

Moving into BP2, 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.

Private Cloud

These are computing services offered primarily over a private internal network for a single company. They offer businesses many of the benefits of a public cloud - self-service, some scalability, and some flexibility - with additional control and customisation. Security may be better as it uses company firewalls and internal hosting to ensure operations and sensitive data are not accessible to third-party providers. Internal IT departments are responsible for the cost and accountability of managing this estate and require the same staffing, management, and maintenance expenses as traditional data centre ownership.

With both cloud types, there are different ways to deliver technology requirements. Infrastructure as a service (IaaS) include infrastructure resources such as computing, network, and storage as a service. Platform as a service (PaaS) are simple cloud-based applications as well as sophisticated enterprise applications.

Private clouds can be combined with public clouds to create a hybrid, allowing a business to take advantage of 'cloud bursting' to free up more space and scale services to the public cloud when demand increases.

At the end of RIIO-1, our employees fed back that our IT was becoming a significant blocker to their effectiveness. Our stakeholders and customers told us they want safe, secure, and reliable networks, efficient energy market operations and greater transparency of data. Above all, they want to be protected from external threat. Delivering these expectations is dependent on IT solutions.

Indeed the full range of solutions for operational platforms, from energy balancing and SCADA platforms to analytical modelling such as digital twins are all dependent on a modern high-performance operating environment.

With this in mind, we have had to prioritise investments into our IT, and along with the escalating threat of cyber-attack, sought to review how we monitor and prevent cyber threats and ensure IT continues to underpin the productivity of our workforce. With a significant proportion of our IT hosting assets at or beyond end of life, a

growing cyber threat, and the increasing risk of failure we have re-examined our asset health policies and increased our spending on IT hosting technologies, mitigating risk, driving improved operational performance, and reducing operating costs.

This investment will continue throughout BP2, and to make our transmission networks ever more efficient, we are also proposing continued investment in condition-based monitoring and analytics for our transmission assets. This generates large volumes of data and requires significant computing power.

In addition, to support our security teams in protecting National Grid and the networks and markets it operates in, it is vital that our core IT assets are fully supported, patched to protect from vulnerabilities and monitored by our cyber security technologies. Failure to continue and complete the modernisation work on our infrastructure would compromise security and performance and limit our capability to provide a high-quality service to our customers and stakeholders. As such this word will continue into BP2.

Costs

	2021/22	2022/23	2023/24	2024/25	2025/26	Group Total
Cloud and hosting	25.4	4.5	5.0	10.0	2.0	46.9
CNI infrastructure	4.3	3.4	3.5	2.0	2.0	15.2
Platforms	15.5	14.3	6.5	4.5	3.5	44.2
Total	**45.2**	**22.2**	**15.0**	**16.5**	**7.5**	**106.3**

Table 158- Group capex investment in hosting, 18/19 pricing

Risks

Description	Mitigation
Suppliers will not be able to deliver the services at the price agreed.	Extensive procurement process and analysis gives confidence that suppliers have a proven track record and can deliver value.
Strategy will not be executed optimally due to us not having the key skills to define new patterns, introducing additional risk of having to re-design at additional cost.	The selection and transition of services is being undertaken by employees who will implement and maintain these services. We will also supplement resource with contractors and partners. Key decisions will be reviewed by our central architecture review board and delivery teams.
The age of our current estate may make migrations challenging or unachievable. This may force application modernisation or other solutions.	Agent-based assessments and application estate assessment is being undertaken to better anticipate any risks and limitations.
New services are not available in time to exit from existing contracts.	Work has already begun to prepare for new hosting models and contract exit. We are regularly reviewing use and capacity.
There is a lack of automation in provisioning. The continued use of old ways of working are not designed for rapid scaling, resulting in not being able to react to future project requirements.	We are implementing a new operating model to focus on automation, update processes and ways of working, and bringing in key skills to meet future demand.
We don't have the capability to host legacy technologies.	Provision will be made in new contracts to allow for legacy systems.

Table 159 - Hosting risk summary

4.4 IT Operations and Tooling

Our IT operations have limited visibility of real user experience, lacking real-time data on end-to-end application performance, topological dependencies, and financial information. This makes application maintenance labour intensive and inefficient. Resources are assigned to manual operational effort with limited return. We don't currently design for automation first, so an incremental approach will miss the opportunities afforded by end-to-end monitoring and intelligent-operations management tools.

This continued investment will address these concerns over the BP2 period. By focusing on the overall end-to-end efficiency rather than incremental efficiency, automation becomes the primary focus and will enable us to balance efficiency with the need for rapid change as we invest in the people, tools and processes needed to manage IT optimally.

To ensure we maximise these benefits, we will be focused on:

- Establishing transparency of IT cost across the business to enable accurate decision-making.
- Investing in tools, automation, and process efficiency so that the IT estate can be managed as efficiently as possible across planning, build, provision and maintenance.
- Investing in the consolidation and automation of the network operations centre to ensure optimised network operations.

Bespoke IT solutions are designed to be deployed and operate without manual intervention. Commodity software platforms (e.g. Office 365) require radically different support models to bespoke solutions.

The implementation timeline for the automation of IT operations in RIIO-2 is as follows:

- Short term (0-24 months) – introduce performance monitoring, create rich performance data, and prove the automation concept.
- Medium term (two-five years) – repurpose applications to fit the new model as they are refreshed.
- Beyond five years – achieve fully automated IT operations.

IT operations includes the processes and services provided by IT to internal and external customers and is used within the IT department to manage the IT estate. This includes the provision of new IT requirements and services, service desk, operational monitoring of network and server infrastructure, application maintenance, and patching.

It is increasingly important to provide a frictionless user experience in all aspects of the IT service. This includes ensuring high availability by maximising uptime of the applications users rely on, providing efficient self-serve capability for requesting new services, and resolving issues before users are impacted. To ensure the effective and efficient delivery of services, IT operations needs key technologies and tools.

IT operates inter-related processes to plan, build, provision, and operate the services required by our business. These are grouped into four categories.

- **Plan** – understand business strategy and translate it into an investment portfolio that is optimised to add maximum value to our organisation and its customers.
- **Build** – from requirement capture to deployment of new applications and IT services.
- **Provision** – from user/customer request through to the provision of services to users.
- **Operate** – the detection through to correction covering the monitoring, operating and remediation of the services IT provides.

We will identify opportunities to digitalise the operation of each process through improved tooling and automation. Our primary approach remains the streamlining of business processes through process re-engineering and using modern platforms – such as ServiceNow and DevOps tools – which support end-to-end processes. Increasing use of automation, robotic process automation (RPA), and machine learning, can result in substantial efficiency improvements. Our objectives are to reduce costs, increase pace and throughput, and reduce business risk. Automation is also necessary to manage the increasing scale and complexity of IT.

During RIIO-1, considerable emphasis was put on improvements to the provision and maintenance processes. Working with our strategic partners, we established ServiceNow as our primary service request and incident

management platform. This enables further opportunities to digitalise IT operations such as application performance monitoring, automated provisioning, and a centralised operations centre.

More recently IT has started to digitalise several build processes such as the use of automated testing and automated provisioning of test, development, and training environments. We are investing in DevOps as a step towards continuous integration and continuous delivery (CI/CD) of new and enhanced services into production. Digital transformation offers new opportunities for a business to drive value. To support this approach, IT also needs a similar step-change to make use of advances in software automation, application performance monitoring and intelligent IT orchestration. We will apply this digital philosophy to all IT functions, from planning to operations.

Plan - Demand, portfolio, project, and architecture management

This covers all activities associated with planning the introduction of new or improved IT services. It includes understanding the business and IT strategic roadmap and requests for new or improved services. Given the amount of proposed investment over the RIIO-2 period it is critical this is planned appropriately and sequenced to deliver greatest value continuing into BP2.

IT is investing in new tools to improve planning and prioritisation capability including planning, demand management, resource planning, financial forecasting, cost management, application portfolio management and technology rationalisation. We will consolidate multiple tools into a single platform with a business intelligence layer across information sources to make better informed decisions. The objectives are to make the most effective decisions based on real data about the existing and future IT services, their costs, health, and configuration. This scenario planning capability will help to model the impacts of decisions before they are made.

Our IT Tool investments also support our ongoing maturity within the agile delivery space, helping us create further flexibility and reduce risk to project delivery. As part of the Agile delivery, we now work in sprints which are based upon communication from our high-calibre people in security, development, and IT operations from cross-functional teams. By working in an agile way, we remove the risk of big bang deliveries. As we know, large scale changes present a risk to the overall technology ecosystem however, by changing this to continuous development deliveries we support the end consumers with stable platforms.

Plan - Financial management and technology business management

We have invested in Apptio to give greater insights into the costs of existing services. Our roadmap includes integration with strategic planning systems and with our configuration item management database (CMDB). This will provide a richer view of IT assets and their health through automated asset discovery, software licence management, and cloud access brokers. This will be extended to provide a full view of IT finances covering the cost of operation and future investment/cost-to-achieve data. Using financial management tools also allows more detailed benchmarking of performance against peer groups.

We will continue to invest in Apptio for asset health and cost analysis. We will be extending this to provide a full view of IT finances covering the cost of operation and future investment/cost-to-achieve data. Using financial management tools also allows more detailed benchmarking of performance against peer groups.

Within a regulated environment, these tools create the ability to apply consumption based financial modelling. This ensures that costs are correctly allocated, driving accountability into the operational businesses for their technology decisions. These investments will improve transparency, traceability, and monitoring of progress against the commitments within our strategic plans.

With significant IT change planned across the BP2 period it is imperative that we continue to invest in our planning tools, the consequences of not using appropriate tooling can cause impact to delivery as well as budget. These types of tools, allow us to foresee the dependencies and impact of projects and with the scale of change we are going through, we want to mitigate against this the best we can.

When delivering a project there is a number of capabilities that are required from our delivery team, planning, demand, resource, financial forecasting, cost management, application, portfolio, and technical rationalisation.

When delivering a project and using multiple applications for each element of this there is an incredible amount of wasted time and likelihood of error. Our ambition is to consolidate all these applications into one. This also presents the benefit of consolidated data which we intend to overlay data analytics to provide business insights which will create the opportunity to make smarter business decisions.

Our view on making smarter business decisions is based upon using real-time data. Where we would like to end up is having a single platform which will hold the data of existing and future IT services, their costs, and projected costs as well as the asset health and configuration. A key element that will assist in the decision-making process is scenario planning. We will be able to leverage the technology to input the scenario and review the data from the output will inform us if this is the correct decision that should be made.

Similarly, there are opportunities to improve lifecycle management and the planning of technology upgrades. Automating the analysis of vendor support lifecycles against our CMDB data allows for improved prioritisation of upgrade or replacement investment. We will also use the CMDB data to provide transparency of IT financial performance focusing investment to achieve the greatest impact.

Build – automating the development and release of services

Development and integration teams are challenged to deliver a greater volume of change on a more frequent basis. Historically, automation has been applied to parts of the development process, such as automated testing tools to execute unit, stress (load), or regression testing. Agile development practices and DevOps processes are used to further increase the speed of delivery, using tools which improve speed through integration and automation of development tasks.

Within operations, automating the provision of infrastructure-as-a-service (IaaS) and platform-as-a-service (PaaS) has been the first step. Other opportunities exist and organisations are moving to continuous integration/continuous delivery (CI/CD) which combines build with continuous infrastructure automation.

We have identified the inefficiency of manual development and releases and begun the automation of IaaS and PaaS in RIIO-1. We are continuing to invest in our capability of continuous integration. This covers the build, integration, testing and delivery of functional changes to software on a scheduled, repeatable, and automated basis. Extending infrastructure automation to support DevOps processes allows for repeatable and scalable CI/CD processes. With continuous integration, software development teams can use automated and repeatable build and test processes. Code management, version control, regression testing, and deployment are managed. Continuous delivery extends this from compilation of new/amended software, assembly as a build package, testing, and deployment into the relevant environments within a repeatable framework.

As our operating model evolves and matures, we will continue to build and enhance our skill sets for the future. Funding models will support more platform-centric programs which concentrate business unit demand around key platforms (CRM / Salesforce, asset management, data platforms, etc.).

We are also continuing to develop new skill sets and automation tools for the build phase in areas such as:

- RPA, AI, machine learning, and data science.
- Design thinking/user focused design and lean UX skills/tools for customer journey definition and wireframing.
- Continuing to build cyber skills and tools to embed security in the build phase improving the speed and consistency of cyber protection in applications and services.

Provisions and Operate

Provision and operate include the processes and technologies used within the IT department to manage the IT estate. This includes service requests associated with the provision of new IT requirements and services, service desk, operational monitoring of network and server infrastructure, incident management, and application maintenance activities such as patching and upgrades.

It is increasingly important to provide a frictionless user experience in all aspects of the IT service, ensuring high availability to maximises uptime of the applications users rely on. Users expect efficient self-serve capability for requesting new services and for issues to be resolved before they are impacted. To ensure the effective and efficient delivery of services, IT operations needs key technologies and tools.

Digitalising IT operations can be applied to the following areas:

- Application maintenance
- Infrastructure and operations
- Application performance monitoring and management
- Discovery tooling

Automation is at the heart of this opportunity. Increasing the role of automation in IT operations accelerates time to value, improves the user experience, and reduces waste by making possible the No-Ops model where systems need little or no manual intervention to run.

Application maintenance

IT operations technology will enable faster development cycles. Advances in automation, application performance monitoring (APM), and tools to create production environments that will require less people to run and afford greater insight into performance and increase uptime.

The opportunity is to build environments specifically designed to extract comprehensive performance data and to use this to then drive automation. This enables a long-term goal of a No-Ops model where systems need little or no manual intervention allowing resources to be focused on value-add activity.

Designing for automation brings benefits throughout the software development lifecycle as it enables rapid progression from build to test to deployment and operations. Such a step-change has the potential for an improvement in uptime, accuracy, and efficient use of resources

This approach has a cumulative effect creating a virtuous circle that starts with real-time performance data and automation, leading to enhanced user experience and rapid development cycles, which creates more opportunity for innovation and value-add activity.

Use of automation has already delivered benefits. The privilege user access review (PUAR) is an example saving significant FTE-hours by applying RPA. In this case, a two-hour manual task is transformed into a sub-minute RPA driven transaction, enabling what used to be an 80-day audit to be run over night and with greater accuracy.

Infrastructure and operations

The infrastructure and operations (I&O) area of IT plays a critical role overseeing IT infrastructure and service management, solution delivery and governance across user devices and services, network connectivity, and compute platforms including SaaS, PaaS, and IaaS.

Current practice relies on manual investigation often by multiple suppliers – which can be a significant portion of the total recovery activity. Time from initial impact to diagnosis of the fault accounted for an average 54% of total impact time in three case studies.

We have invested in process improvements and tools in the following areas that will continue throughout BP2:

- **Technology roadmap and release management** – as part of our delivery plan in BP2 is to maintain a healthy and up-to-date environment, I&O will use automated CMDB discovery tools to track hardware and software inventory to plan and deliver the necessary updates to the infrastructure. Automated patch management utilising AI validated releases will improve update cycles to reduce operational and security risks.

- **Performance measurement** – developing a baseline for infrastructure, applications and service performance using tools and machine learning to measure and predict performance issues before users report problems will allow I&O to track user experience and reduce the number of incidents.
- **Application performance monitoring** – allows IT to measure the real user experience of an IT application in terms of its availability and responsiveness. Historically, when performance degrades, the first alert is generally the users calling the service desk. Consequently, the user experience can suffer for prolonged periods while IT reactively addresses the issue.
- **Cost and operational budget management** – we are using cost management tools like Apptio in combination with automated infrastructure inventory and CMDB discovery. Integrating with SAP, billing management, and our strategic planning tools will allow I&O and IT finance teams to improve visibility, track cost allocation, and measure performance against the targets.
- **Service catalogue** – we are continuing to invest in our delivery of standard services and solutions will improve our time to deploy and reduce costs via automated workflows and change management. It is important that we revisit our service catalogue taxonomy. The taxonomy is critical to delivering a rational, frictionless end user experience.
- **Disaster recovery and business continuity** – as the technology deployed within the IT estate changes with the adoption of new network and storage technologies, it is necessary to continually update and test business continuity and disaster recovery plans. Our standard infrastructure solutions enable I&O to deliver the required availability at a reduced cost, relying on digital twins to deliver the level of assurance required to ensure business continuity in case of a major disaster.
- **Supporting tools** – IT service management tools are vital for I&O to deliver IT services in a frictionless and cost-effective manner. During the RIIO-2 period we are extending the functionality of our ServiceNow platform to include CMDB which, in conjunction with Apptio, will deliver transparency of the IT cost base enabling effective decision making and driving ever greater efficiency within the portfolio.
- **SaaS support** – for the support for SaaS products, the emphasis is placed on business functions and their role in maintaining the business processes within the tool. The role of I&O is to ensure the basics of network connectivity, end user computing and support desk functions are in place.

Application Performance Monitoring

Application Performance Monitoring (APM) allows IT to understand the real user experience of an IT application in terms of its availability and responsiveness. Historically, when performance degrades, the first alert is generally the users calling the service desk. The user experience can suffer for prolonged periods without IT being aware there is an issue.

At present, production environment monitoring is disjointed and incomplete. Root cause analysis is a manual and time-consuming task. Where implemented, APM is retro fitted and incomplete so of limited value. To extract maximum value, systems need to be designed for APM with the aim of exposing rich data on performance.

Designing in automation and monitoring from the start overcomes these problems as it enables the production environment to create rich application performance data insights to drive AI learning and latterly automation via orchestration tools. Automation, performance monitoring, and artificial intelligence present opportunities which were previously out of reach.

Discovery tooling

As the rate of change increases across the IT landscape through increased automation, then the need for automated discovery tooling also increases. Automated discovery tooling enables information to be collected on services, hardware, and software, in real-time ensuring information is up to date in a rapidly changing environment. This is required to address several key areas:

- **Software and service license compliance** – an accurate inventory of software and services and their licensing usage is critical to ensure that we remain compliant with the terms of our licensing agreements.
- **Cost management** – an accurate cost of services is key to decision making and cost transparency. This will enable us to operate services most efficiently to meet customer demand.
- **Configuration management** – accurate configuration management information is critical for incident resolution/change management to ensure that planned or unplanned changes have the desired effect on the services being impacted. Out of date information can lead to intervention errors and inadvertent loss of service.

Moving into to BP2 we will continue to invest in process improvements and tools delivered to all critical I&O functions. In our operations management and governance, we will maintain our asset health policy to improve performance, reduce risk and deliver greater value. The use of common platforms and rationalising how infrastructure and applications are deployed and consumed, will reduce overlap and costs.

By improving availability and capacity management processes, automation, and analytics will deliver a deeper understanding of our IT services and infrastructure consumption, providing a predictive forecast to identify when and where we need to deliver capacity.

We will be investing in our asset management infrastructure discovery tools which will deliver a granular view of our infrastructure inventory, enabling us to correlate infrastructure, applications, and services, saving time and reducing costs.

A key area that we have and will continue to focus on is our change management process. Our change management needs to reach a maturity level where automation and standard changes reduce the time to deliver infrastructure improvements while reducing the risk or failures. The CMBD will play a key role in documenting the relationship between infrastructure, applications and services that will enable the automated risk evaluation, service testing, and validation.

Our service desk automation will rely on bots and pre-defined or automated steps to remotely apply configuration changes or fixes to software and applications will reduce our service desk footprint. This includes our incident and problem management. The combination of application/service performance monitoring tools and automated CMDB discovery can improve visibility and automate problem detection and resolution.

Our technology roadmap and release management are our proposed plan to maintain a healthy and up-to-date environment, I&O will use automated CMDB discovery tools to track hardware and software inventory to plan and deliver the necessary updates to the infrastructure. Automated patch management utilising AI validated releases will improve update cycles to reduce operational and security risks.

Our performance measurement will develop a baseline for infrastructure, applications and service performance using tools and machine learning to measure and predict performance issues before users report problems will allow I&O to track user experience and reduce the number of incidents.

Application performance monitoring allows IT to measure the real user experience of an IT application in terms of its availability and responsiveness. Historically, when performance degrades, the first alert is generally the users calling the service desk. Consequently, the user experience can suffer for prolonged periods while IT reactively addresses the issue.

Moving into BP2 we will use cost management tools like Apptio in combination with automated infrastructure inventory and CMDB discovery. Integrating with SAP, billing management, and our strategic planning tools will allow I&O and IT finance teams to improve visibility, track cost allocation, and measure performance against the targets.

Our service catalogue will receive investment to improve our delivery of standard services and solutions will improve our time to deploy and reduce costs via automated workflows and change management. It is important that we revisit our service catalogue taxonomy. The taxonomy is critical to delivering a rational, frictionless end user experience.

Disaster recovery and business continuity relies upon the technology deployed within the IT estate. These changes require the adoption of new network and storage technologies, it is necessary to continually update and test business continuity and disaster recovery plans. Standard infrastructure solutions will enable I&O to deliver the required availability at a reduced cost, relying on digital twins to deliver the level of assurance required to ensure business continuity in case of a major disaster.

The IT service management tools are vital for I&O to deliver IT services in a frictionless and cost-effective manner. During the BP2 period we will extend the functionality of our ServiceNow platform to include CMDB which, in conjunction with Apptio, will deliver transparency of the IT cost base enabling effective decision making and driving ever greater efficiency within the portfolio.

For the support for SaaS products, the emphasis is placed on business functions and their role in maintaining the business processes within the tool. The role of I&O is to ensure the basics of network connectivity, end user computing and support desk functions are in place.

Our focus for RIIO-2 is to move away from manual processes and realise the benefit of automated processes that allow for our people to focus on thought provoking work. The technology advances will allow efficiencies to be made allowing the savings to be passed on. Areas where we plan to address are:

- Bespoke IT solutions are designed to be deployed and operated without manual intervention.
- Performance monitoring is comprehensive and exhaustive.
- Tools supporting the environment are best of bread and integrated with a single orchestration layer from which actions can be automated.
- Intelligent operations tools use AI and machine learning to detect out-of-bound performance and suggest root causes of failure.
- Principles are strictly applied to qualify applications to run in this environment.
- System improvements are driven by performance data insight, so changes are targeted and efficient.
- New releases are baselined against existing operational performance data, so they are proven before deployment.
- Automation is used throughout the build and test process allowing nightly build and test cycles.
- A modular build approach combined with short development cycles and continuous and automated build/test enables IT to confidently and flexibly adapt solutions to support new business opportunities.
- Software is built and tested against the same APM tools as used in the production environment.
- All suppliers/partners have visibility of the production environment performance data which is regarded as the source of truth.

In the short term we have sought to surface data and implement APM across the existing production environment where compatible. This includes user experience monitoring, automated inventory management, and full software/infrastructure performance monitoring. The outcome is to gain control of the environment, increase uptime and enhance the user experience.

Moving forward we will repurpose applications as they are refreshed through reinvestment. Generic services are provided by vendor platforms, bespoke solutions are designed accorded to the mandated principles, which are fully verifiable in the test environment. Solutions are modular, frequently iterated and rely on automation for deployment and operation. Over 80% of events are fixed without manual intervention. Application maintenance costs are reduced enabling more resources to be directed to developing solutions to support the business.

Our overall aspiration is to remove IT operations. AI and orchestration have enabled applications and infrastructure to run with minimal manual intervention, delivering significant reduction in operational cost.

Strategic Platform Investment Areas

i. Demand, portfolio, project, and architecture management

Aligning business strategy and demand to change initiatives and the underlying architecture is critical to managing change efficiently and cost effectively. A consolidated platform, or set of integrated products, will ensure alignment and visibility across the planning and execution lifecycle. In RIIO-1, investments have been made to maintain and integrate point solutions. This will need to improve and increase throughout the BP2 regulatory period to optimise the delivery of BP2 investments.

ii. Disaster recovery

Disaster recovery is an area of IT and security planning that protects us from the effects of a significant negative event, allowing the quick resumption of mission critical functions. We create and manage large volumes of electronic data, much of which is essential to the normal operations of the business. While every effort is made in the design of IT solutions to prevent outages impacting users, it is not practicable to engineer full resilience to every system.

As the technology deployed within the IT estate has changed with the increased adoption of cloud compute, new network, and storage technologies it was necessary to continually update and test business continuity and disaster recovery plans.

iii. Discovery Tooling

The large and dynamic nature of our IT estate creates specific challenges in maintaining an accurate view of the assets and software packages deployed. One of the key requirements that was previously highlighted, in digitalising IT operations and extracting the benefits of AI and automation is tracking the configuration of the IT estate. A CMDB which was continually monitored, updated, and verified by discovery tools, plays a vital part on the digitisation journey.

iv. ServiceNow

Within the digitalised IT operational environment frictionless workflows to support change management, and orchestrate the automated workflows associated with customers requesting new technology and applications are a vital component of driving operational efficiency and improved customer experience.

The ServiceNow platform is our platform of choice for the provision of digitalised workflows transforming the IT value chain allowing IT to align to the business priorities with speed and agility, delivering AI powered user experiences whilst reducing operational costs. IT service management tools are vital for I&O to deliver IT services in a frictionless and cost-effective manner.

We adopted ServiceNow during the RIIO-1 period. This allowed us to consolidate our IT service management systems and processes that were previously spread across multiple platforms and offline spreadsheets. From this, we started to generate the vital data, analytics and reporting capabilities required to drive the function forward and improve efficiency.

During the BP2 period we will build on these foundations and extend the functionality of our ServiceNow platform to include CMDB. In conjunction with Apptio, this will deliver transparency of the IT cost base enabling effective decision making and driving ever greater efficiency within the portfolio. Core to efficient and effective IT service management is a robust, reliable CMDB. Improved CMDB data stewardship and management will contribute to a reduction in service outages and enable faster incident resolution.

Software asset management provides the ability to set up license abstracts, implement automated license re-use and act upon various license thresholds. To derive maximum value in software asset management, we will need to invest in the ServiceNow software asset management module. This functionality provides transparency and reporting becomes near real-time. This avoids extensive work each time we need to accurately identify overlaps in an increasingly complex licensing model. We can then monitor and rationalise our technology estate in real-time without months of resource-intense analysis.

ServiceNow allows IT to interface directly to other key business services, linking to identity access management (IAM), Successfactors (HR system), and SAP allowing the creation of workflows across a wide range of business services, further improving efficiency of the enterprise.

ServiceNow is a constantly developing platform with incremental capabilities being released in twice-yearly updates. Continued investment is required to ensure that we derive maximum value from the new capabilities as they are added to the platform.

v. Infrastructure and network operations centres (iNOC)

Within our estate, there are multiple network operations centres, each supporting specific assets and providing specific monitoring capabilities. These include teams to support the OPTEL network management, CNI system health, enterprise network monitoring, data centre monitoring, and cyber security operations. These functions operate independently across multiple locations, each with independent management and reporting lines. These operation centres also reflect the functional responsibilities of each of our strategic service partners.

As the IT estate becomes increasingly digitalised, reducing the need for manual intervention in the operation of the IT estate, the standalone nature of the varied iNOC capabilities within the estate becomes increasingly inefficient and less effective than it could be if integrated into a single unified operations centre.

The network operation centres have a key role in enabling us in managing the performance of vendors by being able to directly monitor and interrogate the systems, without being dependent on reports provided by the vendors. Our ability to scrutinise asset discovery, network monitoring, application performance monitoring, and similar tools plays an important role in validating the performance of vendors and providing quantitative data against which to identify and define improvements.

In bringing all independent iNOC capabilities into a single function we drive efficiency by eliminating the multiple management structures required, streamlining to a single line management structure. A single unified iNOC will also improve the effectiveness of communication and cooperation between capabilities by bring them together and improve our overall capability by bringing in-house monitoring and reporting on the holistic IT estate.

The intent of infrastructure and network monitoring capability is not to function in independent silos. As technology becomes ubiquitous in modern workplaces and greater levels of automation are available, it is important to address our legacy services and redefine how of technology will be monitored and managed into the future. Failure to address the historical technology monitoring will perpetuate elevated costs, impair improvement in service, and most critically, block the future automation of technology management.

Once enabled with the required infrastructure and tools, the iNOC will deliver end-to-end visibility across our infrastructure and partners.

Costs

	2021/22	2022/23	2023/24	2024/25	2025/26	Group Total
Cost analytics and transparency	3.0	0.0	0.0	0.0	0.0	3.0
Digital IT operations	5.0	3.0	2.0	2.0	2.0	14.0
Discovery tooling	2.0	1.0	0.0	0.0	0.0	3.0
Disaster recovery capabilities	3.0	0.0	0.0	0.0	0.0	3.0
Total	**13.0**	**4.0**	**2.0**	**2.0**	**2.0**	**23.0**

Table 160 - Group investment in operations and tooling, 18/19 pricing

Risks

Description	Mitigation
There is a risk/opportunity that the level of coordination between IT operations automation and other projects will vary from the levels assumed.	Where possible we will use projects to deliver efficiencies with a resultant impact to cost.

Table 161 – IT Operations & Tooling risk summary

4.5 Enterprise Data Network

As confirmed in BP1, National Grid will invest £46.5million towards network services. National Grid's Enterprise Data Network which comprises the Wide Area Network (connections between sites) and the Local Area Network (the network within sites including wireless networks) supports data and voice communication services that are essential for the safe, secure, reliable, and economic operation of the Energy Management systems operated by ESO to balance the network and support all operational/commercial ESO services. The key areas that we will continue to invest in are the Wide Area Networks (WAN) and Local Area Networks (LAN). These WAN and LAN investments will underpin ESO's consumption of CNI Data Centre, Optel, Azure Cloud, Security Monitoring and Gateway Connectivity services.

Network Infrastructure

We realise that our reliance on our WAN and LAN connections are extensive for the operation of the ESO. These connections support our voice communications, data connections and most importantly keeping us online and accessible for our customers, stakeholders, and people.

The Enterprise Data network is at the core of IT services enabling virtually all IT and Digital activity. Aging network infrastructure not only introduces potential reliability concern but also introduces cyber vulnerability with end-of-life devices no longer receiving software and vulnerability updates.

Moving into BP2 we will continue to invest in our WAN & LAN infrastructure in order to maximise the efficiency of our IT Operations. The future plans for our network infrastructure are focused on working smarter by removing duplicate costs, reducing costs where possible, adopting flexible technology, and moving towards a virtual hardware model. The below outlines our strategy to assure the continued secure, efficient operation of these network services by:

- Using the National Grid operational telecoms Optel network to avoid duplicated costs when connecting to operational sites.
- Shifting from expensive private/dedicated connections to lower cost shared public connections.
- Adopting a technology agnostic approach that ensures flexibility the adoption of future technologies and does not favour technology or individual supplier agendas.
- Using virtualised computing hardware rather than dedicated network appliances to reduce costs, simplify service upgrades, and shift focus from hardware to software-based solutions.
- Transitioning our local area networks within our sites and offices from a predominantly wired network to wireless networks to reduce costs of our local area network (LAN) infrastructure. This enables a smart workspace environment that maximises space/occupancy and promotes collaboration.
- Maintaining a competitive network partner system to deliver the best service and value for customers.
- Using current investment in laptops and mobile devices to support the use of softphones for employees to replace expensive office phones and reduce costs, improve colleague productivity, and maximise occupancy of our offices.
- Maximising the secure and useful life of our data network assets in line with our network refresh policies to balance the cost of services and performance.

Costs

	2021/22	2022/23	2023/24	2024/25	2025/26	Group Total
LAN infrastructure	5.8	4.8	9.1	4.4	3.8	27.8
Network security infrastructure	0.0	0.0	0.0	0.0	0.0	0.0
Voice infrastructure	0.0	0.0	0.0	0.0	0.0	0.0
WAN infrastructure	3.6	7.2	2.9	2.3	2.6	18.6
Total	**9.5**	**11.9**	**12.0**	**6.7**	**6.3**	**46.5**

Table 162- Group investment in enterprise data network, 18/19 pricing

Risks

Description	Mitigation
There is a risk/opportunity that the level of coordination between enterprise network refresh and other IT projects will vary from the levels assumed.	Where possible, we will coordinate projects to deliver efficiencies. with a resultant impact to cost.

Table 163 - Enterprise Data Network risk summary

Part 5 – Technology Business Management data model

In alignment with Ofgem's BP2 ambition, ESO is committed to driving greater cost transparency and improved cost management through the application of the Technology Business Management (TBM) taxonomy.

We see this exercise as offering a dual purpose, providing both Ofgem with the information it needs to rigorously assess ESO's IT investment portfolio for BP2 funding, but also providing ESO with the necessary foundation upon which to drive several cost optimisations benefits over the long-term horizon. We can summarise these benefits as follows:

- **Improved Cost Transparency -** Through implementing a TBM consumption-driven taxonomy, ESO will be able to drive greater cost transparency and visibility of its spending, providing insights on cost consumption and value of IT across the organisation.
- **Enhanced Investment & Transformation Decision making -** A TBM-based cost model will help provide a richer dataset, highlighting areas of focus and informing future ESO spending and investment decision making, as well transformation delivery and improvements.
- **Improved IT Cost Management -** The proposed TBM cost model will also provide a framework for improved IT cost management, enabling the ESO leadership to balance tech spending across the portfolio and make trade-offs to improve value.

Implementing a full TBM cost model that covers the totality of ESO's IT estate and which delivers maximum value for Ofgem and ESO will be a significant undertaking, and ultimately a long-term venture for ESO. Our BP2 Draft submission therefore represents the starting point on this long-term journey.

The below illustrates our future delivery roadmap over the coming 24-month period as we seek to embed robust cost transparency and management across the ESO IT estate.

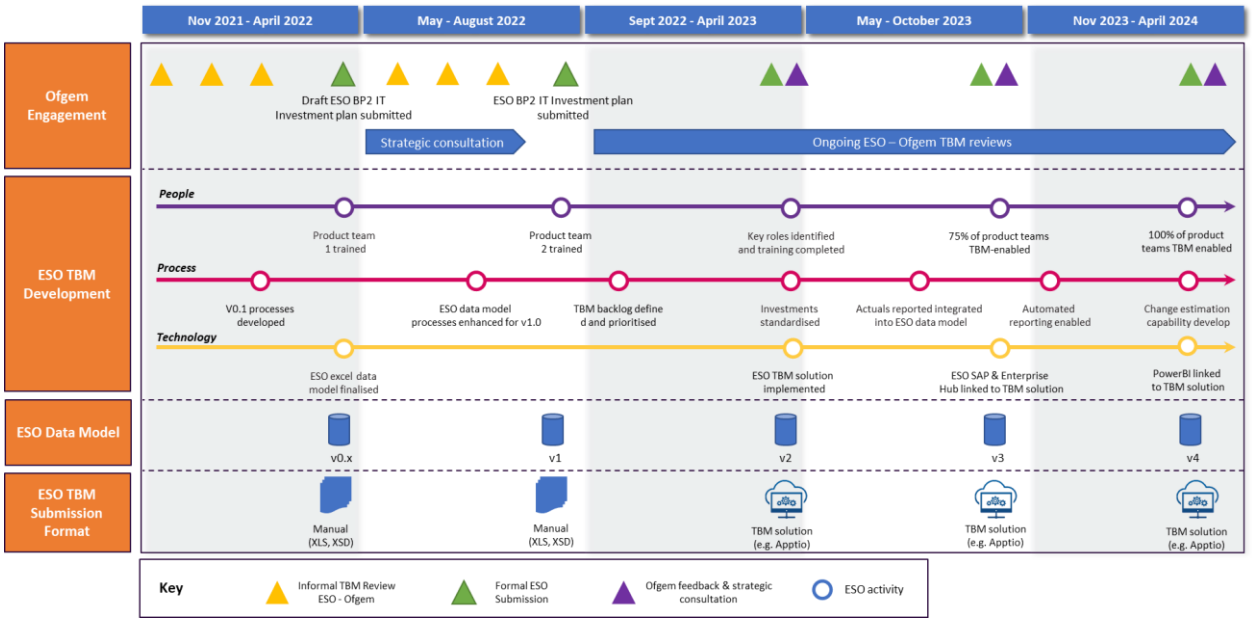

Figure 46 – ESO TBM delivery roadmap

As our journey to implement a TBM cost model represents a long-term transformation, so we anticipate that our TBM model will continue to evolve and mature over time as understanding and experience of TBM matures. Our TBM model which has been submitted as part of our Draft BP2 submission therefore represents the start of this process and should not be regarded as our final model.

From our engagement with our industry partners, it is clear that any TBM model is never fixed or finalised, but rather continually reviewed and updated to ensure that it keeps pace and always reflects the organisation in question.

Our model will follow a similar trajectory and will continue to be updated as our future enterprise architecture is refined and confirmed, and as our cost data set evolves and matures in parallel.

Our TBM processes will also continue to evolve and will aim towards driving estimation accuracy for future change post BP2, meaning that our roadmap focusses on how we get from existing maturity level to the higher maturity level with continual consultation and support from OFGEM.

5.1 Our Draft BP2 TBM Submission Approach

The ESO at present does not have dedicated cost optimisation tooling in place to support Ofgem's requirement to develop a TBM model for the purposes of our BP2 submission.

As shown on the roadmap, ESO has a plan to achieve tooling capability for TBM in the next 12-18 months, initially building out on the NG group IT Apptio platform but with a data set held separately from the NG Group TBM data.

In the interim period whilst enterprise tooling is not in place for ESO, we have developed the BP2 TBM data file formats manually in MS Excel. This has been a significant undertaking but represents the starting point on the ESO's journey to continue to build and mature its capability within this space.

For this reason we have sought to take a measured and pragmatic approach to building out our TBM data model for our Draft BP2 Submission. To aid Ofgem's review we have developed a summary overview of our data model approach within the data model file itself. This summarises our assumptions and logic associated with each of the layers of model and should be read in conjunction with reviewing our TBM data set.

5.2 ESO TBM Portfolio Approach

In order to provide a holistic summary of ESO overall IT investments across the organisation, our TBM model summarises our forecast IT spend across the following areas over the course of FY24 and FY25: our Direct Investment Portfolio, Shared Investment Portfolio, and our Run the Business (RtB) spend.

The below table illustrates the approach ESO has taken in reflecting each of these components with our TBM model.

ESO Portfolio Component	TBM Approach
Direct Investment Portfolio	• For the purposes of defining our Direct Investment Portfolio we have taken a bottom-up approach to populating our cost data, leveraging ESO's delivery cost reporting against standard Work Breakdown Structure (WBS) codes as starting data inputs, and working with our Programme Management and Architecture functional teams to align our costs to the TBM structure • We have sought to map our investments against our Enterprise Architecture framework to reflect how our target sub-system components and solution capabilities will grow and be delivered over the course of the BP2 period, and we have engaged with our Business and Operations teams to reflect the outcomes we will achieve through our investments across internal Business Units and external Customers & Partners • In defining documenting the incremental RtB spend specific to the directs we have also followed a similar approach and built a bottom-up forecast for this component. This differs from our BP1 submission where our incremental RtB forecast was calculated as a percentage proportion of our investment Totex spend

ESO Portfolio Component	TBM Approach
Shared Investment Portfolio	• As agreed with Ofgem and as per the published IT Investment Plan Guidance in 2021, ESO's Shared IT investments will not form part of Ofgem's IT assessment process for BP2. • For the purposes of meeting Ofgem's requirements the cost data that is provided for the Shared IT investments portfolio is the agreed cost dataset that was approved as part of Ofgem's Determination process. • ESO and National Grid have worked to align this dataset into the TBM structure, and this is provided for information purposes only, and should not be used for any other purpose other than that which is stated in Ofgem's IT guidance.
Run the Business (RtB)	• As agreed with Ofgem and as per the published IT Investment Plan Guidance in 2021, ESO's Run the Business (RtB) spend will not form part of Ofgem's IT assessment process for BP2. • As the current RtB forecast dataset that is supplied to Ofgem only provides a limited cost breakdown, ESO has been required to develop a mechanism for providing greater detail in its forecast RtB for the purposes of its BP2 submission. • To achieve this we have used a detailed cost breakdown of RtB spend based on actuals from 2022 and used this to develop a forecast spending profile. This has then been applied to our forecast total RtB spend for FY23/24 to provide a base RTB cost breakdown. The addition of the incremental RtB costs from the Shared and Direct portfolios have then been applied to produce an overall RTB spend profile for FY24 and FY25. • This dataset whilst providing an indication of our forecast RtB cost spread, is heavily assumption driven and should not be regarded as directly relatable with our UCAM allocation costs. Reconciliation between our RtB TBM cost model and UCAM costs will not be possible.

Table 164 – TBM portfolio delivery approach

Part 6 – Appendices

Appendix A: Risk assessment methodology

The risk scoring methodology we have applied is consistent for both portfolio and individual investment risks and is outlined below. This methodology is consistent with the approach we have applied at BP1. Impact scores reflect the potential financial impact to delivery costs either at the individual investment level or in the case of portfolio risks, the impact to overall portfolio delivery costs. In both cases this impact does not reflect the potential impact on benefit losses. Risks with a blank impact score have no effect on delivery costs.

Likelihood

Score	Description	Frequency of occurrence	Probability of occurrence
1	Remote	<Once in 20 years	<20% chance
2	Less likely	<Once in 15 years	>20% & <40% chance
3	Equally likely as unlikely	<Once in 10 years	>40% & <60% chance
4	More likely	<Once in 5 years	>60% & <80% chance
5	Almost certain	One or more a year	>80% & <100% chance
6	Certain		100% chance

Table 165 - Risk likelihood methodology

Impact

Score	£ million
1	Less than 5
2	Between 5 and 10
3	Between 10 and 30
4	Between 30 and 50
5	Greater than 50

Table 166 - Risk impact methodology

Appendix B: RTB cost calculation methodology

Our BP2 Run the Business (RtB) costs for our Direct investments have been derived based on detailed forecasts from our delivery teams. This varies from our previous BP1 approach where a calculation methodology was used based on the level of transformation for each investment.

The purpose of this Appendix is to outline the previous approach that was followed at BP1 to aid understanding and comparison.

Methodology overview

At BP1 a percentage (see below) was calculated for each investment based on whether the project was a lifecycle upgrade ('Run'), provided enhancements to existing technology ('Regulatory', 'Grow'), or was transformative ('Transform'). Transformative activity within critical national infrastructure (CNI) was expected to have a higher impact to base costs based on the levels of system availability and security required. This percentage covered resourcing, facilities, spares, and patching. Upgrades and asset-refresh were budgeted separately. It also assumed the efficiencies from legacy hardware / software retirement.

The assumption applied was that as investment is made in any financial year, RTB cost increases occurred in the following years. The percentage value agreed for each investment was therefore multiplied with the totex value of the previous year's spend to arrive at an RTB cost estimate.

RTB uplift mapping	
Investment Type	**%**
Run	0.5%
Regulatory	2.5%
Grow	2.5%
Transform	4.5%
Transform - CNI	11.0%

Table 167 - RTB uplift mapping approach for BP1

Example: 110 – Network control (£m totex) as at BP1

In the case of Network control this investment was deemed as 'Regulatory' / 'Grow' so a 2.5% value was set. The £3.3 million investment in FY22 resulted in an RTB increase of £0.08 million in FY23 (£3.3M multiplied by 2.5%) and so on. This increase in RTB would then become part of the revised baseline and continue until the service was changed or decommissioned.

		TotEx £m GBP							
ID	**Investment name**	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**Total TotEx**	**Sparkline**	**RTB IT invest. type**
110	Network control	3.3	5.8	7.3	8.8	5.0	30.0		Grow

Run the Business (cumulative £m GBP)								
RTB %	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**FY27**	**Cum. RIIO2 RTB**	**Total cum. RTB**
2.5%	-	0.08	0.23	0.41	0.63	0.75	1.34	2.09

Table 168 - Example of RTB cost calculation for BP1

Appendix C: Governance forums terms of reference

As outlined in Part 1 'Governance and controls', the Cross Entity Investment Decision Making and Direct Investment Decision Making (Portfolio Review Board) forums are particularly important for our IT investment decision making process. As such we have included a summarised view of their terms of reference (ToR).

Summarised Terms of Reference: Cross Entity Investment Decision Making

Purpose

- Ensure that the investment proposals are aligned to each Business Entity Strategic Roadmap.
- Ensure appropriate Business case exists to support the investment either in terms of asset health remediation, risk mitigation or business transformation benefit.

Outcomes

- Approval or rejection of cross entity investments

Line of reporting or escalation

- Rejected investments to reengage with relevant Business Entities to agree how to address concerns and achieve strategic outcomes

Inputs

- Prior assessment and review of investments by each CIO and respective leadership teams.

Frequency

- Every month

Each agenda will include:

1. Presentation of investments
2. Review of investments and potential clarifications
3. Approval/rejection decisions
4. Actions from previous meeting
5. AOB

Roles and responsibilities:

Role	Responsibilities
Chair	• Accountable to Group Investment committee for decisions taken at CEIDM • Responsible for confirmation of Budget forecast, Use of Reg allowance. • Ensures compliance to National grid DOA Policy.
NGET, NGG, ESO, NGV function representatives	• Represents respective Business Unit to: o Approve or reject investment
NG Group finance	• Provides advice and guidance on Finance, capitalisation and budgetary compliance.
Technical Secretary	• Coordinates submission content , agenda and manages end to end process.

Figure 47 - ToR for Cross Entity Investment Decision Making forum

Summarised Terms of Reference: Portfolio Review Board

Purpose

- Provide oversight of RIIO-2 deliverables across ESO portfolio.
- Review and approve ESO direct investment proposals.

Outcomes

- Ensure the portfolio is aligned to current ESO strategic objectives, commitments and RIIO-2 initiatives.
- Approval or rejection of ESO direct investment proposals.
- Issues for escalation to ESO Executive Team (ESOET).

Line of reporting or escalation

- Rejected investments to address concerns and resubmit proposal.
- Supported investments outside of delegation of authority (DOA) amount progressed to ESOET.

Inputs

- Prior assessment and review of investments by CIO and respective leadership teams, finance business partner and sponsor.

Frequency

- Every month

Each agenda will include:

1. Ethics moment
2. Conflicts of interest
3. Actions review
4. ESO Portfolio KPI review
5. Activity prioritisation
6. Investment proposals review
7. Approval/rejection decisions
8. AOB

Roles and responsibilities:

Role	Responsibilities
Chair	• Accountable to ESOET for decisions taken at PRB • Responsible for confirmation of Budget forecast, Use of Reg allowance. • Ensures compliance to ESO DOA Policy.
ESO business unit representatives (IT, Finance, National Control, Markets, Networks, Strategy & Regulation)	• Represents respective department to: o Approve or reject investments
Head of Assurance	• Provides advice and guidance on assurance risk management and assurance.
Head of Regulation	• Provides advice and guidance on regulatory compliance.
Technical Secretary	• Coordinates submission content , agenda and manages end to end process.

Figure 48 – ToR for Portfolio Review Board

Appendix D: BP1 Lessons Learnt

As we started RIIO-2 we looked at what we could improve from RIIO-1 and grouped these into continuous improvement themes. The below diagram summarises the key themes that were identified.

Figure 49 – An illustration of our key continuous improvement themes

The below tables summarise for each of these improvement themes, what changes items were specifically identified, how these were addressed, as well as the improvements that have subsequently been derived.

Engagement

We said	We did	Improvement
Provide greater transparency in our communications with customers and stakeholders.	Established the Technology Advisory Council where we give regular updates.	We have been able to capture better and more timely feedback from our customers and stakeholders allowing for clarifications and better change adoption.

Technical design

We said	We did	Improvement
We will create higher levels of consistency in the user experience.	Introduced ways of working that are customer centric and allow for design thinking with our stakeholders. Started implementation of platform-based architecture that delivers multiple services.	Customer and user feedback has improved, being engaged from the outset and being able to define the product they will get at implementation stage.

Sourcing approach

We said	We did	Improvement
We will ramp up our resources and expertise.	Clarified where we should be using third party expertise. Leveraged new contracts with application development and maintenance partners.	Accelerated and increased throughput of our resourcing engagement process, allowing for quicker and better replies to needs.

Commercial focus

We said	We did	Improvement
We will strengthen our commercial team.	Aligned account managers for each delivery partner.	Better engagement and escalation with our delivery partners, allowing quicker and better delivery of services.

Delivery approach

We said	We did	Improvement
We will have greater adoption of agile methodologies.	Aligned the role of the product owner within the business.	Increased business input and ownership leading to better quality outputs.
	24 of 31 initiatives use agile methodologies now.	Better management of delivery risks and benefits being delivered sooner.

Delivery capability

We said	We did	Improvement
We will build in-house technical capability across aspects of the IT delivery lifecycle.	Enabled a product-based approach, creating release teams that will enable continuous delivery and release of solutions.	Greater stability and alignment of internal and external deployments. Improved visibility of which and when benefits will be delivered.
	Implemented a new leadership structure.	Improved thought leadership into our short and long-term business and technology plans and accelerated move to product model and TechOps community via ways of working.

Continuous improvement

We said	We did	Improvement
We will integrate feedback into our deliverables and ways of working.	Provided greater transparency in our communications with customers and stakeholders.	Improved processes that meet our customers and stakeholders expected experience.

As we continue through BP1, we are also starting to capture lessons learnt and further improvements in these areas. These are the ones we want to focus on:

Engagement

What we learnt	What we want to improve	Expected improvement
We need to be more consistent in the way we communicate with our stakeholders, the same type of communication should be applied to the same type of scenario.	Review generic process for stakeholder engagement, ensuring communication triggers are enacted on in a timely manner.	Consistent and better engagement experience for our stakeholders with clear objectives and asks.

Sourcing approach

What we learnt	What we want to improve	Expected improvement
Market conditions are quite volatile leading to unexpected amounts of churn.	Adopt knowledge transfer processes to be quicker and more effective. Be clear about our employee value proposition. Improve interviewing processes to manage new risks.	Quicker and better onboarding experience. Better retention of knowledge independent of resources.

Commercial focus

What we learnt	What we want to improve	Expected improvement
Energy and technology industry's complexity and fast evolution make estimate exercises beyond current year less accurate as assumptions are less stable.	Implement enduring external assurance to validate internal assumptions. Review potential for more regular review points of ex ante regulatory framework.	More frequent external and consistent assurance, providing more confidence of our plans and costs. Allows for continuous improvements on assurance. Improved regulatory model for IT costs, allowing focus of discussions to move from estimates to deliverables.
Technology business management (TBM) can really help validate and communicate the way we invest.	Move current manual and submission-oriented implementation of TBM to a defined set of processes and tools, supported by resources with the right skillset and expertise.	Allow for better investment insights and their value. Improve frequency of updates and consistency of reporting to regulator and industry.

Delivery approach

What we learnt	What we want to improve	Expected improvement
Portfolio complexity and interdependency has increased substantially.	Improve portfolio's governance visibility and decision-making focus across all roles.	Bigger focus on interdependencies and better risk management.
Previous project delivery model no longer meets the needs of our customers in most of our portfolio, requiring a product model or continuous improvement model.	How to reflect this new approach in our communications and ensure cost impacts are understood and acceptable.	Better external understanding of benefits to gain from this model and resources required to implement and run it.

Continuous improvement

What we learnt	What we want to improve	Expected improvement

TechOps community can add really great value when implemented.	Allow for pockets of excellence to become the norm and standardise the way we implement them.	Technology and operations are working together as one team in all areas, improving company benefits definition and delivery.

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