ESO RIIO-2 Business Plan 2 Digital, Data, and Technology Annex

Annex 4

August 2022

BP2 Technology Investment

nationalgridESO

Please note that it has been necessary to redact certain sections from the public version of this Annex as these sections contain operationally sensitive information.

Executive Summary

Digital, Data and Technology are critical enablers for our mission **to drive the transformation to a fully decarbonised electricity system by 2035 which is reliable, affordable and fair for all.** In addition, our supporting ambitions are also to:

- Ensure the electricity system can operate carbon-free by 2025
- Engage as a trusted partner
- Drive competition for the benefit of consumers
- Be the net zero employer or choice; and
- Be innovative, digital and data driven.

To achieve this, we will adopt modern architecture, develop customer-centric products, and provide greater transparency and access to our data. Energy markets and regulation have continued to evolve since the beginning of our RIIO-2 technology transformation, and we have had to adapt our plans for new cyber malware threats and faster adoption of wider access. Our latest plan continues to drive these core transformation themes, building upon and refining our initial investments proposed in our original RIIO-2 Business Plan, BP1.

Overall, our technology investments can be categorised into three broad categories:

- 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 day-to-day operational IT services and reflect the increase in base RtB as a result of ESO's forecast technology transformation over the BP2 period.

The delivery objectives we proposed in our original BP1 submission continue to remain valid today, and since our BP1 submission we have mobilised 26 of our 33 investments, and plan to mobilise 5 further investments by the end of BP1. We continuously monitor and review our overall RIIO-2 investment portfolio as market conditions evolve, and through this we have identified and proposed new activities for the BP2 period which are outlined in this business plan submission.

When we developed our original BP1 submission we were working to high-level technical assumptions and scope based on the maturity of our projects at that time. We based our estimates on our business delivery experience, plus incorporated external benchmarking to challenge and assure our forecasts. The assumptions used and the value of past experiences have turned out to be less applicable than anticipated. A year into RIIO-2 we now have a greater understanding of our delivery requirements, and a more detailed appreciation of the optimal technology solutions to optimise our portfolio of work.

The extent of change to our BP1 cost estimates reflects the difficulty of accurately forecasting the scope and cost of technology projects in a rapidly evolving industry, and the below table summarises our overall RIIO-2 cost forecasts for all portfolios:

£ million (18/19 prices)		2021/22	2022/23	2023/24	2024/25	2025/26	Total
ESO specific investments (Capex and project Opex)	BP2	79.76	113.82	131.10	128.64	102.44	**555.76**
	BP1	76.5	80.3	92.4	82.4	75.8	**407.3**
	Variance	*3.3*	*33.5*	*38.7*	*46.2*	*26.6*	***148.46***
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	50.7	58.5	78.2	102	130.9	**420.3**
	BP1	47.1	49.6	53.7	59.6	64.2	**274.2**
	Variance	*3.6*	*8.9*	*24.5*	*42.4*	*66.7*	***146.1***
Total	BP2	160.86	194.5	230	251	251.8	**1,088.3**
	BP1	163.6	155.7	166.9	162.3	158.5	**807.1**
	Variance	*-2.74*	*38.8*	*63.1*	*88.7*	*93.3*	***281.2***
2-yr total	BP2	355.36		481			
	BP1	319.3		329.2			
	Variance	36		*151.8*			

Table 1 – A summary of our full RIIO-2 cost forecasts for all portfolios. Note - costs stated in the Shared Investment portfolio for FY24 and FY25 incorporate ESO's cyber resilience costs. Whilst these cybersecurity costs do not form part of this BP2 assessment they were included within the BP1 submission, and so have been added to aid comparison.

There are multiple drivers for the variances in our direct investments, as mentioned in Chapter 9 – Digital, Data and Technology of our main business plan. We are confident in the estimates presented as, in the past year, we have made the necessary scope determinations and critical technical choices for most of our investments. For these, we now have direct estimates based on our chosen software, hardware, resourcing, and delivery timeframes.

External feedback and assurance have put our estimates within a reasonable tolerance based on the lifecycle stage of the investment. In addition, we have tested our estimates and plans against the lessons learnt from RIIO-1 and RIIO-2 BP1 (see Appendix C), and we continue to be on a path of increased transparency, collaboration, and continuous improvement.

Part 1 of this document presents an overview of our digital, data and technology ambitions and ways of working that underpin our delivery. Part 2 provides a summary of our overall portfolio governance, controls and assurances. A deeper view into our direct investments for the RIIO-2 period is in Part 3 whilst Part 4 focuses on our Shared investments. Finally, Part 5 explains our Technology Business Management (TBM) data model which has been submitted to Ofgem as an accompaniment to this annex.

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Part 1 – Digital, Data and Technology overview

Our Technology investments enable a significant proportion of our RIIO-2 proposals, and we are committed to ensuring that these are delivered effectively and efficiently.

As shared in our main business plan, digital, data, and technology are vital enablers to modernising the ESO. Hence, these investments are critical for meeting our current ambitions, with many of them establishing the technology foundations to unlock our transformation to FSO.

Our FSO separation scope makes assumptions based on this BP2 plan. Changes to the proposed BP2 delivery plan may result in increased FSO scope and separation costs.

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

1.1 Digital, data and technology capabilities supporting our business ambition

As outlined in our Digitalisation Strategy[1], for us, 'digital' means that we will review and reimagine our processes, products and services without constraint or bias, to understand the needs of the people we serve, and the future scenarios we will encounter.

We can conceptualise our digital transformation journey as three core pillars that collectively deliver our digitalisation strategy. These pillars describe how we will modernise our tools and processes through digital technology, establish additional skills and capabilities, and deliver the organisational and cultural transformation we require. Our Digitalisation Strategy and Action Plan (DSAP)[2] then outlines how we will achieve these strategic aims by focusing on three practical elements: implementing a digital mindset, product-focused operating models, and agile delivery.

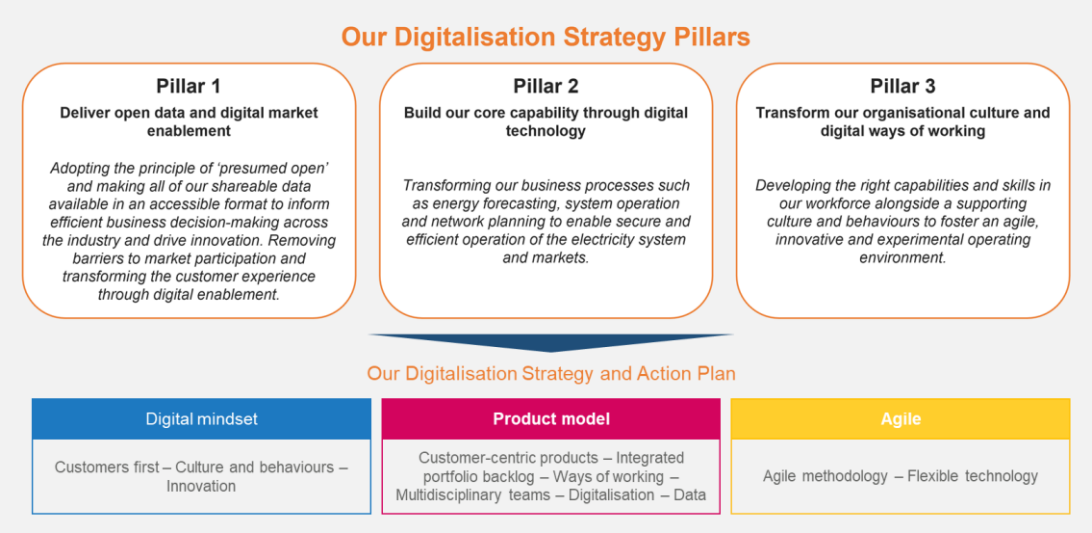


Figure 1 - Our Digitalisation Strategy pillars

We have embedded these strategic themes in our RIIO-2 delivery portfolio and, over the course of the BP2 period, will continue to build upon our key technologies and capabilities aligned to these themes. In the table below, we have summarised the main ESO technologies and capabilities we will continue to build upon during BP2.

[1] ESO Digitalisation Strategy (March 2022) - https://www.nationalgrideso.com/document/248051/download
[2] ESO Digitalisation Strategy & Action Plan (June 2022) - https://www.nationalgrideso.com/document/262371/download

ESO Domain	Scope	Technology	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 Technology 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 Technology investments and internal/external Open Data access
Legacy Applications / Data Migration	ESO Technology 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 Technology 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. Key: '(*)' = ESO-delivered, '**' NG(Group)-delivered*

1.2 Capability Structure and Governance

In BP1 we explained that our capability structure was going through significant transformation and since then have made significant progress in creating the leadership and capability we require to deliver our plans. Our ESO leadership is fully committed to ensuring senior ownership and ESO Board accountability of our technology investment plans and broader DSAP. Our Non-Executive Directors on the ESO Board also have significant experience in digitalisation and digital transformation which we draw from.

Our ESO Technology leadership team, led by our Chief Information Officer (CIO), who sits on both the ESO Executive Team (ESOET) and the National Grid Group Technology Leadership Team (ITLT), provides strategic direction, management, decision making and empowerment to the team to own our digital, data and technology strategy and deliver our short and long-term business and technology investment plans.

Our technology investments are delivered by technology resources dedicated to ESO projects. More general Technology projects, such as infrastructure delivery engagements are delivered by the National Grid shared digital and IT function. We have ESO dedicated representatives from these functions and on the ESO Technology leadership team to ensure integrated delivery.

We continue to grow our leadership and deep expertise across the following areas:

- **Portfolio management** – Provides an end-to-end integrated view across the portfolio, ensuring TBM is applied and creating constant assurance on cost and forecasts.
- **Programme and Product Management** – Employs expertise in creating product centric delivery that works across multiple technology areas as outlined above and ensuring that the products we deliver through our investments deliver their intended value.
- **Solution Engineering** – Offers deep technical expertise across many technology disciplines such as software development, testing, quality assurance, User Experience (UX)/User Interface (UI) and platform management.
- **Strategy and Architecture** – Focuses on creating a seamless end state view where we have integrated systems build on modern architecture which is key to accommodating changes in the external and internal environment at pace.
- **Data** – A data capability that focuses on three areas: data governance, focused on ownership and policies; data as an asset, focused on data analytics, sharing of data, and data literacy across ESO; and data technology, focusing on data platforming and engineering.
- **New Ways of working** – Capability focused on agile delivery and DevOps to create a long-term sustainable environment embedded through delivery roles such as scrum master, product owners and DevOps leads.
- **Operations and Service Management** – Focuses on ensuring that the products we deliver are embedded into our existing landscape and focus on smooth transition from development to operations. In addition, reflecting the critical role this capability plays by ensuring that our current landscape is managed with 24/7 support to CNI applications.
- **Security** – Taking further actions in collaboration with Ofgem to enhance our risk, response, and recovery processes to meet the cyber threats envisaged by NIS-D and develop an ESO-specific cybersecurity posture. As part of this we have appointed a Chief Information Security Officer (CISO) directly accountable to the ESO Executive Team (ESOET) as a key step in evolving the ESO's compliance with the Network & Information Security Directive (NIS-D).
- **Group Services** – Strengthening our partnership with group services such as networks and hosting, through dedicated business partners who ensure that our infrastructure services meet ESO requirements and programmes of work.

In summary, we are building deep in-house expertise across many of these areas giving us a strong ability to deliver to our plan. Equally we are working with top tier technology partners such as International Business

Machines Corporation (IBM), Capgemini, Wipro, and Tata Consultancy Services (TCS) to provide quality resources and bring in niche expertise.

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

ESO's specific investments go through different levels of internal governance depending on their level of spend, where only investments above £150m require review at the National Grid PLC Board (see diagram below).

Shared investments across the Group require approval 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.

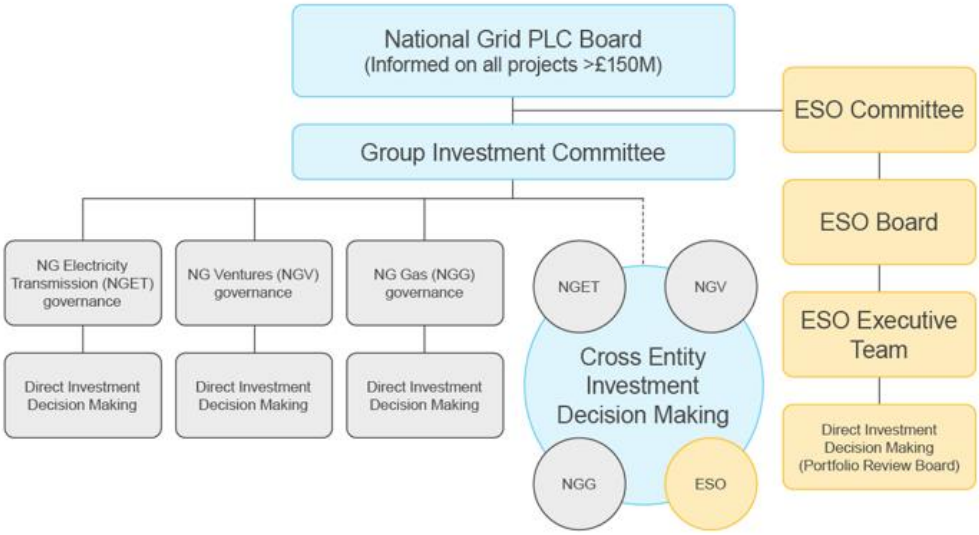


Figure 2 - An illustration of our internal governance structure and forum breakdown

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

1.3. 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 3 - A summary of our core business capabilities

For our original submission we consulted extensively with the ESO RIIO-2 Stakeholder Group (ERSG), our internal Application Development & Maintenance (ADAM) teams, and Gartner to understand in further detail what a platforms architecture approach would entail. We concluded from this exercise that this is the right target architecture approach for the ESO. Since that engagement exercise, we continued with our architecture definition work in BP1, developing a conceptual target architecture to illustrate how ESO IT capabilities will be enabled by our current and future technology platforms.

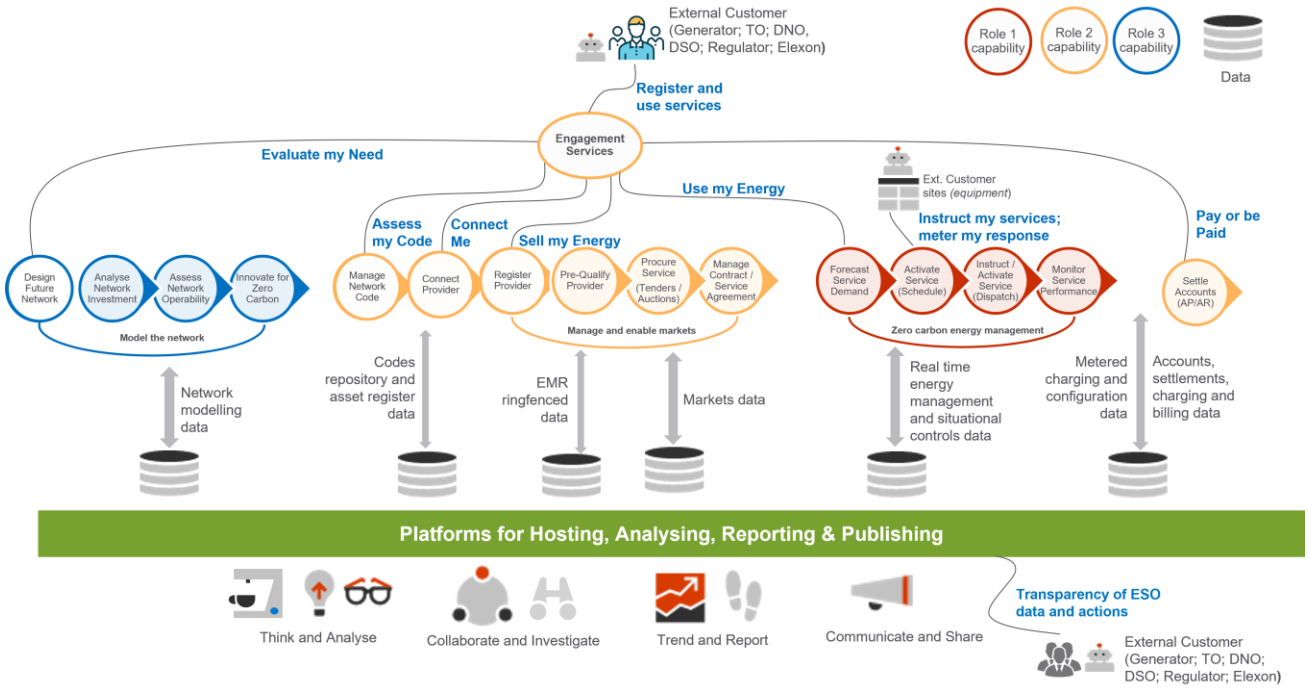


Figure 4 - An outline of our target architecture conceptual model

Since our BP1 submission we have 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 using integration technologies (Application Programming Interfaces – APIs) that minimise the disruption of transformation from legacy system and services to new solutions.

Key features of our subsystem architecture:

- 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 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.

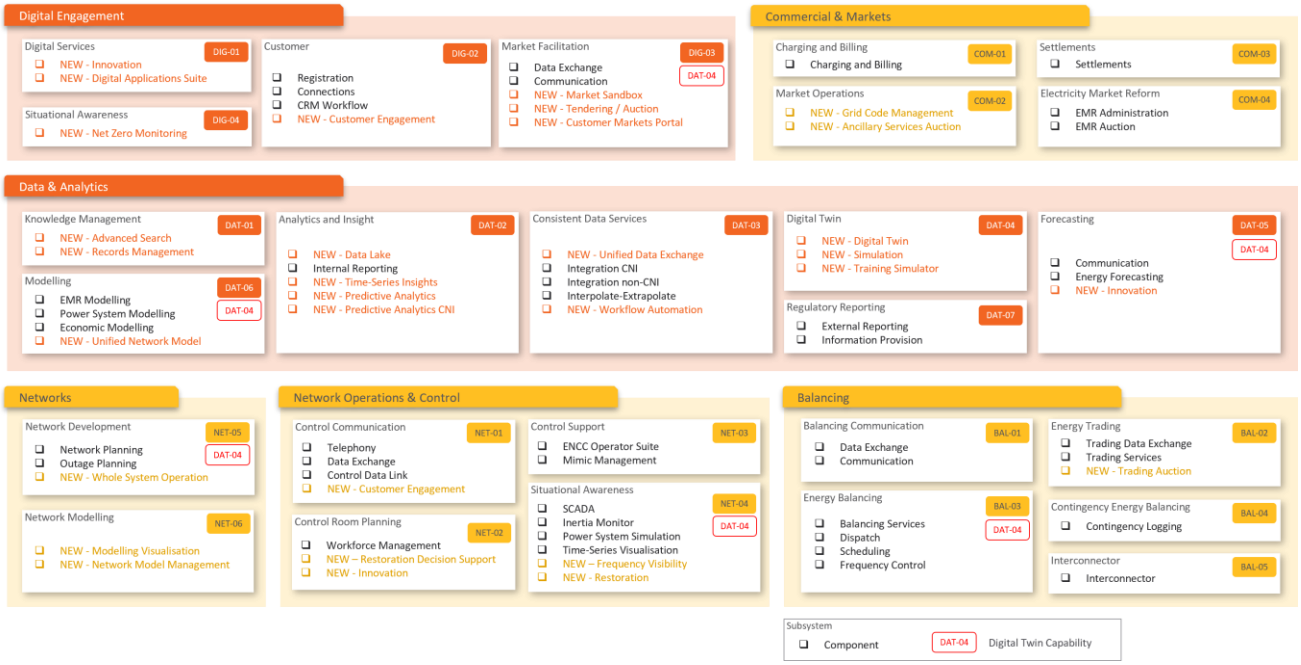


Figure 5 - A summary of our target Enterprise Architecture Framework – Subsystems and Components

	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 6 - Definition of our Enterprise Architecture Framework for IT Platforms

This structure represents a step-change from our previous RIIO-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 our IT Towers TBM model layer.

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.

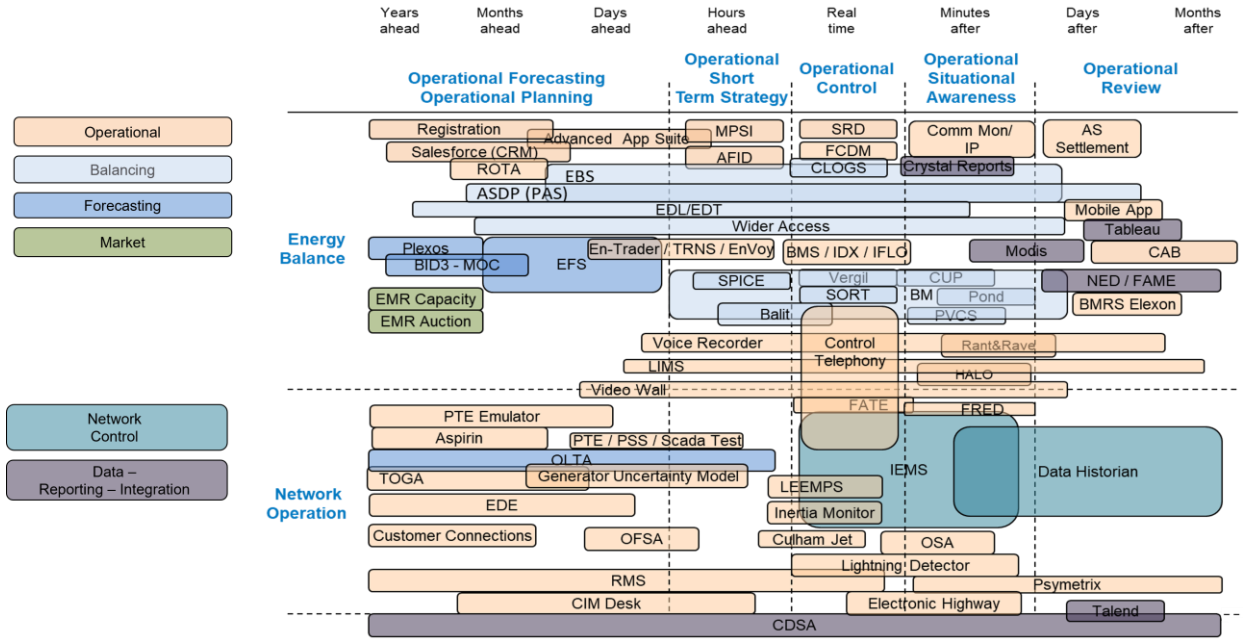


Figure 7 - An illustration of how our legacy applications support the business processes

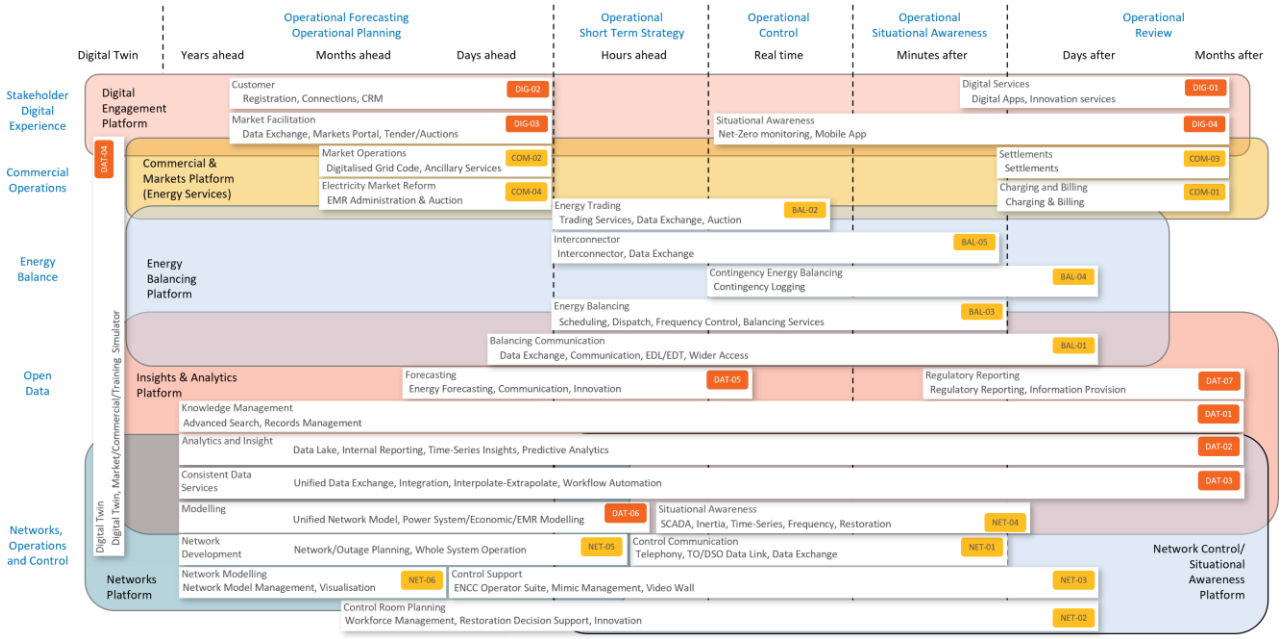


Figure 8 - 9An illustration of how our target EA Framework maps to the business processes

In conjunction with refinement of our target architecture we have made significant progress in our technology platform delivery and operating 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 assessment 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 Technology delivery from Project towards 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 processes

Technology:

- Multiple procurement activities established and underway / nearing completion across the technology investments described in Part 3 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

1.4 Stakeholder Engagement

As outlined in our main business plan document we are proposing to enhance our transparency and data sharing between Business Plans. Given the potential for additional changes in scope to reflect the evolving needs of our stakeholders plus recent feedback for the need to provide further confidence on ongoing delivery activities, it is necessary to increase the level of transparency around our projects as they mature. This has also been identified in our lessons learnt (see Appendix C).

Our digital, data and technology plans plus in-flight investments are reviewed and assessed through different 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 engage with our stakeholders and will continue to do so via various forums, reports, and publications, adapting these as the industry itself changes.

Forum / Report/ Publication	Objective
RIIO-2 Business Plan	Give clarity on what is new / materially changed in our 5-year business plan (covering 2021-2026).
Digitalisation Strategy	Provide an overview of what our data and digital vision is and ensure alignment to industry needs.
Ofgem early view of ESO Incentives report	Share an early indication of our cost updates and reasons for any deviations. Allowing further deep dive engagement.
Incentives report	Outline of ESO performance against plan delivery, metric, stakeholder evidence, plan benefits and value for money.
Technology Advisory Council	Ensure stakeholder input into the ESO transformation, guaranteeing the changes we make reflect wider market needs.
ERSG	Provide independent scrutiny of ESO's approach to stakeholder engagement in BP2's Business Plan proposals.
Specific investment engagement	Allow clarification of external stakeholder needs, collaboration sessions and updates on delivery plans

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

Apart from informing our customers on our ongoing delivery, we want our customers to create industry solutions with us. We will continue engagement across the industry to perform user research, co-create roadmaps, conduct demos, and perform show and listens. A specific example of this commitment is the Balancing Capability Strategic Review, which was conducted during the creation of this submission. Further ongoing external engagement examples coming from investments **250** Digital Engagement Platform and **380** Connections Platform. More information about this can be found in our Stakeholder Engagement [Annex 3] document.

Having reviewed our engagement approach, we want to make it meaningful and ensure it contains value added exercises. As such, we categorised our engagements with either industry stakeholders or Ofgem into three different groups:

- **Forward looking sessions:** covering Business Plan investments, new initiatives or high spend investments (>£5m) that haven't finalised their discovery phase
- **Performance sessions:** covering the entire Technology portfolio, with focus on highest value investments or investments of interest at a specific point in time
- **Collaboration sessions:** covering inflight investments, with focus on externally impacting ones

Engagement Type	Industry Engagement	Ofgem Engagement
Forward Looking	**Method:** Portfolio level pipeline meeting at TAC forum with offer of presentation for a specific new investment requiring industry contribution **Frequency:** Each quarter **ESO representatives:** CIO, portfolio function plus specific investment sponsor	**Method:** Pipeline report at Portfolio level with offer of deep dive **Frequency:** Each quarter **ESO representatives:** CIO, portfolio function plus specific investment sponsor
Performance	**Method:** Session every 6 months to present on performance of highest value investments. Offer of deep dive session for any specific investment **Frequency:** Adhoc for high cost or major plan variances **ESO representative:** CIO, portfolio function, incentives team and specific investment sponsor	**Method:** Incentives report by default via a new Technology section. Offer of deep dive session for any specific investment **Frequency:** • Every 6 months for default reporting • Adhoc for high cost or major plan variances **ESO representative:** CIO, portfolio function, incentives team and specific investment sponsor
Collaboration Sessions	**Method:** Sessions with TAC or specific segments of industry and ERSG on specific topics **Frequency:** Adhoc as per investment needs plus a rotating TAC session every 6 months **ESO representative:** Specific investment sponsor and team	N/A

Figure 10 – A summary of our Stakeholder Engagement plans

We believe this approach delivers further improvements in both reporting commitments and regular updates to our stakeholders regarding digital, data and technology topics. That is reflected in a yearly view of our engagement calendar provided below. Note that all dates specified are subject to change and agreement with the various stakeholder parties involved.

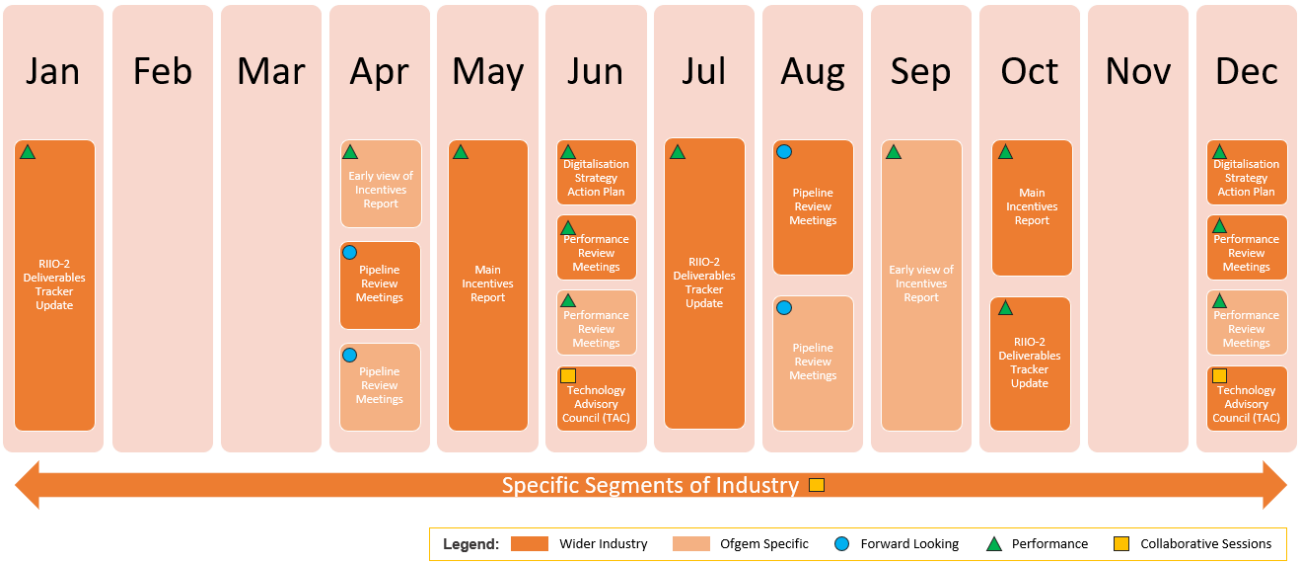


Figure 11 - An illustration of ESO's annual stakeholder engagement calendar

We welcome feedback from the industry and Ofgem on our engagement levels and will continue to periodically review and refine our engagement approach as necessary.

Part 2 – Technology Portfolio

In this section we outline ESO'S technology portfolio, summarising the deliverability and cost assurance exercise that was conducted following our Draft BP2 submission, introduce our TBM Data Model, and outline our key portfolio risks and assumptions.

As outlined in the executive summary of this document, our BP2 submission focuses primarily on our Direct 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 both within this Technology annex and within our TBM Data Model.

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 and obtained a better understanding of the true needs of our internal and external customers which is reflected in our updated forecasts for mobilised investments, where most estimates are now based on known specific application software, hardware, and resourcing costs.

During BP1 we have delivered a number of key business outcomes via our Technology investments, including:

- Meeting our EU and GB regulatory deliverables plan
- Enabling 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
- Introducing three new Interconnectors and two inertia system management solutions
- Increasing the procurement frequency of one reserve product from monthly to day-ahead and implemented the Auction Capability to one new response service
- Enabling better user experience for customers managing capacity market prequalification and registration.

In parallel we have also achieved several key technology delivery milestones to support these initial outcomes and our future delivery:

- Setting the strategic vision for our main programmes with associated business and technology roadmaps plus user journeys
- Progressing our main procurement events and completing proof of concept (POC) phases for main programmes
- Kept our current systems compliant, supported, reliable and where required extended their life
- Increased security compliance in operations and within our system designs
- Removed technical debt as part of asset health activities, including removal of Grey IT in 10 applications

2.1 Deliverability & Cost Assurance

In finalising our BP2 submission we have undertaken a deliverability assessment to validate that our investment plans and activities are deliverable as a collective. We constructed the approach as outlined in the diagram below with several focus areas including cross-investment dependencies, milestone alignment, resourcing, and delivery assumptions.

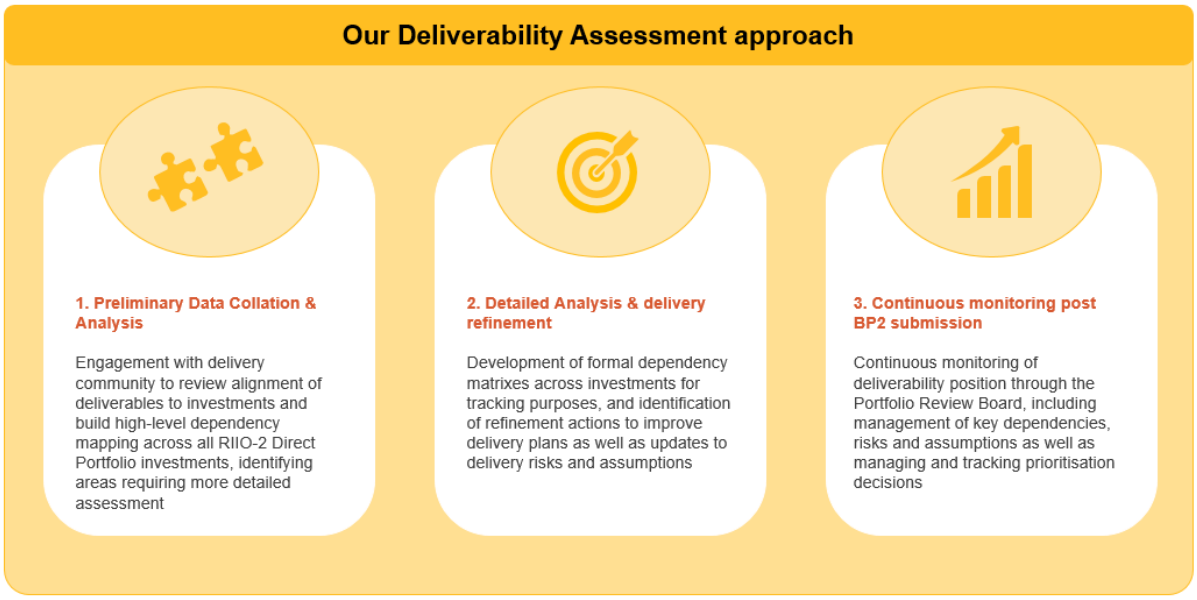


Figure 12 - Our deliverability assessment approach

Whilst we have confirmed the deliverability of our overall RIIO-2 investment portfolio, we did identify the need to apply adjustments to some of our cost and milestone forecasts which have been incorporated within this submission. A high-level summary of these changes is provided in our overall BP2 submission document. Our assessment has also helped highlight where we can further refine our portfolio management capability which we are actively pursuing, establishing additional governance and controls to ensure the continual assurance of our delivery timelines, risks, and dependencies, and enabling ongoing delivery of our milestones and forecast benefits.

To improve our transparency and gain additional insight into our portfolio, we requested external cost assurance from PricewaterhouseCoopers (PwC) for 26 of our 33 Direct investments[3]. PWC defined a methodology and undertook their assessment for ESO based on the 8 criteria shown below. Each of the confidence criteria is underpinned by a set of assessment questions, and individually assessed to form an overall view of the current level of confidence and certainty in the cost forecast:

Criteria	Assessment Questions
Project scope and requirements	Have the project scope and requirements been clearly defined and articulated to support complete and accurate cost estimation?
Project delivery plans	Are credible and detailed delivery plans in place that coherently link projects to investments?
Project status	What is the status of the project in its lifecycle? Are there significant or critical areas of uncertainty remaining with project delivery? Do project status reports or milestone achievement indicate any issues or delays?
Cost estimation approach and methodology	Has a robust approach and methodology been applied for cost estimation including option identification and analysis? Has the method and approach been consistently applied?

3 Seven investments are not included as part of the external assurance output provided in this submission: Investments 650 Accelerating Whole Electricity Flexibility and 670 Real-Time Prediction are new investments and do not have sufficient clarity of scope at this stage to undergo external cost assurance; Investments 450 Future Innovation Productionisation and 510 Restoration Decision Support have not yet commenced delivery and so are also not in a position to undergo cost assurance, and investments 210 Balancing Asset Health, 360 Offline network modelling, and 480 Ancillary Services Dispatch where their cost assurance assessments are still in progress and will be completed post BP2 submission.

	Has the cost estimation been built from a bottom up or top-down approach? If it has been from a top-down approach, what was the logic for taking such an approach? Are cost estimations complete in terms of the expected cost elements, including resources?
Key assumptions, supporting analysis and benchmarking	Have the assumptions, dependencies and risks associated with the cost estimation been captured and addressed? Do any other risks exist that have not been identified? What are the resourcing assumptions?
Completeness and reliability of data sources	Are the cost estimations within the investment cases complete and accurate and is there traceability back to underlying information and the assumptions? Can this be tested?
Governance, oversight, and assurance arrangements in place over cost estimations	What level of validation / benchmarking has been performed over the cost estimation to date? Can this be tested and how confident are the results? For the highly commoditised, as opposed to the bespoke, project elements, are 3rd party costs consistent with the ranges that we would expect?
Involvement of appropriate parties in developing the cost estimation	Have key investment planning controls and internal expert challenge been applied?

Table 4 - External Assurance criteria and assessment questions

The output format defined by PWC is composed of a scale of 1 to 5 and accommodates four key measures:

- **Current confidence level** - this provides the assessment of the current level of confidence in the cost forecast based on the confidence criteria. This should be viewed in conjunction with the expected maturity / confidence level, as an investment should aim to have a current confidence level that meets the expected maturity / confidence level. To note, it is unlikely that an investment would be able to achieve a confidence level that exceeds the expected maturity / confidence level.
- **Expected maturity / confidence level** - this provides a view of the expected level of cost maturity / confidence based on the delivery stage of the investment.
- **Delivery stage** - it would be expected that an investment in its early definition phase, where scope and requirements are still to be fully determined, has a lower level of cost maturity / confidence. In contrast, an investment that is well progressed in it's the delivery and therefore has a well-defined scope and an established delivery track record has a higher expected level of cost maturity / confidence.
- **Delivery methodology** - for investments that adopt an agile delivery method, detailed design activity occurs incrementally throughout the delivery lifecycle. Whilst this is an established methodology, this represents a potential higher inherent risk of scope / cost change and greater emphasis is required over monitoring and control of scope, costs, and value as delivery progresses. As a result, the expected cost confidence / maturity is likely to be lower early in the delivery phase until the process is well established.

The confidence assessment ratings derived are based on the following definitions:

- ***Low confidence or certainty*** in the cost forecast based on the evidence against the assessment criteria. This is either due to the maturity of the cost model based on the investment delivery stage and/or methodology or the integrity of cost forecast itself. Higher likelihood that costs will significantly change.
- ***High confidence or certainty*** in the cost forecast based on the evidence against the assessment criteria. This is either due to the maturity of the cost model based on the investment delivery stage and/or methodology or the integrity of cost forecast itself. Lower likelihood that costs will significantly change.

The PwC output report summarised that our investments are within a reasonable tolerance of the level of cost confidence/certainty we would expect based on their stage of delivery. Most of the investments are in their definition phase, or in the early stages of delivery, where the level of maturity or certainty in cost forecasts is expected to be 3 or under. A summary of the key findings is included below:

- 26 investments were assessed which accounts for 87% of total BP2 investment costs. Of this:
    - 19 investments were found to have a current confidence level that was within the same numerical confidence range (1-5) as the expected confidence level. These 19 equate to 78% of the assessed portfolio spend.
        - Of those that are within range 9 investments had a current confidence value that matched exactly with the expected confidence value.
        - 10 are within the same numerical confidence range but are marginally lower.
    - 7 investments were found to have current numerical confidence range that were lower than the expected level. These 7 equate to 22% of the assessed portfolio spend.

In addition, areas of strength that were established as part of the assessment were:

- Costs are specified to a granular level of detail with “bottom-up” costing
- Costs are based on a clear scope and roadmap and have received a degree of challenge internally
- Costs models include expected cost categories with a clear rationale provided to baseline costs
- Risks and assumptions are considered within cost forecasts
- A standardised documented governance framework and approach is in place that teams consistently leverage

Also highlighted are areas where there were opportunities to further strengthen the cost estimates as we move through the stages. They were mainly focused on:

- Stronger audit trails between forecasts and plans
- Standardising of our cost model inputs/structures and approach across all investments
- Further standardisation of cost estimation processes across the portfolio
- Enhanced quantification of risks and assumptions as part of cost forecasting
- Integrated portfolio assurance, Quality Assurance (QA) and challenge process

Strengths and opportunities highlighted in the report are built into our current plan through two activities:

- In the short to medium term, we are implementing a focussed team looking at portfolio assurance with a view to grow the capability further across ESO, embedding the cost confidence categories used in this assessment into our standard ways of working.
- In the medium to longer term, we will grow our current implementation of Technology Business Management (TBM) into a capability that complements the cost confidence framework categories and provides “what-if?” insights.
- Each programme team is working to action the specific items identified as part of the assessment in order to address gaps and promote further confidence in their cost forecasts

2.2 Technology Portfolio Costs

All costs stated in this document are in 2018/19 prices to allow for a like for like comparison with those that were stated at BP1. Our direct investment Totex plan is £556m across the RIIO-2 period, compared to £407.3m in our original Business Plan. Our IT running costs also increased to £83m from £50.3m. It is worth noting that in our original BP1 submission, we used a calculation methodology based on the level of transformation of each investment to calculated Cumulative Run the Business increase (iRtB). These have now been replaced with detailed forecasts from our delivery teams in BP2 and as such any variance relative to BP1 is to be expected given our now improved forecasting approach.

This submission outlines the drivers of cost changes between our BP1 and BP2 plans. Within each investment summary (see Part 3) a Capex, Opex and Cumulative Run the Business increase (iRtB) cost breakdown is provided, comparing the initial cost stated to deliver the technology investment at BP1 with the latest updated BP2 position. Where a variance exists between the BP1 and BP2 costs we have outlined the cost drivers that are relevant to each investment, the relative contribution of each, and mapped these to the overarching cost driver themes as outlined within the main business plan.

The table below illustrates the key cost driver themes identified. For further details on the overall contribution of each of these themes against each investment, please refer to Part 3.

Cost Driver Themes	Description
Accelerated drive to zero carbon operations	Accelerating pace and complexity of some investments leading to new requirements in others
Systems or assets requiring unexpected spend	Systems or assets which have become obsolete faster than expected or have become unsupported, bringing forward or requiring new spend
Rapid development and deployment of new technologies	Additional requirements to productionise and integrate higher volume of tolls than previously anticipated
Increase of cyber security threats	Addition of new scope to address cybersecurity threats and protect against malware
Technology market exposure	Technology market variability leading to the refinement of our cost assumptions
Evolved or refined scope since BP1	Scope assumptions have been refined and new scope has been identified.

Table 5 - A high-level view of the cost driver themes across our investments

Four of the new business initiatives identified over the course of this submission are not included within our BP2 direct investments as we do not currently have certainty that these new business initiatives will materialise into investments during RIIO-2:

- **Early Competition Onshore** initiative which involves introducing competition that occurs prior to the detailed design, surveying, and consenting phases of transmission system solution development. We have carried out an impact assessed to understand the implications for NGESO IT systems, and we expect this initiative will form part of FSO
- **Offshore Coordination & Network Planning Review** are Role 3 activities. Offshore Coordination is currently delivering without the need for specific technology investment, whilst we expect further clarity later in the year after definition of the new centralised strategic network planning regime under the Network Planning Review with associated technology investment to be managed through the pass-through mechanism
- **Net Zero Operability** arises from the commitment to fully decarbonise the UK electricity system by 2035. This initiative will be in a strategic definition phase through the BP2 period, we anticipate investment impacts to our IT systems across all three ESO roles will only be known in RIIO-3
- **Trading Auction Platform** might be required to ensure we can continue to trade reliably, efficiently, and economically, with an increasing number of counterparties over existing and new Interconnectors. We currently have a tactical interim solution for communication methods in this, progressed under ENCC Asset Health investment. Upon implementation of the tactical solution, need for this initiative will be fully assessed and if required managed through the pass-through mechanism.

2.3 TBM Data Model

In alignment with Ofgem's BP2 requirements, ESO is committed to driving greater cost transparency and cost management through the application of the Technology Business Management (TBM) taxonomy.

Alongside meeting our immediate regulatory requirements and providing Ofgem with the information it needs to assess ESO's technology investment portfolio for BP2, we also see this work as providing ESO with an initial foundation upon which to develop a future 'Bill of IT' TBM model that is actuals driven to realise long-term cost optimisations benefits. We can summarise these future 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.

For the purposes of our BP2 submission we have collaborated with Ofgem throughout 2022 to build a TBM-compliant model which summarises our RIIO-2 investment portfolio costs. Our investment summaries within this document have been purposely built to align to and complement our TBM model construct, and a summary of the key TBM touchpoints within our investment summaries are as follows:

- All investment cost summaries stated within this document (Direct, Indirect and RTB) are fully reflected within our TBM model
- All portfolio and investment risks and assumptions have been mapped to the most appropriate TBM IT Tower components so that readers can understand where these risks reside within our TBM model. This presents which cost elements within the model are 'at risk'.
- Our platform and subsystem architecture ("Enterprise Architecture / EA Framework") forms the basis of our TBM model Solution Layer. Each investment summary contains a 'Future state' section which outlines the subsystem components that the investment will deliver. Costs are then assigned to these same components within the solution layer of our model.
- We have reflected in our investment summarises whether our roadmap milestones deliver outcomes relevant to 'Customer & Partners' or 'Business Units' which tie back to our TBM Business Layer. We have also cross-mapped our delivery schedule activities so that are also included as meta data within our data model to aid interrogation.

For further details on the specific approach, we have taken in building our TBM model and the assumptions we have applied, please refer to Part 5 of this document.

2.4 Portfolio Assumptions

As part of our BP2 submission we have identified a number of key delivery assumptions which we are working to. The below table summaries our portfolio level assumptions, whilst our investment summaries in Part 3 outline those that are specific to each investment.

Category	Assumption	Relevant IT Tower	Impact	Review Frequency
Deliver	FSO will impact assess BP2 delivery in their process of planning, and ensure that BP2 delivery commitments can still be met in parallel	Program, Product & Project Management	BP2 delivery will need to be updated potentially resulting in a delay in delivery of commitments and higher cost	Monthly

Design	Undefined investment designs can be accommodated into ESO Enterprise Architecture framework	IT Management & Strategic Planning	Higher cost due to more complex enterprise architecture structure	6 months
Operate	Ofgem reporting and engagement requirements will continue as per existing BP1 approach	N/A	Higher cost to extend existing reporting mechanism	Quarterly
Deliver	Current TBM data model is for the purposes of the BP2 submission only	N/A	Inappropriate discussions and decisions made based upon directional forecast data	Quarterly
Delivery	Ongoing TBM Operating Model development to utilise actuals spend data will be progressed with Ofgem	N/A	ESO's current cost management approach will be maintained	Quarterly
Operate	SaaS Capex / Opex spend breakdowns will change as a result of new IFRS (International Financial Reporting Standards) treatment changes	Cloud Services	No change to overall Totex spend, but costs will continue to be based on current interpretation of accounting standards	Quarterly

2.5 Portfolio Risks

We have identified six portfolio level risks that apply to some, or all of our technology investment lines. Risks that apply to a single investment are captured in the summary for that investment in Part 3 of this document.

The scoring mechanism that we have applied for both our portfolio and individual investment risks is based on a standard ESO risk scoring methodology and an overview of this methodology can be found in Appendix A.

Risk	Related IT Tower	Mitigation(s)	Likelihood	Impact
Dynamic market conditions and regulatory changes introduce disruption to our investments which may prompt rework	Application Development	• Proactive stakeholder engagement • Portfolio level prioritisation of changes throughout remaining RIIO-2 period	3	2
Relationships with Third Party providers are not aligned to ESO priorities leading to lower ESO service and capability provision	Program, Product & Project Management, Application Development	• Create regular engagement cadence with Third Party providers • Provide early visibility of service and capability requirements • Seek alternative or appropriate contractual arrangements with Third Party providers	2	4
RIIO-2 benefits realisation is delayed if dependencies that exist across roles and investments are not managed	Program, Product & Project Management	• Implement robust dependency management with portfolio level RAID reviews	4	2

		• Clear alignment and engagement across dependent Investments		
Delivery is delayed or costs increase due to a lack of internal resources and capabilities onboarded in time to align to delivery plans	Program, Product & Project Management IT Management	• 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 • Continue to utilise existing established partners and drive early engagement on resource support requirements	3	2
No formal service level agreements in place with National Grid Group for provision of Infrastructure services leading to potential delay in delivery plans	Data Centre Compute Storage Network	• Continue to engage and influence National Grid Group infrastructure service / technology owners to prioritise ESO Azure IaaS/PaaS services and cost transparency data	2	4
FSO separation activities may lead to impact on BP2 delivery plans	Multiple	• Impact assess BP2 and FSO delivery plans for areas of potential challenge • Identify delivery mitigations and agree with Ofgem, maintaining close engagement throughout	2	2

Table 6 - A summary of our overarching portfolio level risks and corresponding likelihood and impact scoring

Part 3 – Technology Investments

This chapter provides a summary of our Direct investments from a Technology 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 delivery forecast for our programmes of work, with high-level views provided on the associated market and customer outcomes that will be delivered. For further detail on this latter aspect, please refer to the corresponding ESO Role chapters within business plan submission document where further information can be found.

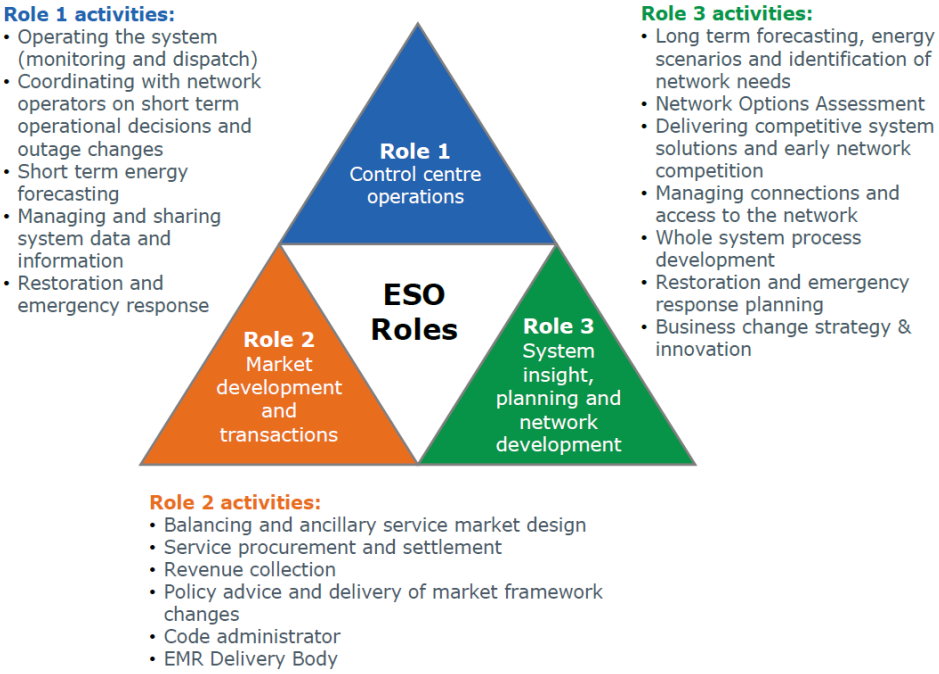


Figure 13 – A summary of our ESO roles

The technology 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, BP2 and beyond. In this submission we therefore are updating their forecast status for where they 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).

At the top of our technology investment narrative a ribbon is displayed which outlines key summary information for each investment:

- **Scope** – summarising whether an investment's scope or change backlog is in 'Draft' format with some aspects requiring further definition, or if it now 'Confirmed' and agreed with all appropriate internal stakeholders
- **Delivery Method** – summarising the investment's intended delivery approach as either Waterfall, Hybrid or Agile. Our definitions for these methodologies are as follows:
    - **Waterfall** – where the investment will follow a linear sequential delivery and deliver the majority of its business outcomes and value at the end of the delivery project
    - **Hybrid** – where the investment may feature some iterative development or incremental value release-trains for specific functional components
    - **Agile** – where the investment follows an agile development methodology such as Scrum, Kanban or SaFE
- **BP1 associated milestones** – summarising the investment's progress in achieving the RIIO-2 delivery schedule milestones associated to that investment and forecast for the BP1 period. These delivery statuses are taken from the ESO's most recent published Incentives Report.

Note that not all of our current investments map to BP1 milestones specified in our RIIO-2 delivery schedule. This is a result of our investments being at an early stage of maturity when the schedule was originally

formulated, and as such for some investments, the milestone counts are stated as ‘n/a’. In addition, the milestones stated for investment **610** Settlements Charging & Billing are the amalgamation of those milestones associated with investments **290** Charging and Billing Asset Health, **390** NOA Enhancements, **410** Ancillary Services Settlements Refresh, which have since been merged into one single investment and which is reflected in this document.

Our investment summaries in Part 3 are broken down into several sections where each follows the same consistent structure as outlined below:

- **Overview & Purpose**: A high-level summary of what each investment is looking to achieve, its key business outcomes, and mapping to our to RIIO-2 delivery schedule and associated sub-activities
- **Current State** – An overview of the delivery outcomes we intend to achieve for each investment by the conclusion of the BP1 period (March 2023)
- **Roadmap** – A summary of the key activities each investment will undertake and associated timelines. The roadmaps also vary depending on the delivery methodology employed by each investment
- **Future State** – An overview of the delivery outcomes we intend to achieve by the end of the BP2 period (March 2025), and how each investment relates to ESO’s Target Enterprise Architecture
- **Approach** – An overview of the intended solution approach that this investment will adopt
- **Solution Options** – A summary of the solution options considered by each investment and the rationale for why a particular option has been selected
- **Costs** – A summary breakdown of each investment’s spend forecast (Capex, Opex and Cumulative RTB increase), supported by a summary explanation for any for cost variances between BP1 and BP2
- **Assumptions** – The assumptions underpinning each investment’s delivery; and
- **Risks** – The key risks outlined by each investment and their respective probability and impact score

Note for investments **650** Accelerating Whole Electricity Flexibility and **670** Real-Time Prediction not all of these section areas are populated, as there is insufficient clarity of scope in areas to populate these sections.

3.1 110 Network Control

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
In Draft	Hybrid	On-Track: 5	Complete: 20	Delay: 0	Total Count: 25

Overview & Purpose

Our Network Control investment delivers our real-time situational awareness capability providing control centre operators capability to manage the electricity network as we move to zero carbon grid operations. Our priority for Network Control is to maintain an efficient, safe, and reliable electricity network.

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

This capability is classed as Critical National Infrastructure and is vital for the control of the electricity network.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A1.3 Transform Network Control • A2.3 Training Simulation and Technology	• Network Monitoring and Operational Limits visibility • Whole System training simulator

Table 7– 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) under this investment by ESO, and the corresponding replacement system by NGET will enable full separation of the systems. Following system separation, ESO will no longer use IEMS and will decommission the old platform.

The scope of our delivery includes:

- Core NCMS system
- Resilient CNI infrastructure & networking
- 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 DNO/DSO data exchange
- An improved state estimator to better understand the state of the electricity network
- Alarm management & display capability
- Contingency analysis
- Enhanced training capabilities

There are strong synergies between this investment and investment **150** Operational Awareness and Decision Support, and we will deliver these as a combined programme with a plan to merge **150** Operational Awareness and Decision Support into **110** Network Control.

Current State

During BP1 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, extending the life of the system until replacement go-live in 2026.

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

We have recently completed the procurement phase for the delivery of the new real-time core situational awareness capability, now known as the Network Control Management System (NCMS). The winning bidder is General Electric (GE Digital), and project delivery activities are now underway.

We remain on track to deploy the core NCMS system into our data centres by April 2023, working closely with the National Grid Group Data Centre Enablement team to mitigate risks around network and hardware deliveries. 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 core software modules and the tuning of models. We will also agree and finalise a transition plan with NGET during BP2 to enable system separation by 2026.

Roadmap

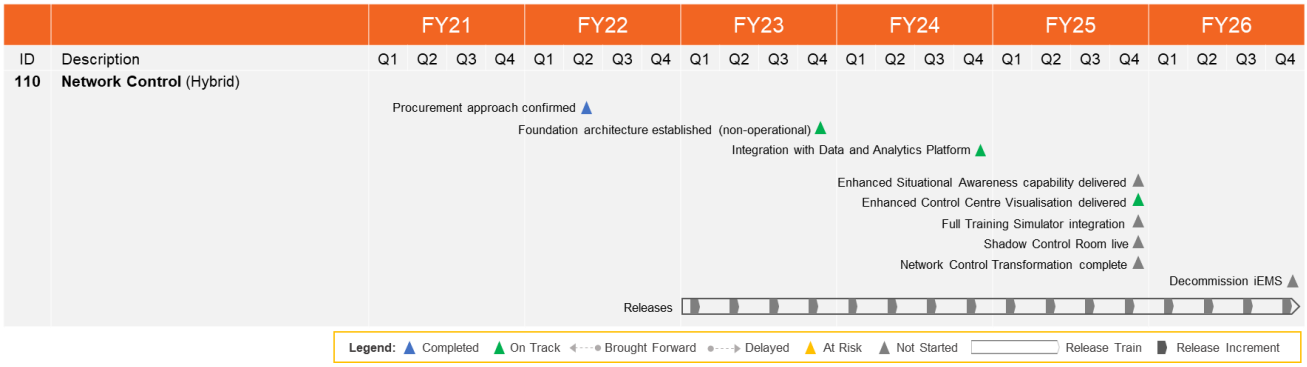


Figure 14 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Procurement approach confirmed	Business Units	Completion of the Procurement Request for Procurement (RFP) process. Selection of NCMS delivery partner
Foundation architecture established	Business Units	First tranche of networking, hardware and software infrastructure deployed within our new Data Centres
Integration with Data Analytics Platform	Business Units Customers & Partners	Initial integration with the **220** Data and Analytics Platform, replacing our long-term retention and analytics capability currently fulfilled by 'Data Historian'
Enhanced situational awareness capability delivered	Business Units Customers & Partners	Control room engineers can make more informed decisions and manage the network more effectively, providing higher confidence of running the system closer to agreed tolerances
Enhanced control centre visualisation	Business Units Customers & Partners	Control room engineers can access data from multiple systems in a single platform to solve real-

		time issues (in conjunction with the **140** ENCC Operator Console)
Full training simulator integration	Business Units Customers & Partners	Control room engineers can run more realistic training scenarios across entire shift team with all available applications
Shadow control room live	Business Units Customers & Partners	NCMS delivery team can 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	Our new NCMS has been successfully accepted into production service, replacing the existing IEMS
Decommission IEMS	Business Units	Decommissioning of IEMS completed including secure infrastructure removal and disposal

Table 8 - Outcome summary descriptions

Future State

The new NCMS will be delivered into our on-premise data centres meeting compliance requirements, replacing the current IEMS and separating the capability from NGET. New capabilities delivered via this investment will enable zero carbon grid operations and integrate with technology investment **220** Data and Analytics Platform.

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 2026.

Target platform	Target Subsystem	Component	Future State
Network Operations & Control	Control Communication	Data Exchange	NCMS operational, interoperating with TO and DNO/DSO SCADA systems.
Network Operations & Control	Control Communication	Control Data Link	NCMS operational, interoperating with TO and DNO/DSO SCADA systems.
Network Operations & Control	Control Support	Mimic Management	NCMS operational, including support for mimics
Network Operations & Control	Situational Awareness	SCADA	NCMS operational, interoperating with TO and DNO/DSO SCADA systems.
Network Operations & Control	Situational Awareness	Power System Simulation	NCMS Simulator configured, populated and operational
Network Operations & Control	Situational Awareness	Time Series Visualisation	Situational Awareness suite implemented for System Operations. Modern Analytics and

			Numerical Modelling Frameworks in place to adapt to changing system rules and conditions.
Digital Engagement	Situational Awareness	Net Zero Monitoring	New Situational Awareness suite implemented for System Operations. Modern Analytics and Numerical Modelling Frameworks in place to adapt to changing system rules and conditions.
Data & Analytics	Analytics and Insight	Predictive Analysis CNI	New Situational Awareness suite implemented for System Operations. Modern Predictive Analytic capability automating and underwriting System Operations.
Data & Analytics	Analytics and Insight	Predictive Analysis	New Situational Awareness suite implemented for System Operations. Predictive and forecast analytics blending local and cloud-based modelling, as demanded by models.
Data & Analytics	Consistent Data Services	Integration CNI	NCMS interfaces implemented as online APIs eliminating IT currency constraints.
Data & Analytics	Digital Twin	Simulation	See Power System Simulation state above. In addition, Network Control data available for emergent General Digital Twin framework.
Balancing	Balancing Communication	Data Exchange	Online interoperation with new Enhanced Balancing Capability.

Table 9 - Future state subsystem component summaries

By the end of BP2 the new NCMS will be operating in parallel 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.

As one of the two major occupants of the new CNI Data Centres during BP2 **110** Network Control will invest in all ESO IT Towers especially servers, storage, 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 Open Balancing Platform, new WAMS system, and the new ENCC Control Room.

We are delivering our NCMS capability using agile requirements discovery, capture and build where possible. Release management will be implemented in phases with sequential releases of capability to the control room. Decommissioning of the IEMS system will take place when all NCMS delivery phases have completed.

Solution Options

For the Network Control Programme, we detailed 3 technical options in our original BP1 submission. These focused on investing in upgrades to our existing legacy tooling, developing our own proprietary solution, or procuring Commercial Off the Shelf (COTS) energy management system product from the external marketplace.

Following an assessment of the relevant solution options, we concluded that a COTS product offers the best 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 vendor subject matter expertise
- 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 has pre-existing integration and development pathways which the nominated vendor will be able to advise on.

The Network Control Programme proceeded on this basis and has now completed the procurement event to source the new real-time core situational awareness capability, with the winning vendor confirmed as GE Digital.

We considered the option of procuring a managed service from our existing delivery partners to create a bespoke energy management system for ESO. This was discounted due to the cost of maintaining this type of software delivery agreement compared to already established vendors for this type of software.

We considered and discounted the option to continue life extension works to IEMS throughout BP2 and beyond as this does not meet requirements for ESO's Zero Carbon grid operations ambition.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	4.3	7.1	10.3	16.4	5.6	43.7
	BP1	2.9	5.2	6.5	7.9	4.5	27.0
	Variance	**1.4**	**1.9**	**3.8**	**8.5**	**1.1**	**16.7**
Opex (£m)	BP2	0.2	0.5	0.6	0.8	0.5	2.7
	BP1	0.3	0.6	0.7	0.9	0.5	3.0
	Variance	**-0.1**	**0.0**	**-0.1**	**0.0**	**0.0**	**-0.3**
Totex (£m)	BP2	4.5	7.7	10.9	17.2	6.0	46.4
	BP1	3.3	5.8	7.3	8.8	5.0	30.0
	Variance	**1.3**	**1.9**	**3.7**	**8.5**	**1.0**	**16.4**
Cumulative RTB increase (£m)	BP2	0.0	0.0	0.0	0.8	0.8	
	BP1	0.0	0.1	0.2	0.4	0.6	
	Variance	**0.0**	**-0.1**	**-0.2**	**0.4**	**0.1**	

Table 10 - Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Technology market exposure	Change in delivery team set up	Capex	Following stakeholder feedback from TAC, the team has adopted a “TechOps” way of working, with a product based agile delivery model	+ ~£4.5m
Technology market exposure	Enhanced IT architecture	Capex	IT hardware solution utilises modern virtualisation technology	+ ~£3.2m
N/A	Substitution	Capex	Delivery of OADS functionality under the IEMS Life Extension project	+ £0.5m
N/A	Planning	Opex	Re-profiling of Capex to Opex split as part of ongoing detailed planning	- £0.3m
Evolved or refined scope since BP1	Planning	RtB	Re-profiling of RtB as part of ongoing detailed planning	+ £0.1m
Costs change since BP1				+16.5m

Table 11 - Investment cost change summary

£500k 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.

[redacted]

We have reviewed the technology hardware and are embracing a more modern virtualisation of our architecture, in collaboration with our remaining supplier submissions. This will allow greater flexibility to manage our estate moving forward. As a consequence, our CAPEX costs have increased by £3.2M and RtB costs associated with our CNI Data Centre spend have likewise increased.

Additionally, the number of business resources assigned to NCMS have increased to ensure successful delivery.

We have consulted with our independent Technology Advisory Council (TAC) and external stakeholders who have provided insights into prioritising end user ownership and operational requirements during delivery. We have listened to their advice for “establishing product-like teams and technology teams who are close to operational teams" and "ensuring our teams understand the operational mindset".

Our vendor bids provide much greater detail on how the teams need to work together to develop these new innovative tools.

These changes have contributed £4.7m to the total cost movement.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Deliver	New CNI Data centres can be provisioned in time to support NCMS delivery timescales	Enterprise Data Centre	Schedule and budgetary impacts due to delays in delivery or tactical measures to minimise issue	Weekly and Monthly

Table 12 - Investment assumption summary

Risks

Risk	IT Tower	Mitigation	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 with OBP 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
Integration with new NGET EMS may not be aligned to NGESO NCMS delivery plan and may require the implementation of additional components to facilitate IEMS migration	Application Development	Maintain engagement via formal 'Technical Working Group' forum Periodic joint review and alignment of delivery schedules and dependent activities, including contingency options Planning and alignment on cutover dates and pre-requisites to migrate away from the IEMS	2	2
Key internal SME/system user resource availability may impact the testing and implementation of NCMS	Program, Product & Project Management	Ensure early forecasting of resource requirements to business units and review periodically via Programme governance Timely recruitment for appropriately skilled resources where not already available	3	1

Adverse change in Cyber threat, including geo-political landscape may impact security posture and result in scope creep.	IT Management & Strategic Planning	Maintain regular dialogue with security representatives ensuring alignment with industry standards	3	2
Feedback from the TAC via their assurance function may result in amendments to programme delivery approach.	IT Management & Strategic Planning	Maintain continuous improvement approach with TAC and ensure change control is adhered to on any proposed amendments	3	2
Delay to the delivery of hardware and networking infrastructure required to successfully test and operate the new tool set	Application Development	Maintain continuous dialogue with Data Centre Enablement team and key suppliers	3	1

Table 13 - Investment risk summary

3.2 120 Interconnectors

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
In Draft	Hybrid	On-Track: N/A	Complete: N/A	Delay: N/A	Total Count: N/A

Overview & Purpose

This investment delivers technology capability to manage the deployment of Interconnector services.

The quantity and scale of Interconnector services to other transmission systems is expected to steadily increase throughout RIIO-2. Our current tools and processes will be extended to handle the additional capacity and data complexity.

This investment enables sub-activity **A1.1 Ongoing Activities** to implement eight new Interconnectors alongside delivering functional, architectural, and technical service improvements. We will improve the capability of the control room to manage the GB system with increasing volumes of Interconnectors.

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 14 - Summary of business outcomes and corresponding sub-activities

Current state

Standardised interconnector architecture and designs were delivered as part of RIIO-1. The existing interconnector capabilities and standard designs for ESO systems will be re-used to accommodate all future new Interconnectors, minimising architectural and technology changes.

The current supporting systems for Interconnectors; Interconnector Flow manager (IFLO), Electronic Dispatch and Logging / Electronic Data Transfer (EDL/EDT) and Balancing Mechanism (BM) systems will continue to operate and deliver services for the next 18-24 months. The Open Balancing Platform (OBP), will gradually replace legacy services including provision for the Interconnector software modules towards the end of RIIO-2 and into RIIO-3.

During BP1 we have improved our system architecture in line with a growing list of Interconnectors to add resilience to our overall solution design. We have also delivered or are delivering:

- **IFA Interconnector:** We updated the trading patterns on the IFA interconnector with the implementation of hourly intraday nomination gates, 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, allowing market participants and NGESO more trading flexibility with a more accurate view of network requirements.
- **IFA2 Interconnector:** The delivery of the IFA2 Interconnector increased the capacity of the GB electricity market by an additional 1GW.
- **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. The planning and development phases of this are scheduled to be completed by October 2022, and an implementation agreement with the connecting Norwegian TSO (Statnett) is expected in or around 2024.
- **ElecLink Interconnector:** The ElecLink interconnector went live during the first quarter of FY23. We are on track to deliver further improvements to this interconnector including the electronic data

exchange for the Net Transfer Capacity (NTC) process, ahead of launching the intraday market auctions expected by Q3 FY23.

- **Viking Link Interconnector:** By March 2023, we anticipate that we will have delivered the core functional and architectural features to manage the receipt of operational flow data for the Viking Link interconnector.
- **NeuConnect Interconnector:** We have begun working with TenneT (Germany) and the interconnector owners to create the contractual and operational documents required from which the IT requirements will be created.
- **GreenLink Interconnector:** We have begun working with SONI and the interconnector owners to create the contractual and operational documents required from which the IT requirements will be created.
- **Moyle, EWIC and NEMO:** 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 into IFLO. We will also migrate the management and support features of EWIC and NEMO Interconnectors from into IFLO.

Roadmap

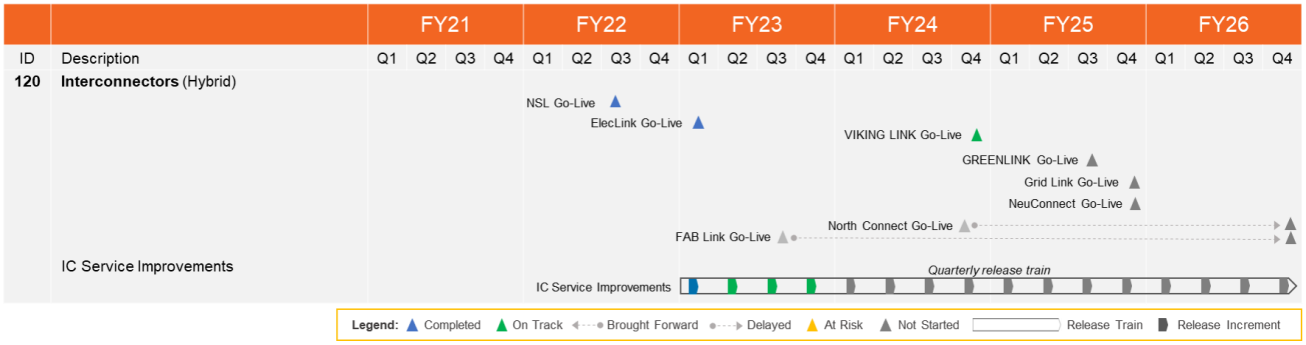


Figure 15 - Outcome roadmap

All Interconnectors go-live dates are our estimations based on current information however some of these can move beyond the RIIO-2 period. The Aquind interconnector has been refused planning permission and has no planned connection therefore not included on our roadmap. NorthConnect and FABLink Interconnectors go-live dates have also been adjusted on our roadmap based on current information published.

Due to uncertainties in external commissioning dates, the implementation process following commencement of work for some Interconnectors expected during FY26, could move beyond the RIIO-2 period.

Service improvements include upgrades and additional features for existing and future Interconnectors to aid operational teams with more tools to facilitate and manage the expected increase in interconnector capacity.

Some examples of these upgrades are:

- Interconnector Overview: Functionality to provide the users with an overview of the current profiles for all selected Interconnectors as well as a combined profile derived from a combination of the current profiles.
- Comparison Functionality: Provides the control room with systems capability to determine the change between the existing Reference Programme detailing the interconnector's flow and an updated version resulting from the latest market gate.
- Provision of user logins, user management and access restrictions to be implemented in IFLO to enable systems access outside of the ESO Control Room.

Milestone	Outcome recipient	Outcome description

NSL Go-Live	Business Units & Customers & Partners	Onboarding of NSL interconnector has allowed additional capability to transport enough clean electricity to power 1.4 million UK homes.
ElecLink Go-live	Business Units & Customers & Partners	ElecLink provides additional interconnection between the UK and France with bi-directional capacity of 1GW and low environmental impact.
Viking Link Go-Live	Business Units & Customers & Partners	Viking Link is a 1400MW HVDC interconnector between the British and Danish transmission systems. It will enable effective use of renewable energy, access to sustainable electricity generation and improved security of electricity supplies.
GreenLink 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.
GridLink 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 1.5GW of bi-directional capacity, enough to power up to 1.5 million homes over the life of the project.
NorthConnect 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.
FabLink Go-Live	Business Units & Customers & Partners	FABLink is an interconnector between France and Great Britain via the island of Alderney. This Interconnector will allow a maximum transmission of 1.4GW, thus contributing 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	Outcomes delivered during BP1: • Migration of all existing Interconnectors from Energy Communication Platform (ECP3) to ECP4, improving asset health. • Migration of existing virtual machines to our Critical Network infrastructure (CNI) consolidated platform Outcomes for BP2 will include:

	• Helping control room users to better manage the energy flow through the Interconnectors. • Enhanced application & service monitoring levels. • Process improvements to the connected TSOs.

Table 15 - Outcome summary descriptions

Future State

We will have extended our technology solution to additional Interconnectors and completed service improvements across our connected parties:

- Completion of implementation of all other functionality to manage reporting, System operator – system operator (SO-SO) / Ancillary services, and other functions on Viking link ahead of interconnector's go-live scheduled for January 2024.
- Continue onboarding of new Interconnectors Greenlink, Grid link, Neuconnect, North Connect and FAB Link.
- Completion of the standardisation of the Intraday Transfer Limit (ITL)/ Net Transfer Capacity (NTC) process on IFA2 interconnector to enable electronic exchange and an improved process.

The existing IFLO platform will continue to provide pan-interconnection balancing services for the BP2 period beyond which the interconnector business processes will be improved during FY26. Our Open Balancing Platform (OBP) will provide us with technology and APIs to deliver further modernised interconnector services. Where applicable we will reuse existing OBP services to fulfil common functions required by the Interconnector functions e.g., dispatch services. This reduces duplication of services and support costs.

The Electronic Data Logging (EDL) and Electronic Data Transfer (EDT) interfaces and business processes will also be replaced in time by services provided by OBP's Application Programming Interface (API) based architecture. This will 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.

Target platform	Target Subsystem	Component	Future State
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.
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 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 16 - Future state subsystem component summaries

Approach

During BP2 we will continue to build out interconnector services on the IFLO application platform whilst maintaining alignment with Balancing Platform development (OBP).

We will regularly review decisions on how/when to begin further modernisation of the IFLO platform to retain independence from Balancing application functionality, whilst ensuring we keep IFLO prepared and ready for future OBP architecture integration.

Beyond BP2, new IFLO functionality will be developed on the OBP technology platform and discrete IFLO functions will be migrated across. This delivers alignment of business functions with a common application landscape and enables us to develop and deploy new Interconnector-related services more rapidly.

The approach for deploying new interconnector services will be phased using agile requirements discovery, capture and build where possible. Release management will be implemented in phases with sequential releases of capability. To enable transition between IFLO and our future interconnector architecture, we require engagement with the OBP delivery team to ensure design, solution technology and release management alignment.

Solution Options

We considered several platform / development approach options for Interconnector services with consideration to both Interconnector and Balancing architecture alignment:

- Retain IFLO and make no plans to replace – does not fully align to RIIO-2 platforms architecture
- Replace IFLO with a further standalone architecture – does not fully align to RIIO-2 platforms architecture
- Retain IFLO for BP2 but plan to intentionally re-platform Interconnector aligned to OBP architecture – aligns with our target architecture
- Procure a package for IFLO replacement – rejected due to no market offerings being suitable for ESO Interconnector requirements

Our options assessment decision is to continue developing the existing IFLO platform and begin planning for its ultimate replacement by OBP capability. 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 during the most critical Balancing change agenda period FY23-26.
- Continue building on currently stable IFLO architecture, so maximising the value from the original investment.
- Transition the functionality to OBP to re-use designs and functionality. The use of OBP software and an API-centric design means the IFLO functionality can be integrated with additional balancing components, 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 FY26.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	2.4	1.9	1.9	2.4	2.3	10.9
	BP1	1.5	1.5	0.7	0.7	0.5	5.0

	Variance	**0.9**	**0.4**	**1.1**	**1.6**	**1.8**	**6.0**
Opex (£m)	BP2	0.0	0.0	0.0	0.0	0.0	0.0
	BP1	0.2	0.2	0.1	0.1	0.1	0.6
	Variance	**-0.2**	**-0.2**	**-0.1**	**-0.1**	**-0.1**	**-0.5**
Totex (£m)	BP2	2.4	1.9	1.9	2.4	2.3	10.9
	BP1	1.7	1.7	0.8	0.8	0.6	5.5
	Variance	**0.8**	**0.2**	**1.1**	**1.6**	**1.8**	**5.4**
Cumulative RTB increase (£m)	BP2	0.1	0.2	0.2	0.3	0.3	
	BP1	0.0	0.1	0.1	0.1	0.1	
	Variance	**0.1**	**0.1**	**0.1**	**0.1**	**0.2**	

Table 17 - Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
Accelerated drive to zero	Change in scope	Capex	Increase in the no. of Interconnectors to be delivered	+ £0.6m
Evolved or refined scope since BP1	Post implementation work	Capex	Costs to accommodate features not delivered/ change post go-live	+ £1.8m
Evolved or refined scope since BP1	Interconnector Service Improvements	Capex	Enhancing the capability of existing application	+ £1.38m
Technology market exposure	Standard/customised features on Interconnectors	Capex	Cost of implementation variation based on the complexity of the non-standardised features per Interconnector	+ £1.2m
Efficiencies	Error in BP1 submission	Capex	Erroneous cost forecasted	+ £1.02m
Efficiencies	Better formed team	Opex	The Programme now has a defined team and infrastructure set up hence no OPEX needed	-£ 0.5m
Evolved or refined scope since BP1	Standard support costs	iRTB	Costs revised based on number of ICs going live and having agreed to standard support costs per IC	+ £0.2m
			Costs change since BP1	+5.7m

Table 18 - Investment cost change summary

Since submitting the cost forecast on our original plan for these investments, we now estimate an increase in total delivery costs by ~£6m. Contributors to the projected cost increase include:

Change in Scope: variation in the number of Interconnectors to be delivered has required the Interconnector programme to reprioritise multiple times. This impacts the amount of work, time to completion and amount of technical debt carried over following implementation, meaning resources are allocated for longer. During BP1, NSL and ElecLink were introduced into scope and Aquind was removed. In our roadmap at the draft

submission, we incorrectly mentioned NSL going live in RIIO-1 when it went live in RIIO-2, but our cost submission reflected the correct go-live date.

Post implementation work on new Interconnectors: Our BP2 submission roadmap represents our expectation of when an interconnector is forecasted to go live. Following go-live however, we expect to incur additional costs to accommodate features either not delivered due to issues, readiness from one or more stakeholders or those deferred. These costs are unpredictable and differ between interconnector sites. For example, when NSL went live on the 1st of October 2021 we had completed about 85% of the work required. The work outstanding included deferred requirements from external parties and change requests for features that were not part of the original scope, which could not be accommodated prior to go-live.

Interconnector Service Improvements including technical upgrades: Continuous implementation of standardised features applicable to all Interconnectors, enhancing the capability of the existing application. In our original plan, the continuous development activities were not planned to be delivered within this investment, however our forecasted cost is now aligned to reflect this.

Standard vs Customised features on Interconnectors: Having delivered our initial model of a standard interconnector during RIIO-1, we now have experience of running our implementations on the back of a standard interconnector model, which hadn't been implemented fully when we submitted our BP1 costs and was the basis for our cost assumptions. We now recognise that it is not always possible to implement a standard model for all new Interconnectors, due to the nature of differing operational processes, system requirements, ancillary services and workflow required by different parties. Complexities with the implementation of different models impact our delivery timelines and have a cost implication.

Additionally, we incorrectly stated our BP1 efficiency savings, applying those savings in FY24 onwards when we were expecting improvements to be seen only after FY24.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Design	The number of Interconnectors to be implemented in BP2 period will remain unchanged.	N/A	Schedule and budgetary impacts	Quarterly
Deliver	Redispatch and Countertrading (RDCT) will be funded by the GB Regulations programme and the Interconnector changes will be implemented by Interconnector Programme.	N/A	Schedule and budgetary impacts	Quarterly
Deliver	Solution delivered by investment **610** Settlement, Charging & Billing will be able to consume the data sent from IFLO, in the same format as is sent to the settlements system currently	Application Development	Schedule and budgetary impacts	Quarterly
Deliver	If the data warehouse system for IC changes/is replaced, investment **220** Data & Analytics Platform holds the accountability for managing it and the	Application Development	Schedule and budgetary impacts	Quarterly

	decommissioning of any of these systems

Table 19 - Investment assumption summary

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
Delays to the delivery of planned tasks or ongoing implementations would impact the ability to start new non- regulatory work thereby increasing overall timelines for delivery and cost.	Application Development	Monitor and review at agreed intervals and carryout prioritisation sessions when required.	4	2

Table 20 - Investment risk summary

3.3 130 Emergent Technology and System Management

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
In Draft	Hybrid	On-Track: 11	Complete: 15	Delay: 6	Total Count: 32

Overview & Purpose

This investment delivers capability and tools for our control room users to manage challenges and risks highlighted in the operability strategy report.

We will implement a new Monitoring and Control System (MCS) capability to supplement Network Control and Situational Awareness delivery. Control room users will benefit from enhanced monitoring of the energy grid in real time and decision-making capability to respond to critical grid events.

The operability strategy report explains the future challenges we face in maintaining an operable electricity system and our corresponding response. Framed by our zero carbon 2025 ambition, it explains how our work aligns with our operability milestones and incorporates the concept of pathfinders.

We will implement solutions to manage these issues operationally and benefitting all 3 Roles:

- Role 1 (National Control): Delivers enhancements to our inertia monitoring and forecasting systems, and additional capability for our control room to instruct new services arising from the pathfinders. It therefore enables sub-activity **A1.2 Enhanced Balancing Capability**.
- Role 2 (Markets): Delivers capability 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): 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**.

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 21 - Summary of business outcomes and corresponding sub-activities

Current State

This investment consists of 2 projects:

Inertia Monitoring and Forecasting: By March 2023 we will have implemented two innovative tools to measure system inertia in real-time. This significantly improves the accuracy and optimisation of our real-time operation with the increasing number of embedded generators. The tools 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.

The GE Digital tool has already provided our initial interface to receive monitoring data from the TOs critical for the delivery of:

- The monitoring and control system (MCS) being delivered by IT investment 500 Enhanced Frequency Control (previously Zero carbon operability)

- The frequency and oscillation monitoring capability being delivered by the IT investment 170 Frequency Visibility.

The Reactive Technologies solution has been installed and has now been handed over to the business for dual running alongside the GE Digital delivered product, with operational testing being undertaken routinely to assess the viability of the outputs being received.

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 and voltage support) which will lead to the lowest possible consumer bills while assisting in the reduction of the environmental impact of the electricity industry.

- **Stability Pathfinder** - by Q4 FY23, the Pathfinder programme will have delivered the ability to accommodate a wider range of units beyond just synchronous compensator units, for example grid forming technology
- **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
- **Constraint Management Pathfinder (CMP)** – solution enhancements 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 anticipation of network fault. This will be operational on the Scotland B6 Boundary.

Note that Pathfinders will be renamed as 'Network Services Procurement' in the future.

Roadmap

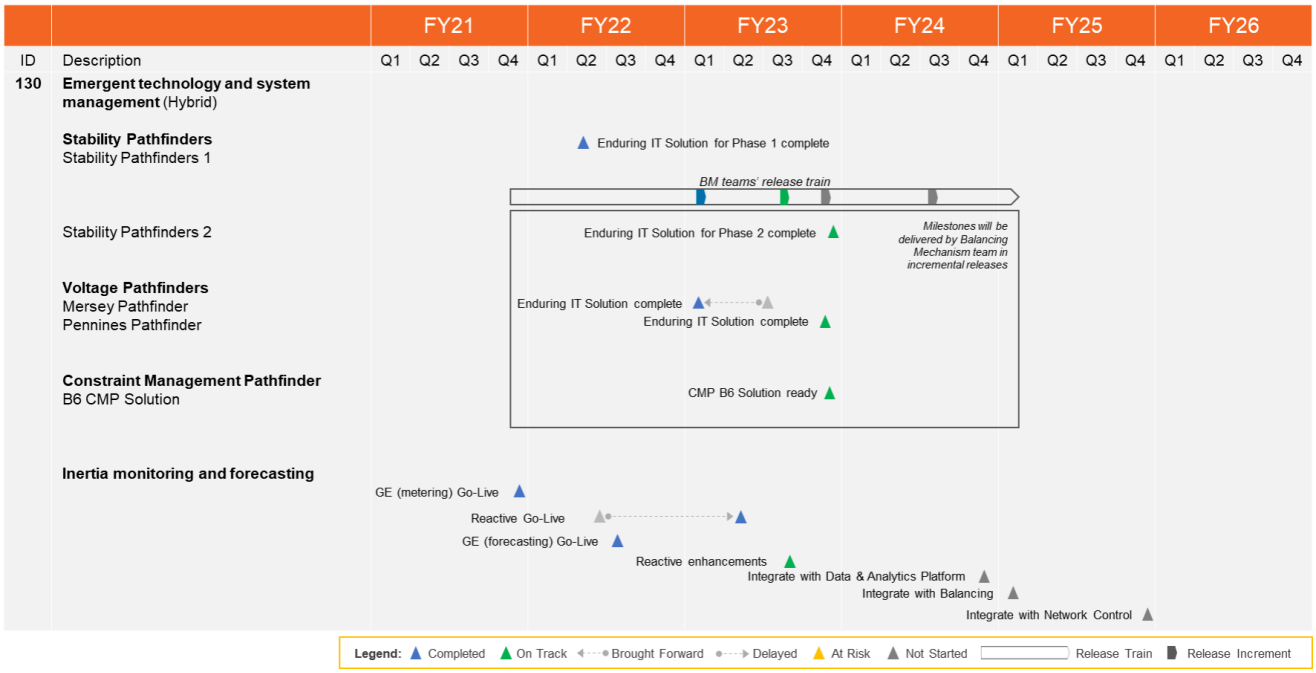


Figure 16 - Outcome roadmap

No work under this investment's scope is currently expected to be done under RIIO-3.

The milestone for the Stability pathfinders: Interim IT solution has been removed as the project is now delivering the enduring IT solution through iterative agile releases.

Milestone	Outcome recipient	Outcome description
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 delivered to disconnect 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 delivered to disconnect 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 enables optimisation of our network 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 22 - Outcome summary descriptions

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 transitionally to the existing Balancing Mechanism and then migrated to the enduring Open Balancing Platform, and our settlement processes to accommodate the necessary dispatch and settlement changes to coordinate service providers.

Our Data & Analytics platform capability will be used for component integration and to provide analytics support. Partner interaction will be implemented using our Digital Engagement Platform channels.

Although our solution is well understood and in the process of being implemented, the interaction with partners is still emerging subject to the outcome of the pathfinder projects. We will refine our solution model to include the network topology required to support distributed partner components.

Target platform	Target Subsystem	Component	Future State
Network Operations & Control	Control Room Planning	Innovation	New Inertia Monitoring and Management tools implemented for FY26 System Operations. Modern Network Analysis tools extended from NCMS or WAMS tools, built on DAP, or a hybrid of both.
Network Operations & Control	Situational Awareness	Inertia Monitor	New Inertia Monitoring and Management capability integrated into overall Situational Awareness suite for 2025/26.
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.
Commercial & Markets	Settlements	Settlements	Settlement systems and processes enhanced to support these new system services.
Balancing	Energy Balancing	Dispatch	Balancing systems and processes enhanced to support these new system services.

Table 23 - Future state subsystem component summaries

Approach

We will implement our new WAMS and NCMS solutions aligned to our target platform architecture and integrate new system services as the pathfinders create them, using Digital Engagement and Data & Analytics.

We are delivering our MCS system initially outside of NCMS and preparing the environment necessary for future NCMS integration. This approach ensures our Network Control architecture will accommodate the final inertia monitoring and management solution.

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.

Some variability of technology design and deployment for individual Emergent Technology solutions is inherent, as the pathfinders have adopted a learning by doing approach.

We will implement MCS using agile requirements discovery, capture and build where possible. Release management will be implemented in phases with sequential releases of capability to the control room.

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.

Wherever possible we are assuming that non-specialist tools or solutions would be aligned to our target architecture framework.

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.

We may consider solution delivery options including in-house resourcing, outsourcing of full or partial scope and additional specialist augmentation of resource in relation to the new technologies described.

Costs

		BP1		BP2		BP3	
		Actuals		Forecast			
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	1.2	1.2	1.6	1.7	1.7	7.4
	BP1	0.0	1.5	1.7	1.9	1.9	6.9
	Variance	**1.2**	**-0.3**	**-0.1**	**-0.2**	**-0.2**	**0.5**
Opex (£m)	BP2	0.1	0.3	0.3	0.3	0.3	1.3
	BP1	0.0	0.2	0.2	0.2	0.2	0.8
	Variance	**0.1**	**0.2**	**0.1**	**0.1**	**0.1**	**0.5**
Totex (£m)	BP2	1.4	1.5	1.9	2.0	2.0	8.7
	BP1	0.0	1.7	1.9	2.1	2.1	7.7
	Variance	**1.4**	**-0.1**	**0.0**	**-0.1**	**-0.1**	**1.0**
Cumulative RTB increase (£m)	BP2	0.3	0.3	0.5	0.7	0.9	
	BP1	0.0	0.0	0.2	0.4	0.6	
	Variance	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	

Table 24 - Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
Evolved or refined scope since BP1	Scope Clarification	Capex	Earlier than anticipated start to Pathfinders delivery during BP1 and following delivery of Stability P1 & Voltage Mersey, the scope for future Pathfinders is now better understood / agreed	+ 2.95m
Evolved or refined scope since BP1	Scope Clarification	Capex	Since delivery of the two novel Inertia Monitoring platforms, the scope for additional delivery has been confirmed.	- 2.45m
Evolved or refined scope since BP1	Scope Clarification	RtB	Incremental RTB forecast for Inertia moved from RIIO-1 into BP1 & Pathfinders based on estimates	+ 0.3m
Evolved or refined scope since BP1	Scope Clarification	Opex	Following delivery of Stability P1 & Voltage Mersey, the scope for future Pathfinders is now better understood / agreed as well as split between Opex & Capex	+ 0.5m
Costs change since BP1				+1.3m

Table 25 - Investment cost change 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.

We have taken the opportunity to bring forward the implementation of inertia forecasting capability, which has led to a suitable reduction in BP2 costs and a corresponding assignment to Pathfinders.

Our Pathfinder costs from FY24 onwards are based upon the assumption that this investment delivers three IT solutions for the three types of Pathfinder (voltage, stability, and constraint) across the four Pathfinder tenders per year.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Deliver	There will be no further needs for new investment areas within the RIIO-2 timescales, arising from requirements identified in future Operability Strategy Reports	N/A	If this is false, raise a new third project against this investment line with additional costs, benefits, and new milestones	Annually
Deliver	Our current expectation is that we will deliver three types of Pathfinders per year against four tenders per year and have estimated our future	N/A	If this false and we do less, less spend will be incurred and less benefit realised. If we do more, there might be additional IT effort required to deliver the additional benefit	Annually

	costs accordingly for their IT solutions			
Deliver	Scale and costs associated with future Pathfinders are based on feedback / learnings from the previous Pathfinders	N/A	If false, we will deliver against an MVP (reduced scope), incurring reduced costs and reduced benefits realisation	Scope & delivery costs will be confirmed at the outset of each future Pathfinder

Table 26 - Investment assumption summary

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
There is a risk/dependency that any delay to NGET and SSE timeline for completing their Phasor Data Concentrator (PDC) installation and commissioning work will affect the usability of the inertia monitoring tool	Program, Product & Project Management	Maintain regular engagement with NGET and SSE with joint reviews of delivery plans and dependencies to track progress and mitigate any delays forecast	2	1
Higher priority projects diverting required technology resources leading to a delay in the delivery of technology 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 and sourced 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 technology activities, potentially impacting upon agreed costs and timescales	Program, Product & Project Management	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 27 - Investment risk summary

3.4 140 ENCC Operator Console

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
Confirmed	Hybrid	On-Track: 3	Complete: 1	Delay: 0	Total Count: 4

Overview & Purpose

We are delivering a single capability to manage the user interface/experience for our control room systems. This includes core application components, visualisation tools, control centre dashboards, video wall and infrastructure/facilities enhancements to update our command and emergency management capability.

Our ambition is to provide a single personalised control room 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**. It also provides 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 benefits the Electricity National Control Centre (ENCC) and associated operational support teams.

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 28 - 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 will be in delivery (**110** Network Control, **180** Enhanced Balancing Capability and **220** Data and Analytics Platform), and requirements will have been clarified. These provide a basis for the Operator Console solution design and the selection of any additional supporting capability.

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

It is expected that a Request for Proposal (RFP) procurement event will be undertaken during BP2 to select a suitable solution if a COTS product is required. For bespoke developments we would look at delivery options including in-sourcing or contracting in a managed service delivery with our partners.

Roadmap

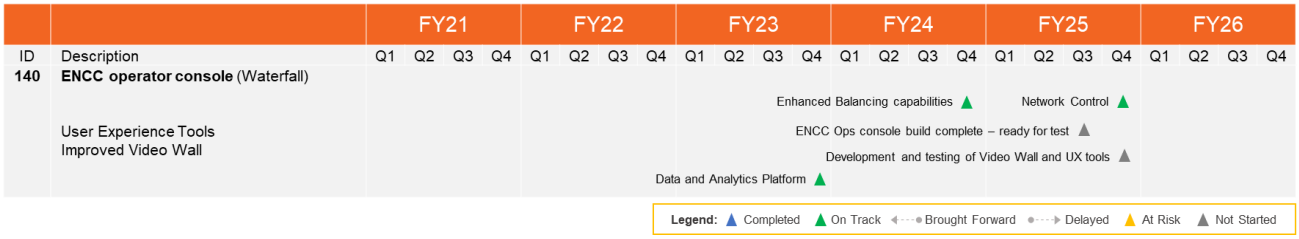


Figure 17 - Outcome roadmap

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 29 - Outcome summary descriptions

Future State

Our control rooms users will access critical systems via a single user interface. The Operator Console will link with our Balancing and Network Control application GUI components to provide a unified operator user experience.

Control room users will have capability to personalise views of the energy grid according to the features available through the operator console and associated/linked systems. This enables support for different roles in the control room to access the views they need.

Additional application linkage and user experience integration will be extended as the delivery continues through BP2 and into future years.

Target platform	Target Subsystem	Component	Future State
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 30 - 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 Open Balancing Platform and our 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.

We have chosen our NCMS solution and the GEDigital GUI capabilities are now available for us to understand design criteria.

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

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.

We will invest in specialist skills and in-house training to implement a dedicated user experience and design capability to support this investment. The nature of this work leads us to more of a waterfall approach for release into the control room as we must understand and link together several critical system user interface designs and be sure of compatibility with the target single UI framework.

A number of proof-of-concept designs may be produced to trial options within the control room; however, this approach will be different from other agile deployments as it is unlikely we would iteratively release Operator Console “trial” designs into the production control room environment due to the potential risks of confusing displays.

We must therefore find the right balance between release of our critical control room applications (with their own user interfaces) and the single operator console. This again leads us to more of a waterfall approach i.e., we are prioritising quality of user experience in this solution design over speed of release.

Solution Options

We have aligned the operator console principles with our NCMS selected software product and Balancing capability design.

This section considers the options for the remaining components of the overall console:

Wall displays and their driver systems:

- There are two basic options: (i) Enhance and upgrade existing supporting systems, and (ii) Procure new supporting systems. We expect to procure a new wall display system, use the UI integration features of the new NCMS and OBP solutions, and refresh or renew the remaining supporting components.

Additional control room applications:

- Inputs will be taken from Inertia Monitoring, Forecasting, Power Systems Modelling and other data feeds into the control room to ensure the UI Framework accommodates all primary display requirements to a single user experience standard.
- A key determinant of our actions is the choice of NCMS and the quality of its UI integration components meeting operator console needs, with any limitations or constraints to be explored during detailed design discussions. 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.

We considered the option to create our own operator console UI framework and apply this design standard to all other procurements and software builds. This was discounted as we have prioritised compatibility of the console and software choices above requiring our software vendors and wider ESO programmes to adapt their UI to suit a single requirement.

We considered the option of enforcing a single native UI design for all potential control room applications – effectively customising the UI for each software component including all COTS purchases. This was discounted as we do not have evidence to show value for money to customise market offerings so extensively. The user interface APIs available from market offerings support our solution approach.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	0.0	0.5	0.8	1.7	2.0	5.0
	BP1	0.0	0.7	0.5	1.7	2.0	5.0
	Variance	**0.0**	**-0.3**	**0.3**	**0.0**	**0.0**	**0.0**
Opex (£m)	BP2	0.0	0.1	0.1	0.2	0.2	0.5
	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**
Totex (£m)	BP2	0.0	0.5	0.8	1.9	2.2	5.5
	BP1	0.0	0.8	0.6	1.9	2.2	5.5
	Variance	**0.0**	**-0.3**	**0.3**	**0.0**	**0.0**	**0.0**
Cumulative RTB increase (£m)	BP2	0.0	0.0	0.0	0.0	0.1	
	BP1	0.0	0.0	0.0	0.0	0.1	
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	

Table 31 - Investment cost summary

Since submitting our original plan for this investment, there has been no material change to the total cost of delivery, but the profile of spend has been re-forecasted to align with current planning.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency

Design	Procured solutions will be able to aggregate input from source platforms and be compatible with the operator console	Application Development	If this assumption is false, there will greater than planned complexity and integration effort leading to extra cost and delay	Prior to contract with delivery vendors
Delivery	It is assumed that a Commercial Off the Shelf (COTS) product will be procured for this investment line	Business Software	If this assumption is false, then costs may increase due to the need to custom develop a new solution.	Completion of Request for Information (RFI)

Table 32 - Investment assumption summary

Risks

Risk	IT Tower	Mitigation	Likelihood	Impact
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. Undertake suitable due diligence in advance of procurement event award to ensure tooling fit for purpose end to end.	2	2
Lack of key internal SME/system user resource availability may delay the implementation and testing phases of the new system.	Program, Product & Project Management	Ensure early forecast of resource requirements to business units Timely recruitment for appropriately skilled resources	3	1
Global microchip could impact Hardware delivery timescales.	Program, Product & Project Management	Place hardware orders as early as possible within delivery lifecycle	3	1
There is a risk that the cost of refreshing the existing video wall and associated components will exceed budget allocation.	Application Development	Agree technology options for refresh vs risk profile Request and review supplier quotations Mobilise delivery	3	1

Table 33 - Investment risk summary

3.5 150 Operational Awareness and Decision Support

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
Confirmed	Hybrid	On-Track: N/A	Complete: N/A	Delay: N/A	Total Count: N/A

Overview & Purpose

This investment enhances our network modelling capabilities by providing online analysis of voltage and power flow profiles closer to real-time. It ensures 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 DNO / DSO networks, we require new capability (e.g., machine learning) and upgrades to existing tools to support enhanced decision-making. This investment also enables whole-system simulation and online/offline modelling.

This investment supports Network Control transformation 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, e.g., contingency analysis enhancements.
- Assessing options to enhance the state estimator using techniques such as AI and machine learning
- Online Stability Analysis enhancements.

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 capabilities and database/model maintenance capabilities to support operation of the ENCC.

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 34 - Summary of business outcomes and corresponding sub-activities

There are strong synergies between this investment and **110** Network Control, and we will deliver these as a combined programme, with the plan to merge this investment into **110** Network Control.

Current State

Our online and offline network analysis tools were designed to assess the transmission system at a time when its complexity, conditions and generation mix were 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.

The existing Integrated Energy Management System (IEMS) and Online Generator Stability Assessment (OSA) tools 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

This investment's primary inputs **110** Network Control and **220** Data and Analytics Platform will have refined their solution models and be in delivery, having defined a clear delivery and data integration strategy. This will provide the basis for the solution design and development of further tools and linkage to additional system or data sources.

The core Network Control Management system (NCMS) will have established a sandbox environment for early visibility, enabling users to gain hands on experience of the new systems user and data interfaces.

Roadmap

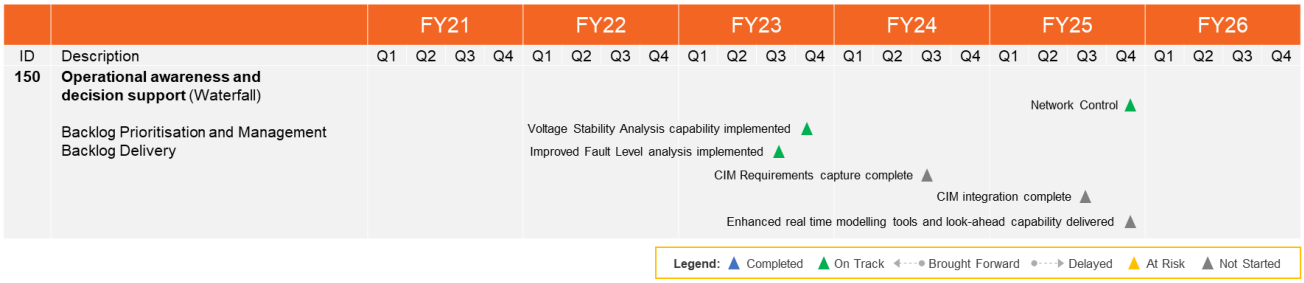


Figure 18 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Enhanced balancing capabilities	Business Units	New Enhanced Balancing Capability is deployed and available for integration.
VSAT (Voltage Stability Analysis 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.
Improved Fault Level Analysis implemented	Business Units Customers & Partners	Achieving new business functionality to effectively manage system fault level, control system voltage, etc.
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 EMS)
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 35 - Outcome summary descriptions

Future State

Enhanced Situational Awareness capability has been delivered to support zero carbon grid operations. Network issues are visualised quickly and supported by system-provided guidance enabling 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 into NCMS, building on the WAMS capability being delivered by **170** Frequency Visibility.

Target platform	Target Subsystem	Component	Future State
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 and DAP
Network Operations & Control	Situational Awareness	SCADA	New Situational Awareness suite implemented for 2025/26, with power analytics tools integrated into NCMS to support net zero grid operations
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 36 - Future state subsystem component summaries

Approach

We will base our capability around the frameworks established by 110 Network Control. This will provide the basis of many of the OADS tools we need and will be extended by data, models, and software 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 investment **220** Data and Analytics Platform, including artificial intelligence and machine learning methods to recommend and/or automatically execute actions.

We will follow the delivery approach established by **110** Network Control and integrate requirements for this delivery into the wider Network Control programme. It is likely that releases for this capability will tend more towards waterfall due to the need to carefully introduce decision support capability into the control room.

Solution Options

Our final options and solution decisions for OADS have not yet been completed. Our NCMS product selection provides a base for OADS integration.

If individual tools within NCMS do not meet our needs, buy or build will be considered. Analysis against our selected NCMS product is underway with regards to how much of the OADS functionality is accommodated within the core NCMS offering.

We are prioritising native NCMS delivery to control costs and risks for integration, operations and commercial sourcing and speed up delivery.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	0.0	1.4	3.6	3.8	1.7	10.6
	BP1	0.4	1.7	3.4	3.8	1.7	11.1
	Variance	**-0.4**	**-0.3**	**0.2**	**0.0**	**0.0**	**-0.5**
Opex (£m)	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**	**-0.1**
Totex (£m)	BP2	0.0	1.6	4.0	4.3	1.9	11.8
	BP1	0.5	1.9	3.8	4.3	1.9	12.3
	Variance	**-0.5**	**-0.3**	**0.2**	**0.0**	**0.0**	**-0.5**
Cumulative RTB increase (£m)	BP2	0.0	0.1	0.1	0.2	0.3	
	BP1	0.0	0.0	0.1	0.2	0.3	
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	

Table 37 - Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
N/A	Substitution	Capex	Substituted into **110** Network Control as both investments are being delivered as a combined programme	- ~£0.5m
N/A	Rounding	Opex	The variance shown in the Opex Total Variance row is due to rounding's and no real variance has occurred	£0.0m
Costs change since BP1				-£0.5m

Table 38 - Investment cost change summary

There are strong synergies between this investment and IT investment **110** Network Control, and we will deliver these as a combined programme. ~£0.5m expenditure in FY22 has been substituted into **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 a re-forecast of ~£0.2m from FY23 to FY24.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Design	It is assumed that ESO will deliver three modules	Application Development	If further modules are identified or required, then this could exceed budget	Weekly and Monthly
Delivery	It is assumed that a Commercial Off the Shelf (COTS) product will be procured for this investment line.	Business Software	If this assumption is false, then costs may increase due to the need to custom develop a new solution	Weekly and Monthly

Table 39 - Investment assumption summary

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
Delay to dependent NGESO platforms (NCMS+NGET SCADA Integration, Open Balancing Platform (OBP) and Data and Analytics Platform) 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
Lack of key internal SME/system user resource availability may delay the implementation and testing phases of the new system.	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 40 - Investment risk summary

3.6 170 Frequency Visibility

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
Confirmed	Hybrid	On-Track: N/A	Complete: N/A	Delay: N/A	Total Count: N/A

Overview & Purpose

This investment delivers Frequency Visibility capability into the control room to improve access to TO, DNO/DSO and smaller embedded generator frequency measurements.

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.

Dynamic System Monitoring (DSM) equipment is required to be installed by all large generators, however direct access by the ESO to theses DSMs is restricted to providers that are directly connected to a NGET substation. This access is currently managed via a NGET application.

The changing generation profile has resulted in an increase in the number of new, smaller providers who are unable to connect to the existing tool, requiring data to be requested manually following a system event or fault. This results in delays, and often missing data when investigating system issues as well as customer frustrations due to the ESO being unable to directly access the data.

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

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 41 - 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.

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 Transmission Operator phasor measurement units (PMUs).

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

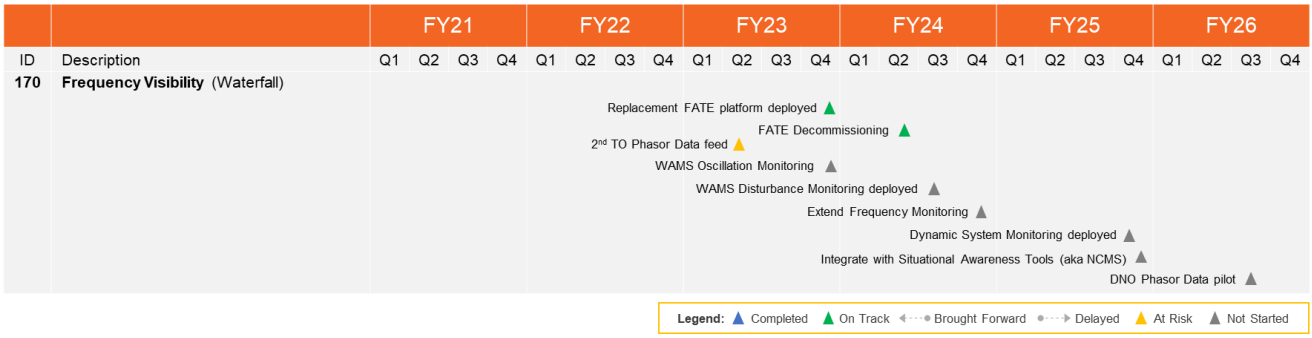


Figure 19 - Outcome roadmap

The roadmap has been updated during BP1 following changes to requirements due to a change in approach to managing FATE and increased requirements around system monitoring. It is anticipated that the volume of PMU monitoring across the network will continue to increase, especially of the distribution network, and new WAMS applications will continue to be developed within RIIO-3.

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 and via NGET 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
Dynamic System Monitoring deployed	Business Units Customers & Partners	New products to enable service providers to connect their DSM kit and provide ESO with high resolution generator data post event and for compliance validation

Integrate with Situational Awareness Tools	Business Units	Improved user experience by integrating WAMS tools into our broader Situational Awareness Toolset
DNO Phasor Data pilot	Business Units Customers & Partners	Understanding of the requirements to obtain PMU data from the distribution networks

Table 42 - Outcome summary descriptions

Future State

We have delivered enhanced capability to monitor and assess PMU data.

During BP2 we will be:

- Decommissioning the legacy FATE system, following a period of parallel running with the new solution
- Complete 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
- Expand 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).
- Enhance the availability of PMU data by migrating our Gateway Phasor Data Concentrator (PDC), enabling third party PMU data for our Network Control tools in our new Data Centre.
- Replace the products used for Dynamic System Monitoring (DSM) to enable connectivity to all services providers who are required to install DSM equipment as part of their Connection Agreements. This will provide the ESO with direct access to data collected following system events; reducing balancing costs, improving customer relations, and reducing the time to resolve generator compliance issues.

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

Table 43 - Future state subsystem component summaries

Delivery of our Frequency Visibility solution also supports investments **130** Emergent Technology and System Management and **500** Enhanced Frequency Control (formerly known as Zero carbon operability), for inertia monitoring and wide area monitoring systems respectively.

Approach

Our overall approach is to deploy the GE WAMS system and supporting frequency/phase monitoring devices, with integration into NCMS and the wider Network Control solution.

Following completion of the legacy FATE solution replacement, we will follow the delivery approach established by 110 Network Control and ensure our requirements are managed in line with wider control room deployments.

Post initial deployment, developing Frequency Visibility requirements will be met with additional NCMS or WAMS modules or customisation.

Our approach for the Dynamic System Monitoring (DSM) solution is to deploy a new networking and infrastructure solution into our data centres and link with our communications gateways. This will provide a central point of access for ESO and providers.

We expect to align releases of the DSM solution to a waterfall approach due to the nature of this solution.

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.

Alongside WAMS our feasibility analysis has concluded that modernising the DSM is the best option, in conjunction with our partners who own the devices. We will seek to improve and replace our collection of DSM diagnostics data using the tools we are implementing to manage data in the cloud.

We are exploring options to limit the cost and complexity for DSM deployment to smaller embedded generation providers.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	0.4	2.2	1.3	2.6	0.1	6.6
	BP1	0.6	0.6	0.2	0.2	0.2	1.6
	Variance	**-0.2**	**1.6**	**1.1**	**2.4**	**0.0**	**4.9**
Opex (£m)	BP2	0.0	0.1	0.1	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**
Totex (£m)	BP2	0.4	2.3	1.4	2.6	0.1	6.8
	BP1	0.6	0.6	0.2	0.2	0.2	1.8
	Variance	**-0.2**	**1.6**	**1.2**	**2.4**	**0.0**	**4.9**
Cumulative RTB increase (£m)	BP2	0.0	0.2	0.2	0.3	0.3	
	BP1	0.0	0.0	0.0	0.0	0.0	
	Variance	**0.0**	**0.2**	**0.2**	**0.2**	**0.3**	

Table 44 - Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
Systems or assets requiring unexpected spend	New scope included	Capex	Inclusion of FATE replacement project	+ ~£1.8m
Evolved or refined scope since BP1	New Scope included	Capex	Inclusion of Dynamic System Monitoring	+ ~£3.2m
Evolved or refined scope since BP1	New Scope included	RtB	Replacement of FATE	+ ~£0.3m
		Costs change since BP1		+ ~£5.3m

Table 45 - Investment cost change 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.

We have included the costs to replace the capability used by DSM to enable connectivity to all services providers following completion of our business case analysis with regards to Ancillary Service Monitoring (ASM) and DSM. This inclusion has increased projected costs by ~£3.2m.

We have also concluded that there is currently no benefit case for investment in ASM solutions at this time

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Deliver	It is assumed that the DSM project will mobilise in Q4 FY 23/24 and take 12-18 months to deliver	N/A	If this assumption proves false, then there would be a budgetary and schedule impact	Quarterly
Operate	It is assumed that the FATE Replacement will not be re-deployed to new CNI Data Centres until after RIIO-2.	Application Development	If this assumption proves false, then there would be a budgetary and schedule impact	Quarterly

Table 46 - Investment assumption summary

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	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

Concentrator (PDC) installation and commissioning work will affect the delivery plan for Frequency Visibility				
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
Lack of key internal CNI/system user resource availability may delay the implementation and testing phases of the new system and toolset	Program, Product & Project Management	Ensure early forecasting of resource requirements to CNI resource team to agreed timescales	2	1
Connectivity between CNI operations and DMS for all generator types leads to unforeseen cost and delay	IT Management & Strategic Planning	Explore and communicate options to limit the cost and complexity for DSM deployment to smaller embedded generation providers.	3	2

Table 47 - Investment risk summary

3.7 180 Enhanced Balancing Capability

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
In Draft	Hybrid	On-Track: 2	Complete: 7	Delay: 3	Total Count: 12

Overview & Purpose

This investment delivers the Open Balancing Platform (OBP), a new real-time balancing capability to replace legacy ESO balancing systems and processes and support zero carbon grid operations.

The Electricity National Control Centre needs to deliver reliable and secure system operation, facilitate competition everywhere and meet our ambition for net-zero carbon operability. This investment funds new balancing systems to deal with decentralisation of providers and accommodate closer-to-real-time energy markets.

Our existing balancing systems architecture cannot be adapted to support zero carbon grid operations.

The OBP is designed and built flexibly to enable new energy services and access for smaller generation units far more quickly and at lower risk than is currently possible.

This investment enables sub-activity **A1.2 Enhanced Balancing Capability** and is part of the wider Balancing Programme, whose state is covered in same section.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A1.2 Enhanced Balancing Capability	• Enhanced balancing optimisation for market participants

Table 48 - Summary of business outcomes and corresponding sub-activities

Current State

During BP1, we have conducted a Balancing Transformation Foundation phase which defined our future capabilities framework. This includes our 'as-is' capability description (BM, EBS and ASDP), high-level design for new system including modular architecture, delivery framework, business, and technical roadmaps for the 'to be' state.

We completed the Blueprint phase, which further increased our understanding of the systems capabilities required to meet the outcomes required by the ESO and consumers of Balancing services. This included a core architectural design and definition of a product backlog.

With a much-improved understanding of the scale of change and efforts required to transform our balancing capabilities, we have reviewed our roadmaps, delivery plans, benefits and associated costs with our business and delivery teams. Subsequently we completed an open Balancing Capability Strategic review with our industry stakeholders. This was necessary to provide a cost-efficient, transparent, and robust delivery schedule to meet our own goals, support the needs of the market and ensure that delivery of this critical capability provides strong benefits to consumers. For further details please refer to the Stakeholder Engagement [Annex 3] document.

This investment has established its delivery team to build the OBP. At the end of BP1, the OBP product team will have completed seven Programme Increments (PI) - a timebox during which an Agile Release Train (ART) delivers incremental value in the form of working, tested software and systems. Through these PIs we will achieve completion of the core platform which will enable generation request, basic optimisation and instructions handling and form the basis of further development for production of Release 1 in September 2023.

The current BM systems continue to provide the primary Balancing Scheduling and Dispatch capabilities for the ESO into the BP2 period. The EBS system provides an 8-hour scheduling capability, however changing operational needs for scheduling in the Control Room have reduced the operational value obtained from the tool. This is driven by the shifting energy mix experienced in recent years and an increased requirement for

flexible real-time balancing operations. The strategic review has concluded with our decision to retire EBS under investment 210 Balancing Asset Health.

Conceived prior to the Open Balancing programme, we built a Modern Dispatch Advisor as a supportable, direct replacement for the ageing and unsupported BM component Legacy Dispatch Advisor (LDA). The MDA ensures dispatch advice resilience while we transform to OBP. The programme will continue development of the MDA to mitigate risk of the LDA failing, improving economic advice to the Control Centre and forming the basis of the National Optimiser platform for the new OBP for deployment during BP2.

Roadmap

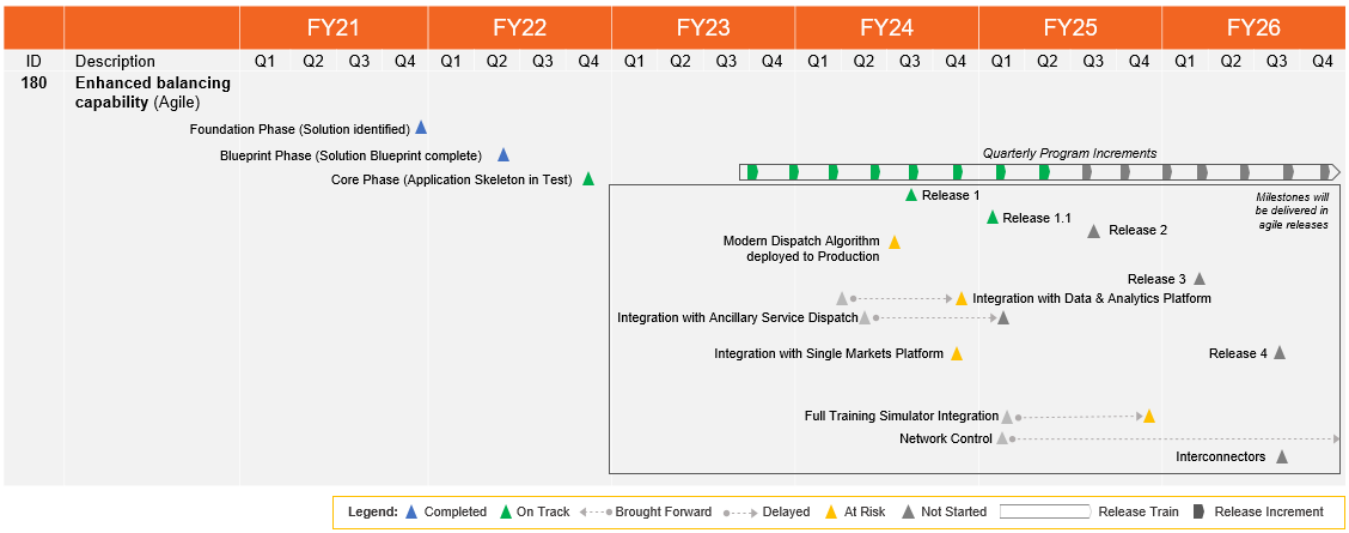


Table 49 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Foundation phase (Solution Identified)	Business Units	Completion of initial functional and non-functional requirements gathering, enabling selection of platform component candidates into the Blueprint phase.
Blueprint Phase (Solution Blueprint complete)	Business Units	Completion of evaluation and selection of the core components that will be used to architect the OBP platform. High level design of application, delivery method and team structure designed.
Core Phase (Application Skeleton in test)	Business Units	Completion of initial design of the core application container and User Interface services for OBP.
Release 1 - Basic Energy Balancing	Business Units / Partners	First release of OBP to the Control Room. Will improve efficiency and reduce workload by enabling multi-dispatch instruction, which will reduce unit skips. Functionality for Real-Time Energy Balancing and First Tranche Margin Analysis
Release 1.1 Energy Contracts	Business Units	Functionality for Unit Pre-qualification, Contracts, registration & Predicted Generation Forecasting. Provides Meter, Market, Network, and constraints data for improved Situational awareness.

DAP integration	Business Units Customers & Partners	Initial integration with the Data and Analytics Platform which will replace our long-term retention and analytics capability.
Single Markets Platform Integration	Business Units	Integration of unit contract data with the OBP to ensure procured services are scheduled, optimised and available for dispatch.
Release 2 – Optimisation & Forecasting	Business Units, Customers and Partners	Release of new National Optimiser, reducing energy balancing costs.
Full Training Simulator integration	Business Units	Full integration with the training simulator, increasing effectiveness in the Control Room.
Release 3 – Frequency Response, Inertia Monitoring, Settlements	Business Units	Release of response requirement and response management. Inertia monitoring capabilities available. Integration with Settlements Platform for energy supplier payments, reducing errors and workarounds Enables decommission of ASDP.
Release 4 – Enhanced Margin Analysis, Unit commitment	Business Units, Customers and Partners	Enhanced Margin analysis completed, Unit commitment and EDT/EDL instruction underway.
Interconnectors	Business Units	Integration with Interconnector Manager IFLO, reducing risk on BM.

Table 50 - Outcome summary descriptions

At the end of BP2, the OBP will master the vast majority of Balancing data and all Balancing processes. In early RIIO-3, OBP will also be fully integrated with Network Control Management System (NCMS) and the BM system will be decommissioned. The product development capability established for OBP will continue to deliver value-based enhancements and changes throughout RIIO-3.

Future State

The BP has delivered significant benefits into the ENCC and to our stakeholders, through release of OBP functionality including:

- Zero carbon grid operations for dispatch and optimisation capabilities of smaller units
- Grid constraint management across decentralised providers
- Accommodation of closer-to-real-time energy markets
- Simpler implementation and management of new Energy Services including reserve and response
- Integration of improved forecasting capability
- Re-usable balancing service technology capabilities to support future integration e.g., Interconnectors

We will have implemented our core OBP architecture into a Production state and will be operating the new OBP platform and legacy Balancing systems in parallel.

Target platform	Target Subsystem	Component	Future State
Balancing	Balancing Communication	Data Exchange	CNI-hosted integration layer, interoperating with related CNI OBP platforms and non-CNI ESO services.

Balancing	Energy Balancing	Scheduling	A new service running in the OBP platform which will perform scheduling functions to provide advice to the control room
Balancing	Energy Balancing	Dispatch	A new dispatch service running in the OBP platform to send instructions to BMUs
Balancing	Contingency Energy Balancing	Contingency Logging	The OBP will be designed to provide a high-availability platform; a critical element to this is the high-availability / contingency service that will be required, currently in the initial design stage for OBP.
Balancing	Interconnector	Interconnector	The IFLO platform will be retained and integrated with the OBP platform (utilising communications platforms as described in BAL-01)

Table 51 - Future state subsystem component summaries

Approach

The Open Balancing Platform (OBP) has been designed to meet the business functional and non-functional requirements using modular component design patterns (microservices) and a combination of cloud-native and on-premise infrastructure and software environments.

The use of microservices to design, build and deploy modular component solutions allows business functions to be built, deployed, and maintained independently. This reduces the impact of future change on the Balancing solution, limits outages during deployment of new features and enhancements and enables the addition of new modules aligned to a standard and predictable release model.

ESO Technology will utilise DevOps to accelerate deployment times and reduce risk when deploying solution changes using proven methods and practices that combines software development and operations management capability.

To exploit DevOps consistently and effectively we are using industry standard methods for continuous integration, continuous delivery (CI/CD) development pipelines to facilitate rapid, automated code development, testing and deployment. We will build code in non-production cloud environments and deploy to on-premise environments via our secure development pipelines.

To mitigate the impact of this platform change to our customers, we will develop adapters that will act as ‘gateways’ between the new OBP micro-services and existing systems. These will enable the OBP platform to be developed and enhanced whilst minimising change impact to customers and existing systems.

Delivery progress is tracked within Programme Increments with our team organised into delivery squads with a Principal Product Manager, Product Managers and Product Owners working closely with the ESO Business and Industry. We measure squads on their ability to complete stories/features (inclusive of bugs, debt & risk) as planned which we report weekly in the form of a burn up.

Release management will be implemented in phases with sequential releases of capability to the control room.

Solution Options

The options that were evaluated regarding the Enhanced Balancing Capability focussed on providing a stable and extensible platform which can adapt to meet the demands of RIIO-2, the expectations of our customers and the increasing number and diversity of generation units and types used to balance the system.

We evaluated the possibility of porting the existing BM Fortran code set to a new platform such as Java as well as the option of retaining the code-base and re-platforming the existing legacy BM; essentially replacing the legacy hardware and operating systems with more modern equivalents. This was discounted as being too complex and with an uncertain outcome given the significant technical difference between Fortran and Java like

technologies. It was envisaged that there would be as much re-development of code and extensive regression testing as there would developing new functionalities from scratch.

We evaluated the option to extend the capabilities of EBS as a scheduler, whilst building a new dispatch platform to integrate with it. The monolithic design and architecture adopted in EBS means that system modifications to integrate with other services would be complex, high risk and costly to achieve. Significant investment in upgrading its current infrastructure will also be required in order to maintain CNI levels of availability and security. This would mean the OBP platform would inherit a high degree of technical debt with the integration of EBS. The operational importance of a 4-hour ahead scheduler in the control room has also decreased significantly with the introduction of hourly market gates on the Interconnectors. We finally discounted this option during the Balancing Capability Strategic Review.

The option of re-platforming EBS infrastructure was also evaluated and discounted as this would not resolve the existing issues and risks around application support / availability of development resources. In addition, this approach would still result in a monolithic application with its inherent challenges of testing and deploying new services in a rapid manner. It would not provide ESO with the agility and flexibility of service deployment required by RIIO-2 and the market.

The proposed option to re-engineer balancing services into a new platform (OBP) with containerised micro-services and hybrid cloud model for infrastructure management is recommended for several reasons. This approach enables us to leverage new technologies such as Kubernetes and containers so we gain 'runtime certainty' as well as deploying a micro-service architecture that provides ESO with a highly flexible platform, meaning we can develop and deploy new services faster and with much lower risk than is currently possible. The program completed a market selection event to identify the technology vendors that could deliver the capabilities required, resulting in selection of Red Hat as the chosen technology framework. We have undertaken several phases of tool selection and rationalisation of software packages into the OBP Blueprint and will continue to refine this as designs are finalised.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	15.1	29.7	20.7	17.3	16.5	99.2
	BP1	8.1	10.1	12.2	6.1	4.1	40.5
	Variance	**7.0**	**19.5**	**8.5**	**11.2**	**12.5**	**58.7**
Opex (£m)	BP2	0.1	0.7	1.0	0.9	0.9	3.6
	BP1	0.9	1.1	1.4	0.7	0.5	4.5
	Variance	**-0.8**	**-0.4**	**-0.4**	**0.3**	**0.5**	**-0.9**
Totex (£m)	BP2	15.1	30.4	21.6	18.2	17.4	102.8
	BP1	9.0	11.3	13.5	6.8	4.5	45.0
	Variance	**6.1**	**19.1**	**8.1**	**11.5**	**12.9**	**57.8**
Cumulative RTB increase (£m)	BP2	0.0	0.0	3.9	4.9	6.0	
	BP1	0.2	0.2	0.3	0.4	0.4	
	Variance	**-0.2**	**-0.2**	**3.6**	**4.5**	**5.6**	

Table 52 - Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
Evolved or refined scope since BP1	Better understanding	Capex	Better understanding of scope	+ £55.7m
Evolved or refined scope since BP1	Change in Scope	Capex	Inclusion of forecast cost for delivering a tertiary site for added protection against Cyber threats	+ £3.0m
Efficiencies	Better understanding	Opex	Better understanding of Opex, attributed to pre-go-live CNI support, training, and expenses	- £0.9m
Evolved or refined scope since BP1	Better understanding	RtB	Better understanding of support resources requiring RtB funding for new platform	+ £3.7m
Evolved or refined scope since BP1	Better understanding	RtB	Better understanding of hardware and Software resources requiring RtB funding for new platform	+ £1.9 m
Costs change since BP1				+ £63.4

Table 53 - Investment cost change summary

During BP1, we have obtained a much deeper understanding of the complexity and scope of transitioning away from our legacy systems to our new balancing tool. We have now developed a bottom-up cost model of the capacity and resources required to deliver our OBP transition roadmap.

The roadmap has been sized and a team capacity has been created to deliver the changes. The duration of the change has increased from the original FY24 completion to the end of FY26 and into RIIO-3.

Validation of market and industry priorities for the balancing system functionality has been conducted which has led to change in scope.

Balancing Transformation costs have now been aligned to updated changes in scope using our improved cost model. We have revisited our original plan which was based upon high-level estimation and assumptions.

Our original plan was to enhance EBS to deliver the creation of our 4-hour ahead schedules for balancing and integrate with a new modular dispatch platform, which would eventually replace BM by 2023/24. Our Foundation and Blueprint phases determined that the changes required in EBS to enable this integration would be too complex, high risk and costly to achieve. Furthermore, changes in control room requirements driven by market changes, have determined that our current scheduling capability would not meet operational needs in the future. We therefore need to build new Optimisation and Scheduling capability within the OBP platform which has added to the cost of this investment.

During BP1 we have obtained a better understanding of the pre go-live support and training needs of the OBP system, this has reduced our Opex forecast.

Based on the scope changes stated above we are now able to better forecast the likely RtB cost for maintenance and support for the new service.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Deliver	The Balancing transformation programme can absorb the costs of replicating new functionality implemented in BM and ASDP during BP2, as part of its planned capacity.	Application Development	Material impact of new changes will need to be prioritised in the backlog leading to delay of the existing backlog delivery.	Quarterly
Deliver	Significant market reform will not take place during the BP2 period. Allowing the backlog to delivered according to the current backlog.	Application Development	Material impact of new changes will need to be prioritised in the backlog leading to delay of the existing backlog delivery	Quarterly
Deliver	The development of a Core platform, followed by functional releases will provide the necessary capabilities required by the control room.	Application development	Use of the existing BM system will need to be for a longer time period.	Quarterly

Table 54 - Investment assumption summary

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
The new datacentres required for hosting the OBP platform may not have been commissioned in time to meet OBP milestones for production services leading to delays in go-live of release 1 of the OBP.	IT Management & Strategic Planning	Prioritise delivery of the Datacentre. Develop the core OBP services in our Azure development environment Note: Azure would only be used for development and not for any operational service, or for any link to CNI environments	3	4
Our Control Room and Operations teams may not be ready to receive and operate a new balancing platform leading to slower than expected benefit realisation	IT Management & Strategic Planning	Ensure the Business Squads have sufficient SME expertise to hand. Ensure process design governance is robust Ensure business unit is adequately trained.	3	3
Lack of energy system optimisation and modelling in-house skills to provide	Strategic Planning &	Recruit additional optimisation resources into the Business	3	1

input into optimisation and modelling design leading to slower than expected optimisation development	Programme Team	Maintain, enhance, and expand academic and other external relationships for Subject Matter Expertise		
Implementing the interim changes in Balancing Mechanism (BM). E.g. Generation Export Management System (GEMS) and Regional Development Programmes (RDP) or ASDP (e.g. ASR Day 2) in the Open Balancing Programme (OBP) will have a material impact on the roadmap, delaying the implementation of the OBP and decommissioning of the BM or ASDP.		Ensure OBP design work for GEMS and RDP is co-created with the OBP architectural resources and aligned to BM design work. Ensure ASDP design work for ASR is co-created with the OBP architectural resources and aligned to BM design work. Assess the impact of OBP design for RDP, GEMS and ASR against the roadmap as early as possible.	3	3
Key internal SME/system user resource availability may impact delivery of the backlog and roadmap	Program, Product & Project Management	Ensure early forecasting of resource requirements to business units and review periodically via Programme governance Timely recruitment for appropriately skilled resources where not already available	3	1

Table 55 - Investment risk summary

3.8 190 Workforce and Change Management Tools

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
In Draft	Agile	On-Track: 2	Complete: 0	Delay: 7	Total Count: 9

Overview & Purpose

This investment enables publication of learning materials and operational updates on new platforms and provide enhanced training and operational decision-making capability. New tools will support management of workforce planning, shifts, change and contracts/documents with tailoring to individual user profile settings.

We are investing in our workforce and the technologies required to support more frequent updates to policies and standards. Our current processes and tools are not designed to support the workforce requirements for zero carbon grid operations. We must replace and improve these capabilities to avoid introducing safety, compliance, and wellbeing risks.

There is a significant amount of change expected on our ESO critical, operational, and supporting systems landscape during the BP2 period. We need to automate our change processes and ensure accurate, timely updates are provided to our control centre users in an appropriate format. Our ambition for 2026 is to operate a training repository system, with automated linkage between training options and our staff development plans.

This investment enables sub-activity **A2.4 Workforce and Change Management Tools**.

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 56 - Summary of business outcomes and corresponding sub-activities

Current State

By March 2023 we will have implemented our central workforce management system with end users accessing, reviewing, and requesting shift changes through web and mobile phone applications. 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 document management improvements.

Roadmap

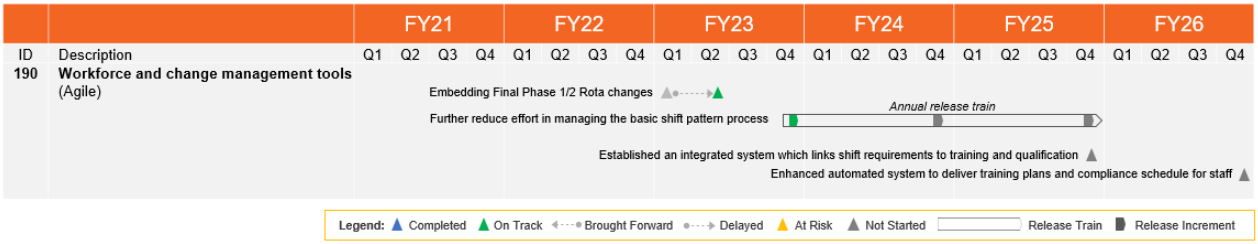


Figure 20 - Outcome roadmap

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.
Further reduced effort 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	Integration of training and qualifications tracking into shift management processes 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 57 - Outcome summary descriptions

Future State

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

Table 58 - 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.

Completion of these changes allows us to reduce the overall cost associated with management of shift rotas and individual staff training and authorisation processes.

Approach

We will extend and enhance the core Salesforce-based workforce management system. If appropriate we will extend our solution using supporting tools and services to provide our teams with 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 using cloud services where we can, building on the SaaS base offered by Salesforce.

Our release approach into the control room is governed by their operational priorities and training needs with consideration to critical control room systems.

Solution Options

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.

We explored but discounted the option of selecting alternate market tools offering similar functionality as no additional benefits were present in moving away from our Salesforce core platform.

We explored but discounted the option of building a bespoke ESO suite of workforce management tools as this would require complex software framework design and high levels of maintenance to meet our requirements.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	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 (£m)	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**
Totex (£m)	BP2	0.0	0.2	0.8	1.2	1.6	3.8
	BP1	0.0	0.4	0.8	1.2	1.6	4.0
	Variance	**0.0**	**-0.2**	**0.0**	**0.0**	**0.0**	**-0.2**
Cumulative RTB increase (£m)	BP2	0.0	0.0	0.0	0.1	0.1	
	BP1	0.0	0.0	0.0	0.1	0.1	
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	

Table 59 - Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
N/A	Cost shift	Opex	Opex expenditure migrated to Capex spend	- £0.4m
Efficiencies	Lower supplier cost	Capex	From a total of £0.4m (shifted from Opex) only £0.2m was spent due to lower supplier cost	+ £0.2m
			Costs change since BP1	- £0.2m

Table 60 - Investment cost change summary

The move from Opex to Capex is due to requirement being identified as design related work as opposed to the original plan incorrect assessment as Opex spend.

The reduction in capex spend is down due to lower actual supplier cost for the initial phase 1 design built into the future plans.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Design	The solution is based on a Salesforce platform which will be configurable to our future needs	Business Software	Schedule and budgetary	Half-yearly

Table 61 - Investment assumption summary

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
There is a risk that the tool may not meet ESO functional requirements or required support levels leading to a review in solution	Business Software	Reviews with the supplier are being undertaken on a regular basis	1	1

Table 62 - Investment risk summary

3.9 200 Future Training Simulator and Tools

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
In Draft	Hybrid	On-Track: 3	Complete: 4	Delay: 1	Total Count: 8

Overview & Purpose

This investment delivers the Electricity National Control Centre training simulator. Scope of delivery includes training for refresher and upskill sessions, special events, introduction of changes, feedback, and authorisation exams.

Our ambition is to provide a single training simulation capability for the ENCC.

We will enable simulation tools to accurately reflect the changing energy landscape with real-time data. This will allow us to train Control Centre engineers on a range of past and future scenarios.

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

This investment supports 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 63 - Summary of business outcomes and corresponding sub-activities

Current State

During BP1 we will operate our two existing Training Simulation capabilities.

By the end of the BP1 period the Network Control Management System (NCMS) Training Simulator requirements capture will be complete. We will have started scoping of requirements for the Enhanced Balancing Training Simulator and scoping of requirements for the Integrated Network Control Simulator to be delivered as part of this investment.

Minor upgrades to the current simulators will only be made if necessary to extend their life until the new simulation capabilities are ready.

Roadmap

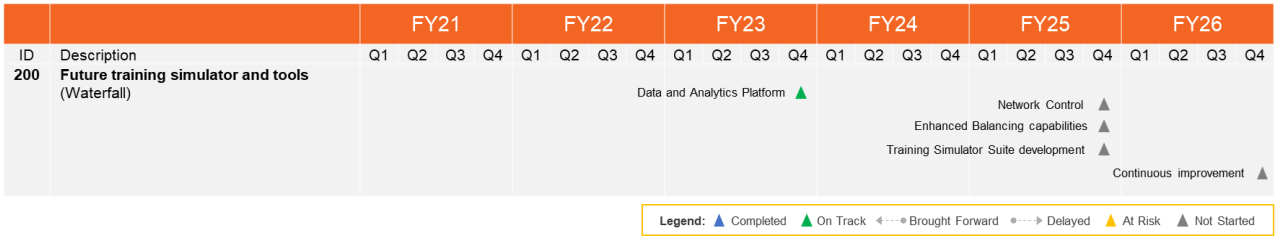


Figure 21 - Outcome roadmap

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 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 64 - Outcome summary descriptions

Future State

Our end-to-end simulation and training capability, representative of our live operational systems has been implemented.

Control Room and support teams will use an Integrated Network Control Simulator built on the NCMS platform.

The core simulation capability is extended to include Balancing, NCMS enhancements and other integrated control systems.

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

Table 65 - Future state subsystem component summaries

Development of the new simulator has a key dependency on delivery of the transformational Network Control and Balancing systems.

By the end of BP2 we expect the new integrated training simulation capability including new Network Control and Balancing simulator tools to provide a user experience equivalent to real-time operation.

Approach

We will configure and extend the simulation and training component of NCMS. This component will provide the Network Control element of our capability

We will integrate the simulation and training component of OBP. This component will provide the Balancing element of our capability

We will build out automated simulation tools to allow trainers to control the scenario presented to trainees and to measure their performance.

Security policies will be defined in line with NIS-D and ESO information security requirements to ensure appropriate levels of protection as data is made available into Training Simulation environments. These policies will apply equally across CNI and Cloud data centre operating environments and will ensure data sets are correctly protected as our users switch between Production and Training Simulator platforms.

Our delivery approach follows the methodology defined by 110 Network Control, using agile requirements discovery, capture and build where possible. We will release initial NCMS training simulation capability into a sandbox environment for the control room. Production training simulation services will be implemented in phases with sequential releases of capability to the control room.

Solution Options

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

We intend to build out the core training simulator based on metering, telemetry, and connected DNO/DSO data feeds to then be able to provide a baseline into Balancing and other services requiring training simulation.

Where additional systems require adaption to integrate with the new simulator, we will assess individual options as required.

For data management, data sharing, and data analytics use cases the full solution will use the capabilities of the 220 Data and Analytics Platform investment.

The option to procure a completely separate or standalone training simulation capability was considered but discounted as we do not have evidence to show how this could be integrated natively with our selected NCMS solution. This would have led to high risk of non-delivery and technology incompatibility.

We considered but discounted the option to build a completely bespoke training simulation capability but discounted due to complexity and our NCMS product offering a packaged capability.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	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 (£m)	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**
Totex (£m)	BP2	0.0	0.0	1.5	2.9	2.9	7.3
	BP1	0.0	0.0	1.5	2.9	2.9	7.3
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Cumulative RTB increase (£m)	BP2	0.0	0.0	0.0	0.1	0.2	
	BP1	0.0	0.0	0.0	0.1	0.2	
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	

Table 66 - Investment cost summary

Our BP2 forecast remains the same as originally forecast and this is based on identified high level requirements. These requirements will be defined in the latter half of FY23 which will drive further details regarding deliverables and cost forecast as we progress.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Deliver	Current resource rates stay within tolerance for the duration of the BP2 period.	Programme, Product & Project Management	Application Development Cost increases will be reported and checked for value through monthly reporting	Monthly
Deliver	It is assumed that a Commercial Off the Shelf (COTS) product will be procured for this investment line.	Programme, Product & Project Management	If this assumption is false, then costs may increase due to the need to custom develop a new solution.	Completion of Request for Information (RFI)
Design	NCMS product can support our training simulation requirements	IT Management & Strategic Planning	Alternative training simulation procurement may be required	Every 3 months

Table 67- Investment assumption summary

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
As the detailed requirement are yet to be determined at this stage of the project lifecycle, it could lead to an increase in costs and delays to delivery of enduring solution.	Application Development	Crystalise requirements, assure/agree scope, and delivery timescales/costs	3	1
We develop short-lived tools due to difficulty in predicting how simulation 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
Delays in delivery plans for the corresponding balancing and Network Control systems will impact the integration of the new training simulator	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

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 and review periodically via Programme governance Timely recruitment for appropriately skilled resources where not already available	3	1

Table 68 - Investment risk summary

3.10 210 Balancing Asset Health

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
In Draft	Hybrid	On-Track: 0	Complete: 0	Delay: 1	Total Count: 1

Overview & Purpose

This investment allows ESO to maintain its existing Balancing systems and services.

ESO operates the Balancing Mechanism (BM) in real-time using the existing Scheduling and Dispatch systems. Whilst we transform the balancing capabilities under **180** Enhanced Balancing Capability, we need to maintain and enhance our legacy systems to continue operating the electricity system safely and economically.

We need to maintain a viable BM delivery capability to maintain and improve system performance and stability. Investing in this capability enables us to deliver safe and secure balancing systems, support short-term market value and prepare for transforming our balancing capability.

This investment enables sub-activity **A1.1 Ongoing activities**.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A1.1 Ongoing activities	• Maintenance and enhancement of existing balancing capabilities

Table 69 - Summary of business outcomes and corresponding sub-activities

Current State

At the start of BP1, we organised our existing balancing systems change pipeline around a product model, with a backlog owned and prioritised by a product manager. For BM, we built a change capability reliably delivers enhancements and new functionality to the BM, up to four times a year. This was a significant adjustment from our previous approach and has ensured that what we develop delivers clear value.

As of August 2022, we have enabled increased automation in BM, removed workarounds, performed vital asset health work, and enabled changes to the BM for other projects to go live (such as Ancillary Services Reform (ASR)), which are funded by separate investment lines). We have further releases forecast for September and November 2022 and Spring 2023.

For EBS, our original plan at the start of BP1 was to enhance EBS to deliver a 4-hour ahead scheduling capability to our Control Room. Subsequently, this scheduling capability was to be integrated with OBP. In October 2021, we delivered an EBS release in line with our original plan, to provide current functionality fixes and enable new functional testing capability.

We reviewed the capabilities of the EBS system and found that its current scheduling capability has a reduced operational value in Control Room. This is primarily driven by the shifting energy mix in recent years (increased wind, solar and hourly interconnector trade gates) and an increased requirement for flexible real-time balancing operations. These operational changes are also defining the future needs of both control room users and external stakeholders. Zero carbon grid operations requirements cannot be met by EBS without significant bespoke functional enhancement.

We paused further EBS releases until a thorough assessment would be completed as part of our Balancing Capability Strategic Review. This concluded that future business and industry needs would not be met by EBS in its current form and that further investment in EBS will not deliver value for money to our customers.

By the end of BP1, we will have completed the analysis to migrate functionality from the EBS system. In parallel we will make the decision on the optimum time to decommission EBS.

Roadmap

The roadmap for this investment is split into two parts – one for BM system and the other for EBS.

BM roadmap:

This investment will retain a limited BM change capability during BP2. Continuing its product release model, the team will deliver critical defect fixes and changes to enable wiESO investments e.g., ASR and RDPs. The team will also deliver the on-going integration with the new Open Balancing Platform (OBP). BM work to support other projects will be delivered by the BM capability but funded by the investment line requesting the change.

The BM team will continue to deliver multiple releases per year during BP2, based on a prioritised roadmap that will be subject to quarterly reviews. Our intention is to share this roadmap and progress against it with industry stakeholders, as part of our Programme Increment reporting.

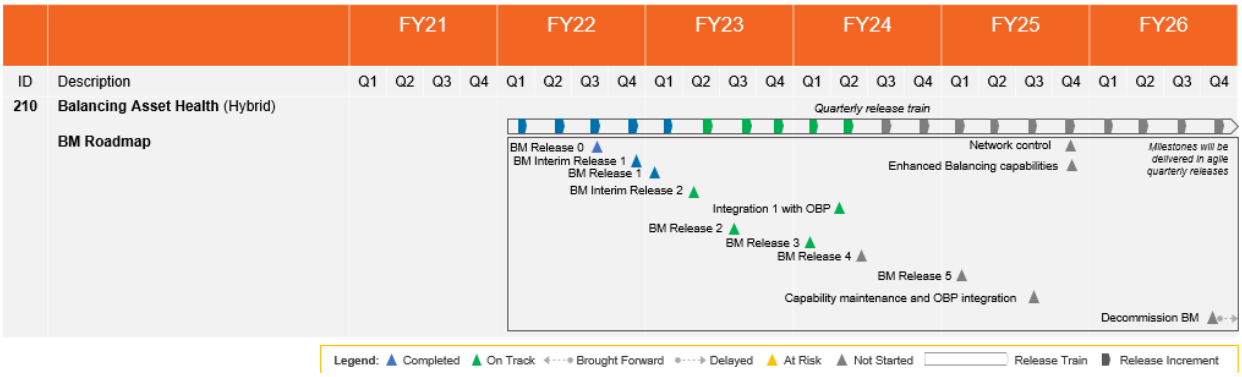


Figure 22 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
BM Release 0	Control room, CNI Operations team, business units	Asset health and performance improvements Control room functionality improvements including Automated Instruction Repeat (AIR) functionality and automated data input Improvements to dispatch optimiser handling of wind power BM changes to support other projects including CEP 6.9 and Stability Pathfinder phase 1c. (Funded by the requesting investments)
BM Interim Release 1	Control room, business units	Automated data input functionality, removing a workaround for the control room and supporting launch of DM/DR funded under investment 400 Single Markets Platform
BM Release 1	Control room, CNI Operations team, business units	Asset health and performance improvements, including major rearchitecting of a key process to enable further changes and BMU growth plus performance improvements to ensure EDL and EDT data to and from market participants is handled quicker Control room functionality improvements including updates to bulk dispatch tool, improvements to AIR functionality and other priority enhancements BM changes needed to support MDA, Mersey High Voltage Pathfinder, Stability Pathfinder phase 1c, DM/DR Day 1, Stability Pathfinder 1C, and OLTA (Funded by the requesting investments) Decommissioning of redundant elements
BM Interim Release 2	Control room, CNI Operations team, business units	Improvements to bulk dispatch tool and priority control room functionality enhancements Priority asset health improvements and defect fixes Decommissioning of redundant elements

BM Release 2	Control room, CNI Operations team, business Units	BM changes needed to support Constraint Management Pathfinder, RDP MW Dispatch, Market Settlements Manager (Funded by requesting investments) Improvements to use of DM/DR and Voltage Pathfinder in the control room (Funded by the requesting investments) First transfer of functionality from EBS to BM Asset health and performance improvements Priority control room functionality enhancements Decommissioning of redundant elements Work to support EBS decommissioning decision
BM Release 3	Control room, CNI Operations team, business units	BM changes needed to support DM/DR Day 2, Reserve reform, RDP GEMS, Stability Pathfinder phases 2/3, Constraints Management Pathfinder, Market Settlements Manager (Funded by the requesting investments) Continued integration with OBP for Dispatch Asset health and performance improvements Priority control room functionality enhancements Decommissioning of redundant elements Work to support EBS decommissioning decision
Integration 1 with OBP	Control Room	Integration of the initial micro-services (Dispatch) with the existing BM platform
BM Release 4	Control room, CNI Operations team, business units	BM changes needed to support projects across the ESO Continued integration with OBP for Dispatch Asset health and performance improvements Priority control room functionality enhancements Decommissioning of redundant elements Work to support EBS decommissioning decision
BM Release 5	Control room, CNI Operations team, business units	BM changes needed to support projects across the ESO Continued integration with OBP for Dispatch Asset health and performance improvements Priority control room functionality enhancements Decommissioning of redundant elements Work to support EBS decommissioning decision
Capability maintenance and OBP integration	Control room, CNI Operations team	Final integration with OBP. Removing obsolete functions.
Decommission BM	Control room, CNI Operations team	Disconnection of the legacy balancing platform from the ESO network, end of support.

Table 70 - Outcome summary descriptions

EBS roadmap:

We are currently defining our EBS systems management plan for maintain, migrate, and decommission. Our roadmap below is indicative to provide our current best view of timescales.

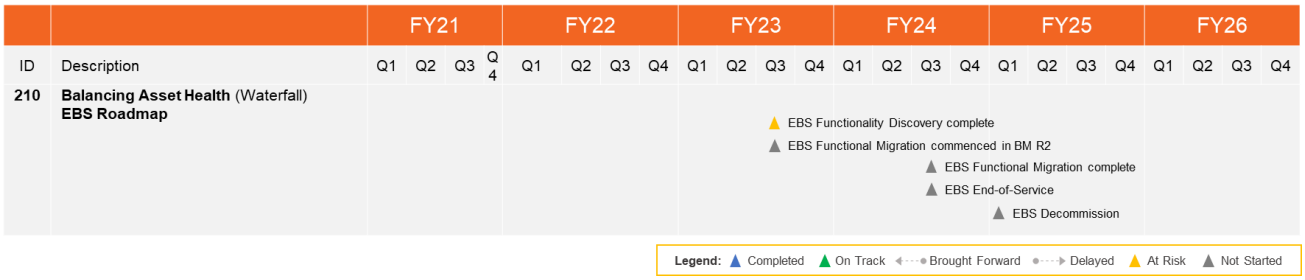


Figure 23 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
EBS Functionality Discovery complete	IT programme team	Completion of discovery of critical business processes supported by EBS and to be retained and migrated. Processes documented and understood allowing for a migration plan to be created, costed, and executed.
EBS functional Migration commenced in BM R2	Control room	First major functional migration (STOR file transfer) migrated to BM as part of R2.
EBS functional Migration complete	Control room	All remaining unique/critical functionality provided by EBS, migrated to alternative system or process.
EBS end of service	Control room, Commercial, IT operations	EBS no longer used by the ESO for any purpose. License agreement not renewed.
EBS decommission	IT operations	EBS hardware disconnected from ESO network, Hardware removed from legacy data centre / re-purposed.

Table 71 - Outcome summary descriptions

Future State

The current BM platform will be retained and maintained as the OBP platform is developed. Discrete BM functions will be replaced by OBP services as the OBP platform is developed. The BM platform will maintain a change capability including assessment of new requirements to justify delivery through BM capability. Justification will include measuring benefit of early implementation against cost of making the change twice.

By April 2026, the OBP will assume primacy of Balancing data from the BM platform. A reduced change capability for BM will be retained until the end of FY26 to ensure continuity of service to the control room and market participants, and to ensure a successful transition to the OBP for all remaining Balancing capabilities. It may be necessary to create temporary functionality within BM legacy application components to support the OBP transition.

We will have also completed the required migrations and plan for EBS decommissioning activities, whilst ensuring stability of key processes until decommissioning.

Target platform	Target Subsystem	Component	Future State
Data & Analytics	Consistent Data Services	Wider Access	We will continue to operate the Wider Access integration service into BM until replacement via the RedHat Integration capability within OBP

Balancing	Balancing Communication	Data Exchange (WAAPI)	We will continue to operate Wider Access API (WAAPI) services until replacement via the RedHat Integration capability within OBP
Balancing	Balancing Communication	Data Exchange (EDL/EDT)	We will continue to operate EDL/EDT services until replacement via the RedHat Integration capability within OBP
Balancing	Scheduling	BM SPICE	We will continue to operate BM SPICE to preserve integrity of legacy application Scheduling services until BM is decommissioned. EBS Scheduling will be decommissioned as per the EBS section above.
Balancing	Dispatch	BM SORT	We will continue to operate BM SORT to preserve integrity of legacy application Dispatch services until BM is decommissioned.
Balancing	Balancing Services	VERGIL (Pumped Storage Instructor)	We will continue to operate VERGIL to preserve integrity of legacy Pumped Storage Instructor services until BM is decommissioned.
Balancing	Contingency Logging	CLOGS	We will continue to operate CLOGS to preserve integrity of legacy Contingency Logging services until BM is decommissioned.

Table 72 - Future state subsystem component summaries

Approach

As part of the Balancing Capability Strategic Review, we co-created a roadmap with industry stakeholders setting out when we will deliver outcomes based on industry priorities, Control Room needs and consumer value. We will continue to review and develop this roadmap with industry as part of the ongoing engagement.

To maintain continuity of service and operation of balancing markets, we will steadily and safely transition balancing services between BM and OBP platform. This transition will take the form of multiple phases and will also require careful preparation of BM software for these activities.

During the BP2 period, a change capability will be retained in BM to ensure modifications can be made to BM without risking failure and/or system security.

The legacy BM platform will be kept running in parallel as new services are deployed into OBP. Once the new services have been proven, the legacy services will be kept running but ‘disconnected’ so any data they send are not received by an active system. After a period of running on OBP, the legacy services will be shut down and the platform retired, this is expected to commence early in RIIO-3.

We will manage asset health delivery using agile requirements discovery, capture and build where possible. Release management will be implemented in phases with sequential releases of capability to the control room.

Solution Options

The options for the future of the BM and EBS platforms were evaluated in the context of the work already undertaken in BP1, the continued evolution of the needs of our customers for new services and the constraints imposed by the current BM application landscape.

For the BP2 period, the plan submitted during the original submission has been revised. The optimum approach for ESO and our customers is to replace the functionality of the current BM and EBS platforms and the supporting hardware with a newly developed capability based on new hardware and modern, cloud-native technologies that enable ESO to respond far more quickly to market demands

This approach was decided from the following factors:

- [redacted]
- The development of bespoke services means that ESO will get the precise functionality they require; rather than a Commercially available off the shelf (COTS) product which may not deliver the functionality required to meet the unique needs of the UK market. COTS products are suitable for platforms that adhere to specific functions that are very similar globally, but the UK energy market has very specific needs that are not met by a generic, industry standard approach, so developing bespoke standards-based code using industry patterns is the optimum approach.
- The cost of continuing to develop and maintain the monolithic 'stack' of code was too great and was a significant limiting factor on our ability to develop new services quickly and at low risk.
- For EBS, we reviewed the technology changes and upgrades that would be required to adapt to future business and market requirements. We also assessed how these could be delivered economically against the operational value delivered to Control Room. Our conclusion was to enable decommissioning of EBS and deliver future requirements on the open balancing platform.

The **180** Enhance balancing capability investment has considered solution options for balancing systems replacement and as such this investment has not considered alternate solutions to the balancing legacy systems.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	8.5	3.7	5.0	0.0	0.0	17.1
	BP1	1.3	1.3	1.3	0.0	0.0	3.8
	Variance	**7.2**	**2.4**	**3.7**	**0.0**	**0.0**	**13.3**
Opex (£m)	BP2	0.8	1.5	0.3	4.9	2.9	10.4
	BP1	0.1	0.1	0.1	0.0	0.0	0.4
	Variance	**0.7**	**1.4**	**0.1**	**4.9**	**2.9**	**10.0**
Totex (£m)	BP2	9.3	5.2	5.2	4.9	2.9	27.5
	BP1	1.4	1.4	1.4	0.0	0.0	4.3
	Variance	**7.9**	**3.8**	**3.8**	**4.9**	**2.9**	**23.3**
Cumulative RTB increase (£m)	BP2	0.5	0.5	0.5	-1.4	-1.4	
	BP1	0.0	0.0	0.0	0.0	0.0	
	Variance	**0.5**	**0.5**	**0.5**	**-1.4**	**-1.4**	

Table 73 - Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
Evolved or Refined scope since BP1	Better understanding	Capex	Better understanding of the capability size	+ £13.3
Evolved or Refined scope since BP1	Better understanding	Opex	Better understanding of the capability size	+ £0.9m
Evolved or Refined scope since BP1	Functional support	RtB	Functional support for non-scheduling activities to move EBS to 24/7 support	+ £0.5m
Evolved or Refined scope since BP1	EBS support	RtB	EBS support not required from FY25	- £1.9m
Evolved or Refined scope since BP1	Better understanding	Opex	Better understanding of duration and not being able to capitalise on the FY25 and FY26 period due to decommissioning of BM	+ £7.7m
Evolved or Refined scope since BP1	Cannot capitalise cost	Opex	EBS migration plan development cannot be capitalised due to decommissioning planned by end of FY24	+ £1.4m
Costs change since BP1				+ £21.9m

Table 74 - Investment cost change summary

Contributors to Capex uplift:

- In 2019, we underestimated the amount Asset Health change required to BM and the size of the team required to reliably undertake that change.
- In the original submission there was an assumption made that EBS 4-hour ahead scheduler would be live before the start of BP1, but this was not the case. This work continued into FY22 which increased costs. We have now taken the decision to stop this work, meaning avoidance of additional EBS hardware and environment upgrade cost following the planned EBS decommission in BP2.
- The investment assumed that benefits of fixing defects, making upgrades to performance, reduction in manual processes could be deferred until new services were ready to switch-off BM. However, the need to retain BM for longer and maintain a viable capability for BM maintenance and security operations has increased our costs.

Contributors to Opex uplift:

- We expect to maintain a viable Asset Health change capability until decommissioning, the final two years of which cannot be capitalised.

Note: EBS costs assumed Opex from FY23, BM costs assumed Opex from FY25.

Risks

Risk	IT Tower	Mitigation	Likelihood	Impact
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
The migration of remaining unique EBS functionality cannot be completed by February 2024 due to business and/or technical dependencies	N/A	Assess each functional component on its criticality and consider operating without components where migration Is incomplete.	3	1
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Other initiatives such RDP, GEMS will consume the available delivery capacity of the BM team. This will result in a lower delivery of asset health changes but also reduce the cost of this investment	Program, Product and Project Management	Replan BM changes to either be part of OBP scope	4	2

Table 75 - Investment risk summary

3.11 220 Data and Analytics Platform

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
In Draft	Hybrid	On-Track: 24	Complete: 18	Delay: 5	Total Count: 47

Overview & Purpose

This investment delivers the capability for ESO to meet its Open Data commitments.

The Data and Analytics Platform (DAP) will:

- Provide the technology underpinning the management of all our data, making it discoverable and accessible to internal and external stakeholders.
- Focus on connecting people with data and investing in data skills for our teams
- Create a new architecture that allows new systems to be integrated seamlessly in a 'plug-and-play' or 'app-like' way. This allows our future system upgrades, to flex as needed and meet the challenges of facilitating the transition to net zero.
- Replace our data legacy systems and implement modern data services for ESO and external customer
- Provide analytical capability to deliver insights. This allows quicker, accurate operational decisions and give our customers value added information.
- Provide consistent services for our modelling and simulation capabilities.
- Act as a foundational component for our target platforms architecture.

Our ambitions, strategy and capability plan for data and analytics are described in **A19** Data and Analytics Operating Model, covering the provision of the capability for efficient and effective development, operation, and governance of the data products necessary to fulfil our mission.

This investment enables delivery of sub-activity **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 and **A17** Open data and transparency.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A19 Data and Analytics Operating Model • 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 • A17 Open data and transparency	• 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 76 - Summary of business outcomes and corresponding sub-activities

Current State

During BP1 we have delivered:

- Backlog of user stories, spanning strategic programmes and specific high-value initiatives
- Appointed a core Data and Analytics implementation partner
- Logical platform solution design, providing the starting point for the physical implementation
- Created and implemented design patterns on our Azure Cloud target platform and used for proof-of-concept demonstration
- Designs for the ingest of data from legacy data sources
- POCs executed to prove out data ingest and BI/reporting capabilities (National Economic Database (NED, Data Historian and Inertia Monitoring))
- Implementation of Microsoft Power BI Service as the strategic reporting and BI platform for ESO

By March 2023 we will have completed the following:

- Physical design and implementation for core platform services
- Implementation of an ESO Data Catalogue
- Design of Consistent Data Services solution for CNI workloads
- Finalisation of solution model for ESO Metering and Time Series data
- Expanded range of ESO data sets available on the platform
- Implementation of a TechOps model for data products
- Python and R analytics delivery to support Platform for Energy Forecasting (PEF) requirements
- Assessment for data services and solutions that may need to be deployed within the CNI landscape, dependent upon use case definitions and a detailed architecture and strategy review

Roadmap

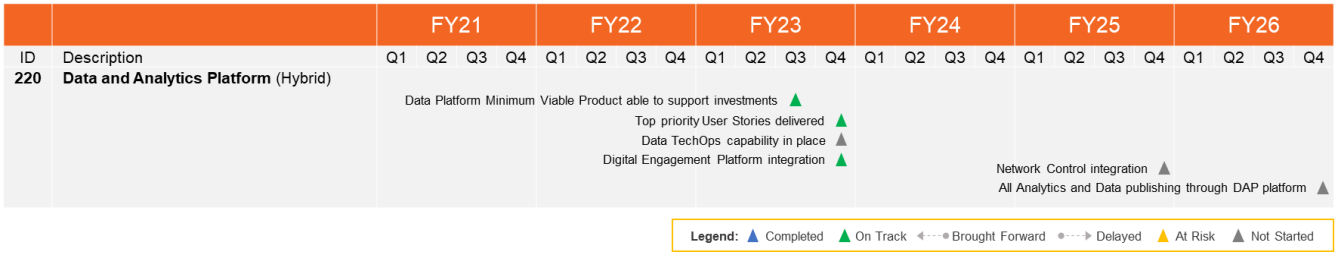


Figure 24 - Outcome roadmap

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 Continuous Integration/ Continuous Delivery 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 77 - Outcome summary descriptions

Future State

By the end of BP2, our data platform will be operational for:

- Replacement capabilities for our legacy data systems
- Consistent use of APIs across our platforms architecture
- Open Data publication in line with industry commitments

- Regulatory compliance reporting
- 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).

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.

Target platform	Target Subsystem	Component	Future State
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.
Data & Analytics	Analytics and Insight	Data Lake	DAP will provide several data lake partitions for its own usage and for analytics teams. DAP will provide external access to partitions to fulfil the ESO open data requirement.
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.
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.
Data & Analytics	Analytics and Insight	Predictive Analysis	DAP will provide analytics services for use in Predictive Analysis and forecasting.
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.
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.
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.

Data & Analytics	Consistent Data Services	Workflow Automation	DAP will automate the data analytics life cycle to bring Data TechOps practices to data consumers.
Data & Analytics	Regulatory Reporting	External Reporting	See Internal Reporting above. Reporting services will apply to external parties too, in multiple forms.
Data & Analytics	Regulatory Reporting	Information Provision	DAP will provide a range of data services to internal Regulatory Reporting processes and to regulators directly.

Table 78 - 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 of user-stories of relevance to data consumers. Future phases will deliver incremental build out of the platform via a use-case led approach. In this way, our deployment is aligned with business priorities and value creation.

We will leverage established design patterns for Azure using our implementation partner expertise and standardising around Microsoft recommended approaches.

Our strategy is to deploy Azure cloud-native technologies in the first instance, and review technology choices as and when required, subject to use-case requirements. If needed, DAP analytics will be deployed on premise to meet the highest CNI-levels of availability using a hybrid cloud approach.

The Data and Analytics Platform will utilise the ESO API Architecture to standardise and automate access to the RIIO-2 business service. We will extend the ESO API Architecture to participants as managed APIs, permitting controlled access to ESO data and analytics services in the most cost-efficient way that meets industry standards.

The operating model for data products will continue to evolve aligned to priorities for our teams and customers.

We will develop data products using agile requirements discovery, capture and build where possible. Release management will be implemented in phases with sequential releases of capability to data consumers. Infrastructure release for major Azure product services and associated capability will follow a sequential release process.

Solution Options

We have implemented the data platform on Microsoft Azure using native Azure services.

The choice of Azure was the subject of a National Grid selection process and is the National Grid Group standard for cloud platform deployment. Azure attracts high product roadmap investment, innovation, and available skill base, and is established within the UK energy sector.

There are still solution options to be considered for specific application software services within our overall DAP design. We will follow our usual Enterprise Architecture processes to select the correct solution. For example, we are currently running a selection process for a data catalogue tool. 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.

We considered but discounted the option to go outside of the National Grid Group cloud standard as this would have required a standalone ESO procurement that was not appropriate considering our National Grid infrastructure services model.

We considered on-premise hosting and the integration of a virtualisation and/or "Cloud on premise" style implementation but discounted this due to the overheads of managing additional hosting and application infrastructure service alongside the National Grid Group infrastructure strategy.

We considered the option of implementing a "data hosting" SaaS-style service and integrating with our Azure capability. This was discounted due to not offering benefits beyond the native Azure offerings.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	4.2	4.9	8.3	4.7	3.8	26.0
	BP1	3.1	5.8	5.8	3.1	2.2	20.0
	Variance	**1.1**	**-1.0**	**2.5**	**1.6**	**1.7**	**6.0**
Opex (£m)	BP2	0.2	1.2	1.3	0.7	0.5	3.9
	BP1	0.8	1.5	1.5	0.8	0.5	5.0
	Variance	**-0.6**	**-0.2**	**-0.1**	**-0.1**	**0.0**	**-1.0**
Totex (£m)	BP2	4.4	6.1	9.7	5.4	4.3	29.9
	BP1	3.8	7.3	7.3	3.8	2.7	25.0
	Variance	**0.5**	**-1.2**	**2.4**	**1.6**	**1.7**	**5.0**
Cumulative RTB increase (£m)	BP2	0.0	0.1	0.5	0.5	0.5	
	BP1	0.0	0.1	0.3	0.5	0.6	
	Variance	**0.0**	**0.0**	**0.2**	**0.1**	**0.0**	

Table 79 - Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
Systems or assets requiring unexpected spend	Change in scope	Capex	Included Grey IT cost	+ £6m
Efficiencies	Resource Roll-off	Opex	The reduction is due to rolling-off of project implementation resource	- 1m
Costs change since BP1				+ £5m

Table 80 - Investment cost change summary

The cost forecast since the original submission has increased. £6M additional spend in BP2 includes:

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 potential 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 decision-making process. Until full analysis of the options is carried out, anticipated costs for Grey IT Remediation have been added to this forecast but will be re-allocated to other specific investments during BP2.

The Opex cost has reduced due to rolling off project implementation resource as once the foundational platform is live the underlying platform is managed by operational teams.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Design	DAP external services development will be informed by market demand captured by market engagement.	Application Development	Schedule and budgetary	Quarterly
Design	DAP external consumers are entities engaged in the GB wholesale power market only.	N/A	Scope of the investment	Quarterly
Design	DAP will not be the only NGESO analytics and data management platform: Extant platforms will continue as needed, new specialist platforms will be commissioned as needed, and both will be expanded and enhanced if they offer economic or performance advantages.	N/A	Scope of the investment	Quarterly
Design	DAP will use externally provided SaaS where they offer economic or performance advantages.	Business Software	Scope of the investment	Quarterly
Design	For external users of DAP, DEP will provide the presentation and security services, while DAP provides the data services.	N/A	Scope of the investment	Quarterly
Design	DAP is not a primary source of data – DAP will receive data from the likes of operational systems.	N/A	Scope of the investment	Quarterly

Table 81 - Investment assumption 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	Application Support & Operations	Publish and maintain API and Data catalogues.	3	2

processing by our external and internal stakeholders.				
Incomplete, late, inaccurate, and inconsistent data impacts the quality of analysis and business information.	Business Software	Validate and report on data systems content before ingestion into DAP	3	2

Table 82 - Investment risk summary

3.12 240 ENCC Asset Health

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
Confirmed	Hybrid	On-Track: 0	Complete: 0	Delay: 1	Total Count: 1

Overview & Purpose

This investment delivers operational systems stability to the Electricity National Control Room (ENCC).

To operate the grid system, to handle unforeseen events and to ensure we continue to operate the system safely, economically, and efficiently, we need to invest in maintaining our stand-alone non-CNI specific tools and communication links. It is necessary to maintain the reliability and usability of these tools, 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 and independently from the arrival of our new technology platforms.

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 unsupported.

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.

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 83 - Summary of business outcomes and corresponding sub-activities

Current State

By March 2023 we will have completed 20 projects under the ENCC Asset Health investment line. These projects delivered the following:

- 18 cases of remedial actions to address issues with business supported applications and bespoke systems
- 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 needs 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 plan and prepare tools to meet external demands, such as increased numbers of market participants or new performance reporting requirements. Ongoing general software and hardware patching maintenance will be delivered reducing security and technical debt risk.

BP1 has proved that flexibility in delivery is important to maintaining and upgrading our ENCC systems. Through this investment and our strong understanding ENCC Asset Health needs we can manage planned and priority requirements arising during BP2.
Further information on the current state can be found in the Role 1 narrative for sub - activity A1.1.

Roadmap

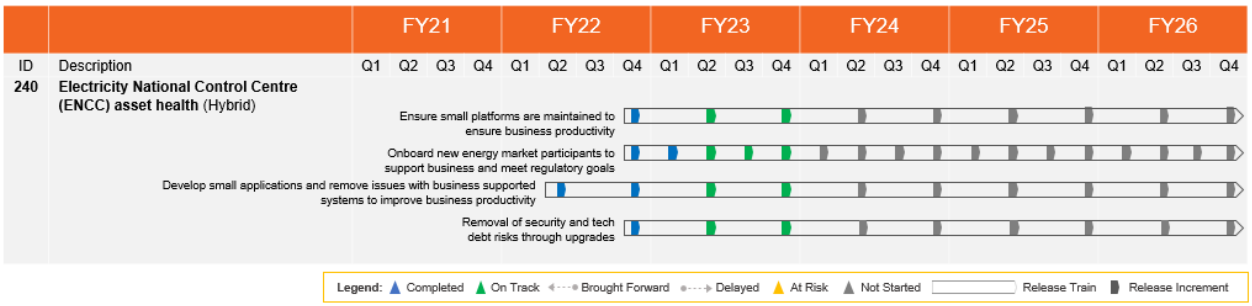


Figure 25 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Ensure ENCC platforms are maintained to ensure business productivity	Business Units	Operational impacts from maintenance or end of life are minimised for systems outside of transformation 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 technically connect to participate in our markets
Manage small applications and remove issues with business supported systems to improve business productivity	Business Units	Small business-built tools and information management sources can be correctly maintained ahead of ESO target architecture platforms implementation.
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 84 - Outcome summary descriptions

Future State

This investment ensures the ENCC technology estate is maintained to the required standard. We will integrate to the target platform architecture benefitting from cross-cutting platforms like DAP and DEP where appropriate. This investment will ensure the reliability, usability, and cyber security of these tools and network capabilities.

Target platform	Target Subsystem	Component	Future State
Network Operations & Control	Control Communication	Data Exchange	NCMS and DAP operational. Data exchange implemented and managed by DAP or services provided by DAP,

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.
Network Operations & Control	Control Room Planning	Workforce Management	Additional Network Control tools consolidated into seamless reliable IT managed system.
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.
Network Operations & Control	Situational Awareness	Power System Simulation	System simulation capabilities extended to additional Network Control tools.
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.
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.
Data & Analytics	Modelling	Power Systems Modelling	As above. Additional Network Control tools will use data and data services provided by DAP.

Table 85 - 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

Our approach requires a blend of sequential activities and more flexible agile releases.

For ongoing systems maintenance and asset health activities we follow a structured process for development, testing and release. Business and value case approval for systems health change is managed through control room stakeholder engagement and ESO Technology sponsorship.

For our agile releases we manage a backlog of known maintenance and improvement activities. A ‘Rapid Development Team’ - a scalable team of external partners has been established to progress these activities.

We will focus on modernising and rationalising our tools to our target platform-based architecture, where this is possible. Some tools and services will be maintained in existing forms until their eventual replacement and/or decommissioning.

Solution Options

This investment provides asset health and maintenance of ENCC operational tools and is not a new solution.

We will operate our existing hardware, software, networking, and facilities capabilities to deliver ENCC solutions maintenance. This includes the use of commercial contracts to ensure appropriate support levels are maintained on legacy tools. Our approach addresses the needs of the ENCC where they are unique to ESO, whilst allowing us to leverage our in-house and partner services to meet our security and resilience requirements.

We considered procurement of specialist energy control room single or combined software-suite packages to attempt wider-scale coverage of our interim ENCC requirements. This was discounted due to lack of suitable market options available and likely requiring extensive customisation with much higher costs.

We considered leaving our legacy ENCC tools in current state but discounted due to this not meeting our operational or security requirements.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	3.7	1.5	2.0	2.0	2.0	11.3
	BP1	2.0	2.0	2.0	2.0	2.0	10.2
	Variance	**1.7**	**-0.5**	**0.0**	**0.0**	**0.0**	**1.1**
Opex (£m)	BP2	0.0	0.2	0.9	0.9	0.9	2.9
	BP1	0.9	0.9	0.9	0.9	0.9	4.4
	Variance	**-0.9**	**-0.7**	**0.0**	**0.0**	**0.0**	**-1.5**
Totex (£m)	BP2	3.7	1.7	2.9	2.9	2.9	14.2
	BP1	2.9	2.9	2.9	2.9	2.9	14.6
	Variance	**0.8**	**-1.2**	**0.0**	**0.0**	**0.0**	**-0.4**
Cumulative RTB increase (£m)	BP2	0.1	0.6	0.6	0.6	0.6	
	BP1	0.0	0.0	0.0	0.1	0.1	
	Variance	**0.1**	**0.5**	**0.5**	**0.5**	**0.5**	

Table 86 - Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
N/A	Cost Shift	Capex	Transfer of Opex to Capex	+ £1.1m
N/A	Cost Shift	Opex	Opex to Capex spend transfer	- £1.1m
Efficiencies	Change in Scope	Opex	Reduction of Opex spend in FY21/ 22 covering additional upgrade /replacement costs	- £0.4m
Evolved or refined scope since BP1	Better understanding	RtB	Increased maintenance costs	+ £0.5m
		Costs change since BP1		+ £0.1m

Table 87 – Investment cost change summary

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 business applications into support leading to RtB increase in FY22-23.

The initial split between Capex and Opex were incorrect for the first two years of RIIO-2, hence there was higher BP1 Capex spend and lower BP1 Opex spend. Also, there was further Opex reduction due to reduction of scope of work initially forecasted.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Design	The budget is structured with correct funding mix (Capex and Opex) to enable a consistent delivery against the backlog	Application Development	Spend may be out of sync with forecasted cost	Quarterly
Design Operate	Demand for ENCC Asset Health remains broadly the same as BP1 and that the pipeline of work is consistent in terms of size and complexity	N/A	Schedule and budgetary impacts	Yearly

Table 88 - Investment assumption summary

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	Detailed analysis of requirements and control room priority. Maintenance updates to systems being replaced will be closely monitored to avoid regret spend.	1	1

Table 89 - Investment risk summary

3.13 250 Digital Engagement Platform

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
In Draft	Agile	On-Track: 2	Complete: 1	Delay: 0	Total Count: 3

Overview & Purpose

This investment delivers engagement platform technology services to connect ESO with our customers.

Our Digital Engagement Platform (DEP) sits at the heart of our vision for digital capability and supports investments across all roles, providing a common engagement experience for all stakeholders:

Providing a single point of access into ESO systems and external facing processes

Secure access and visualisation of open and subscribed content and data, compliant with data classification policies and standards.

Replaces the current nationalgrideso.com website and provides management capability for all internet channels of engagement.

DEP will enable external customers and stakeholders to access ESO data and services in a simple, intuitive, predictable, personalised, and seamless manner, offering a frictionless user experience and 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.

This Role 1 investment contributes to enabling activity **A17 Open data and transparency**.

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 90 - Summary of business outcomes and corresponding sub-activities

Current State

During BP1 we completed a discovery and strategy definition phase with extensive user and customer engagement. This work has established our vision for DEP to provide:

- A single point of access through a Digital Experience Platform (DXP) for all ESO data and services
- Transformation of user experience across all customer interaction points

We have mapped our user journeys and requirements, refined delivery scope and identified technical capabilities required for our BP1 and BP2 commitments.

The team has delivered multiple procurement events to select the most suitable products and vendors to deliver on the ESO vision.

By July 2022 we had selected several enabling vendors, and the delivery teams mobilised on the foundational releases for the DEP capability.

In Q4 FY23 we will implement a major release including:

- The Customer Access and Identity Management (CIAM) solution to manage customer identities in a consistent and secure manner, and will ultimately provide a single sign-on experience across all constituent ESO platforms and services accessed via DEP.
- The ESO Design System, a common framework enabling a consistent user experience across our customer facing portals and websites, aligned to the NGESO brand and style guidelines. Design System will also be used to ensure consistent development of user interfaces across all customer-facing applications.

- The Digital Experience Platform (DXP) that will provide the core elements of the content management suite and key user-experience features improving user navigation and personalisation, such as advanced search, communications preference management and personalised user dashboards.
- The new ESO web capability and its Contents Management System, developed on a dedicated ESO platform to provide web/social channels of engagement.
- 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

Timelines for integration with downstream systems such as Data and Analytics Platform and Single Market Platform are dependent on progress of those programmes.

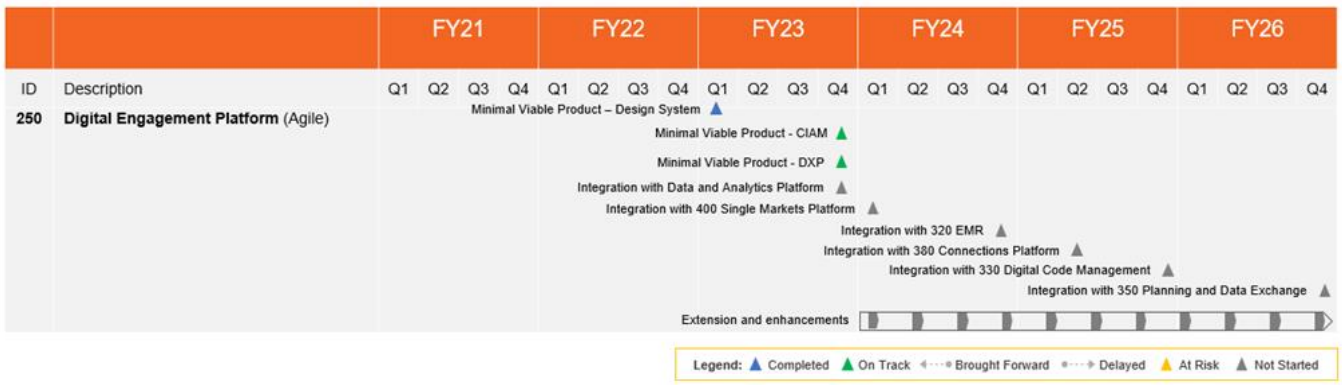


Figure 26 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Minimum Viable Product: Design System	Customers & Partners Business units	ESO customers will benefit from a consistent user experience across our customer facing portals and websites, aligned to the NGESO brand and style guidelines. Business units will benefit from a common framework for consistent development of user interfaces across all customer-facing applications.
Minimum Viable Product: Customer Identify Access Management	Customers & Partners Business units	ESO customers and stakeholders will benefit from single sign on capability, which will be gradually rolled out to wider ESO digital state applied to further user journeys including Single Markets Platform and Connections Portal.
Minimum Viable Product: DXP	Customers & Partners Business units	Customers 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. The MVP will also deliver the

		integration of several features to join up the experience across one user journey.
Integration with Data and Analytics Platform	Customers & Partners Business units	DEP will seamlessly join up insight, data, and operational processes to facilitate greater market engagement, participation, and decarbonisation.
Integration with other strategic platforms	Customers & Partners Business units	In line with the vision of providing secure access and visualisation of open and subscribed content and data, users will be able to access content to integrated platforms via DEP.
Extensions, enhancements, integration with other platforms (SMP and Connections Portal)	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. 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 91 - Outcome summary descriptions

Future State

By the end of BP2, the platform will be enriched with additional functionalities and a more personalised access to data and insights, alerts, and notifications as well as customisable dashboards made available to offer most users providing a personalised experience.

Throughout BP2 we will combine advanced digital engagement capabilities to support further customer journeys transforming the user experience across a wide range of ESO services.

We will further evolve the DEP capabilities with a phased deployment of enhancements, including:

- Guided navigation for our customers
- Increased personalisation for customer and portal features
- Integrated query management to improve access to ESO data insights
- Co-ordinated interactive ESO calendar, and newsletters
- Alerts and notifications for key developments via our digital channels
- Account dashboard integrated with other ESO systems such as the Single Markets Platform and Connections Portal

Over the course of BP2 and beyond we will have refined and improved user experience by further integrating DXP with ESO's customer-facing subsystems and portals including **400** Single Markets Platform, **380** Connections Platform and **220** Data and Analytics Platform.

Other customer facing platforms we expect integration activities to start in BP2 include **320** EMR and CfD Improvements, **330** Digitalised Code Management. **350** Planning and Outage Data Exchange.

These customer facing platforms and services will be further use cases for adoption and alignment to our Design System and identity management using the CIAM service, to provide a consistent single sign-on user experience.

We also foresee much greater provision of open data, harvested from multiple subsystems, and shared via the DXP data portal. As such, we will further enhance our integration between DEP with DAP to facilitate the

provision of further data sets. This will underpin improvements in the publishing of analytical reports and the visualisation of our data sets in interactive 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.

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

Table 92 - Future state subsystem component summaries

Approach

Our overall approach in BP2 is to refine and enhance the platform via incremental and regular releases. We will enrich the functionalities and integration of the platform with subsystems and platforms such as SMP or DAP and other communication channels. This will provide improved personalisation and seamless navigation and deliver regular, incremental but tangible digital experience improvements to the end users.

A backlog of enhancements will be prioritised and managed, and releases will be deployed to deliver tangible benefits to the end user, on a regular cadence to be agreed with business stakeholders.

As we anticipate a regular pipeline of enhancements to the platform, an enduring 'product core team' has been set-up at the end of BP1, to manage this backlog of requirements and oversee the developments and enhancements to the platform, working alongside the delivery vendors chosen in BP1. The team will also provide support and oversight to projects developing customer-facing platforms, to facilitate the adoption of Design System and CIAM.

We are following an agile delivery methodology to achieve initial platform capability and deliver subsequent functional release.

Solution Options

To enable secure and consistent access to our core platform we have selected a Customer Identity and Access Management (CIAM) solution to provide customers with Secure Single Sign-On to all ESO externally facing systems. An external partner was selected via a procurement process as its service best aligned with ESO requirements to:

- Provide access to our digital services in a secure and frictionless manner
- Manage identity and authentication

- Provide customer journey authorisation and personalisation

For the DxP element, Acquia was chosen as the platform of choice following a competitive procurement process as it:

- Enables ESO to build out the capabilities required to enhance user experience, personalisation and enable greater engagement with users of our digital platforms
- Allows ESO to migrate off the current platform without significant re-work, as the underlying content management system is the same as the current platform
- Provides capabilities to enhance and extend the platform to support future integration with subsystems using standard connectors as well as our CIAM platform for managing user identities using standard design patterns
- Enables us to rapidly develop and deploy new changes to the platform due to use of SaaS i.e., no hosting element to our change projects (Acquia manage the auto-scale of hosting)
- Supports our plan to deliver foundational capabilities by Q4 FY23

The current nationalgrideso.com website is the main access point for external users to the 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.

We initiated procurement activities to replace the current service with a new website hosted on an NGESO owned and managed Digital Engagement Platform (DEP), with four options considered:

- Build DEP capabilities on existing National Grid shared corporate platform
- Replicate 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 is best aligned with the ESO strategic goals of delivering its own digital platform capability.

We explored but discounted the option to build our own new bespoke platform due to the selection of market SaaS offerings available with relatively high maturity and choice available to us via procurement.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	0.8	4.5	1.8	1.4	1.3	9.7
	BP1	1.3	1.3	1.1	0.6	0.0	4.2
	Variance	**-0.5**	**3.2**	**0.7**	**0.8**	**1.3**	**5.5**
Opex (£m)	BP2	0.3	0.2	0.4	0.4	0.4	1.7
	BP1	0.8	0.8	0.7	0.4	0.0	2.8
	Variance	**-0.5**	**-0.6**	**-0.3**	**0.0**	**0.4**	**-1.1**
Totex (£m)	BP2	1.1	4.7	2.1	1.8	1.7	11.4
	BP1	2.1	2.1	1.8	1.1	0.0	7.0
	Variance	**-1.0**	**2.6**	**0.4**	**0.7**	**1.7**	**4.4**

Cumulative RTB increase (£m)	BP2	0.0	0.2	0.5	0.5	0.5
	BP1	0.0	0.1	0.2	0.3	0.3
	Variance	**0.0**	**0.1**	**0.3**	**0.2**	**0.1**

Table 93 – Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
Evolved or refined scope since BP1	FY25/6 enhancements	Capex	User Research and the discovery exercise clarified the user-experience enhancing functionalities to develop. This created a backlog for the later RIIO-2 years which has been accounted for in the updated forecast.	+ £2.1m
Evolved or refined scope since BP1	Design System, DxP and CIAM	Capex	Variance in the forecast cost of DXP and CIAM and the development of the Design System	+ £3.4m
Evolved or refined scope since BP1	Discovery	Opex	Variance due to reallocation from Opex - Capex as the programme moves into the development phase.	- £1.1m
			Costs change since BP1	+ £4.4m

Table 94 - Investment cost change summary

The current DEP forecast shows an increase in funding of £4.4m over the 5-year RIIO-2 period. This is largely attributed to a much better understanding of the components required to deliver the foundational elements as well as the roadmap of future enhancements for the digital platform.

The 2019 plan did anticipate some of the components required such as a web development framework (DXP) and single sign on capabilities, however, costs submitted were estimates based on the high-level knowledge of those components at the time.

Our original plan underestimated the costs for the purchase and implementation of the ESO DXP platform as we had originally assumed re-use of an existing National Grid Group (corporate) web experience and content management capability. This clarification of solution strategy and additional work / purchase of DXP makes up a large part of DEP delivery effort in BP1.

Development of the CIAM capability – A single sign on service was envisaged in the original plan however the component's complexity, costs and implementation timelines became much clearer after the RFP process and have resulted in a BP2 increase.

Development of a Design System to support future developments in providing a consistent user experience (delivered May 2022)

Development of personalisation features e.g., communications preferences, subscriptions, user dashboards, integrated query management.

In addition, while the original plan accounted for a small level of development in FY25, it had no provision for further enhancements made for the following year in FY26. User Research and the discovery exercise revealed the need to deliver a wider range of enhancements. This created a backlog for the later RIIO-2 years which has been accounted for in the updated forecast.

Through competitive procurement our vendor product costs, and implementation timelines are now reflected in this submission.

Phasing of spend has also changed, reflecting the desire to implement a much more substantial production release by March 2023 delivering value sooner to the ESO business and customers.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Design	We assume that every customer facing platform built over the BP2 period will adopt the common CIAM for unified customer authentication and fund its adoption.	Business Software	If this assumption is false, there could be delays in delivering a unified end user system sign on experience, with further funding required to deliver the capability.	Quarterly
Design	We assume every system will utilise the query management capability being built by DEP.	Application Development	If this assumption is false, there could be delays in delivering a unified end user system sign on experience, with further funding required to deliver the capability.	Quarterly

Table 95 - Investment assumption summary

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
Constituent customer-facing platforms haven't planned nor budgeted for their adoption of Design System, CIAM and Query Management functionality, leading delays in the roll out of these capabilities and subsequent customer experience improvements as well as additional spend	Application Development	Ensure adoption of those capabilities are mandated centrally for consistent and timely roll-out Digital Engagement Design Authority has been put in place to ensure the consistent adoption of digital capabilities	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.	3	1

Table 96 - Investment risk summary

3.14 260 Forecasting Enhancements

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
Confirmed	Hybrid	On-Track: N/A	Complete: N/A	Delay: N/A	Total Count: N/A

Overview & Purpose

This investment delivers improvements to our Energy Forecasting capability to enable net zero grid operations.

We will continually enhance our national demand, wind and solar forecasting products providing improved accuracy, frequency, granularity, and transparency to market participants. This investment has delivered improvements in forecasting accuracy during BP1 and will continually target further improvements for the remainder of the RIIO-2 period.

Our RIIO-2 ambition is to exploit our industry-leading forecasts to enable the highest possible accuracy leading to cost effective operational decisions. We will regularly release new forecasting products and deliver the associated data to our systems and data consumers. Our forecast models will be optimised to meet the needs of future balancing products and services. This supports the business ambition to improve demand forecasts and facilitate the achievement of Role 1 performance metrics (1b) & (1c).

Our forecasting platform technologies and services enable and complement the investment we are making in people and processes for our data science practice.

The current platform was not designed to provide the level of accuracy or speed required by our Control Room or our customers. We will address this by replacing our existing solution with technology that allows our models to meet net zero requirements. We will incrementally move our forecasting capability to a new cloud hosted platform and ultimately decommission the legacy solution.

This investment enables sub-activity **A1.1 Ongoing Activities**

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A1.1 Ongoing activities	• Production of timely, frequent, granular & accurate possible demand & generation forecasts & data

Table 97 - Summary of business outcomes and corresponding sub-activities

Current State

During BP1 we have implemented new enhanced forecasting capabilities and products including Grid Supply Point, Solar Power, and National Demand forecasts. We have achieved more accurate, frequent, and granular forecasts being supplied to downstream systems and Electricity National Control users, with improved user experience capability. These forecasts are being used to supplement the data provided by the legacy Energy Forecasting (EFS) system until such time this legacy system can be removed.

By March 2023, we will have commenced transition of the Platform for Energy Forecast (PEF) onto our strategic Azure cloud platform, enabling future integration with downstream applications through common design patterns and data standards aligned to the Data and Analytics Platform investment. This enables further exploitation of forecasting models developed to date and provides a platform for the development of new forecast models on a fully supported infrastructure. We have completed a strategic review of the architecture roadmap to consolidate our cloud platform services and overcomes a constraint of availability of the required computing services within the current solution.

For other forecasting techniques, including blending/now-casting multiple forecasting models, we will have introduced business intelligence tools to improve decision making and visibility of forecasting performance. Out of the four core forecasting sub-products, (1) National Demand, (2) Grid Supply Point (GSP), (3) Solar Power, and (4) Wind Power, the development and implementation of Grid Supply Point (GSP) into the new platform will also be delivered by March 2023 and the 3 remaining products will be delivered in BP2 period in-line with our milestones stated in the roadmap.

Roadmap

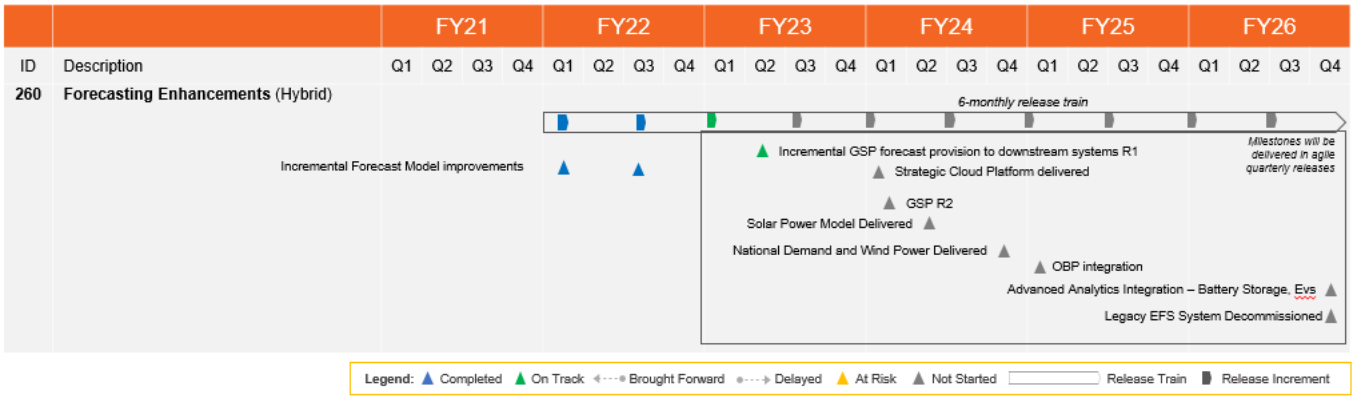


Figure 27 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Incremental forecast model improvements	Business Units, Customers & Partners	Continued improved accuracy of demand forecasts
GSP forecast provision to downstream systems R1		Phase 1 of enabling provision of GSP (Grid Supply Point) forecasts in offline transmission analysis & network studies forecast to downstream systems through the current platform until the strategic platform is delivered
Strategic cloud platform delivered	Business Units	Fully supported platform to enable PEF products to present data to connected systems and leverage the full benefits of the improved forecast models
GSP R2	Business Units, Customers & Partners	Phase 2 of enabling provision of GSP (Grid Supply Point) forecasts in offline transmission analysis & network studies to downstream systems via the strategic platform
National Demand and Wind power generation	Business Units, Customers & Partners	Improved accuracy of National Demand & Wind forecasts
Solar Power	Business Units, Customers & Partners	Improved accuracy of solar power generation forecasts
OBP integration	Business Units, Customers & Partners	Integration with the Open Balancing Platform, enabling the consumption of PEF forecasts
Advanced Analytics Integration – battery storages, EVs	Business Units, Customers & Partners	Continued improved accuracy of demand forecasts
Legacy EFS system decommissioned	Business Units	Removal of legacy forecasting solution, reducing technical debt and Run the Business (RTB) costs

Table 98 - Outcome summary descriptions

Future State

By June 2023, we will have created our PEF solution design and implemented on the strategic Azure Platform as non-production.

By the end of BP2, we will have completed:

- Migration of our legacy forecasting services onto the Azure architecture
- Implementation of enhanced GSP, National Demand, Wind and Solar forecasting models
- Established continuous improvement capability for forecasting models on the Azure architecture
- Conversion of energy forecasting communications capability into our target DAP solution
- Implementation of analytics capability from the DAP solution to support energy forecasting services
- Integration of PEF forecast data with downstream systems including the strategic Open Balancing Platform
- Integration of PEF forecast data with Offline Network Modelling tools
- Additional work beyond BP2 is required to complete our forecasting solution transformation and decommissioning of the legacy system.

Target platform	Target Subsystem	Component	Future State
Data & Analytics	Forecasting	Energy Forecasting	Energy forecasting migrated to DAP. Legacy business logic running on Azure. CNI Demand predictor successor operational
Data & Analytics	Forecasting	Communication	Energy forecasting communicating using DAP
Data & Analytics	Forecasting	Innovation	Energy forecasting extending to new analytics styles using DAP

Table 99 - Future state subsystem component summaries

Approach

A combination of agile product development workstreams and structured, sequential releases for infrastructure capability is required to achieve delivery of the PEF solution. We are combining solution components from multiple infrastructure services whilst bringing new functionality online for the control room and external customers.

We continue to evolve our agile delivery methodology and will focus our agile product teams on the enhancement of our forecasting models. These models will require continuous rework to keep pace with changing requirements and energy balancing priorities. Our backlog of delivery activities will be managed in line with operational and regulatory requirements.

We will implement tactical integration enhancements to our legacy system to meet these requirements, for example where legacy downstream systems require new forecast model data to deliver control room benefit.

Our target solution will also leverage DAP common capabilities, for example data ingress and API management, extending to DataOps and Machine Learning in line with our forecast model requirements.

Solution Options

We conducted a feasibility options analysis during RIIO-1 and refreshed this during RIIO-2 BP1 to understand the best fit for our forecasting solution. During this we assessed:

Rewrite of our existing forecasting application into more modern programming language technologies – discounted due to lack of fit with our requirements and no support for enhanced model complexity/frequency within the existing software code.

Procurement of packaged third party software – discounted due to lack of available products that met our requirements and high risk of customisation leading to increased dependency on an external provider for frequent product development and change.

Bespoke ESO forecasting models and platform services with direct integration into our ESO strategic technology platform services – this was our recommended option.

We determined that creation of bespoke energy forecasting models with forecasting services designed by us and leveraging our Data platform capability offered the best fit to our strategic requirements. Building our own models means that we retain the intellectual property in house and maximise our flexibility to adapt to GB specific conditions.

The forecasting solution will run models using Python and R Code languages, which are recognised languages for data science and mathematical modelling. DAP will provide capabilities around hosting, compute, data management, APIs, DataOps, and PowerBI reporting, and more advanced capabilities such as machine learning runtime components. These capabilities are core to the DAP platform through the use of Azure native services.

We considered but discounted the option of continuing to extend our legacy forecasting architecture due to not meeting our requirements for net zero grid operations.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	3.0	3.1	3.1	2.7	1.0	13.0
	BP1	0.0	0.3	0.0	0.3	1.4	2.0
	Variance	**3.0**	**2.8**	**3.1**	**2.4**	**-0.4**	**11.0**
Opex (£m)	BP2	0.0	0.0	0.1	0.2	0.1	0.4
	BP1	0.0	0.2	0.0	0.2	0.9	1.3
	Variance	**0.0**	**-0.2**	**0.1**	**0.0**	**-0.8**	**-0.9**
Totex (£m)	BP2	3.0	3.1	3.2	2.9	1.1	13.4
	BP1	0.0	0.5	0.0	0.5	2.3	3.3
	Variance	**3.0**	**2.6**	**3.2**	**2.4**	**-1.2**	**10.1**
Cumulative RTB increase (£m)	BP2	0.1	0.4	1.5	1.9	2.3	
	BP1	0.1	0.1	0.1	0.1	0.1	
	Variance	**0.0**	**0.3**	**1.4**	**1.8**	**2.2**	

Table 100 – Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)

Evolved or refined scope since BP1	Additional Model Complexity	Capex	Data Science and technical resources to forecasting models and promote models to PEF platform	+ £3.0m
Evolved or refined scope since BP1	Ongoing Delivery Capability	Capex	Data Science and technical resources to continue to develop new models, enhance existing and promote to PEF platform, whilst enabling integration to downstream applications	+ £6.5m
Evolved or refined scope since BP1	Move to Strategic Platform	Capex	Migration to Azure platform to enable integration with strategic platforms	+ £1.5m
Evolved or refined scope since BP1	Discovery Work	Opex	Reduction in allocated budget to discovery as completed in RIIO-1, Real Time predictions discovery removed from the scope of this investment. Additional provision for legacy system (EFS) asset health	- £0.9m
Evolved or refined scope since BP1	RTB	Opex	Requirement to maintain legacy EFS alongside new cloud service for longer whilst awaiting readiness of OBP for migration of PEF interfaces (avoiding investment in re-pointing interfaces to legacy BM)	+ £5.7m
			Costs change since BP1	+ £15.8m

Table 101 - Investment cost change summary

At the time of the original submission, the expectation was that the first iteration forecasting products would be largely complete and minor incremental changes would be applied during the RIIO-2 period. However, during RIIO-1, only 2 out of the 4 first iteration forecasting products (National Demand & Solar Power) were delivered. Delivery of the Grid Supply Point (GSP) & Wind power product moved into the RIIO-2 BP1 period. The reasons contributing to the increased forecast over the BP2 period are as follows:

RIIO-1 delivery delays:

- The remaining products proved significantly more complex than originally envisaged, with Photovoltaic (PV) and Wind along with GSP net demand needing to be factored into the model to ensure an as accurate as possible forecast is produced. Along with additional data science, development, and testing resource to deliver this, larger IT infrastructure resources were also required to run the models. This also required additional time to finalise their delivery, moving into RIIO-2.
- As the delivery of PEF moved into RIIO-2, integration with strategic systems is now required during this period to enable the PEF forecast data to supply new strategic initiatives Open Balancing Platform (OBP) & Data Analytics Platform (DAP) along with our current offline modelling tools, aligning with our target architecture.

New Scope for the BP2 period:

- The PEF delivery plan has evolved to adopt our new product approach and new technologies moving from intermittent Forecasting Enhancements to a continuous improvement model. With the ever-changing generation and demand landscape, to maintain consumer benefits delivered under PEF, we are continuously required to update our forecasting products/models with new & frequent data, embedding new technology (scalability & flexibility) and modelling approaches (machine learning).

- Requirement's complexity has increased for complete integration of newly developed forecasting products and services into energy forecasting processes, transmission analysis studies and balancing tools.

During BP2 period, we will maintain the increased size of delivery team capability to implement the forecasting products backlog whilst also moving PEF to the new cloud platform, with integration to our strategic platforms being the focus for FY25.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Design	PEF will not develop any enduring interfaces with legacy applications (such as BM) to avoid technical debt and additional costs.	Application Design	Schedule and budgetary impacts, interim approach to supply PEF data to legacy applications through this investment to ensure benefits can be maximised until strategic connectivity can be established	Quarterly
Deliver	Use Existing iEMS feed to supply PEF until the strategic Network Control Management System (NCMS) is ready to provision either directly or via Data and Analytics Platform (DAP)	Application Support & Operations	Schedule and budgetary impacts, existing interface will continue to provide the data until such time the strategic replacement is in place	Quarterly

Table 102 - Investment assumption summary

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
Evolution of energy technologies and consumer patterns are greater than expected leading to further forecasting models complexity to keep accuracy levels as per ambition	IT Management & Strategic Planning	Monitor forecasting needs closely as the industry evolves, adjust and implement models as required and maintain a core team who can develop and release new products on demand.	2	1
Dependencies and scope of connected systems continue to evolve leading to potential delay or increased cost	Application Development	Continue to work closely with other product teams to manage integrated plans and prioritise backlogs as appropriate.	3	1
The cost of cloud services could be higher than anticipated for delivery and support due to increased complexity and scope change, leading to an increase in delivery and RTB costs	Program, Product & Project Management	Continuously assess the value for money against service costs Work with product vendors to optimise cloud services efficiencies	3	1

		De-commission legacy services at the earliest opportunity to reduce RTB Integrate common DAP services to reduce delivery and maintenance overheads

Table 103 - Investment risk summary

3.15 450 Future Innovation Productionisation

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
In Draft	Hybrid	On-Track: 1	Complete: 0	Delay: 1	Total Count: 2

Overview & Purpose

This investment delivers capability to take successful innovation schemes into operational ESO Technology service.

It supports future digital ESO innovation projects that have been recognised has having a wider benefit to the business and/or industry. Those that require formal IT "productionisation" will fit within this investment to ensure alignment with our technology strategy, commercial terms, support requirements and security standards.

This investment allows ESO Technology to:

- Engage with innovation projects to understand the transition between innovation and operational status
- 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

A number of projects identified for productionisation are aligned to RIIO-2 investments and are included elsewhere in the BP2 submission:

- EFCC Monitoring and Control System (MCS) demonstrator covered under investment **500** Enhanced Frequency Control
- Optimal Outage Planning System covered under **360** Offline Network Modelling
- Future of Reactive Power under investment **400** Single Markets Platform

En-Twin-e (Digital Twin) is enabled through various investments:

- **110** Network Control
- **190** Workforce and Change Management Tools
- **220** Data and Analytics Platform
- **460** Restoration

Some innovation projects identified in BP1 did not meet the success criteria for further development or are still under evaluation. The list of innovation projects detailed below is continually being evaluated to better understand timelines and scope should productionisation be required. There is also the potential for new innovation projects to be added to the list throughout RIIO-2, such an example might be some machine learning work that could enhance outputs from **140** ENCC Operator Console.

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. The projects shown are a subset of the full innovation portfolio detailed in Table 76.

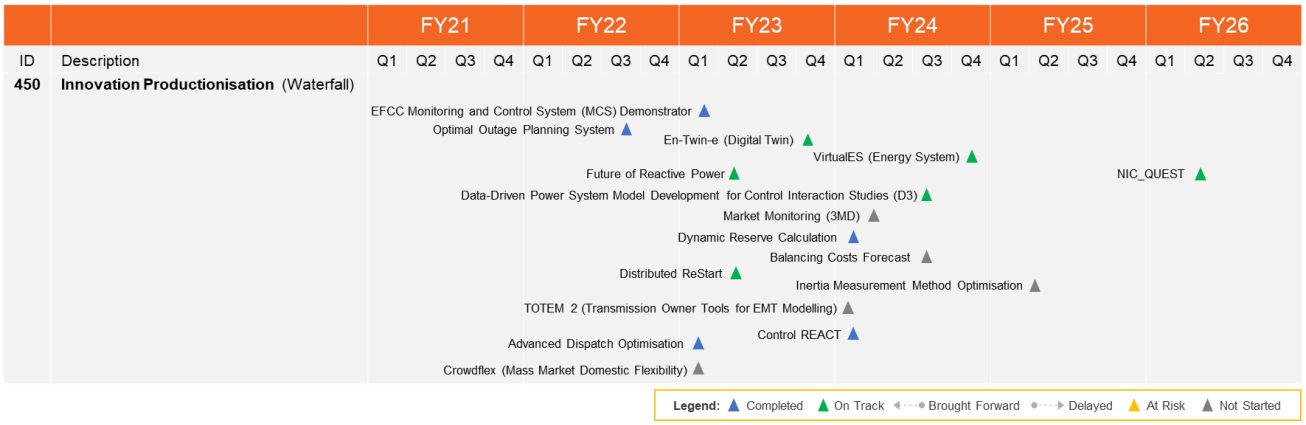


Figure 28 - Outcome roadmap

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 Scottish Power Transmission 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

NIC_QUEST	Customers & Partners Business units	An Electricity North West-led project. The QUEST project will create an overarching control system to co-ordinate our voltage management techniques
Future of Reactive Power	Customers & Partners Business units	Investigating the possibility of a market-based solution to procure reactive power.
Dynamic reserve calculation	Customers & Partners Business units	Investigate the adoption of a dynamic reserve setting approach which would set reserve levels for the day ahead based on current system conditions (reserve covering both basic, renewables and interconnector reserve)
Balancing Costs Forecast	Customers & Partners Business units	Exploring whether time series machine learning methods could be used to improve the performance of the forecast model. Control room have requested improvements to the forecast at short (<12 m) lead times. Higher granularity output (e.g., half-hourly) for the short term should also be considered as the current forecast outputs at monthly granularity only (if input data sources allow).
Market Monitoring (3MD)	Customers & Partners Business units	Development of a more sophisticated, machine-learning based solution to monitor ESO markets, increasing efficiency of team activities, scalable to new products and increasing market participant numbers.
Distributed ReStart	Customers & Partners Business units	Explores how distributed energy resources in Great Britain can be used to restore power in the event of a total or partial blackout.
Inertia Measurement Method Optimisation	Customers & Partners Business units	Analyse and verify data from GE and Reactive inertia monitoring tools and compare to NGESO operational data, establishing different generation and demand scenarios for inertia and Rate of Change of Frequency (ROCOF). Through development of measurement parameters and specifications for reference instrumentation, project will build on existing data and use cases with the goal to establish standardisation for inertia measurement.
TOTEM 2 (Transmission Owner Tools for EMT Modelling)	Customers & Partners Business units	Developing and validating a full-scale model of electromagnetic transient (EMT) behaviour for the GB transmission system. Which could replace conventional phasor-based Root Mean Square simulation tools that have limitations in studying weaker, low inertia systems Extension to deliver the remaining deliverables including (NGET network, validation, additional

		studies, hardware and software setup and documentation, etc.)
Crowdflex: Discovery	Customers & Partners Business units	Discovery project will focus on the characterisation of domestic flexibility for use in grid operations. It will describe the key inputs needed for system operations, consider statistical modelling approaches, and identify key hypotheses to test in a future practical trial.
Control REACT	Customers & Partners Business units	Provide insight into the cost impacts of forecast uncertainty. Allowing NGESO to prioritise schemes for improving forecasting accuracy, managing uncertainty, and improving operational efficiency in the control room.
Advanced Dispatch Optimisation	Customers & Partners Business units	This study will help us understand the development and delivery pathway for a new Dispatch Optimisation tool and how the tool could employ new techniques to assess the variability of the different input variables and enable optimisation across a range of likely scenarios. The scope of the optimisation could be increased to include network modelling and also cost modelling, where the likely future market impact of current decisions could be included. Such a tool would be part of developing an integrated future Digital Twin network for the GB energy system envisioned through the VES initiative; a tool would leverage various Digital Twin capabilities, such as scenarios building, physical grid modelling as well as real time grid data tracking and analysis, to understand and predict market dynamics while projecting possible consequences that could result from a particular balancing action. This could provide the ENCC dispatch recommendations that would result in greater efficiency within the BM; improved optimisation across the range of system operability challenges, over different timeframes, to improve the GB energy system's ability to manage a transition to net zero carbon operation, at the lowest cost to consumers.
CrowdFlex (Mass Market Domestic Flexibility)	Customers & Partners Business units	Explore the sizeable amount of flexibility within domestic consumers that is growing exponentially with the rapid growth of Electric Vehicles

Table 104 - Outcome summary descriptions

Future State

Target platform	Target Subsystem	Component	Future State
TBD	TBD	The target platforms and systems will be defined post the completion of any Proof of Concept (PoC) trials and confirmation of productionisation requirements. Some requirements may require an extension to the Technology Architecture, each Innovation activity will be assessed for alignment into the target architecture and technology decisions communicated as required.	

Table 105 - Future state subsystem component summaries

This investment is required 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 Network Innovation Competition funding), provided they meet the criteria and timescales for this process (and are successfully awarded). We aim to utilise this investment as much as possible, in coordination with ongoing Network Innovation Allowance (NIA) activities.

We will continue 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.

At present there are 58 innovation projects in the innovation portfolio that are estimated to fall inside the RIIO-2 period. Many are in the proposal phase and therefore too difficult at the present time to confirm which of these projects will progress to ESO Technology delivery. 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 production 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 productionisation is required
■	Some probability that budget for IT productionisation is required
■	Unlikely to require budget for IT productionisation but may still require data integration with other ESO Technology services

Table 106 – Innovation Productionisation: Probability of IT Implementation Legend

Innovation 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.

Table 107 – Innovation Productionisation: Project Status Legend

Title	Project Status	Probability of IT implementation	Estimated Innovation project Start Date	Estimated Innovation project End Date	Role
Gas and Electricity Transmission Infrastructure Outlook	Project	🟥	Feb 2022	Dec 22	Role 3
NIC_QUEST	Proposal	🟨	Apr 2021	Jul 2025	Role 3
Future of Reactive Power	Project	🟦 (**400** Single Markets Platform)	Sep 2021	Q4 FY24	Role 2
Operational Planning under New Technologies (OpNet)	Proposal	🟥	BP2 Period	BP2 Period	Role 3
Stability Market Design	Proposal	🟥	Jun 2021	Mar 2022	Role 2
Data-Driven Power System Model Development for Control Interaction Studies (D3)	Project	🟩	Jan 2022	Dec 23	Role 3
EFCC Monitoring and Control System (MCS) demonstrator	Proposal	🟦 (**500** EFC)	BP2 Period	BP2 Period	Role 3
Future of Interconnectors	Proposal	🟥	BP2 Period	BP2 Period	Role 2
Dynamic reserve calculation	Complete	🟩	May 2021	May 2022	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	🟩	Sep 22	Dec 23	Role 2
Market Monitoring (3MD)	Proposal	🟩	Sep 22	Sep 23	Role 1
Exploring cross border participation in Dynamic Containment	Proposal	🟩	BP2 Period	BP2 Period	Role 2
En-Twin-e (Digital Twin)	Proposal	🟦 (multiple)	BP2 Period	BP2 Period	Role 1

VirtualES (Energy System)	Proposal		BP2 Period	BP2 Period	Portfolio
Solar PV Phase 3	Project		BP2 Period	BP2 Period	Role 3
Distributed ReStart	Project	(**460** Restoration)	Jan 19	Q1 FY24	Role 1
Inertia Measurement Method Optimisation	Proposal		Sep 22	Sep 24	Role 1
AI Centre of Excellence	Proposal		Sep 22	Oct 22	Role 1
TOTEM 2 (Transmission Owner Tools for EMT Modelling)	Project		Apr 22	Apr 23	Role 3
COMMANDER	Proposal		Sep 22	Dec 23	Role 3
Dunkelflaute Modelling	Proposal		Sep 22	Dec 23	Role 3
SSO Identification in the frequency domain	Proposal		Aug 22	Dec 23	Role 3
Strength to Connect	Proposal		Aug 22	Dec 23	Role 3
Peak Demand Forecasting	Proposal		Sep 22	Sep 22	Role 3
System value from V2G peak reduction	Proposal		22/23	Jun 23	Role 3
Role and value of electrolysers in low-carbon GB energy system	Proposal		Feb 2022	Apr 23	Role 3
Carbon Intensity Modelling	Proposal		Sep 22	BP2 Period	Role 1
REVEAL	Proposal		Sep 22	BP2 Period	Role 2
Locational Signal Development within TNUoS	Proposal		22/23	BP2 Period	Role 2
Constraint Cost Forecasting	Proposal		22/23	BP2 Period	Role 3
Generation & Demand Scenario Application for Offline Analysis	Proposal		22/23	BP2 Period	Role 3
Consumer Archetypes Building Blocks	Proposal		Dec 22	BP2 Period	Role 3

DER Visibility and Probabilistic modelling	Proposal		Sep 22	BP2 Period	Role 3
Inertia Optimised Frequency Response (IOFR)	Proposal		22/23	BP2 Period	Role 3
Balancing Services co-ordination - demonstrate holding headroom on ANM	Proposal		22/23	BP2 Period	Role 3
Impact of New Technology HGV's	Proposal		22/23	BP2 Period	Role 3
Fast RoCoF and larger frequency nadirs in low inertia systems	Proposal		23/24	BP2 Period	Role 3
The Value of Energy Storage for Constraint Management and System Security	Proposal		23/24	BP2 Period	Role 3
Digi-Gift	Proposal		23/24	BP2 Period	Role 1
Gas Networks Interoperable Digital Twin	Proposal		23/24	BP2 Period	Role 1
Nuclear Net Zero (N-NZO)	Proposal		23/24	BP2 Period	Role 3
Fast Flex	Proposal		23/24	BP2 Period	Role 3
Network-DC (Innovation of the implementation of DC circuit breakers in DC Network)	Project		Jan 2022	BP2 Period	Role 3
INCENTIVE (Innovative Control and Energy Storage for Ancillary Services in Offshore Wind)	Project		Jan 2022	BP2 Period	Role 3
Gas System of the Future – Digital Twin	Proposal		23/24	BP2 Period	Role 1
Sustainable Electrical Gas Insulated Lines (SEGIL)	Proposal		23/24	BP2 Period	Role 3
Crowdflex: Discovery	Proposal		Sept 22	Mar 23	Role 2
Control REACT	Completed		Oct 19	Jul 22	Role 1
Advanced Dispatch Optimisation	Completed		Apr 21	Jun 22	Role 1
CrowdFlex (Mass Market Domestic Flexibility)	Completed		Apr 21	Jun 22	Role 2

Short-term System Inertia Forecast	Completed	■	Mar 19	Mar 22	Role 2
Advanced Modelling for Network Planning Under Uncertainty	Completed	■	Oct 19	Oct 21	Role 3
Decarbonisation of Heat – an integrated market study	Completed	■	Apr 21	Sep 21	Role 3
SHEDD - System HILP Event Demand Disconnection	Completed	■	May 20	April 22	Role 3
Probabilistic planning for stability constraints	Completed	■	Jan 22	April 22	Role 3
DETECTS (Developing Enhanced Techniques to Evaluate Converter-dominated Transmission System Operability)	Completed	■	May 20	April 22	Role 3

Table 108 - Innovation portfolio

The list above is based on current projects. New projects could be added to the portfolio during the RIIO-2 period.

Approach

Unless an exceptional change to the target state architecture is required for productionising an innovation solution, its 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 suitable we would seek to utilise an agile methodology for implementation. Innovation projects to be productionised are still to be determined. Our approach to delivery may include packaging of productionisation work into backlogs for other investments, creating new investments (if a distinct business case is justified) or delivering as minor works through our Digital Engagement Platform applications suite. We may choose to utilise agile, waterfall or a hybrid delivery methodology or a combination of these depending on the scope, situation, and nature of the works to be completed may choose to utilise agile, waterfall or a hybrid delivery methodology or a combination of these depending on the scope, situation, and nature of the works to be completed

The engagement and delivery lifecycle for productionisation can generally be broken down into the following:

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

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

Completion

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

Funding for the Innovation Proposal and Project stages would be classified as Opex with Productionisation activities classified as Capex.

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 delivery of innovation scope was rejected as there is no IT operational or consumer/stakeholder benefit in treating this scope differently. Our ESO target architecture already includes capability for delivering 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 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.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	0.0	0.0	1.2	1.2	1.8	4.2
	BP1	0.6	0.6	1.2	1.2	1.8	5.4
	Variance	**-0.6**	**-0.6**	**0.0**	**0.0**	**0.0**	**-1.2**
Opex (£m)	BP2	0.0	0.0	0.8	0.8	0.8	2.4
	BP1	0.4	0.4	0.8	0.8	1.2	3.6
	Variance	**-0.4**	**-0.4**	**0.0**	**0.0**	**-0.4**	**-1.2**
Totex (£m)	BP2	0.0	0.0	2.0	2.0	2.6	6.6
	BP1	1.0	1.0	2.0	2.0	3.0	9.0
	Variance	**-1.0**	**-1.0**	**0.0**	**0.0**	**-0.4**	**-2.4**
Cumulative RTB increase (£m)	BP2	0.0	0.0	0.1	0.1	0.2	
	BP1	0.0	0.0	0.1	0.2	0.3	
	Variance	**0.0**	**0.0**	**0.0**	**-0.1**	**-0.1**	

Table 109 – Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
Evolved or refined scope since BP1	No productionisation requirements	Capex	Some candidate projects did not require productionisation or timescales were aligned to fit within other IT programmes	- £1.2m
		RtB		- £0.1m
		Opex		- £1.2m
Costs change since BP1				- £2.5m

Table 110 - Investment cost change summary

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 111 – Investment risk summary

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Design Deliver Operate	Technology Commercial & Enterprise Architecture review will be performed as part of each Innovation workstream for any commercial agreement formed from within the innovation workstream	IT Management & Strategic Planning	Implementation delays and productionisation cost increases	Every 3 months
Design Operate	Enterprise Architecture and the Delivery/Service Management functions in ESO Technology will review any innovation proof-of-concept solutions	Application Support & Operations	Implementation delays and productionisation cost increases	Every 3 months

Table 112 - Investment assumption summary

3.16 460 Restoration

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
In Draft	Waterfall	On-Track: 0	Complete: 2	Delay: 1	Total Count: 3

Overview & Purpose

This investment delivers our capability to manage emergency restart of the electricity network in the context of net zero grid operations.

Changes to systems and communication methods have been identified by the Distributed ReStart innovation project started in RIIO-1. The project explores how distributed energy resources (DER) such as solar, wind and hydro can be used to restore power to the transmission network in the unlikely event of a blackout - a process known as black start.

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 commercially and technically assessed, modelled, and operated. We need to update our systems to facilitate communications and visibility requirements.

We will provide resilient communication infrastructure to new distribution-connected generators contracted for Restoration services following upcoming regional tenders. 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 changes will be made via this investment.

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

The communication infrastructure to be built between NGESO and DNOs under this investment will facilitate the solution for **510** Restoration Decision Support Tool.

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 113 – Summary of business outcomes and corresponding sub-activities

Current State

During BP1 we will complete the Distributed Restart NIC (Network Innovation Competition) project and publish the closedown report (Spring 2023), roadmap for implementing recommendations and evidence of the project's engagement with industry.

As part of the Distributed Restart NIC, a Distributed Restart Zonal Controller (DRZC) prototype will be built and tested to demonstrate design concept’s feasibility.

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. Not all DNOs are currently linked in such a way to the ENCC.

At the time of writing the Distributed ReStart project recommendations, it is possible that stakeholders will decide against adopting some or all recommendations. We will update our milestones and technology investment planned for this deliverable as necessary to meet the needs of stakeholders.

Due to synergies in the investments, there is a high probability the milestones and budget for this investment and 510 Restoration Decision Support tool investments will be merged under a single investment after the discovery in the latter half of FY23.

Roadmap

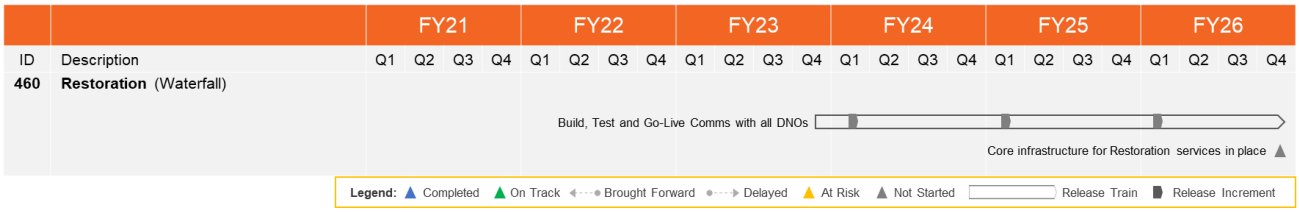


Figure 29 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Build, Test, and Go-Live comms with all DNOs		Establish communication link between NGESO and DNOs, namely: • Scottish Power Energy Networks • Electricity North West • Northern Power Grid Any other based on the re-usability assessment Upon conclusion of a business led assessment, there might be additional requirement to establish communication links between NGESO and DNOs, namely: • UK Power Networks • Scottish and Southern Energy Networks • Western Power Distribution
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 114 - Outcome summary descriptions

Future State

This investment covers building, commissioning, and enhancement of resilient communication infrastructure to DNOs to facilitate participation of new distribution-connected generators contracted for Restoration services.

Target platform	Target Subsystem	Component	Future State
Data & Analytics	Analytics and Insight	Predictive Analysis CNI	New Situational Awareness suite implemented for 2025/26 System Operations. Predictive Analytic capability used to support Restoration.

Data & Analytics	Consistent Data Services	Integration CNI	NCMS DNO Restoration interfaces implemented.
Data & Analytics	Regulatory Reporting	External Reporting	Custom reporting for Restoration service providers and regulator.
Digital Engagement	Customer	Customer Engagement	Customer administration processes enhanced to manage Restoration service providers.
Digital Engagement	Market Facilitation	Communication	Non-operational B2B interfaces with Restoration service providers implemented using DEP and DAP capabilities.
Digital Engagement	Market Facilitation	Data Exchange	Non-operational B2B interfaces with Restoration service providers implemented using DEP and DAP capabilities.
Network Operations & Control	Control Communication	Telephony	Upgraded operational telephony supporting new Restoration systems.
Network Operations & Control	Control Communication	Control Data Link	Upgraded OpTel network supporting new distributed Restoration system.
Network Operations & Control	Situational Awareness	Restoration	NCMS operational. Restoration functions extended and configured to support new distributed Restoration system.
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 115 - Future state subsystem component summaries

Approach

We will follow the delivery approach established by **110** Network Control and ensure our requirements are managed in line with wider control room deployments. It is likely that we will continue to follow the waterfall approach defined in our roadmap for this investment due to the nature of this solution.

Implementation of our Restoration management capability is expected to entail enhancement of our Operational Telecommunication (Optel) and general wide area data networks. We will work with our operational 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 e.g., data integration services provided by DAP and stakeholder communications and external alerts being provided through DEP.

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

Solution Options

There is only one high-level solution option. This investment delivers the connectivity enhancements needed for Distributed ReStart to work and thus extends existing network and integration services alongside our NCMS, Balancing and other control room critical services.

Investment 510 Restoration Decision Support delivers the central components which, together with Distributed ReStart, form the new Restoration Management capability.

The Restoration Management will rely on NCMS capabilities to monitor the system during a Restoration event, coordinating Restoration actions directly through NCMS and indirectly through the OBP to restore the system.

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 DEP.

We did not explore the option to build a separate Restoration solution outside of our on-premise infrastructure capability as this would not fit with our control room operational requirements.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	0.0	0.0	6.3	6.3	5.4	18.0
	BP1	0.9	1.8	6.3	6.3	5.4	20.7
	Variance	**-0.9**	**-1.8**	**0.0**	**0.0**	**0.0**	**-2.7**
Opex (£m)	BP2	0.0	0.0	0.7	0.7	0.6	2.0
	BP1	0.1	0.2	0.7	0.7	0.6	2.3
	Variance	**-0.1**	**-0.2**	**0.0**	**0.0**	**0.0**	**-0.3**
Totex (£m)	BP2	0.0	0.0	7.0	7.0	6.0	20.0
	BP1	1.0	2.0	7.0	7.0	6.0	23.0
	Variance	**-1.0**	**-2.0**	**0.0**	**0.0**	**0.0**	**-3.0**
Cumulative RTB increase (£m)	BP2	0.0	0.0	0.1	0.9	1.7	
	BP1	0.0	0.1	0.3	1.1	1.9	
	Variance	**0.0**	**-0.1**	**-0.2**	**-0.2**	**-0.2**	

Table 116 - Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
Evolved or refined scope since BP1	Change in scope	Capex	Distributed Restart Zonal Controller (DRZC) was moved out of scope and is now being delivered by the DNOs	- £2.7m
		Opex		- £0.3m
		RTB		- £0.2m
Costs change since BP1				- £3.2m

Table 117 - Investment cost change summary

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Design	Innovation project will be completed by Spring 2023	Transport	Commencement of the comms links build with DNOs	Quarterly
Design	The communication links will take 12-18 month with a cost profile in line with those deployed historically.	Transport	Schedule and budgetary impact	Quarterly

Table 118 – Investment assumption summary

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
As the project is yet to mobilised, detailed requirement is yet to be determined at this stage of the project lifecycle, which could lead to an increase in costs and delays to delivery of enduring solution.	Application Development	Crystalise requirements, assure/agree scope, and delivery timescales/costs	2	1
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

Higher number of communication links to be built and tested than the initial estimate of 3 link to 3 DNOs	Program, Product & Project Management	Early engagement with DNOs to identify change in requirements	3	3

Table 119 – Investment risk summary

3.17 480 Ancillary Services Dispatch

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
In Draft	Agile	On-Track: N/A	Complete: N/A	Delay: N/A	Total Count: N/A

Overview & Purpose

This investment delivers asset health and operational maintenance capabilities for our Ancillary Service Dispatch Platform (ASDP) system, prior to replacement by our Open Balancing Platform.

ASDP provides dispatch services to smaller generation units such as Non-BM Fast Reserve, Optional Fast Reserve, and non-BM Short Term Operating Reserve (STOR). ASDP is the primary system for ESO to utilise Non-BM Ancillary Services in real-time.

As we transform the balancing capabilities for Ancillary Services, we will maintain and adapt our ASDP system to help balance the network frequency safely and economically. It forms a key component of the overall balancing function as the number of non-BM generation units and new reserve products increase within the balancing portfolio.

We need to maintain a non-BM delivery capability to remove defects, improve system performance and stability, and introduce new functionality to the Control Centre. We must also maintain regulatory compliance and will add new reserve and response services to support Ancillary Services Reform and Regional Development Programmes priorities.

We will strike the right balance between delivering value as soon as possible by enabling market change in the current systems, while we transform our balancing capability for future market needs, these decisions will be made collaboratively with industry and having consumer interests as priority.

This investment enables sub-activity **A1.2 Enhanced Balancing Capability**.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A1.2 Enhanced Balancing Capability	• Energy Balancing Services

Table 120 - Summary of business outcomes and corresponding sub-activities

Current State

ASDP followed a customer-centric approach using agile methodologies to define, build, and release a continuous flow of valuable and enhanced products and services to the ESO control room.

The ASDP product team reliably deliver up to 4 releases a year, to improve control room features for dispatch of non-BM units, provide a capability to modify existing and add new non-BM services. Our Releases are characterised by rapid, value-driven, iterative change cycles for 3 product improvements per release.

The team have successfully delivered their BP1 product backlog, including:

- Migration of ASDP middleware platform CDSA from on-premise to cloud hosting capability
- Implementation of production functionality and defect fixes to the Control Room
- Integration with the new strategic Settlement platform foundation release
- Deployment of Dynamic Containment, Dynamic Moderation and Dynamic Regulation functionality to support Ancillary Services reform
- Regulatory compliance releases containing P399, P371, PAS EBGL (European Balancing Guidelines) and Clean energy package changes.

ASDP has realised measurable benefits and operational improvements at low operational risk due to these releases. For example, we have delivered an improved business continuity process by adding a telephone dispatch facility and scripts to support system recovery, optimised database queries to reduce user interface response time and provided price change alerts to control room users.

The ASDP team have a full backlog of work planned for FY23, including release trains for internal ASDP, ASR, RDP, and changes. This investment funding scope is solely related to the ASDP changes with ASR, RDP and any other enabling work being funded via their respective investments.

Current known backlog changes include:

- ASDP changes: functional changes requested by control room users and production support needs have also been prioritised to keep the system performant. We will deliver functional and technical changes based on priorities defined by the control room. This will also include transitioning ASDP to be compatible with Windows10.
- Ancillary Services Reform: Utilising a release-based model to include support for new response products (DM/DR/DC). We have already implemented and deployed the 'Day 1' requirements and are currently planning for 'Day 2'.
- Regional Development Programmes: Capabilities to encourage participation of renewable energy sources in the overall balancing market. These changes help our control room users prioritise renewable energy sources safely and economically, supporting the larger goal of Net Zero.

Roadmap

During BP2 our Ancillary Services Dispatch functionality will be replaced using technology services including microservices and data APIs provided by the OBP platform, with integration into our new control room operator console. The ASDP platform will continue to be operated and maintained until it is replaced in 2025 by the OBP.

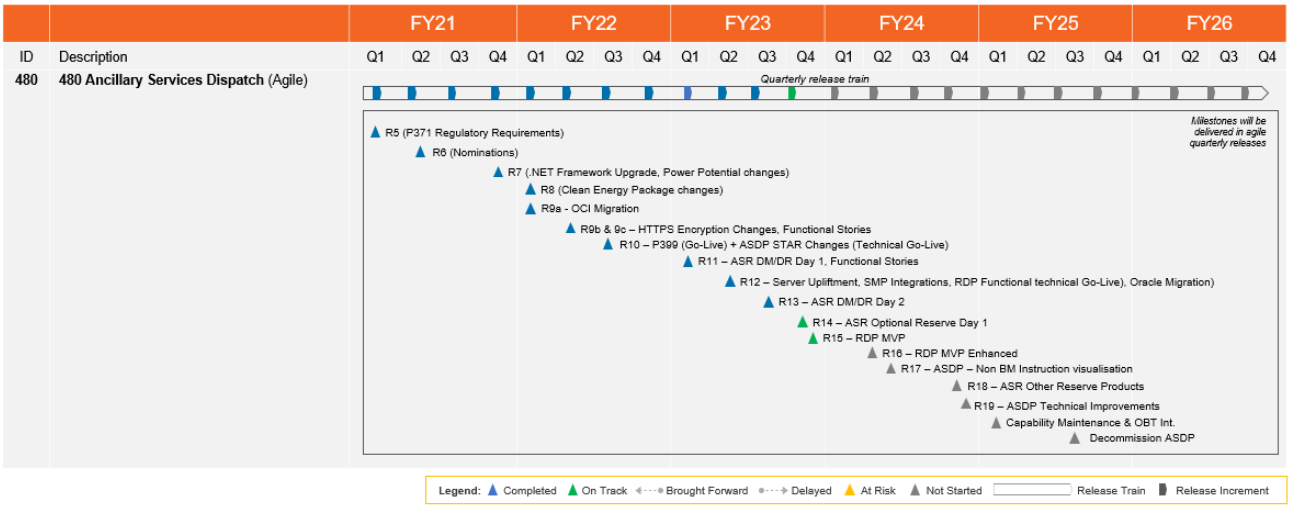


Table 121 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
R5 (P371 Regulatory Requirement)	Business Units	Regulatory compliance project. To include the details of non-BM Fast reserve actions in the BSAD file used in the imbalance price calculations, mirroring the treatment of other non-BM (i.e., STOR) actions
R6 (Nominations)	Business Units, Customers & Partners	Fixes provided for the issues around while a service provider re-declare any future available window for the Non-BM Fast Reserve with perpetual nominations in place

R7 (.NET Framework Upgrade, Power Potential changes)	Business Units	UI visualisation and Query performance enhancements. Power Potential change for LAG/LEAD MVArs interpretation
R8 (Clean energy package Changes)	Business Units	STOR functionality enhancements. Integration of contracts data to downstream systems
R9a OCI migration	Business Units	Successful migration of integration services to cloud hosting platform
R9b - HTTPS Encryption Changes	Business Units, Customers & Partners	Improved security of transactions with suppliers and enhanced Control Room user security
R10 - P399 + STAR	Business Units	Regulatory compliance with P399 Integration with the new Settlement system
R11 - ASR DM/DR Day 1, Functional Stories	Business Units, Customers & Partners	Ancillary Services Reform DM/DR Day 1 and Cease and Dispatch improvements available in the control room.
R12 - Server Upliftment , SMP Integrations, RDP Functional, Oracle Migration	Business Units	Database server and software asset health and version upgrade to improve support status. Enable dispatch of RDP services and integration of Contract data for Single Market Platform,
R13 - ASR DM/DR Day 2	Business Units, Customers & Partners	Release of Additional DM/DR functionality, improving use of new services.
R14 - ASR Optional Reserve Day 1	Business Units, Customers & Partners	Optional reserve services into the control lowering costs of reserves.
R15 - RDP MVP	Business Units, Customers & Partners	Release of RDP WPD integration
R16 - RDP MVP Enhanced	Business Units, Customers & Partners	Improvements to RDP WPD integration
R17 - Non BM Instruction visualisation	Business Units, Customers & Partners	Integration services enhancements Improving end-user experience, improving security
R18 - ASR Other Reserve Products	Business Units, Customers & Partners	Further Ancillary Services Reform reserve products to lower costs to end consumers.
Capability Maintenance & OBP Int.	Business Units, Customers & Partners	Final integrations with the Open Balancing platform, to prepare for Decommission.
Decommission ASDP	IT operations	Decommission ASDP legacy application

Table 122 - Outcome summary descriptions

Future State

During BP2, we will deliver several new service capabilities into ASDP aligned to our agreed industry roadmap to support:

- RDP MW Dispatch Day 2
- Functional and technical changes for Ancillary Services Reform Reserve products
- Integration between ASDP and WPD to utilise the distributed energy resources for the RDP Programme
- Integration between ASDP and other ESO downstream systems for required reporting purposes for RDP and ASR.
- Additional technical changes to improve security and system stability

Changes made to ASDP during BP2 will also need to be implemented in OBP.

We will deliver hosting and environments changes for our ASDP infrastructure to ensure reliable and secure operation in the control room until replacement by OBP in FY25. This may involve hardware capacity upgrades, improvements to load-balancing services and critical security patches to maintain compliance for control room operations.

Currently we do not expect to maintain a development (enhancements) capability for ASDP beyond FY24, as further balancing and dispatch changes for non-BM units will be made in the OBP from FY25.

Target platform	Target Subsystem	Component	Future State
Balancing	Balancing Communication	Data Exchange	OBP-ancillary dispatch services will use the OBP service mesh to discover and exchange data with other services required to dispatch to non-BM units
Balancing	Energy Balancing	Dispatch	ASDP non-BM dispatch functionality replaced by newly developed non-BM dispatch services provided by the OBP platform

Table 123 - Future state subsystem component summaries

Approach

For ongoing delivery of ASDP services and maintenance activity we will continue to use our proven release model as described in Current State.

For preparation of OBP migration activity, we will use a similar services migration approach for ASDP as the **210** Balancing Asset Health investment.

Our team will complete an exercise to define existing ASDP functionality into high-level discrete services, followed by a service-design exercise for the OBP platform which will describe the new services, interfaces and data exchanges that are required for OBP ancillary services functionality.

Once the new services have been deployed on OBP, the legacy services will be retained but disconnected, until an extended acceptance test is approved by the business. Following approval, we will remove the legacy ASDP services and complete decommissioning.

Our releases are managed through agile requirements discovery, development and build with change cycles for 3 product improvements per release.

Solution Options

We evaluated several options for the future provision of ancillary dispatch services, particularly with regard to the trend of increasing numbers of smaller generation units.

The option of retaining and building upon the existing ASDP platform was discounted on the basis that the existing ASDP platform currently requires re-architecting and infrastructure upgrades to reflect the increasing dependency Control Room have on non-BM balancing services.

Given the investment being made in the OBP platform, the phased migration of ancillary services into OBP is considered the most appropriate approach. This enables us to maximise the investment made in in both ASDP and OBP.

We additionally considered and discounted the option of procuring a 3rd part software package to meet future non-BM ancillary service requirements. No viable product offerings were available that could achieve the control room functionality required or outweigh the benefits of OBP integration.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	4.3	1.5	0.0	0.0	0.0	5.8
	BP1	2.3	1.8	0.5	0.0	0.0	4.5
	Variance	**2.1**	**-0.3**	**-0.5**	**0.0**	**0.0**	**1.3**
Opex (£m)	BP2	0.0	0.2	2.4	0.0	0.1	2.7
	BP1	0.3	0.2	0.1	0.0	0.0	0.5
	Variance	**-0.3**	**0.0**	**2.4**	**0.0**	**0.1**	**2.2**
Totex (£m)	BP2	4.3	1.7	2.4	0.0	0.1	8.5
	BP1	2.5	2.0	0.5	0.0	0.0	5.0
	Variance	**1.8**	**-0.3**	**1.9**	**0.0**	**0.1**	**3.5**
Cumulative RTB increase (£m)	BP2	0.1	0.1	0.3	0.3	0.3	
	BP1	0.4	0.7	0.9	0.9	0.9	
	Variance	**-0.3**	**-0.6**	**-0.6**	**-0.6**	**-0.6**	

Table 124 - Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
Evolved or refined scope since BP1	Hardware cost	Capex	Hardware procured will be used in OBP	+ £1.7m
Evolved or refined scope since BP1	Increased project throughput	Capex	Further funding available from other projects due to increase in throughput of work than previously forecasted	- £0.4m
Efficiencies	Support cost	RtB	Support cost reduced due to transformation rather than migration to CNI	- £0.6m
Evolved or refined scope since BP1	Cost that cannot be capitalised	Opex	Extension of the capability into 2024 with decommissioning in FY26, cost cannot be capitalised	+ £2.2m
Cost changes since BP1				+ £2.9m

Table 125 - Investment cost change summary

The uplift in hardware cost was committed prior to the strategic review as we had previously planned to extend ASDP service life. The Balancing strategic review concluded that the hardware will be re-used by OBP.

Work requested by other investments during BP1 was higher than expected, leading to a small reduction in this investment's forecast as our ASDP team capacity was fully utilised.

Our plan for FY24/25 is to deliver enhancements and maintain asset health, along with new Ancillary services and preparation for integration with Balancing Transformation. This is a change to our expected diminished team size in the original RIIO-2 submission.

The RtB cost of ASDP will not increase as much as expected in BP1, as we will carefully manage future system infrastructure growth in anticipation of replacement by the Open Balancing Platform.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Deliver	Additional ancillary service definition beyond the current known ASDP backlog would need to be aligned to OBP delivery.	Application Development	ASDP development capability would need to be retained, at additional cost.	Monthly as part of portfolio review.
Deliver	All demand initiatives have features/requirements refined adequately to enable a constant backlog of development work.	Application development	Development team would not be fully utilised. Possible need to extend the capability for longer term.	Monthly as part of portfolio review.

Table 126 - Investment assumption summary

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
Delays to OBP result in ASDP being operated for longer than planned leading to increased costs	IT Management & Strategic Planning	Prioritise transition to OBP solution	2	3
There is a risk that other initiatives (e.g., RDP, GEMS, PD and ASR) will consume the available delivery capacity of the ASDP team. This will result in a lower deliver of ASDP changes but also reduce the cost of this investment	IT Management & Strategic Planning	Replan ASDP changes to either be part of OBP MVP or be delivered by ASDP later than current roadmap.	4	2

Table 127 - Investment risk summary

3.18 510 Restoration Decision Support

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
In Draft	Hybrid	On-Track: 3	Complete: 2	Delay: 1	Total Count: 6

Overview & Purpose

This investment delivers our capability to support operational insights for emergency Restoration activities.

We will deliver a decision support tool based on real-time data to deliver a dynamic, feasible Restoration plan to Government standards. The tool will support the 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) of the network, availability, and response time of the Restoration providers.

We will link this work to our **460** Restoration investment and Distributed ReStart innovation projects. This explores how distributed energy resources (DER) such as solar, wind and hydro can be used to restore power to the transmission network in the unlikely event of a blackout - a process known as black start.

Restoration standards were 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 managing 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.

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.

This investment enables sub-activity **A3.2 Restoration Standard**.

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 128 - Summary of business outcomes and corresponding sub-activities

There is no change to the scope of this deliverable, from the milestones 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
- Identified software for the tool
- Decided on fully inhouse build or off the shelf tool for modification/reconfiguration
- Commenced tool development

Due to synergies with investment **460** Restoration, there is a high probability the milestones will be merged under a single investment after the discovery work in the latter half of FY23.

We expect to commence project in Q2 FY23 and deliver the Restoration Decision Support tool by Q4 FY25.

Roadmap

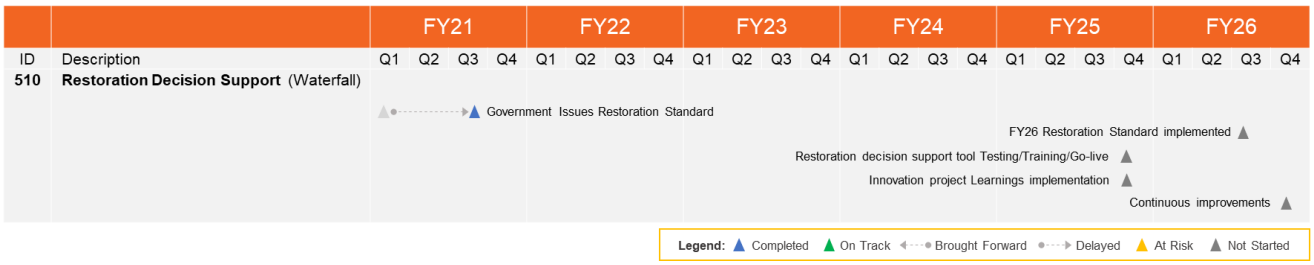


Figure 30 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Government Restoration standards issued	Business Units	ESO Licence Change to include the Electricity System Restoration Standard (ESRS) obligation to restore 60% demand within 24hrs and 100% within 5 days
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 129 - 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. 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.
- It will be flexible to accommodate learnings from Restoration innovation project and meet Government Restoration standards, including user defined scenarios for multiple Restoration strategies.

Target platform	Target Subsystem	Component	Future State
Data & Analytics	Analytics and Insight	Predictive Analytics CNI	New Situational Awareness suite implemented for 2025/26 System Operations. Predictive Analytic capability used to automate or guide operator decision making.
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.
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.
Data & Analytics	Forecasting	Power System Modelling	Integration of new RDS tool into network modelling software.
Network Operations & Control	Control Room Planning	Restoration Decision Support	New RDS tool fully operational.

Table 130 - Future state subsystem component summaries

Approach

Our overall approach is to use the Restoration management capabilities of the new NCMS. We will use the standard NCMS capability and extend or customise situational awareness components, provider management components, and Restoration operations components.

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, with integration between systems using capabilities of the Data and Analytics Platform.

We will align development and release activity for the decision support solution to 110 Network Control and assume that an approach closer to waterfall is appropriate for releases into the control room.

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 selected GEDigital NCMS product by March 2023 to confirm suitability.

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.

We have currently discounted the option of creating bespoke ESO software to provide decision support capability as our existing architecture framework and the NCMS product offering are the preferred route for delivery. This will be revisited as an option if required.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	0.0	0.4	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 (£m)	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**

Totex (£m)	BP2	0.0	0.4	1.5	2.0	1.0	4.9
	BP1	0.0	0.5	1.5	2.0	1.0	5.0
	Variance	**0.0**	**-0.1**	**0.0**	**0.0**	**0.0**	**-0.1**
Cumulative RTB increase (£m)	BP2	0.0	0.0	0.0	0.0	0.0	
	BP1	0.0	0.0	0.1	0.2	0.4	
	Variance	**0.0**	**0.0**	**-0.1**	**-0.2**	**-0.4**	

Table 131 - Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
Evolved or refined scope since BP1	Delayed Start	Capex, Opex,	Unspent cost due to delayed start of project	- £0.1m
Efficiencies	Future merger of investments	RtB	As the project hasn't commenced yet, the exact costs for iRTB are unknown. We plan to merge the delivery and cost forecast of investments **460** and **510**, hence the predicted reduction.	- £0.4m
Cost changes since BP1				- £0.5m

Table 132 - Investment cost change summary

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

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Deliver	Communication link will be delivered in time by investment 460 Restoration	Transport	Schedule and Budgetary	Quarterly

Table 133 - Investment assumption summary

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
As the project is yet to mobilised, detailed requirement is yet to be determined at this stage of the project lifecycle, which could lead to an increase in costs and delays to delivery of enduring solution.	Application Development	Crystalise requirements, assure/agree scope, and delivery timescales/costs	2	1

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
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
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

Table 134 – Investment risk summary

3.19 670 Real-Time Prediction

Overview & Purpose

This investment delivers a real-time demand and generation prediction capability to the control room.

Our forecasting capabilities do not extend to real-time data granularity and require minute-by-minute demand & generation profiles. The predictions will use minute-by-minute outturn data to replace the current Demand Predictor for current forecasting products, National & GSP Demand & Generation forecasts (Wind & Solar Power).

This product will use new mathematical algorithms consuming PEF forecasts. having more robust methods of assessing demand and weather-related uncertainties, such as wind and PV output.

This is a new investment for BP2 that did not exist in BP1 and enables sub-activity 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	• Production of timely, frequent, granular & accurate possible demand & generation predictions to improve real-time decision making

Table 135 - Summary of business outcomes and corresponding sub-activities

Current State

As this is a new investment for BP2, we will not have delivered towards this investment in BP1.

There is no existing ESO Technology solution for this capability, and we anticipate our target platforms architecture will accommodate these requirements.

Roadmap

Information not available at this time.

Future State

At the start of BP2, we will be performing the discovery phase of the Real Time predictions product.

Based on the outcome of the discovery phase, we will scope out the investment, design principles and will re-submit investment with clearly defined scope, milestones, costs, and benefits.

Approach

Information not available at this time.

Solution Options

Information not available at this time.

Costs

Information not available at this time.

Assumptions

Information not available at this time.

Risks

Information not available at this time.

Role 2 Investments

3.20 270 Role in Europe (formerly EU regulations)

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
Confirmed	Hybrid	On-Track: 0	Complete: 3	Delay: 4	Total Count: 7

Overview & Purpose

This investment enables ESO technology to deliver regulatory change arising from our TCA obligations.

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 includes the resource required to support options development, planning, design, and implementation of solutions for:

- A Cross Border Balancing solution, both 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 because 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 to maintain security and adequacy reporting plus enable options for coordinated capacity calculation.

The Role in Europe investment will interact with various investments across the entire IT portfolio, including but not limited to **110** Network Control, **120** Interconnectors, **180** Enhanced Balancing Capability, **350** Planning and Data Outage Exchange, **610** Settlements, Charging and Billing. These interactions are managed through early engagement with each investment area as the regulatory requirements and its impact become clearer.

This investment aligns and supports the delivery of the business cross-role activity **A21 Role in Europe**.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A21 Role in Europe	• Management and delivery of EU regulatory change retained in UK law and TCA obligations

Table 136 - 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, when the ESO 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. This enabled one day duration Day Ahead contracts and 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 to support discussions between ESO, BEIS, Ofgem and the industry.
- Initial discovery to establish potential impacts on ESO IT systems for System Operations Guidelines (SOGL) 118/119 (GC0154) has been completed.
- The ENTSO-E Common Grid Model programme has gone live. Service packs and additional modelling requirements are expected to be needed for the remainder of BP1 and during BP2.
- Provided early analysis and contributed to options development on the technical elements of the Trade and Co-operation Agreement (TCA), such as Cross Border Balancing and Day Ahead Capacity Calculation.
- ESO teams have 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 discussions with Interconnector operators, TSOs, EU TSOs and ENTSO-E.

Roadmap

Our implementation dates are dependent on multilateral agreements with EU TSOs, guidance from GB and EU regulatory bodies and the outcome of detailed impact assessments, and are subject to change. The term 'implementation' in this plan refers to ESO implementation, it does not consider the impact of third party implementation timeframes which is reflected in our investment risks.

Delivery of an enduring solution for cross border Balancing starts in the BP2 period and continues into RIIO-3.

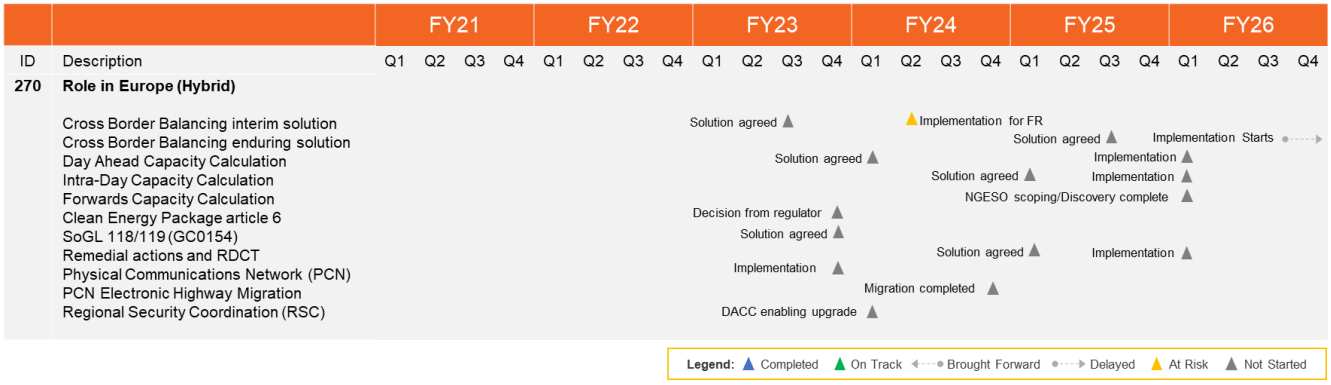


Figure 31 - Outcome roadmap

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 Remedial Actions including 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, 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 article 6	Customers & Partners Business units	Ensure ESO compliant to European codes retained in UK law post Brexit.

SoGL 118/119 (GC0154)		
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 awareness of system conditions affecting EU TOs. PCN supports compliance to TCA by providing the ESO with the ability to securely connect to European partners.

Table 137 - Outcome summary descriptions

Future State

At BP2 final submission there is high uncertainty relating to the implementation of TCA technical procedures as those are still being agreed with the EU TSOs, ENTSO-E and Interconnector operators.

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

- Implementation and operation of a Cross Border Balancing interim solution and 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'.
- Migration away from the legacy Electronic Highway network (EH) to the PCN service, enabling ESO to continue to exchange data securely with our TSO partners. Pending the completion of a cost-benefit analysis to be completed in FY23, a satellite-based out-of-band service may be delivered 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. The Electricity National Control Centre (ENCC) will continue to exchange accurate network models and highly valuable security analysis with Coreso, 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 6.9, CEP 6.5 and SOGL.

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.

Approach

We will grow the existing IT regulatory change team with resource and capabilities to support ESO business teams with option development, design and implementation of the deliverables as outlined in the business plan.

To deliver 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 assign resources to represent these changes within the relevant Product Teams during design and implementation, with the objective of increasing visibility and communication of regulatory requirements.

We will implement regulatory change using agile requirements discovery, capture and build where possible. Release management will be implemented in phases with sequential releases of capability to the relevant target solution, aligned to each area of delivery and their stated implementation method.

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 Technology systems. This analysis is provided 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. When necessary, the ESO may recommend that a regulatory change be managed to minimise the impact to legacy platforms and reduce 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 in the future systems design.

When the requirements for specific regulatory change as described in this investment are clearer and agreed with our EU delivery partners, we will assess and share solution options accordingly.

Our overall strategy for delivery of regulatory change in the BP2 period is to align systems change with our target architecture framework wherever possible.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	2.5	3.0	2.7	3.7	4.8	16.6
	BP1	9.0	7.2	7.2	7.7	7.7	38.7
	Variance	**-6.5**	**-4.2**	**-4.5**	**-4.0**	**-2.8**	**-22.1**
Opex (£m)	BP2	0.2	0.9	1.5	1.5	1.5	5.7
	BP1	1.0	0.8	0.8	0.9	0.9	4.3
	Variance	**-0.8**	**0.1**	**0.7**	**0.7**	**0.7**	**1.4**
Totex (£m)	BP2	2.7	3.9	4.2	5.2	6.3	22.3
	BP1	10.0	8.0	8.0	8.5	8.5	43.0
	Variance	**-7.3**	**-4.1**	**-3.8**	**-3.3**	**-2.2**	**-20.7**
Cumulative RTB increase (£m)	BP2	0.5	0.5	0.7	1.2	1.5	
	BP1	0.8	1.0	1.2	1.4	1.6	
	Variance	**-0.3**	**-0.5**	**-0.5**	**-0.2**	**-0.1**	

Table 138 - Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
Evolved or refined scope since BP1	Brexit	Capex	The variance is driven by the reduction in scope and breadth of changes forecasted in the original plan, prior to Brexit. Those changes have been superseded by TCA obligations which will require multi-lateral agreements over the BP2 period.	- £22.1m
	Brexit	Opex		+ £1.4m
	Brexit	Cumulative RtB		- £0.1m
Cost changes since BP1				- £20.8m

Table 139 - Investment cost change summary

This investment has changed significantly due to the impacts of Brexit on the UK / EU relationship. 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, ESO Technology has reviewed all EU delivery work with the ESO European Frameworks team. This includes 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 ongoing European activity is subject to collaborative work, first with all UK TSOs to agree a UK position and then engagement with EU TSOs. ESO Technology and the ESO EU frameworks team collaborated on the expected direction of each TCA activity, and a forecast has been produced based on documented assumptions. Any deviation from those assumptions during the BP2 period could result in cost variances.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Deliver	When developing this plan, we assumed a certain volume of change to be delivered in BP2 based on discussions with business teams and a review of the current/future change landscape.	Program, Product & Project Management	If this assumption is false, there could increases in the costs and time to deliver those changes.,	Monthly via the Programme Delivery Board (PMB).

Table 140 - Investment assumption summary

Risks

Risk	Relevant IT Tower Component	Mitigation(s)	Likelihood	Impact
This investment plan may need to change over the RIIO-2 period should there be any significant deviations from assumptions on the timescales and scope, leading to potential increases or reductions in costs.	Program, Product & Project Management	Invest sensibly and avoid committing resources until a direction of travel on each regulatory change becomes clearer. Work closely with ESO European Frameworks Team to understand the potential solutions being discussed with the industry.	5	1
The volume and pace of regulatory is incompatible with the ESO technology change capability leading to the ESO missing regulatory compliance dates.	Program, Product & Project Management	ESO Technology regulatory change team to analyse and communicate impacts to Code Change Delivery so that ESO delivery capability is considered in the industry wide decision-making process.	4	1
Changes to existing or new regulatory commitments are incompatible with the wider ESO technology change roadmap, leading to potential additional costs and diverting	Application Development	Ensure close collaboration so ESO technology strategy and long-term commitments are considered by industry and Ofgem when making decisions on regulatory change.	4	1

Risk	Relevant IT Tower Component	Mitigation(s)	Likelihood	Impact
resource from other planned RIIO-2 investments.				
An interim solution for cross border balancing may be delayed by negotiations with EU TSO	Program, Product & Project Management	European Framework team engaging with EU TSOs supported by IT regulatory change resource.	3	1

Table 141 - Investment risk summary

3.21 280 GB Regulations

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
Confirmed	Hybrid	On-Track: N/A	Complete: N/A	Delay: N/A	Total Count: N/A

Overview & Purpose

This investment enables ESO technology to deliver regulatory change arising from our GB obligations.

Note that regulatory changes affecting the ESO Settlements and Charging system are captured under investment **610** Settlements, Charging and Billing.

We anticipate that over the BP2 period the volume of GB 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's commitment to a fully decarbonised power system by 2035. We anticipate systems changes relating GB Grid Code, Balancing and Settlement Code, Connection and Use of Systems Code.

The GB regulatory change investment will engage and deliver alongside most investments in our portfolio, including **110** Network Control, **220** Data and Analytics Platform, **180** Enhanced Balancing Capability, **350** Planning and Data Outage Exchange, **610** Settlements, Charging and Billing.

This investment also enables sub-activity **A6.1 Code management / market development and change** in the ESO business plan and supports **A6.3 Industry revenue management.**

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A6.1 Code management / market development and change • A6.3 Industry revenue management	• Management and delivery of UK code changes

Table 142 - Summary of business outcomes and corresponding sub-activities

Current State

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 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 an early insight to a proposed modification or regulation, and its likely impact on ESO technology systems. This information is compared against the RIIO-2 product roadmaps to provide an indication of when the ESO technology changes could be delivered. The discovery documents are refined to provide indicative delivery timescales helping ESO teams to understand potential IT implications and assist discussions with the working group and/or regulator during the code modification process.

An impact assessment goes into further detail and is completed when there is an expectation that the proposed regulatory change is likely to result in implementation. It provides the business with a high-level solution design for the modification and associated costs to deliver the change. Depending on the modification, an impact assessment may be required as an 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 they will often involve detailed assessments by multiple IT delivery teams and partners.

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

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

- 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 as business and IT stakeholders have a clearer and earlier understanding of the impact of regulatory change.–We will continue to evolve the process and team over the BP2 period by funding dedicated regulatory resources aligned to the ESO technology product groups. This 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

In BP2 we will continue to assess all IT change proposals for market wide initiatives and implement in ESO systems as they are approved by industry and regulator. The timelines below are indicative, modifications vary in complexity and discussions with industry participants through workgroups will vary in time depending on the change. The roadmap for individual regulatory changes will be refined on an ongoing basis over the RIIO-2 period.

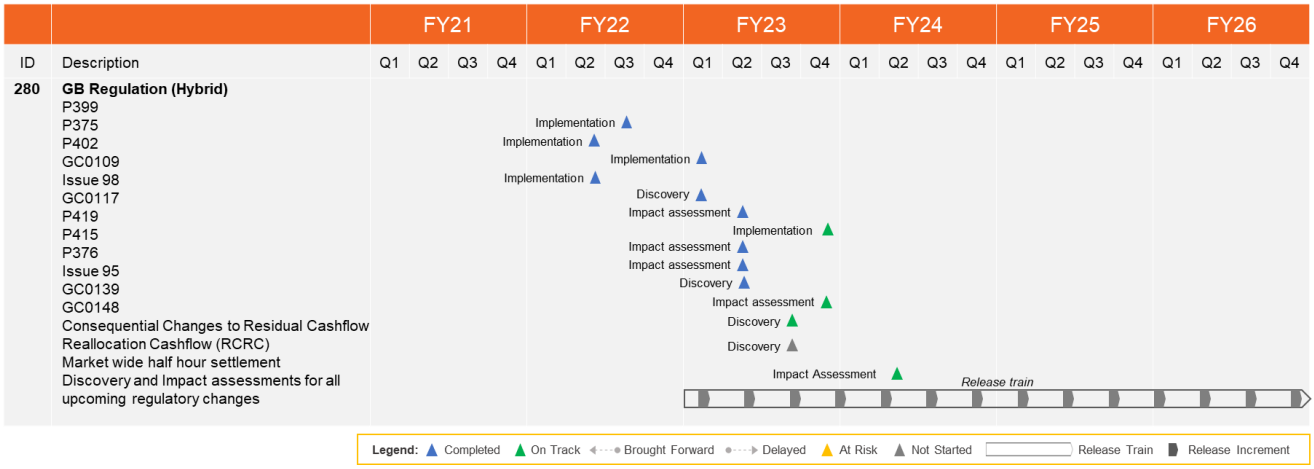


Figure 32 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
P399 – BSAD Identity Visibility	Customers & Partners	P399 made the identity of balancing service providers visible in the Balancing Services Adjustment Data (BSAD).
P375 'Settlement of Secondary BM Units using metering behind the site Boundary Point'	Customers & Partners	P375 allows Metering Equipment situated 'behind' the defined Boundary Point to be used for Settlement purposes in place of the Boundary Point Meter.
P402 'Enabling reform of residual network charging as directed by the Targeted Charging Review'	Customers & Partners	P402 introduced new reporting requirements on Licensed Distribution System Operator and Elexon that will ensure the provision of data to enable the NETSO to set TNUoS demand residual tariffs and enable accurate billing of subsequent charges.

GC0109: Publication of the various GB electricity Warnings	Customers & Partners	This modification introduced the requirement for the ESO to publish various system warning messages to the Balancing Mechanism Reporting Service (BMRS).
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.
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 Virtual Lead Parties' energy account to facilitate an electricity consumer’s participation in wholesale markets with no involvement from their Supplier
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 Physical Notifications. An impact assessment was delivered to understand the impact NGESO IT systems, with a minimal approach to implementation.
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
GC0148 Implementation of EU Emergency and Restoration Code Phase II		This modification seeks to outline Grid Code modifications to ensure alignment with the European Network Code Electricity Emergency and Restoration Code (NCER)
Consequential Changes to Residual Cashflow Reallocation Cashflow (RCRC) following BSUoS Reform	Customers & Partners	Review of Residual Cashflow Reallocation Cashflow (RCRC), expectation is that an issue group will start by end of 2022.
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 Early competition, Net Zero Market Reform and TNUOS reform and any new modifications raised by the industry or ESO in the period.

Figure 33 - 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.

The GB investment line will support the ESO Code Change Delivery Team with Discovery and Impact Assessment as and when required for each activity.

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
- P415: 'Facilitating access to wholesale markets for flexibility dispatched by Virtual Lead Parties'
- GC0139: Enhanced Planning-Data Exchange to Facilitate Whole System Planning
- 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
- GC0148: Implementation of EU Emergency and Restoration Code Phase II

Most of the regulatory changes outlined in the plan are in discussion with industry and Ofgem. We have based this investment on assumptions relating to the potential solutions for each regulatory change, using the best information available at the time of writing. Consequently, depending on the nature of the change, implementation costs may increase or decrease over the BP2 period.

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.

The overall approach is to augment the existing IT regulatory change team that will support the ESO business with option development, design and implementation of the deliverables as outlined in the business plan.

We will implement regulatory change using agile requirements discovery, capture and build where possible. Release management will be implemented in phases with sequential releases of capability to the relevant target solution, aligned to each area of delivery and their stated implementation method.

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 Technology systems. This analysis is provided to the ESO Code Change Delivery team, which in turn uses the information in workgroup discussions with industry participants and Ofgem.

This process will help to ensure that any decisions made, or options chosen by industry participants at workgroup level, consider the overall impact to the ESO technology landscape.

When necessary, the ESO may recommend that a regulatory change be delivered later, to minimise the impact to legacy platforms, and reduce the total costs of delivering the change.

Our overall strategy for delivery of regulatory change in the BP2 period is to align systems change with our target architecture framework wherever possible.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	0.8	1.6	1.1	4.3	5.2	13.0
	BP1	2.7	2.7	2.7	2.7	2.7	13.5
	Variance	**-1.9**	**-1.1**	**-1.6**	**1.6**	**2.5**	**-0.5**
Opex (£m)	BP2	0.2	1.1	1.5	1.8	1.8	6.4
	BP1	0.3	0.3	0.3	0.3	0.3	1.5
	Variance	**-0.1**	**0.8**	**1.2**	**1.5**	**1.5**	**4.9**
Totex (£m)	BP2	1.0	2.7	2.6	6.1	7.0	19.4

	BP1	3.0	3.0	3.0	3.0	3.0	15.0
	Variance	**-2.0**	**-0.3**	**-0.4**	**3.1**	**4.0**	**4.4**

Cumulative RTB increase (£m)	BP2	0.0	0.0	0.1	0.2	0.3
	BP1	0.0	0.1	0.2	0.2	0.3
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Table 143 - Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
Evolved or refined scope in BP1	Increased investment upfront in discovery and impact assessment activities	Opex Capex	There are 3 key factors at play: The concept of Discovery and Impact assessment analysis was developed in BP1 and therefore not included in the original forecast. The changes considered 2 years ago in the original plan are different to the changes in current backlog. The expectation that regulatory change will continue to increase supporting the UK net zero ambition. Capex variance due to Capex to Opex shift.	+ £4.9m - £0.5m
			Costs change since BP1	+ £4.4m

Table 144 - Investment cost change summary

As with the **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. Any assumptions as to the direction we expect each of the changes to go, have been documented.

The updated forecast variance compared to the original plan is attributed to:

- The introduction of the Discovery and Impact assessment process – Increased Opex spend earlier in the change lifecycle to support industry discussions.
- Updated backlog of changes - The original plan forecast was set two years ago based on historical regulatory change against a significantly different background.
- The expectation that regulatory change will be required to support the UK net zero ambition - We expect the volume of regulatory change to continue to increase over BP2 as more regulatory code changes are required to enable and support all major net zero programmes.

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).

For regulatory changes that, at point of writing, we had completed impact assessments with costs provided by the affected IT product teams, 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 benchmark 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, and forecasts adjusted through the existing ESO governance framework.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Deliver	When developing this plan, we assumed a certain volume of change to be delivered in BP2. This is based on discussions with business teams and a review of the current/future change landscape.	Program, Product & Project Management	If this assumption is false, there could increases in the costs and time to deliver those changes.	Monthly via the Programme Delivery Board.

Table 145 - Investment assumption summary

Risks

Risk	Relevant IT Tower Component	Mitigation(s)	Likelihood	Impact
This investment plan may need to change over the BP2 period should there be any significant deviations from assumptions on the timescales & scope, leading to potential increase in costs.	Program, Product & Project Management	To invest sensibly and commit resources when scope and priority is clear To work closely with ESO Code Change Delivery Team for early visibility of changes that could impact ESO IT systems.	4	1
Changes to existing or new regulatory commitments are incompatible with the wider ESO technology change roadmap, leading to potential additional costs and reducing benefits. GC0117 is an example, where should the industry push for an earlier delivery date out of step with the ESO Balancing Programme, this could cause costs to increase beyond original expectations.	Program, Product & Project Management	Ensure IT regulatory team and ESO Code Change Delivery Team collaborate with Ofgem, to highlight risks early in the change process	4	1

Table 146 - Investment risk summary

3.23 320 EMR and CfD Improvements

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
Confirmed	Hybrid	On-Track: 1	Complete: 2	Delay: 0	Total Count: 3

Overview & Purpose

This investment delivers an enhanced platform for Electricity Market Reform (EMR).

We will deliver capability supporting the Capacity Market registration, pre-qualification, and agreement management processes. This will also include functionality to manage Contracts for Difference (CfD). The platform will be continually enhanced in response to stakeholder feedback, delivering regulatory change at greater speed and lower costs and automate manual processes. This will allow the business to focus increasingly on higher value activities and better supporting our customers.

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 defining regulatory change.

The ESO plays a key role in advising BEIS and Ofgem on regulatory changes specific to Capacity Market and Contracts for Difference where 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 engagement 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.

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 147 - 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 to deliver the new EMR portal as it can meet the majority of requirements as well as allowing us to leverage the existing Salesforce support function.

Also, during BP1 we adopted a product model using agile sprints to deliver prioritised functionality with regular releases as required, with a particular focus on must have user cases covering user experience and customer outcomes.

The annual Capacity Market (CM) prequalification and auction processes commence in July and runs until February/March each year. The CM processes will continue to be hosted by the existing portal in FY23 rather than the Salesforce platform. This decision was driven by customer feedback and to manage the risk of being able to complete the end-to-end CM process within the operational deadlines.

With the constraints of the CM operational milestones removed, the EMR programme is now replanning to maximise efficiency and ensure there is appropriate opportunity for customers and delivery partners to familiarise themselves with the new solution prior to using it for the CM prequalification process in FY24. This will allow customers to see the end-to-end CM process before production release of a critical revenue stream and winter security product. We will update our roadmap with milestones based on efficiency and customer engagement whilst ensuring operational deadlines are met for FY24.

If the new portal is not fully operational for the CM process in FY24 the delay would be another year due to the operational deadlines of the CM process. Every effort is therefore being made to ensure the re-sequencing of activities does not impede the FY24 process.

By the end of BP1, we will have implemented:

- User and company registration
- Creation and management of capacity market units
- Manage pre-qualification and pre-auction processes
- Foundational integration with our capacity markets auctions platform
- Publish capacity markets register
- Foundational elements of Agreement Management

The above is being achieved using optimised user journeys with intuitive workflows, enhanced data validation and reduced workarounds and manual checks. We will deliver prioritised regulatory changes during this stage, alongside continuous enhancements of the new EMR solution.

Roadmap

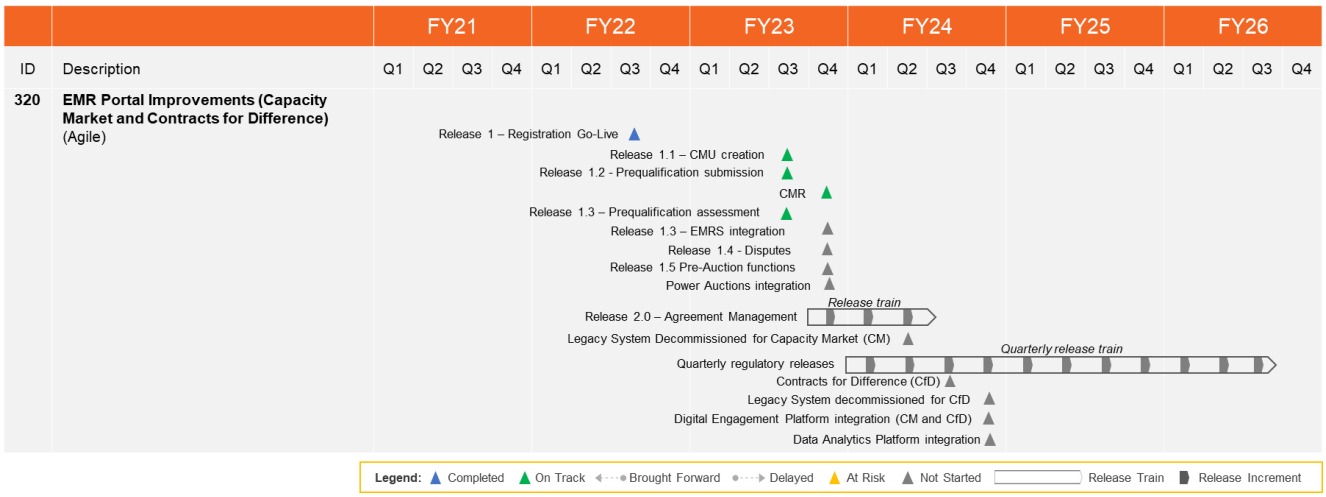


Figure 34 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Release 1 - Registration "Go live"	EMR Business Unit Customers	Provides capability for registration and management of companies and users.
Release 1.1 - CMU creation	Customers	Provides capability for customers to create and manage Capacity Market Units.
Release 1.2 - Pre-qualification submission	Customers	Provides capability and an improved experience for customers to create, manage and submit prequalification applications for auctions.

CMR - Release TBD	EMR Business Unit	Capability to create and publish capacity markets register.
Release 1.3 - 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.
Release 1.4 - EMRS integration	EMR Business Unit Delivery Partner	Integration with EMR Settlements body to allow settlement of the Capacity Market
Release 1.4 - Disputes	EMR Business Unit Customers	Provides enhanced capability and an improved experience for customers and the EMR Business Unit to manage disputes.
Release 1.5 - 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.
Release 2 - 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 148 - Outcome summary descriptions

The outcomes described above will be delivered in the RIIO-2 period and will continue to deliver benefits to customers, stakeholders and EMR Business Unit in RIIO-3.

Future State

In BP2, we will move to a regular 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.

Our plan for BP2 is to integrate the EMR service into the **250** Digital Engagement Platform (DEP), aligning our front-end user interface to the DEP system design 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 and will enable external customers and stakeholders to access ESO data and services in an intuitive, predictable, personalised, and seamless manner.

We will continue to improve and enhance our self-service reporting functionality developed in BP1, with EMR consolidating into the wider target architecture, utilising DAP design standards, and integrating for authorised EMR services/processes, whilst ensuring EMR data is ringfenced for security, operational and regulatory compliance reasons.

Further work will also include exploration and potential implementation of new API-driven interfaces with external parties.

Our original intention was to integrate the EMR portal into the ESO's Single Market Platform (SMP) to drive further benefits to market users. However, the CM and CfD processes and data are currently substantially different from other markets in terms of detail, nomenclature, and taxonomy. As explained in the narrative for sub-activity **A4.4 Deliver a single integrated platform for ESO** in the Business Plan, integration between SMP and the EMR Portal would require standardisation of the CM and CfD data structures with other market services and products (e.g., common nomenclatures instead of the current distinction between BMUs and CMUs). We do not foresee those changes taking place during BP2.

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 BP2.

Target platform	Target Subsystem	Component	Future State
Commercial & Markets	Electricity Market Reform	EMR Administration	EMR Administration capability implemented with alignment to the target architecture including Digital Engagement and Market Services components
Commercial & Markets	Electricity Market Reform	EMR Auction	EMR Auction Capability implemented with alignment to the target architecture including Digital Engagement and Market Services components
Digital Engagement	Customer	CRM Workflow	Managing workflows in SMP
Digital Engagement	Customer	Customer Engagement	Core markets platform capability in Salesforce CRM
Digital Engagement	Market Facilitation	Data Exchange	Management of data exchange with internal systems and 3rd party systems
Digital Engagement	Market Facilitation	Communication	Managing communication channels with our customers
Digital Engagement	Market Facilitation	Market Sandbox	A sandbox capability to simulate or train market participants
Digital Engagement	Market Facilitation	Tendering / Auction	Alignment with our existing CM auctions platform

Digital Engagement	Market Facilitation	Customer Markets Portal	Portal functionality for markets
Commercial & Markets	Settlements	Settlements	Integration with EMRS
Balancing	Energy Trading	Trading Auction	Integration with future trading platforms
Data & Analytics	Analytics & Insight	Internal Reporting	DAP reporting for insights and market reports
Data & Analytics	Analytics & Insight	Predictive Analytics	Analytical reporting from our DAP for market participants
Data & Analytics	Consistent Data Services	Integration Non-CNI	Integration services with auctions and LCCC
Data & Analytics	Regulatory Reporting	Information Provision	Provision of CMR regulatory reports

Table 149 - 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 readiness for the 2023 prequalification process. In BP2, we will continue to build and enhance the new EMR solution, decommission the residual elements of the legacy portal, as well as implement the integration with the external Electricity Market Reform Settlements (EMRS) and Low Carbon Contracts Company (LCCC) bodies.

Integration with our Digital Engagement Platform (DEP) and Data and Analytics Platform (DAP) will provide for greater levels of alignment with our design system, identity/access management, analytics platform and API based data exchange services.

In BP1 we introduced the product model, using an agile methodology to deliver new functions and features. 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. In addition, APIs to support data exchange with external parties will be explored and implemented where appropriate.

Solution Options

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

- A detailed review of the options for re-engineering the current platform to address existing pain points
- A Request for Information (RFI) with our Application Development and Application Maintenance (ADAM) partners to propose alternative solution options that would address existing pain points as well as provide flexibility for future changes. These included Customer Relationship Management (CRM) solutions such as Salesforce, Microsoft Power Platform as well as low-code alternatives.

Salesforce was the preferred solution presented by the majority of RFI responders and was chosen as it best aligns with ESO's goals of delivering customer-centric user experience, cost efficiency and speed of change:

- Salesforce is National Grid's strategic CRM tool for customer centric digital solutions and has been used within UK business units since 2017, establishing a centre of excellence combining National Grid and partner resources.
- 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 (Software as A Service model), with focus on building applications. Other options such as MS Power Platform and low code options were assessed to have higher initial setup costs.
- Contractual/Commercial relationships already exist, reducing RFP lead time.
- EMR has a number of unique requirements which cannot be satisfied 'off the shelf'. With pre-existing commercial arrangements and an internal Salesforce delivery team the time and cost to deliver these customisations is reduced. The alternative would be to constrain customer requirements to minimise cost and timescales, but this would not align with customer expectations.
- We anticipate that the Salesforce platform, augmented by its partner eco-systems apps available on the App Exchange, will support the ESO and customer requirements for the long term.

Power BI was selected as our self-service reporting solution, as it aligned to our Data & Analytics Platform (DAP) strategy and was implemented ahead of DAP services coming online due to the high importance of self-service reporting requirements to our stakeholders.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	5.6	5.2	4.1	3.1	3.1	21.0
	BP1	1.2	0.9	0.9	0.9	0.9	4.7
	Variance	**4.3**	**4.4**	**3.2**	**2.2**	**2.2**	**16.4**
Opex (£m)	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**	**-2.8**
Totex (£m)	BP2	5.6	5.2	4.2	3.1	3.1	21.3
	BP1	2.1	1.4	1.4	1.4	1.4	7.8
	Variance	**3.6**	**3.8**	**2.8**	**1.7**	**1.7**	**13.5**
Cumulative RTB increase (£m)	BP2	0.0	0.4	0.5	0.3	0.3	
	BP1	0.0	0.1	0.1	0.1	0.2	
	Variance	**0.0**	**0.3**	**0.3**	**0.1**	**0.1**	

Table 150 - Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
Evolved or refined scope since BP1	Solution and approach confirmation	Capex Opex RtB	Roadmap was being developed during our original submission. Therefore delivery and post-implementation costs were indicative based on high level EPICs ahead of solution and approach confirmation or detailed business requirements.	+ £7.5m - £2.8m + £0.1m
Evolved or refined scope since BP1	Requirement complexity	Capex	Higher cost and additional resources and delivery times to deliver the more complex requirements	+ £8.8m
			Costs change since BP1	+ £13.6m

Table 151 - Investment cost change summary

The need to shift the delivery of the platform from RIIO-1 into RIIO-2 has meant that Capital Expenditure costs that were expected to incur in RIIO-1 were incurred in RIIO-2. The original numbers in BP1 were also set before we had full understanding of the new EMR portal replacement solution. Our updated EMR roadmap now provides clarity on the solution, delivery approach and timescales and thus improved certainty on our estimates.

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.

The variance in costs is largely driven by the detailed definition of the requirements, solution pattern, data migration and reporting use cases. The BP1 submission provided costs based on high-level EPICs and features, using a small, medium, large t-shirt sizing estimation model for Salesforce based solutions.

Detailed reviews of user stories and technical components have indicated higher development complexity to deliver the regulated processes for CM and CfD. Other drivers to the cost variance include a higher cost in securing Salesforce partner resources for development, longer than anticipated delivery times and extra resources to deliver more complex requirements.

Additional investment is also required for FY24-26 to support new anticipated levels of change required post the new portal implementation.

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.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency

Design	We have assumed DAP will support the EMR reporting functionality and infrastructure.	Application, Platform and Security Compliance	There will be an impact on enhancing and improving the capability. Standard salesforce reporting will reduce impact. Explore alternative options (approved by ESO strategy) to deliver the enhanced capability and support arrangements to meet our BP2 commitments.	Quarterly

Table 152 - Investment assumption 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 at the required time due to business and/or technical dependencies, leading to increased cost or project delays	Application Support & Operations	Align product roadmap to IT strategic platform roadmap Assess each functional component on its criticality and consider operating without components, or tactical options, where migration is incomplete	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

Table 153 - Investment risk summary

3.24 330 Digitalised Code Management

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
In Draft	Hybrid	On-Track: 1	Complete: 4	Delay: 1	Total Count: 6

Overview & Purpose

This investment delivers the ESO Technology capability to make industry codes accessible and consumable for customers.

We will transform the customer experience for the code management process through:

- Digitalisation of codes
- Contextual guidance and relevance for customers
- Provision of enhanced navigation capabilities
- Greater clarity on relevant sections using metadata tagging, document and workflow management tools
- Automated version control

This investment line interacts with **250** Digital Engagement Platform in the IT portfolio and supports sub-activity **A6.8 Digitalisation of Codes** in the ESO business plan.

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 154 - 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 sub-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 several 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 activity **A6.8 Digitalisation of code**, which is concerned primarily with looking at digital solutions to enable easier access to code.

In addition, the ESO is bringing forward this activity by 1 year compared to the original RIIO-2 plan, to deliver value sooner by leveraging the ongoing customer engagement as part of the Energy Code Review, where customers are being actively engaged on how to manage, visualise and amend/maintain codes in the future.

In BP1 the project has mobilised a customer focussed technical team, consisting of a Product Owner, UX Designer and Business Analyst to progress Phase 1 of the digitalisation work.

During FY23 we are undertaking significant engagement with industry stakeholders through user research activities with customers surveys, focus group activities, journey and process mapping and prototype development. This phase is invaluable in allowing the team to produce foundational project artefacts such as customer journey maps, user persona and requirements documentation and to obtain feedback on early solution prototypes.

By the end of BP1, once requirements are fully defined, the team will also deliver a technical review of the requirements which in turn will inform the assessment of the potential delivery options into the BP2 period.

Roadmap

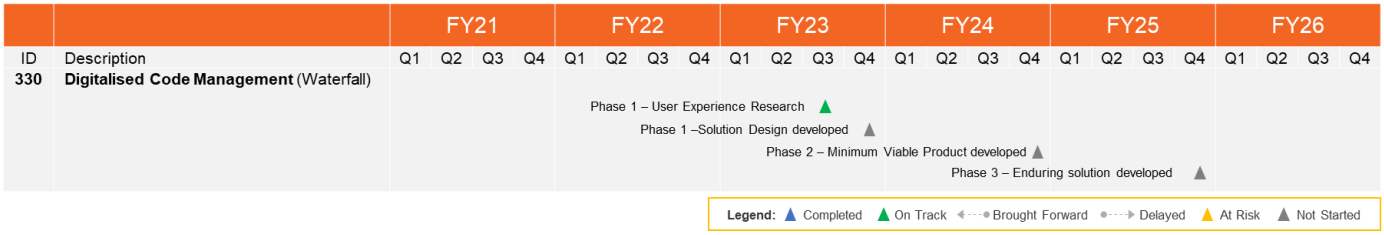


Figure 35 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Phase 1 – User Research	Business units	Engage stakeholder groups and forums Understand and define the problem/customer pain points Develop and validate user personas Understand the customer journey Develop and prioritise user requirements Forming and publishing a clear scope of work Produce a high-level project plan Produce an initial prototype
Phase 1 – Solution Design Developed	Business units	Complete technical review Complete delivery options assessment Assess potential solutions Agree most suitable solution design Ensure new platform is flexible and scalable to support digitalisation of further code
Phase 2 – Minimum viable product developed	Business units Customers & Partners	Develop MVP Test and iterate improvements on core design Define BAU processes
Phase 3 – Enduring solution implemented	Business units Customers & Partners	Launch enduring product Refine via BAU process Digital Engagement Platform integration is expected to take place during phase 3 of the project.

Table 155 - Outcome summary descriptions

Future State

We will digitalise and transform the external user experience through:

Digitisation of code text, including embedded data such as equations and graphics

Guided navigation and search capability of codes, which will mean stakeholders are guided to sections of code that apply to them, based on their characteristics.

Our approach and solution will be defined for the GB grid code and will be scalable to other codes, building on our investments in open data and digital engagement. We will utilise the target architecture framework to define the solution and expect to leverage Cloud IaaS/SaaS/PaaS capability to achieve the desired functionality.

The code modification process could also be enhanced by the provision of workflow automation capability, to make the change process more efficient and accessible to stakeholders depending on user research findings taking place in FY23.

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 BP2.

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

Table 156 - 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 industry codes with much less manual intervention.

Our roadmap assumes an 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.

We propose a phased implementation of digitalised code capability to deliver a platform flexible enough to support further codes as required by ESO and Industry:

- Phase 1 (FY23) – User research, prototype development, requirements definition complete technical review and assess solutions and delivery options.
- Phase 2 (FY24) – Agree on solution and delivery vehicle, produce Minimum Viable Product.
- Phase 3 (FY25) –Develop enduring solution to include functionalities as informed by user research, which could include advanced navigation capabilities, meta tagging and cross-linking and API capability if appropriate. Integrate with Digital Engagement Platform to deliver on an improved customer journey.

The outcome of user research and design system activities completed in Q3 FY23 will determine the approach to deliver the digitalisation of codes. We may identify enough synergies with the Digital Engagement Platform (DEP) technology and features to deliver the Digital Code Management through the DEP backlog.

Alternatively, a stand-alone project may be mobilised to identify the suitable technologies and deliver the digitalisation of codes in a prioritised manner.

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 enhanced search capabilities from our Digital Engagement Platform, though some advanced document versioning and control capabilities may be delivered outside of this.
- Review market leading Commercial Off the Shelf (COTS) or Software as a Service (SaaS) solutions that may support these requirements.
- Leverage or extend existing document management and visualisation tools that may provide some of these capabilities.
- Consideration has been given to bespoke options however we do not believe it would be feasible to create a digitalisation solution that would offer additional features or improve upon a COTS or SaaS offering from the marketplace.

For all solution options it is noted that the complexity of some of the Grid Code content requires extensive structural data work – for example to manage embedded power systems mathematical equations and graphics that are unique to our industry. This is expected to require manual data preparation and validation and this activity aligns to market offerings for software designed to import structured/unstructured data and make it accessible and searchable for internal and external users.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	0.0	0.1	1.1	0.5	0.0	1.7
	BP1	0.0	0.0	0.3	0.8	0.5	1.6
	Variance	**0.0**	**0.1**	**0.8**	**-0.3**	**-0.5**	**0.1**
Opex (£m)	BP2	0.0	0.1	0.5	0.4	0.0	1.0
	BP1	0.0	0.0	0.2	0.5	0.3	1.0
	Variance	**0.0**	**0.1**	**0.3**	**-0.1**	**-0.3**	**-0.1**
Totex (£m)	BP2	0.0	0.2	1.6	0.9	0.0	2.7
	BP1	0.0	0.0	0.5	1.3	0.8	2.6
	Variance	**0.0**	**0.2**	**1.1**	**-0.4**	**-0.8**	**0.1**
Cumulative RTB increase (£m)	BP2	0.0	0.0	0.0	0.0	0.1	
	BP1	0.0	0.0	0.0	0.0	0.1	
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	

Table 157 - Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
N/A	Rounding	Capex	Totex variance due to rounding error	+ £0.1m
		Costs change since BP1		+ £0.1m

Table 158 - Investment cost change 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 project is at the very beginning of the problem definition phase, working with users to understand the key pain points.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Design	We assume that business requirements can be fulfilled by a Commercial off the Shelf or Software as a Service platform.	Business Software	If false, it could lead to additional costs being incurred to develop and maintain a scalable and flexible bespoke solution	Quarterly
Design	We assume a digital solution for Grid Code can be applied equally to the future consolidated transmission and distribution code.	Application Development	If false, it could lead to additional costs being incurred to develop and maintain a scalable and flexible bespoke solution.	Quarterly

Table 159 - Investment assumption summary

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
Current lack of clarity on requirements and technical solutions at this stage of the project lifecycle could lead to an increase in costs and delays to delivery of enduring solution.	Application Development	Crystalise requirements in the User Research phase. Conduct a market assessment of relevant comparable tools available in the industry and their alignment to user requirements and digital strategy.	3	1
Energy Codes Review initiative may create unforeseen impact leading to potential delays in delivering the complete capability.	Application Development	Maintain Engagement with ESO Code Administration Team Periodic review of dependencies & programme interlocks Review, impact assess and develop fallback options	2	1

Grid code data structure complexity may require significant additional pre-work to make suitable for a COTS or SaaS solution, leading to increased costs and potential time delay	Application Development	Engage data modelling and technical documentation expertise during FY23 Ensure source data fully represented in any technology product scoping discussions	3	1

Table 160 – Investment risk summary

3.25 400 Single Markets Platform

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
Confirmed	Hybrid	On-Track: 0	Complete: 7	Delay: 4	Total Count: 11

Overview & Purpose

This investment delivers access for all market participants into ESO market and energy services.

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 of flexibility to facilitate decarbonisation and deliver consumer benefits that follow:

It 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.

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

Across the IT portfolio, this investment interacts with **220** Data and Analytics Platform, **610** Settlements, Charging and Billing, **420** Auction Capability and **180** Enhanced Balancing Capability. In the original plan, we envisaged synergies between **320** EMR and SMP based on the high-level scope available at the time. However, when common features were considered significant data taxonomy differences emerged between SMP and EMR, which need to be addressed before any integration can successfully be delivered. As such, we do not foresee any integration within the BP2 timescales

In the ESO business plan, this investment line enables sub-activities **A4.3 Deliver an efficient frequency market**, **A4.4 Deliver a single integrated platform for ESO markets** and supports **A4.5 Facilitate whole electricity system market access for distributed energy resources (DER)** in the ESO business plan.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A4.3 Deliver an efficient frequency market • A4.4 Deliver a single, integrated platform for ESO Markets • A4.5 Facilitate whole electricity system market access for distributed energy resources	• Designing and developing the services so they are implemented and procured efficiently. New frequency response and reserve services interaction with each other operationally and commercially, and the wider market. • Single, seamless user experience for providers of balancing services • Improved DER asset visibility

Table 161 - Summary of business outcomes and corresponding sub-activities

Current State

The original RIIO-2 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.

As we considered the introduction of new response and reserve services onto the market, it became evident that changes were required to the SMP to allow for the onboarding of the market participants and also to the

systems that SMP integrates with downstream, providing the effective management of these new services end-to-end. This was not factored in the original RIIO-2 submission and led to restructuring of this investment line.

The SMP investment line has therefore been split 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) – provides 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) – delivers 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

Within the first year of BP1 we successfully selected Salesforce as our preferred platform for customer facing interactions for market participants and have commenced the development of the Single Markets Platform. The foundational release of SMP went live in Q4 FY22 in support of the onboarding process for the new frequency response services.

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, auction, and settlement systems
- Foundational work to integrate our enduring auctions platform

During BP1, the introduction of the SMP platform enabled the onboarding and participation of providers to the three newly launched frequency response products: Dynamic Containment, Dynamic Moderation and Dynamic Regulation, procured using the EPEX SPOT auctions platform, a tactical solution implemented in advance of the enduring Auction Capability to enable day-ahead procurement, underpinned by the required changes to downstream systems, delivered via ASR.

In the later stages of BP1, we will start to align SMP with our Design System (delivered by **250** Digital Engagement Platform). This provides 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 scrum teams and defined release trains delivering a prioritised backlog of features.

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

Roadmap

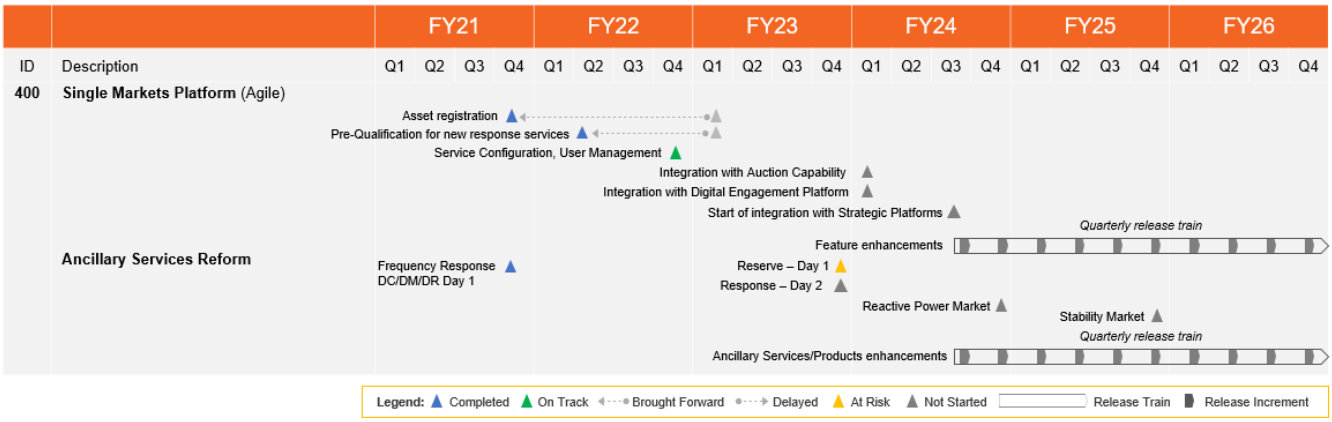


Figure 36 - Outcome roadmap

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.
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 Digital Engagement Platform (DXP)	Customers & Partners	Market participants will benefit from a consistent login experience when accessing multiple services on SMP, through a centrally managed single sign on by DEP CIAM solution. They will also benefit from a more personalised experience when accessing open data via the DXP through the use of account pages that provides relevant, contextual information.
Start of integration with Strategic Platforms **420 Auction Capability, 610 Settlement, 180 Balancing	Customers & Partners Business units	Quicker, more efficient market provider onboarding and management across end-to-end internal processes Faster entry to market for market participants Increased flexibility for market providers to update and change their market offering and participation

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.
ASR		
Frequency response DC/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, including DER 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.
Response day 2	Customers & Partners Business units	Customers - The introduction of new standardised products supported by automated process will grow market participation, including DER and increase competition and driving prices down in the long term. Business – critical to improve further the effectiveness of Response services, and enable the lifting on the MW cap, which will enable the decommissioning of Firm Frequency Response. Better visibility and management of products by the control room.
Ancillary services enhancements E.g., Future changes to new response services		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 37 - Outcome summary descriptions

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

**Dependent on availability and backlog of those of those platforms

Future State

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

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

- **420** Auctions platform - flexible procurement engine for new products
- **220** Data and Analytics Platform - self-service reporting and metered services performance monitoring
- **250** Digital Engagement Platform - managing customer identities and publishing open data
- **180** Enhanced Balancing platform - control room for situational awareness and decision-making

- **610** Settlements, Charging & Billing platform - 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.

Closer integration with the upstream Connections Platform will allow us to optimise the wider Balancing Mechanism registration process. We will complete the integration with our downstream systems such as the new balancing and dispatch systems as well as the 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 optimisation 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 to optimise ESO and DSO/Flexibility markets 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 start to understand the data exchange required 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 BP2.

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

Data & Analytics	Consistent Data Services	Integration CNI	Integration with downstream control room systems
Data & Analytics	Consistent Data Services	Integration Non-CNI	Integration services with auctions and other business applications
Data & Analytics	Modelling	Economic Modelling	Data modelling within DAP for markets
Data & Analytics	Regulatory Reporting	Information Provision	Provision of regulatory reports
Balancing	Balancing Communications	Data Exchange	Transfer of contract and availability information to control room balancing systems
Balancing	Energy Balancing	Balancing Services	Changes required in balancing service to deliver changes for ASR

Figure 38 - 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 frequency response, reserve, stability, and reactive power markets are introduced and further enhanced.

We intend to exploit the platform to deliver significant enhancements and greater levels of integration with our wider platform architecture utilising Salesforce's out of the box connectors, integration patterns and application exchange services.

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 RIIO-2, in alignment with market reform activities and the introduction of new market products.

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). We will continue to mature our product model as we enhance our internal capabilities and tooling to reduce delivery timescales and maximise efficiency and reuse.

The ASR workstream will manage the delivery of changes to the downstream systems including auctions, settlements, balancing and reporting system. The impact on these systems will be assessed, prioritised alongside other changes in downstream system backlogs and delivered as part of downstream system releases.

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 functionality 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.

From an ASR perspective, the programme will consider the following when assessing the solutions to deliver new services:

- Minimise the developments on interim platforms and wait for the strategic platforms to be available, if possible, or
- Develop interim solution options and, where available, leverage existing solutions on the estate rather than developing bespoke solutions to minimise additional costs.
- Only consider development on interim/legacy platforms when benefits to consumer and internal teams largely outweigh project costs.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	4.6	7.7	6.7	6.5	6.3	31.8
	BP1	3.1	3.1	2.2	1.2	1.3	11.0
	Variance	**1.5**	**4.6**	**4.5**	**5.3**	**5.0**	**20.8**
Opex (£m)	BP2	0.8	0.5	0.8	0.5	0.5	3.0
	BP1	2.1	2.1	1.5	0.8	0.9	7.3
	Variance	**-1.3**	**-1.6**	**-0.7**	**-0.3**	**-0.3**	**-4.3**
Totex (£m)	BP2	5.4	8.2	7.4	7.1	6.8	34.9
	BP1	5.2	5.2	3.6	2.1	2.2	18.3
	Variance	**0.2**	**3.0**	**3.8**	**5.0**	**4.6**	**16.6**
Cumulative RTB increase (£m)	BP2	0.2	0.8	1.3	1.4	1.4	
	BP1	0.0	0.6	1.1	1.5	1.8	
	Variance	**0.2**	**0.2**	**0.2**	**-0.1**	**-0.4**	

Figure 39 - Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
Evolved or refined scope since BP1	Downstream system changes (ASR programme)	Capex	Back-end changes required on platforms such as Procurement, Balancing and Settlements that underpin the introduction of new services and enhancements, omitted from original submission.	+ £20.8m
Efficiencies	Backlog optimisation	Opex	SMP backlog review and rationalisation.	- £4.3m
Costs change since BP1				+ £16.5m

Table 162 - Investment cost change summary

The SMP programme has gone through significant restructuring since the original RIIO-2 submission was published.

The original RIIO-2 focused on the upstream steps for onboarding and enabling markets participants to participate in day ahead markets for delivery as soon as achievable. As such, it did not reflect the back-end changes required on platforms such as Procurement, Balancing and Settlements that underpin the introduction of new services (response and reserve), and their enhancements.

Consequently, the Ancillary Services Reform (ASR) programme of work had to be initiated and included under this investment line to reflect the omission from the original plan, driving a variance in costs.

The changes under ASR include development on legacy and interim platforms to support the introduction of new reserve or response services, whilst replacement strategic systems such as Open Balancing Platform, Enduring Auction Capability and Charging and Billing are introduced.

The most significant downstream systems impacted are:

- Nortech DataConcentrator for Performance monitoring (until now used for operational metering) and the development of a Performance Analytics Platform (PAP) to support the requirement for Performance Monitoring and facilitate availability redeclaration and baselining new frequency response products (DC, DM, DR).
- ASDP (Non-BM Dispatch) and BM (Dispatch and Scheduling) legacy platform changes have been required to support the new frequency response and reserve products in advance of the new OBP platform being available, to reap the benefits of introducing new products for BOM and non-BM and meet RIIO-2 milestone
- Changes to User Written Applications (UWAS) such as Firm Frequency Inertia Calculation (FFRIC), Apollo, Spice, and offline Energy Response tool before the new OBP and Settlement strategic platforms.
- EPEX Auction software to meet the day-ahead procurement requirements, initially used with firm frequency response (FFR) before the enduring Auction Capability (EAC) is in place (due Q2 FY24).
- Interfaces up and downstream to facilitate the introduction of response and reserve end to end including strategic platforms.
- The costs of the changes above are reflected in the scope of the Ancillary Services Reform programme explained earlier, which represent an increase of £20.8m across the RIIO-2 period for the **400** Single Markets Platform investment line.

These were estimated based on the learnings of delivering the new frequency response products, and assuming further products (reserve, reactive power and stability) and enhancements to those would be delivered across the period. It also includes £240k of migration/decommissioning costs to transfer data, decommission interfaces and manage business change as we move from legacy systems to strategic platforms.

The increase in costs is partially offset by £4.3m worth of efficiencies on the SMP programme budget, identified by reviewing and prioritising a customer-driven backlog of work. That means a total net increase of 16.5m for the investment line over the 5-year RIIO-2 period.

The BP2 updated forecast for **400** Single Markets Platform benefits from:

- Consideration for end-to-end costs including integration of downstream systems, migration and decommissioning of interim EPEX solution and other legacy interfaces.
- A bottom-up review of the SMP backlog of requirements has taken place, justifying the sustained use of 2 scrum teams to deliver change backlog.
- Subject to business product release plans, this investment will develop and deliver one new product per year, with regular enhancements to these products thereafter:
- FY24 – Delivery of firm reserve and development of reactive power, enhancement to launched services and migration from legacy systems to strategic platforms. As stated earlier, reactive power and stability services 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 and enhancement of launched services.
- FY26 – Delivery of stability and any new projects (issued from Pathfinders or other requirements) and enhancement of launched services.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Deliver	We assume that new products such as reactive power and stability will be delivered in alignment with the introduction of strategic platforms, for example, Open Balancing Platform. Timings for the release of these new products will be determined by the business requirements.	Program, Product & Project Management	If false, this could lead to additional spend on legacy platforms	Quarterly
Deliver	The forecast assumes strategic platforms (Auction Capability, Settlement, Charging and Billing platform, Enhanced Balancing Capability, Data and Analytics Platform) will be in place from Q3 FY24.	Program, Product & Project Management	If false, this could lead to additional spend on legacy platforms.	Quarterly

Table 163 – Investment assumption 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.	2	1
Strategic platforms are not available, and changes need to be completed on legacy platforms, leading to increase in costs and use of grey IT solutions.	Application Development	Align product roadmap to IT strategic platform roadmap Align product feature release roadmap (Day 1, Day 2 release) to IT Strategic roadmap. Continuous engagement with business stakeholders to ensure cost benefit of introducing new services in legacy IT platforms is considered.	3	2
Single Markets Platform is the early adopter of the National Grid API/ integration service, which is itself is its early stages of implementation, leading to early adoption teething	Application Development	Raise issues early and work with API/integration tower to ensure resources, tooling and deployment process are in place. We are working with the relevant stakeholders to ensure the processes are in place to	4	2

issues and potential delays in new services implementation.		support the API integration within the BP1 period		
The ESO technology Agile operating product model, of which SMP is an early adopter, is in its early stages of maturity leading to potential impact the programme delivery timelines.		Work with the organisation to ensure that the infrastructure, resources, tooling, governance, and culture can support the product model and agile delivery.	4	1
End-to-end changes required to manage integration and data exchange with DNOs and DERs are not yet fully understood and not included in the forecast.	Application Development	Work with business stakeholders to understand requirements and timelines for implementation and define what levels of integration will be required in the future.	2	1
Specific requirements for SMP extend service level scope beyond Salesforce existing SLA	Application Support & Operations	Work with National Grid commercial team to review service level options with supplier; Review Business service level requirements to understand appropriate alternative mitigation options	5	1
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 40 – Investment risk summary

3.26 420 Auction Capability

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
Confirmed	Agile	On-Track: 1	Complete: 2	Delay: 1	Total Count: 4

Overview & Purpose

This investment delivers an Auction Capability for ESO customers to offer their energy services.

The capability will improve the experience of how parties participate in our markets. It provides ESO with greater flexibility to support changes such as enhanced bidding granularity and the ability to expand and facilitate new services integration.

Across the IT portfolio, this investment interacts with **400** Single Markets Platform, **180** Enhanced balancing capabilities and the **610** Settlements, Charging and Billing and **220** Data and Analytics Platform and **250** Digital Engagement Platform. This investment enables business sub-activity **A4.3 Deliver an efficient frequency market**, specifically aligning with deliverable **D4.3.5 Auction Capability**.

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

Table 164 – Summary of business outcomes and corresponding sub-activities

Current State

During BP1 we enabled the early day-ahead procurement of Short-Term Operating Reserve (STOR) on our Salesforce CRM platform, and new Frequency services on the EPEX auctions platform. Procuring these services much closer to real-time has provided greater flexibility to market participants and for ESO to be more dynamic in meeting our operational scenarios. These are interim solutions and will remain in place until such time that the strategic platform is up and running.

Leveraging the learning from running daily auctions on both Salesforce and EPEX, the project has completed a procurement event to select the strategic vendor for ESO's enduring Auction Capability. The vendor was chosen in Q1 FY23, based on its technology capabilities, its ability to scale and adapt their solution to meet the needs of ESO and the market.

By the end of BP1, the project will have delivered regular proof of concepts throughout FY23 and early FY24, focussing on the integration with the Single Markets Platform and the adoption of the customer identity and access management (CIAM) (developed by **250** Digital Engagement Platform). These will also demonstrate viability of new auction algorithms and prove operational and business readiness, in advance of the main implementation and deployment by the end of Q2 FY24.

Roadmap

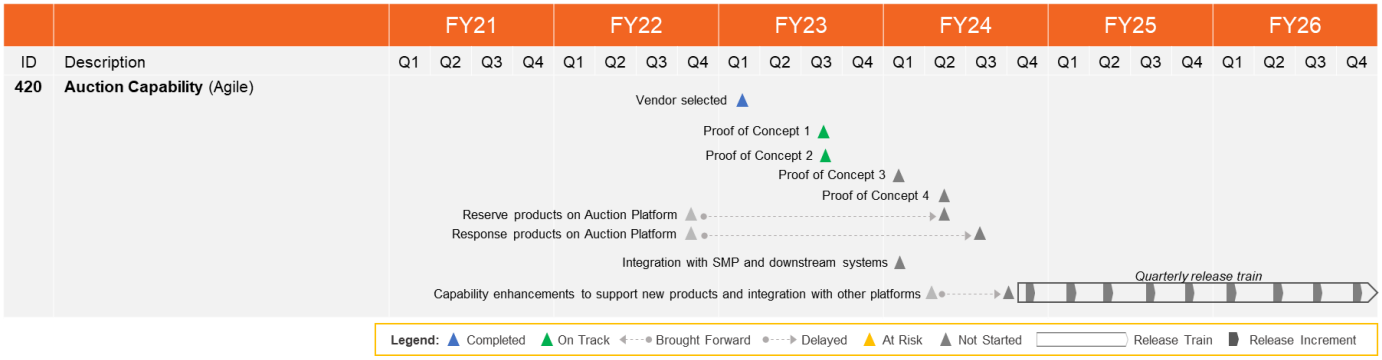


Figure 41 – Outcome roadmap

Milestone	Outcome recipient	Outcome description
Vendor selected	Business units	Partner selection for auction platform, algorithm development and consultancy services
Proof of Concept (POC) 1	Business units	Solution for user interface hosting and integration with the Single Market Platform is confirmed, to ensure a seamless user experience
Proof of Concept (POC) 2	Customers & Partners Business units	Single sign on is enabled using the Customer Integration Access Management tool via DEP
Proof of Concept (POC) 3	Business units	Enduring Auction Capability integration with SMP and CIAM proof of concept in pre-production environment to demonstrate the co-optimisation algorithms are functional and to begin proving our operational and business readiness ahead of market trials.
Proof of Concept (POC) 4	Customers & Partners Business units	Auction results are published for both ESO downstream consumption and public access
Reserve products on Auction Platform	Customers & Partners Business units	A new single solution supported by automated processes and an efficient algorithm to procure day ahead reserve services Automation of decision making, reducing the risk of manual error, and increasing operational effectiveness
Response products on Auction Platform	Customers & Partners Business units	A new single solution supported by automated processes and an efficient algorithm to procure day ahead reserve services Automation of decision making, reducing the risk of manual error,

		and increasing operational effectiveness Connected and co-optimised auctions will lead to increased market efficiency and more auction participants.
Integration with SMP and ESO downstream systems (Pre-Production)	Customers & Partners Business units	Market participants benefit from single integrated view of auctions they are eligible for, submit bids and view auction results ESO will benefit from reduced manual processes for business units, using APIs built to be consumed by downstream systems Connected and co-optimised auctions will lead to increased market efficiency and more auction participants.
Platform capability enhancements to support new products and integration with other platforms	Customers & Partners Business units	Conversion of interim solutions for the procurement of day-ahead ancillary services, to target architecture platforms Increased automation of manual processes

Table 165 – Outcome summary descriptions

Future State

As we transition into BP2 we will implement the enduring Markets and Auctions capability and the enrolling of markets onto the platform will take place in a phased approach. This will start with new reserve and response services introduced in Q2 and Q3 FY24 respectively, followed by reactive power and stability services as and when they are introduced onto the market.

We will work with our enduring auction partner to optimise auction timings, the order in which we buy these services, and improving the design of market rules and algorithms to ensure market efficiency.

To improve user experience and enhance automation and alignment to future ancillary service products we will integrate with the Single Markets Platform and downstream systems. This will enable ESO to procure services more flexibly through enhanced granularity (e.g., procuring by settlement period), requirement setting or streamlined route to market. This will unlock additional value for ESO, wider industry and the end consumer.

By the end of BP2, this investment will 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 co-optimised algorithms 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.

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 BP2.

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

Table 166 – Future state subsystem component summaries

Approach

Building on from the PoCs delivered in FY23 and FY24, the programme will deliver the ESO enduring Auction Capability, with the first release delivered at the end of Q2 FY24.

We will manage our delivery using an agile methodology linked to our Auctions product management function.

Working with our selected vendor to expand and scale the platform, we will implement further ancillary services for reserve and reactive markets. The core team will capture, 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.

Solution Options

During BP1, we chose to implement tactical solutions to address customer priorities for:

- Day-Ahead solution in Salesforce for short term operating reserve (STOR) in response to regulatory changes resulting from Clean Energy Package (CEP6.9).
- Solution for Firm Frequency Response (FFR) auction trials, procuring via EPEX SPOT platform

- Early developments of a Day-Ahead solution for response products (Dynamic Containment, Regulation and Moderation), delivered using EPEX SPOT, building on the work from the weekly FFR auction trial

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 – rejected due to the complexity of auction algorithm requirements
- Build bespoke solution using software created by ESO Technology or low-code alternatives - rejected due to the complexity of auction rules and algorithms requiring extensive maintenance functionality
- Extend and enhance EPEX SPOT for future needs – rejected as we do not believe this tactical solution can meet future flexibility requirements
- Undertake a tendering event to procure a leading day ahead solution that could be adapted to market evolution

We chose the full tender process as our preferred solution approach as market research indicated that flexible and scalable products were available which could meet future functional needs and provide a strong API-driven architecture to support integration with our strategic platforms.

A preferred supplier has been selected with significant market expertise via additional partnerships to maximise value delivered to ESO and market participants. A Q2 FY24 release has been planned with the preferred supplier, and the project plans to deliver additional value via incremental releases after this point.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	0.4	0.2	0.0	0.1	0.1	0.8
	BP1	0.0	0.0	0.0	0.0	0.0	0.0
	Variance	**0.4**	**0.2**	**0.0**	**0.1**	**0.1**	**0.8**
Opex (£m)	BP2	0.3	2.4	2.7	1.4	1.4	8.1
	BP1	4.0	2.0	2.0	0.0	0.0	8.0
	Variance	**-3.7**	**0.4**	**0.7**	**1.4**	**1.4**	**0.1**
Totex (£m)	BP2	0.7	2.5	2.7	1.5	1.5	8.9
	BP1	4.0	2.0	2.0	0.0	0.0	8.0
	Variance	**-3.3**	**0.5**	**0.7**	**1.5**	**1.5**	**0.9**
Cumulative RTB increase (£m)	BP2	0.0	0.0	1.1	1.2	1.2	
	BP1	0.1	0.5	0.8	1.0	1.0	
	Variance	**-0.1**	**-0.5**	**0.3**	**0.2**	**0.2**	

Table 167 – Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
Technology market exposure	Vendor selection, enhancements	Capex Opex	Refinement of costs following vendor selection in FY23 and additional cost in later years of RIIO-2 to support platform enhancements.	+ £0.8m + £0.1m
		Cost changes since BP1		+ £0.9m

Table 168 – Investment cost change summary

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

- The programme has completed the RFP process in July 2022, providing us with a quoted vendor cost.
- The original BP1 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 RIIO-2 period. The new forecast accounts for that requirement.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Design	EAC will fund APIs interfaces between EAC and SMP platform, as well as APIs to share and report on results. API interfaces to downstream operational systems for processing will be funded by ASR	Middleware	If this assumption is false, it could lead to additional costs being incurred on SMP or EAC.	

Table 169 – Investment assumption summary

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
API capabilities required for SMP integration are not available in time for MVP release leading to an incomplete product / delay	Application Development	Ensure early engagement with API and SMP teams to align with delivery timescales Include API capabilities in SMP and Auction's backlog	2	1
Algorithm requirements are too complex to deliver within the agreed timescales leading to an incomplete product / delay 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	Program, Product &	Work closely with business subject matter experts (SMEs) to understand and manage lead times for	2	1

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
consultations may delay or request enhancements to the auction's capability	Project Management	consultation and reflect those into the delivery plan		
Additional market requirements emerge 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 stakeholders to communicate scope and capacity of backlog Work with business SMEs to ensure early visibility of market trends and build those in the contingency plan	2	1

Table 170 – Investment risk summary

3.27 610 Settlement, Charging & Billing

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
Confirmed	Hybrid	On-Track: 15	Complete: 9	Delay: 3	Total Count: 27

Overview & Purpose

This investment delivers the ESO Technology capability to manage industry charging and revenue collection.

We have 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

The **610** Settlements, Charging and Billing investment rationalises the previous submission by aligning it with the new Settlements and Charging business landscape. It supports transition to a product model designed to deliver continuous and sustained changes to the new 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 with industry wide initiatives such as Balancing System Use of System (BSUoS) and Transmission Network Use of System (TNUoS) reform, also new Ancillary Services.

Investment lines **290** and **410** were previously defined 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 manage “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 the plan outlined in investments **290** and **410**.

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 efficient frequency market**.

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 an efficient frequency market	• Management, collection, and dispersal of charges to operating system (Revenue Management) • Ancillary services settlements for existing and new services

Table 171 – Summary of business outcomes and corresponding sub-activities

This investment will support the delivery of the following business outcomes over the RIIO-2 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 and methodology complexity, data, and market demand 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

A procurement exercise has been completed for a new Settlements And Revenue (STAR) solution to deliver the business capabilities required for RIIO-2 and beyond. The Oracle Metering Settlements Management (MSM) product has been selected to replace the legacy Settlements (ASB) solution.

In parallel to the Settlements procurement exercise a review of the Charging and Billing system was initiated which recommended that the replacement of the existing solution would be more cost effective than reengineering due to complexity of existing system architecture. Oracle MSM was selected as the replacement product for CAB, reducing the time and cost for a second procurement exercise for a similar niche product. However, this has delayed the overall roadmap milestones from the original submission, the reasons for which are detailed in the Costs section.

To improve efficiency and reduce costs the CAB and ASB programmes have combined into one product team during FY22. Having now fully onboarded the required suppliers, the product team is progressing towards delivering its first release in FY23.

By the end of the BP1 period the programme will also have established its enduring Product team to migrate remaining revenue streams, ancillary services, and delivery of regulatory change.

Roadmap

By March 2023 the programme's product team will have completed the implementation of the ancillary service for Short Term Operating Reserve (STOR) and delivered revenue streams covering Assistance for Areas with High Electricity Distribution Costs (AAHEDC), BSUoS and TNUoS. In addition, several significant regulatory changes arising from the BSUoS charges reform and Ofgem's Targeted Charging Review (TCR) will have been implemented.

From FY24 our key priority is to ensure the delivery of services and revenue streams onto the STAR platform in line with the roadmap below. We will decommission the legacy systems (ASB & CAB) and offline tools by the end of FY26.

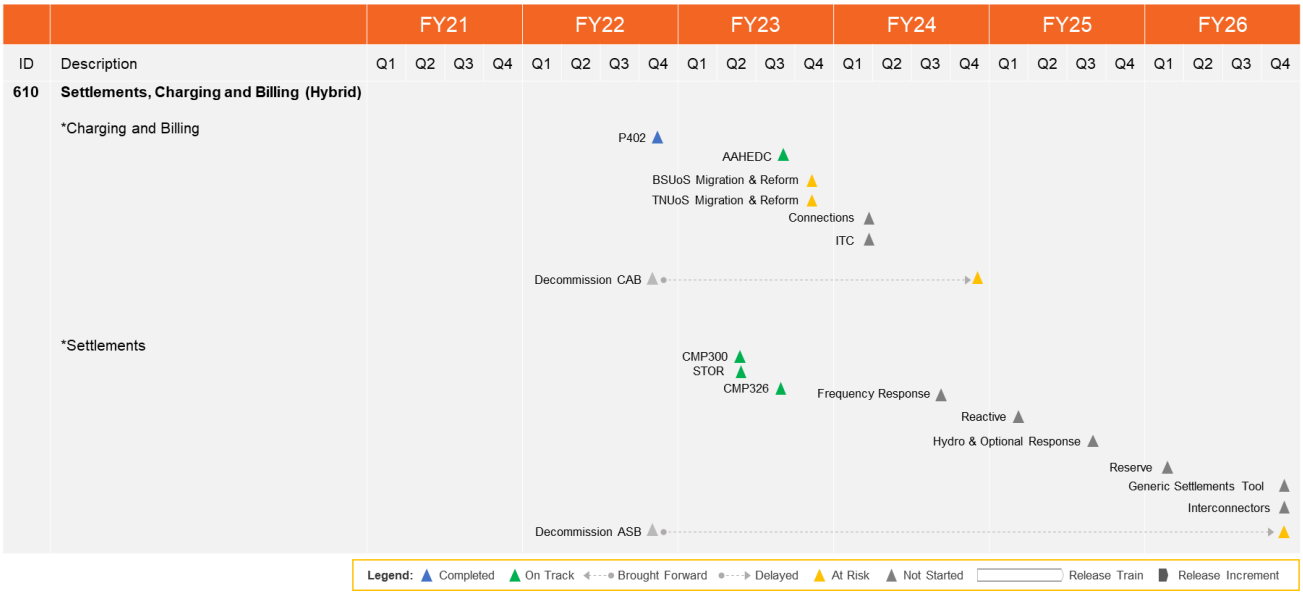


Figure 42 – Outcome roadmap

Milestone	Outcome recipient	Outcome description
CMP300	Customers & Partners	Improvements for Response Energy Payment (REP) for Balancing Mechanism Units (BMUs) with low or negative marginal costs, because of having a Contract for Difference (CfD)
CMP326	Customers & Partners	To introduce a 'Turbine Availability Factor' into the CUSC to enable accurate calculation in the ESO ENCC and consequently accurate settlement of the Frequency Response capability when some turbines on site are unavailable
P402	Business units Customers & Partners	Ability to directly ingest and store LSDO and BSCCo data within ESO, this solution is a first step in open data exchanges, this data is required for New TNUoS
BSUoS Migration & Reform and TNUoS Migration & Reform	Business units Customers & Partners	Data integration from legacy CAB to STAR and enhanced reporting outputs leveraging Oracle Analytics and PowerBI, allowing the business to automatically share reports with customers. Delivers the changes required for the ESO to comply with regulatory changes: • TDR/TGR: CMP343 and 335/336 • BSUoS Reform: CMP361/2, CMP308 and P419 • TNUoS Reform: CMP391 (superseded CMP368/9)
Short term operating reserve (STOR) Assistance for Areas with High Electricity Distribution Costs (AAHEDC)	Business units Customers & Partners	Migration of ancillary services settlement process from legacy ASB to STAR, data integration, resulting in reduction in business manual processes. Enhanced reporting outputs using Power BI

Frequency response Reactive Hydro & Optional Response Reserve Connections ITC Interconnectors		
Generic Settlements Tool	Business units	Replacement of manual processes within the Settlements team and ensure controls are in place to collate and extract data across multiple business processes
Decommission CAB and ASB	Business units	Removal of interfaces, data exchanges and physical servers/hardware.

Table 172 – Outcome summary descriptions

Future State

In BP2, we will build on our foundational releases of STAR in BP1, by extending functional features to support statutory, regulatory, customer and market-driven changes. This includes revenue changes mandated by the TNUoS task force which will reform the TNUoS charging methodology. The impact of Market Wide Half Hourly Settlement (MHHS), a key enabler of a more flexible energy system, will be delivered by settlements and revenue services built upon STAR. The pipeline of regulatory changes is continually assessed to determine the impact on the STAR platform.

During BP2, we will implement a co-ordinated approach to interact with market participants for all monetisation related information. This will be managed via the Single Markets Platform (SMP) for market participant related data and via the Data and Analytics Platform (DAP) and Digital Engagement Platform (DEP) for all open data requirements. We will develop a roadmap of changes in conjunction with the relevant product teams early in BP2, following consultation with key stakeholders and users of these services.

Our product model approach requires a dedicated delivery team to improve cadence and reduce overall costs, by removing the need to mobilise and demobilise resource.

Throughout BP2 the team will continue to migrate ancillary services settlement processes into the STAR platform including frequency response, reactive and reserve 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 STAR 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 BP2.

Target platform	Target Subsystem	Component	Future State
Commercial & Markets	Charging & Billing	Charging & Billing	Core Oracle MSM (STAR)
Commercial & Markets	Settlements	Settlements	Core Oracle MSM (STAR)
Data & Analytics	Analytics & Insight	Data Lake	Harvesting data from Oracle MSM (STAR)

Data & Analytics	Analytics & Insight	Internal reporting	Self-service advanced analytics & reporting
Digital Engagement	Analytics & Insight	Predictive Analytics	Analytical reporting
Digital Engagement	Consistent Data Services	Integration – CNI	Integration with downstream systems
Digital Engagement	Consistent Data Services	Integration – Non-CNI	Integration with downstream systems
Digital Engagement	Digital Services	Digital Applications Suite	Integration with DEP
Digital Engagement	Customer	CRM Workflow	Workflows with SMP
Digital Engagement	Customer	Customer Engagement	To manage customer queries
Digital Engagement	Market Facilitation	Customer Markets Portal	Integration with SMP
Data & Analytics	Modelling	Economic Modelling	Analytical modelling
Data & Analytics	Regulatory Reporting	Information Provision	Provision of reporting to the regulator

Table 173 – Future state subsystem component summaries

Approach

Our overall approach beyond the initial STAR solution implementation is to maintain functionality of the 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 deliver changes for 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 dynamic nature of the code modification engagement process. A process has been established with stakeholders to review and assess proposed modifications at the earliest opportunity with a view to reaching a consensus on our delivery pipeline.

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 Technology infrastructure estate.

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 Data and Analytics Platform (DAP) and published on the Digital Engagement Platform (DEP).

We will implement functionality on the STAR solution using an agile methodology to manage requirements, design, and build. On our legacy systems we will follow a sequential release management process to either retire or decommission functional and technology components.

Solution Options

The ESO utilises two legacy systems in its Revenue and Settlements function: SAP-based Charging and Billing (CAB) and a bespoke Ancillary Services Business (ASB) solution.

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), General Data Protection Regulation 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.

A bespoke ESO Technology development route was considered but not explored due to the complexity of requirements and the software development lifecycle required to replicate functionality provided by a market product offering.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	9.3	8.5	4.8	4.8	4.8	32.2
	BP1	4.7	0.7	0.7	0.7	1.9	8.5
	Variance	**4.6**	**7.8**	**4.2**	**4.2**	**2.9**	**23.7**
Opex (£m)	BP2	0.0	1.0	0.1	0.1	0.1	1.3
	BP1	3.1	0.4	0.4	0.4	1.3	5.7
	Variance	**-3.1**	**0.6**	**-0.3**	**-0.3**	**-1.2**	**-4.4**
Totex (£m)	BP2	9.3	9.5	4.9	4.9	4.9	33.5
	BP1	7.8	1.1	1.1	1.1	3.2	14.2
	Variance	**1.5**	**8.4**	**3.8**	**3.8**	**1.7**	**19.3**
Cumulative RTB increase (£m)	BP2	0.3	1.4	2.3	2.4	2.5	
	BP1	0.5	0.7	0.7	0.7	0.7	
	Variance	**-0.2**	**0.8**	**1.6**	**1.7**	**1.8**	

Table 174 – Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
Evolved or refined scope since BP1	Settlements RFP delay and complexity of requirements	Capex RtB	BP1 submission assumed replacement by Q1 FY22 and costs were indicative ahead of solution selection. RFP timescales were extended for extensive evaluation of options against strategic business and technical requirements.	+ £7.2m + £0.9m
Evolved or refined scope since BP1	Capitalisation rules	Opex	Functionality initially thought to be Opex could be capitalised	- £2m
Evolved or refined scope since BP1	CAB Replacement rather than re-engineering	Capex Opex RtB	BP1 plan assumed re-engineering. A review of the roadmap against future requirements recommended replacement and alignment with the Settlements solution	+ £4.9m - £2m + £0.9m
Accelerated drive to zero carbon operation	Increased regulatory demand	Capex Opex	High regulatory demand including Significant Code Review necessitating teams to deliver requirements onto legacy and new systems	+ £11.6m - £0.4m
			Costs change since BP1	+ £21.1m

Table 175 – Investment cost change summary

As indicated earlier in this chapter, this investment line represents 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 – replacement of the Ancillary Services Business system and **300** Charging Regime and CUSC changes – ensuring funding is available to deliver regulatory change throughout RIIO-2.

The ESO Settlements and Revenue landscape has changed considerably since the original submission was drafted and as a result so have the costs for this particular investment. Our cost change drivers can be summarised as follows:

Settlements RFP delay and complexity of requirements – In our original submission we committed to the replacement of the ancillary services settlement system. As part of this process, we assessed solution options and feasibility and completed an extensive procurement exercise to the wider market whilst indicative costs were submitted.

The decision to replace CAB – the original submission plan, and its forecast, assumed that the ESO would re-engineer the legacy CAB system and continue to manage as asset health activity. Our review highlighted the complexity and increasing cost of delivering change on the existing service. We have chosen to replace the legacy CAB system with the same solution as Settlements (STAR), driven by the alignment of outcomes and requirements, and benefits of merging technology and programme delivery capability. The costs of replacing CAB in its entirety were not accounted for in the original submission, which has caused the delta between BP1 the BP2 forecast.

Increased regulatory change demand – The regulatory 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 with several significant code changes, 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 milestones section for details of those changes.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Operate	Enduring STAR Business As Usual product team will insource required Oracle MSM skills and capability, reducing reliance on partners and ensuring Intellectual Property (IP) retention within ESO.	Application Development	There will be a dependency on partners if we are unable to insource the required skills, which will increase the cost and reduce the value of the IP retained within ESO.	Every Month

Table 176 – Investment assumption summary

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
Dynamic nature of 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	Program, Product & Project Management	Maintain Product roadmap to ensure regulatory vs functional changes are prioritised appropriately with Market / Internally within ESO Increase Product team velocity (through additional Agile teams)	5	2
Complexities of implementing new technology (Oracle MSM) and successfully integrating may increase the time and cost	Program, Product & Project Management	E2E testing will describe the approach to mitigate and minimise impact to schedule, close alignment across ESO Technology suppliers for integration support	4	2
We do not invest sufficiently in ESO Technology domain knowledge for Oracle MSM	Program, Product & Project Management	Building core technology product team , transition key roles from partner to ESO. Retain partner change capability sufficient to continue onboarding of ESO Technology domain knowledge	3	2

Table 177 – Investment risk summary

Role 3 Investments

3.28 340 RDP Implementation and Extension

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
In Draft	Hybrid	On-Track: 5	Complete: 12	Delay: 10	Total Count: 27

Overview & Purpose

This investment delivers our ESO Technology capability to support net zero grid operations for electricity transmission and distribution networks.

We will implement an integrated data exchange and situational awareness capability with DNOs and 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.

Greater control room interaction and sharing of information with TOs, DNOs and DSOs is required to enable operation across boundaries and understanding the impacts of actions on other parties.

We are aligning to the Energy Data Taskforce (EDTF) key finding in operational optimisation, enabling operational data to support system optimisation, and facilitating network access at all levels across the system.

This work provides benefits across each of the three role areas, and it enables sub-activity **A15.5 Develop Regional Development Programmes (**RDPs). This investment also provides enhanced capability to the Electricity National Control Centre so therefore also enables **A1.1 Ongoing Activities.**

It is expected that this investment will inform elements of the new cross-role activity **650 Accelerating Whole Electricity Flexibility (AWEF)** including delivery of GB wide service co-ordination and DER visibility through activity **A15.8 Enabling whole electricity system operational service co-ordination**. The RDP investment will continue to deliver whole electricity system regional solutions at the Transmission-Distribution interface, based on the applicable operability needs case.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A15.5 Develop Regional Development Programmes (RDPs)	• Registration, planning & coordination, instruction (dispatch), settlement, and reporting of regional constraint services • Automated constraint management system (GEMS)

Table 178 - Summary of business outcomes and corresponding sub-activities

Current State

During BP1 we have supported the regional development programmes across the whole-system landscape to identify opportunity for the provision of additional network capacity, the introduction of new tools to manage constraints, and to open up new revenue streams for market participants. These are developed on a need's-case basis, and we continue to work with other network organisations to proactively identify their need.

The N-3 intertripping functionality go live for UK Power Networks (UKPN) 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 defined as a post fault scenario of a planned transmission outage (N-1) followed by a double circuit fault (N-3).

Our work as part of RDP1 (WPD – MW Dispatch), which will increase the ESO's access to smaller DER to help support constraint management, has also progressed well with most of the new development work now complete. The remainder of the BP1 period will focus on the testing activities required to go-live across the south-west, whilst also completing the scoping, requirements, and initial design activities with UKPN as part of RDP2. This work will then move forward to implementation into BP2.

The GEMS project has also continued to progress with the appointment of Scottish Power Energy Networks (SPENs) vendor and the commencement of detailed design work. This work will continue over the coming months, followed by the build phase prior to BP2.

By March 2023 we will achieve:

- N-3 intertripping functionality – Implementation within the Distribution Network Operators (DNO) networks of Scottish and Southern Electricity Networks (SSEN) and Western Power Distribution (WPD).

This delivers the systems and processes required for 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.

- MegaWatt (MW) Dispatch – to provide the ENCC with the ability to manually select and directly instruct Distributed Energy Resources (DERs) to manage thermal boundary constraints. This instruction will be facilitated through the connection of the ESO's Ancillary Service Dispatch Platform and the DNO's Distributed Energy Resource Management System (DERMS). This work will result in an initial release of the MW Dispatch functionality with WPD in the south-west and the continued design, development, and implementation of equivalent functionality with UKPN in the southeast.
- Generation Export Management System (GEMS) – proceeding to take forward the conceptual design to an agreed detailed solution with SPENs and commence the build phase in all environments.

Roadmap

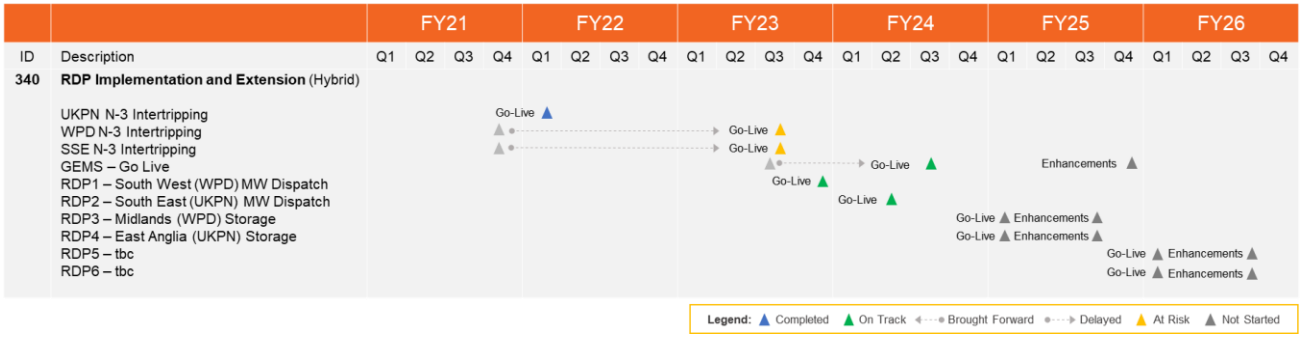


Figure 43 - Outcome roadmap

The RDPs will be delivered using agile and waterfall techniques as appropriate to the type of change, with an MVP being delivered for go live and further enhancements beyond the go live based on a prioritisation exercise informed by stakeholder feedback, which are integrated across the impacted platforms.

Currently no scope of this investment has moved into RIIO-3.

Milestone	Outcome recipient	Outcome description

UKPN N-3 Intertripping	Business Units Customers & Partners	N-3 Intertripping introduced to ensure that the transmission network remains operable by reduction of load during an N-3 event in relation to UKPN
WPD N-3 Intertripping	Business Units Customers & Partners	N-3 Intertripping introduced to ensure that the transmission network remains operable by reduction of load during an N-3 event in relation to WPD
SSE N-3 Intertripping	Business Units Customers & Partners	N-3 Intertripping introduced to ensure that the transmission network remains operable by reduction of load during an N-3 event in relation to SSE
GEMS Go Live	Business Units Customers & Partners	Transmission and distribution parties are connected 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	New thermal transmission constraint management service delivered with Western Power Distribution (WPD). Service instructed from the ESO control room via WPD's DER System, enabling ESO to manage export constraints in the South West of England.
RDP2 - South East (UKPN) MW Dispatch	Business Units Customers & Partners	New thermal transmission constraint management service delivered with UK Power Networks (UKPN). Service instructed from the ESO control room via UKPN's DER System, enabling ESO to manage regional export constraints in the South East of England.
RDP3 - Midlands (WPD) Storage	Business Units Customers & Partners	Economic and operable solution/s delivered with WPD to manage growth of distribution storage in the Midlands.
RDP4 - East Anglia (UKPN) Storage	Business Units Customers & Partners	Economic and operable solution/s delivered with UKPN 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
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

Table 179 – 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.

Target platform	Target Subsystem	Component	Future State
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.
Network Operations & Control	Situational Awareness	SCADA	Situational awareness will be implemented for DERs
Balancing	Energy Balancing	Dispatch	The dispatch component will be enhanced to enable dispatch of DERs
Commercial & markets	Settlements	Settlements	This is for settlement of DERs.
Digital Engagement	Market Facilitation	Customer Markets Portal	This is to facilitate DER registration and price submission

Table 180 – 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, OBP.

Approach

Implementation is expected to require enhancement of our Optel and general data networks throughout the country to connect the necessary RDP sites. We will work with our partners to implement these changes.

The RDP enhancements will be implemented utilising existing platforms where possible and developing new capabilities where required. We will utilise the RIIO-2 target platform architecture and integrate into cross-cutting platforms like DAP and DEP, for data and delivery channel services when appropriate functionality is available.

We will create RDP solution components for Balancing and Network Control using agile requirements discovery, capture and build where possible. Release management will be implemented in phases with sequential releases of capability to the control room. Releases to external connected parties will be more controlled and highly sequential.

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. We have also discounted creating of completely separate bespoke applications for RDP functionality as we are reliant on several ESO legacy applications and the new ESO platforms to align our core systems with the DNOs.

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.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	1.3	4.0	3.6	3.6	3.7	16.3
	BP1	2.9	3.2	3.2	5.4	9.9	24.5
	Variance	**-1.6**	**0.9**	**0.5**	**-1.8**	**-6.2**	**-8.3**
Opex (£m)	BP2	0.2	0.2	0.3	0.2	0.0	0.9
	BP1	0.3	0.4	0.4	0.6	1.1	2.7
	Variance	**-0.1**	**-0.1**	**-0.1**	**-0.4**	**-1.1**	**-1.9**
Totex (£m)	BP2	1.5	4.2	3.9	3.8	3.7	17.1
	BP1	3.3	3.5	3.5	6.0	11.0	27.3
	Variance	**-1.7**	**0.7**	**0.4**	**-2.2**	**-7.3**	**-10.1**
Cumulative RTB increase (£m)	BP2	0.1	0.6	1.0	1.4	2.1	
	BP1	0.3	0.6	1.0	1.4	2.1	
	Variance	**-0.2**	**0.0**	**0.0**	**0.0**	**0.0**	

Table 181 – Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
Evolved or refined scope in BP1	Scope Reduction	Capex	Removal from scope of Power Potential future learnings and Cross vector opportunities	- £10m
Evolved or refined scope in BP1	IT Resources	Capex	Additional complexity of Balancing Mechanism changes to deliver GEMS integration	+ £1.7m
Efficiencies	IT / ESO Resources	Opex	Reduction in expected spend on discovery work, assuming re-use of existing solutions delivered in earlier phases	- £1.9m
Efficiencies	Application Support	RtB	Lower anticipated support costs, assuming re-use of solutions developed in earlier phases	- £0.2m
Costs change since BP1				- £10.4m

Table 182 – Investment cost change 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 and impact to completion of the N-3 roll-

out due to ICCP network link commissioning issues. There has also been a minor reduction in BP2 costs arising from an update to the delivery plan.

It is not expected that this investment will be impacted by the new investment **650** AWEF which is anticipated instead to build upon and learn from the solutions implemented under RDP, with its own costs to be defined after completing its discovery stage.

We have removed costs related to power potential future learnings because of the reduction in this scope.

The plan previously included consideration of opportunities and needs arising from the electrification of heat and transport and included investment towards the end of the RIIO-2 period. However, our current thinking is that these costs could now fall within scope of the new cross-role activity Net Zero Operability in a future business plan submission or within a future FSO submission. Consequently, these costs have been removed from this submission.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Deliver	Resources are adequately allocated across product and supplier teams to sufficiently support RDP deliveries	Program, Product & Project Management	Timelines and additional cost	Monthly
Deliver	Commercial agreements between ESO and DNOs will be met for new service enhancements	Program, Product & Project Management	Timelines and additional cost	Monthly
Deliver	RDP 5 and RDP 6 are yet to be defined so costs have been estimated on the basis of what we learnt delivering earlier RDPs	Program, Product & Project Management	Timelines and cost may be greater or less than planned	Quarterly

Table 183 – Investment assumption summary

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
We may need to deliver more or less than six RDPs in the RIIO-2 period. Costs could vary up or down depending upon the final number of RDPs	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 their ability to fund investments, leads 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

The need to deliver across multiple ESO technology platforms and uncertainty in delivery timeframes from external stakeholders, with potential for conflicting priorities, leads to delays in realisation of benefits.	Program, Product & Project Management	Build integrated delivery plans and ensure alignment of RDP changes with wider portfolio	3	1

Table 184 – Investment risk summary

3.29 350 Planning and Outage Data Exchange

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
Confirmed	Hybrid	On-Track: 6	Complete: 4	Delay: 2	Total Count: 12

Overview & Purpose

This investment delivers electricity network outage planning and data exchange capability.

We will enhance ESO's outage planning and data exchange services across transmission and distribution networks.

Our delivery consists of 3 workstreams:

Improve and extend the outage planning process - enhancements to our Network Access Management System. This enables 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.

Enable Deeper Access Planning with Distribution Network Operators (DNOs) as they transition to become Distribution System Operators (DSOs) - giving all parties greater visibility of changes on other networks and enabling DER to provide services to facilitate outages. This enables the ongoing sub-activity A16.3 Work more closely with DNOs and DER to facilitate network access.

Enable bi-directional data exchange and automated data checking - replacement of the legacy External Data Exchange (EDE) to manage significantly increased volumes, types, and frequency of data.

Enable the implementation of the Common Information Model (CIM) standard, arising from Grid Code Modification GC0139 (Enhanced Planning-Data Exchange to Facilitate Whole System Planning).

This enables sub-activities **A15.4 Manage our operational data and modelling requirements** and **A15.6 Transform our capability in modelling and data management** and supports **A16.3 Work more closely with DNOs and DER to facilitate network access**.

This investment also indirectly benefits Role 1, by providing outage information to enable short term planning and analysis of the network.

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 185 - Summary of business outcomes and corresponding sub-activities

Current State

We have delivered the Electricity Network Access Management System (eNAMS) and Electricity Generator Availability and Margin Analysis (eGAMA) capabilities to replace the Transmission Outage and Generator Availability (TOGA) system.

Building on the first release of eNAMS and eGAMA products, we have initiated 3 key workstreams to address the future capabilities for Outage Management, to be delivered by March 2023 as summarised below.

Workstream 1:

- Enhancing the outage planning and reporting process within eNAMS further to address customer needs. We will address the following key functional and technical enhancements:
- Advanced key performance indicator (KPI) reporting 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, increasing separation of ESO services

Workstream 2:

- Initiated capture of the capabilities required to enable Deeper Access Planning with Distribution Network Operators (DNOs) as they transition to become Distribution System Operators (DSOs), including:
- Establishing ways of working with customers / industry to streamline DSO process by forming a working group with suitable governance model
- Capturing end to end customer journeys and personas
- 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) 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.
- Establishing a strategy and roadmap to replace External Data Exchange (EDE)
- Review and address current customer pain points whist we are waiting for the conclusion of CIM Standards as part of GC0139 grid code change
- Publishing IT solution blueprint and roadmap for solution delivery

Roadmap

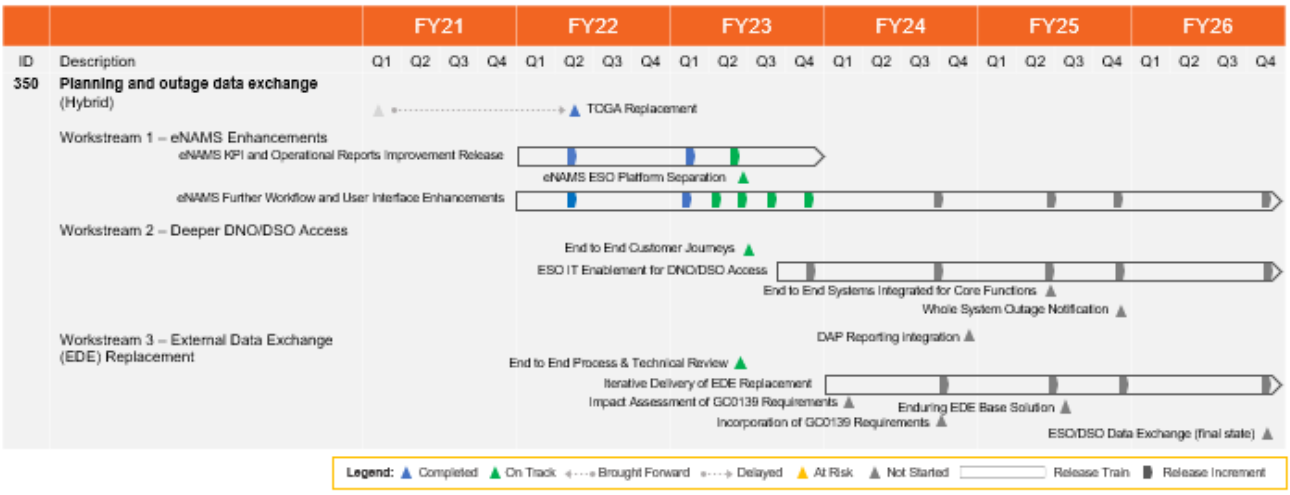


Figure 44 - Outcome roadmap

Currently no scope of this investment has moved into RIIO-3.

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 186 - 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.

Target platform	Target Subsystem	Component	Future State
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.
Network Operations & Control	Network Development	Network Planning	Streamlined and automated Network Planning processes.
Network Operations & Control	Network Development	Outage Planning	Streamlined and automated Outage Planning processes. Timely availability of outage data via data APIs.

Table 187 - Future state subsystem component summaries

Approach

Network data, regional models and outage planning data exchange will be transformed from legacy methods of file transfer and faxing into API and data service push/pull capabilities. Access to systems will be extended to a wider range of stakeholders via our Digital Engagement Platform (DEP).

We will continue to extend our eNAMS solution in this 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 will implement communication channels with customers, stakeholders, and the market, for example by using mobile apps, alerts, social media feeds, via integration with **250** Digital Engagement Platform.

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.

Our Network Access Management capability will be extended by managing a backlog of requirements into our agile delivery team.

Our DNO/DSO connectivity and External Data Exchange implementations will be managed using sequential releases co-ordinated across all parties.

Solution Options

For the BP2 period we will build on the platform provided by eNAMS 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.

We considered but discounted a bespoke software solution due to this not offering value for our requirements and the availability of our existing Salesforce platform.

For DNO/DSO connectivity and External Data Exchange we will use our Data & Analytics platform services including API management and cloud gateway.

We did not consider alternative options to using our strategic choices for Salesforce or Azure.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	2.0	1.2	1.2	1.4	1.4	7.2
	BP1	0.4	0.4	1.2	1.4	1.4	4.8
	Variance	**1.6**	**0.8**	**0.0**	**0.0**	**0.0**	**2.4**
Opex (£m)	BP2	0.1	0.1	0.3	0.4	0.4	1.2
	BP1	0.1	0.1	0.3	0.4	0.4	1.2
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Totex (£m)	BP2	2.1	1.2	1.5	1.8	1.8	8.4
	BP1	0.5	0.5	1.5	1.8	1.8	6.0
	Variance	**1.6**	**0.7**	**0.0**	**0.0**	**0.0**	**2.4**
Cumulative RTB increase (£m)	BP2	0.3	0.6	0.7	0.7	0.7	
	BP1	0.0	0.0	0.0	0.1	0.1	
	Variance	**0.3**	**0.6**	**0.6**	**0.6**	**0.6**	

Table 188 - Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
Evolved or refined scope since BP1	Increase in Scope	Capex	Additional development work discovered during end-to-end testing	+ £1.2m
Evolved or refined scope since BP1	Increase in Scope	Capex	Additional data migration works due to complexity in transitioning between products	+ £1.2m
Evolved or refined scope since BP1	Support enhancement	RtB	Extended support requirements for Deeper Access Planning	+ £0.3m
Evolved or refined scope since BP1	Delivery enhancement	RtB	Further Salesforce licences for Deeper Access Planning	+ £0.3m
Costs change since BP1				+ £3m

Table 189 - Investment cost change summary

The table above reflects the cost change summary since submitting our original plan. Our BP2 period costs are unchanged.

The Capex cost increase is attributed to eNAMS go-live delay from November 2020 to September 2021, caused by:

- Additional development work during end-to-end regression testing (before go-live) due to the need for access to eNAMS functionality by a wider external customer base
- Data Migration delay due to the complex nature of the legacy data structure and the need for additional data validation/testing.

The delays in eNAMS implementation have also led to an increase in RtB. In our BP1 submission we had assumed that implementation would be complete in FY21 and that any RtB increase would have been included in the starting baseline for BP2.

Further RtB increases are also anticipated to arise from extended support requirements. An uplift to 24x7 support is expected post deployment of Deeper Outage Planning together with an increase in Salesforce licences for external users.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Design	All DNOs will provide data as required to satisfy Deeper Access Planning design and delivery	Application Development	Final solution design and delivery will only fulfil needs of those DNOs that meet data request requirement	Quarterly
Design	GC0139 grid code change requirements and change will emerge in Q1 FY 2024	N/A	Delay in GC0139 will cause workstream 3 EDE deliverables and milestones resulting in further external costs	Quarterly
Deliver	ESO CRM Salesforce platform migration and release work	Program, Product &	eNAMS functional enhancement work will be pushed back and	Weekly

	will complete at the end of Sept 2022 as planned	Project Management	delayed resulting in cost increases	
Deliver	Interim reporting solution will be replaced as part of DAP solution design and completed by Q4 FY 2024	Program, Product & Project Management	Future enhancements to reporting will be impacted with reliance on existing interim reporting and lack of self-serve and enhanced visualisation capability	Quarterly

Table 190 - Investment assumption summary

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	Program, Product & Project Management	Ensure regular GC0139 delivery schedule tracking and impact analysis of CIM Standards Focus resource on data modelling activity within our product team structure	3	1
Clearer DSO transition and responsibilities arising from GC0139, leads to an overall solution delivery delay and further budget impact.	Program, Product & Project Management	Ensure regular review of requirements throughout RIIO-2 period. Cross Industry working group to be established to ensure frequent communication and alignment on requirements and design	3	1
Delay in delivery of strategic 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 required to deliver objectives as early as possible	2	1

Table 191 - Investment risk summary

3.30 360 Offline Network Modelling

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
In Draft	Hybrid	On-Track: N/A	Complete: N/A	Delay: N/A	Total Count: N/A

Overview & Purpose

This investment delivers our ESO Technology capability to support development of future electricity network strategy. Our Offline Network Modelling tools deliver the day-to-day analysis required to operate the transmission system in a safe and secure manner. We use these tools to deliver the electricity 10-year statement and regulatory reporting. 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. 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, to facilitate use of a common data set and seamless exchange of data.
- Development & ongoing maintenance of Electromagnetic Transient (EMT) Capabilities
- Enhance and maintain ESO Networks system analysis capability using EMT tools. This provides greater confidence and forward planning for voltage oscillations, system interaction and power quality issues as the system moves towards zero carbon operation.
- 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. We will improve our simulation speeds and our ability to analyse both small and large signal behaviour of the system.

Other enhancements for BP2 include:

- Develop automation capabilities to enhance data validation and performance of studies for multiple scenarios to understand the operating envelope for a higher granularity of time points.
- Enhance modelling into the DNO networks to support Deeper Access Planning, improving visibility of change scenarios 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.**

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 • Deeper outage planning

• A16.3 Work more closely with DNOs and DER to facilitate network access • A16.5 Network Access Planning Automation	• Network Access Planning Automation

Table 192 - 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 the Offline Transmission Analysis (OLTA) tool will be carried out in BP1 that increases our G74 capability for enhanced short circuit analysis. We will further develop and share our offline modelling technology systems and features roadmap.

Our Networks teams will build a proof of concept for Electromagnetic Transients (EMT) Modelling using PSCAD's system transient simulation software package.

Roadmap

Figure 45 - Outcome roadmap

A strategic modelling review is underway that may drive further investment beyond BP2.

Milestone	Outcome recipient	Outcome description
CACM Go Live	Business Units Customers & Partners	Compliance with the European Capacity Allocation and Congestion Management guideline, improving system security
G74 capability	Business Units Customers & Partners	Enhanced ability to calculate short circuit fault levels, improving system security
Major refresh of models	Business Units Customers & Partners	Upgrades to offline modelling capability to analyse a 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 EMT tools, providing greater planning confidence for voltage oscillations, system interaction and power quality 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 further parts of the GB system.

Co-simulation: Feasibility evaluated	Business Units Customers & Partners	Confirm the feasibility of combining standard & EMT modelling techniques to enhance and speed up our ability to analyse the system. If this is feasible, capability delivered for the relevant business areas
Automation tools available	Business Units	Automated data validation and faster study performance
Deeper access planning integrated in to modelling tools.	Business Units Customers & Partners	Modelling integrated into DNOs to support Deeper Access Planning
Integration with Data and Analytics Platform	Business Units	Offline modelling tools integrated with the Data and Analytics Platform, facilitating seamless exchange of data between tools

Table 193 – 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.

Target platform	Target Subsystem	Component	Future State
Networks	Network Modelling	Modelling Visualisation	Expanded set of modern network modelling tools, configured, and customised to ESO requirement.
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 194 – 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.

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

We will combine commercial software and inhouse developed analytic software using the data capture, ingestion, storage, and data science tools supplied by the Data and Analytics Platform.

Specifically, we will consolidate on the PowerFactory and PSCAD applications and modernising, deploy and integrating in line with our platforms architecture strategy. Where required we will extend and complement these applications with bespoke ESO software and models.

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 and support Open Data access.

We will deliver sequential releases to align with industry and ESO timings for publication of our future models.

Solution Options

The range of macro-level solution options, i.e. No Investment, Upgrade Existing, or Buy New, have been applied to the Offline Network Modelling investment.

We have initially selected PSCAD and PowerFactory as our enduring tools around which we will build our enduring modelling suite. Further tools and bespoke models will complement these initial selections.

Our feasibility analysis and market research 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.

We considered and discounted procurement of a single tool to meet all possible ESO/Industry modelling needs as our market analysis indicated this was not plausible.

We considered and discounted building a completely bespoke technology solution to replicate a packaged modelling suite as suitable market products are available to us and meet initial requirements.

We considered and discounted starting with a bespoke build and then adding further packaged tools as this did not meet our enterprise architecture principles and we have existing experience with the chosen initial tools.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	0.6	2.2	0.8	2.0	0.8	6.3
	BP1	1.2	0.8	0.8	2.0	0.8	5.6
	Variance	**-0.6**	**1.4**	**0.0**	**0.0**	**0.0**	**0.7**
Opex (£m)	BP2	0.0	0.9	0.2	0.5	0.2	1.8
	BP1	0.3	0.2	0.2	0.5	0.2	1.4
	Variance	**-0.3**	**0.7**	**0.0**	**0.0**	**0.0**	**0.4**
Totex (£m)	BP2	0.6	3.0	1.0	2.5	1.0	8.1
	BP1	1.5	1.0	1.0	2.5	1.0	7.0
	Variance	**-0.9**	**2.0**	**0.0**	**0.0**	**0.0**	**1.1**
Cumulative RTB increase (£m)	BP2	0.0	0.1	0.2	0.2	0.2	
	BP1	0.0	0.0	0.1	0.1	0.2	
	Variance	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	

Table 195 - Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
Evolved or refined scope in BP1	Design Change	Capex	Longer Implementation of OLTA Refresh due to move to Azure completion in FY23	+ £0.7m
Evolved or refined scope in BP1	Timescale	Opex	Opportunity taken for early implementation of PSCAD maintenance service	+ £0.4m
Evolved or refined scope in BP1	Timescale	RtB	Delayed implementation of eNAMS	+ £0.1m

Costs change since BP1	+£1.2m

Table 196 - Investment cost change summary

Since submitting our original plan for this investment, our BP1 costs have increased due to later than planned delivery of the hardware upgrade for the OLTA offline analysis tool. However, our BP2 costs are unchanged.

The delays in the implementation of the OLTA hardware and software upgrade to deliver the G74 capability 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.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Design	We have assumed that the automation capability will use the PySCA tool already developed	Application Development	Delay and extra cost to identify and deploy a different solution	Quarterly
Design	We have assumption that ESO's strategic ONM review will not affect the prioritisation of this investments' milestones	Program, Product & Project Management	Re-prioritisation of roadmap deliverables and re-scoping leading to further investment	Quarterly
Design	We have an assumption that the TOTEM project (a NIA collaboration project between ESO and the TOs) will deliver an EMT capable model of the GB network	N/A	Usage of pessimistic operational assumptions eroding the benefit of this investment	Quarterly

Table 197 - Investment assumption summary

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 to delay in project timescales, extra cost and continued use of pessimistic operational assumptions.	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 platforms (DAP) will impact enduring OLTA Modelling capability, delaying realisation of the benefits of seamless data exchange between tools.	Program, Product & Project Management	Early engagement and regular review with platform delivery teams to identify critical-path modelling backlog items and manage impact/review process	2	1

Our cost estimates and timings may be inaccurate for the availability of the automation tools, due to current uncertainties over the outcomes of proof of concepts planned in FY24, leading to delays and extra support costs	Program, Product & Project Management	Collaboration with the team developing the automation capability whilst they progress the proof of concepts Detailed definition of the IT and business support models Potential re-phasing of project costs	2	1

Table 198 – Investment risk summary

3.31 380 Connections Platform

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
In Draft	Agile	On-Track: 4	Complete: 3	Delay: 2	Total Count: 9

Overview & Purpose

This investment delivers capability for customers to engage with ESO services for electricity grid connections.

The changes in UK Government environmental targets have driven 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 and continued increase in the number of connection applications coming into the ESO.

As the number of connection applications increases, we must address and improve the efficiency and effectiveness of our processes to deal with the sustained volume. Phase 1 of the connections portal, implemented in BP1, will digitalise the connection application process and introduce automation, for ESO and our customers. This will lead to more efficient use of industry resources and consequently lead to consumer savings. Phase 2 of the portal which will begin early in BP2, will build on the Phase 1, and enable similar efficiencies to additional connections processes.

The customer Connections Platform will provide a single 'hub' capability for guiding customers through connection to the electricity transmission network and online account management functionality for all live projects. This hub will enable customers to see regular updates on the progress of their active applications as well as information on other projects already contracted.

The platform will also facilitate enduring contract management during the delivery phase of the project as well as providing a source of information for customers who are researching opportunities for connection.

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.**

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 199 - Summary of business outcomes and corresponding sub-Activities

Current State

We have delivered improvements during BP1 and are proposing further improvements as a direct result of customer and stakeholder feedback. Customers and stakeholders have told us that the ESO should lead development of a customer connections portal, and their detailed feedback informed the scoping of the Minimum Viable Product

We will deliver foundational capabilities in Q2 FY23 and further extensions to these capabilities in Q3 and Q4 FY23. These focus on digitising the connection application process and will deliver the following functionality:

- Modernised, transparent process steps
- Guided assistance to all key processes
- Self-service account registration
- Requesting pre-applications
- Submitting applications
- Automating the fee calculation process
- Tracking the lifecycle of their application
- Overview of current contracted portfolio as well as key milestones
- Query Management functionality
- 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 aligning with the Design system by early FY24.

Following this foundation phase of the portal, incremental improvements will be added in future subsequent releases, including process efficiencies and automation which continue into BP2.

Roadmap

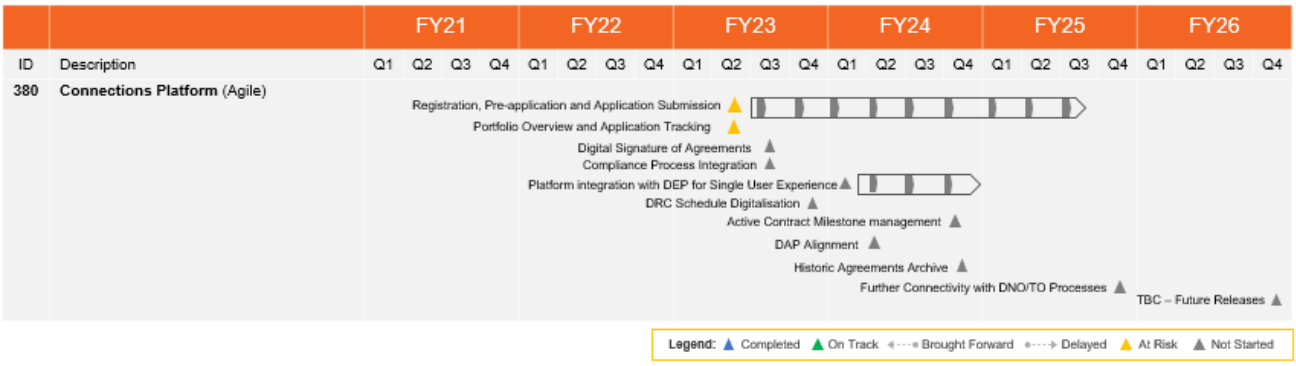


Figure 46 - Outcome roadmap

The detailed scope of future releases is yet to be finalised and will be under continuous review, informed by stakeholder engagement and by the Connections Reform programme (A14.5) delivery.

No work under this investment's scope is currently expected to be done under RIIO-3.

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 progress of their live applications
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 (DRC) schedule.
DAP Alignment	Integrated Systems Customers & Partners	Connections data availability across platforms
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 200 - Outcome summary descriptions

Future State

During BP2 we will extend the Connections Hub self-service capability to include:

- A centralised document storage solution to manage customer contracts, documents including archival management
- Capability for customers to provide live updates to their projects via the portal
- 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 submission for generators
- Additional portal connectivity to enable seamless connection process with TOs and DNOs
- User Experience enhancements e.g., interactive, and richer features such as Heatmaps
- We will use our strategic platforms and services for wider integration to ESO services including:
- Standard functions and features of the Salesforce CRM platform including App Exchange
- 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 Data and Analytics Platform (DAP) to develop internal reports and APIs 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 BP2.

Target platform	Target Subsystem	Component	Future State
Digital Engagement	Customer	Connections, CRM Workflow	Customer Connections self-service application process on Salesforce CRM
Digital Engagement	Digital Services	Digital Applications Suite	Integration with and use of the DEP Design System
Digital Engagement	Market Facilitation	Customer Markets Portal	Alignment with SMP during BP2
Data & Analytics	Analytics and Insight	Internal Reporting	Reporting capability delivered by DAP
Data & Analytics	Consistent Data Services	Integration non-CNI	Integration with downstream systems and TOs and DNOs

Table 201 - Future state subsystem component summaries

Approach

Through BP2, we anticipate continued development of the Connections Portal 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 backlogs against defined products.

Our Connections Portal agile delivery team will release prioritised capabilities based on customer value, informed by user journeys, industry consultation and stakeholder engagement (e.g., show and listen seminars). We will continue to mature our product model as we enhance our internal capabilities and tooling to deliver more efficiently across our platforms and services.

Solution Options

The choice of Salesforce to develop the self-service Connections Portal was taken early in BP1, primarily because existing internal connections processes already operate on Salesforce and can be extended to external customers through this existing capability.

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 App Exchange where appropriate. In BP2, we anticipate further integration with our strategic platforms for API/integration management, DEP, and DAP, aligning to our other investments.

We considered but discounted procurement of an external SaaS service due to lack of differentiators with the Salesforce-based option.

Additionally, we considered but discounted the option of bespoke development due to the scope and scale of user workflow functionality required, which was already net by our Salesforce capability.

Costs

	BP1		BP2		BP3	
	Actuals	Forecast				
	2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL

Capex (£m)	BP2	0.9	1.3	1.4	1.4	1.4	6.4
	BP1	0.7	0.7	0.2	0.1	0.1	1.8
	Variance	**0.2**	**0.6**	**1.2**	**1.3**	**1.3**	**4.6**
Opex (£m)	BP2	0.0	0.3	0.1	0.1	0.1	0.6
	BP1	0.5	0.5	0.1	0.1	0.1	1.2
	Variance	**-0.5**	**-0.2**	**0.0**	**0.1**	**0.1**	**-0.6**
Totex (£m)	BP2	0.9	1.6	1.5	1.5	1.5	7.0
	BP1	1.2	1.2	0.3	0.2	0.2	3.0
	Variance	**-0.3**	**0.4**	**1.2**	**1.4**	**1.4**	**4.0**

Cumulative RTB increase (£m)	BP2	0.0	0.0	0.2	0.2	0.3
	BP1	0.0	0.1	0.1	0.1	0.1
	Variance	**0.0**	**0.0**	**0.0**	**0.1**	**0.2**

Table 202 - Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
Accelerated drive to zero carbon operation	IT Resources	Capex	New requirements established to increase the functionality of the Connections Platform Portal covering user experience, digitalisation, self-service, and richness of data. Increased functionality requirements have been informed by stakeholder engagement.	+ £3.4m
Evolved or refined scope in BP1	IT resources	Capex	Integration with various downstream systems (DNOs & TOs) and alignment with other portals (DEP, DAP, SMP)	+ £1.2m
Evolved or refined scope in BP1	Infrastructure / Licenses	RtB	Extended support and Salesforce licenses required for Connections Platform operability	+ £0.2m
Efficiencies	IT & Business Resources	Opex	Reduction in expected spend of delivery work	- £0.6m
Costs change since BP1				+ £4.2m

Table 203 - Investment cost change 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 capex cost increase above reflects the renewed ambition and scope of Phase 2 and our cost-benefit analysis for Phase 2 requirements. This process has been driven by customer feedback, the continued increase in application volumes and more clarity on the integration with external and internal systems. The reduction in Opex spending relates to assumptions that were previously applied regarding financial treatment of certain spend items in the early stages of the project which will now be capitalised.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Design	DEP will provide a single landing area for all customer engagement, applying consistent user interfaces aligned to our brand and style guidelines and SSO capabilities	Middleware	Without DEP integration customer engagement, useability and experience will be impacted	Quarterly
Design	Integration with the Data and Analytics Platform (DAP) to develop internal reports and leverage consistent data services to manage data exchange with third parties.	Middleware	Data integrity impacted along with reporting limitations based on reliance on standard salesforce reporting capabilities	Quarterly

Table 204 – Investment assumption 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
Complexity anticipated in dismantling current sign-on and Query management features when aligning with DEP (CIAM) and SMP integration	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
Overall connections process is highly likely to undergo significant change over the next 2 years due to Connections Reform programme (A14.5). The scope of this change is not yet understood but is likely to result in re-work for the Connections Portal project as any changes to the industry process will need	Product & Project Management	Align business requirements with product backlog to prioritise deliverables with minimal business disruption	2	1

to be reflected in the ESO portal functionality.				
ESO Migration to new Salesforce org has delayed and pushed Connections deliverables back which could result in spill over of FY23 deliverables into FY24	Application Development	Engagement with ESO Migration team to ensure completion followed by successful ELS to ensure system stability	2	1

Table 205 – Investment risk summary

3.32 390 NOA Enhancements

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
In Draft	Hybrid	On-Track: 11	Complete: 7	Delay: 0	Total Count: 18

Overview & Purpose

This investment delivers our capability to plan and optimise transmission and distribution electricity network assets for zero carbon grid operation.

Our modelling capabilities underpin our Role 3 investments for BP2 and beyond into RIIO-3, enabling us to unlock significant benefits and maintain a secure and operable network.

We need to model an increasingly diverse range of scenarios to maintain efficient investment aligned to net zero. Our current analytical tools offer only limited focus on thermal needs and some voltage issues.

We need greater integration between the enhanced modelling tools to allow us to better understand the interactions between different network needs and optimise our economic decision-making.

In addition, this investment indirectly enables enhancements to the network development systems and tools required to deliver:

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

A22 Further development of our network planning tools and systems to support the Network Planning Review (NPR)

By delivering 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.**

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**

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A7.1 Analyse and communicate future network needs • A7.2 Advise on economically efficient ways to address networks needs • A7.3 Undertake ad hoc analysis in response to external requests • A13.1 Carry out analysis and scenario modelling on future energy demand and supply • A22.1 Network Planning Review	• Economic Efficiency Advice Services • Network options economic evaluations • Modelling and Data Management • Derivation of system requirements

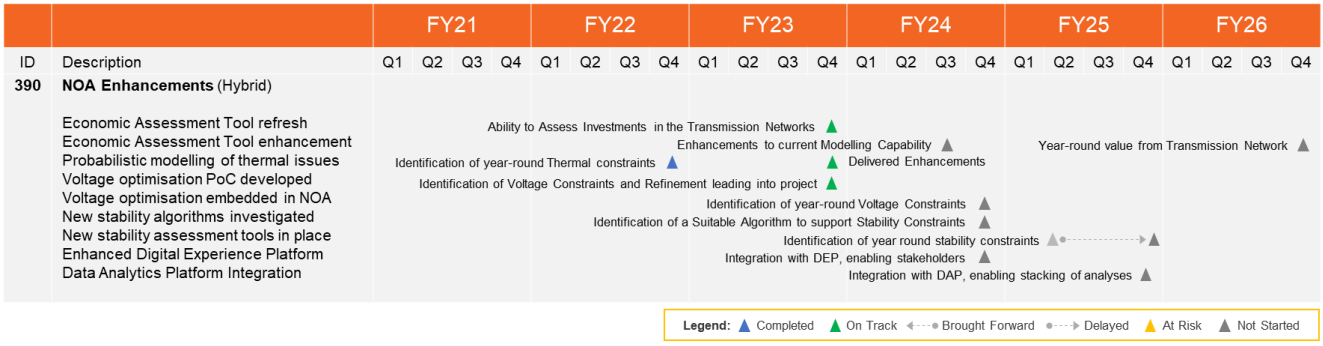
Table 206 - Summary of business outcomes and corresponding sub-activities

Current State

By the end of BP1 we will have completed delivery of Economic Assessment Tool, 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 completed by end of March 2023 leading into a formal project in this investment. Additional resources have been assigned to maintain the delivery timetable. The Stability Assessment tool within the innovation project has highlighted areas of data quality improvement required within our current systems to enable success with this project.

Roadmap



No scope within this investment has moved into RIIO-3.

Figure 47 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Economic assessment tool refresh	Business Units	Implementation of a new Economic Assessment 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 Economic Assessment tool through internal assessment of market tools available, to reflect the latest modelling approach and technologies and integration into NOA process.
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	Preferred optimisation model and algorithm selection for the *NOA - type* process for voltage assessment.
Voltage optimisation embedded in NOA – type processes	Business Units	Model implemented that enables year-round assessment of voltage needs. Needs identified across multiple year-round snapshots instead of 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 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 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. Nodal modelling is used to assess requirements where boundary methodology is insufficient.

Table 207 – Outcome summary descriptions

Future State

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.

Target platform	Target Subsystem	Component	Future State
Data & Analytics	Modelling	Economic modelling	Strategic Economic Assessment, Probabilistic Modelling, Voltage Optimisation, and Stability Assessment tools implemented and integrated into the RIIO-2 Platform Architecture.

Table 208 – Future state subsystem component summaries

The tools will utilise the RIIO-2 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.

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

Our NOA tools will be built in Python and use common Python libraries integrated with components of the new Economic Assessment Tool. They are expected to run locally on analyst workstations and made available on our cloud-based data platform tooling to support collaboration across ESO teams and Open Data publication.

We operate a product backlog managed through an agile delivery team, but do not directly implement an ESO Technology solution as our outputs are fed into other processes. We expect to enhance models through our agile data requirements capture and design, but our approval processes for publication on the data platform and externally remain sequential.

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 have procured a new Economic Assessment Tool. We will implement the Probabilistic Modelling tool using custom builds and re-use of 3rd party data and economic/power systems model 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.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	-0.1	1.8	3.2	1.6	1.2	7.7
	BP1	3.0	3.0	3.2	1.6	1.2	12.1
	Variance	**-3.1**	**-1.3**	**0.0**	**0.0**	**0.0**	**-4.4**
Opex (£m)	BP2	0.0	0.1	0.8	0.4	0.3	1.5
	BP1	0.8	0.8	0.8	0.4	0.3	3.0
	Variance	**-0.8**	**-0.7**	**0.0**	**0.0**	**0.0**	**-1.5**
Totex (£m)	BP2	-0.1	1.8	4.0	2.0	1.5	9.3
	BP1	3.8	3.8	4.0	2.0	1.5	15.1
	Variance	**-3.9**	**-2.0**	**0.0**	**0.0**	**0.0**	**-5.8**
Cumulative RTB increase (£m)	BP2	0.2	0.5	0.6	0.8	0.9	
	BP1	0.0	0.2	0.3	0.5	0.6	
	Variance	**0.2**	**0.3**	**0.3**	**0.3**	**0.3**	

Table 209 – Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
Efficiencies	Commercial	Capex	Negotiations with supplier during best and final pricing for new tooling vs early estimates	- £4.4m
Evolved or refined scope since BP1	Environments	RtB	Future inhouse products will be built in house and will require hardware with licensing of applications	+ £0.3m
Efficiencies	Resources	Opex	With the Economic Assessment Tool procurement which took place in Jan-Jun 2022 we utilised less resources and are protecting the project go live in FY23 Q4. Detailed planning had been performed which reduced costs forecasted	- £1.5m
Costs change since BP1				- £5.6m

Table 210 – Investment cost change 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). Some expenditure has been moved from FY22 to FY23 due to procurement timescales deferring the license purchase for the economic assessment tool. Our BP2 costs have remained unchanged since our previous submission.

RtB costs have increased due to a more informed view of initial costings from the Economic Assessment tool procurement event.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Deliver	Voltage Optimisation proof of concept being run by business teams will provide sufficient information and insight to launch project	Program, Product & Project Management	Insufficient and insights prompts delay in kicking off project	Quarterly
Operate	NOA business process will kick off in May 2023 after planned go-live of new tooling in March 2023 where existing licensing Economic Assessment tool is due to be replaced.	Business Software	Extend licencing for existing Economic Assessment as new tooling would not be ready for release incurring additional delivery costs	Quarterly
Deliver	Voltage and Stability analytical tooling will be built in-house	Application Development	Additional cost and extension to delivery timelines due to need for additional procurement exercise if proof of concept deems in-house build is not possible	Quarterly

Table 211 – Investment assumption summary

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
Delay in delivery of strategic platforms (DEP/DAP) may 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 leads to postponement 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
Transition between current economic assessment tool BID3 and PLEXOS during critical BAU activities leading to Q4 FY23	Program, Product & Project Management	Detailed project plan at a granular level engaging with users, service management and technology	2	1

Table 212 – Investment risk summary

3.33 500 Enhanced Frequency Control (formerly Zero Carbon Operability)

Scope	Delivery Method	Business Plan Associated Milestones (BP1 Period)			
Confirmed	Hybrid	On-Track: N/A	Complete: N/A	Delay: N/A	Total Count: N/A

Overview & Purpose

This investment delivers our capability to extend frequency monitoring from the transmission network into the distribution network.

We will implement a monitoring and control system (MCS) to provide fast and coordinated frequency response for low inertia zero carbon grid operation.

These activities were formerly named 'Deliver an operable zero carbon system by 2025'. As the deliverables are specific to the Enhanced Frequency Control tool, we have renamed this investment.

Through implementation of the MCS system we will 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. The potential for instability is increasing due to reduced system inertia and increased levels of maximum infeed loss risk.

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.

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 213 - Summary of business outcomes and corresponding sub-activities

Current State

During the BP1 period, a new "Phase Zero" milestone was introduced, which was not in the original five-year plan. This provided a strategy and design blueprint for the programme and mobilised 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.

We have identified and engaged with industry parties to participate in the Phase One non-operational demonstration and completed Phase One design and requirements definition. NIA funding for the Phase One non-operational demonstration has been sanctioned and the project team is working on implementing and testing Phase One.

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 the original submission, as is commencement of the second-stage roll-out (Phase Five).

By March 2023 the Enhanced Frequency Control (EFC) team will have:

- Completed the Phase Zero – Strategy, which will provide a roadmap to implement the EFC for Phases Two-Five

- Engaged industry participants and mobilised for Phase One Non-Operational Demonstration
- Completed the build of the prototype and commenced the Phase One NIA Project to run the Non-Operational Demonstration.
- Outcome and findings published incrementally throughout delivery
- Confirm the business case for the EFC / MCS services and deployed technology

Roadmap

Figure 48 - Outcome roadmap

Milestone	Outcome recipient	Outcome description
Phase Zero – EFC Implementation Strategy	Business Units Customers & Partners	Requirements and technical design for the programme developed. Participants mobilised for the Phase One non-operational demonstration
Phase One – 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 detect real grid system events and issue dummy instructions
Phase One – 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 Two – 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 Three – 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 Three – 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 Four – 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 Four – First Stage rollout: 1st stage EFC Service Operation	Business Units Customers & Partners	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 supporting the commercial response framework.
Phase Five – Second Stage Rollout: Commence 2nd Stage requirements	Business Units Customers & Partners	Requirements commenced for extending the functionality of the MCS

Table 214 – Outcome summary descriptions

Further information on the scope and objectives of Phases One-Five can be found in our original ESO RIIO-2 Business Plan: Annex 4 - Technology Investment report.

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).

Target platform	Target Subsystem	Component	Future State
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.
Network Operations & Control	Situational Awareness	Frequency Visibility	MCS will complement the strategic WAMS solution, sharing infrastructure where possible.
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
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.
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.
Commercial & markets	Settlements	Settlements	Placeholder for Settlement services commercial framework integration
Digital Engagement	Market Facilitation	Customer Markets Portal	Placeholder for tendering and contract process integration

Table 215 - Future state subsystem component summaries

Approach

We will work with our partners to develop and prove a working prototype MCS. We plan to run an open procurement cycle to select an MCS solution.

The MCS will be integrated with our Wide Area Management System (WAMS) and NCMS to provide a complete operational solution. The MCS will integrate into our target platforms architecture utilising the capabilities of DAP.

A phased approach to implementation of the monitoring and control system (MCS) is needed to align with development and performance of stability related balancing services. This will include a full assessment of how the MCS will operate on the live electricity system to improve technical and systems integration readiness before any potential roll-out.

Consideration must also be given to a new commercial service design, prior to implementation, to understand process and technology implications.

We will sequentially release capability into our WAMS and NCMS solutions following their release cycle approaches.

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 and implement an alternative solution.

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.

We have not been able to identify any market offerings that would satisfy requirements for this investment, so a procurement event was not considered at this stage.

We do not have existing capability that could be repurposed to achieve the solution requirements so have discounted the option to build out on legacy technology.

We have not explored alternative networking options for the solution as our critical systems are reliant on specific networking capability and this solution must seamlessly integrate into the available networking environment.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	0.0	0.6	9.1	6.3	3.4	19.4
	BP1	4.0	5.2	7.0	3.9	2.3	22.4
	Variance	**-3.9**	**-4.6**	**2.1**	**2.4**	**1.1**	**-2.9**
Opex (£m)	BP2	0.2	0.2	1.4	0.4	0.6	2.9
	BP1	0.4	0.6	0.8	0.4	0.3	2.5
	Variance	**-0.2**	**-0.4**	**0.7**	**0.0**	**0.4**	**0.4**
Totex (£m)	BP2	0.2	0.8	10.6	6.7	4.0	22.3
	BP1	4.4	5.8	7.8	4.4	2.5	24.9
	Variance	**-4.2**	**-5.0**	**2.7**	**2.4**	**1.5**	**-2.5**
Cumulative RTB increase (£m)	BP2	0.0	0.2	0.8	1.6	2.1	
	BP1	0.0	0.5	1.1	2.0	2.5	
	Variance	**0.0**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	

Table 216 – Investment cost summary

Cost Driver Theme	Cost Driver	Cost Type	Description	Cost change variance (£)
Evolved or refined scope since BP1	Commercial	Capex	Creation of new Phase Zero, commenced Phase One in FY23 and deferred Phase Two into BP2. Delayed due to commercial completion	- £7.7m
Evolved or refined scope since BP1	Funding Source	Capex	Phase One Funded through NIA Budget	- £0.7m
Evolved or refined scope since BP1	Phased Sanction	Capex	Completion of Phase Zero and Phase One in BP1 has deferred completion of Phase Two onwards into BP2	+ £5.6m
Evolved or refined scope since BP1	Phased Sanction	Opex	Commence Phase Two Op Demo in FY24	+ £0.4m
Evolved or refined scope since BP1	Phases Sanction	RTB	Start of Phase Two moved to BP2. Design assumption that existing local devices will be updated for reuse	- £0.3m
			Costs change since BP1	- £2.7m

Table 217 – Investment cost change summary

Since submitting our original plan for this investment, there has been a reprofiling of spend across the BP1 and BP2 periods due to re-planning of the later phases around our Phase Zero strategy activities. The implementation rollout (Phase Four) is still on track for implementation in 2024/25 as specified in BP1.

Cumulative RtB increases have been delayed due to the later delivery dates for non-operational demos and integration with other production platform components.

Current overall reduction in forecast by £2.5m. This is likely to change once Phase 0 is completed and the full implementation roadmap is established in FY24.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Design	We assume that the future frequency response needs require an EFC-like service	Application Development	The project team is evaluating if the service can be already delivered through other Markets led services. This could lead to the project being stopped or deferring any further work in Phase 0, and reallocating to realise any residual value in other initiatives	Quarterly from FY23
Design	Based upon EFCC findings the project is assuming the communication latency post-frequency event will still allow a quick enough response to	Application Development	Phase 1 will look at measuring latency and the impact to the solution's response to a frequency event. The outcome could be providing thresholds for response to	Quarterly from Q4 FY23

	the event to keep frequency within the agreed thresholds		different market providers. If the latency response is too great the project could identify alternative frequency response services to meet our response needs	
Design	There is an existing market service, or a new service can be developed for EFC. This will be required for the 1st Stage deployment and will be designed during Phase 2	Application Development	Markets teams will be engaged to onboard the new EFC service during Phase 2. The solution may need to be redesign for commercial viability	Quarterly from Q1 FY24
Deliver	There is an assumption that the DAP project backlog will support the 1st Stage rollout of the EFC service	Program, Product & Project Management	Phase 4 rollout to engage DAP team for deployment of data management requirements into DAP programme. If the backlog does not support the EFC service, a tactical solution may be needed followed by future DAP integration, with an impact to the budget	Quarterly from Q2 FY24
Design Deliver Operate	We will enhance our Optel networks, other Wide Area Networks and deploy of frequency control appliances in conjunction with our TO and DSO partners.	LAN / WAN	Engagement with third party providers required to assume implementation responsibility	Quarterly

Table 218 – Investment assumption summary

Risks

Risk	Relevant Tower component	IT	Mitigation(s)	Likelihood	Impact
Our 3rd party network providers may not provide sufficient bandwidth, leading to a failure to achieve the objective of response to a system event with 0.5 seconds.	LAN / WAN		Network communication requirements will be assessed and agreed in phases 1 and 2. Additional bandwidth provisioned or requirements lessened.	2	1
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]

Risk that technology tested through the EFCC innovation project is harder to scale. 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 higher investment in communications network.	LAN / WAN	Phased approach and rollout strategy will seek to minimise data volumes. Full capability will only be deployed in Phase Five, based on learnings from the first 4 phases.	3	3
There is a risk that the proportion of distribution connected providers is greater than20%, leading to higher than budgeted implementation costs.	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 and reassessment of the investments business case	Business Software	Include development of commercial terms in the criteria for project progression.	2	2
The proposed EFC solution may overlap with other ESO frequency response services and business cases.	Program, Product & Project Management	Include stakeholders in the Phase Zero Strategy and Roadmap to validate the service delivery of EFC against overlapping post frequency response services	2	3

Table 219 – Investment risk summary

3.34 650 Accelerating Whole Electricity Flexibility (formerly Facilitating Distributed Flexibility)

Overview & Purpose

This new investment is a discovery activity and does not deliver ESO Technology capability.

Our discovery work arises from a new cross role activity related to Accelerating Whole Electricity Flexibility (AWEF), which has resulted in new deliverables across all 3 roles with associated 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 distributed energy resources**. 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 in addition to our work on DSO policy and RDPs. 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 ensure our technical requirements for service provision remain appropriate for smaller distribution assets. Further details are under **A15.8 Facilitate distributed flexibility and whole electricity system alignment**.

Our understanding of the scope of IT work under these deliverables is evolving both internally and externally as agreements are made with other stakeholders within the industry. We have proposed provision for a Discovery stage at the start of BP2 to elicit the business needs across the deliverables, assess the impacts to our platforms and define a change strategy with estimates of the effort and costs for the further work.

Whilst our future state and solution options are to be confirmed following the delivery of the Discovery stage, there are tentative relationships between the investment to be made for AWEF and the following other investments:

For our increased operational visibility, we anticipate a need for operational data exchanges or ICCP links with all DNOs. These links are being put in place by the **340** RDP Implementation and Extension and **460** Restoration investments.

There may be impacts on the **110** Network Control, **180** Enhanced Balancing Capability and **340** RDP Implementation and Extension investments. As agreements 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.

There may also be a need for enhancements within the **400** Single Markets Platform and the **250** Digital Engagement Platform investments to ensure interoperability with DSO platforms described in their RIIO-ED2 Business Plans. In addition, these investments may need to consider interoperability with third party platforms.

Associated RIIO-2 Sub-Activities	Key Investment Outcomes
• A1.5 Operational coordination with DER and DSO • A4.5 Facilitate whole electricity system market access for distributed energy resources • A15.8 Facilitate distributed flexibility and whole electricity system alignment	• Discovery stage: business needs, impacts to platforms, change strategy with estimates of effort and costs for further work

Table 220 - Summary of business outcomes and corresponding sub-activities

Current State

As part of the scope of work for the ENA – Open Networks project in 2022, the ESO has been working across a number of Products which will help define the required business processes and IT outputs for this investment area. The key Products that will ultimately lead to the need for new investment are WS1A – P5 (Primacy) and WS1B – P6 (DER Visibility). The approach taken so far for Primacy will see basic Rules deployed across several Use Cases by the start of BP2. These will then need to be evolved and expanded as the Product work progresses and more requirements/scenarios are considered. In order to enable this continuation of Rules deployment, it is expected that investment across a number of core platforms will be required.

In addition, facilitating additional data and information requirements from the Product focused on DER Visibility will also require existing and new platforms to be scaled to cater for an increase in DER numbers.

Following the formation of the Primacy work so far, the ESO has already commenced discussions on the likely new functionality that will be required to deliver improvements to the basic Rules. This work will continue throughout the remainder of BP1 and feed into the 'Discovery' phase of BP2 as lessons are learned from the initial roll-out of Primacy Use Cases.

Roadmap

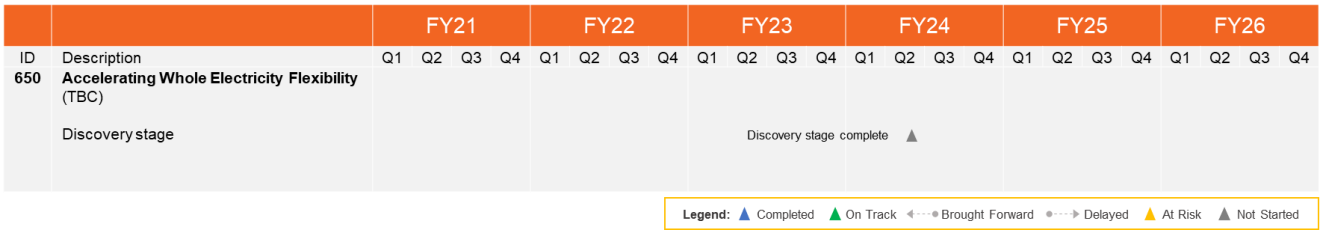


Table 221 - Outcome roadmap

This investment is anticipated to continue into RIIO-3.

Milestone	Outcome recipient	Outcome description
Discovery stage complete	Business Units Customers & Partners	Definition of business needs, impacts to platforms, change strategy with estimates of effort and costs for further work

Table 222 – Outcome summary descriptions

Future State

Indicative architecture scope for this investment.

Target platform	Target Subsystem	Component	Future State
Digital Engagement	Market Facilitation	Customer Markets Portal	Facilitates emerging business models (e.g., aggregation models, third party platforms).
Data & Analytics	Forecasting	Energy Forecasting	Better understanding of underlying demand and generation will improve operational forecasts and adequacy margins
Data & Analytics	Modelling	Power Systems Modelling, Unified Network Model,	Better understanding of future system backgrounds allowing for more informed options assessment. Better understanding

		Economic Modelling, EMR Modelling	of DER output trends ensures consumer value is maximised through the CM.
Data & Analytics	Regulatory Reporting	External Reporting	
Network Operations & Control	Control Room Planning	Restoration Decision Support, Innovation	Utilising distributed generation to restore power following an electricity system Restoration event.
Network Operations & Control	Situational Awareness	SCADA	Improved situational awareness of system issues and co-ordination of actions
Networks	Network Development	Whole System Operation	Ensures that ESO services are not counteracted by automated systems on the distribution network, such as Active Network Management. It also allows greater optimisation of ESO and DSO service needs across different time horizons.
Networks	Network Modelling	Modelling Visualization, Network Model Management	Better understanding of future system backgrounds allowing for more informed options assessment. Supports transition from conservative assumptions on available network capacity
Balancing	Energy Balancing	Dispatch, Scheduling, Frequency Control	Facilitates market access for increasing volumes of DER particularly for locationally dependent requirements. Improved real time assessment and situational awareness of network needs and associated contingency planning. Improved inputs to online modelling tools leading to increased efficiency of dispatch services.

Table 223 – Future state subsystem component summaries

Approach

The Approach for this investment is to be confirmed after the discovery stage has completed.

Solution Options

The solution will be implemented utilizing existing platforms where possible and developing new capabilities where required. As discussed in “Future State” section, the indicative scope includes:

- Energy Forecasting
- Power Systems Modelling, Unified Network Model, Economic Modelling, EMR Modelling
- External Reporting
- Restoration Decision Support, Innovation
- SCADA
- Whole System Operation
- Modelling Visualisation
- Network Model Management
- Dispatch, Scheduling, Frequency Control

The Solution Options for this investment are to be confirmed after the discovery stage has completed.

It is unlikely that a fully bespoke separate software application would be developed for this investment as we would seek to leverage modules of our core platform subsystems and associated software services. However, we cannot rule out bespoke development being required for any niche Flexibility requirements at this stage.

Costs

		BP1		BP2		BP3	
		Actuals	Forecast				
		2021/22	2022/23	2023/24	2024/25	2025/26	TOTAL
Capex (£m)	BP2	0.0	0.0	0.0	0.0	0.0	0.0
	BP1	0.0	0.0	0.0	0.0	0.0	0.0
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Opex (£m)	BP2	0.0	0.0	0.1	0.0	0.0	0.1
	BP1	0.0	0.0	0.0	0.0	0.0	0.0
	Variance	**0.0**	**0.0**	**0.1**	**0.0**	**0.0**	**0.1**
Totex (£m)	BP2	0.0	0.0	0.1	0.0	0.0	0.1
	BP1	0.0	0.0	0.0	0.0	0.0	0.0
	Variance	**0.0**	**0.0**	**0.1**	**0.0**	**0.0**	**0.1**
Cumulative RTB increase (£m)	BP2	0.0	0.0	0.0	0.0	0.0	
	BP1	0.0	0.0	0.0	0.0	0.0	
	Variance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	

Table 224 – Investment cost summary

The costs shown above are for the Discovery stage only. Estimates for the remainder of the investment are to be confirmed after the discovery stage has completed.

This investment is a new business initiative in BP2.

Assumptions

Category	Assumption	Relevant IT Tower Component	Investment Impact Areas	Review Frequency
Deliver	There is an assumption that we have budgeted sufficient effort for the Discovery stage based upon our experiences with a similar scale regulatory change	N/A	If the scope of the Discovery stage increases due to further agreements with industry and / or internal clarity, greater cost may be incurred or a follow up second stage may be needed	Review scope of work within detailed planning of the Discovery stage in Q1 FY24

Table 225 - Investment assumption summary

Risks

Risk	Relevant IT Tower component	Mitigation(s)	Likelihood	Impact
Further agreements on the industry designs might be made with industry stakeholders between now and the start discovery stage, which affect the scope of work	Program, Product & Project Management	Ongoing engagement with industry stakeholders, and subsequent update of the scope and plan for the discovery stage	3	1
As this investment covers emerging concepts, our evolving understanding of the scale of change may affect the scope of work within the discovery stage	Program, Product & Project Management	Ongoing internal engagement with operational teams prior to start of the discovery work to update the scope and plan of the discovery stage and ensure their input to the discovery outcomes	3	1

Table 226 – Investment risk summary

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 227 – 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 49 - 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 228 – 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 229 – 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 230 – 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 231 – 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 232 – 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 233 – 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 234 – 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 Opex and Capex may change but Totex will remain same or be reduced.	Current planned solutions will not change unless there is a financial/efficiency benefit.

Table 235 - 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 RIIO-2 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 236 - 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 237 - 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

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.

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.

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.

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.

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 238 - 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 239 – 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 240- 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 241 - Enterprise Data Network risk summary

Part 5 – Technology Business Management data model

5.1 ESO TBM – BP2 Submission Approach

To align with the BP2 IT Guidance provided by Ofgem, our Technology Business Management (TBM) Data Model applies ESO's forecast IT Portfolio spend against the different layers and levels of the TBM over FY24 and FY25. This covers our Direct Investment Portfolio, National Grid Group Shared Investment Portfolio, and Run the Business (RtB). The overall costs within the TBM Data Model match the figures reported in the IT Annex document.

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 within the General Ledger 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 the incremental RtB spend specific to the direct investments 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
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

ESO Portfolio Component	TBM Approach
	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 242 – TBM portfolio delivery approach

The ESO at present does not have dedicated IT Financial Management tooling in place to support Ofgem's requirement to develop a TBM model for the purposes of our BP2 submission. Therefore, ESO's TBM Data Model has been built manually in Microsoft Excel. This has been a significant undertaking but represents the starting point on the ESO's journey to continue to build and mature its IT cost management capability.

For this reason, we have sought to take a measured and pragmatic approach to building out our TBM data model for our 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 Data Model Considerations

ESO TBM – Information/Data Policy

As part of our BP2 Final Submission, we are taking the opportunity to define and communicate the Information/Data policy that we apply to the ESO TBM Model structure and content. Terms used are based on the standard National Grid / ESO Information Management policies used for all of our business operations around the creation, storage, management and sharing of data.

Our BP2 Final Submission TBM scope includes the ESO TBM Taxonomy v1.5 and ESO TBM Financial Data v1.0

Information Classification: For our BP2 Final Submission we are classifying the TBM structure/taxonomy v1.5 as Public and the ESO financial data content v1.0 within that taxonomy as Confidential.

ESO Classification	Definition
Public	Information approved for publication outside of the company. Unauthorised disclosure will not cause any harm to National Grid businesses, employees, or customers. Examples: information published on external websites and social media.
Internal Use	Information for National Grid staff and authorised contractors. The disclosure or loss of such information would be inappropriate and could have a negative impact on National Grid. Examples: information published on Infonet, in internal policies or in procedures.
Confidential	Information that is commercially or operationally sensitive, where disclosure or loss could have an impact on National Grid businesses, not limited to financial or reputational damage. This could also include information about individuals where a duty of confidentiality is owed. Examples: staff performance and reward records, commercial contract/tender information.
Strictly Confidential	This refers to information that is commercially or operationally sensitive and where disclosure would have a significant impact on National Grid, its assets, or its individuals. Information is to be addressed to named groups or individuals only. Examples: critical electricity or gas networks and

	related computer system operational details, possible acquisition of commercial information, Executive Board discussions.

Considerations

As part of our BP2 Final Submission, we are taking the opportunity to outline the status of cost transparency management within ESO and use of the TBM framework within our Portfolio management function for current and future states.

Our target state objective is to manage ESO Technology costs as a "Bill of IT" model using TBM to describe our Technology portfolio as a business model. This submission represents a first step on that journey.

ESO is currently at the foundational stage of TBM maturity as of August 2022, with our BP2 final submission based solely around a financial forecast for years FY24 and FY25. This has been built using a manually constructed model based heavily upon assumptions, using both bottom-up and top-down methods. Our existing TBM data set as submitted for BP2 should be taken as directional due to being based around future financial year forecasts only.

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 cost data set evolves, and our future enterprise architecture matures in parallel.

To achieve our strategy and outcomes we are committing to managing the ESO cost model using the TBM Taxonomy to describe our actual spend on our IT estate. This requires us to switch approach on TBM data gathering and taxonomy validation and focus on our General Ledger / Supplier Invoice data set.

We expect the work on our Actuals data set to include further updates to our TBM Taxonomy categories, particularly in the Cost Pools and Towers layers when compared to our v1.5 Forecast-driven model.

From our analysis and further reviews held with National Grid Group and our internal/external framework partners, we have identified key action areas to achieve a Production baseline standard with our TBM model:

- Move away from forecast/example models that at best are directional and at worst could lead to presumptive views of ESO's Technology spend breakdown – and move towards actuals/consumption-driven modelling
- Identify and standardise feeds from required data sources including General Ledger, Configuration Management (CMDB), Vendor Management and People/Timesheeting systems
- Establish process to true-up those data feeds into enhanced versions of the ESO TBM taxonomy i.e., detailed mapping of those disparate/complex data sources into our standardised TBM view (which will change for Actuals compared to v1.5)
- Redesign modelling logic and calculations to truly reflect a consumption-driven set of outcomes
- Clarify specific requirements for Reporting with OFGEM and our internal IT Leadership / ESO Board membership to understand their needs on analysing the "Bill of IT" and "Impact of Change"
- Work with our technology vendors and partners to adjust invoicing approaches to align with TBM reporting – for example where existing invoices cover multiple services, we need those breakdowns categorised into compatible structures for TBM data ingestion.
- Embed TBM-specific logic and workflow into our IT Finance and Portfolio processes

The above requires significant further effort to be planned, communicated, and integrated into our TBM Roadmap as part of our Cost Management operate model design activities.

Operate Model & Governance: As part of our internal processes, ESO will establish a governance function around the use of TBM for managing cost data aligned to our Cost Management Operate Model (currently in development). We are working on establishing clarity internally with our Portfolio Management, Delivery Management, IT Commercial, IT Finance and Strategy/Architecture functions to deliver and embed this operate

model into our standard ways of working. We expect to be publishing updates on our plans and progress for TBM governance/operate model during Q3 and Q4 of FY23.

Usage/Sharing: The ESO TBM Taxonomy v1.5 will be shared on our website and can be re-shared by external parties in line with our ESO public website terms and conditions. Our ESO Financial Data v1.0 contained within our TBM model will not be shared on our website and cannot be shared with external organisations without our permission. Throughout our BP2 engagement with OFGEM we have shared regular TBM model updates to arrive at v1.5 and versions prior to this are now considered by ESO to be "Archived". ESO will no longer be referring to versions prior to v1.5 and will supersede with new versions as more accurate cost data is applied into the model – including Actuals when available.

Current State Analysis: We have conducted a Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis on our TBM Model v1.5 for BP2 Final Submission.

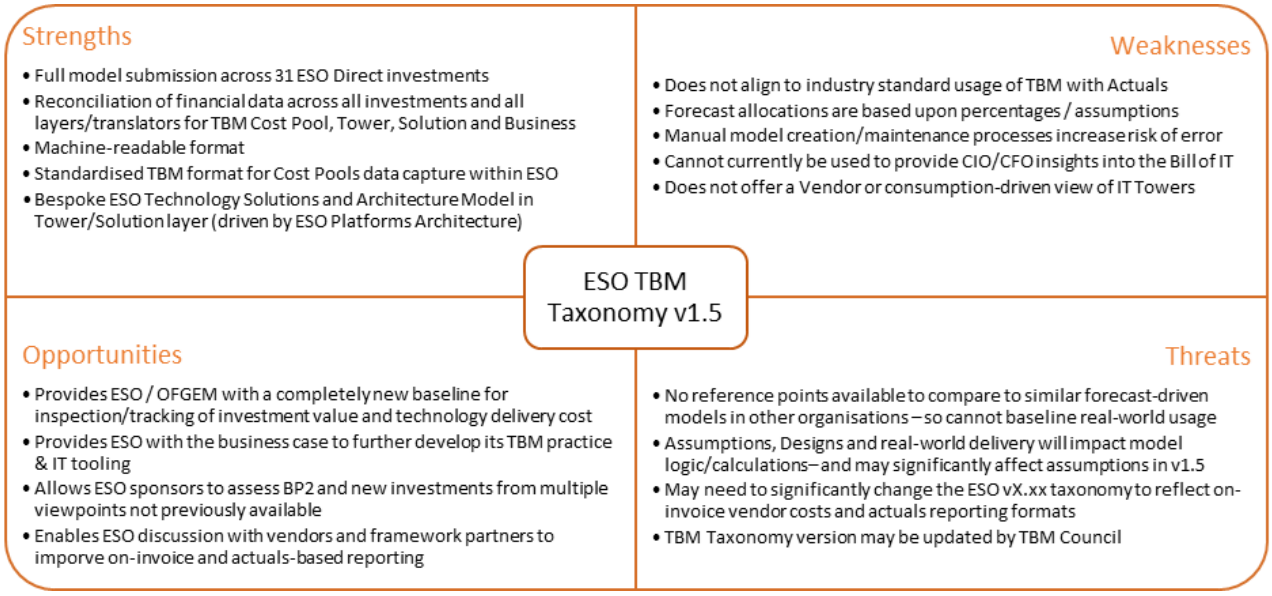


Figure 50 – SWOT analysis performed on our TBM Model v1.5

ESO Benefits & Outcomes

Our Portfolio Management and Strategy & Architecture functions have defined 3 strategic focus areas for use of TBM within an ESO cost management practice:

Demonstrating the value of IT: providing our business sponsor and IT leadership transparent views on the Bill of IT to aid with analysis and tracking of value – TBM (when populated with Actuals) lends itself naturally to this purpose and we fully embrace the opportunity to implement TBM in ways that achieve this aim. Note – we have not yet achieved this outcome

Delivering Regulatory Compliance: a component of our BP2 final submission is our TBM model v1.5 which has been developed in collaboration with OFGEM. We have implemented bespoke requirements as inputs from the OFGEM team to support ongoing regulatory / performance management reporting as laid out in the RIIO-2 IT guidance – we will continue to use TBM to provide updated cost transparency data in the baseline format v1.5. Note – we have achieved a first stage of maturity for this outcome but have several stages yet to achieve to be continually compliant for future submissions/reviews.

Improving our Portfolio Practice: we will embed TBM knowledge and skills capability into key People roles within our Portfolio Management, Strategy & Architecture, Delivery Management and Product Ownership teams to support the above two outcomes and to strengthen/optimise our Estimation capability. We will re-engineer Business and IT Process that embed TBM alignment into our standard ways of working using TBM-native tool

into ensure ongoing compliance and reporting and therefore will need to train our team in this Technology capability. Note – we have not yet achieved this outcome.

ESO TBM Capability

We are outlining our internal team capability in terms of TBM competency and its linkage into our overall Cost Management operate model framework.

At BP2 Final submission – our overall competency in TBM is "Low". This is driven by our position of being at first draft model delivered into OFGEM using Forecast-only data and no embedded TBM practice within the ESO organisation. At this stage we have not designed an ESO TBM taxonomy structure that will work with Actuals from our General Ledger system.

At the start of BP2 – our overall competency in TBM will be "Low-Medium". We will have designed our first iteration of ESO's cost management framework and operate model, including TBM ways of working for our first rollout to ESO teams and will have started to test an updated TBM model structure for Actuals from our General Ledger. We will have implemented additional controls and some process improvements for consolidation of cost estimation processes into the TBM Cost Pools format, with MI reporting using an automated data load / reporting tool to improve visibility of the working TBM data set. Only a limited Actuals data set will be available and therefore our taxonomy for Actuals and overall data set will still be "Work in Progress" at this stage.

To support the design of a taxonomy and population for our Actuals data set, we will implement TBM-native tooling within ESO to move us away from manual model creation/management and will focus on basing our TBM operate model around the use of this tooling.

We will still be reliant on the TBM v1.5 taxonomy and Forecast-only data set at this stage and therefore the Actuals-driven taxonomy and the BP2 submission V1.5 must remain compatible throughout.

By end FY23 – Several investment data sets will be integrated into the updated taxonomy for Actuals and the quality of our target TBM data set will be significantly improved. Programmes that have passed their design stages and are delivering scope into Production state will be mandated to report their Actuals from General Ledger into the Cost Pools layer and we will have matured to being able to automate delivery of the Towers, Solutions and Business Layers in the appropriate TBM-Native tooling. Some investment programmes will still be reliant on the V1.5 Forecast-driven data sets, meaning we will still have a mixture of Forecast and Actual data in our combined model during FY23. Our estimation practice will still require further maturing into FY24 activities.

By end FY24 – We will have converted our portfolio into a TBM-Native operate model and will default to a TBM-driven cost input, management and reporting process. Our estimation practice will be standardised across the portfolio to allow us to forecast using TBM Actuals as a data source (plus others), with future forecasts being driven from these controlled data environments. We expect to retire the V1.5 Forecast-driven taxonomy by the end of FY24.

External Assurance

To complement our internal activities, we will utilise external assurance capability for our cost transparency, management and estimation activities including the use of TBM. Our current thinking is that this will be provided from

- National Grid Group – TBM practice within Group IT
- External independent provider – to be determined via our sourcing frameworks

We have commenced activities around assurance for our TBM work to help us accelerate the move from Forecast to Actual and to help us understand the work required to link to General Ledger and Supplier Invoice data sources.

Risks

In consultation with industry and our technology delivery partners, we have identified the following risks in relation to our cost management, estimation and TBM approach/capability:

Risk	Relevant IT Tower component	Mitigation(s)
Forecast-driven TBM data set is used as “certainty” for early Bill of IT analysis	IT Management & Strategic Planning	Stakeholder engagement and communications to manage expectations and demonstrate roadmap to Actuals-driven model
Level of structural change required to support Actuals delays progress	IT Management & Strategic Planning	Start with small Actuals data set and grow out from a baseline capability, avoid attempting to finalise a 100% Actuals view up-front
Lead time for General Ledger alignment to TBM Taxonomy delays ESO progress with move to Actuals-driven model	IT Finance	Engage and influence IT Finance stakeholders to support target outcomes for ESO
ESO may make decisions about maturing TBM into Actuals-driven model that do not align to desired outcomes	IT Management & Strategic Planning	Seek external assurance and guidance on TBM, adopt best practice from real-world implementations of TBM
Sufficient TBM skills and knowledge may not be available in time to support the ESO cost management roadmap	IT Management & Strategic Planning	Ensure sponsorship for TBM/Cost management operate model high on ESO/CIO agenda

Table 243 – TBM risk summary

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 an evolution of the approach presented at BP1. The probability scores reflect the likelihood of the risk occurring and becoming an issue. Whilst impact scores record the impact should the risk become an issue. This is assessed at both an individual investment level and 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.

Score	Category	Impact of occurrence	Probability of occurrence
1	Remote	Low Impact - Minimal loss, delay inconvenience or interruption. Can be easily and quickly remedied.	Less than 10% (remote)
2	Less likely	Low / Medium Impact - Minor loss, delay, inconvenience, or interruption. Short to medium term effect	10-30% (less likely to occur)
3	Equally likely as unlikely	Medium Impact - Significant waste of time and resources. Impact on operational efficiency, output, and quality. Medium term effect which may be expensive to recover.	30-50% (possible it may occur)
4	More likely	Medium / High Impact - Major impact on costs and objectives. Serious impact on output and /or quality. Medium to long term effect and expensive to recover.	50-70% (likely to occur)
5	Almost certain	High Impact - Critical impact on the overall achievement of objective and overall performance. Critical impact on costs and/ or reputation. Very difficult and possible long term to recover	More than 70% (almost certain)

Table 244 - 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 245 - Risk impact methodology

*Note whilst an impact score may be stated as '1' for some investments this may still represent a high impact for the investment in question. This is particularly the case if the total forecast cost for the investment is small in nature.

Appendix B: 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 51 - 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 52 – ToR for Portfolio Review Board

Appendix C: 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 53 – An illustration of our key continuous improvement themes

As we continue through BP1, we are starting to capture lessons learnt and further improvements. The below tables summarise for each improvement theme what changes we promoted during BP1 based on RIIO-1 learnings (top section). Based on a similar exercise conducted over the course of the BP1 period, we have then identified further actions which we will apply during BP2 where required (bottom section).

Engagement

We said for BP1	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.
What we have learnt in BP1	**What we want to improve**	**Expected improvement in BP2**
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.

Technical design

We said for BP1	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 for BP1	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.
What we have learnt in BP1	**What we want to improve**	**Expected improvement in BP2**
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

We said for BP1	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.
What we have learnt in BP1	**What we want to improve**	**Expected improvement in BP2**
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	Allow for better investment insights and their value. Improve frequency of updates and consistency of

	with the right skillset and expertise.	reporting to regulator and industry.

Delivery approach

We said for BP1	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 for BP1	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

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.
What we have learnt in BP1	**What we want to improve**	**Expected improvement in BP2**
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.

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