Project Overview

Advanced Dispatch Optimisation 2

17th of November 2023

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1. Executive summary

This report describes the work done as part of the Advanced Dispatch Optimisation – Phase 2 project. (ADO 2). The project is a continuation of the Advanced Dispatch Optimisation project previously completed by Google Tapestry, where Tapestry created a strategic vision for an efficient dispatch process that is fit for purpose for the energy system of the future. Tapestry introduced several concepts to achieve the desired outcome, including:

- Automated insights through adaptive machine-learning input data models.
- Probabilistic trajectories of various system states.
- A series of look-ahead time-coupled security-constrained economic dispatch optimisation engines creating a system operating plan (SOP), instructions and reserves.
- Enhanced or automated operator decision support.
- Automated performance monitoring.

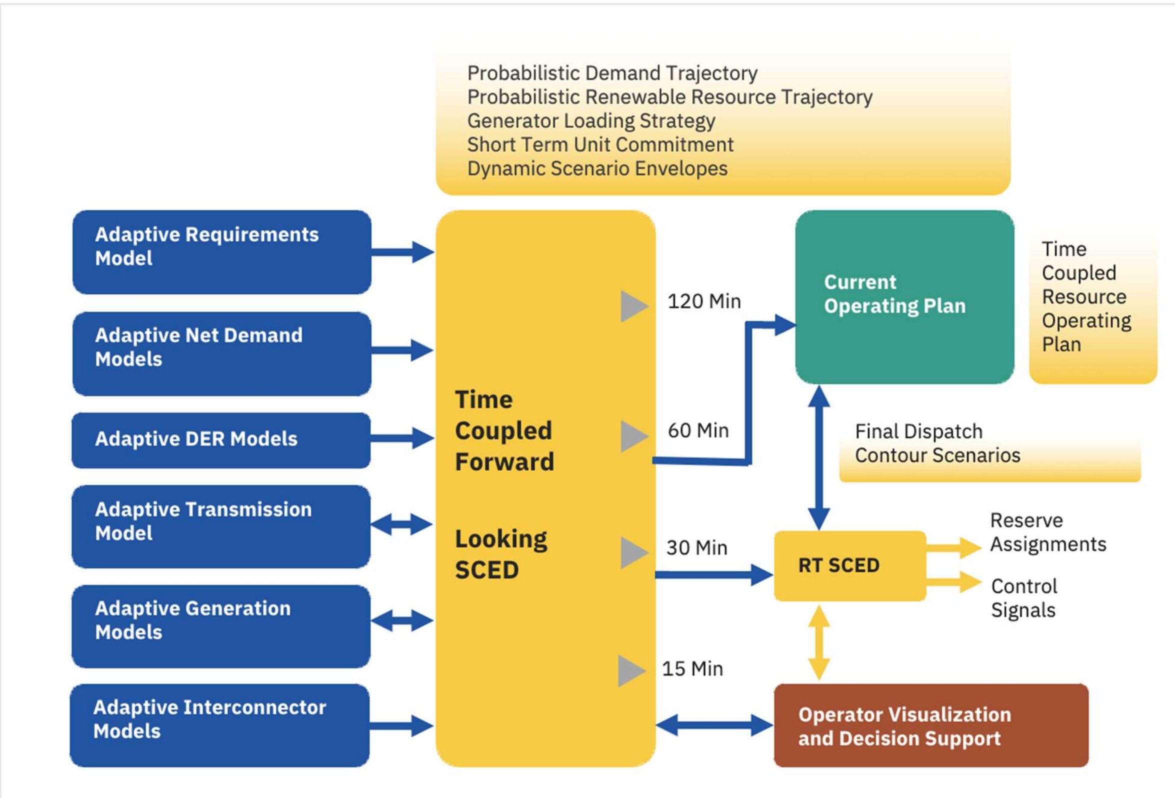


Figure 1: Strategic vision created by Google Tapestry

The ADO 2 Project aimed to meticulously explore the effective and efficient implementation of the vision outlined in the Tapestry report.

The project delved deeply into the input data models, comprehensively assessing the required input and output data for each model as well as data quality and data availability.

In the course of the ADO 2 project, an architectural framework was proposed to support the realisation of the objectives described above.

The project identified the capabilities necessary for realising the envisioned objectives and performed a comprehensive analysis of the current state of these capabilities. Once the to-be and the as-is were articulated, a gap analysis was conducted to ascertain the steps required for transitioning ESO from its current state to the desired future state. The identified work packages were added to a roadmap for clarity and actionable guidance.

This report summarises the key insights derived from each of these activities, which collectively constitute the final deliverables of the ADO 2 project.

2. Target architecture

To ensure a technically sound roadmap we created a high-level view of a potential logical architecture for the ADO system. We created four key architectural artefacts, which are described in more detail in the architecture report:

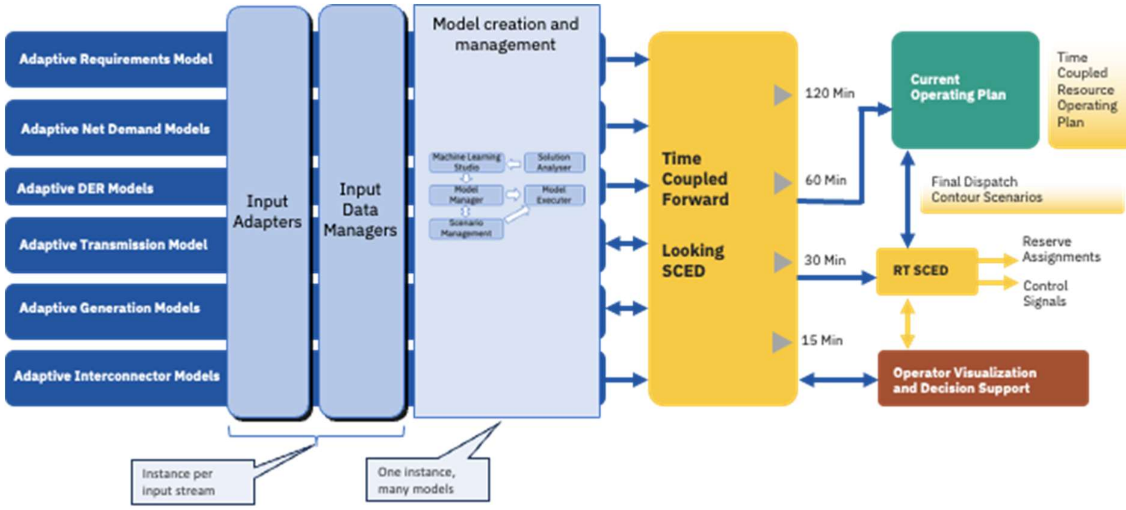
- A System Context Diagram: This provides an overview of the ADO system and its relationship to other systems and components.
- Architectural Principles: They outline the guiding principles and constraints that have shaped the architecture of the ADO system.
- Architectural Decisions: To capture the key decisions that will need to be made during the design process, including the rationale behind each decision.
- A Component Model: This diagram provides a detailed view of the components that make up the ADO system, including their relationships and interactions.

The architecture is designed to build upon the existing Open Balancing Platform (OBP) and leverage its strengths, while also utilizing the Platform for Energy Management (PEF) for certain components. The ADO system will re-use design patterns from borh platforms, where appropriate. This will help to ensure consistency and efficiency in the development process. The underlying assumption is that the OBP will serve as the primary platform, although some elements could also be implemented on the PEF. The OBP offers the benefit of high availability of the CNI (Critical National Infrastructure) supporting platform, while the PEF offers fewer development restrictions. Therefore, functionality may initially be developed on the PEF and then moved to the OBP as needed. This approach will allow for more flexibility in the development process and enable the team to take advantage of the strengths of both platforms.

In addition, ADO will introduce several new services, including:

- A Machine Learning Studio: This service will provide a platform for developing and testing machine learning models.
- A Model Manager: This service will include version control and execution capabilities for managing models.
- Scenario Management: This service will manage scenarios across multiple data input streams and tie scenario definitions to resultant optimised solutions.
- A Solution Analyser: This service will provide post-event analysis of performance, identify model drift, and aid in training models.

Please note this is a logical view. Services may be combined, especially if a ML Studio is procured that provides some of the other service that are listed above. Figure 4 shows how the components map to the Architecture Overview Diagram produced in the preceding Google Tapestry report.



3. Input Data Model Deep Dive

In order to be able to create a meaningful roadmap, we needed to further detail the input data models proposed by Google Tapestry in their vision. Tapestry defines six input data model groups which feed into the optimiser engines (see Table 1):

1. **Adaptive Generation Models**
    a) Thermal
    b) Renewable
    c) Grid-scale duration limited assets, such as batteries and pumped storage [added following Google X clarification and not explicitly referenced within the Tapestry report]
2. **Adaptive Transmission Model**
3. **Adaptive Interconnector Models**
4. **Adaptive Distributed Energy Resources (DER) Models**
5. **Adaptive Net Demand Models**
    d) Demand Forecast and Consumer Behaviour
    e) Embedded DER
6. **Adaptive Requirements model /Reserve (out of scope for our project)**

The Requirements model was out of scope for our project, but we explored current and planned capabilities, the required final capability, as well as the associated gaps, data quality and next steps for all the other model groups.

Except for Transmission, all model areas have the same high-level process architecture – training a predictive supervised learning model, with an ongoing evaluation and retraining element, to enable testing of scenarios.

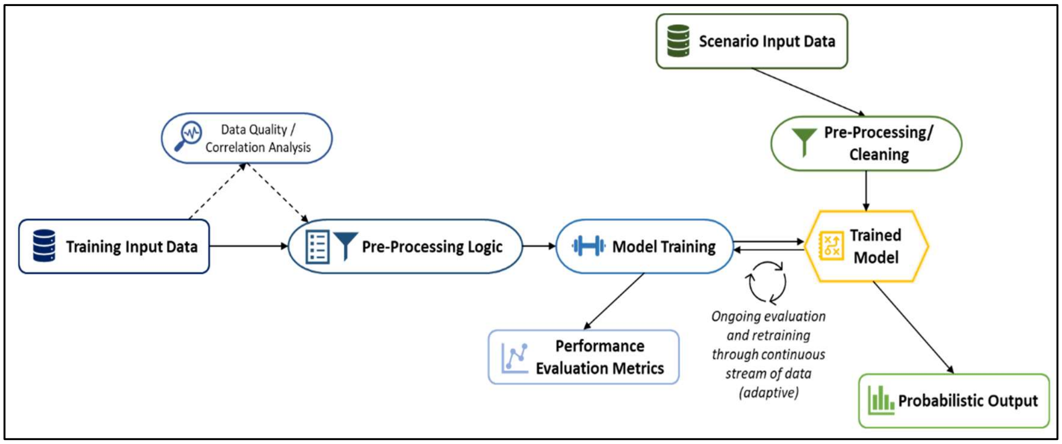
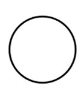
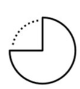


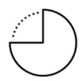
Figure 2: High-level process architecture

We found that data availability varies greatly by modelling area, though there are clear instances where multi-year data collection processes are necessary to meet the outlined historic data requirements. Data quality and granularity vary by input data source. For example, there are multiple known issues with Data Historian, but no anticipated issues with the Transmission model data (in part due to the sophistication of existing processes)[1]. More details on the input data models can be found in the input data model report that was produced as part of this project.

Table 1:Data Availability and next actions Table

Adaptive Input Data Models	Generation	 Availability  Quality	• Planning of real-time data collection period where required (e.g., generator conditions, total system demand, binding transmission constraints etc.). • Full analysis of quality and granularity issues (e.g., Data Historian, NED, weather data).
	Transmission (IBM View)	 Availability  Quality	• Discussion with TOs regarding the ownership, format, and required frequency of dynamic line ratings. • Full analysis of quality and granularity issues (e.g., accuracy / granularity of current weather forecasts for scenario building).

1

	Interconnector	 Availability  Quality	• Detailed analysis of data sources (some requiring purchase) to establish whether granularity and quality are sufficient for this purpose (e.g., timescales of “scheduled flows”, ability to forecast market data in the creation of scenarios).
	DER	 Availability  Quality	As for generation: • Planning of real-time data collection period where required (e.g., generator conditions, total system demand, binding transmission constraints etc.). • Full analysis of quality and granularity issues (e.g., Data Historian, NED, weather data).
Net Demand Forecast Module	Demand Forecast and Consumer Behaviour	[Unable to obtain SME input.]	• Initial availability and quality analysis (as completed for the other modelling areas).
	Embedded DER	Dependent on methodology – see discussion in section **Error! Reference source not found.**.	N/A

A summary of the insights identified in the deep dive can be found in the below table.

Table 2:High-Level Input Data Model Insights

End Vision Module	Input Data Model Area	Core Question	Data Requirements Headlines	Data Availability Headlines	Data Quality / Granularity Headlines
Adaptive Input Data Models	Generation	Given a set of dispatch instructions to test, combined with forecast input data such as weather, likely maintenance etc., what is the predicted actual MW output for a specified generator?	Historic Training Data - Generator Offer Data - Production Forecast Data - Instructed MW output - Actual MW output - Weather - Generator Conditions - Total System Demand - Binding Transmission Constraints - Dispatch State Scenario Input Data (Forward-Looking) - Theoretical Dispatch Instructions - Existing PNs for given period - Generator Offer Data - Weather - Etc. as above	• Approx. 3 years of data collection in real time necessary to meet the historic “Additional Information” data requirements. • Data groups required for scenario testing are generally more available, and hence not as restrictive to model development as the training data.	Data Historian Issues • Muddled data timestamps. • No differentiation between out-of-service and decommissioned. • Incorrect flow direction. • Untrustworthy static generator data. • Slow data extraction. • Potential sunsetting. Lack of data dictionary for Data Historian and National Grid Economic Database (NED).
	Transmission (IBM View)	Split by constraint problem type (e.g., thermal, generator stability, voltage etc.), what are the forecasted transmission constraints to be fed into the optimiser module?	For the identified constraint problem types (Thermal, Generator Stability, Voltage, Rate of Change of Frequency / Inertia / Largest Loss), - Local Network Characteristics - (Dynamic) Line Ratings - Generator Characteristics - Network Model - Fault Understanding	• Not subject to the historic data availability issues observed in other areas.	• No known significant data quality issues • Unknown factors for consideration include: the agreed quality and granularity of any TO-produced dynamic line rating data, and accuracy / granularity of current

			- Contract Information - Weather - Network Configuration - Generation, Demand, and Interconnector Forecasts - System Operating Plans - Faults - Voltage Profile - Largest Demand Loss - Largest Generation Loss	• No significant data availability issues anticipated.[2]	weather forecasts for scenario building.
	Interconnector	Given a prescribed set of forecasted scenario conditions, what is the forecasted actual flow on the interconnectors (prior to any further required reactive manual trading / intervention post-optimiser run)?	Historic Training Data - Scheduled interconnector flow trends - Actual interconnector flow trends - GB Market Data - Foreign Market Data Scenario Input Data (Forward-Looking) - Real-time power flows on transmission interconnectors - Scheduled interconnector flow trends - GB Market Data - Foreign Market Data	• Most elements of the historic training data are available in some form (perhaps requiring purchase). • Whilst some variables are readily available, the limited forecasting of market conditions may lead to difficulty in defining relevant, accurate scenarios.	• Actual interconnector flow of good quality / granularity. • Forecasted market data considered poor quality and accuracy. Further Considerations • Granularity of historic scheduled flows. • Usability of historic market data.
	DER	Given a set of dispatch instructions to test, combined with forecast input data such as weather, likely maintenance etc., what is the predicted	Historic Training Data - DER / DER Group Offer Data - Production Forecast Data - Instructed MW output - Actual MW output - Weather - Resource Conditions	• Approx. 3 years of data collection in real time necessary to meet the historic "Additional Information" data requirements.	As for Generation above.

[2] Whilst there may be availability issues with, for example, network sensor data in the TO-owned calculation of dynamic line ratings, these would be observed by ESO through the quality / granularity of said ratings – see unknown factors for consideration comment.

		actual MW output for a specified resource / aggregated resource group?	- Total System Demand - Binding Transmission Constraints - Dispatch State Scenario Input Data (Forward-Looking) - Theoretical Dispatch Instructions - Existing PNs for given period - DER / DER Group Offer Data - Weather - Etc. as above	• Data groups required for scenario testing are generally more available, and hence not as restrictive to model development as the training data.	
Net Demand Forecast Module[3]	Demand Forecast and Consumer Behaviour	Given a set of fixed inputs (e.g., day of week, time of day etc.), combined with forecast input data such as weather, market prices etc., and the existing demand forecast, what is the predicted actual demand at the chosen level of granularity?	Historic Training Data - Demand Forecasts - Actual Demand - Demand Flexibility Service instructions - Weather - Market Prices Scenario Input Data (Forward-Looking) - Demand Forecasts - Demand Flexibility Service instructions - Weather - Market Prices	[Unable to obtain SME input.]	[Unable to obtain SME input.]
	Embedded DER	What is the amount and type of embedded DER at a given level of granularity, and what is the subsequent	Dependent on methodology – see discussion in section **Error! Reference source not found.**.	N/A	N/A

[3] Note that, with this view, demand modelling is split into actual (gross) demand and embedded DER, with net demand calculated as the difference between these values. This approach vs. direct modelling of net demand is discussed in section **Error! Reference source not found.**.

		impact on net demand?			

4. Capability Framework

The capability framework that was developed as part of the ADO 2 project aims to break down the vision defined by Google Tapestry into distinct (to-be) capabilities. These direct and value-adding capabilities (L0) were then broken down into enabling capabilities (L1), which in sum provide the means to the L0 capability, as depicted in the accompanying image.

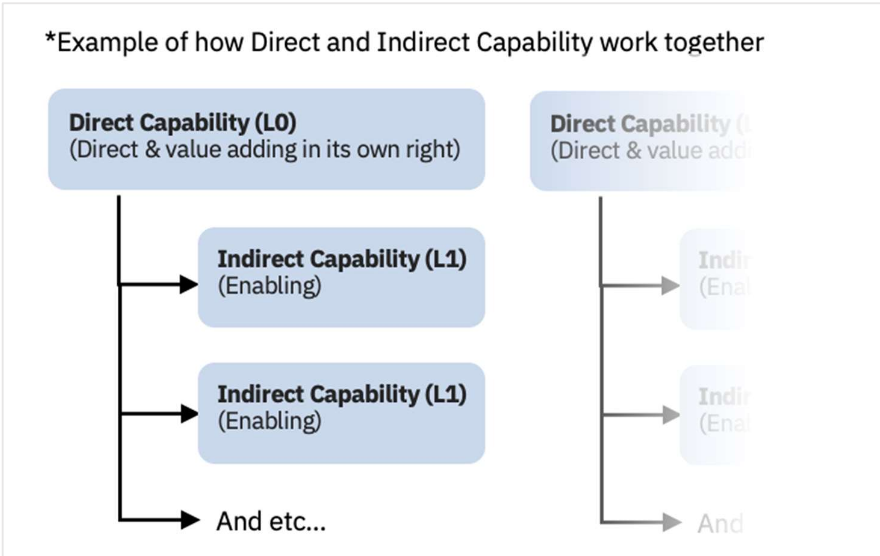


Figure 3: Capability Framework

The comprehensive gap analysis report provides an in-depth explanation of the capabilities and the associated value that each of these capabilities may offer. It is worth noting that Capability L0.7 (The capability to dynamically calculate reserve requirements based on actual system conditions) remained unexplored in further detail due to its descope status from the study.

The following is a list of the level 0 capabilities and their respective level 1 capabilities:

L0.1. FORECAST DEMAND AND CONSUMER BEHAVIOUR IN A GIVEN SCENARIO:	• **L1.1.1.** Model of demand and consumer behavior, correlating the difference between forecast and actuals with external parameters (such as weather, time of day etc.). • **L1.1.2.** Scenario modelling capability which enables the prediction of demand over the current and upcoming operating period, under a specified set of conditions. • **L1.1. 3.** Ongoing evaluation and retraining of the model.
L0.2. FORECAST EMBEDDED DERS (I.E., DISTRIBUTION CONNECTED AND NOT CONTROLLABLE) OUTPUTS GIVEN A CERTAIN SCENARIO:	• **L1.2.1.** Modelling the output of embedded DERs, correlating the difference between the forecast and actual outputs with external parameters (e.g., generator conditions and weather). • **L1.2.2.** Scenario modelling capability which enables embedded DERs over the current and upcoming operating period, under a specified set of conditions. • **L1.2.3.** Ongoing evaluation and retraining of the model.
L0.3. FORECAST THERMAL GENERATOR OUTPUTS IN A GIVEN SCENARIO:	• **L1.3.1.** Model of demand and consumer behavior, correlating the difference between forecast and actuals with external parameters (such as weather, time of day etc.). • **L1.3.2.** Scenario modelling capability which enables the prediction of demand over the current and upcoming operating period, under a specified set of conditions. • **L1.3. 3.** Ongoing evaluation and retraining of the model.
L0.4. FORECAST RENEWABLE GENERATOR (TRANSMISSION CONNECTED) OUTPUTS IN A GIVEN SCENARIO:	• **L1.4.1.** The capability to correct, physical parameters (e.g., MW limits and ramp rates) that are provided by renewable generators. • **L1.4.2.** Modelling the output of a renewable generation resource, correlating the difference between the forecast and actual outputs with external parameters (e.g., generator conditions and weather). • **L1.4.3.** Scenario modelling capability which enables the prediction of a renewable generator's output in response to a set of dispatch instructions, under a specified set of conditions. • **L1.4.4.** Ongoing evaluation and retraining of the model.
L0.5. FORECAST OF DISTRIBUTED ENERGY RESOURCE (DER) OUTPUTS IN A GIVEN SCENARIO:	• **L1.5.1.** The capability to automatically correct physical parameters (e.g., MW limits, ramp rates, minimum non-zero time, minimum zero-time, MEL, MIL, SEL) that are provided by DERs (visible and participating in the market). • **L1.5.2.** Modelling the output of DERs (visible and participating in the market), correlating the difference between the forecast and actual outputs with external parameters (e.g., weather). • **L1.5.3.** Scenario modelling capability which enables the prediction of DER outputs in response to a set of dispatch instructions, under a specified set of conditions. • **L1.5.4.** Ongoing evaluation and retraining of the model.
L0.6. FORECAST STORAGE CAPACITY IN A GIVEN SCENARIO:	• **L1.6.1.** The capability to automatically correct physical parameters (e.g., MW limits, ramp rates, minimum non-zero time, minimum zero-time, MEL, MIL, SEL) that are provided bystorage assets (visible and participating in the market). • **L1.6.2.** Modelling the output of storage assets (visible and participating in the market), correlating the difference between the forecast and actual outputs with external parameters (e.g., weather). • **L1.6.3.** Scenario modelling capability which enables the prediction of storage asset outputs in response to a set of dispatch instructions, under a specified set of conditions. • **L1.6.4.** Ongoing evaluation and retraining of the model.
L0.8. CALCULATE A SET OF RANKED TRANSMISSION CONSTRAINTS AND SUGGEST STRATEGIES TO MITIGATE:	• **L1.8.1.** Capability to dynamically calculate line ratings. • **L1.8.2.** Capability to forecast 11+ transmission constraint types, which are then grouped and ranked. • **L1.8.3.** Develop mitigation strategies to address transmission 11+ constraints. • **L1.8.4.** Capability to input constraints and mitigation strategies into the optimisers. • **L1.8.5.** Enable automated interoperability of the transmission models with optimisers solving the energy problem. • **L1.8.6.** Ongoing evaluation and retraining of the models.
L0.9. FORECAST INTERCONNECTOR FLOWS GIVEN A CERTAIN SCENARIO:	• **L1.9.1.** Modelling of interconnector flows, correlating the difference between forecast and actual outputs with external parameters. • **L1.9.2.** Scenario modelling capability which enables the forecast of interconnector flows, under a specified set of conditions. • **L1.9.3.** Ongoing evaluation and retraining of the model.
L0.10. OPTIMISE FOR THE UPCOMING DISPATCH PERIOD TO MINIMISE COST:	• **L1.10.1.** Capability to optimise residual energy balancing (national load) for the lowest cost during the dispatch period. • **L1.10.2.** Capability to satisfy MW constraints (thermal constraints) in optimisation during the dispatch period. • **L1.10.3.** Capability to satisfy MW constraints (stability and vector shift) in optimisation during the dispatch period. • **L1.10.4.** Capability to satisfy MVar constraints (voltage) in optimisation during the dispatch period. • **L1.10.5.** Capability to optimise for frequency response requirements and constraints (regional response, largest loss, frequency impact - dynamic and static) in optimisation during the dispatch period. • **L1.10.6.** Capability to optimise reserve levels in the dispatch period. • **L1.10.7.** Capability to optimise all asset types for all service types during the dispatch period. • **L1.10.8.** Capability to create dispatch advice/targets for the instruction optimiser to work to during the dispatch period. • **L1.10.9.** Capability to create instructible output during the dispatch period. • **L1.10.10.** Capability to create dispatch instructions during the dispatch period. • **L1.10.11.** Capability to perform day-ahead scheduling using a similar integrated optimisation. • **L1.10.12.** Produce multiple final dispatch options providing the operator with a choice, based on different input scenarios. • **L1.10.13.** Perform a daily performance review of the integrated advance dispatch optimisation. • **L1.10.14.** Complete traceability and transparency on how and why the optimiser got to the final output.
L0.11. PROVIDE OPERATORS WITH VISUALISATION OF DISPATCH SCENARIOS AND OPTIMISER OUTPUT, TO IMPROVE SITUATIONAL AWARENESS:	• **L1.11.1.** Operators can view input data, probabilistic trajectories, input scenario information, optimization results and scenarios, dispatch envelopes, etc.

5. Gap Analysis

This section has been deemed commercially sensitive and removed from the report.

6. Work packages

Closing the gaps identified in the gap analysis section will necessitate the initiation of a series of strategic initiatives. The total scope of work has been systematically broken down into a series of workstreams and modular work packages.

The work package report provides a comprehensive overview of the work packages, including their detailed descriptions, the duration of each initiative, the dependencies involved, and the corresponding effort needed for successful completion.

While work packages can exhibit diversity in terms of type, the current approach involves their categorisation into specific key work package categories as elaborated below:

1. **Regulatory Framework Agreement and/or Stakeholder Engagement:**

This work package type encompasses:

- Engagement with regulatory bodies, industry stakeholders, or other relevant parties to agree on who is best placed to provide certain data or forecast certain values and what the impact would be if those parties were made responsible.
- Actions to agree on responsibilities and ownership of data/models within the industry.

2. **Value and/or feasibility analysis:**

This work package type encompasses:

- A thorough examination if the full functionality is required and by when e.g., do we expect model drift, which would justify the high cost of developing an adaptive model.
- An analysis to understand if creating the model is feasible.

3. **Design:**

This work package type encompasses:

- Detailed planning and specification of how the components will be developed, their functionality, and their integration into the overall system.

4. **Agile Development:**

This work package type encompasses:

- The actual development. All development is foreseen as an agile iterative process. The iterative approach is to enable the ongoing understanding of what is needed to improve the models and therefore build on to each increment.
- Includes design and testing.
- Once development is completed, the component could be handed over to IT/BAU.
- Whether it's refining existing models or starting from scratch, each increment involves defining requirements, developing the next iteration of the model, and validating its sufficiency.
- The goal is to continuously improve and refine the model or tools to meet the specified targets and ensure they are integrated into the overall operational architecture effectively.

5. **Research:**

Two work packages are of this type:
1) a qualitative benchmarking exercise and,
2) a wider impact assessment for potential market changes.

- The "benchmarking" work package in the roadmap involves conducting a systematic comparison of specific capabilities, processes, and tools. The analysis aims to identify if other TSOs have similar gaps as the ones identified as part of this project to assess whether they face similar challenges and, if not, how they successfully addressed them. Furthermore, this work package seeks to uncover best practices, lessons learned, realistic benchmarks and requirements for the input data models and the optimisers. The findings from this benchmarking exercise are then incorporated into the relevant work packages, helping to enhance and align the capabilities of the organisation with industry standards and best practices.
- The wider impact assessment is an analysis of the impact of potential market changes such as centralised dispatch or nodal pricing on the ADO vision.

7. Roadmap

In order to address the gaps identified through the gap analysis, a comprehensive strategy has been determined as indicated in the roadmap. This roadmap is designed to orchestrate the execution of essential initiatives that have been termed "work packages" for this report. Work packages that are set to start in Q1 2024 can be initiated independently, they have no prior dependencies. Nevertheless, it's important to note that the commencement dates for these work packages remain flexible and are subject to the discretion of the ESO team.

It is essential to recognise that certain work packages are interlinked with dependencies that have an impact on them. For example, the ADO 2 project has identified dependencies with ongoing programmes, which include:

- The PEF initiative is an ongoing programme. For any work pertaining to the development of adaptive models for demand, renewables or DER forecasting, their progress might be relevant.

- Several projects, namely NCMS, OLTA, PNA, and OSA, are actively engaged in constructing models for specific constraint types. These will need to be aligned with the transmission models described in ADO.
- The Balancing Transformation model is building the bulk dispatch optimiser (BDO), which needs to be considered in the optimiser design strategy

The roadmap presents a visual representation of the proposed timelines, detailing the sequence of work packages, their associated dependencies, and scheduled milestones. For more in-depth information, including detailed descriptions of each work package and their scope, please refer to the "Work Package Report."

In addition to the comprehensive roadmap, we offer two visual aids to facilitate a clearer understanding of the project's structure. The street view image provides a high-level overview of key milestones, while the full version of the roadmap offers a more detailed insight into the execution of work packages, including groupings of common initiatives.

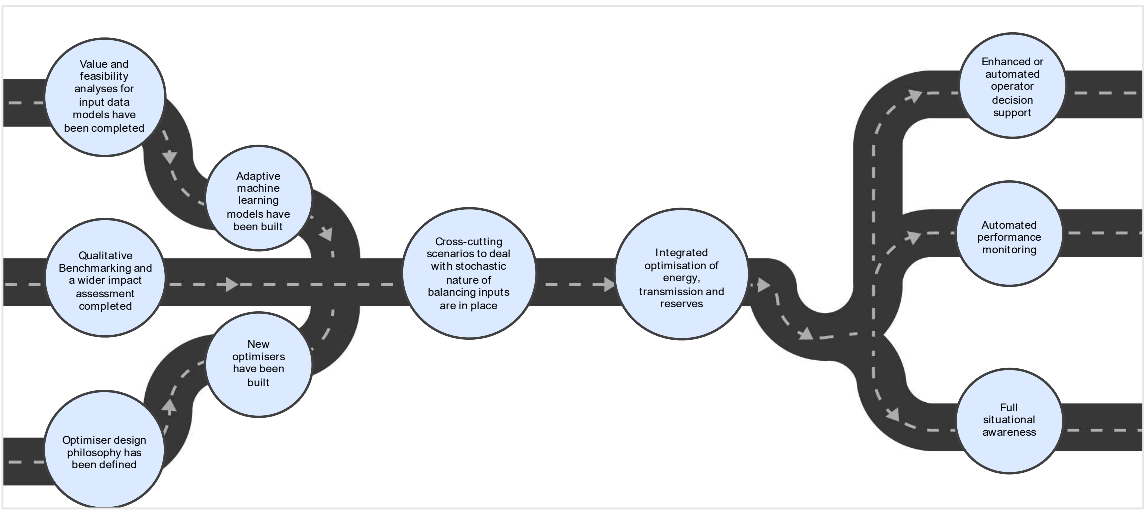


Figure 4: Street View Roadmap

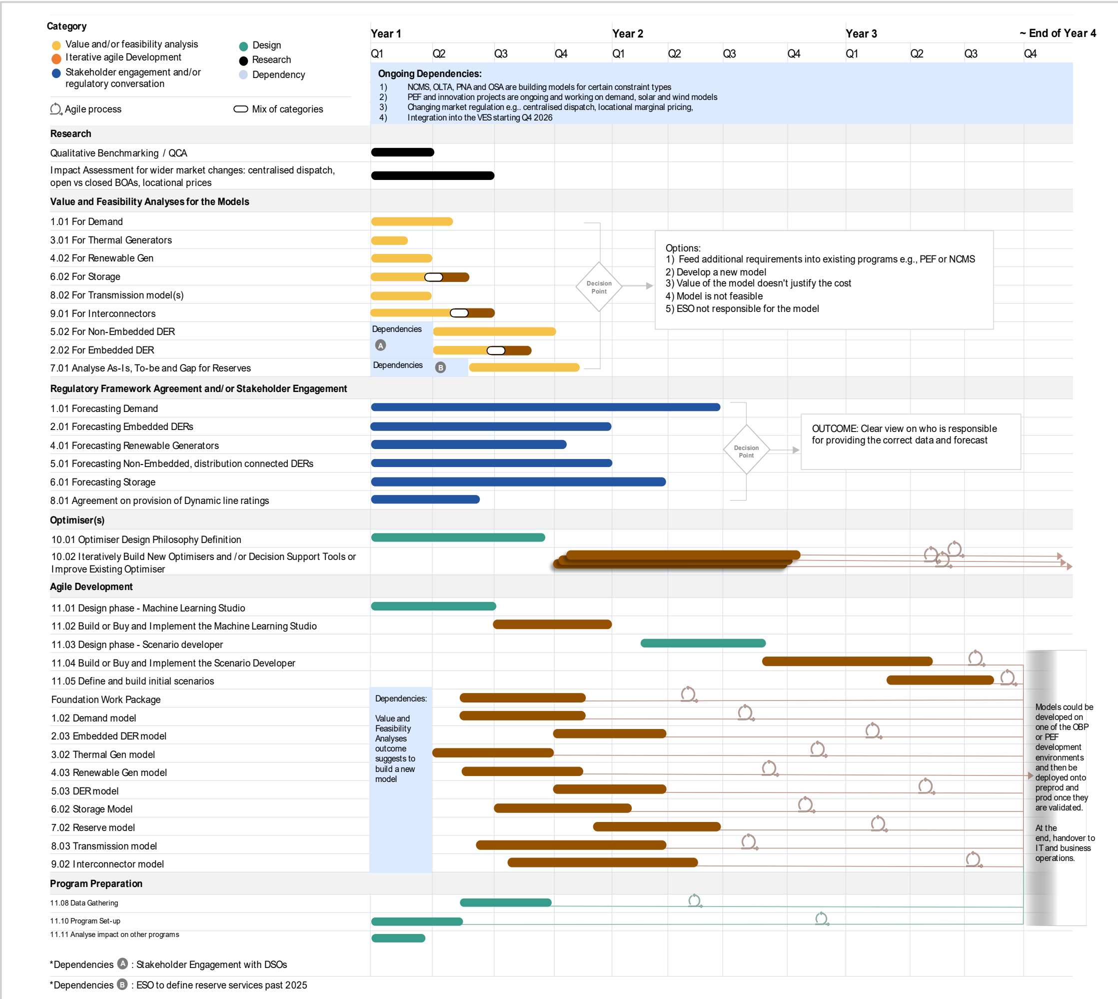


Figure 5: Roadmap

8. Organisational impact

This section provides a set of opportunities and challenges, as well as new skills and retraining needs that the introduction of ADO would bring to the ENCC organisation and certain job roles within ESO. The organisational impact was identified by engaging with SMEs representing the ESO Strategy, Energy and Transmission Teams.

The current scope of ADO (from 2 to 4 hours look-ahead to real-time) corresponds to the activities carried out by the Transmission and Energy teams today. Therefore, we firstly focus on these teams and in a second step we consider the potential extension of the scope to the Strategy (S) and Performance (P) teams.

a. Opportunities

The following opportunities to improve the operating model of the control room were identified.

Table 3:Opportunities to improve the operating model.

Opportunity	Team	Benefits	How to enable
Automation of data handling activities currently done manually.	T / E	Increased efficiency and reduction of capacity for entry level jobs like CTA.	Business change and retraining on new operating model.
The control room will "own" and manage the models, with a new role (model owner) to be created in each team [4]	T / E	Better control of the models by the end users, allowing better governance to maximize value.	Train the Model Owners on how to co-design, maintain, train and adapt the models (with the active support of the Data Scientists).
ADO to bring additional capabilities and value to a "what if" / simulation platform for training purposes (separate project)	T / E	More effective and efficient training process	Redesign the training and authorisation process and introduction of continuous training
Closer collaboration between Energy and Transmission teams	T / E	Faster convergence towards the "best" plan	Business change and retraining on new operating model
Creation of a robust and systematic daily performance retrospective analysis to assess / train the models	T / E	Continuous improvement leading to better decisions	Business change and retraining on new operating model
Possibility to perform more fine-grained analysis e.g.,	T / E	Better decision leading to reduced balancing cost	Business change and retraining on new operating model

[4] For example, the Transmission team would own the Transmission and DSO models (network centric models), the Energy team to own all the generation models and the optimiser; Strategy to own the IC and demand models.

group constraint to individual constraint			
Remove the lack of end-to-end visibility on the cumulated risk margins integrated in a system plan	T / E	Ability to take the right level of risk margins and find the optimal cost versus risk position.	Provide managers with a dashboard showing cumulated margins. Business change and retraining on new operating model

b. Challenges

We also identified a set of challenges that can be addressed by retraining efforts.

Table 4:Challenges brought by the ADO.

Challenges	Team	Risk	How to mitigate
New mindset is required as engineers will have to trust the system in two key areas: data accuracy and relevance of the predictive scenario	**T / E**	Slow adoption and regression to “manual” operations	Business change and retraining with extensive hands-on simulation practicing letting them “experience” the value of ADO.
Engineers shifting towards a more passive behaviour, as the ADO would / could handle most of the analysis and decision making	**T / E**	Loss of “practical sense” and ability to operate independently from the system. Reduced job interest	Need to find the right balance of “automation” in the design of the future operating model. Regular hands-on training sessions on a “real-life” training simulator.
Creates a lack of “entry level” tasks typically assigned to less experienced Engineers.	**T / E**	“Broken” career paths especially for less experienced engineers	Redesign career path and redesign the onboarding and authorisation process with extensive hands-on simulation practicing

c. Extending the organisational scope of the ADO

The ADO vision from Tapestry is only looking at 2-4 hours before real-time. Extending the timeframe potentially creates additional opportunities and brings value to other teams like Strategy and Performance.

Table 5:Opportunity to create value beyond Transmission and Energy teams.

Opportunity	Team	Value	How to enable
Extend time window to strategy	S	Continuum across strategy and energy. Automatic creation of the initial plan by ADO.	Feasibility needs to be further explored.

		Value needs to be further explored.	
Strategy to operate 48 hours ahead which would allow to provide an optimised plan before the day ahead markets. The Energy team could "start" at 8 hours ahead of real-time.	S	Reduced cost of balancing through better use of the market Convergence and improved continuity between Strategy and Energy roles with potential consolidation of roles e.g., managers	Explore feasibility and value of extending ADO time window (technology and process) Business change and retraining on new operating model
ADO can bring additional capabilities and value to the post-fault analysis and contingency plan development activities	P	Improved decisions in the control room leading to reduced balancing cost	Explore feasibility and value of "integrating" ADO with post-fault / contingency plans analysis approach. Business change and retraining on new operating model
ADO could bring additional capabilities and value to the system and network planning functions within ESO e.g., VES	Planning	Help identify where new resources are needed on the system by creating hypothetical units (what if)	Explore feasibility and value with respect to other initiatives in this area (Role 3).

We have added a work package to the roadmap called "Analyse impact on other programmes", which explores how the ADO programme could deliver value for other in-flight or planned initiatives within ESO, in areas like:

- Activities performed by the Strategy and Performance teams
- Activities around modelling of the broader energy system (Digital Twin) e.g., VES

d. Summary of retraining needs and approach

Enabling these opportunities and mitigating the potential challenges will require multiple retraining efforts as set out in the figure and table below:

Table 6:Retraining needs and approach.

Challenges	Team	Approach
Retraining of the Engineers to understand and adopt a new way of working (a shift towards a "collaboration" with the system; need for system feedback to continuously improve its performance, prevent "passive" behaviour) will be required for all engineers.	All T / E All S / P if in scope	One time classroom training on how to use the ADO including extensive hands-on to "experience" the value of the ADO with specific module for each team. Regular classroom "refresh" to "experience" the improvements in the system performance.

The authorisation process will have to be adapted to address the reduction of "entry level" tasks in the Control Room typically assigned to new engineers. This will also mitigate the risk of a shift of the engineer's mindset towards a more passive role and a loss of expertise in handling specific situations.	T / E on-boarding	Increase the level of "hands-on" simulation performed in classroom training to increase the level of autonomy and confidence before starting the training phase 2 (real life operations with coaching).
A new role needed in each team: the model owner, in charge of maintaining and continuous training of the adaptors and optimizer. Supported by a group of Data Scientists.	2 per team T / E / (S) / (P)	Full classroom training curriculum focusing on data science technics, combined with shadowing by data scientists; With specific module for each model.

e. Potential synergies with other Activities in the RIIO2 Business Plan

We have reviewed the RIIO2 Business Plan (BP2 August 2022) to identify potential synergies, duplications and dependencies with the ADO programme. Dependencies means that element of design of ADO could have an impact on the cost or benefit of the BP activity, and vice versa. These are provided as a guidance only to help set up the right level of coordination and governance. Synergies and dependencies would have to be confirmed as part of a specific work package dedicated to that purpose.

Role	Activity	Type of dependency	Recommendation
Innovation / X-role	Virtual Energy System	**Synergy**: The ADO can be one of the key use case of the VES leveraging the VES industry models.	Ensure the data models are consistent and interoperable.
R1	A2 Control Centre Training and Simulation	**Synergy**: Both designs should be interoperable so that the ADO could be embedded in the training simulator	Ensure that the designs are synchronised through proper governance.
R1 / 3	A1.5 Operational coordination with DER and DSO	**Dependency**; New sub-activity to support the DSO transition and improve DER visibility. This will allow us to implement, in real-time, the enhanced whole electricity system coordination proposed under Role 3.	Ensure that the team in charge of this activity is aware of the capabilities of the ADO to leverage them if needed.
	A1.6 Minimising Balancing Costs –	**Dependency**: this is a new sub- activity to coordinate and improve strategy and activities to minimise balancing costs across our organisation. ADO could provide some of the	

		insights needed to drive additional cost reductions.	
R2	A21: Define and build our new role in Europe	**Dependency**: This activity includes a cross-border strategy for interconnectors which will focus on operability, adequacy, system planning, flexibility and balancing. The ADO IC connector and optimiser will have to comply with the future strategy	Understand the future strategy to design the IC connector and optimiser.
R3	A15.4 Manage our operational data and modelling requirements	**Dependency (and potential synergy):** The implementation of A15.4 will see ESO and all DNOs migrate to a Common Information Model (CIM) standard and collaborate closely with these parties throughout BP2.	Understand in details the scope of this activity to explore potential synergies around the governance and how models are documented.
R3	A15.6 Transform our capability in modelling and data management	**Dependency (and potential synergy):** This activity will seek to provide the foundational architecture for an interchangeable suite of tools. This requires a common data set for seamless data exchange and enabling higher volumes of network data, regional models, and outage planning data to be exchanged.	Understand in details the scope of this activity to explore potential synergies around the governance and how models are documented.