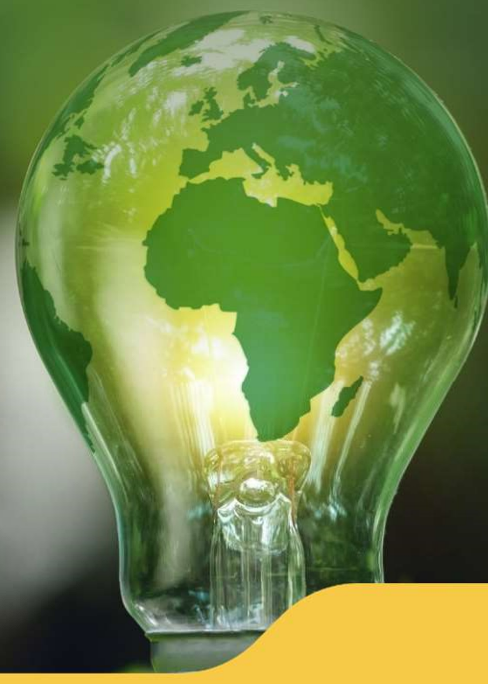
Advanced Dispatch Optimisation - Phase 2 (ADO 2)

Making ESOs strategic vision for dispatch optimisation become a reality



The IBM Team

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Scope and Objective

ESO engaged IBM to undertake a **21-week strategic engagement** to develop a:

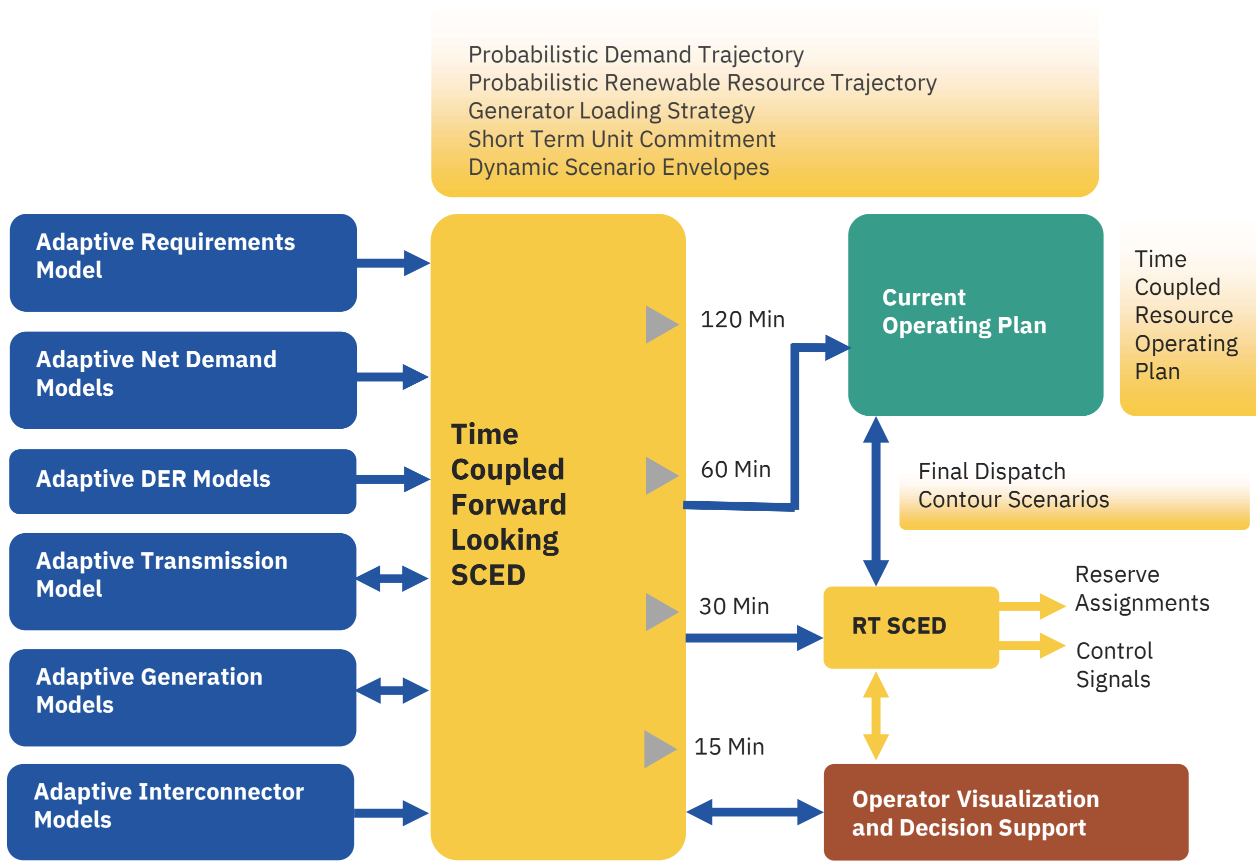
- Roadmap, to help ESO define a new programme
- Deep dive into the input data models, to understand the data gaps and ways to address these gaps
- Logical architecture
- Assessment of the organisational impact and retraining needs

★ Objective today is to share our findings and discuss next steps

Our Starting Points

ESO vision created by Tapestry as the north star

- Automated insights through adaptive ML input data models
- Probabilistic trajectories of various system states, taking into account external conditions
- Time coupled security-constrained economic dispatch optimisation engines creating SOP , instructions and Reserve
- Enhanced or automated operator decision support
- Automated performance monitoring



We developed a high-level logical architecture

- Provides a view on how the ADO system could be realised
- Designed to build upon the existing OBP and leverage its strengths, while also utilizing the PEF for certain components
- Introduces several new services

Architecture Artefacts

- System Context
- Architectural Principles
- Architectural Decisions
- Component Model

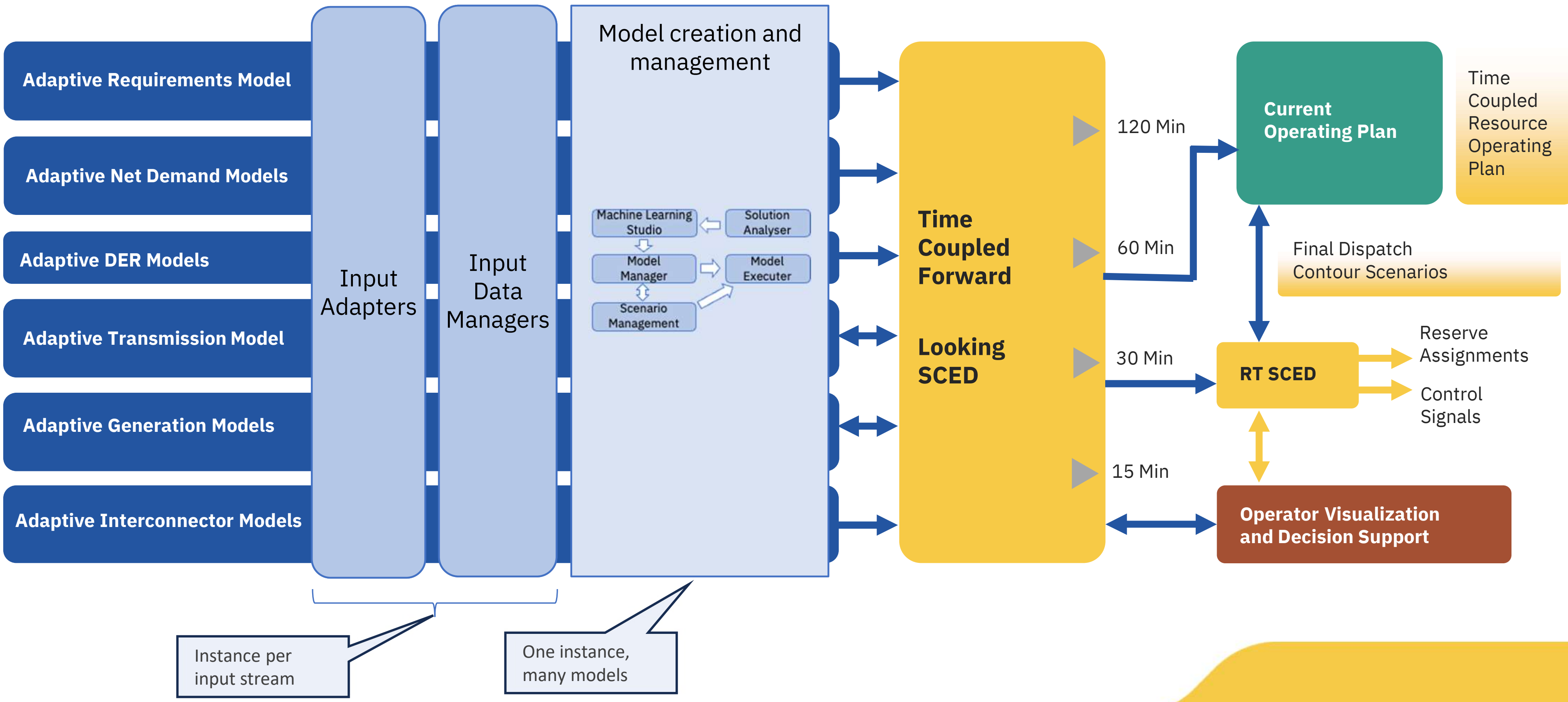
Platforms

New Components

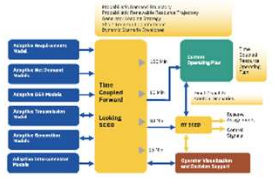
- Machine Learning Studio
- Scenario Management
- Model Manager
- Solution Analyser

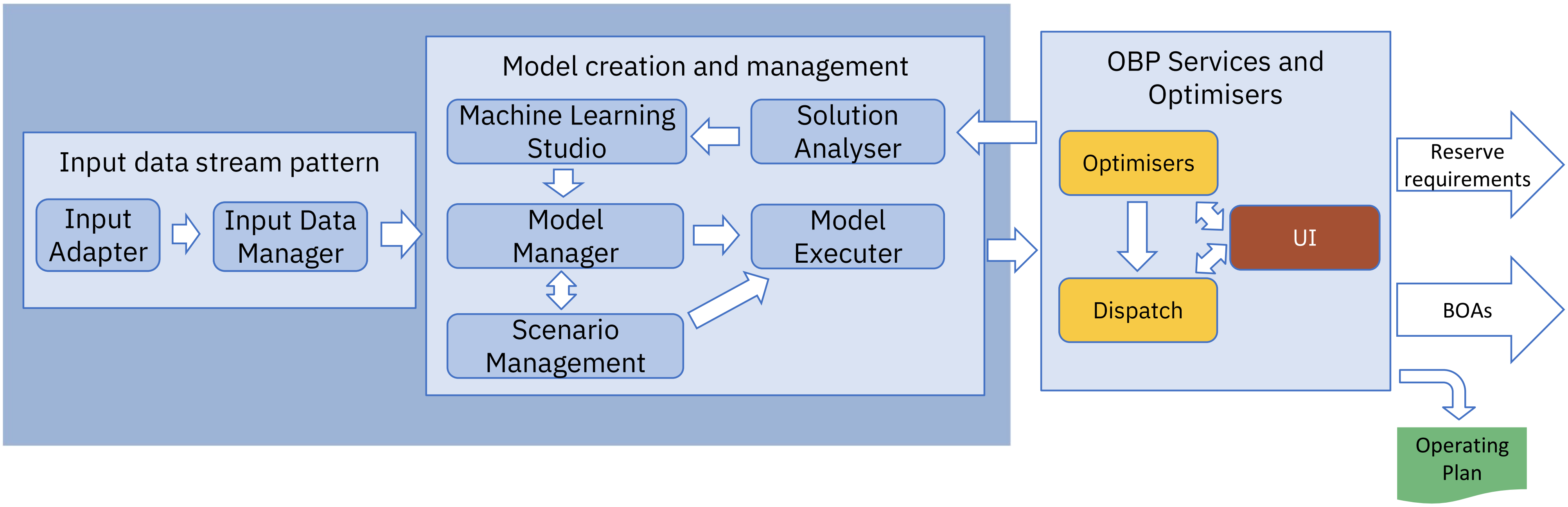
- OBP (Open Balancing Platform)
- PEF (Platform for Energy Forecasting)
- CNI Private
- Azure Public

Architecture mapping to the north star



Architecture Overview Diagram

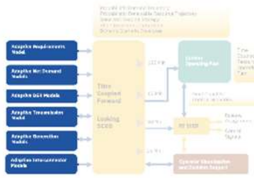




Architectural decisions

ID	Topic	Possible Alternatives	Decision
001	Data cleaning	1. Data cleaning component for each (or a group of) input stream(s) 2. One data cleaning component	Data cleaning component for each (or a group of) input stream(s)
002	Scenarios	1. Optimise multiple scenarios 2. Optimise single scenario	Optimise single scenario
003	Input adapters	1. One adapter per input stream type 2. One adaptor to Digital Spine 3. Share adapters	Share adapters
004	interfaces	1. Direct interface 2. Use existing interfaces	Direct interface
005	ML Models	1. Models represented as components 2. Models treated as data	Models treated as data
006	Hosting and technology	1. Build enhanced forecasting on OBP 2. Expand PEF	Not Decided

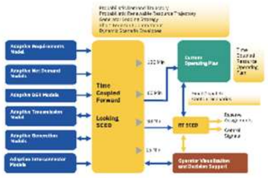
We detailed out the proposed forecasting models…



- Detailing out the end vision for adaptive, machine learning models to forecast optimiser input variables
- Data requirements to train and run the model
- Current data availability
- Data Quality
- Identify key decisions and next steps

End Vision Module	Input Data Model Area	Key Data Challenges	Immediate Actions
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).
	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 6.4.	N/A

We developed a capability framework…



In order to create a roadmap, we needed to truly understand the to-be capabilities that are required to enable the vision. We identified **11 direct capabilities**. These were then broken down into enabling capabilities:

L0.1
Forecast demand and consumer behaviour in a given scenario

L0.2
Forecast embedded DERs outputs in a given scenario

L0.3
Forecast thermal generator outputs in a given scenario

L0.4
Forecast renewable generator outputs in a given scenario

L0.5
Forecast of Distributed Energy Resource outputs in a given scenario

L0.6
Forecasting of storage assets in a given scenario

L0.7
Dynamically calculate reserve requirements based on actual system conditions

L0.8
Calculate a set of ranked transmission constraints and suggest strategies to mitigate

L0.9
Forecast interconnector flows given a certain scenario

L0.10
Optimise for the upcoming dispatch period to minimise cost and satisfy the energy balance requirement, transmission security constraints and all reserve requirements, for all assets and service types

L0.11
Provide operators with visualisation of dispatch scenarios and optimiser output, to improve situational awareness

Example of how we broke down the capabilities

Direct capability: Forecast renewable generator outputs in a given scenario

Indirect, enabling capabilities:

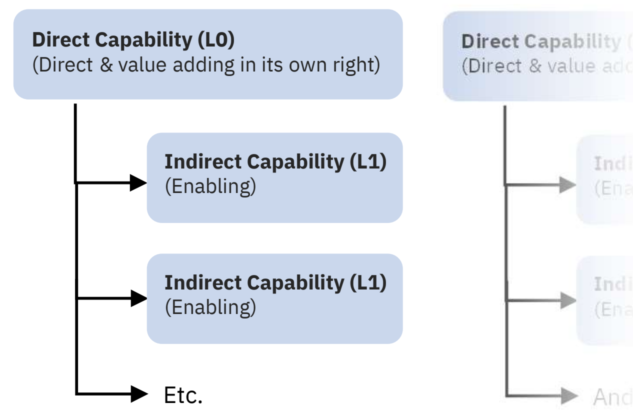
Step 1 The capability to correct, physical parameters (e.g. MW limits and ramp rates) that are provided by renewable generators.

Step 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).

Step 3 Scenario testing capability which enables prediction of a renewable generator's output in response to a set of dispatch instructions, under a specified set of conditions.

Step 4 Ongoing evaluation and retraining of the model.

*Example of how direct and indirect capabilities are linked



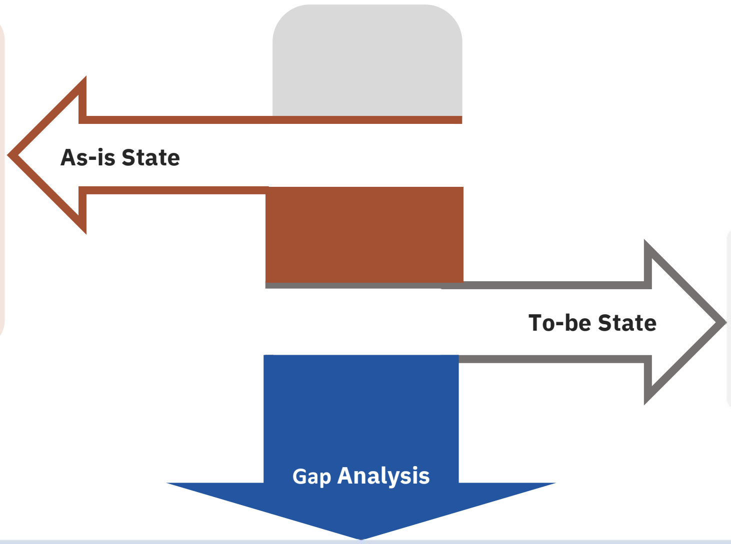
… to perform a gap analysis

Example: Forecast renewable generator output in a given scenario

The ESO control room uses two tools currently to forecast renewable generation:

- Platform for Energy Forecasting (PEF)
- AMIRA (external tool, no ESO capability)

PEF uses self-adaptive machine learning models for solar forecast. ML Wind model is in progress. PEF is aiming towards probabilistic forecasting.



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).

Key gap is accuracy for PV, wind and demand models. The models are only updated once per hour e.g., with weather nowcasting. Potential to increase temporal and spatial granularity based on data availability. If ESO want to model the output based on dispatch instructions, this would require building a new model, which might reuse existing capabilities. It would also benefit from ESO already having the right people and skills. Three alternative solutions to close the gap:

- Address problems through the proper use of penalties and/or incentives
- Developing a predictive error forecasting model.
- A combination

Evolving the end vision

In our engagement with the users, we have gone above what Tapestry suggested and have added:

- Forecasting of storage assets
- Forecasting of aggregated units
- Differentiation of transmission constraint types including inertia
- Cross-cutting scenario capability

To close the gaps, we identified different types of work packages

Regulatory Framework Agreement and/or Stakeholder Engagement

- Agree responsibilities and ownership of data
- Who is best placed to forecast certain values and what is the impact

Value and Feasibility analysis

- Is the full functionality required and by when? E.g. adaptive model, value plateau
- Is it possible to build such a model, e.g interconnectors

Agile Development

- All development is foreseen as agile development. Includes design and testing
- Once development is completed, the model could be handed over to IT/BAU

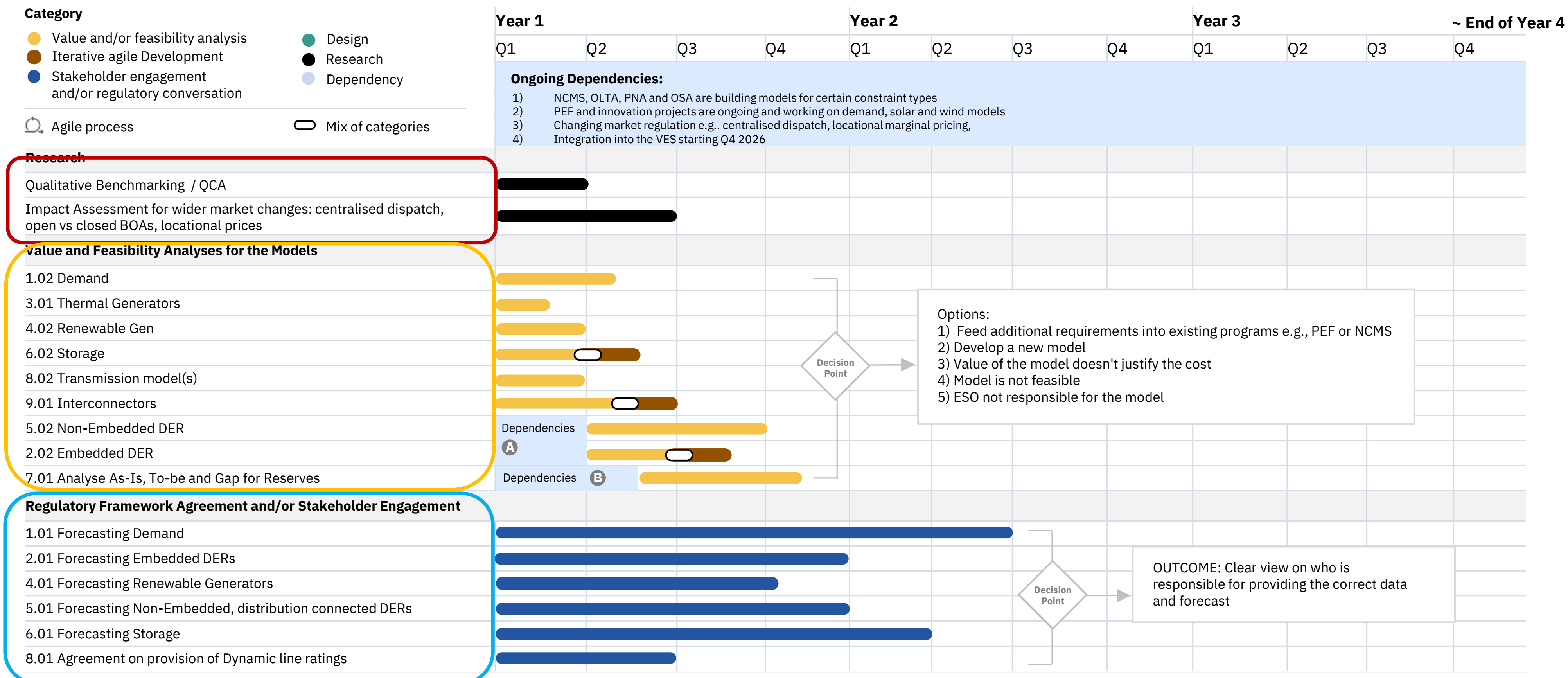
Research

- Benchmarking
- Impact Assessment

Design

- detailed planning and specification of how the components will be developed, their functionality, and their integration into the overall system
- Optimisers and software that enables developing global scenarios

Full Roadmap – Page 1

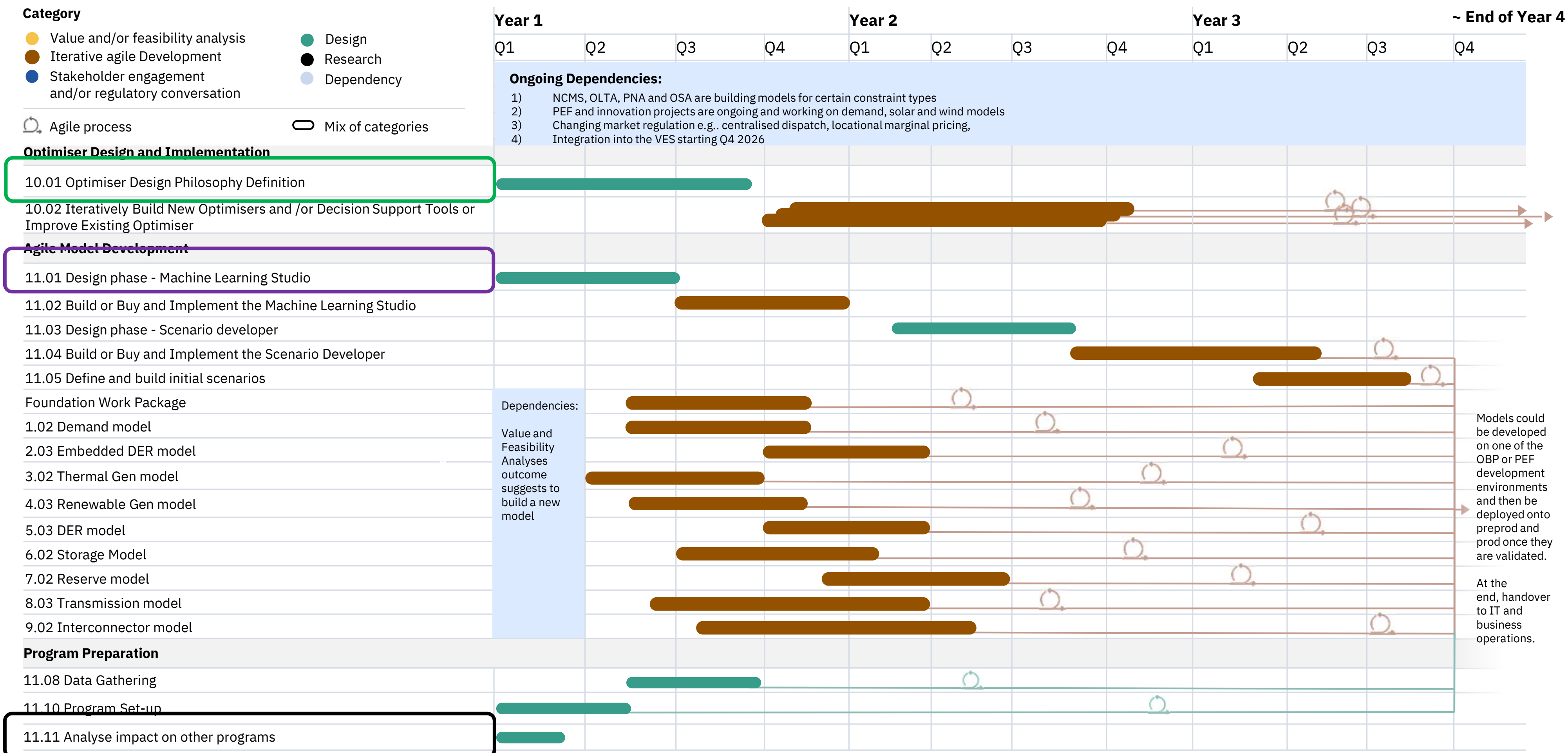


*Dependencies A : Stakeholder Engagement with DSOs

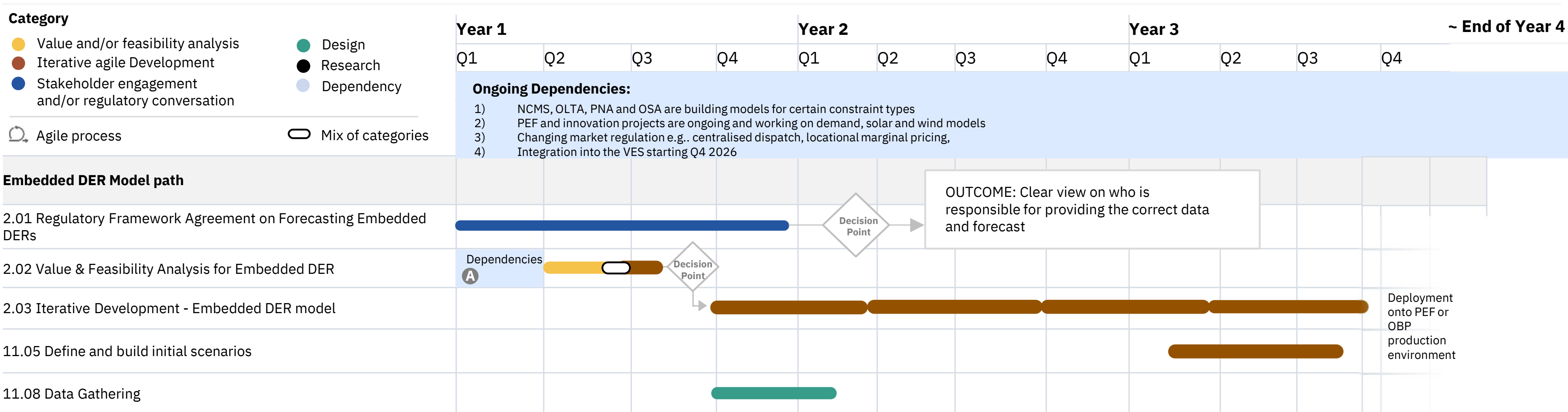
*Dependencies B : ESO to define reserve services past 2025

Continue...

Full Roadmap – Page 2

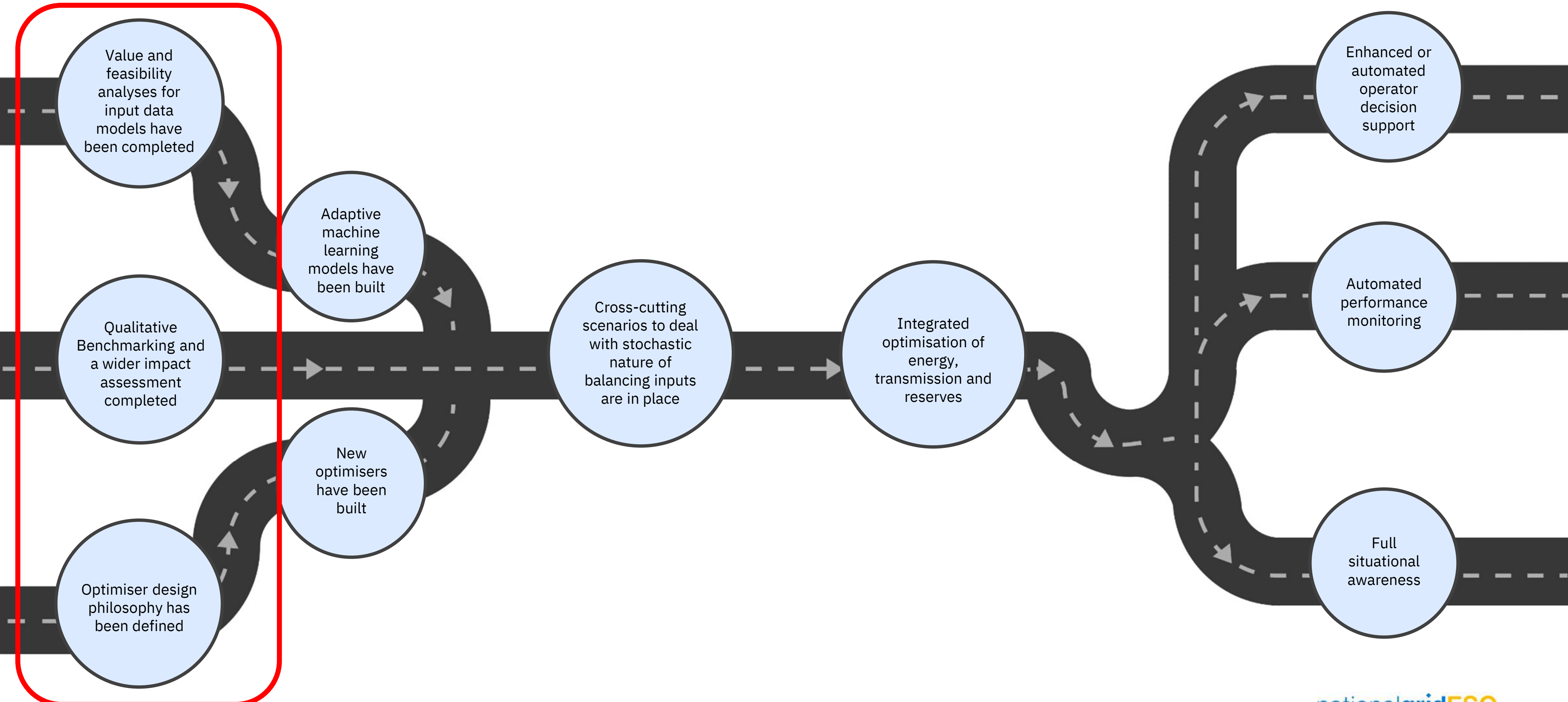


Embedded DER Model



*Dependencies (A) : Stakeholder Engagement with DSO

Street View Roadmap - Milestones



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Next steps – Projects to kick off

Category

- Value and/or feasibility analysis
- Iterative agile Development
- Stakeholder engagement and/or regulatory conversation
- Design
- Research
- Dependency

Project	Cost estimate	Suppliers (see supplier list for suggestions)	ESO involvement
Benchmark	L	Consulting, REEF, ENTSO-E	e.g., Innovation team…
Impact Assessment	L	Research/ Universities	
Value and/or feasibility analyses (in sum)	H	Tech Consulting companies	
Optimiser Design and Implementation	M/H	Lead by Tech consulting, support from research	
ML Studio Design	L/M	Tech Consulting companies	
Stakeholder Engagement and/or Regulatory Framework Agreement	L	ESO internal, possibly supported by consulting	
Program Preparation	L	ESO internal, possibly supported by consulting	

Cost Legend: L <500,000; M >500,000 - <1,000,000; H>1,000,000

Organisational Impact

The ADO can enable a new operating model in the control room that will require business change and retraining activities.

#	Key retraining needs
1	Base roles and **team organisation will remain** (strategy / transmission and energy), building the right operating plan, monitoring events and activation of contingency plans. However, the introduction of ADO creates multiple **opportunities to improve the Operating Mode**l across all 3 teams thanks to a higher level of organisational flexibility and team integration (e.g. time horizon of each team, definition of the zones, level of granularity of the studies, consolidation of roles, etc.). Extensive business change and retraining on the new operating model will be required.
2	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) will be required for all engineers.
3	A new role needed in each team : **data engineer**, in charge of maintaining and continuous training of the adaptors and optimiser. Supported by a group of data scientists. These new roles will obviously require training.
4	Data manipulation and the handling of more simple events will be managed almost automatically (with supervision); The overall **training and authorisation process will have to be adapted** to increase the level of training “hands-on” simulation and address the reduction of “entry level” tasks in the Control Room. 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.
5	Each team in the Control Room already includes today a significant share of more **digital-savvy engineers** in their respective workforce, who will adopt these new roles with greater ease.

Next steps for the project

The ADO 2 project ends on Friday. All milestones were met on time. Deliverables have gone through multiple review cycles. On Friday we submit

- Gap analysis report + capability framework + value tree
- Work package and roadmap report + supplier list
- Architecture overview report
- Project overview report, including a section on organisational impact
- This presentation

The final input data model report has already been submitted. **We will need email confirmation that all deliverables have been received and are considered signed off.**

Next steps after the project

- Kick off the next set of projects
  - Decide on approach e.g., priority order, VFA as one or separated etc.
  - Internal communication to ensure buy in
  - Secure finances
- ADO video
- Programme set up

Why is ADO needed?

The ADO vision was created to ensure that the ESO dispatch optimisation process and tooling are fit for purpose for the future. It helps ESO **handle growing uncertainty** (e.g., caused by more fluctuating assets, the growing number of small, distribution connected assets, storage, aggregation and demand side flexibility) **through better forecasts.**

Furthermore, ADO aims to **optimise the bigger picture across longer time frames** and not just decision by decision. This ensures that balancing actions are reliable and cost-efficient. The co-optimisation of energy, reserves and constraints are vital to achieve this.

ADO will **enable performance monitoring** and continuous improvements of the forecasts, optimisers and control room decisions.

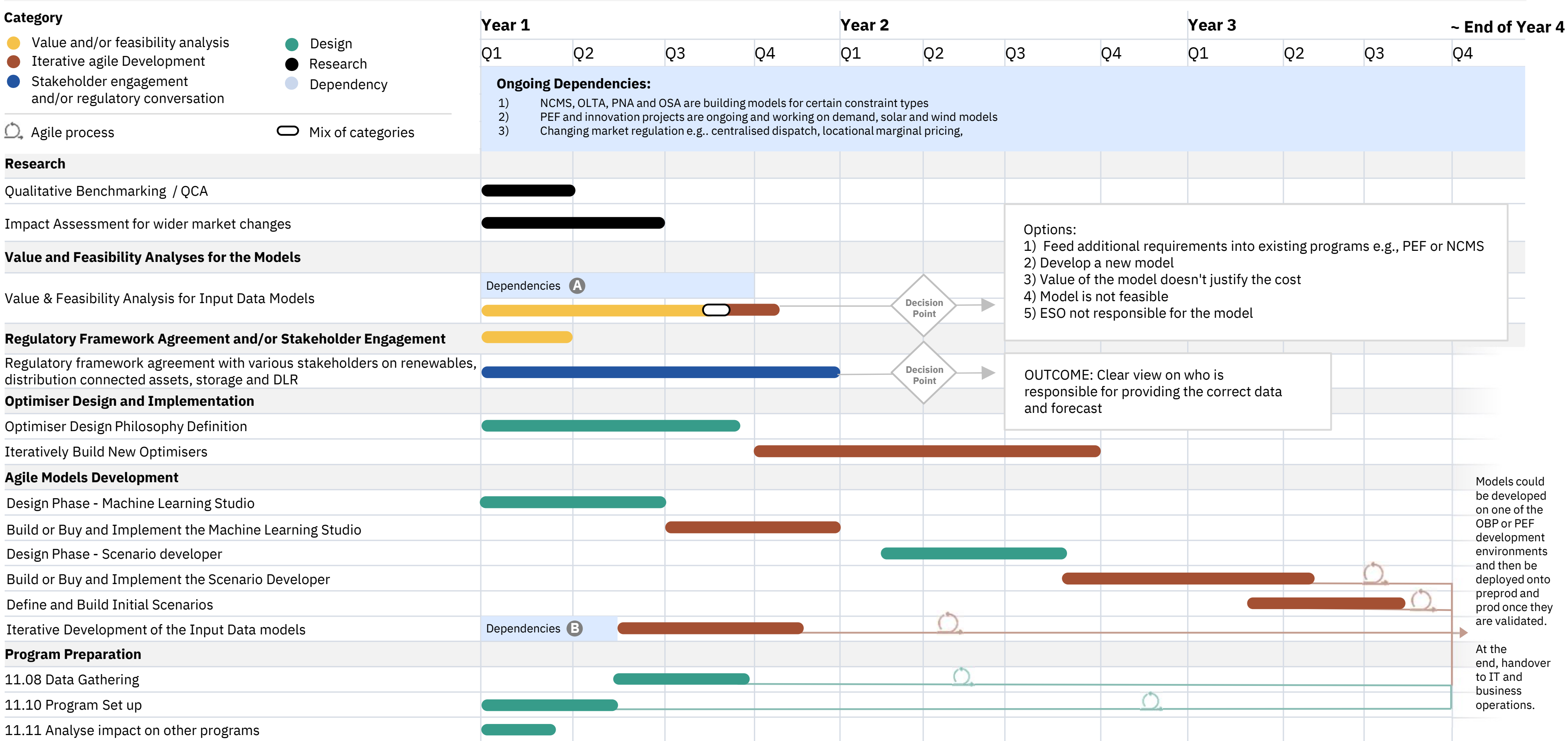
It also helps ESO make their **decision more transparent** and comprehensible.

Key values achieved by ADO are:

- Reduction of MW volume bought
- Buying the MW cheaper
- Reduction of workload

Backup

Simple Roadmap



*Dependencies A : DSOs, Reserve Service Definition

*Dependencies B : Value and feasibility analysis

NG ESO – Advanced Dispatch Optimisation 2 (one pager)

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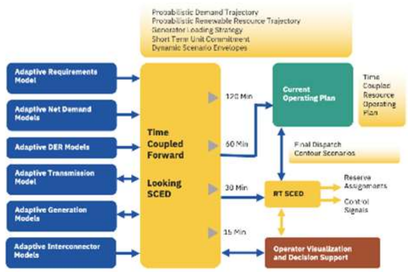
NG ESO are the transmission system operator for Great Britain. They ensure that electricity supply meets demand every second of every day.

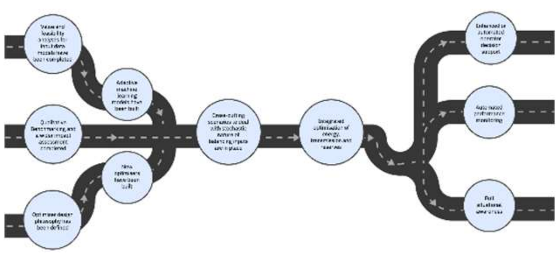
Business Problem

Google Tapestry created a strategic high level vision for ESO that describes how dispatch optimisation could look like in 5 to 10 years. ESO wanted IBM to figure out how this vision could become a reality.



Solution

To develop a meaningful roadmap, we needed to do a gap analysis first.
We defined to-be capabilities based on Tapestry's vision and compared it to the as is. We then defined meaningful work packages to close the gaps and identified dependencies, cost and potential suppliers.



Value Realisation

A tangible roadmap, to help ESO define a new programme

- Deep dive into the input data models, to understand the data gaps and ways to address these gaps
- Logical architecture
- Assessment of the organisational impact and retraining needs