Balancing Strategy Capability Review
Balancing Programme
Quarterly Updates – October 2022

nationalgridESO

Introduction & Aims of the day

nationalgridESO

Welcome

#BalancingreviewESO

Purpose of today

- This is the first time we have met since the balancing strategic review concluded

- We committed to meet with you on a quarterly basis to:
  - Show you the progress we have made in delivering against our industry roadmap
  - Show you what we plan to do next and get your feedback and input
  - We need to ensure that our plans provide what both the Control Room and industry needs
    - Trust, collaboration, competition, reduced costs and meeting net zero

- We also want to lift the bonnet, show you the inner workings of our programme and understand what you are doing so we can collaborate and learn from each other

- Some focus areas for today – we need your input
  - Innovation
  - Market Trials
  - Storage

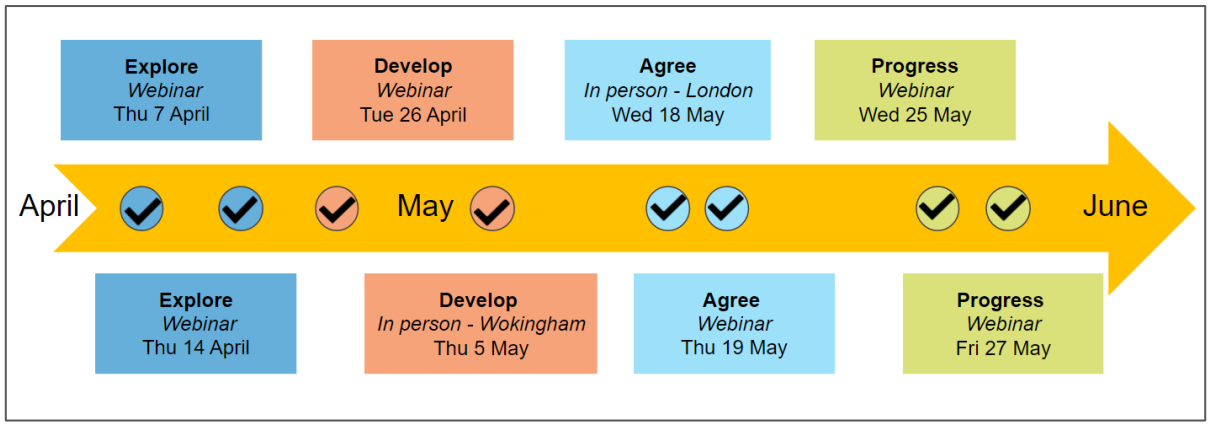
Agenda

Time	Location	Title	Details
09:30 – 10:00	Foyer	Welcome	Tea and coffee
10:00 – 10:15	W1.101 & 02	Introduction	Overview of the day and objectives
10:15 – 10:45	W1.101 & 02	Recap on Balancing Strategy Capability Review	- How/why we did the review? - What we agreed (roadmap, benefits, delivery plan/costs) - Playback how our co-created plan feeds into BP2
10:45 - 11:30	W1.101 & 02	High Level Progress Updates	- Updates on elements of our roadmap - What have we achieved in the past three months
11:30 – 12:15	W1.101 & 02 & 06	Under the bonnet of Balancing Programme	Break out sessions across 6 areas, plus control room viewing gallery Open Balancing Platform, Existing Balancing, Forecasting, Market Trials, Innovation, Future of Storage
12:15 – 13:15	Foyer	Lunch	Networking Opportunity
13:15 – 14:30	W1.101 & 02 & 06	Under the bonnet of Balancing Programme - continued	As above
14:30 – 15:30	W1.101 & 02	Panel Discussion (Q&A)	Topics you want to discuss with Balancing Programme and industry community
15:30 – 16:00	W1.101 & 02	Review of day	Recap and how we are doing

Recap on Balancing Strategy Capability Review

nationalgridESO

The stages of our engagement



Explore – Setting the scene

Following our open letter, we established our scope, focusing on:

- Understanding current capabilities, market participation challenges, pain points and future requirements
- Review transformation and new capabilities to be developed
- Challenge original assumptions

Develop – Co-creating a new plan

On 5 May, we prioritised a new Balancing Capabilities Roadmap with industry members, enabling us to:

- Capture further industry requirements
- Validate control capabilities required
- Identify technology changes required to achieve Transformation

Agree – Reviewing the new plan

- Played back the outputs from the 5 May workshop
- Shared proposed co-created balancing capability roadmap, showing supporting benefits and costs
- Corroborated and sought agreement of an initial roadmap with associated risks and assumptions
- Captured the confidence level of industry of the joint proposed approach

Progress – Agreeing next steps

- Recap of the balancing capability review
- Opportunities to ask further questions regarding the proposed roadmap, costs and delivery plan
- Understand how we continue to build confidence in our roadmap and approach
- Validating if we have successfully included your input and is there anything missing?
- Future engagement

Stakeholders involved

ENGIE POWER LIMITED
EP UK INVESTMENT
UK POWER RESERVE
INTERGEN (UK) LTD.
RWE LIMITED

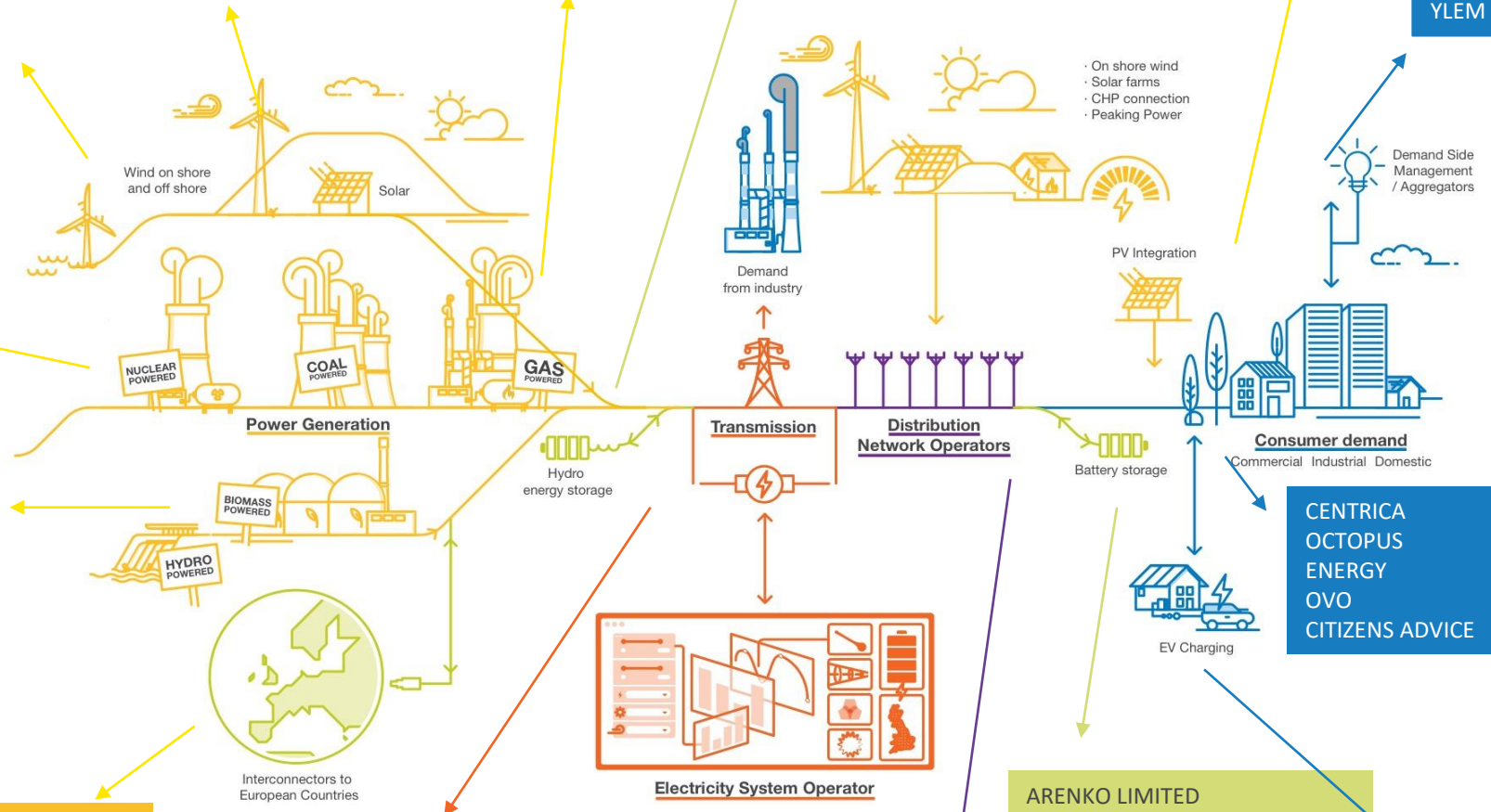
EELPOWER LIMITED
HUAWEI ENERGY

HIGHVIEW POWER STORAGE LIMITED

ION VENTURES

AMP ENERGY SERVICES LIMITED
ENAPPSYS LTD
KRAKENFLEX LIMITED
SHELL ENERGY UK LIMITED
YLEM Energy

EQUINOR ASA
ORSTED POWER (UK) LIMITED
RWE RENEWABLES
FIELD ENERGY LTD
SIEMENS LTD



SSE GENERATION LIMITED
EDF ENERGY LIMITED
DRAX POWER LIMITED

ESBII UK LIMITED
N-ERGY
SEMBCORP UTILITIES (UK) LIMITED
UNIPER UK LIMITED

CENTRICA
OCTOPUS ENERGY
OVO
CITIZENS ADVICE

WHOLE INDUSTRY

ACCENTURE
AMAZON WEB SERVICES
BEIS
BP
ELECTRON
ELEXON
ENEGEN POWER SYSTEMS
ENERGY SYSTEMS CATAPULT
ENERGY UK
GRID SMART
HITACHI LTD
HYONSUNG
LIMEJUMP
NIPPON KOEI ENERGY EUROPE B.V.
OAKTREE POWER LIMITED
PICLO FLEX
QUORUM DEVELOPMENT LTD
REACTIVE TECHNOLOGIES LIMITED
SMITH INSTITUTE FOR INDUSTRIAL MATHEMATICS AND SYSTEM ENGINEERING SUSTAINABILITY FIRST
THE ASSOCIATION FOR DECENTRALISED ENERGY
UNIVERSITY OF EDINBURGH
UNIVERSITY OF STRATHCLYDE
WATERS WYE ASSOCIATES LIMITED

ELECLINK
ELIA (NEMO LINK)
MUTUAL ENERGY (MOYLE)
NG VENTURES

NATIONAL GRID ET TRANSMISSION INVESTMENT
SCOTTISH POWER ENERGY NETWORKS

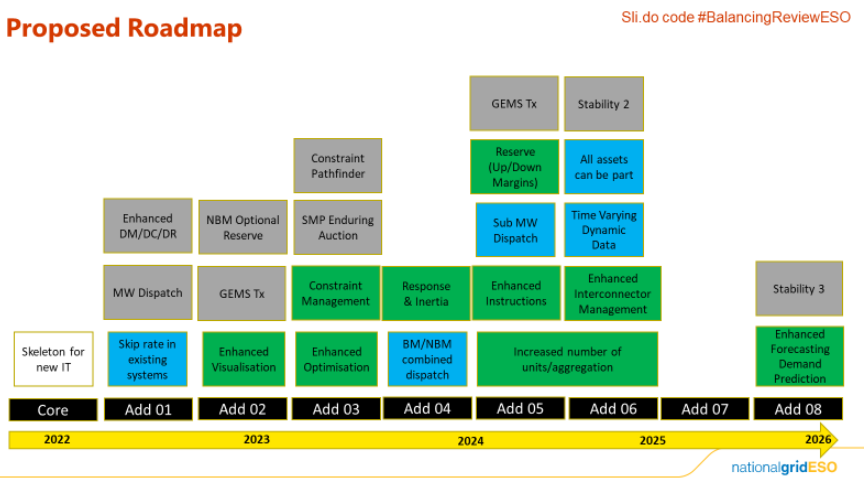
SCOTTISH POWER ENERGY NETWORKS
UKPN

ARENKO LIMITED
CONSTANTINE GROUP
FLEXITRICITY
GRID CODE POWER LIMITED
INVINITY
KONA ENERGY LIMITED
HABITAT ENERGY LIMITED
TESLA MOTORS LIMITED
UK POWER RESERVE LIMITED

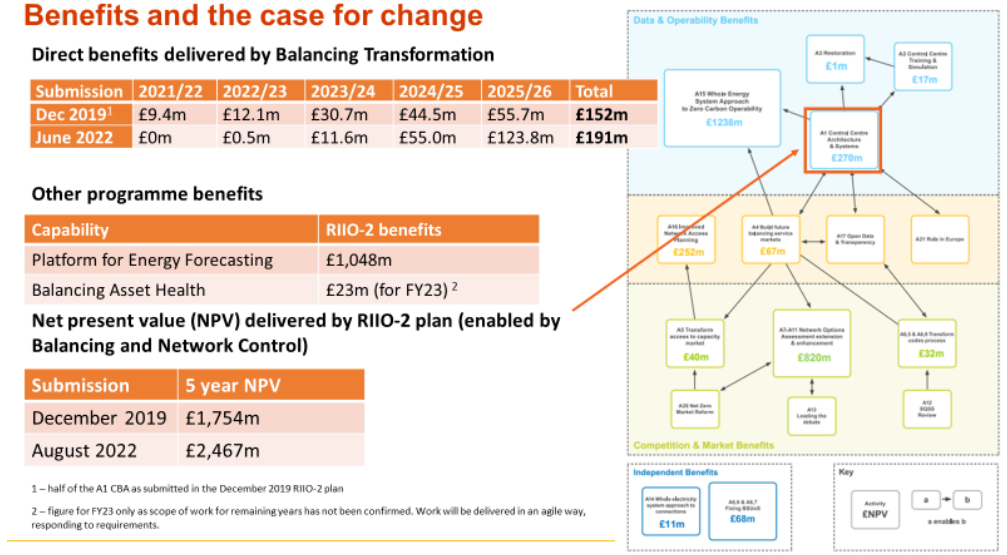
ENEL X UK LIMITED
FLEXITRICITY LIMITED
OCTOPUS ENERGY LIMITED

nationalgridESO

Outputs from our strategic review



Roadmap: A roadmap which stated when functionality would be delivered by the balancing programme. This was influenced by priorities voted for by the industry participants.



Benefits and the case for change

Direct benefits delivered by Balancing Transformation

Submission	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Dec 2019[1]	£9.4m	£12.1m	£30.7m	£44.5m	£55.7m	**£152m**
June 2022	£0m	£0.5m	£11.6m	£55.0m	£123.8m	**£191m**

Other programme benefits

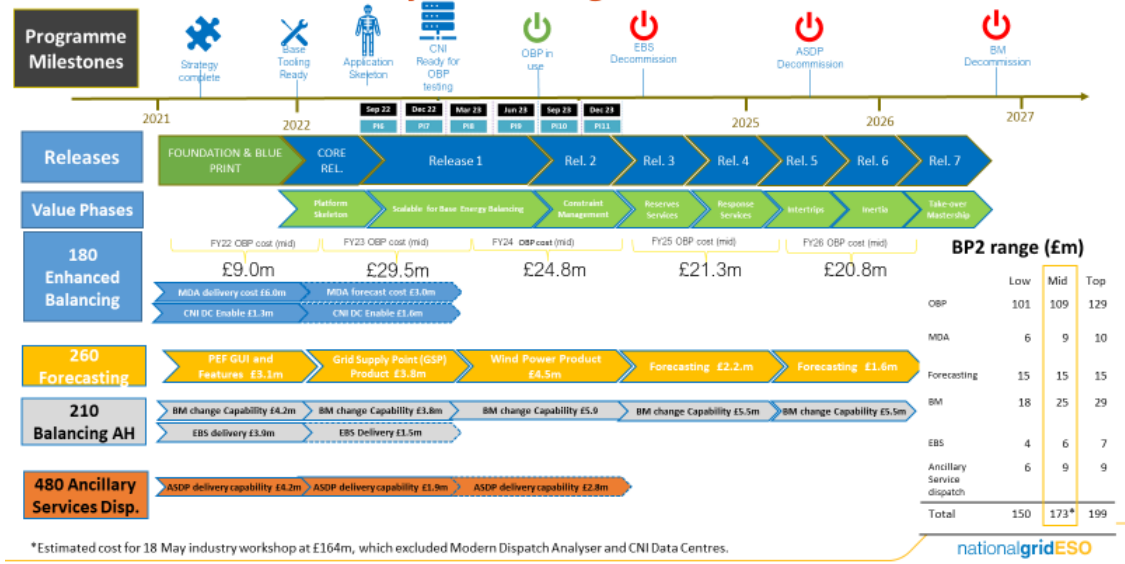
Capability	RIIO-2 benefits
Platform for Energy Forecasting	£1,048m
Balancing Asset Health	£23m (for FY23) [2]

Net present value (NPV) delivered by RIIO-2 plan (enabled by Balancing and Network Control)

Submission	5 year NPV
December 2019	£1,754m
August 2022	£2,467m

1 – half of the A1 CBA as submitted in the December 2019 RIIO-2 plan

2 – figure for FY23 only as scope of work for remaining years has not been confirmed. Work will be delivered in an agile way, responding to requirements.



Costs: High level estimates to deliver the roadmap during BP2 period

Benefits: Articulation of the benefits from the implementation of the roadmap

Value for money: Implicit from relationship between costs and benefits

Formal Feedback

"I am supportive of the work done to date and have been encouraged by the level of openness surrounding the state of the current systems."

""Very supportive. I have been working with the ESO for some time now and no one had ever managed to get me to understand the entirety and magnitude of the problem and constraints so far. It completely changed my understanding of what needs to be accomplished and why it is difficult".

"The feeling in the room when the costs were presented is that they were not high at all. This capability will be transformative and essential to enable the transition into the future, we are supportive of the project costs"

"Yes, the roadmap has ambitious delivery targets. It is important that it is stuck to however and not allowed to slip".

"The scale of value from savings will significantly outweigh the risks of inaction"

"As previously, I think it is challenging for someone external to the ESO to really understand the trade-offs in the roadmap. To the extent I understand these, I believe the ESO has done a good job to balance competing priorities".

"I have no doubt there are benefits but I think it will be really challenging to deliver. It's complex in its own right, before you take into account the level of change happening across ESO and wider industry"

"Costs are considerable, however in the context of the amount of investment across the electricity industry, it is proportionate to ensure the investments that are being made have a physical and reliable route to market. The ESO requires the investment to ensure reliable system operation. However, the ESO must deliver the promised functionality this time"

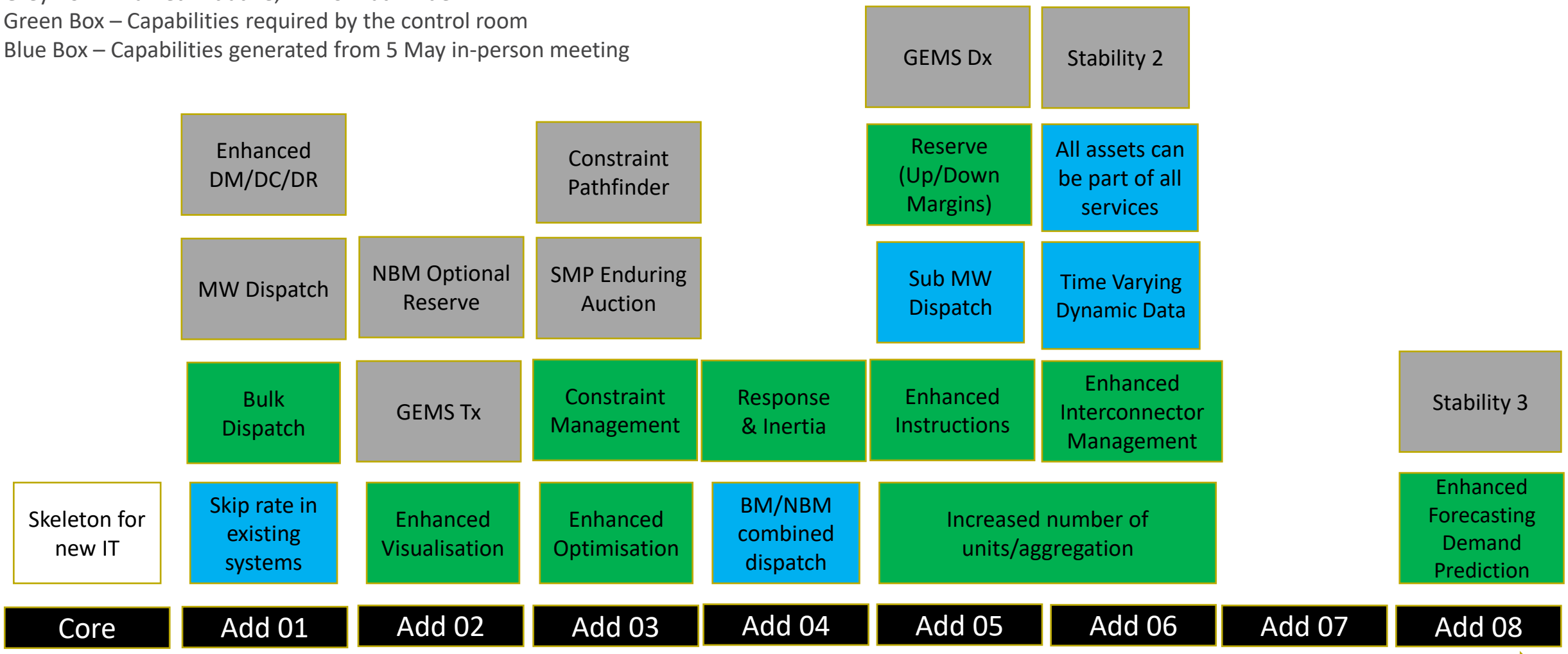
High Level Progress Updates

nationalgridESO

Industry Co-created Roadmap

Key:

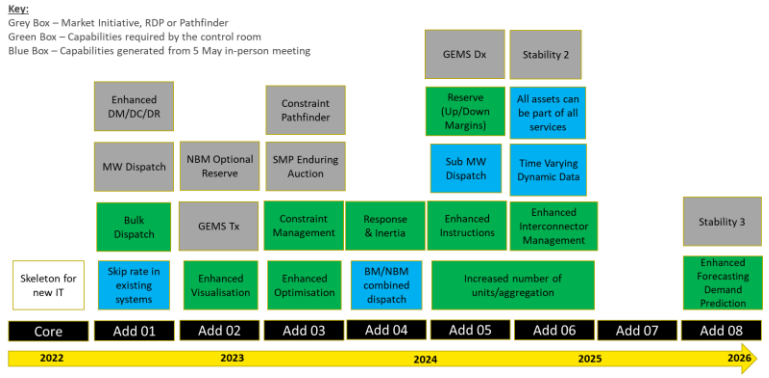
Grey Box – Market Initiative, RDP or Pathfinder
Green Box – Capabilities required by the control room
Blue Box – Capabilities generated from 5 May in-person meeting



Progress Updates

Skeleton for new IT	Provides the baseline infrastructure of our Open Balancing Platform
Delivery Mechanism	Open Balancing Platform

Reduced Emissions	Greater Interconnection	Flexible Technologies	Situational Awareness	IT System Availability



What has been delivered in Q2 2022

Delivered core infrastructure ready for further testing

What will be delivered in Q3 2022

Building towards release 1

- BM Interface
- Notifications
- Security Enhancements
- Features to support Batteries

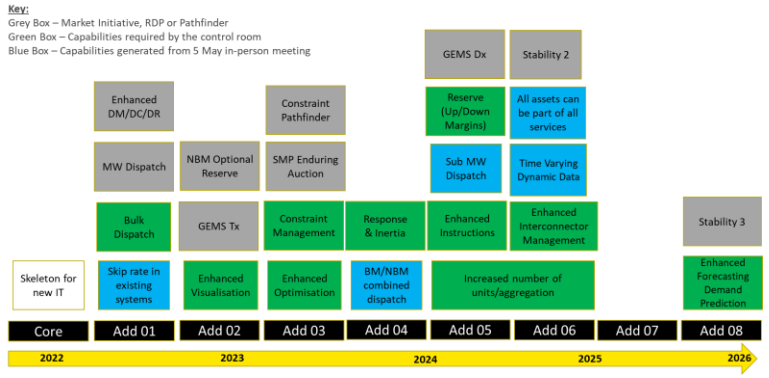
What issues are we managing?

CNI Data Centres, Options being considered and planned to enable release 1

Progress Updates

Skip rates in existing platforms	Provides the baseline infrastructure of our Open Balancing Platform
Delivery Mechanism	Existing Balancing Mechanism (short term) OBP (medium/long term)

Reduced Emissions	Greater Interconnection	Flexible Technologies	Situational Awareness	IT System Availability



What has been delivered in Q2 2022

Direct Benefits

Vergil / AIR Improvements
System Performance

What will be delivered in Q3 2022

Direct Benefits

Fixes to price stack pages to ensure only available units are considered

New BOA constraints overview screen

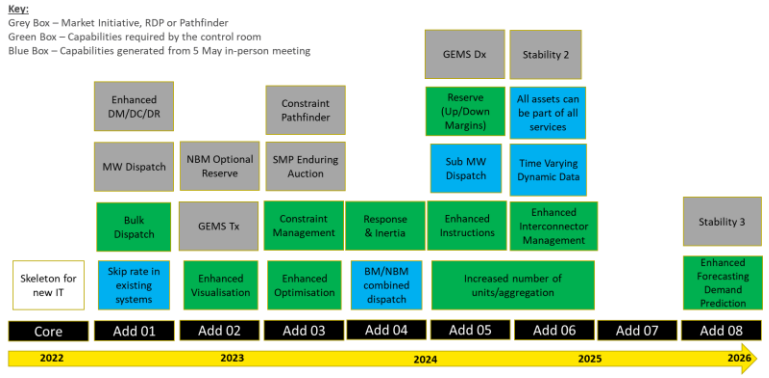
What issues are we managing?

No major issues

Progress Updates

Bulk dispatch	Provides the baseline infrastructure of our Open Balancing Platform
Delivery Mechanism	Existing Balancing Mechanism (short term) OBP (medium/long term)

Reduced Emissions	Greater Interconnection	Flexible Technologies	Situational Awareness	IT System Availability



What has been delivered in Q2 2022

Testing of future releases

What will be delivered in Q3 2022

Direct Benefits

Improvements to Automatic Instruction Repeat (AIR) functionality

Functional and user interface improvements to bulk dispatch tool

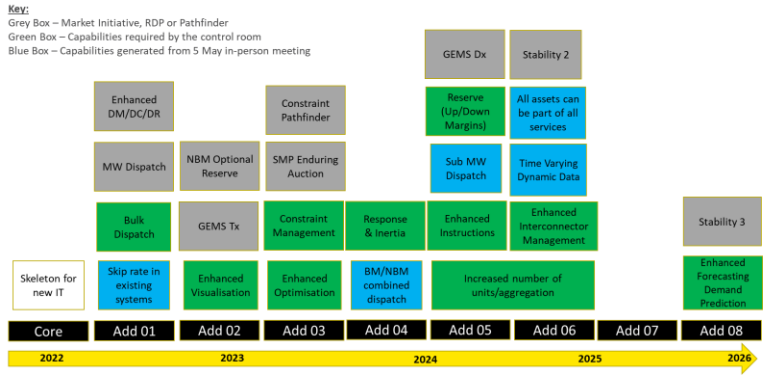
What issues are we managing?

No major issues

Progress Updates

MW dispatch	Provides the baseline infrastructure of our Open Balancing Platform
Delivery Mechanism	Existing Balancing Mechanism

Reduced Emissions	Greater Interconnection	Flexible Technologies	Situational Awareness	IT System Availability



What has been delivered in Q2 2022

Direct Benefits

Indirect Benefits

What will be delivered in Q3 2022

Direct Benefits

Delivery of MW Dispatch (NGED) in existing balancing systems

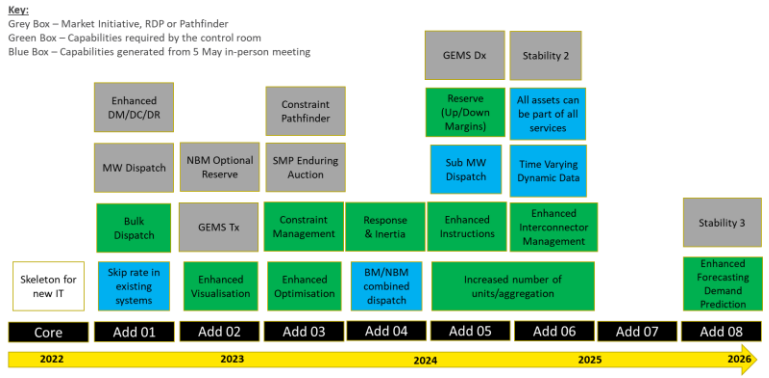
What issues are we managing?

No Major issues

Progress Updates – Over and above main roadmap

PEF	Provision of demand forecasting data for the industry and control room
Delivery Mechanism	Platform for Energy Forecasting

Reduced Emissions	Greater Interconnection	Flexible Technologies	Situational Awareness	IT System Availability



What has been delivered in Q2 2022

Direct Benefits

Grid Supply points net forecast

Machine Learning Improvements

What will be delivered in Q3 2022

Direct Benefits

- Greater resolution of GSP forecasts
- Improved forecast models from more data

Future Direct Benefits

- Foundation for GSP PV & GSP wind power generation forecast products

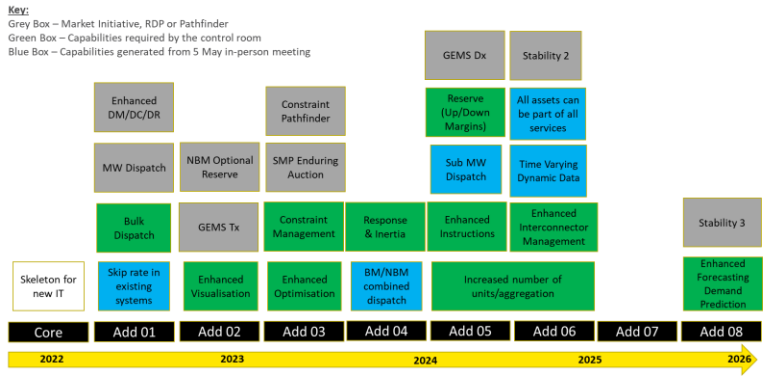
What issues are we managing?

Required security enhancements when connecting with CNI infrastructure

Progress Updates – Over and above main roadmap

BM System Updates	Ensures the ongoing BM systems remain fit for purpose ahead of transition to Open Balancing Platform
Delivery Mechanism	Balancing Mechanism

Reduced Emissions	Greater Interconnection	Flexible Technologies	Situational Awareness	IT System Availability



What has been delivered in Q2 2022

Indirect Benefits

Discovery work for Day 2 DM/DR/DC

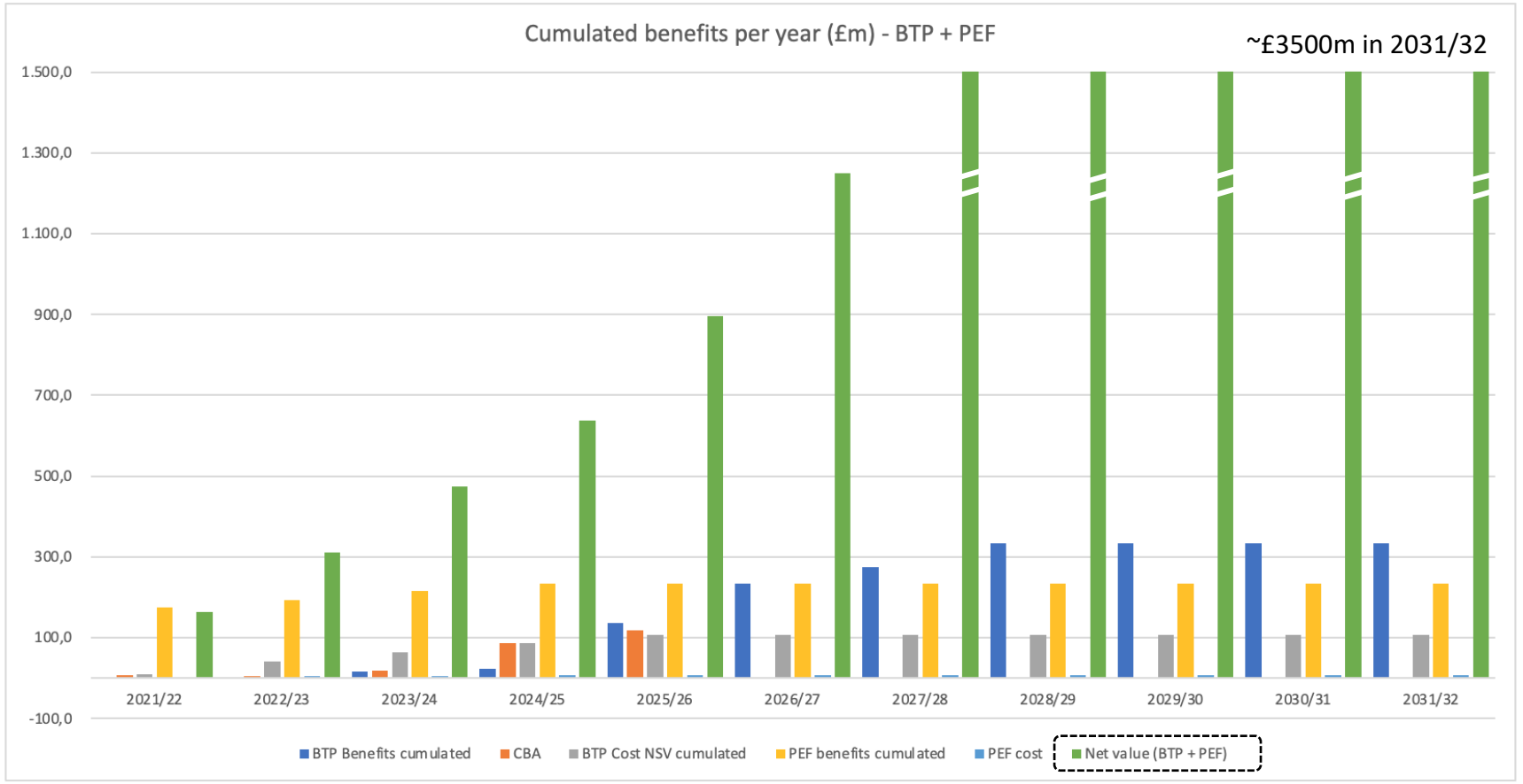
What will be delivered in Q3 2022

Work to enabling volume cap to be lifted for DM/DR/DC in Q4

What issues are we managing?

No major issues
(IT perspective)

Benefits realisation – OBP + PEF Net Value (not actualised) - Version : October 2022



Updated

1. BTP benefits increased by ~£300m as now also include indirect benefits (non A1 in BP)
2. Other figures not updated

Financial year	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	2031/32
BTP Benefits cumulated	0,3	0,3	16,2	23,5	136,8	234,8	275,0	333,5	333,5	333,5	333,5
BTP Cost NSV cumulated	9,4	40,2	64,0	85,3	106,1	106,1	106,1	106,1	106,1	106,1	106,1
BTP Net value	**- 9,2**	**- 49,1**	**- 96,9**	**- 158,6**	**- 127,9**	**0,8**	**169,7**	**397,1**	**624,5**	**851,9**	**1.079,3**
PEF benefits cumulated	175,0	192,0	215,0	233,0	233,0	233,0	233,0	233,0	233,0	233,0	233,0
PEF cost	3,1	3,8	4,5	7,2	6,6	6,6	6,6	6,6	6,6	6,6	6,6
Net value (BTP + PEF)	**162,8**	**311,0**	**473,7**	**637,8**	**894,9**	**1.250,0**	**1.645,3**	**2.099,1**	**2.552,9**	**3.006,7**	**3.460,5**

Under the Bonnet of Balancing Programme

nationalgridESO

Under the Bonnet of Balancing Programme – Stands

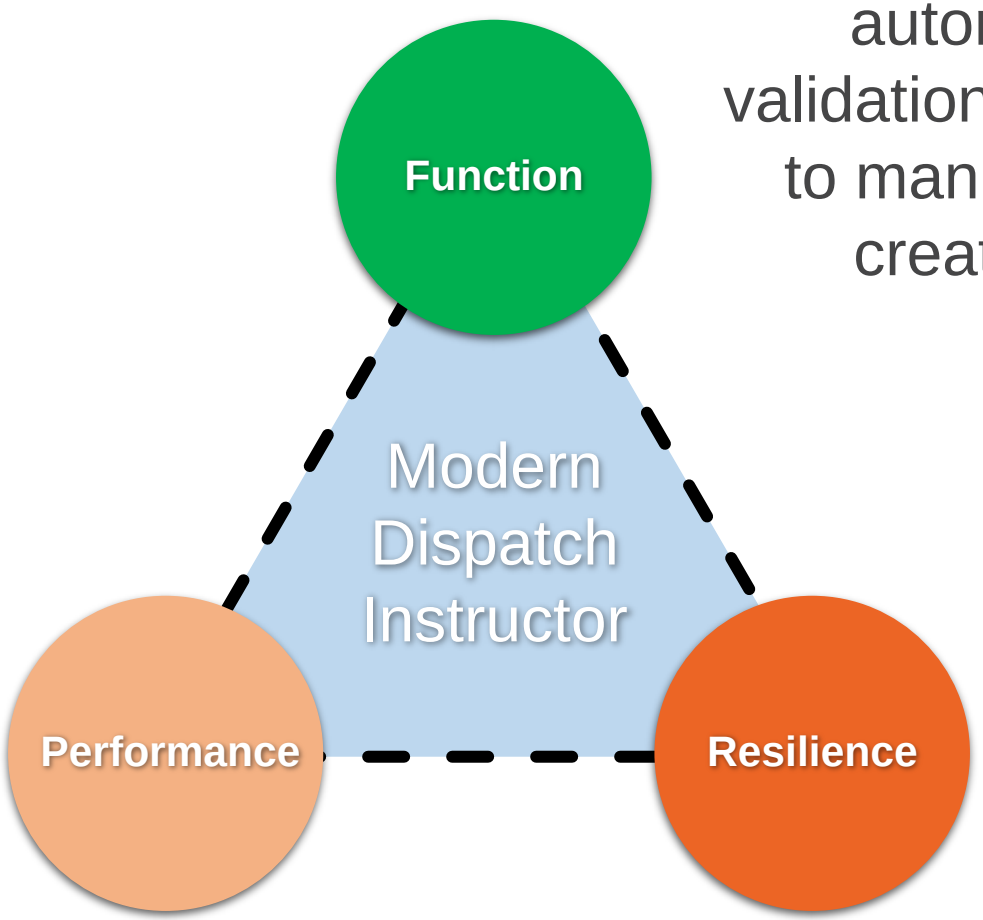
Open Balancing Platform

nationalgridESO

Direction for Modern Dispatch Instructor

Ability for Control Room to safely and securely dispatch in bulk, cross service instructions to balance the network

Ability to issue the instructions semi-automatically (with validation) without the need to manually individually create instructions



Future Facing Targets:

Sub-second optimisation

1000s of units

Highly available, multi-resilient solution to meet CNI standards for the Control Room

Bulk Dispatch – Why is it important?

For the control room

- Alleviates workload
- Allows us to enhance co-ordination across teams

For Market Participants

Improves Certain Skip Rate Categories

- “Time to Take Decisions – will have major affect on this
- “Zonal Management” – will help to some degree

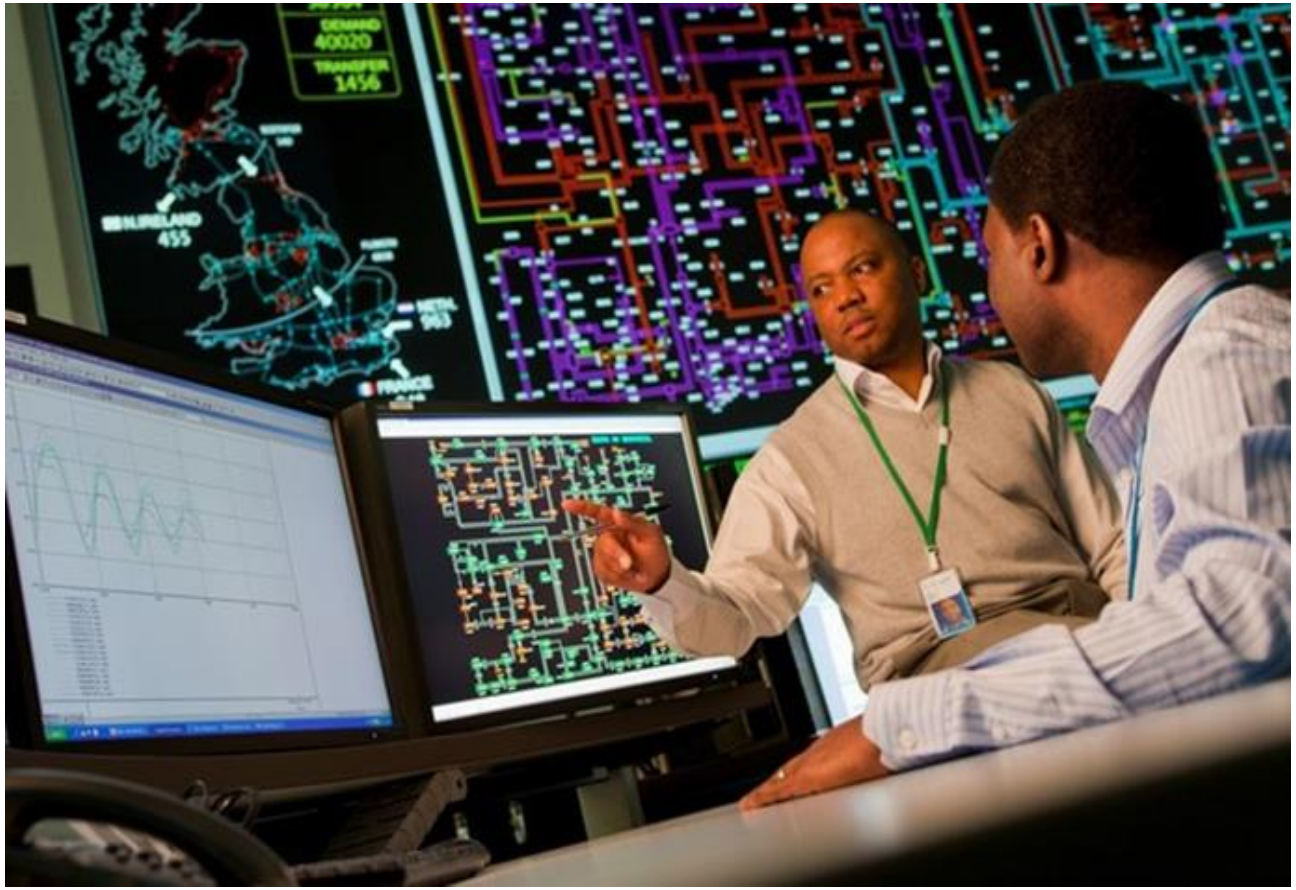
Target release – End of 2023

- First release “small BMUs”
- Second release wind units

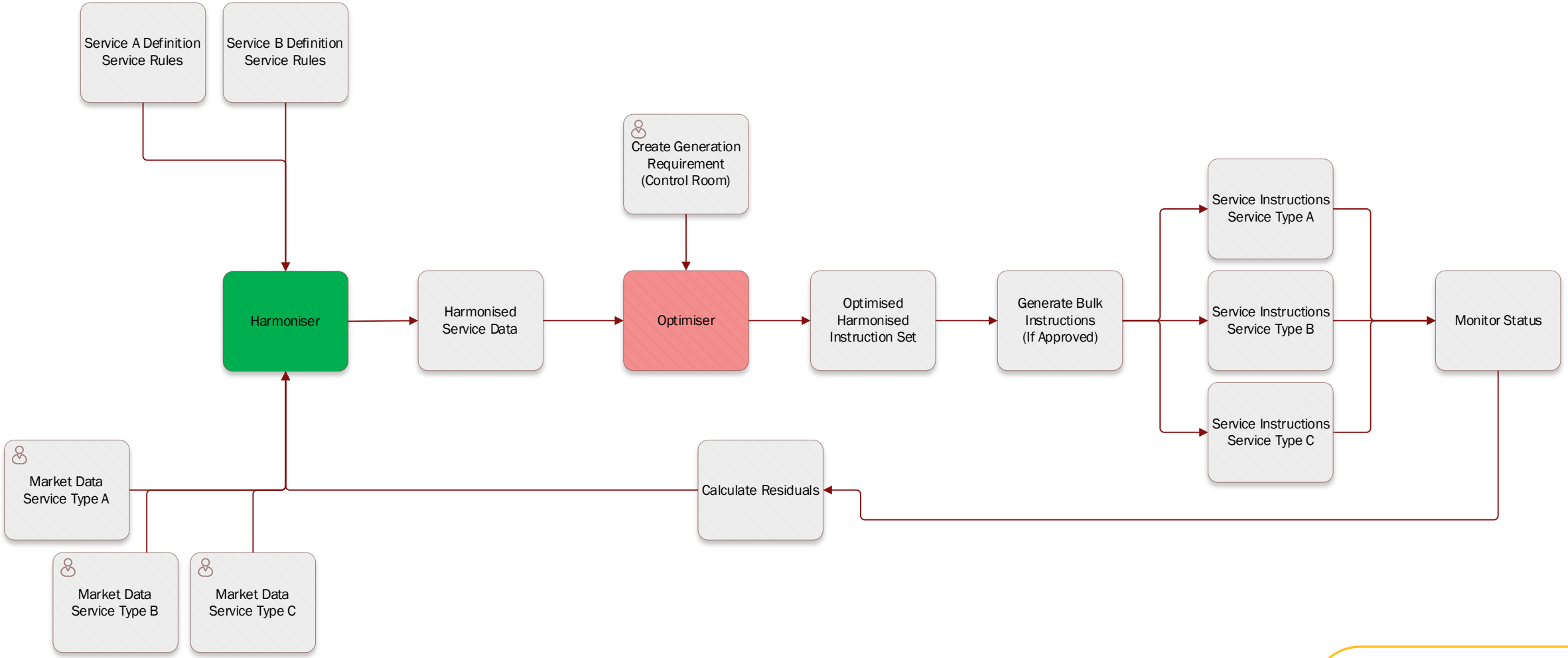
The Problem of Scale – National Balancing

The Control Room has a manual based process for the Interpretation of Optimisation and subsequent Dispatch

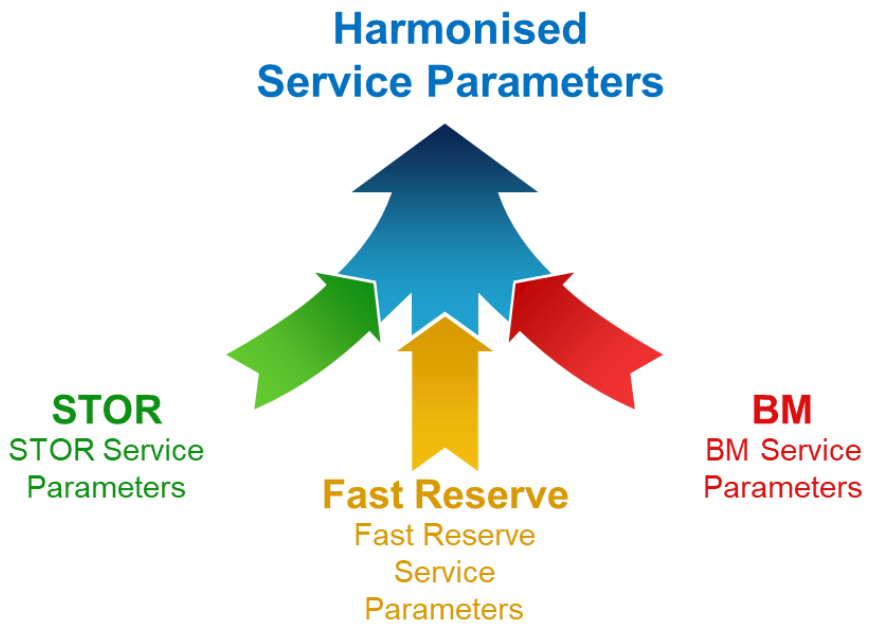
With increasing number of smaller units, the Control Room has an urgent need to scale and automate its processes for Optimisation, Dispatch and Monitoring



The New End to End Process



The Harmonised Service



A **Harmonised Service** will allow the Control Room to optimise consistently in a fair and equal manner minimising skip rate

Control Room will be able to visualise the National Balancing situation, and can set a Generation Requirement against the **Harmonised Service** visually – overlaying the Generation Requirement curve over the Imbalance Curve

Modern Dispatch Instructor – Handling Bulk Instructions

As Balancing Transformation had not started, a small project (MDI) was created to develop a new optimiser which would facilitate National Energy Balancing and some areas of MW Constraints.

The project sought to develop best practice and experts in their field.

MDI engaged academic Optimisation experts via Strathclyde University to develop the Optimiser component, and NG SMEs for Control Room processes.

University of Strathclyde

nationalgridESO

Non-BM STOR

- ✓ Harmonisation between Non-BM and BM
- ✓ Seasonal windows
- ✓ Firm and optional
- ✓ All or nothing units
- ✓ Utilisation price
- ✓ Open instructions
- ✓ Contract data

- ❖ Will be retired by the time OBP is live
- ❖ Fairly large to implement with no end user benefit

Slow reserve

- ✓ Harmonisation between Non-BM and BM
- ✓ Potential for daily windows
- ✓ Firm and optional
- ✓ All or nothing units
- ✓ Utilisation price
- ✓ Open instructions
- ✓ Contract data

- ❖ Still being developed could change before OBP goes live
- ❖ Unknown effort to implement as it's a moving target

Non-BM STOR

- ✓ Harmonisation between Non-BM and BM
- ✓ Seasonal windows
- ✓ Firm and optional
- ✓ All or nothing units
- ✓ Utilisation price
- ✓ Open instructions
- ✓ Contract data

- ❖ Will be retired by the time OBP
- ❖ Fairly large to implement with benefit

Service X

- ✓ Harmonisation between Non-BM and BM
- ✓ Windows
- ✓ Firm and optional
- ✓ All or nothing units
- ✓ Utilisation price
- ✓ Open instructions
- ✓ Contract data
- ✓ Minimum of 0.5 MW unit (future MW dispatch capability)
- ✓ Reduced implementation effort whilst still challenges our service capability

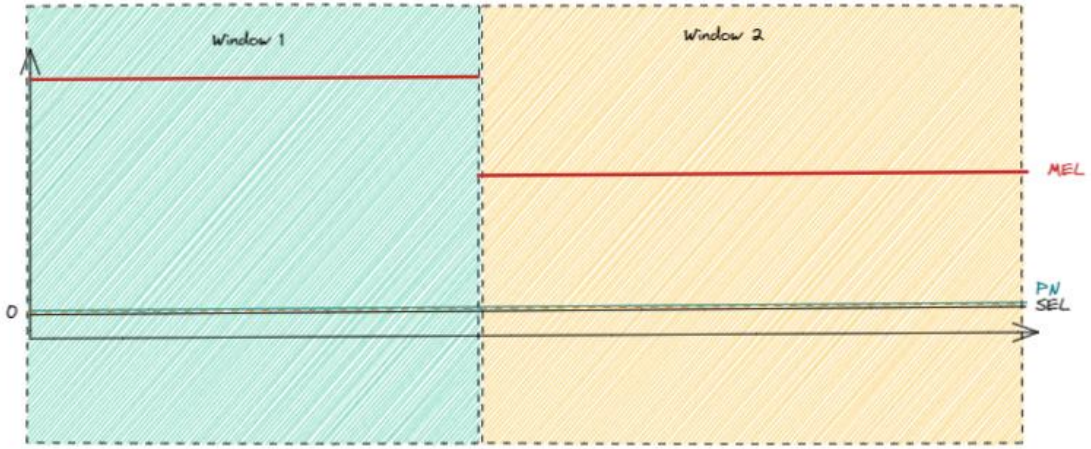
- ❖ No direct end user benefit as it only proves our technology (BUT it proves the technology!)

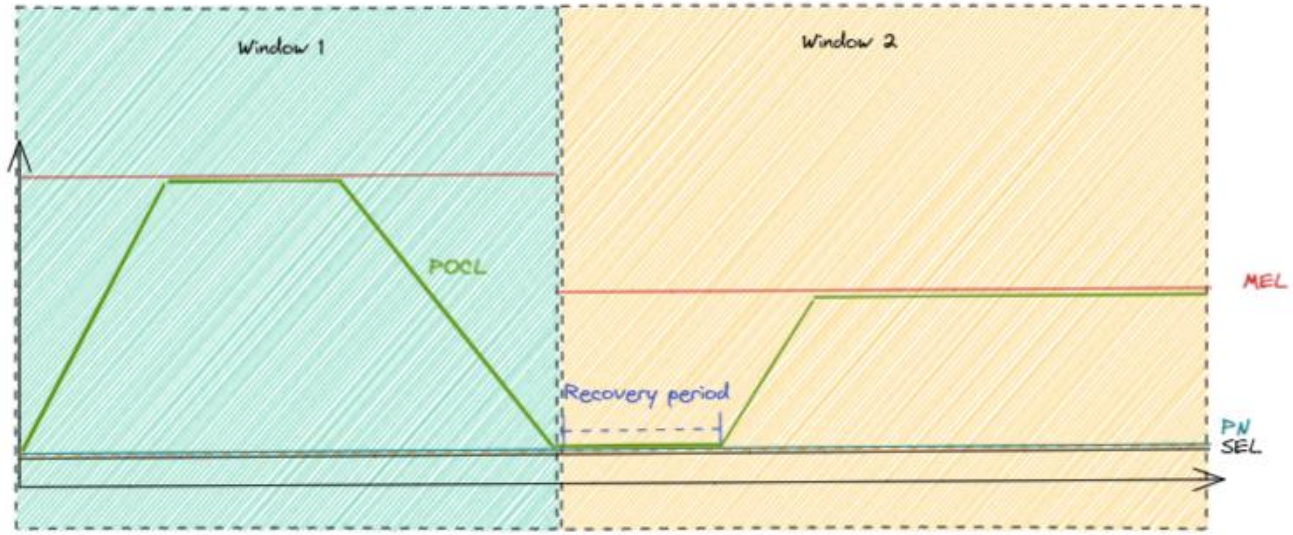
Slow reserve

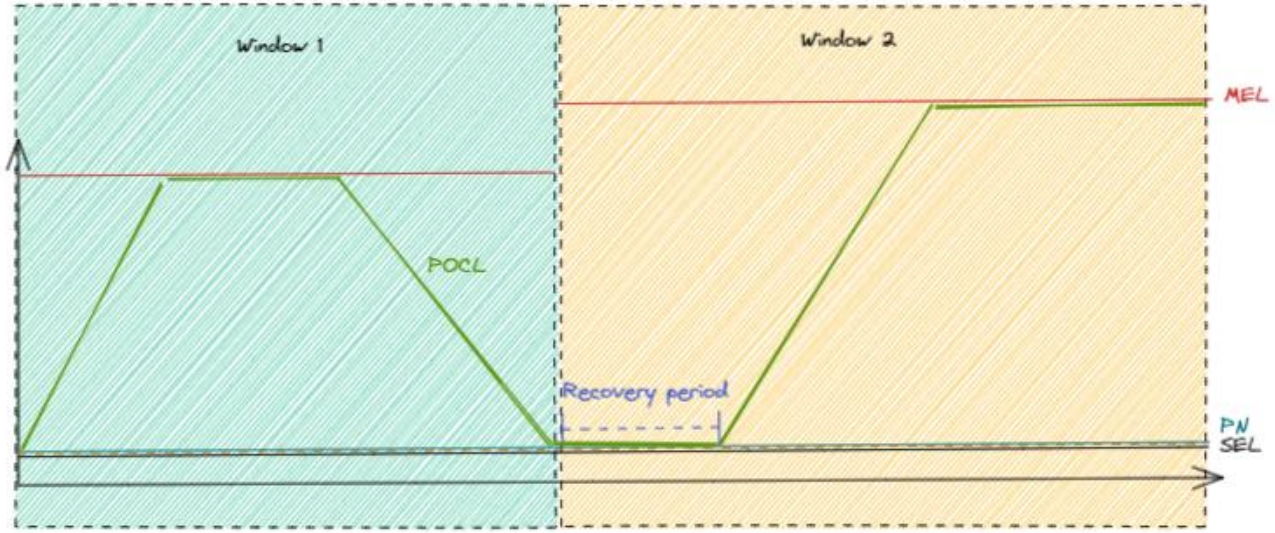
- ✓ rmonisation between Non-BM and
- l for daily windows
- l optional
- thing units
- on price
- structions
- data

- g developed could change
- BP goes live
- n effort to implement as it's a
- target

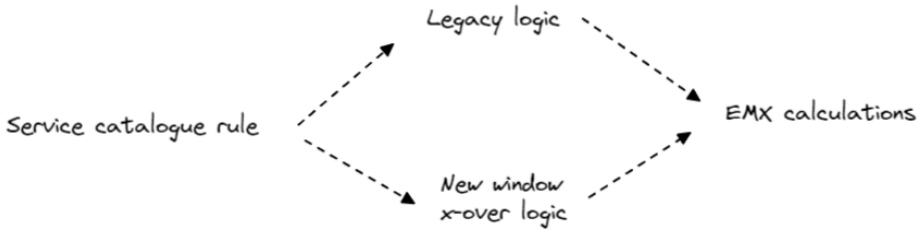
Non-BM unit varying MEL between windows

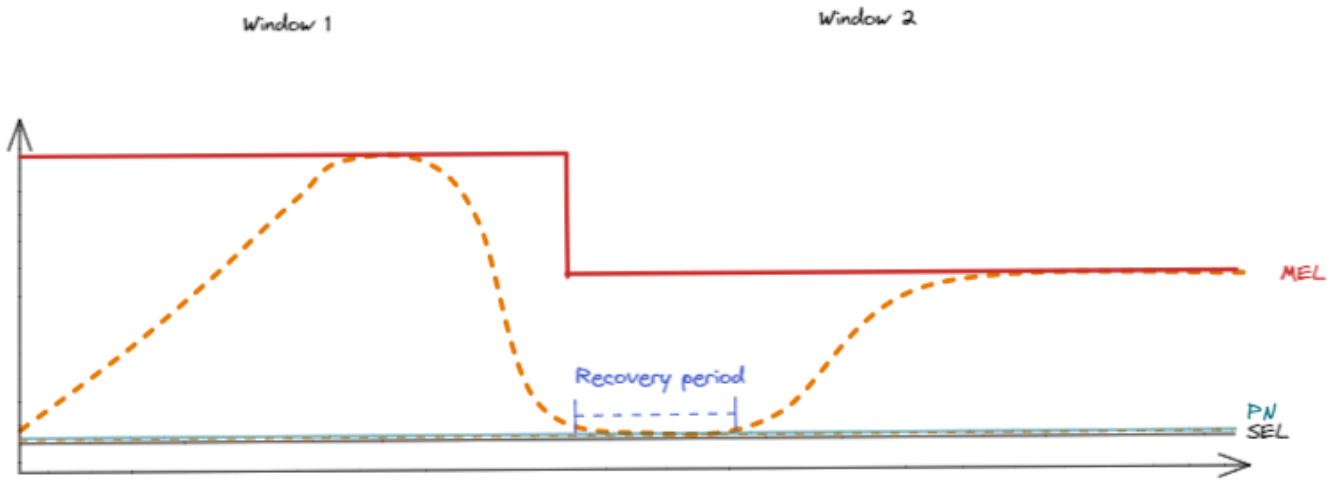


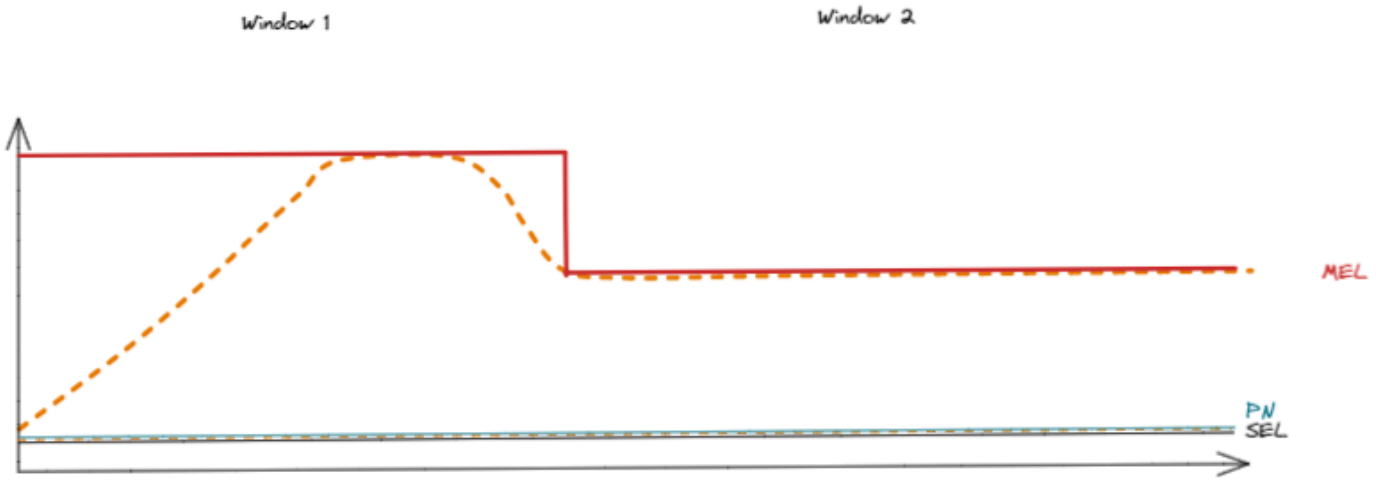




Designing a configurable future







Under the Bonnet of Balancing Programme – Stands

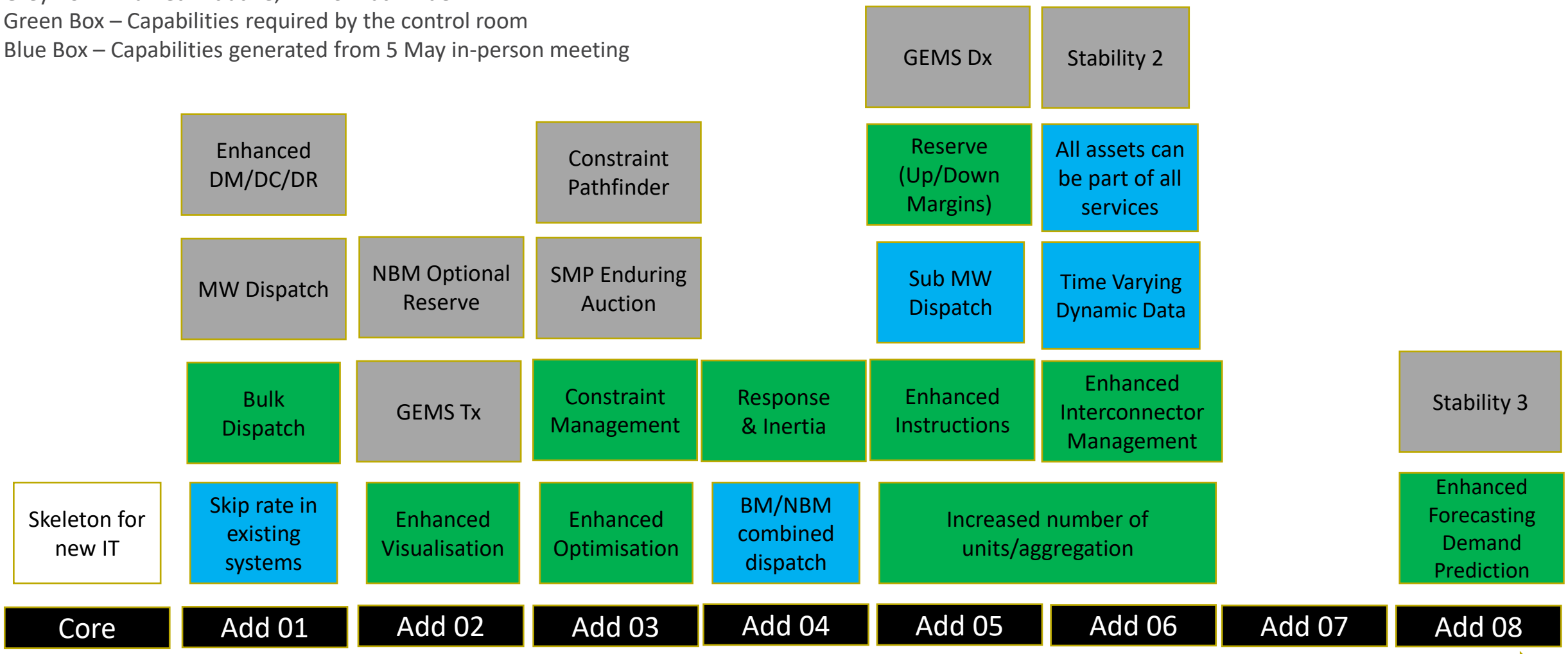
Existing Balancing (David/Gabriel)

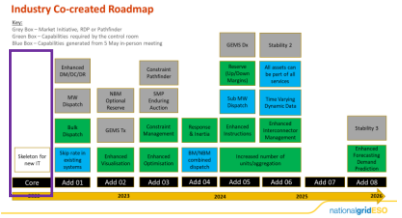
nationalgridESO

Industry Co-created Roadmap

Key:

Grey Box – Market Initiative, RDP or Pathfinder
Green Box – Capabilities required by the control room
Blue Box – Capabilities generated from 5 May in-person meeting





Work delivered to date

RIIO-2 Business Plan and Regulatory Commitments

DC/DM/DR day 1

- Automated frequency response requirements data input functionality
- Development of new reason codes and fast keys for sending instructions

Regulatory

- Changes to support CEP 6.9
- Changes to comply with GC0109 and GC0148

Pathfinders

- New control room screens and reason codes to dispatch new services

Asset health and performance improvements

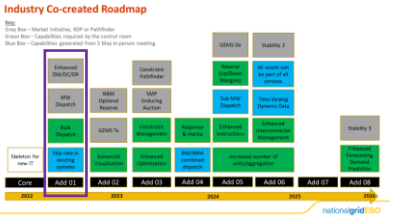
Fixing defects and production issues. This represents savings of ~£16.8m in risk avoidance.

40% improvement in processing time of EDT/EDL files to/from market participants

Control room user functionality improvements

- Alphabetisation of units in screens
- Automatic Instruction Repeater functionality
- Auto Flex Flag functionality of small BMUs
- Automatic entry of calc times
- Changes to dispatch optimiser to improved economic advice for wind
- New filtering on screens to improve situational awareness

Workarounds removed: 13,000 hours per year



Add 01

Enhanced DM/DC/DR

Control room monitoring of response reserves

Control room disarming of response services

MW Dispatch

Delivery of MW Dispatch (NGED) in existing balancing systems

Bulk Dispatch

Improvements to Automatic Instruction Repeat (AIR) functionality

Functional and user interface improvements to bulk dispatch tool

Skip rate in existing systems

Explore changes that could reduce skip rates

Fixes to price stack pages to ensure only available units are considered

Improved situational awareness through new BOA constraints overview screen

Other

Constraints Management Pathfinder MVP

EBS phase-down step 1

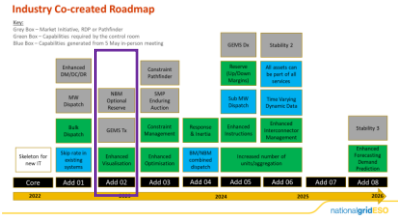
Asset health and performance improvements

Control room functionality improvements

Windows 10 work

Regulatory compliance work

Increase interconnector limits



Add 02

NBM Optional Reserve

Capability to bulk dispatch new reserve services

GEMS Tx

Delivery of outgoing and incoming interfaces between ESO control systems and GEMS control units

Enhanced Visualisation

New control room screen to show dispatch advice separate from forecast profile

Improving visualisation and management of bi-directional units

Improved display of IEMS overrides of metered data in SORT

Other

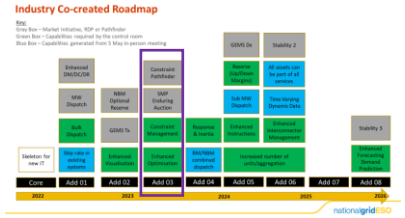
Constraints Management Pathfinder MVP

Stability Pathfinder phases 2/3

EBS phase-down step 2

Asset health and performance improvements

BMU volumetric testing and associated fixes



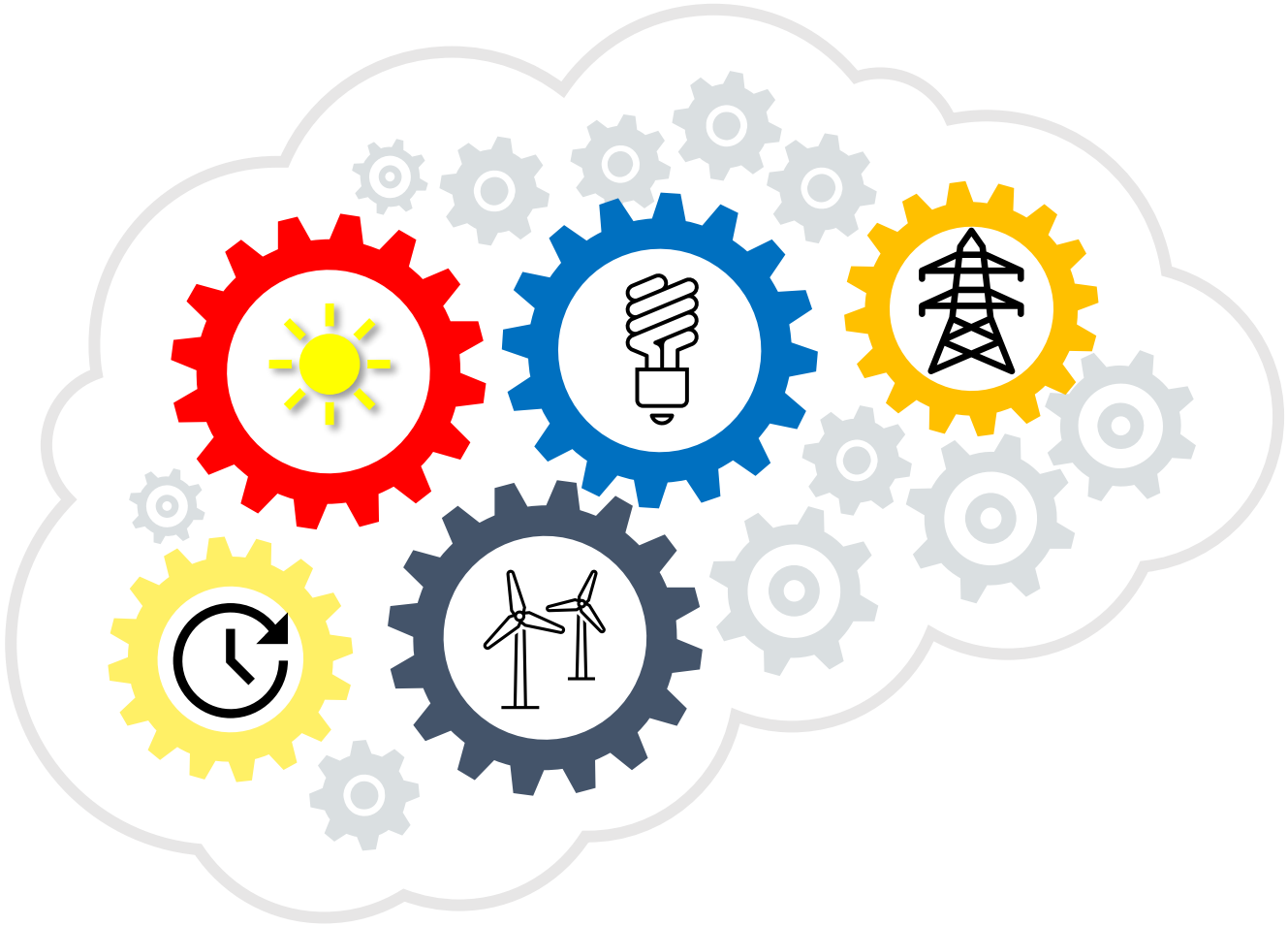
Add 03

Constraint Pathfinder	SMP Enduring Auction	Constraint Management	Enhanced Optimisation	Other
Constraint Management Pathfinder – final delivery	Potential interface changes	Constraint Management Pathfinder – final delivery	Modern Dispatch Adviser (shadow mode / parallel run, and then switching on)	Stability Pathfinder phases 2/3 EBS phase-down step 3 Asset health and performance improvements Control room functionality improvements

Under the Bonnet of Balancing Programme – Stands Forecasting (Sumit)

nationalgridESO

Forecasting Products



Solar Power Generation
Aims to provide solar power generation forecasts , data , processes & tools

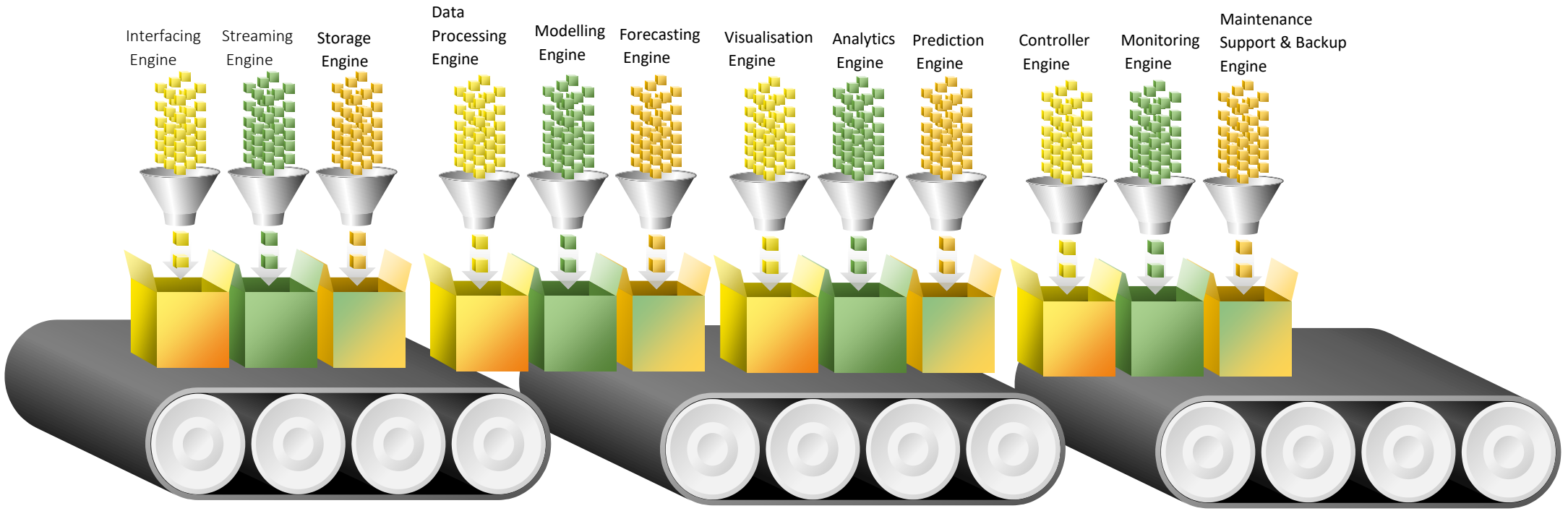
National Demand
Aims to provide national demand forecasts, data , processes & tools

GSP Forecasting
Aims to provide grid supply point level forecasts , data , processes & tools

Wind Power Generation
Aims to provide wind power generation forecasts , data, processes and tools

Real Time Predictions (New)
Real-time predictions for the new and existing products , data , processes and tools

Forecasting Modular Approach



Our forecasting platform adopts a modular design
for each of the engines shown above.
All the engines can be called out by other engines

Forecasting

Delivered to date (Core)	• Grid supply point net demand forecasts (~20% improvement)
	• Machine learning models
	  • Most recent demand patterns
	  • Most recent & frequent data inputs
		• Improvement in processing & delivery time in planning & operational systems (~80% better)
		• Improved forecasting visualisation & dashboards for ENCC with better quality, more frequent & timely forecasts

ADD 01	• Incremental GSP forecast improvements in planning & operational systems (hourly update) • Weather data improvements for Forecast models (~2.5 times more data) • Foundation for GSP PV & GSP wind power generation forecast products	• Maintain & improve (where possible) forecasting performance • Detailed design & development of scalable and flexible future forecasting platform • Asset health & performance improvements

Forecasting

ADD 02	• Forecasting improvements for local constraints market (LCM) • Grid Supply point (GSP) level solar & wind power generation forecasts in planning & operational systems • Forecasting model improvements (where possible) – consumption of new weather data	• Development & testing of new scalable and flexible future forecasting platform • Asset health and performance improvements • Additional control room forecasting visualisation and dashboards
ADD 03	• Forecasting model improvements (where possible) • Solar Power generation – National level forecast • Wind power generation forecasts (BMU level) - Discovery & Designs	• Asset health and performance improvements • Market publication of GSP forecast

Forecasting Capabilities

- **Interfacing Engine** – Access and connection to Forecasting data(input, output, and reference) streams in business and system required output structures**.**
- **Streaming Engine –** Consumption of all required input and output data.
- **Storage Engine –** Store the all data types(structured/unstructured).
- **Data Processing Engine –** Processing and transformation of data (input, output, and reference).
- **Forecasting Lab –** To develop, validate and publish the modelling algorithm to modelling engine.
- **Modelling Engine –** To process, train and release the modelling algorithms to produce predictions.
- **Visualization Engine –** To view and manage the input, output, reference data and system health.
- **Analytics Engine –** Analyse the data for multiple scenarios against forecasting data
- **Prediction Engine** – To produce the predictions and publish the data.
- **Controller Engine –** To control the process frequency, composition of output data, and flow of Forecasting data to systems.
- **Notification Engine –** Alerts to business, modellers and support team about system and processes health.
- **Backup & Support Engine –** 24/7 monitoring support from IT for bugs and issues and fixes as per service operating model and NG ESO guidelines

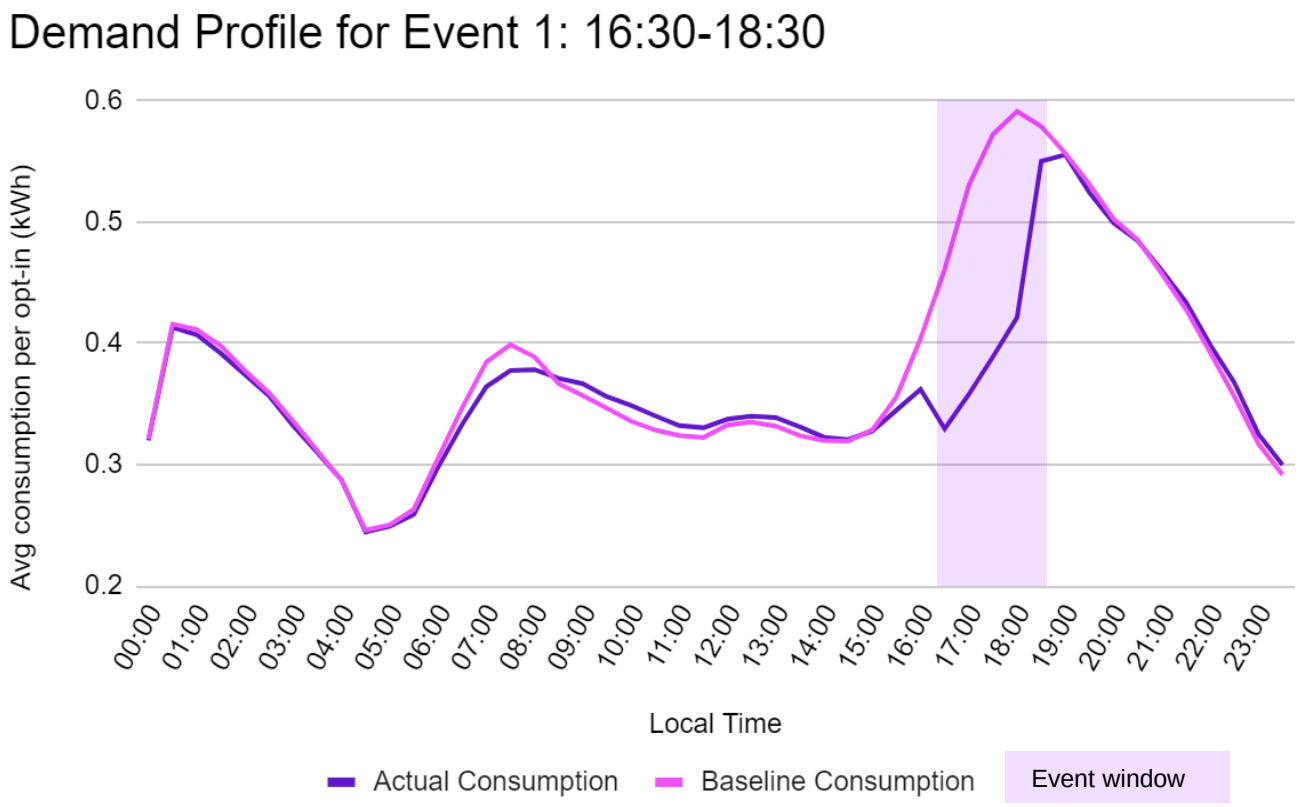
Under the Bonnet of Balancing Programme – Stands

Market Trials

nationalgridESO

Domestic Reserve Scarcity Trial - Snapshot of key figures

105,320	customers ‘signed up’[1] to the trial out of 322,245 emailed
197 MWh	total turn down across the trial
12.3 MW	average turn down per event
44%	average ‘event opt-ins’[2] hitting target[3] (‘participating’) per event
0.51 kWh	average turn down per hhold per event – 0.79 kWh smart tariff & 0.46 kWh flat tariff
£227/ MWh	average cost of demand reduction

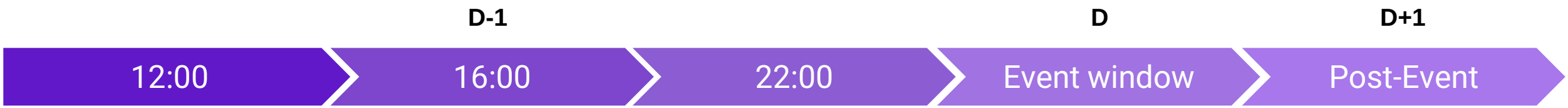


Note: (1) 1 Trial ‘sign-ups’ are people confirming they wanted to join the trial and formed the group of customers emailed ahead of each event, or the ‘trial group’; (2) ‘Event opt-ins’ are people confirming they wanted to take part in a particular event; (3) A customer was judged to have participated in an event when they decreased their consumption by the benchmark amount (30% or 40% of their forecasted demand, depending on the event window).

octopus energy nationalgridESO

Domestic Reserve Scarcity Trial - Trial Design

- Three two-hour time windows selected for trial events: **00:00-02:00**, **09:00-11:00**, **16:30-18:30**
- Trial events ran on any day **Monday to Friday**
- Trial events initiated based on **day ahead de-rated margin forecast**
- OE provided customers with a **financial incentive** if they reduced their demand
- Two key methodologies explored utilising half hourly (HH) data from household smart meters:
  - **Baseline** – Forecasted consumption
  - **Forecast** – Expected demand reduction from baseline
- OE calculated the **turn down response** as the difference between actual demand and baseline demand.



At 12pm Sunday to Friday inclusive, OE sent NG ESO a day-ahead **volume forecast.**

Notification sent from NG ESO to OE if thresholds in de-rated margins forecast met. OE emailed all customers in the trial group with an 'event opt-in' [1] request, the **turn down window** and **their turn down target.**

OE sent an **updated volume forecast** to ESO based on event opt-in numbers.

Customers reduce their energy in the given 2 hour window, attempting to reach their target in order to **receive an incentive.**

Customers who **successfully reached their target** were deemed to have 'participated' and received an incentive. OE provided a post-event summary of demand response to ESO including participation rate and depth of response.

Note: (1) 'Event opt-ins' are people confirming they wanted to take part in a particular event

Domestic Reserve Scarcity Trial - Customer comms: Flexibility dispatched through simple process

Event notification 4pm day-ahead

Customers received an event notification via email at 4pm day-ahead. This included information about the turn down window, their turn down target and their chosen incentive.

Example event notification email

Hi Simona,

We'll make your energy FREE between 4:30pm to 6:30pm tomorrow **if you manage to cut down your typical energy use by 40% during that time.** Are you up for the challenge?

Let us know you're in

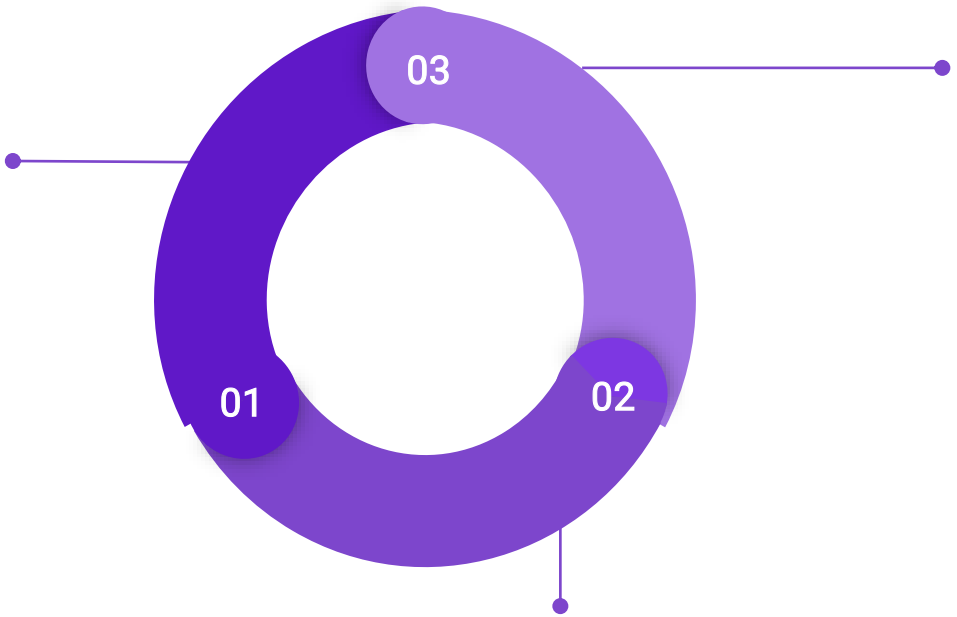
Turn down window: 4:30pm - 6:30pm on 24/02/2022

Your target: reduce your usage by 2.39 kWh

This is 40% less than you'd normally use across the two hours. This is based on smart meter data showing you normally use 5.98 kWh over the period.

Let us know you're up for the challenge by 9pm tonight by clicking the link below.

I'm in!



Results sent within one week

Octopus Energy calculated turn down response as forecasted demand minus actual demand, and sent customers their results within one week of the event.

Customers who successfully reached their target were deemed to have 'participated' and received an incentive.

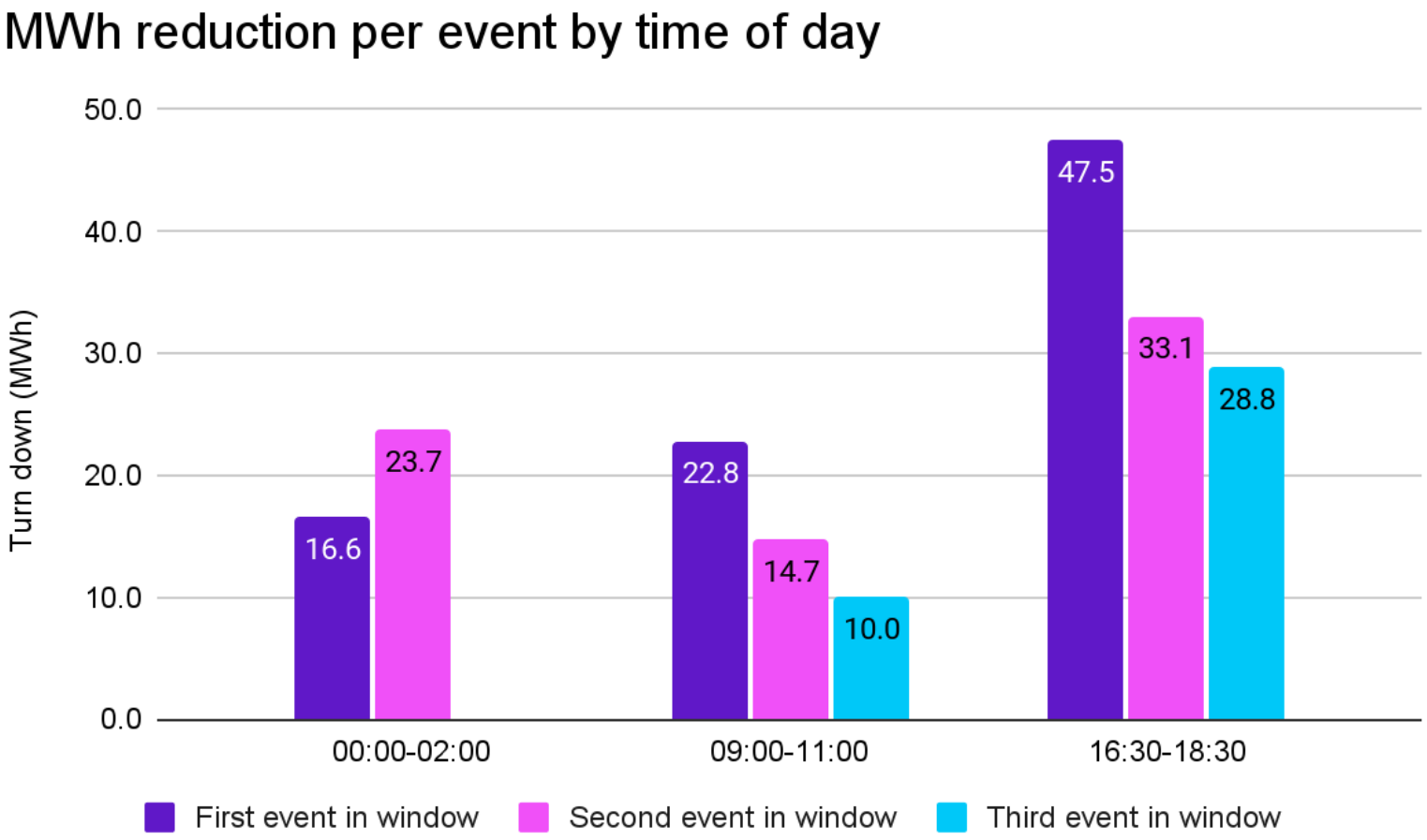
Reminder 30 minutes before event

Customers received an event reminder via email 30-minutes before the 09:00-11:00 and 16:30-18:30 events. Customers who had opted-in to SMS notifications also received a text notification 30-minutes before the 16:30-18:30 events.

Note: The turn down target was calculated as 30% or 40% of the customer's forecasted demand for the event window. A 30% reduction was chosen for the 00:00-02:00 events, and 40% for the other two windows.

Domestic Reserve Scarcity Trial

Customers showed high engagement and large, repeatable demand response to grid needs, turning down by a total of 197 MWh over the trial



Note: A customer was judged to have participated in an event when they decreased their consumption by the benchmark amount (30% or 40% of their forecasted demand, depending on the event window).

octopus energy nationalgridESO

Powerloop Trial – Overview

Overview

Octopus came to the ESO with a collaboration request for the Powerloop Project, to run a trial to understand the viability of vehicle to grid assets joining the Balancing Mechanism. They had a potential fleet of 135 Nissan Leaf EV's using Wallbox Quasar V2G chargers with a combined capacity of 918kW spanning 3 GSP groups.

Objectives

- Understand pathway to BM for Vehicles to Grid (V2G) through
- Understand blockers in current BM registration process (via Virtual Lead Party route) for V2G units
- Understand market interaction between wholesale & BM
- Understand how V2G assets could be dispatched in the BM
- Understanding how units spanning multiple GSP groups affects ENCC processes

Powerloop Trial events activities

To avoid impact on downstream systems, all trial events during trial will took place on the BM test environment

Pre-trial: Desktop assessment

- Post event analysis where Octopus would send NGESO parameters
- NGESO would compare this to dispatch transparency dataset to issue theoretical dispatch
- Octopus confirmed whether they could deliver against theoretical dispatch based on SoE and other parameters

Stage 1: End-to-end test

- End-to-end test between BM test environment and trial BMUs

Stage 2: Carrying out dispatch at pre-determined times

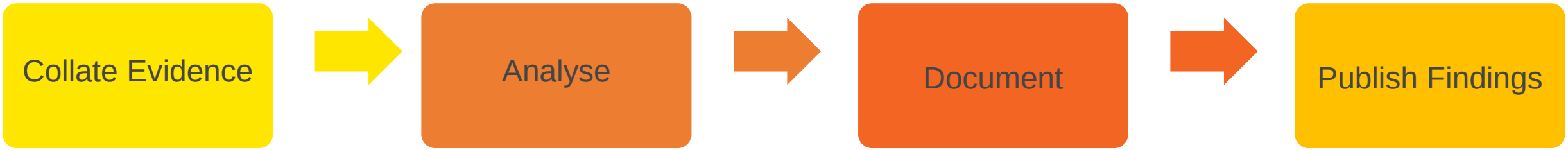
- Instructed at pre-determined settlement periods using an agreed set of instruction schedule
- Different types of instructions to be issued to iron out functional issues

Stage 3: Carrying out dispatch after commercial assessment

- Submission of Bid Offer Data
- Dispatch would take place anytime during availability window based on ENCC engineer's decision following a commercial assessment
- This helped analyse V2G enabled EVs against other assets in the BM

SUCCESS: First instructions of V2G by ESO to provider within the test environments and response to the instructions from providers

Powerloop Project: What now



Ongoing work which sits alongside these trials

Virtual Energy System
Powered by National Grid ESO

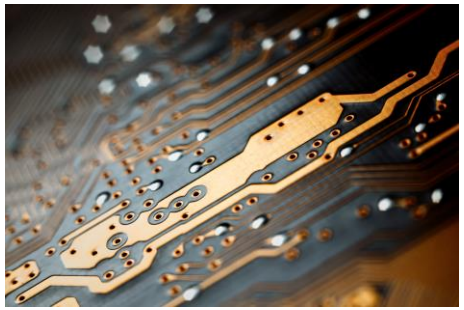
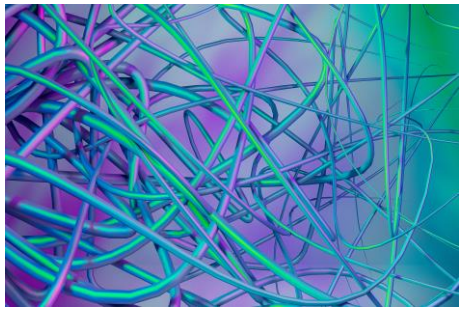
Crowdflex Project

power responsive

Power Responsive working group looking at Operational Metering – this is a blocker to current participation

Trials – Future Pipeline

Any Ideas?

box.balancingprogramme@nationalgrideso.com

Under the Bonnet of Balancing Programme – Stands

Innovation

nationalgridESO

Innovation Engagement is about helping to Solving the Energy Balancing Problem with New Ideas and products

How our Innovation Process Works

Big Idea

Pitch the Big Idea

Plan & Refine

Get funding approved

Launch & Deliver

Complete the project

Close & Disseminate

Review

Big Idea

This is the entry point to our innovation process.

At this stage you need to articulate the specific challenge under one or more of the identified innovation priorities (see our Innovation Strategy) and consider different approaches to solving it. Your Big Idea is then pitched to the Innovation team.

Plan & Refine

The second stage of our innovation process develops the idea into a more detailed project proposal, underpinned by a robust cost-benefit analysis. This is then presented for the funding approval.

Launch & Deliver

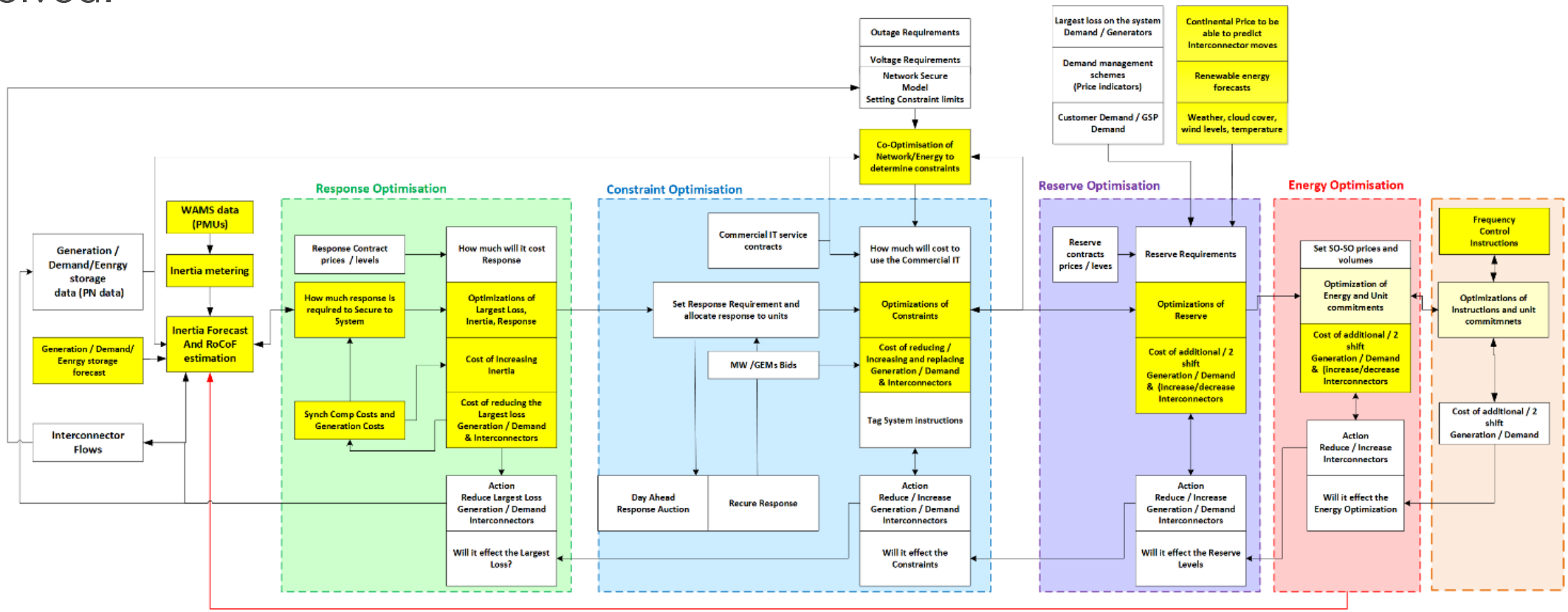
Once the innovation funding is approved, we register the project, sign the contract and kick-off with the delivery of the project.

Close & Disseminate

The final stage of our innovation process is the project closure, which includes dissemination of project findings and learnings through reports and industry events.

Optimisation Strategy

The total optimisation problem cannot be solved by one optimiser, the optimisation problem has been divided into five areas and need new ideas on how this could be solved.



Innovation Projects in Pipeline:

Innovation Project: Course Correction Dispatch Instructor

Context:

- The first task is to **build a course corrector** that provides **situational awareness to the Control Room** engineer as well as instruct a small set of units to deal with the **forecast errors**.
- While the course corrector will have the ability to **correct any energy imbalance**, it must provide **appropriate warnings** to the control engineer to invoke wider **dispatch/scheduling optimisation engine** in cases where significant errors/deviations are dedicated from the optimal schedule.
- The tool should have the following features:

 → Very fast run-times (in seconds)

 → Ability to instruct a small set of units to correct the course

 → Provide situational awareness to the control room engineer

 → Ability to check against a selected set of constraints (e.g. reserve/response violations)

 → Issue system warnings if significant errors are detected

University of Strathclyde

nationalgridESO

Innovation Project: Co-Optimisation of Energy and Frequency Control Services

Context:

- The core innovation of the project is to enhance the models that have been investigated in an academic setting and develop a **practical tool to be used in the National Control Room**.

- This has never been done before because the costs of ancillary services were traditionally only a small percentage of overall system costs (~1%), therefore there was no real incentive to change the operational practices. However, **cost of ancillary services is projected to reach up to 20% of total system costs** in low-inertia grids such as GB, therefore **fundamentally new operational tools are needed** for cost effectiveness.

- **The mathematical models have been tested extensively by Imperial College** in different simulations frameworks. However, extensive engagement with the ESO Balancing Programme members will be essential to ensure that these models can effectively be incorporated in a tool that could be **used within the operational practices of the control room**.

Imperial College London

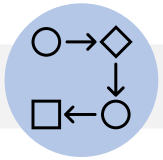
nationalgridESO

Innovation Project Reveal

Context:

- A new project named **ESO Reveal** was launched on September 14th to investigate the feasibility of a sandbox environment to acquire and test new balancing services. From the business plan, the environment was intended to be an ESO hosted digitally ringfenced balancing market which enables the ESO (supported by energy sector service providers) to build innovative concepts, services, and solutions, to accelerate the ESO's Markets Roadmap and drive to Net Zero
- The Reveal project team have been holding short sessions with stakeholders that could interact with and benefit from this environment to understand and validate our **problem and vision statements**

Project Timeline:

1. Future Vision and Purpose

- Gather views from across the ESO on the future vision and purpose of Reveal
- Gather views from market participants
- Assess the regulatory and market impacts

2. Design and Solutioning

- To-be design state and solutioning workshops
- Develop the business case
- Align with the future market
- Understand the business requirements / use cases

3. Pilot and Funding Planning

- Pilot project costs
- Define risks and mitigations
- Agree participants and services for trial
- Develop Go / No-Go Decision Paper

4. SIF Application

- End of Feasibility Study
- Move onto next phase (trial)

Innovation Project Reveal

Problem Statements

Problem Statement 1

There is currently no environment for the ESO / Market Participants to test / trial new services, technologies and concepts which may sit outside of the current regulatory framework

Problem Statement 2

There is a need for new services which are becoming more critical as we move away from conventional sources to more sustainable sources

Problem Statement 3

There is a need to improve the confidence that the Control Room has in new services to enable optimised energy supply

Problem Statement 4

Trialling across the business is being conducted but often they are difficult to coordinate with other activities and they are often performed on an ad-hoc basis

Vision Statement

For	National Control and Market Participants
Who / Opportunity	Test and trial new services in an unregulated environment with the capability for communication and collaboration with Market Participants
The	National Control Reveal platform, that sits outside of the BM
That	Enables new services to be communicated and discussed with Market participants, and allows services to be agreed and then tested in a sandbox environment
Unlike	Live trials that can only be performed at low volumes so as not to affect the transmission system, and ad hoc simulation work performed without a test environment
Our Product	**ESO Reveal will support new innovative services by facilitating a collaborative and transparent environment where new services can be ideated, discussed and tested, whilst broadening and enhancing market participation. The environment will be unregulated and used to inform service launches to the live markets, and as a case for regulatory change where necessary**

Innovation – Future Pipeline

Any Ideas?

box.balancingprogramme@nationalgrideso.com

Innovation@nationalgrideso.com

Scan QR code to email ESO innovation

Under the Bonnet of Balancing Programme – Stands

Future of Storage

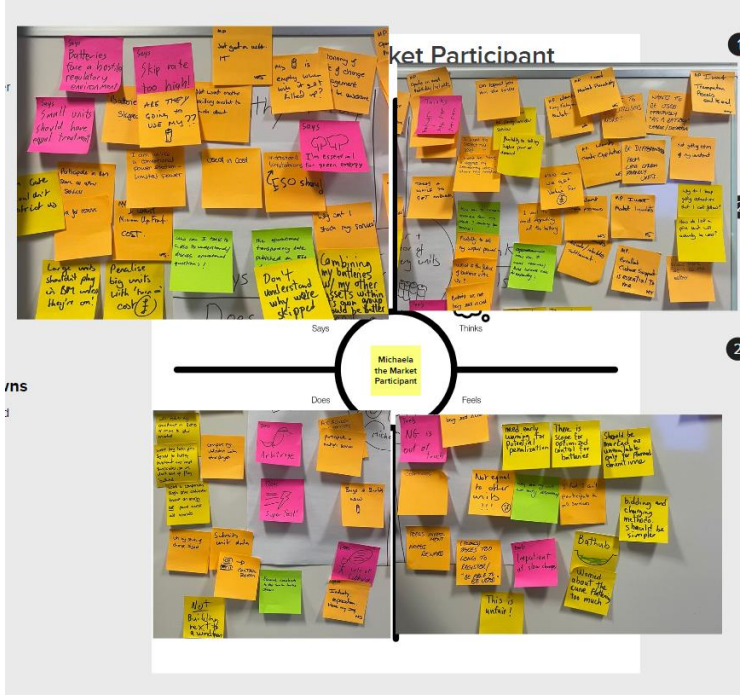
nationalgridESO

Storage in about moving energy in time

What stops us from storing energy now use for later?

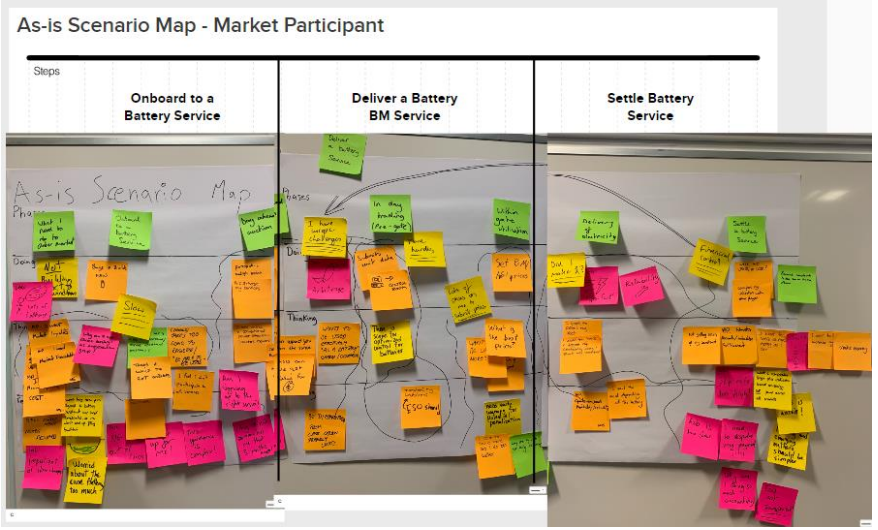
Internal sessions earlier this year

Market participant empathy map



Lots of assumptions

Scenario map



Forming a new Storage Stakeholder Group

- Continue the work started internally
- Challenge and clarify assumptions
- Bring storage industry voices into discussion for the future systems used by the control room

Batteries vs Pump storage or Just Storage

How adequate are parameters such as MDV and MDP

Storing and releasing energy, find the most optimal time and volume

Storage blocked by constraints

Panel Discussion

nationalgridESO

Day Recap

nationalgridESO

Review of Day (Charlie/Nazar)

nationalgridESO