Enduring Connection Policy (ECP) 2.4 Constraints Analysis

Assumptions Document

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2 Summary

This document outlines the assumptions made in developing a model for the Enduring Connection Policy (ECP) 2.4 Constraints Analysis. These studies include energy balancing (surplus), curtailment, and constraints to be applied and analysed on the study models.

Table 2-1 - summary of assumptions

Feature	Assumptions
Study period	The study horizons are 2027, 2029, and a Future Grid (aligned with the Shaping Our Electricity Future (SOEF) 1.1 Roadmap).
Demand	The Total Electricity Requirement (TER) is from the National Resource Adequacy Assessment (NRAA) 2025 – 2034, median demand scenario.
Generation	The total generation capacity to be studied under ECP-2.4 batch is 4.3 GW (0.4 GW gas, 1.8 GW solar, and 0.5 GW onshore wind). The total IE generation capacity (wind, solar and battery) considered in this study is 23.1 GW, including up to 5 GW of offshore wind in Ireland.
Security constraints	System Non-Synchronous Penetration (SNSP), inertia and min. set rules are defined for each study year and are based on the Operational Roadmap Policy 2023 – 2030[1] and the SOEF 1.1 Roadmap.
Network developments	The network developments are based on the Network Delivery Portfolio (NDP) for 2027 and 2029 and the latest version of SOEF 1.1 Roadmap[2] for the Future Grid horizon.
Core ECP-2.4 scenarios	2027 – Initial, 50%, and ECP scenario (constraint allocation based on grandfathering). 2029 – Initial, 50%, and ECP scenario (constraint allocation based on grandfathering).
Sensitivities	<u>2027:</u> 2027 - 50% scenario (constraint allocation based on pro-rata). <u>2029:</u> 2029 - 50% scenario (constraint allocation based on pro-rata). 2029 - ECP scenario without batteries (constraint allocation based on grandfathering). <u>Future:</u> Future Grid – ECP scenario (constraint allocation based on grandfathering). Future Grid – ECP scenario + 3.1 GW offshore (constraint allocation based on grandfathering). Future Grid – ECP scenario + 3.1 GW offshore (constraint allocation based on pro-rata).

[1] See link: https://www.eirgridgroup.com/site-files/library/EirGrid/Operational-Policy-Roadmap-2023-to-2030.pdf
[2] See link: https://www.eirgridgroup.com/site-files/library/EirGrid/Shaping-Our-Electricity-Future-Roadmap_Version-1.1_07.23.pdf

	Future Grid – ECP scenario + 3.1 GW offshore with renewable hubs (constraint allocation based on grandfathering). Future Grid – ECP scenario + 5 GW offshore (constraint allocation based on grandfathering). Future Grid – ECP scenario + 5 GW offshore with interconnector sensitivity (constraint allocation based on grandfathering).

3 Introduction

The Enduring Connection Policy (ECP) 2.4 is the fourth batch of connection offers planned under ECP-2 by the Commission for Regulation of Utilities (CRU) to facilitate opportunities for connections to Renewable Energy Sources (RES) on to the Irish electricity network. The ECP-2.4 Constraints Analysis is carried out by the TSO (as mandated by CRU/20/060 decision[3] on ECP-2) to forecast dispatch down levels for ECP-2.4 wind and solar projects. Upon completion of this constraint forecast analysis, EirGrid plans to publish 12 regional constraints reports, which will provide ECP-2.4 developers with information on forecasted dispatch down levels in each region. The expected time for release of these reports is in Q1 2025.

While the progression of offshore wind applications is considered separately from the ECP process, EirGrid has decided to include offshore-based study scenarios in the ECP-2.4 constraint forecast as sensitivities to the core study scenarios, following engagement with the CRU and wider industry.

This document briefly presents the current working assumptions for performing the ECP-2.4 Constraint Analysis studies.

3.1 High Level Timeline

[3] See link: https://cruie-live-96ca64acab2247eca8a850a7e54b-5b34f62.divio-media.com/documents/CRU20060-ECP-2-Decision.pdf

4 Total Dispatch Down

Total Dispatch Down (TDD) is the key metric for the ECP-2.4 Constraint Analysis. TDD is the sum of Surplus, Curtailment, and Constraints, where:

- Surplus represents dispatch down applied for energy balancing when the available generation exceeds demand plus interconnector export.
- Curtailment represents dispatch down applied to ensure operational limits are met.
- Constraints represent dispatch down applied to manage localised congestion on the grid, whereby variable generator output is constrained to stay within overload limits of the transmission lines. This is applied at a nodal level.

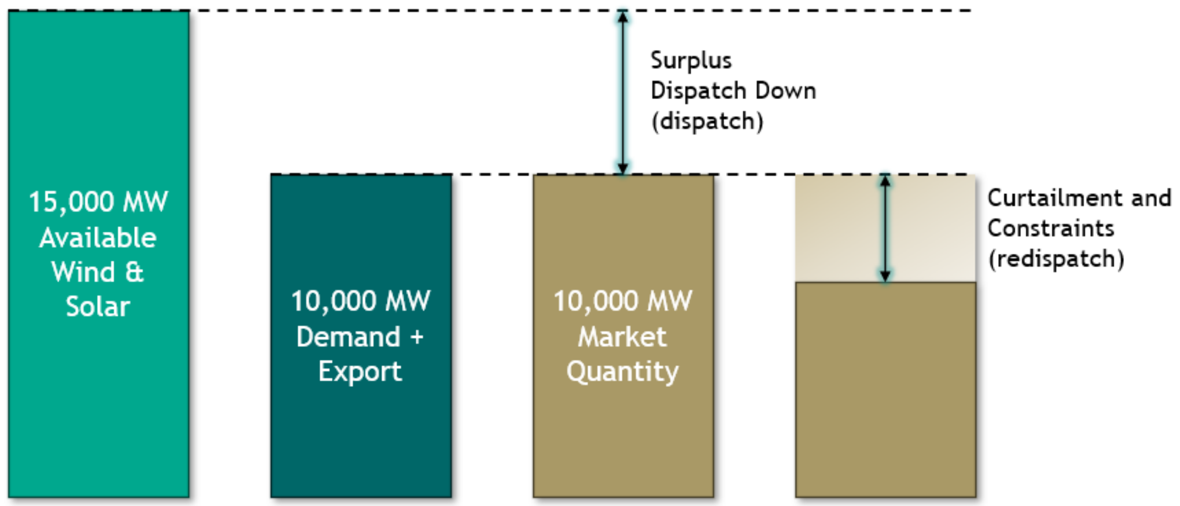

Figure 4-1 Illustration of Surplus, Curtailment and Constraints in the SEM.

5 Article 12 and Article 13

Following the Judicial decision on the SEM-22-009 Decision Paper on Dispatch, Redispatch and Compensation Pursuant to Regulation EU 2019/943, the detailed design for implementing Articles 12 and 13 is yet to be determined and may differ from the implementation for Total Dispatch Down used in this study. Therefore, an assumed interpretation will be used for ECP-2.4 Constraint Analysis that applies a grandfathering[4] approach to resolving Surplus and Constraint conditions. However, in addition to the Core ECP 2.4 constraint forecast studies a set of sensitivity studies are also included in the study scenarios which employs pro-rata allocation of constraints. The assumed interpretation of Article 12 and Article 13 that will be modelled in ECP-2.4 constraints analysis is outlined below for each category of dispatch down.

Surplus

Firstly, all non-priority dispatch units generating during *Surplus* will reduce output on a pro-rata basis. If the *Surplus* is unresolved by non-priority dispatch unit reduction alone, priority dispatch units will also reduce output on a pro-rata basis.

This is unchanged from ECP-2.3.

Curtailment

All non-priority and priority dispatch units generating during *Curtailment* will reduce output on a pro-rata basis.

This is unchanged from ECP-2.3.

Constraints

Firstly, with grandfathering (GF) of constraints, all non-priority dispatch units contributing to a *Constraint* problem will reduce output on a pro-rata basis. If a *Constraint* is unresolved by non-priority dispatch unit reduction alone, priority dispatch units contributing to the Constraint will also reduce output on a pro-rata basis. This grandfathering approach is similar to how market Surplus is resolved in ECP 2.4 modelling.

In the pro-rata constraints allocation, all priority and non-priority units are dispatched down on a pro-rata basis at relevant nodes to manage the network constraints. This method is applied to the relevant sensitivity scenarios.

[4] 'Grandfathering' is where an old rule continues to apply to some existing situations while a new rule will apply to future cases. In the context of Article 12 and Article 13, grandfathering refers to the distinction between how priority dispatch renewable generators (those installed prior to 4th July 2019) and non-priority dispatch renewable generators (those installed on and after 4th July 2019) are treated in the SEM.

6 Study Scenario Matrix

The core ECP-2.4 study horizons are 2027 and 2029. The RES generation capacities in the initial study include all renewable generation currently connected, plus all renewable generation expected to connect before the end of 2026.

The 50% generation scenario is formulated by adding half of the difference between the initial and ECP scenarios to the initial study. The ECP generation scenario includes all the RES generation in the pipeline up to and including ECP-2.4 applicants (some of whom may not have received offers at this point in time but are still considered within these studies).

A battery sensitivity study has been included based on an industry request, which will contain all renewable generations as in ECP study scenario with non-connected batteries removed.

The offshore sensitivity studies include a study with the Phase 1 offshore projects in addition to the ECP generation on a SOEF 1.1 Roadmap-based network (Future Grid). Additionally, a sensitivity with a potential partial implementation of renewable hubs is included. A 5 GW offshore generation scenario is also included to align with the SOEF 1.1 offshore assumptions; this is based on a Future Grid network. Further, an interconnector sensitivity study is included with 5GW offshore scenario, which does not contain LirIC and a 2nd France Interconnector.

Three sensitivity studies with pro-rata allocation of constraints are included in the study list. They are based on; the 50% scenario for 2027 and 2029, and on the 3.1 GW offshore scenario.

All studies will include a representative maintenance schedule. A maintenance sensitivity scenario based on the ECP generation, and the Future Grid network is also included (not shown in the figure). The maintenance sensitivity removes the representative maintenance schedule from the model and compares the results to the core ECP study (which includes the representative maintenance schedule).

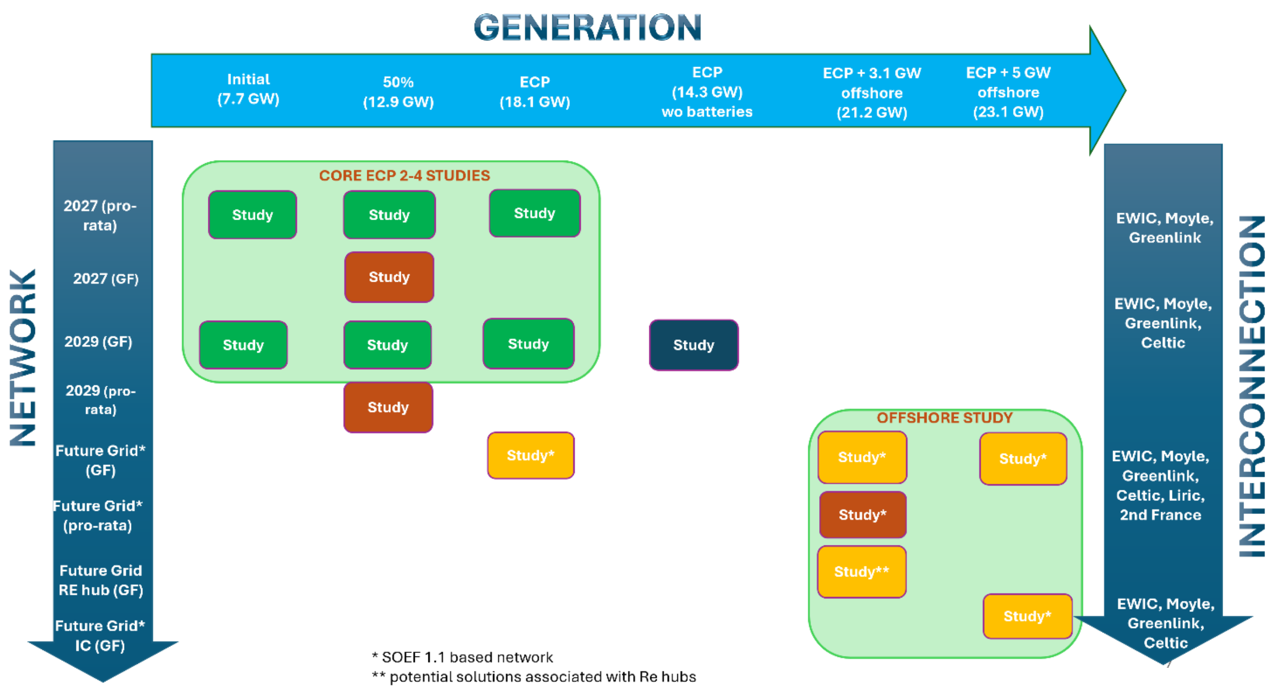

Figure 6-1: ECP-2.4 Study Scenarios.

7 Demand

Demand in each of the study years will be based on the forecasted median scenario due to be published in the National Resource Adequacy Assessment (NRAA) 2025 – 2034.

Further details on demand data will be available to the public following the publication of the NRAA 2025 – 2034.

8 Generation

The conventional generation in the ECP-2.4 studies will be updated with the NRAA 2025 – 2034. The RES capacities given in Table 8-1 below are the sum of all offers (Pre-Gate, Gate 3, Non-GPA, ECP-1, ECP-2.1, ECP-2.2, ECP-2.3 & ECP-2.4) and existing generation. The different study scenarios will have various levels of RES capacities. The total IE installed capacity (of solar, wind and battery) considered in this study is 23.1 GW, which includes 5 GW of offshore wind in Ireland.

The initial study includes currently connected generation and generation expected to connect by the end of 2026.

Table 8-1: Generation Capacities for Ireland (IE).

ECP 2-4 Breakdown of IE Generation Capacity (MW)					
	Initial Study	**50% Study**	**ECP All Study**	**ECP + 3.1 GW offshore**	**ECP + 5 GW offshore**
Battery	896	2,319	3,742	3,742	3,742
Solar	1,539	4,223	6,927	6,927	6,927
Wind	5,212	6,272	7,333	7,333	7,333
Wind Offshore	25	25	25	3,099	5,025
Totals	**7,672**	**12,877**	**18,082**	**21,156**	**23,082**

9 Interconnection

Interconnector capacities for the different scenario years are detailed in Table 3. The hourly capacity modelling of each interconnector is expected to be similar to that used in the ECP-2.3 studies, where the interconnectors between Ireland and GB are given full export capacity for 63% of the time, while the capacity is reduced for the remainder of the time. This assumption is based on the interconnector flow analysis conducted during high wind periods over the course of a year. Recently, the interconnector flows have been more volatile and sufficient data or modelling methodology is not yet available to include in the ECP 2.4 constraint forecast and thus the methodology used in the ECP 2.3 constraints forecast will be continued. This may be updated in the next iteration of constraint analysis if a revised modelling methodology is available.

The second North-South Interconnector is included in the 2029 and Future Grid studies.

In the model, the export capacities of the Celtic and the 2nd France-Ireland interconnectors are derated by 20%. This assumption, consistent with the ECP-2.3 studies for the Celtic interconnector, accounts for times when the market schedules less export than theoretically possible.

Table 9-1: Interconnector Export/Import Capacities.

Interconnector Capacity (MW)	Export/Import	2027	2029	Future Grid
Moyle	Export	400	500	500
	Import	450	500	500
EWIC	Export	500	500	500
	Import	500	500	500
Celtic	Export	-	560	700
	Import	-	700	700
Greenlink	Export	500	500	500
	Import	500	500	500
LirIC	Export	-	-	700
	Import	-	-	700
2nd France-Ireland	Export	-	-	700
	Import	-	-	700

Based on industry feedback and to ensure alignment with the recently published SOEF 1.1 Roadmap, the Future Grid scenario will also include the LirIC and 2nd France-Ireland interconnector.

10 Network Developments

The network development in each network year is obtained and based on the information published within the:

- Network Delivery Portfolio (NDP)[5] for the 2027 and 2029 network horizons.
- Shaping Our Electricity Future Roadmap (SOEF) 1.1[6] for the Future Grid network horizon.

[5] See link: https://www.eirgridgroup.com/customer-and-industry/general-customer-information/network-delivery-portfoli/
[6] See link: https://www.eirgridgroup.com/site-files/library/EirGrid/Shaping-Our-Electricity-Future-Roadmap_Version-1.1_07.23.pdf

11 Operational Constraints

The list of operational constraints applied in the study is provided in Table 11-1. Other system specific operational rules and system constraints are modelled in the studies and will be detailed in the final report. These operational constraints are derived from the Operational Policy Roadmap 2023 - 2030[7], the TSO Imperfections and Constraints Multi-year Plan 2024 – 2028[8], and are aligned to the SOEF 1.1 Roadmap where applicable.

Table 11-1: Operational Constraints.

Active System Wide Constraints		ECP-2.4 Assumptions
Non-Synchronous Generation	There is a requirement to limit the instantaneous penetration of asynchronous generation connected to the All-Island system.	• 2027 – 85% • 2029 – 90% • Future Grid – 95%
Operational Limit for Inertia	There is a requirement to have a minimum level of inertia on the All-Island system.	• 2027 – 23,000 MWs • 2029 – 23,000 MWs • Future Grid – 23,000 MWs
Minimum Sets (IE, NI)	There is a requirement to have a minimum number of conventional generators in Ireland and Northern Ireland.	• 2027 – 7 (4,3) • 2029 – 4 (2,2) • Future Grid – 3 (No jurisdictional split)
Reserve (IE, NI)	The amount of spare capacity in the system to manage any system disturbance.	• POR • SOR • TOR I • TOR II

[7] See link: https://www.eirgridgroup.com/site-files/library/EirGrid/Operational-Policy-Roadmap-2023-to-2030.pdf
[8] See link: https://consult.eirgrid.ie/en/system/files/consultation-outcomes-reports/Imperfections%20and%20Constraints%20Multi-Year-Plan%202024_2028%20FINAL.pdf

12 Modelling Approach to Dispatch Down

The main modelling approach for each of the ECP-2.4 constraint forecast studies is outlined below.

- Renewable generation is modelled at 110 kV stations.
  - A 110 kV station can have wind/solar Priority Dispatch (PD), non-Priority Dispatch (non-PD) or Uncontrolled generation connected to it.
  - Wind and solar hourly profiles are used to calculate RES generation within the model.

- Surplus
  - Applied if there is not enough demand or export capability to accommodate renewable generation.
  - For each hour, non-PD renewable generators are initially dispatched down (applied pro-rata across the All-Island grid). If the surplus situation cannot be resolved by non-PD reduction alone, PD generators are then dispatched down.

- Curtailment
  - Following dispatch down for surplus reasons, curtailment is applied to meet operational limits e.g. SNSP, Inertia, Min. Sets Rules, Generator Must Runs, Operating Reserve.
  - For each hour, the reduction in output due to curtailment is shared equally between PD and Non-PD renewable generators (applied pro-rata across the All-Island grid).

- Constraints
  - Following curtailment, reduction in output due to generation constraint is applied to resolve localised transmission issues.
  - The model dispatches down by individual station to mathematically minimise the total renewable generation dispatch down.
  - For annual energy, the results are then averaged across adjacent 110 kV stations.
  - In the grandfathering based approach, non-PD renewable generators are dispatched down first (applied pro-rata across renewable generators that are effective in managing a particular network limitation). If the constraint situation cannot be resolved by non-PD reduction alone, PD generators are then dispatched down.
  - In the pro-rata constraints approach, all priority and non-priority units are dispatched down on a pro-rata basis at relevant nodes to manage the network constraints.

Definitions:

1. Surplus: Dispatch down applied for energy balancing when generation exceeds demand plus interconnector export. Applied According to Article 12, whereby non-priority dispatch generation is dispatched down ahead of priority dispatch generation.
2. Curtailment: Dispatch down applied to ensure operational limits are met. Applied to all priority dispatch and non-priority dispatch generation pro-rata.
3. Constraints: Dispatch down applied to manage network constraints. Applied depending on the approach (grandfathering or pro-rata).

13 ECP-2.4 Analysis Process

The constraint forecast modelling will use PLEXOS software to model the generation, loads, transmission lines and operational constraints. Three studies will be run sequentially, as shown in the Figure 3, to simulate the dispatch down of RES generation at each stage. A post calculation methodology will be employed in the final stage to process the results according to the assumptions.

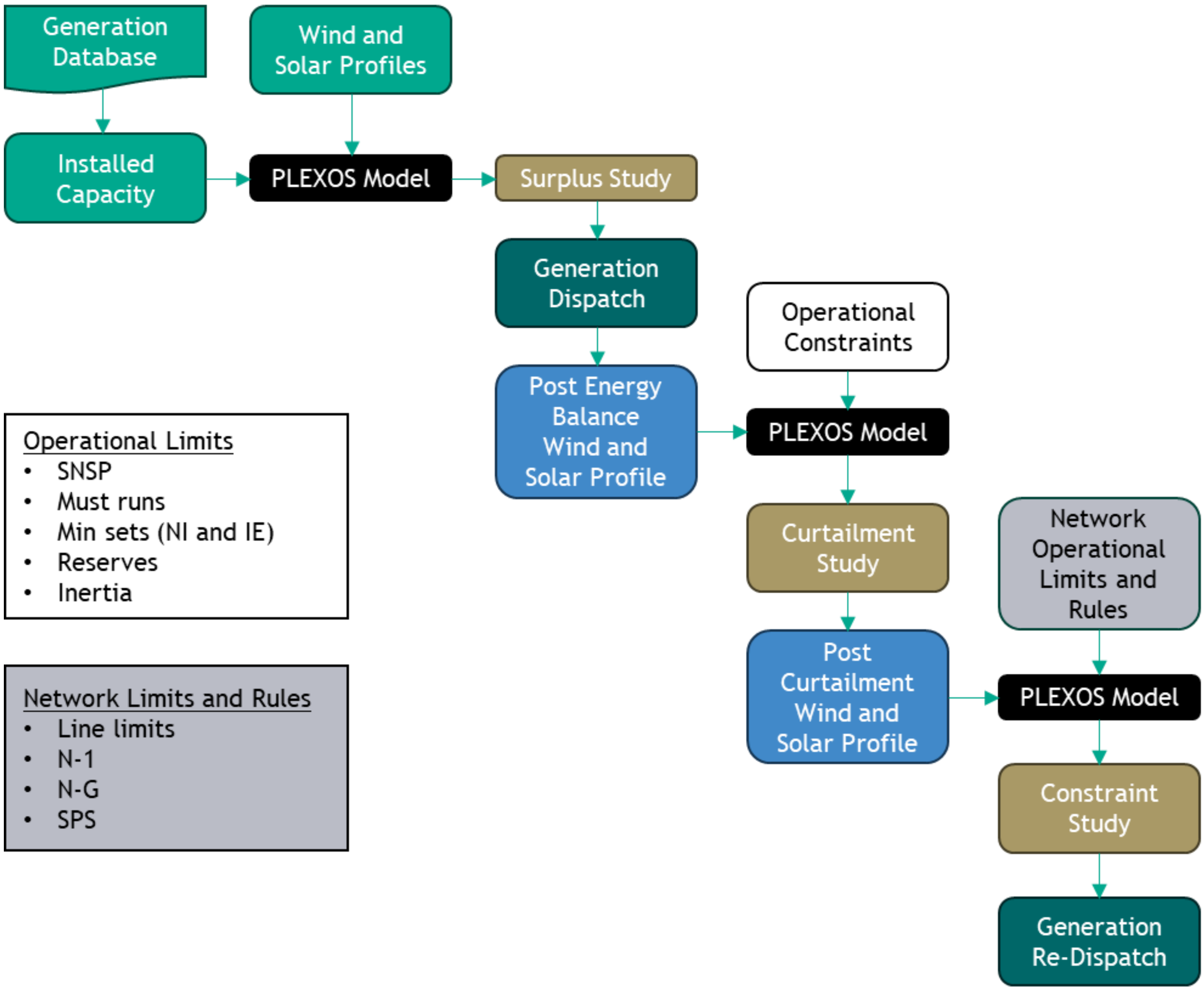

Figure 13-1 ECP-2.4 Analysis Process Flow Chart.

14 Other Assumptions

Wind Profile – The available wind profile for each area is selected by analysing wind profiles from the respective areas for the year 2020. A representative wind profile is then chosen for each specific area.

Solar Profile – The solar profile for the three regions in Ireland – North, Middle and South – will use 2020 data procured from an external vendor.

Offshore Wind Profile – The offshore wind profile has also been procured from an external vendor. This data is specific to the offshore wind location and has been synthesised from 2020 data.

Batteries – Short-duration batteries (batteries with a storage duration of up to 2 hours) are modelled to supply reserve, and any residual short-duration batteries are used for energy arbitrage once the reserve requirements are met. Batteries with a storage duration greater than 2 hours are used within the model for energy arbitrage. The cycling of these batteries is decided by PLEXOS's Battery Optimisation tool, which identifies the optimal charge and discharge times to maximise financial returns. Furthermore, a limit of maximum 2 cycle per day is applied to all batteries.