Enduring Connection Policy (ECP) 2.3 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) 2.3 Constraints Analysis studies, which includes energy balancing (surplus), curtailment and constraints to be applied and analysed.

Table 1: Summary of Assumptions.

Feature	Assumptions
Study period	The study horizons are 2026, 2028 & Future Grid (aligned to the SOEF 1.1 Roadmap).
Demand	The Total Electricity Requirement (TER) demand is from the Generation Capacity Statement (GCS) 2023 – 2032, median demand scenario.
Generation	Total generation capacity to be installed under ECP-2.3 is 3.7 GW (0.7 GW battery, 0.5 GW gas, 2.0 GW solar, 0.5 GW onshore wind). The total IE generation capacity (wind, solar and battery) considered in the study is 20.3 GW including up to 5 GW offshore wind in Ireland.
Network developments	The network developments are based on the Network Delivery Portfolio (NDP) for 2026 & 2028 and the latest version of Shaping Our Electricity Future - (SOEF 1.1 Roadmap), for the Future Grid study.
Security constraints	System Non-Synchronous Penetration, Inertia and Min. set rules are defined for each study year and are based upon the Operational Policy Roadmap 2023-2030[1] and the SOEF 1.1[2] Roadmap.
Core ECP-2.3 scenarios	2026: • Initial, 33%, 66% & 100% of all offers up to and including ECP-2.3. 2028: • Initial, 33%, 66% & 100% of all offers up to and including ECP-2.3.
Sensitivities	2028: • 100% of all offers up to and including ECP-2.3 + 3.1 GW offshore. Future Grid: • 100% of all offers up to and including ECP-2.3. • 100% of all offers up to and including ECP-2.3 + additional maintenance sensitivity. Offshore Future Grid: • 100% of all offers up to and including ECP-2.3 + 3.1 GW of offshore. • 100% of all offers up to and including ECP-2.3 + 5 GW of offshore.

[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

3 Introduction

The Enduring Connection Policy (ECP) 2.3 is the third of four batches 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-2.3 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-2.3 wind and solar projects. On completion of this constraint forecast analysis, EirGrid plans to publish 12 regional constraints reports, which will provide ECP-2.3 developers with information on forecasted dispatch down levels in each region. The expected time for release of these reports is in Q4 2023.

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-2.3 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-2.3 constraint analysis studies.

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-2.3 Constraint Analysis. TDD is the sum of Surplus, Curtailment and Constraints, where:

- Surplus represents dispatch down applied for energy balancing when generation exceeds demand + 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.

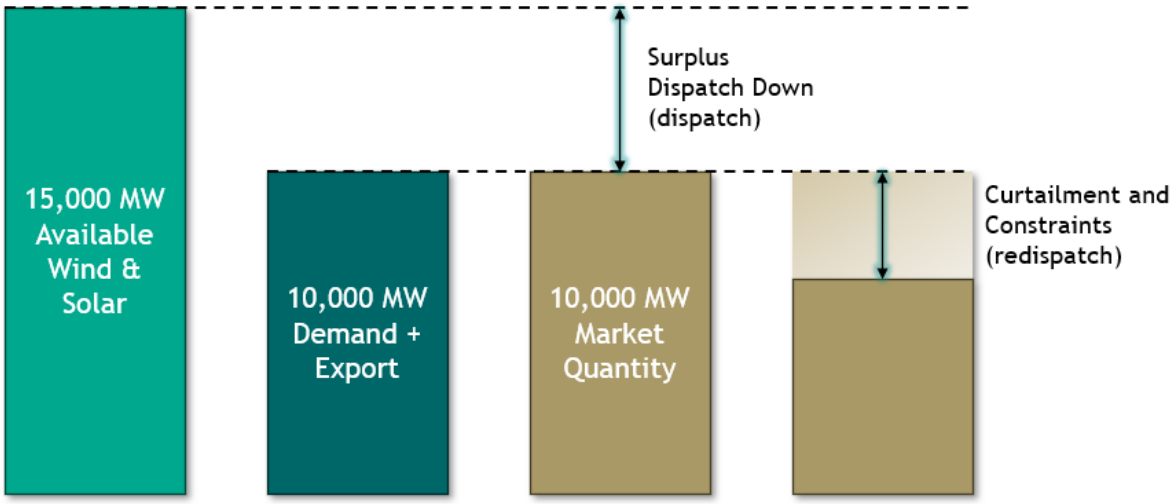

Figure 4-1 Illustration of Surplus, Curtailment and Constraints in the SEM.

5 Article 12 and Article 13

Following the SEMC decision on the 22nd of March 2022[4] (SEM-22-009 Decision Paper on Dispatch, Redispatch and Compensation Pursuant to Regulation EU 2019/943) the detailed design of Articles 12 and 13 implementation 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-2.3 Constraint Analysis that applies a grandfathering[5] approach to resolving Surplus and Constraint conditions. The interpretation of Article 12 and Article 13 that will be modelled in ECP-2.3 is outlined below.

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 reduce output on a pro-rata basis.

This is unchanged from ECP-2.2.

Curtailment

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

This is unchanged from ECP-2.2.

Constraints

Firstly, all non-priority dispatch units contributing to a *Constraint* 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 reduce output on a pro-rata basis. This grandfathering approach is similar to how market Surplus is resolved in ECP modelling.

Proposed change in methodology from ECP-2.2.

[4] See link: https://www.semcommittee.com/sites/semc/files/media-files/SEM-22-009%20Decision%20Paper%20on%20Dispatch%2C%20Redispatch%20and%20Compensation%20Pursuant%20to%20Regulation%20EU%202019943.pdf

[5] '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-2.3 study horizons are 2026 and 2028. 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 2025.

The remainder of the RES generation in the offer pipeline is split into 33% and 66% to give the respective generation scenarios. The ECP generation scenario includes all the RES generation in the pipeline up to and including ECP-2.3 applicants (some of the ECP-2.3 applicants may not have received offers at this point in time but are still considered within these studies).

The offshore sensitivity studies include a study with the Phase 1 offshore projects in addition to the ECP generation on a 2028 network and on a SOEF 1.1 Roadmap-based network (Future Grid). A 5 GW offshore generation scenario is also included to align with the SOEF 1.1 offshore assumptions, this is based upon a Future Grid network.

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. 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).

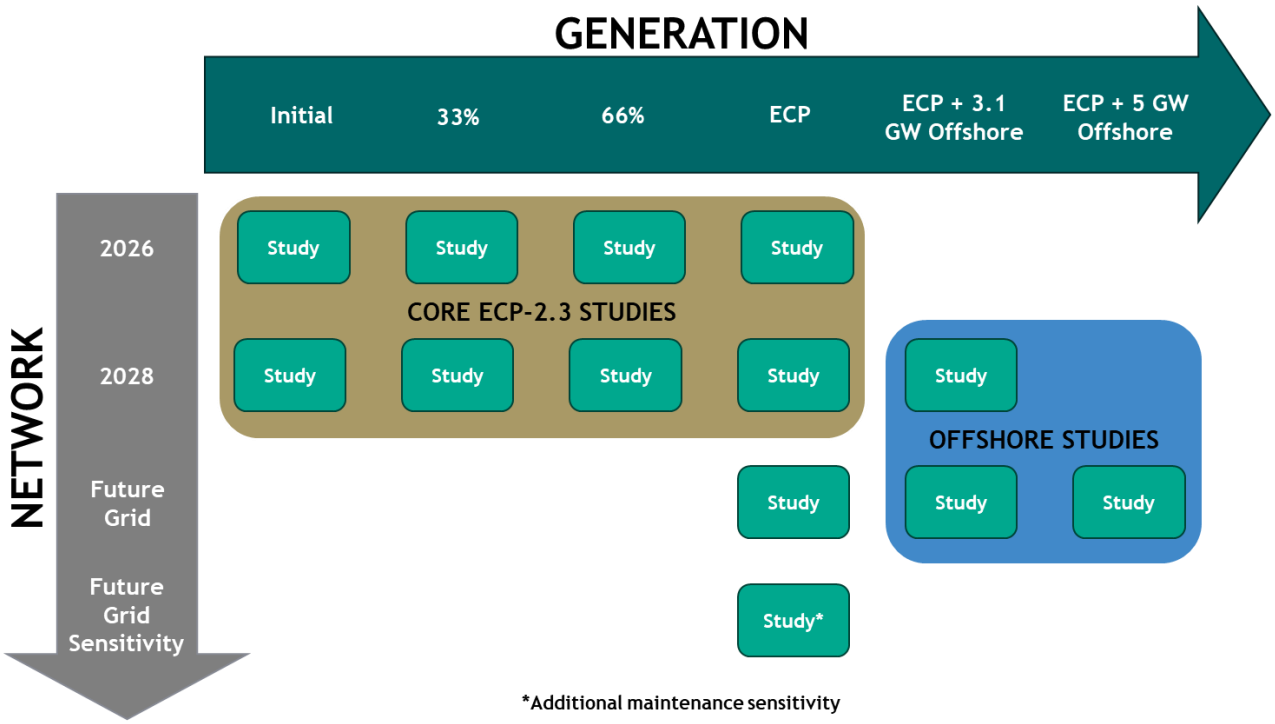

Figure 6-1: ECP-2.3 Study Scenarios.

7 Demand

Demand in each study year is based on the forecasted median scenario due to be published in the Generation Capacity Statement (GCS) 2023 – 2032. The shape of demand is based on the 2022 demand year.

Further details on demand data will be available to the public following the publication of the GCS 2023 – 2032.

8 Generation

The conventional generation in the ECP-2.3 studies will be obtained from the GCS 2023 - 2032. The RES capacities given in Table 2 below are the sum of all offers (Pre-Gate, Gate 3, Non-GPA, ECP-1, ECP-2.1, ECP-2.2 and ECP-2.3) 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 20.3 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 2025.

Table 2: Generation Capacities for Ireland (IE).

ECP-2.3 Breakdown of IE Generation Capacity (MW)						
	Initial Study	**33% Study**	**66% Study**	**ECP All Study**	**ECP + 3.1 GW offshore**	**ECP + 5 GW offshore**
Battery	896	1,358	1,819	2,295	2,295	2,295
Solar	1,563	3,046	4,528	6,056	6,056	6,056
Wind	5,144	5,728	6,312	6,913	6,913	6,913
Wind Offshore	-	-	-	-	3,100	5,000
Totals	**7,604**	**10,132**	**12,660**	**15,264**	**18,364**	**20,264**

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-2.2 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 upon the interconnector flow analysis conducted during high wind periods over the course of a year.

The second North-South Interconnector is included in the 2028 and Future Grid studies.

The export quantities of the Celtic and the 2nd France–Ireland interconnectors are derated by 20%. This assumption is consistent with that taken in ECP-2.2 for the Celtic interconnector. This has been assumed as there will be times when the market will schedule less export than theoretically possible.

Table 3: Interconnector Export/Import Capacities.

Interconnector Capacity (MW)	Export/Import	2026	2028	Future Grid
Moyle	Export	400	400	400
	Import	450	450	450
EWIC	Export	500	500	500
	Import	500	500	500
Celtic	Export	-	560	560
	Import	-	700	700
Greenlink	Export	500	500	500
	Import	500	500	500
LirIC	Export	-	-	700
	Import	-	-	700
2nd France-Ireland	Export	-	-	560
	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 interconnectors.

10 Network Developments

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

- Network Delivery Portfolio (NDP)[6] for the 2026 and 2028 network horizons.
- Shaping Our Electricity Future Roadmap (SOEF) 1.1[7] for the Future Grid network horizon.

[6] See link: https://www.eirgridgroup.com/customer-and-industry/general-customer-information/network-delivery-portfoli/
[7] 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 are given in Table 4. Other system specific operational rules and system constraints are modelled in the studies and will be detailed in the final report. Operational constraints have been taken from the Operational Policy Roadmap 2023 - 2030[8] and aligned to the SOEF 1.1 Roadmap where applicable.

Table 4: Operational Constraints.

Active System Wide Constraints		ECP-2.3 Assumptions
Non-Synchronous Generation	There is a requirement to limit the instantaneous penetration of asynchronous generation connected to the All-Island system.	• 2026 – 85% • 2028 – 90% • Future Grid – 95%
Operational Limit for Inertia	There is a requirement to have a minimum level of inertia on the All-Island system.	• 2026 – 20,000 MWs • 2028 – 20,000 MWs • Future Grid – 20,000 MWs
Minimum Sets (IE, NI)	There is a requirement to have a minimum number of conventional generators in Ireland and Northern Ireland.	• 2026 – 6 • 2028 – 4 • 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

[8] See link: https://www.eirgridgroup.com/site-files/library/EirGrid/Operational-Policy-Roadmap-2023-to-2030.pdf

12 Modelling Approach to Dispatch Down

The main modelling approach for each of the ECP-2.3 constraint forecast studies is given 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 meet renewable generation.
  - For each hour, the non-PD renewable generators are dispatched down initially (applied pro-rata across the All-Island grid), and PD generators are then dispatched down if the surplus situation cannot be resolved by non-PD reduction alone.

- 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, 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 solve 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.
  - Non-PD renewable generators are dispatched down first (applied pro-rata across renewable generators that are effective in managing a particular network limitation), and PD generators are then dispatched down if the constraint situation cannot be resolved by non-PD reduction alone.

Definitions:

1. Surplus: Dispatch down applied for energy balancing when generation exceeds demand + 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 According to Article 12 and 13, whereby non-priority dispatch generation is dispatched down ahead of priority dispatch generation at relevant nodes.

13 ECP-2.3 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 in sequence, as shown in the Figure 3, to simulate the dispatch down of the RES generation at each stage. A post calculation methodology is also employed in the final stage to process the results according to the assumptions.

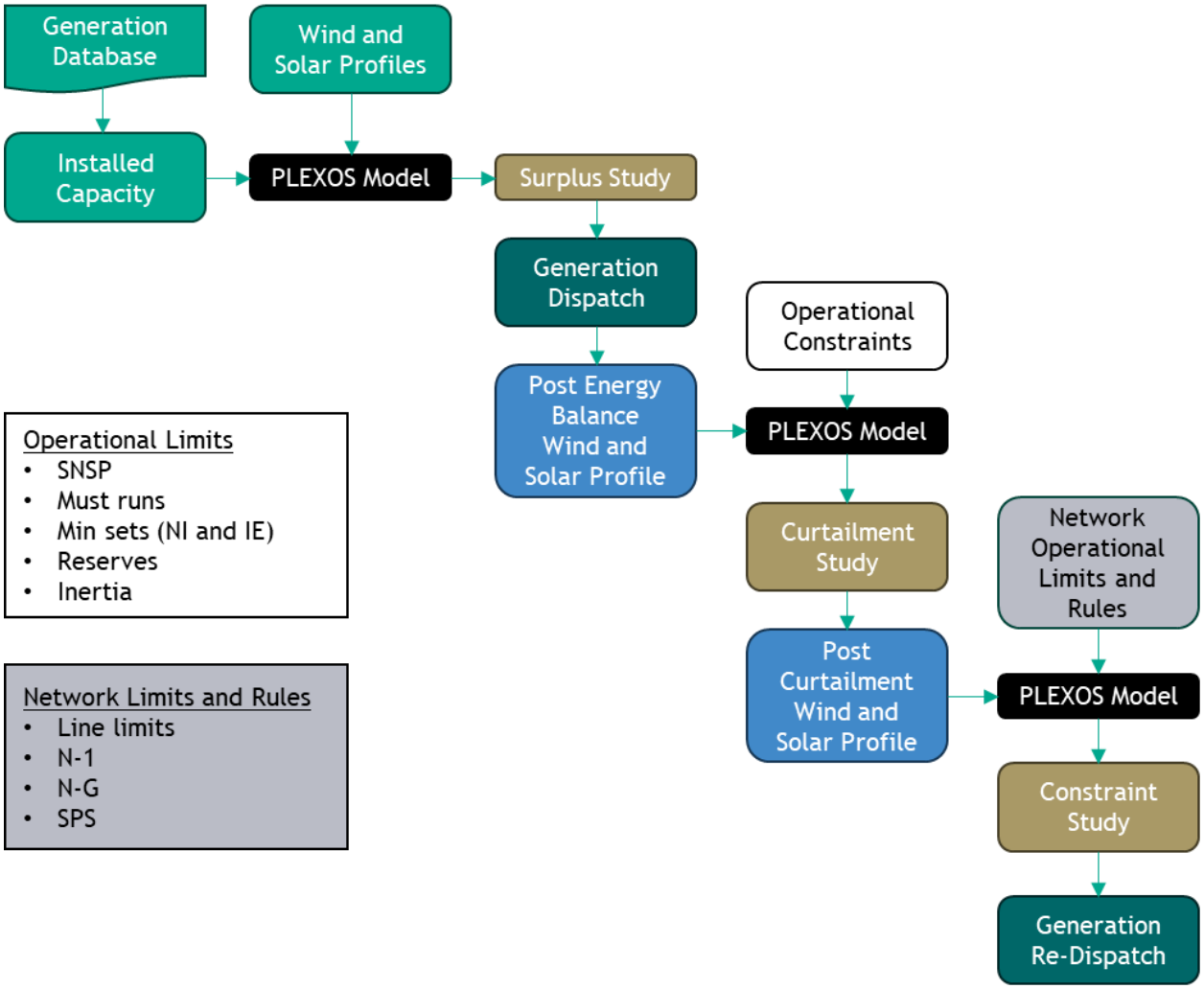

Figure 13-1 ECP-2.3 Analysis Process Flow Chart.

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 wind profile is then selected to represent that specific area.

Solar Profile – The solar profile for the three regions in Ireland – North, Middle and South – will use 2020 data, this data has been 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 residual shorter duration batteries are used for energy arbitrage when 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, where the software identifies the optimal charge and discharge times to maximise financial returns.

15 FAQs

Q1: What assumptions have been made regarding interconnectors? Will data on interconnector flows be provided to industry?

EirGrid Response:

The ECP-2.3 interconnector modelling method will be kept consistent with the previous ECP-2.2 analysis:

Interconnectors can be used to export surplus renewable energy; however, it may not be feasible for the interconnectors to be available to export at full capacity 100% of the time. Historical interconnector flow analysis was used to determine the assumptions to be used in this regard. Based on this analysis the interconnectors to GB (Moyle, EWIC, Greenlink and LirIC) are modelled as follows:

- Available at full capacity for 63% of the time.
- Available at 75% of their full capacity for 14% of the time.
- Available at 50% of their full capacity for 11% of the time.
- Available at 25% of their full capacity for 5% of the time.

EirGrid intends to make the interconnector profiles available to the public following the publication of the ECP-2.3 Constraint Analysis Area Reports.

Q2: What assumptions have been made in relation to solar, onshore and offshore profiles?

EirGrid Response:

The solar profiles, the onshore wind profiles and the offshore wind profiles used in the ECP-2.3 constraint analysis will be published online after the publication of the area reports. Each onshore wind farm on the island is represented by an onshore profile that is recorded from a representative windfarm from the same area. The onshore wind profiles are consistent with that used in the ECP-2.2 constraint analysis and are from the year 2020.

The onshore wind profiles chosen to represent the areas are above average in terms of capacity factors. However, this helps to capture the expected improvement in efficiency of wind turbines in the future.

The offshore wind profiles and the solar profiles to be used for the ECP-2.3 constraint analysis were procured from a forecast vendor.

Q3: What assumptions have been made relating to constraint groups?

EirGrid Response:

Constraint groups are formulated based on the initial results from the study. Hence, the details on the constraint group assumptions are currently not formulated. However, the underlying assumptions on the constraint groups are based on the issues faced by each area to the power flow in the same area and adjacent area. Furthermore, since the results are averaged over a year, certain generalisations are considered based on multiple contingencies observed in the region.

Even though the fundamental principle of constraint groups is the same as that implemented in the NCC, the constraint groups formulated in the ECP study may not be exactly the same as the current ones in NCC due to the temporal difference in the network and the issues observed.

Q4: Given that it is expected that grandfathered constraints may only be implemented towards the end of this decade, will EirGrid provide sensitivity scenarios of pro-rata constraints for the 2026 scenarios in particular?

EirGrid Response:

The process of grandfathering constraints has been implemented across the three study horizons (2026, 2028 and Future Grid). The grandfathering assumption used in ECP-2.3 is included in order to reflect the SEMC decision which was published on the 22nd of March 2022 (SEM-22-009 Decision Paper on Dispatch, Redispatch and Compensation Pursuant to Regulation EU 2019/943). This change has been accommodated based upon industry feedback from the previous ECP-2.2 constraints analysis.

Q 5: It appears that EirGrid intend to include the MARES, LirIC and 2nd France – Ireland interconnectors in the Future Grid/2030 scenario. While it is hoped that the Greenlink and Celtic interconnectors will be delivered before the end of this decade, it is considered very optimistic that a further 3 interconnectors will also be delivered in this timeframe. As a result, it is requested that EirGrid include a sensitivity scenario where the MARES, LirIC and 2nd France – Ireland interconnectors are removed from the Future Grid/2030 scenario.

EirGrid Response:

We have not included MARES in our study assumptions, however, the LirIC and 2nd France-Ireland interconnectors have been included in the Future Grid scenarios. It is not yet clear if time will allow for an additional sensitivity to be included as the TSOs have a requirement to publish the 12 area reports by Q4 2023. The Future Grid scenario is not intended to reflect 2030 specifically, rather it provides a future view in line with the SOEF 1.1 Roadmap.

Q 6: Can you provide a link to the Long Duration Energy Storage call for evidence?

https://consult.eirgrid.ie/en/consultation/call-evidence-market-procurement-options-long-duration-energy-storage-ldes

Q 7: Constraint areas/subgroups in the PLEXOS model are different to NCC areas - can EirGrid communicate this difference? How does EirGrid model this in PLEXOS vs how NCC models dispatch down from a constraints perspective?

a. The details regarding constraint groups used in the NCC can be found here [9]. The methodology used in the constraint forecast analysis is detailed here [10]. The ECP-2.3 constraint analysis subgroup methodology involves the same approach to that used in ECP-2.1 and is given in Figure 15-1. In the review process we use the NCC constraint group philosophy as the basis for identifying the study constraint groups and this is reviewed by SME's in this area. Additionally, this year we intend to use shift factor analysis and LMP (Locational Marginal Pricing) analysis to verify the sensitivity of the constraint groups.
b. The NCC would consider the current network in their assessment, whereas ECP analysis looks into future network horizons where the network may be further reinforced in an area/s.
c. It should be noted that, constraint subgroupings are part of the ECP analysis to ensure balanced allocation of constraints, this is done to overcome the PLEXOS modelling limitations. e.g. PLEXOS is a cost optimisation model and may over constrain particular nodes for a given contingency. Furthermore, the constraint groups are based on the averaged (yearly) dispatched down volumes and not on an hourly basis. The purpose of this study is not to predict future wind dispatch tool sub-groups, rather it aims to enable appropriate allocation of network constraints within the boundaries of the ECP-2.3 studies. Future iterations of the ECP constraint reports will re-assess these constraint groups.

[9] See link: https://www.eirgridgroup.com/site-files/library/EirGrid/Wind-Dispatch-Tool-Constraint-Group-Overview.pdf
[10] See link: https://www.eirgridgroup.com/site-files/library/EirGrid/ECP-2.1-Addendum-Final.pdf

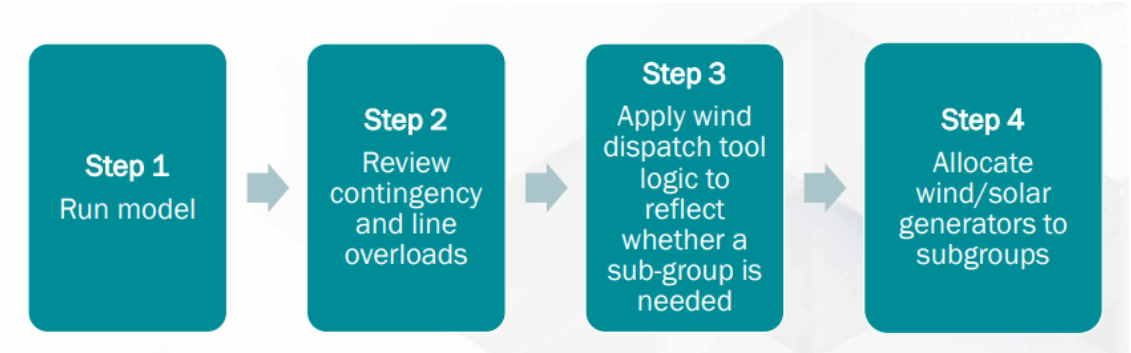

Figure 15-1 ECP Constraint Forecast Subgroup Methodology.

Q 8: Is there a plan to present the ECP-2.3 constraint analysis results? What are your next steps, do you plan to publish all results reports together or area by area?

The next steps in the ECP-2.3 constraint analysis involves the modelling of studies, QA of the model, QA of the results, formulating the constraint groups and then communicating the results (webinars and area reports). Currently, the intention is to publish all area reports at the same time.