TSO Imperfections & Constraints

Multi-year Plan 2023-2027

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1 Introduction

The CRU/20/154[1] Decision Paper contains direction and guidance to EirGrid as the Transmission System Operator (TSO) on incentives and reporting arrangements for the Price Review 5 (PR5) period, 2021-2025. The objective of the Commission for Regulation of Utilities (CRU) PR5 reporting and incentives, as per the Executive Summary of CRU/20/154, is to ensure that network companies are focused on delivering better outcomes for customers; using innovation to deliver services more efficiently; and meeting key national strategic objectives. This paper outlines the TSO imperfections and constraints multi-year plan for 2023-2027.

CRU/20/154 Section 7.12 provides an overview of the objectives of the PR5 Imperfections and Constraints incentive process. Managing system imbalance in real-time is a core role of the TSO. In doing so, the TSO seeks to optimally balance the tools and techniques available to it to ensure that any disconnect between supply and demand is addressed in a cost-effective manner. The incentive has been developed in an effort to address the higher imperfection charges that are naturally expected to arise as a direct consequence of the higher share of renewables envisaged in the Climate Action Plan. In that context, the TSO is tasked with establishing a set of planned measures to curb imperfection costs over the PR5 period, acknowledging that imperfections costs are influenced by many factors that are outside the control of the TSO.

This paper outlines proposed measures to curb imperfection costs during 2023-2027 using a multi-year Balanced Scorecard approach. It contains the targets for 2023, 2024 and 2025 calendar years. The detailed targets for 2026 and 2027 will be confirmed as part of the rolling annual submission.

Progress against the targets set out within previous multi-year plans does not form part of this document. EirGrid TSO will report to CRU on progress as part of the annual outturn performance reporting.

[1] CRU/20/154, PR5 Regulatory Framework, Incentive and Reporting

2 Workstream Overview

In this section, more specific information is provided on how we intend to address constraints that will be progressed as part of the TSO's delivery on this incentive.

In December 2022, EirGrid and SONI published the Operational Policy Roadmap for 2023-2030[2] ('the Roadmap'). The Roadmap outlines the key actions in the operational policy space that will be required to deliver on the climate action targets while continuing to securely operate the electricity system. Included in the roadmap are the Transmission Constraint Groups (TCGs) that the TSOs plan to remove or relieve in 2023-2030, which will further reduce the impact of operational constraints on imperfections costs. The Roadmap also provides milestones on delivery of Reserve Policy changes envisaged out to 2030.

The power system will undergo radical transformation in order to meet 2030 targets. This will include the connection of two new HVDC interconnectors (to Great Britain and France), large offshore wind farms and solar generation connections, hydrogen energy production, demand response and energy storage innovations, coupling to European markets and anticipated market evolvement, major growth in demand driven by electrification of society and large electricity users. The Roadmap aims to plan a pathway for the evolution of operational policy to facilitate these radical transformations while maintaining and enhancing security of supply, reliability and resiliency for customers on the island of Ireland.

Further to engagement with the CRU on the methodology used when estimating annual costs of constraints, the imperfections backcast model is the best model to use as it contains actual data, rather than using forecast models. Forecast models contains assumptions that can and have been subject to significant change. The purpose of a backcast model is to allow the individual breakdown of all components (e.g. constraints) with a good degree of accuracy, whereas the purpose of a forecast model is to provide an approximate total imperfections cost for a future year, rather than determining a best estimate cost of the total imperfections cost of a future year.

No method of estimating the annual imperfections cost associated with constraints is perfect but using the backcast model to determine these costs would be most accurate and would be less open to challenge. It would also better reflect what the TSOs actually achieved, in a measurable way, and repeated in this consistent manner with subsequent backcast models. The TSO will use this methodology to set out the estimated annual cost of constraints as part of the annual outturn performance reporting to the CRU.

2.1 Constraints

The actions proposed for 2023 are operational in nature.

2.1.1 Reserve Policy Review and Changes

Frequency control is the real-time continuous act of balancing generation and demand. To ensure the operational frequency limits are met, in a cost-efficient manner, frequency response and reserves are essential to cope with the inherent variability of demand, generation and changes in HVDC interconnector power transfers, and especially for the loss of large infeed or outfeed.

[2] The Operational Policy Roadmap for 2023-2030

Frequency reserves are critical for the frequency control process across all system states (normal, alert, emergency and restoration) and every effort must be made to maintain adequate levels of reserves and ensure these are replenished as soon as possible.

Traditionally, reserve was provided primarily by conventional generation sources such as gas, coal and pumped hydro. In the coming decade, as conventional generation is replaced by other technologies, the sources of reserve will have to diversify.

EirGrid are developing a platform for reserve auctions as part of the future arrangements for system services, open to all generation and system service providers. The timeline for go live of this platform is c.2025[3]. In advance of this, it's expected that studies and operational trials will be carried out on the full range of technologies that can provide reserve, in line with a new reserve policy document for EirGrid and SONI.

As new technologies displace system services from existing providers, the effect will be observed in maximising renewables and minimising imperfection costs. Once EirGrid has overseen the commissioning of new technologies, comprising the testing necessary for system services and Grid Code compliance prior to energisation, the TSO will be better positioned to design and structure studies to help inform any changes to enduring operational policy.

The process involves an internal review which will be carried out by EirGrid's Operation Policy Review Committee (OPRC); approval via this forum will be required before changes to enduring operational policies can be formalised. It is worth noting that it may be necessary to conduct trials in order to verify and stress-test the proposals put forward to the OPRC.

Actions under this workstream for 2023:

- Update Reserve Policy including Upward & Downward Reserve,
- Undertake System Services Product Review and develop System Services Volume Forecast Methodology.

2.1.2 Transmission Constraint Group Review and Roadmap

The physical network limits on the system impose constraints on the least cost market schedules. These constraints are reflected in the generation schedule by means of TCGs entered in the market. The TCGs that the TSOs plan to remove or relieve in 2023-2030 have been included in the recently publish Operational Policy Roadmap. The removal or easing of TCGs will further reduce the impact of operational constraints on imperfections costs. Under this incentive in 2023, we will conduct an assessment and study of the voltage and thermal based TCGs that are actively constraining the power system.

Actions under this workstream for 2023:

- Conduct a review of thermal based TCGs that are actively constraining the power system and
- Conduct a review of voltage based TCGs that are actively constraining the power system

[3] The exact timeline is dependent on the outcome of the Future Arrangements for System Services detailed design and implementation process.

2.1.3 The Minimum Convectional Units Online Constraint

The Minimum Conventional Units Online (MUON) constraint was introduced to ensure enough large synchronous units are operating to preserve the voltage control capability and maintain a minimum level of system inertia. Currently, the constraint is set to 8 large conventional generation units (from a selected list of generators considered large). A minimum of 5 units in Ireland and 3 in Northern Ireland are required to satisfy this constraint.

One of the aims of the TSOs as outlined in the Operational Policy Roadmap is to relax and eventually remove the minimum conventional unit constraint while ensuring any local constraints are satisfied and linked to specific system scarcities. The aim is to achieve secure system operation with three or less conventional units on the island by 2030. In working towards the removal of this constraint the TSOs in 2023 will begin a trial reduction of the minimum number of conventional sets from 8 to 7 across the island of Ireland. Based on the outcome of the operational trial, a review and decision on if an update to the operational policy is required/not, to potentially move to a minimum of 7 conventional units all-island.

Action under this workstream for 2023:

- Commence operational trial on reducing the minimum number of conventional sets from 8 to 7 across the island.

This trial will assist in maximising renewable generation on the island.

2.1.4 Inertia

The inertia of a power system refers to the ability of the system to oppose changes in system frequency due to the resistance imposed by the large rotating masses of the synchronous machines. The inertial energy has an important role in the frequency control process. The natural resistance of the synchronous machines to a change in speed assists with keeping the power system frequency close to its nominal frequency of 50 Hz. Inertia is a global metric, introduced to ensure enough synchronous generator traits are maintained to a level that guarantees secure and safe system operation.

When reduced levels of synchronous generation are running on a power system, such as on a system with increased levels of RES-E, low system inertia may require greater intervention from the system operator as frequency is more volatile when system inertia is low (which, in turn, occurs more often). Furthermore, insufficient reserve capability means that frequency varies more quickly in the case of power equilibrium incidents and is less manageable; alongside this, an increase in weather-dependent generation and associated potential for forecast errors results in a need to carry ramping capability.

Thus, the TSO is seeking to identify the optimal means of balancing these challenges whilst seeking to reduce the inertia floor, which will “free up” additional capacity for renewable generation on the network.

In 2022 there was an all-island inertia floor of 23 GWs, in 2023 the TSO will begin an inertia floor trial to lower the inertia floor level to 20 GWs. Based on the outcome of this operational trial, a review and decision on if an update to the operational policy is required to potentially move to 20 GWs all-island inertia will be made.

Action under this workstream for 2023:

- Commence an operational trial on 20 GWs all-island inertia floor.

2.1.5 Interconnection Procedures

The Greenlink interconnector is a proposed 500MW subsea link connecting the Single Electricity Market (SEM) and Great Britain (GB) transmission systems. Greenlink will deliver increased security of supply for electricity consumers, by diversifying energy sources and providing additional import and export capacity in both countries. Furthermore, it may enhance the integration of renewables in Ireland as it allows excess renewable generation to be exported. These benefits minimise costs.

In order to take advantage of the opportunities presented by this interconnector, EirGrid will need to work extensively with the project developer and National Grid ESO as part of a comprehensive multi-year programme to design how the interconnector will operate in real-time.

The Celtic Interconnector, a joint project between EirGrid and RTE, the TSO in France, will deliver increased security of supply for electricity consumers, by diversifying energy sources and providing additional import and export capacity. The Celtic Interconnector will enhance the integration of renewables in Ireland by supporting the growth of renewable sources of energy and will have strategic importance by increasing the interconnection capacity between Ireland and mainland Europe. At times of high renewables in Ireland, the interconnector can export renewable generation to Europe.

In the coming years, EirGrid will need to work extensively with RTE as part of a comprehensive multi-year programme to design how the interconnector will operate in real-time.

The benefits of these operational arrangements will lead to increased system security and capability to export excess renewable generation.

Actions under this workstream for 2023:

- Develop TSO specific and joint detailed processes and operating procedures (Interconnector Operating Protocol) for Greenlink
- An ongoing action for 2023-2025 is the development of TSO processes and procedures related to the operation of the Celtic Interconnector

2.2 Imperfection Reporting

In 2021, the TSOs began publishing quarterly imperfections reports on the TSO Responsibilities landing page[4] on the SEMO website rather than in the EirGrid and SONI website libraries, with the aim of improving accessibility to historical imperfection cost reports for stakeholders.

In 2023, to build on this, the TSOs intend to publish a mid-year report, the purpose of which is to analyse the first five months of data of the tariff year, and provide a view of imperfections spend for the last seven months of the tariff year.

The purpose of this off-centre 'review point' is to ensure a gap between this report, and the submission of the annual k-factor submission. This is important as any change to the imperfections charge factor, as a result of the mid-year review, will need to be taken into consideration for the k-factor submission.

[4] Quarterly Imperfections Reports

3 Actions

Workstream	2023	2024	2025	Outcomes for customers and market participants
1. **Reserve Policy Review and Changes**	Update Reserve Policy including Upward & Downward Reserve (Q4) Undertake System Services Product Review and Develop System Services Volume Forecast Methodology (Q4)	Study enhanced use of non-conventional generation and demand resources for reserve provision (Q2) Trial enhanced use of non-conventional generation and demand resources for reserve provision (Q4)	Reserve Policy Update (Q2) Ongoing Monitoring (Q4)	Outcomes for customers are a more diverse range of reserve providers leading to an optimisation of costs while operating the power system securely.
2. **Transmission Constraint Group (TCG) Review and Roadmap**	Conduct a review of thermal based TCGs that are actively constraining the power system (Q2) Conduct a review of voltage based TCGs that are actively	New Network Flexibility Technology Policy (Q2) Annual Review Process & Update of TCGs (Q2)	Weekly TCG Study Process & Updates (Q2) New System Strength Policy (Q2)	As TCGs are assessed more regularly and updated, costs will be minimised while operating a secure system.

Workstream		2023	2024	2025	Outcomes for customers and market participants
		constraining the power system (Q2)			
3. Minimum Conventional Units Online (MUON)		Operational Trial commences (Q1)	Operational Trial Review (Q1)	On-Going Monitoring	As the number of conventional units are reduced, the imperfections costs in turn also reduce.
4. Inertia		Commence operational trial on 20 GWs all-island inertia floor (Q2)	Trial review with Policy Update (Q4)	Action(s) to be confirmed in future multi-year plan	Obtain inertia from sources other than conventional generators, such as from synchronous condensers.
5. Interconnection Procedures	Green link	Develop TSO-specific and joint detailed processes and operating procedures (Interconnector Operating Protocol) for Greenlink.	Finalise TSO-specific and joint detailed processes and operating procedures (Interconnector Operating Protocol) for Greenlink.	N/A	Ensure that the integration of the Greenlink interconnector into the network and the development of the Celtic interconnector effectively facilitates renewable penetration in Ireland and allows for efficient operations which optimises costs.
	Celtic	Develop TSO processes and procedures related to the operation of the Celtic Interconnector (e.g. ramping approach, inter-TSO service provision).			
6. Imperfections Reporting		Prepare a mid-year report to analyse the first 5 months of data of that tariff year and provide a view of imperfections spend for the last 7 months	On-going enhancement and monitoring of reporting	On-going enhancement and monitoring of reporting	Mid-year reporting will provide enhanced information to market participants on the likely end of year imperfections spend and helps reduce k-factor volatility.

Workstream	2023	2024	2025	Outcomes for customers and market participants
	of the tariff year. The mid-year report is to be submitted to the CRU by the end of March. Following this, the TSO submission will then follow RA timelines, which may include time for an industry consultation, RA approval and publication.			

Table 1: Deliverables 2023-2025

4 High Level Plans for 2026-2027

The high-level plans for 2026 and 2027 will be dependent on the outcome of the work undertaken in 2023 to 2025. A number of actions for 2023-2025 include studies and trials, the outcome of these will shape more detailed actions for subsequent years. The Operational Policy Roadmap is expected to be updated in December 2024, actions included in the updated roadmap will be incorporated into future multi-year plans. Therefore, more detail on the proposed plans for future years will be provided as part of the rolling annual submission.

5 Interdependencies & Assumptions

With the increase of future generation and system service providers expected to be connected to the distribution system as the portfolio decentralises and diversifies, EirGrid will need to partner with the Distribution System Operator (DSO) to ensure that the needs of both distribution and transmission systems, and ultimately the needs of consumers are met.

There will be a dependence on the timely execution of new connections (e.g. new technologies such as synchronous condensers). In addition, successful assimilation of these new technologies into the power system, and the proving of their capabilities, in a controlled manner, will influence the ability of the TSO to transform and/or remove existing TCGs.

6 Performance Assessment for 2023

We propose that the incentive should be weighted in accordance with the Table 2 below. In EirGrid's annual outturn performance report to the CRU, we will evidence how we have performed against the plan based on Plexos modelling.

Item	Criteria	Weighting (%)
1	Reserve policy Review and Changes	20%
2	Transmission Constraint Group Review and Roadmap	20%
3	Minimum Conventional Units Online	20%
4	Inertia	20%
5	Interconnection Procedures	10%
6	Imperfections Reporting	10%

Table 2: Performance Assessment 2023

7 Next Steps

Stakeholders are invited to respond outlining their views on the proposed structure of and approach to the proposals in this Imperfections & Constraints multi-year plan.

Interested stakeholders' views are invited until 17:30 on 27 March 2023, responses can be submitted through the EirGrid consultation portal.

Please note that, in the Imperfections and Constraints consultation response document, we will respond to consultation respondents' comments and feedback within the scope of this consultation only. Comments and feedback outside the scope of this consultation will not be included in the consultation response document.

If you do not wish for your consultation response to be published post submission, please mark it as confidential. Please note that all responses will be shared with the CRU in any case.

8 Appendix

8.1 Acronyms

Abbreviation	Definition
CRU	Commission for Regulation of Utilities
DSO	Distribution System Operator
HVDC	High-Voltage Direct Current
MW	Megawatts
MUON	Minimum Conventional Units Online
OPRC	Operation Policy Review Committee
PR5	Price Review 5
SEM	Single Electricity Market
TCG	Transmission Constraint Group
TSO	Transmission System Operator
VTT	Voltage Trajectory Tool