

TSO Imperfections & Constraints

Multi-year Plan 2024-2028

September 2023



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1 Introduction

The CRU/20/154¹ 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 2024-2028.

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 2023 (CAP23). 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 2024-2028 using a multi-year Balanced Scorecard approach. It contains the targets for 2024, 2025 and 2026 calendar years. The detailed targets for 2027 and 2028 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.

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 2023-2030² ('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.

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

² [The Operational Policy Roadmap for 2023-2030](#)

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 evolution, and 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 2024 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 infeeds or outfeeds.

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 the Layered Procurement Framework (LPF) arrangements is c. May 2025 and the Day Ahead System

Services Auction (DASSA) arrangements is c. December 2026³. 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 Operational 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.

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. The TSO's plan to enhance how it assesses TCGs over 2023-2030 is included in the recently published Operational Policy Roadmap. The removal or easing of TCGs will further reduce the impact of operational constraints on imperfections costs. As part of the Operational Policy Roadmap, the TSO is improving the constraint assessment approach including moving to an annual based assessment for each constraint to progress against a plan to remove each of the constraint. Under this incentive in 2024, we will continue to conduct the annual assessments of the voltage and thermal based TCGs that are actively constraining the power system. Further improvements are planned in future years, and the TSO has outlined its intention to move in time to a weekly assessment approach for each constraint.

2.1.3 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

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

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 assessed the potential to carry out an inertia floor trial to lower the inertia floor level to 20 GWs, which was detailed in our previous imperfections and constraints multi-year plan. The outcome of this assessment was that to ensure the stability and security of the All-island system, it is recommended to maintain a minimum inertia floor of 23 GWs. In 2024, the TSO will assess the potential implementation of jurisdictional inertia floors.

2.1.4 The Minimum Conventional 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 will conclude a trial commenced in 2023 operating with a reduction in the minimum number of conventional sets from 8 to 7 across the island of Ireland. Based on the outcome of the operational trial in 2024, a review and decision on if an update to the operational policy is required or not will be made, to potentially move to a minimum of 7 conventional units all-island.

2.2 Imperfection Reporting

In 2021, the TSOs began publishing quarterly imperfections reports on the TSO Responsibilities landing page⁴ 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, the TSOs have published the first 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 TSOs intend to continue this reporting mechanism in 2024 and have included the appropriate action.

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

⁴ [Quarterly Imperfections Reports](#)

charge factor, as a result of the mid-year review, will need to be taken into consideration for the k-factor submission.

In 2024, the TSO will continue to build on and improve the imperfection reporting including the imperfection analysis concluded as part of the annual business process and in completion of the annual outturn report for this incentive.

2.3 Constraints Reporting

The TSO has communicated to CRU the challenge in assessing the volume of system services dispatched by the TSO through non-energy actions (during periods when there were available volumes of system services at FPN that were not dispatched), and the associated cost. Taking account of the CRU proposal to utilise the application of flagging rules as described in the TSOs' 'Methodology for System Operator and Non-Marginal Flagging', the TSO has commenced an assessment of how such a report could be developed. In 2023, the TSO is developing a high level methodology, based on CRU feedback.

In 2024, following engagements with CRU on the methodology, the TSO will develop a reporting test case on a 3 month data set to assess the ability to use energy and non-energy actions from the scheduling and dispatch process to assess the volume of system services dispatched by the TSO through non-energy actions. On review of the constraint reporting test case, a final agreed reporting methodology will be approved and utilised for future TSO constraint reports.

We acknowledge and will continue to engage with the CRU on Article 13/Clean Energy Package and resolving the issues therewithin.

2.4 Additional Considerations & Feedback

Following CRU feedback in the Balance Scorecard for 2023 and additional engagement with the TSO, the TSO reviewed and assessed feedback and additional considerations noted by CRU.

CRU set out the need to be mindful of duplication in our development of the multi-year plans. In that context, the TSO has removed the interconnection procedures from this plan. In relation to inertia, for which CRU referenced a similar duplication, we have retained inertia in both this plan and the Strategic Objectives Incentive while ensuring there is no overlap in their deliveries.

The TSO has outlined an approach to constraint system service reporting and included an overview of the impact of the actions in the table below. The TSO notes the CRU comments regarding the need to prioritise actions which deliver greatest savings; however it is not appropriate to prioritise based on savings alone. Actions required to manage imperfections and constraints must comply with our licensed obligations and market rules while also aligning to developed roadmaps and business strategy. Actions are instead prioritised on technical merit in accordance with licence obligations, operational policies and parameters and their effect on the secure, resilient and reliable operation of the power system, whilst also considering the cost implications of same.

TSO has also given consideration to the inclusion of Climate Action Plan 2023 (CAP23) references.

CAP23: Procurement of reserve services from zero carbon sources (end 2027)

With regard to the procurement of reserve services from zero carbon sources as commented by the CRU, the TSO does not propose to include initiatives relating to this topic this year as the ongoing development and detailed design of the system services future arrangements (SSFA) is underway. The SEMC's SSFA design decision will drive the need for actions to be proposed in future multi-year plans.

CAP23: TSO to measure and reduce carbon emissions from non-market actions

The CRU has suggested that actions to measure and reduce carbon emissions from non-market actions should be included in this iteration of the multi-year plan; this relates to the TSO's dispatch actions. The TSOs operate a centrally dispatched system and the scheduling algorithm optimises across all the operational constraints. It is not possible to split out carbon emissions due to non-energy actions as the scheduling algorithm may have made a dispatch decision based on both energy and non-energy considerations. The TSOs' dispatch actions are governed by the SEMC and outlined in the Balancing Markets Principles Statement in accordance with our licensed obligations and therefore we are not in a position to include any workstreams to address this.

2.5 Stakeholder Feedback

The purpose of stakeholder engagement is to gather feedback concerning the views of our customers and stakeholders, ensuring their involvement in our key decision making process.

Stakeholder feedback and consultation responses received are assessed and utilised to assist in:

- Driving prioritisation, needs and dependencies.
- Process re-engineering and/or development, as needed.

As part of the call for evidence to support the development of the 2024 - 2028 Multi-Year Plan, one consultation response was received and taken into account in this incentive.

Regarding Energia's comments as to the need for an effective management plan for constraint and curtailment of renewable generation, EirGrid considers that its proposals as set out in this Multi-Year Plan, coupled with the other relevant initiatives detailed in EirGrid's other PR5 Multi-Year Plans and in the Joint System Operator Multi-Year Plan equate to such an effective management plan. There is a need to balance generation and demand customer risk with transmission system risk whilst also taking the needs of consumers into account. The respondent outlined the need to include a focus on reducing dispatch down of renewable generators. The TSO plan above takes this into account. Better management of constraints, assessment of regional inertia, the reduction of minimum conventional units online and the review of reserve policy all contribute to supporting more renewable generation on the power system.

Please note that stakeholder feedback has been taken into account solely for matters within the scope of this multi-year plan.

3 Actions

2024 deliverables initiatives for this incentive have been outlined in the table below, noting the expected quarter for delivery of the initiative. For subsequent years more detail on the proposed deliverables will be provided as part of the rolling annual submission.

Workstream	2024	2025	2026	Impact and Outcomes for customers and market participants
1. Reserve Policy Review and Changes	<p>System Services - Layered Procurement Framework (LPF) Product Review & LPF volume methodology (Q1)</p> <p>Undertake Day Ahead System Service Auction (DASSA) Arrangement Product Review (Q2)</p> <p>Undertake DASSA Arrangements volume forecast methodology (Q3)</p>	<p>Study enhanced use of non-conventional generation and demand resources for reserve provision</p> <p>Trial enhanced use of non-conventional generation and demand resources for reserve provision</p>	Review Reserve Policy	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	Annual Review Process & Update of TCGs (Q4)	<p>Weekly TCG Process & Updates</p> <p>New System Strength Policy</p>	Day Ahead TCG Process & Updates	As TCGs are assessed more regularly and updated, costs will be minimised while operating a secure system.
3. Inertia	Assessment of the potential for implementation of	Regional Inertia Policy Implementation	The Operational Policy Roadmap is expected to be updated in December	Obtaining inertia from sources other than conventional generators, such as from Low Carbon Inertia Service

Workstream	2024	2025	2026	Impact and Outcomes for customers and market participants
	jurisdictional inertia floors (Q4)		2024. The output of this update will establish the initiatives which will be incorporated into future multi-year plans.	providers, will support the reduction of costs.
4. Minimum Conventional Units Online (MUON)	Subject to review of trial outcomes, develop and confirm enduring operational policy for operation with a minimum of 7 large synchronous units. (Q2)	Monitor system operation with multiple Low Carbon Inertia Providers and other new/enhanced system services providers, and perform analysis to determine further relaxation and removal of this system constraint	Monitor system operation with multiple Low Carbon Inertia Providers and other new/enhanced system services providers, and perform analysis to determine further relaxation and removal of this system constraint	Operating the future power system with fewer conventional synchronous generators to accommodate large penetrations of variable non-synchronous RES and keeping curtailment levels to a minimum
5. Imperfections Reporting	Quarterly Imperfections Reports Prepare a mid-year report to analyse the first 5 months of data of that tariff year and provide a view of imperfections spend	Quarterly Imperfections Reports Prepare a mid-year report to analyse the first 5 months of data of that tariff year and provide a view of imperfections spend	Quarterly Imperfections Reports Prepare a mid-year report to analyse the first 5 months of data of that tariff year and provide a view of imperfections spend	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	2024	2025	2026	Impact and Outcomes for customers and market participants
	<p>for the last 7 months 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.</p>	<p>for the last 7 months of the tariff year.</p> <p>On-going enhancement and monitoring of reporting</p>	<p>for the last 7 months of the tariff year.</p> <p>On-going enhancement and monitoring of reporting</p>	
<p>6. Constraints reporting</p>	<p>Following development of a high-level methodology to assess the volume of system services dispatched by the TSO through non-energy actions, prepare and develop Constraints reporting test case to share with CRU (Q2)</p>	<p>Prepare Constraint reporting assessment for the previous calendar year for inclusion in outturn reporting</p>	<p>Prepare Constraint reporting assessment for the previous calendar year for inclusion in outturn reporting</p>	<p>Impact and outcome is dependent on the outcome of the conclusion of the work set out for 2024 under this workstream</p>

Workstream	2024	2025	2026	Impact and Outcomes for customers and market participants
	Engage and iterate Constraint reporting approach to agree a methodology for the annual assessment (Q4)			

Table 1: Deliverables 2024-2026

4 High Level Plans for 2027-2028

The high-level plans for 2027 and 2028 will be dependent on the outcome of the work undertaken in 2024 to 2026. A number of actions for 2024-2026 include studies and trials, the outcome of which 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 Low Carbon Inertia Service providers). 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 2024

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	20%
3	Minimum Conventional Units Online	20%
4	Inertia	20%
5	Imperfections Reporting	10%
6	Constraint Reporting	10%

Table 2: Performance Assessment 2024

7 Acronyms

Abbreviation	Definition
CAP23	Climate Action Plan 2023
CRU	Commission for Regulation of Utilities
DASSA	Day Ahead System Service Auction
DSO	Distribution System Operator
FPN	Final Physical Notification
GW	Gigawatts
HVDC	High-Voltage Direct Current
LPF	Layered Procurement Framework
MW	Megawatts
MUON	Minimum Conventional Units Online
OPRC	Operation Policy Review Committee
PR5	Price Review 5
RES-E	Renewable Energy - Electricity
SEM	Single Electricity Market
SEMC	Single Electricity Market Committee
SSFA	System Services Future Arrangements
TCG	Transmission Constraint Group
TSO	Transmission System Operator