Current System Services Volume Requirements Information Paper

July 2024

EirGrid SONI

Glossary of Terms

Acronym	Meaning
APC	Active Power Control
BESS	Battery Energy Storage System
DASSA	Day-Ahead System Services Auction
DPOR	Dynamic Primary Operating Reserve
DRR	Dynamic Reactive Response
DSU	Demand Side Unit. One of more individual demand sites
DS3	Delivering a Secure, Sustainable Electricity System
FASS	Future Arrangements for System Services
FFR	Fast Frequency Response
FPFAPR	Fast Post-Fault Active Power Recovery
LCIS	Low Carbon Inertia Services
LSAT	Look Ahead Security Assessment Tool
LSI	Largest Single Infeed
PIR	Phased Implementation Roadmap
PN	Physical Notification
POR	Primary Operating Reserve
RA	Regulating Authority
RES-E	Renewable Energy Sources - Electricity
RM	Ramping Margin. RM1 (margin at 1 hour), RM3 (margin at 3 hours), RM8 (margin at 8 hours)
RoCoF	Rate of Change of Frequency
RRD	Replacement Reserve Desynchronised
RRS	Replacement Reserve Synchronised
SEM	Single Electricity Market
SIR	Synchronous Inertial Response
SNSP	Synchronous Non-Synchronous Penetration
SOR	Secondary Operating Reserve
SSRP	Steady State Reactive Power
SVC	Static Var Compensator
TCG	Transmission Constraint Group
TOR	Tertiary Operating Reserve
TSO	Transmission System Operator. (SONI for N. Ireland, EirGrid for Ireland)
TSS	Temporal Scarcity Scalar

Table 1: Glossary of terms

Contents

Glossary of Terms 2

Disclaimer & Copyright 4

1. Introduction 5

2. Current System Services 7

2.1. Background and Real-Time Volumes Requirements 7
2.1.1. SIR (Synchronous Inertial Response) 7
2.1.2. FFR (Fast Frequency Response) 7
2.1.3. POR (Primary Operating Reserve) 8
2.1.4. SOR (Secondary Operating Reserve) 8
2.1.5. TOR1 (Tertiary Operating Reserve 1) 8
2.1.6. TOR2 (Tertiary Operating Reserve 2) 8
2.1.7. RRS (Replacement Reserve Synchronised) 9
2.1.8. RRD (Replacement Reserve Desynchronised) 9
2.1.9. RM1, RM3 & RM8 (Ramping Margin) 9
2.1.10. SSRP (Steady State Reactive Power) 9
2.1.11. Summary of System Service Definitions and Requirements 10
2.1.12. Weekly Operational Constraints Update 11
2.1.13. Scalars 13
2.2. Scheduling and Dispatch of System Services 13

3. Illustrative Scenarios 15

3.1. Reserve Services 15
3.1.1. Reserve Scenario 1 16
3.1.2. Reserve Scenario 2 16
3.1.3. Reserve Scenario 3 16
3.2. Ramping Margin 16
3.2.1. Ramping Margin Scenario 1 – High Ramping Margin Requirement 17
3.2.2. Ramping Margin Scenario 2 – Low Ramping Margin Requirement 17
3.3. General Commentary 18

4. Next Steps 20

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1. Introduction

The DS3 (Delivering a Secure, Sustainable Electricity System) System Services arrangements were designed to facilitate new and existing technologies and participants to provide the system services[1] required to maintain a resilient power system with up to 40% renewables underpinned by a 75% System Non-Synchronous Penetration (SNSP) capability. The current DS3 arrangements became operational in 2016 and have been one of the key initiatives for facilitating the delivery of the 40% renewable target by 2020. The next phase of the energy transition requires the implementation of new arrangements which are known as the Future Arrangements for System Services (FASS).

The TSOs have created this Information Paper in line with the FASS Phased Implementation Roadmap[2] (PIR) to provide detail on the current System Service volume requirements and provide context for the FASS Programme. The Day-Ahead System Services Auction (DASSA) Product and Volume Consultations will build on the points highlighted within this paper and set out the TSOs' proposals for development of some System Services.

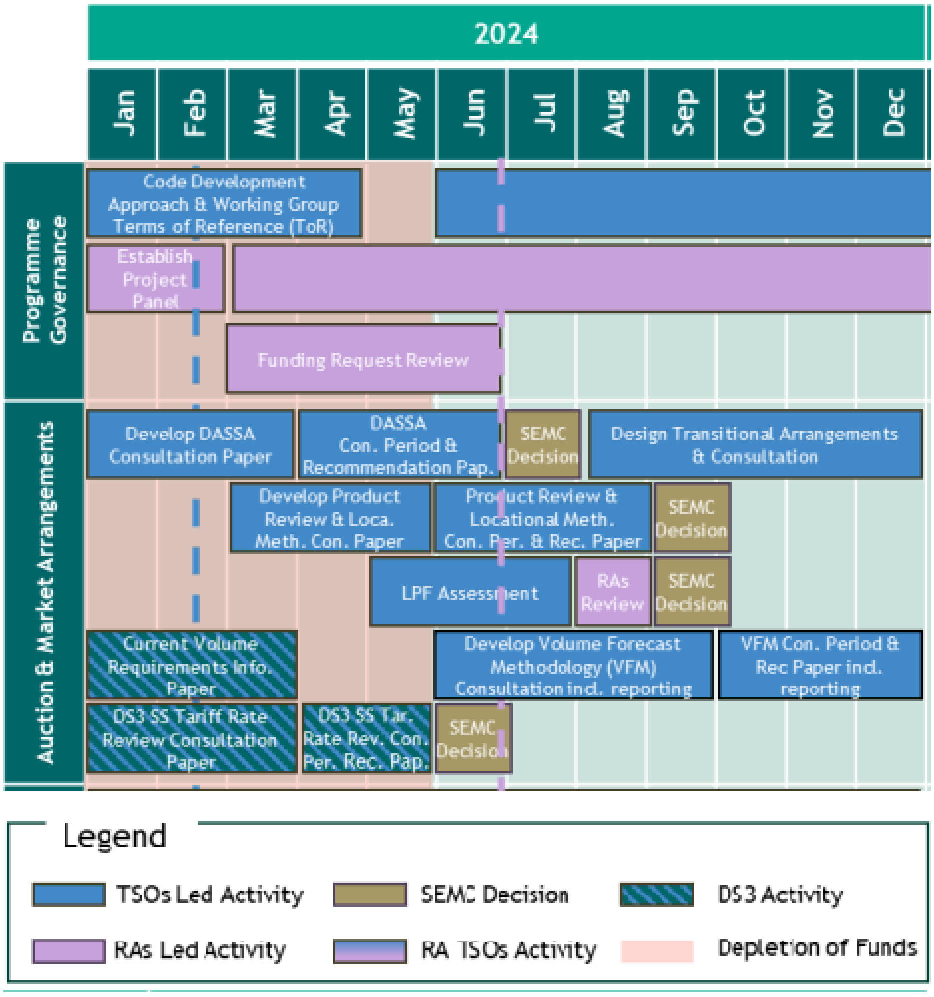

Figure 1 - Phased Implementation Roadmap (extract)

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[1] System services are products, other than energy and capacity, that are required for the continuous, secure operation of the power system.

[2] FASS-TSOs-PIR-March-2024-EirGrid.pdf

Previously, the TSOs have published papers on the topic of future System Service volumes to provide an indication of potential future volumes, including a paper focused on 2030[3]. The forecasting of volumes is a complex process, as Ireland and Northern Ireland is at the leading edge of renewable integration, with limited interconnection and where the real time demand and generation is and will become more weather dependent. Therefore, deep engagement with the Regulatory Authorities and industry participants will be essential in developing the Volumes Forecasting Methodology. The TSOs have also delivered publications on the definitions of, and technical requirements associated with, System Services including publications and agreements that are required by the European Network Codes.

The purpose of this Information Paper is to provide additional detail on the temporal impacts which alter both System Service requirements (e.g. as the Largest Single Infeed (LSI) varies) and the providers who can deliver those requirements (e.g. the market scheduled position of generators and Interconnectors). These temporal impacts, along with high availability of some service providers (e.g. reserves from Battery Energy Storage Systems (BESS)), generally result in periods of overprovision of some System Services. This will be illustrated through the inclusion of actual example scenarios in Section 3 of this Information Paper.

This information is designed to provide additional context on the utilisation and need for System Services and is not intended to provide any commentary on, or analysis of, any payment, procurement, or commercial aspect of the existing System Services arrangements. It does not supersede any of the publications, methodologies or approvals on this subject required by the Network Codes.

Separate to this Information Paper, the TSOs recently consulted on DS3 System Services Tariffs[4]. This Tariffs consultation includes a breakdown of the contracted volume growth in System Services for each service procured, a breakdown of expenditure across technology types and the impact of the Temporal Scarcity Scalar (TSS).

1.1 Terminology Relating to Volumes

When discussing System Service volumes, it is important to distinguish between Capability Volume Requirements, Available Volumes, and Real-Time Volume Requirements.

- Capability Volume Requirements – These are the volumes of System Services which are required within the portfolio to ensure that sufficient real-time volume requirements are available across a year.
- Available Volumes - These are the volumes of System Services that can be provided by a service provider at a given time. This volume varies depending on the state of the service provider, e.g. heat state, connected to the system or not, fully charged or not, dispatch position.
- Real-Time Volume Requirements - These are the volumes of System Services which are required at any point in time to ensure system security is maintained. These requirements vary depending on system conditions.

1.2 Structure of Information Paper

This paper is structured as follows. Section 2 describes the current System Services as well as their technical and volume requirements. Section 3 uses real-world illustrative scenarios to highlight the varying real-time requirements for reserve and ramping services that are seen on the power system. Finally, Section 4 sets out relevant next steps, which includes the undertaking of System Services Product and Volumes reviews.

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[3] System-Services-Indicative-2030-Volumes.pdf (eirgrid.ie)

[4] DS3-System-Services-Tariffs-Consultation-27-March-2024.pdf (eirgrid.ie)

2. Current System Services

2.1. Background and Real-Time Volumes Requirements

A short description of the existing System Services products and their respective requirements are provided below. Collectively, these System Services are critical to the TSOs' capability to operate a secure, resilient and economic all-island power system.

2.1.1. SIR (Synchronous Inertial Response)

The management of frequency disturbance in the instant following the initial frequency deviation requires rapid response from providing units through the provision of inertia. A minimum inertia requirement of 23,000 MW.s ensures that the initial inertial response from providing units is sufficient to maintain a stable frequency. The methodology used to calculate this volume is prepared by SONI and EirGrid in line with Article 39(3)(b) of the System Operations Guideline and approved by both Regulating Authorities (RAs) under Article 6(3)(a) of the same code. The SIR service was introduced to incentivise the provision of inertia at low MW output levels. By lowering the minimum generation levels of conventional generators, increased levels of renewable generation can be accommodated on the all-island power system. Unlike for inertia itself, there is no defined volume requirement for SIR[5].

The minimum inertia requirement is being kept under review by the TSOs. Factors that will influence future requirements include changes to the magnitude of the LSI/LSO and consideration of jurisdictional requirements for inertia. It is also anticipated that future inertia requirements will increasingly be met by Low Carbon Inertia Services (LCIS) which will reduce the dependency on running conventional generation.

2.1.2. FFR (Fast Frequency Response)

For underfrequency events, following the initial frequency disturbance, energy needs to be provided to the system to arrest the frequency deviation. FFR has become more important as the share of renewable generation has increased. A system with higher renewable penetration sees a greater RoCoF (Rate of Change of Frequency) and a lower frequency nadir following a system event. As a result, increased quantities of energy need to be provided in the seconds following the system event which caused the frequency deviation.

The speed at which FFR is provided has a material impact on both RoCoF and frequency nadir / zenith. The quicker the FFR, the lower the RoCoF and the smaller the magnitude of the frequency deviation. To incentivise this faster FFR and to recognise its benefit, the TSOs utilise a product scalar for FFR which incentivises provision as quickly as 150 ms after the dimensioning incident. While providers are currently required to provide their full FFR capability within 2 seconds, if they provide it more quickly, they are financially compensated through this product scalar. There is currently no defined volume requirement for FFR. However, FFR has been a critical enabler of changes to operational policy, such as the increase to 75% SNSP. The volume of FFR on the system is taken into account in real-time operations through the use of the LSAT (Look Ahead Security Assessment) Tool.

The definition and volume requirements for FFR are being examined as part of the 2024 DASSA Product and Volume reviews[6]. Future requirements will be influenced by changes to the LSI/LSO with jurisdictional requirements also considered.

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[5] The definition of SIR uses actual physical parameters such as inertia and minimum generation capabilities as part of a commercial / contractual arrangement to incentivise provision of inertia at low MW output levels. It has been very successful to date in lowering the minimum generation capabilities of conventional generators.

[6] FASS-TSOs-PIR-March-2024-EirGrid.pdf

2.1.3. POR (Primary Operating Reserve)

POR acts to arrest the frequency deviation caused by a system event within 5 seconds of the event occurring and helps to begin the recovery of frequency post event.

The POR real-time volume requirement is set at 75% of the LSI. This 75% value is based on the historic performance characteristics of the power system in which conventional generators provided the majority of POR response. As part of the 2024 DASSA Product and Volume reviews, the utilisation of a 75% requirement will be reviewed[7].

It is necessary to obtain a portion of POR from regulating sources[8](see Table 3 below), known as dynamic POR (DPOR). This ensures that frequency regulation is maintained as a byproduct of the requirement for dynamic POR. This DPOR requirement will likely change in the future as the minimum number of conventional units on the system decreases and the renewable levels increase. Therefore, a separate frequency regulation product may be required. The utilisation of renewable resources for frequency regulation will be an important step towards a fully decarbonised energy system.

Future volume requirements for POR will be influenced by changes to the LSI/LSO and the sources of reserves transitioning from synchronous generation to inverter-based sources such as BESS, RES and HVDC Interconnectors.

2.1.4. SOR (Secondary Operating Reserve)

SOR takes over from POR and maintains the frequency at a stable level following a system event. Providers of SOR are required to achieve their full SOR output 15 seconds after the system event occurs and to maintain this provision until 90 seconds after the system event.

The SOR real-time volume requirement is set at 75% of the LSI. This 75% value is based on the historic performance characteristics of the power system in which conventional generators provided the majority of SOR response. As part of the 2024 DASSA Product and Volume reviews, the utilisation of a 75% requirement will be reviewed[9].

2.1.5. Future volume requirements for SOR will be influenced by changes to the LSI/LSO and the sources of reserves transitioning from synchronous generation to inverter-based sources such as BESS, RES and HVDC Interconnectors. TOR1 (Tertiary Operating Reserve 1)

TOR1 takes over from SOR and begins to restore the frequency level following a system event. Providers of SOR are required to achieve their full TOR1 output 90 seconds after the system event occurs and to maintain this provision until 5 minutes after the system event.

The TOR1 real-time volume requirement is set at 100% of the LSI. As part of the 2024 DASSA Product and Volume reviews, the utilisation of a 100% requirement will be reviewed[10].

2.1.6. TOR2 (Tertiary Operating Reserve 2)

TOR2 takes over from TOR1 and continues to restore the frequency level following a system event. Providers of TOR2 are required to achieve their full TOR2 output 5 minutes after the system event occurs and to maintain this provision until 20 minutes after the system event.

The TOR2 real-time volume requirement is set at 100% of the LSI. As part of the 2024 DASSA Product and Volume reviews, the utilisation of a 100% requirement will be reviewed.

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[7] FASS-TSOs-PIR-March-2024-EirGrid.pdf

[8] Regulating sources (currently conventional units) are those which automatically regulate their output (using narrow frequency deadbands) to maintain the frequency at 50 Hz.

2.1.7. RRS (Replacement Reserve Synchronised)

RRS is provided by units that are synchronised at the time of the system event. RRS and RRD take over from TOR2 and maintain the frequency at a stable level. Providers of RRS are required to achieve their full RRS output 20 minutes after the system event occurs and to maintain this provision until 1 hour after the system event.

The real-time volume requirement for RRS and RRD as a combination are set to 325 MW in Ireland and 125 MW in Northern Ireland. As part of the 2024 DASSA Product and Volume reviews, the utilisation of 325 MW in Ireland and 125 MW in Northern Ireland requirements will be reviewed.

2.1.8. RRD (Replacement Reserve Desynchronised)

RRD is provided by units that are desynchronised at the time of the system event. RRS and RRD take over from TOR2 and maintain the frequency at a stable level. Providers of RRD are required to achieve their full RRD output 20 minutes after the system event occurs and to maintain this provision until 1 hour after the system event.

As noted in Section 2.1.7, the real-time volume requirement for RRS and RRD as a combination are set to 325 MW in Ireland and 125 MW in Northern Ireland. As part of the 2024 DASSA Product and Volume reviews, the utilisation of 325 MW in Ireland and 125 MW in Northern Ireland requirements will be reviewed.

2.1.9. RM1, RM3 & RM8 (Ramping Margin)

The management of variability and uncertainty is critical to a power system with high levels of renewable penetration, mainly wind and solar. At times the all-island generation portfolio is at increased risk of ramping inadequacy over all the necessary timeframes to efficiently and effectively manage variable renewable sources as well as changes in all-island demand and interconnector flows while maintaining system security.

To incentivise the portfolio to provide the necessary margins to securely operate the power system, three new ramping-up products were created over three distinct product time horizons. Ramping Margin is defined as the guaranteed margin that a unit provides to the system operator at a point in time for a specific horizon and duration. The TSOs have implemented horizons of one, three and eight hours with associated durations of two, five and eight hours respectively. The Ramping Margin products are called RM1, RM3 and RM8 respectively.

The RM1, RM3 and RM8 requirements are calculated on a continuous basis by the Ramping Margin Tool in the TSO Control Rooms. The tool is used as part of the wider scheduling process and takes account of future uncertainty on the all-island power system. Parameters such as renewable forecast uncertainty and demand uncertainty are accounted for by the tool to ensure that the generation portfolio maintains ramping adequacy. It is worth mentioning that currently the main drivers of Ramping Margin Requirements are wind ramps and the wind forecast error.

Ramping margin requirements (and potentially the products) may change in the future as more and more RES, both wind and solar, is connected to the all-island power system and the percentage of demand that can be met by these energy sources increases. A power system with 80% RES-E will be much more susceptible to weather uncertainty than a power system operating with 40% RES-E. The TSOs will review the Ramping Margin products as part of the DASSA Product Review next year.

2.1.10. SSRP (Steady State Reactive Power)

SSRP is provided by a range of service providers during steady state operations. SSRP supports a stable voltage and helps to maintain voltage standards during normal operations.

Historically, minimum reactive power capabilities have been defined as mandatory Grid Code requirements for all generation, storage and interconnector resources on the power system. The TSOs dispatch the reactive power capability of these resources to achieve voltage targets. TCGs (Transmission

Constraint Groups) are utilised to ensure that the requisite amount of conventional generation is running in an area to maintain system standards. There are several reasons for TCGs with the most common being the management of thermal overloads and voltage standards. While volume requirements for SSRP are not currently defined, SSRP provides an important incentive to service providers to provide the TSOs with the capabilities required to ensure voltage standards and system security are maintained.

There are various sources of reactive power on the all-island power system. The main sources of reactive power that are available to the TSOs to control voltage levels are:

- Production / Absorption of reactive power by conventional generators.
- Production / Absorption of reactive power by renewable generators (Note: most renewable generators cannot control reactive power production / absorption when not producing real power).
- Production / Absorption of reactive power by synchronous condensers and BESS.
- Production of reactive power by capacitors.
- Absorption of reactive power by reactors.
- Production /Absorption of reactive power by SVCs (Static Var Compensators)
- Production /Absorption of reactive power by Statcoms.
- Absorption of reactive power by circulation of power between voltage levels through transformer tapping.

While capacitors, reactors, SVCs, Statcoms and the use of transformer tapping can all provide voltage support, it is still necessary to have BESS, synchronous condensers and conventional generators on the system supporting voltage levels to keep them within operational limits. When producing real power, renewable generators can support voltage on the system which means that typically high renewable generation periods are not as challenging to manage for the TSOs from a voltage perspective. However, when renewable generators are not producing real power, most cannot produce / absorb reactive power. This means that typically periods of low renewable generation are more difficult to manage[11]. During these periods, synchronous condensers, BESS, and conventional generators are relied on more heavily to provide voltage support.

Future requirements for reactive power capability will need to consider the changing technologies capable of providing this service, the steady-state and dynamic aspects of reactive power response, and the objective to reduce the existing dependency on running conventional thermal generation to provide reactive power support. The TSOs will review the reactive power product as part of a future DASSA Product Review.

2.1.11. Summary of System Service Definitions and Requirements

Table 2 below summarises the current minimum requirements for all currently procured System Services. All System Service Products are approved by the RAs. The volumes are determined by the TSOs in line with the European Network Codes to maintain transmission system security standards, such as keeping frequency and voltage within defined limits[12].

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[11] High renewable generation in local areas can create reactive power challenges for the TSOs. This is due to the high power flows which can be seen on local circuits which increases reactive power requirements. This is typically seen in areas which have low levels of demand but high levels of installed renewable capacity.

[12] Operational Agreements for Ireland and Northern Ireland Synchronous Area

Service Name[13]	Abbreviation	Units of Payment	All-Island Real-Time Requirement[14]
Synchronous Inertial Response	SIR	MWs^2h	N/A[15]
Fast Frequency Response	FFR	MWh	N/A[16]
Primary Operating Reserve	POR	MWh	75% of LSI
Secondary Operating Reserve	SOR	MWh	75% of LSI
Tertiary Operating Reserve 1	TOR1	MWh	100% of LSI
Tertiary Operating Reserve 2	TOR2	MWh	100% of LSI
Replacement Reserve Synchronised	RRS	MWh	325 MW IE 125 MW NI
Replacement Reserve Desynchronised	RRD	MWh	
Ramping Margin 1	RM1	MWh	Calculated based on forecast uncertainty
Ramping Margin 3	RM3	MWh	Calculated based on forecast uncertainty
Ramping Margin 8	RM8	MWh	Calculated based on forecast uncertainty
Steady State Reactive Power	SSRP	MVArh	N/A

Table 2: Summary of Currently Procured System Services

Current System Service requirements for reserves are focused on underfrequency events and, as a result, only positive reserves are procured. Outside of the System Services arrangements, the TSOs employ mechanisms to ensure effective management of over-frequency events. These include, but are not limited to, wind farm APC (Active Power Control), holding foot-room on conventional generators and over-frequency generation tripping.

2.1.12. Weekly Operational Constraints Update

On a weekly basis, the TSOs publish the Weekly Operational Constraints update on the SEM-O website[17] which details system constraints and operating reserve requirements. The TSOs actively review and respond to changing requirements which are set out in this weekly document. For example, a series of outages in a region may limit generation in a particular region during a given week. TCGs which are described in the Weekly Operational Constraints Update detail these limitations.

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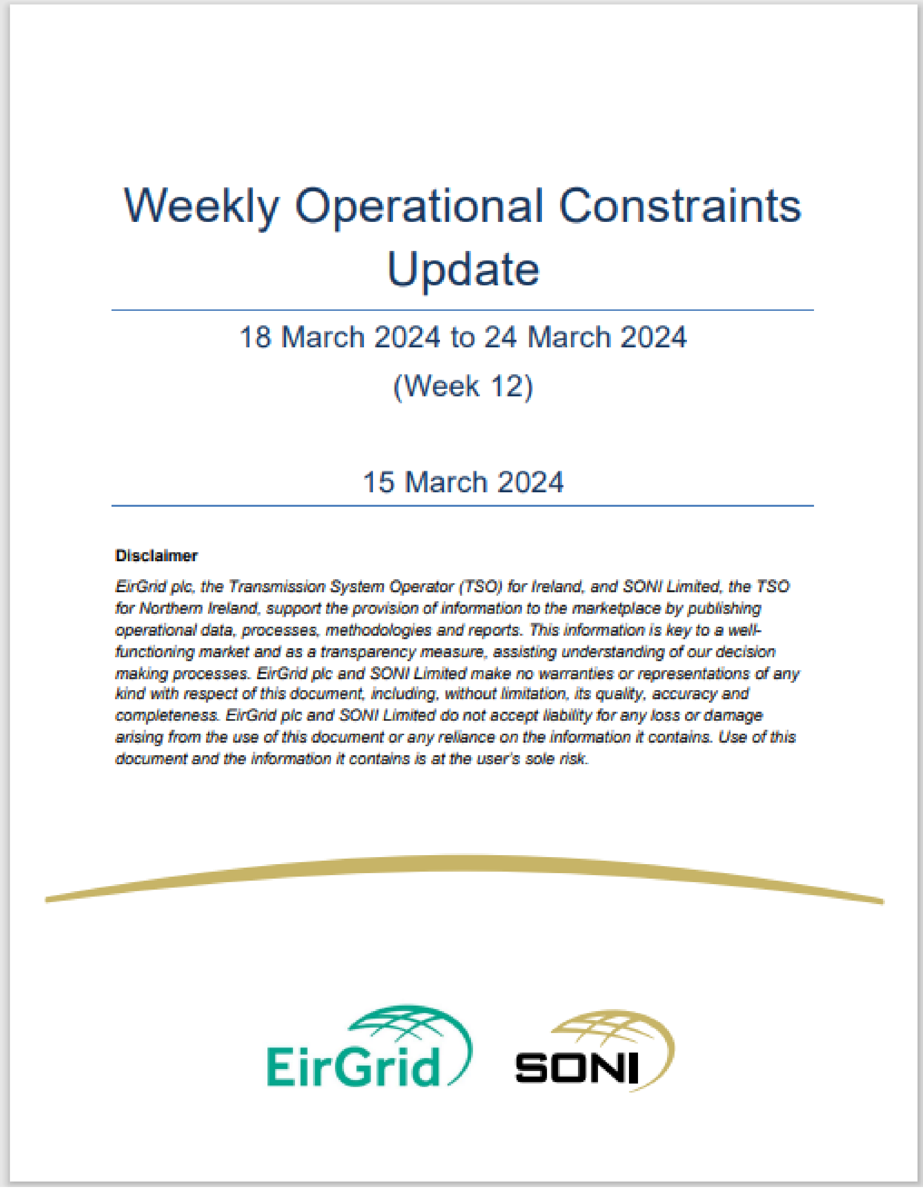
[13] The two services that are currently not contracted (Fast Post-Fault Active Power Recovery - FPFAPR and Dynamic Reactive Response - DRR) are not discussed in this Information Paper as the focus of this paper is on current requirements.

14 The System Service Products and their respective requirements are currently under review by the TSOs as part of the FASS Programme.

[15] There is no minimum requirement for SIR. Inertia on the all-island system is maintained at 23,000 MW.s

[16] There is currently no set minimum requirement for FFR. FFR has been critical to increasing levels of renewable penetration on the all-island power system and a minimum requirement for FFR is being examined as part of the FASS Programme.

[17] General Publications (sem-o.com)



Weekly Operational Constraints Update

18 March 2024 to 24 March 2024
(Week 12)

15 March 2024

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EirGrid plc, the Transmission System Operator (TSO) for Ireland, and SONI Limited, the TSO for Northern Ireland, support the provision of information to the marketplace by publishing operational data, processes, methodologies and reports. This information is key to a well-functioning market and as a transparency measure, assisting understanding of our decision making processes. EirGrid plc and SONI Limited make no warranties or representations of any kind with respect of this document, including, without limitation, its quality, accuracy and completeness. EirGrid plc and SONI Limited do not accept liability for any loss or damage arising from the use of this document or any reliance on the information it contains. Use of this document and the information it contains is at the user's sole risk.

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Figure 2: Weekly Operational Constraints Document

Table 3 is taken from the Weekly Operational Constraints update and sets out operational reserve requirements. Table 3 is not exhaustive and does not cover all operational constraints. Other aspects of operational constraints are outlined in the Weekly Operational Constraints update.

Category	*All Island Requirement % Largest Single Infeed*	Ireland Minimum (MW) Day / Night	Northern Ireland Minimum (MW)
POR	75 %	155 / 150	50
Regulating Sources POR		75 / 75	50
SOR	75 %	155 / 150	50
Regulating Sources SOR		75 / 75	50
TOR1	100 %	155 / 150	50
Regulating Sources TOR1		87 / 87	50
TOR2	100 %	155 /150	50
Regulating Sources TOR2		87 / 87	50

Table 3: Operational Reserve Requirements

The POR, SOR and TOR requirements are highlighted in the above table which is produced on a weekly basis. In addition to the high-level all-island requirements, the TSOs also provide the jurisdictional minimums for each jurisdiction along with additional detail and explanation. As mentioned above, these reserve requirements will be reviewed in 2024 as part of DASSA Product and Volume reviews.

As mentioned in Section 2.1.3 on POR, there is a requirement for a portion of POR to come from Regulating Sources (i.e. DPOR). These Regulating Sources of reserve are all currently synchronous generators that operate with narrow frequency deadbands. The requirements for Regulating Sources of reserve are shown in the above table. It should be noted that the requirements for Regulating Sources of reserve can be binding, especially as the number of synchronous generating units is reduced to facilitate more renewables.

2.1.13. Scalars

Scalars are applied to system service payments to incentivise flexibility, reliability, value for money and performance as per SEM-14-108.

An example of a Scalar is the Product Scalar, which incentivises faster response times for FFR and the dynamic provision of other Reserve Services. Faster response above the minimum requirement, for services such as FFR, is of benefit to the all-island power system and providers are rewarded accordingly. Scalars have been an important aspect of System Services and their future utilisation is currently under review as part of the FASS Programme. For example, the Product Scalar which incentivises the faster response of FFR has been essential to increasing the penetration of renewables on the all-island power system. To ensure faster response of FFR is delivered in the future, the TSOs are currently examining the FFR product definition and volume requirements as part of the DASSA Product and Volume reviews.

2.2. Scheduling and Dispatch of System Services

The Scheduling and Dispatch of System Services is part of the wider Scheduling and Dispatch of resources on the all-island power system. PNs (Physical Notifications) are submitted by market participants based on their market positions. These PNs are input into the scheduling optimisation which accounts for a variety of different constraints. Among these constraints are those that drive the scheduling of the required volumes of System Services, some explicitly (e.g. inertia, reserve and ramping requirements), some implicitly (e.g. reactive power).

While the system must have enough generation to meet demand at all times, other system security requirements must also be satisfied, one of which is the reserve requirements. At all times, there must be sufficient reserve on the system to account for the constantly changing demand and to cover the potential of a loss of generation or interconnection. To facilitate this, it is necessary to have units in a position from which they can respond to provide reserve services. For example, a conventional generator at maximum output cannot provide any upward reserve as it cannot increase its generation beyond this maximum value. To provide reserve, the generator would need to be positioned below its maximum value. It should be noted that this is a simplified example, and the optimisation takes account of generation characteristics such as reserve curves which are provided to the TSOs[18]. The scheduling optimisation ensures the most economic provision of both generation and reserve in combination which can result in units being moved away from their PN positions. Other considerations, such as transmission constraint groups (TCGs) are also accounted for in the scheduling optimisation.

The reserve requirements specified in section 2 are an input to the scheduling process. As an example, the scheduling optimisation will schedule units to ensure that 375 MW of POR is available in a period with a 500 MW LSI (POR requirement = 75% of LSI). This may or may not be a binding constraint in the optimisation as the POR contribution of each unit is a function of its scheduled position. In recent years, and largely due to the significant reserve contribution from BESS, reserve requirements have generally not been binding in the scheduling optimisation as sufficient reserves are inherently provided in the underlying schedule. This is also reflected in the real-time available volumes of reserves (see illustrative scenarios in section 3) which are calculated based on the real-time operating position of each reserve provider.

While there are normally sufficient ‘positive’ reserve services available within the scheduling and dispatch processes, there are often more binding requirements related to the provision of ‘Regulating Sources’ of reserves (which are currently only deemed available from synchronous generating units) and ‘Negative Reserve’ (which is provided by foot-room on synchronous generators). These are not currently defined System Service products but are required to ensure secure power system operation. Requirements for these other reserve capabilities are defined in our published Weekly Operational Constraints Update and are reflected in the scheduling optimisation.

The TSOs are currently conducting a Scheduling and Dispatch Programme which is further developing our scheduling and dispatch capabilities for System Services. At present, the reserve services are scheduled and dispatched to maintain the real-time volume requirements. However, there are some challenges at present, for example, it is not currently possible to schedule wind reserves through the TSOs’ systems; this challenge is being addressed as part of Tranche 2 within the Scheduling and Dispatch Programme.

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[18] Balancing Market Principles Statement

3. Illustrative Scenarios

3.1. Reserve Services

The purpose of this section is to present a number of actual real-time operational scenarios and to discuss reserve service volume requirements and availabilities in each case and more generally. Not all reserve services will be discussed in these examples. POR in particular is focused on to illustrate temporal impacts on reserve requirements and provision.

It is important to note that capability volumes and available volumes differ. This can occur for a variety of reasons, one of the main reasons being the current state / position of the providing units at a specific point in time. It is important to note that real-time volume requirements are constantly changing based on system conditions, for example the size of the LSI for the reserve services.

System Overview (All values are All-Island)	Scenario 1 26/03/24 17:45	Scenario 2 27/03/24 20:55	Scenario 3 30/03/2024 13:10
Demand	5889 MW	5592 MW	4595 MW
Conventional Gen.	3667 MW	3028 MW	1365 MW
Wind & Solar	1488 MW	1584 MW	3316 MW
SNSP	37 %	43 %	71 %
Inertia	37965 MW.s	34342 MW.s	29873 MW.s
Interconnectors (+=import)	734 MW	980 MW	-38 MW
Largest Single Infeed	434 MW	502 MW	257 MW
Calculated Real-Time Available Volumes of POR and System Requirement (75% of LSI)			
Conventional Gen.	238 MW	145 MW	129 MW
Interconnectors	94 MW	0 MW	144 MW
BESS	364 MW	364 MW	364 MW
DSUs	65 MW	65 MW	65 MW
Wind & Solar	0 MW	0 MW	0 MW
Total POR Availability	**761 MW**	**574 MW**	**703 MW**
POR Requirement	**325 MW**	**377 MW**	**193 MW**
Calculated Real-Time Total Available Volumes of SOR and System Requirement (75% of LSI)			
Total SOR Availability	**857 MW**	**647 MW**	**800 MW**
SOR Requirement	**325 MW**	**377 MW**	**193 MW**
Calculated Real-Time Total Available Volumes of TOR1 and System Requirement (100% of LSI)			
Total TOR1 Availability	**953 MW**	**829 MW**	**1022 MW**
TOR1 Requirement	**434 MW**	**502 MW**	**257 MW**
Calculated Real-Time Total Available Volumes of TOR2 and System Requirement (100% of LSI)			
Total TOR2 Availability	**1043 MW**	**947 MW**	**1163 MW**
TOR2 Requirement	**434 MW**	**502 MW**	**257 MW**

Table 4: Illustrative Scenarios

3.1.1. Reserve Scenario 1

In this sample scenario, a high demand and high conventional generation period is presented.

Although there was high conventional generation in this scenario (3667 MW), the majority of conventional units were not at or close to their maximum output. As a result, most of these units were available to provide reserve services (238 MW POR).

BESS, Interconnectors and DSUs were also available to provide significant levels of reserve.

No operational metric was close to binding in this scenario. However, as a knock-on effect of the underlying generation and interconnection schedule at this time there was an excess of the reserve services available relative to requirements.

3.1.2. Reserve Scenario 2

In this sample scenario, there is reduced POR availability, and increased POR requirement, relative to Scenario 1.

Interconnectors were at maximum import levels resulting in a LSI of 502 MW which set a high real-time POR volume requirement. The interconnectors importing at such high levels meant that they were not capable of contributing to POR provision. This example highlights the impact of a changing LSI and also the circumstances under which certain resources would not be available for POR provision (in this case Interconnectors).

The contribution of conventional generation to reserve requirements is also significantly reduced compared to Scenario 1. This is a function of the revised generation commitment and dispatch position in this case.

3.1.3. Reserve Scenario 3

In this sample scenario, a high SNSP period is presented.

There is a high level of renewable generation and a low LSI with a high level of reserve availability relative to reserve requirements.

There are two primary reasons for this; firstly, the interconnector export results in the provision of 144 MW of POR availability on the interconnectors which drives up overall POR availability when compared to Scenarios 1 and 2. Secondly, the LSI of 257 MW is lower than that seen in Scenarios 1 and 2 which decreases the real-time POR volume requirement.

However, even though there is a high level of reserve services available, the availability of Regulating Sources of reserve (i.e. DPOR), which is provided by conventional generation, is close to the lower limit (129 MW available with a requirement of 125 MW, see Table 3) due to the low level of conventional generation on the system.

3.2. Ramping Margin

As discussed in Section 2.1.9 the need for Ramping Margin is increasing with the increased penetration of renewable generation on the all-island power system. There are two main reasons for this. Firstly, the increased levels of renewable generation means that generation production can ramp up / down quickly driving the need for ramping of other market participants to balance this. Secondly, uncertainty of future forecasts drives the need for ramping margin to be held in reserve.

Two illustrative examples are utilised to detail the changing Ramping Margin Requirements that can be seen on the all-island power system. These examples are purposely designed for ease of explanation and understanding and do not reflect all variables which impact Ramping Margin Requirements.

3.2.1. Ramping Margin Scenario 1 - High Ramping Margin Requirement

The main driver of uncertainty is renewable generation forecasts which can be impacted by magnitude and temporal forecast errors. This means that during high renewable generation periods, in particular those which have a high forecast uncertainty, there is an increased Ramping Margin Requirement on the all-island power system. In addition, it is likely that during these periods of high renewable generation there are less conventional generators operating on the system. The increased Ramping Margin Requirement combined with the decreased level of traditional Ramping Margin availability from conventional units drives an increased need for Ramping Margin provision from other sources. As renewable penetration continues to increase and the minimum number of conventional generators on the all-island power system decreases the Ramping Margin Requirement is likely to increase further.

The below actual snapshot of a 3-day period shows a high Ramping Margin 1 (RM1) Requirement scenario. High renewable generation and renewable forecast uncertainty are the primary drivers of the high and variable Ramping Margin Requirement. The Ramping Margin Available also changes over time primarily due to the changing number of conventional units operating on the all-island power system. As units come online increased Ramping Margin is available from these conventional sources.

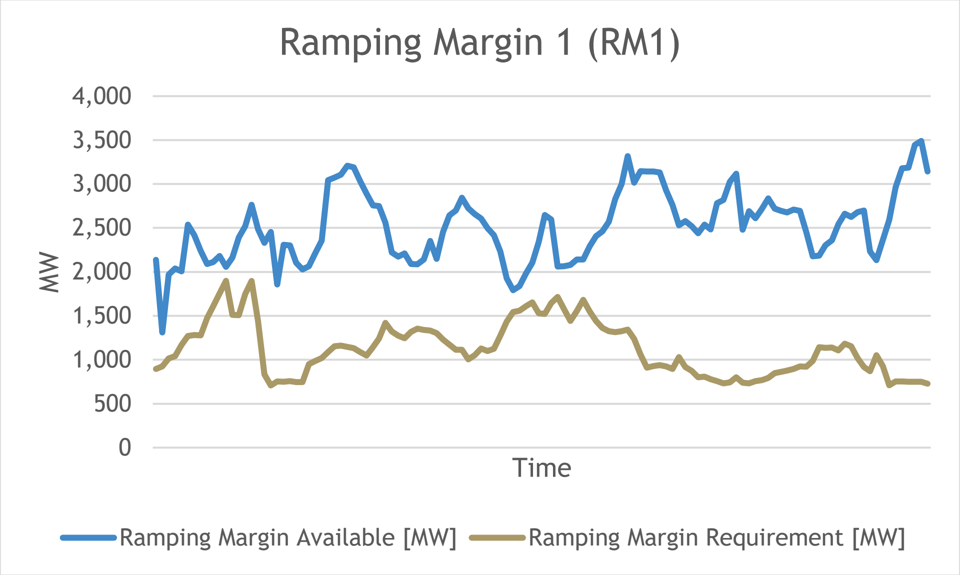

Figure 3: High Ramping Margin Requirement

3.2.2. Ramping Margin Scenario 2 - Low Ramping Margin Requirement

During periods of low renewable generation which have low forecast uncertainty, it is likely that the Ramping Margin Requirement will be lower. It is also likely that a large number of conventional generators will be operating on the system. This will typically drive an excess of Ramping Margin availability in these periods due to the lower Ramping Margin Requirement.

The below actual snapshot of a 3-day period shows a low Ramping Margin Requirement scenario. Low renewable generation on the system is the primary driver of the low and relatively consistent Ramping Margin Requirement. Despite this, it is interesting to see that for a short period of time the Ramping Margin Requirement exceeds the available Ramping Margin. In fact, the Ramping Margin Available changes significantly over time primarily due to the changing number of conventional units operating on the all-island power system.

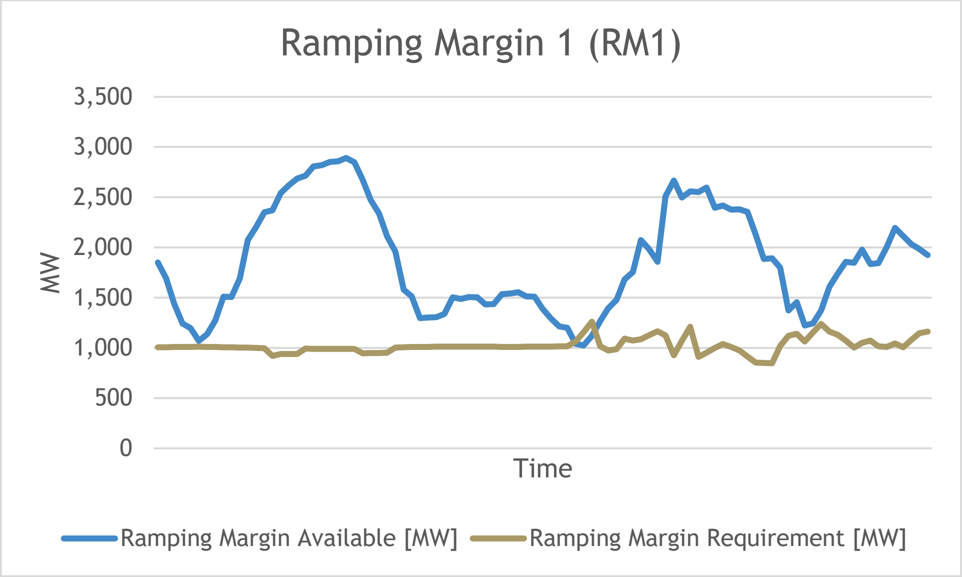

Figure 4: Low Ramping Margin Requirement

3.3. General Commentary

As shown in the illustrative scenarios, both the availability of System Services and the requirements for System Services can vary significantly as system conditions change. The changes in the available volume of System Services from each provider means that capability volume requirements of the entire portfolio must exceed the real-time requirements to account for periods when certain providers are unavailable. In addition, changing system conditions, such as the magnitude of the LSI for the reserve services and the forecast uncertainty for the ramping services, alter the real-time requirements which means that there will be lower volume requirements at certain times. These factors result in periods where excess levels of reserve services are available.

With regard to the reserve services, the Available Volume of reserve provided by conventional generators and interconnectors is determined dynamically based on the real-time outputs, availabilities and reserve capability curves of these unit types. However, the reserve contribution of (short duration) BESS, DSUs, Wind and Solar that are used in real-time operations are not determined in this way and different assumptions are made regarding the reserve contributions of these unit types:

- BESS contribution is set to 50 % of real-time available BESS capacity.
- DSU contribution is set to 65 MW.
- Wind and Solar contribution not accounted for in real-time.

Note that these assumptions apply in the real-time operation of the power system and reflect the capability of scheduling and dispatch tools to account for reserve services from these unit types. During actual system events, when reserves are triggered, these unit types may contribute additional reserves which assists in the secure operation of the power system. For example, the full capability level of BESS is considered and modelled in the LSAT tool. Different availability assumptions are made in System Services Settlement systems which account for contracted System Service capabilities and expected responses. The TSOs' Scheduling and Dispatch Programme is enhancing the capability of the TSOs' scheduling and dispatch tools to better account for the actual availability of reserves from BESS, Wind and Solar.

It should also be noted that capabilities and requirements for Regulating and Negative Sources of reserve are not captured under the existing System Services arrangements. However, requirements for these capabilities are reflected in the scheduling and dispatch process and, particularly in the case of Regulating Sources of reserve, are sometimes binding.

As part of the DASSA Programme, in 2024 the TSOs are conducting product and volume reviews which will focus, amongst other items, on the procurement of daily reserve volumes based on day ahead requirements. In 2025, the TSOs plan to conduct product and volume reviews for ramping and other system services. It is worth noting that the current DS3 Regulated Arrangements are paid based on tariffs and units do not compete against each other. The FASS arrangements intend to address this through the introduction of system service auctions. This is expected to significantly reduce the gap between procured volumes and real-time requirements.

4. Next Steps

This paper provides information on current volume requirements for System Services. Separately the TSOs are awaiting a decision from the SEM Committee on the DS3 System Service Tariff arrangements, following a consultation and submission of a recommendations paper[19] and the TSOs are also consulting on the review of existing System Service reserve products (FFR, POR, SOR, TOR1, TOR2 and RR)[20]. Later in 2024, there will be a TSO-led consultation on System Services volume forecasting methodologies. The intent of these consultations is summarised below.

Existing DS3 System Services Tariff Consultation

In December 2023, the SEM Committee published a decision on a PIR for System Services Future Arrangements[21] in which it directed EirGrid and SONI to initiate a System Services tariff review and consultation in Q1 2024. In this consultation[22], the TSOs set out options for reducing System Services expenditure under the existing DS3 Regulated Arrangements.

Future Arrangements for System Services (FASS)

As part of the FASS activities required to implement DASSA arrangements in 2026, the TSOs are currently consulting on the review of existing System Service reserve products (FFR, POR, SOR, TOR1, TOR2 and RR) and their locational requirements.

As a follow-on to this product review, the TSOs will be developing methodologies for forecasting volume requirements for reserve services (FFR, POR, SOR, TOR1, TOR2 and RR) that will feed into the DASSA when it goes live towards the end of 2026. The TSOs will be consulting on these volume forecasting methodologies towards the end of Q3 2024.

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[19] DS3-System-Services-Tariffs-Consultation-27-March-2024.pdf (eirgrid.ie)

[20] FASS DASSA Product Review & Locational Methodology Consultation Paper-May-2024

[21] System Services Future Arrangements – Phase III: Detailed Design & Implementation – Phased Implementation Roadmap

[22] DS3-System-Services-Tariffs-Consultation-27-March-2024.pdf (eirgrid.ie)