FASS Programme

Day-Ahead System Services Auction (DASSA) Product Review & Locational Methodology Consultation Paper V1.0

May 2024

Executive Summary

The current 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 up to 40% renewable target underpinned by 75% System Non-Synchronous Penetration (SNSP). 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.

To ensure sufficient provision of the required operational services to deliver 2030 Renewable Energy Source (RES) targets and to align with EU requirements, the SEM Committee (SEMC) outlined in its High Level Design Decision on the System Services Future Arrangements[2] the need to move to a day-ahead auction-based procurement of appropriate system services. In this decision paper, the SEMC also outlined the need to review the products to be procured in such an auction, and the development of a locational methodology that would support these RES-E (electricity from renewable generation sources) objectives.

In consultation with the Regulatory Authorities, it was agreed that this paper would focus on a Product Review and locational requirements for the Reserve services that will be included in the initial Day-Ahead System Services Auction (DASSA). These Reserve services are: Fast Frequency Response (FFR), Primary Operating Reserve (POR), Secondary Operating Reserve (SOR), Tertiary Operating Reserves (TOR1 and TOR2), Replacement Reserve Synchronised (RRS) and Replacement Reserve Desynchronised (RRD). Later in 2024, EirGrid and SONI, the Transmission System Operators (TSOs) in Ireland and Northern Ireland, will consult on the Volumes Forecasting Methodology to be used to determine the procurement quantities for Reserve services. During 2025 a second phase of a Product Review will be conducted that will consider the System Services not reviewed in this paper. 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 Product Review presented in this paper addresses several trends and evolving risks that need to be mitigated by updated reserve product definitions. Most notably, increased levels of non-synchronous generation (wind, solar and HVDC imports) continue to displace synchronous generation leading to a reduction in system inertia. Larger infeeds to, and outfeeds from, the power system have the potential to drive larger frequency deviations (lower nadirs, higher zeniths) and higher Rates of Change of Frequency (RoCoF) under these lower inertia conditions.

In order to manage these evolving challenges, Reserve services have been reviewed taking into account changes such as the introduction of Low Carbon Inertia Services (LCIS), new HVDC interconnectors, the performance of new Large Energy Users (LEUs), new Renewable Energy Sources (RES) and new Battery Energy Storage Systems (BESS).

The main outcomes of this review are:

- The TSOs propose the introduction of 'downward' reserve products (FFR, POR, SOR, TOR1, TOR2, Replacement reserve) that will mirror the existing 'upward' products. Downward response means a reduction in generated output or an increase in power consumption. The main reason for introducing these new products is that over-frequency events are becoming more critical because of changing inertia levels, increasing HVDC interconnection export capacity, the jurisdictional impact of the North-South tie-line contingency, less running of conventional generation and the performance of LEUs. Moreover, EU legislation requires the dimensioning of downward reserves and the separate procurement of upward and downward reserves. Accordingly, these products are defined and to be procured in both upward and downward direction.

[1] System services are products, other than energy and capacity, that are required for the continuous, secure operation of the power system.
[2] System Services Future Arrangements High Level Design Decision Paper.pdf (semcommittee.com)

- Based on detailed studies and analysis, and evolving operational characteristics of the All-Island power system, the TSOs consider that the current standard Full Activation Time (FAT) of FFR of 2 seconds should reduce to 1 second, to deliver faster response capability.
- The existing System Services arrangements include the application of a scalar that incentivises provision of faster FFR capabilities within the full activation time range of 150ms to 2 seconds. As a result, many FFR providers can provide a full response in less than 300ms or even at 150ms. The TSOs consider that very fast FFR provision remains essential for system operations, and are therefore proposing that FFR is procured in three activation time sub-categories:

FFR subcategory	Full activation time
FFR Enhanced subcategory 1	150ms & sustainable up to 10s
FFR Enhanced subcategory 2	150ms ≤ FFR FAT <300ms & sustainable up to 10s
FFR Enhanced subcategory 3	300ms ≤ FFR FAT<1 second & sustainable up to 10s

- The TSOs recommend the introduction of minimum capability requirements on frequency deadbands, trajectories, reserve step sizes and reserve step triggers, that will remain configurable by the TSOs, outlined further in Chapter 5 (Section 5.3.1 Upward reserves and Section 5.4.1 Downward reserves).
- The TSOs propose that Replacement reserve will no longer encompass RRS and RRD but will become one Replacement Reserve (RR) product to be procured and dimensioned separately in upward and downward directions. This will help align with EU standard product definition[3] and reflects the changing technologies capable of providing reserves.
- In advance of the delivery of the second North-South Interconnector, the locational requirements for Reserve services are driven by the potential for a 'system split' event which would result in the electrical separation of the Ireland and Northern Ireland power systems. Minimum reserve requirements must continue to be held within each jurisdiction to ensure the security of each power system in such an event.
- The TSOs propose that the majority of the existing scalars are removed, apart from the Performance scalar, where two new scalars are proposed; Availability performance scalar and Event performance scalar.

Further information on the proposals can be found in the relevant chapters. These proposals are based on the TSOs' consideration of the operational requirements of the power system, service provider capabilities and the DASSA implementation timelines as outlined in the TSOs' Phased Implementation Roadmap[4] (PIR).

In this consultation we are seeking stakeholders' views on these proposals and have set out a series of questions to frame this response. The feedback received will then be used to inform a recommendation paper that will be submitted to the SEMC for its consideration and decision.

Responses to the questions set out in this paper should be submitted through either the EirGrid or SONI consultation portals **before 18 July 2024.**

[3] As per standard product definition in the Implementation framework for exchange of replacement reserves.

Glossary of terms

Acronym	Meaning
AGU	Aggregated Generator Unit
APC	Active Power Control
BESS	Battery Energy Storage Systems
DASSA	Day-Ahead System Services Auction
DPOR	Dynamic Primary Operating Reserve
DRR	Dynamic Reactive Response
DSO	Distribution System Operator
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
LFDD	Low Frequency Demand Disconnection
LEU	Large Energy User
LSI	Largest Single Infeed
LSO	Largest Single Outfeed
MUON	Minimum Units Online
OFGS	Over Frequency Generation Shedding
OSS	Operating Security Standards
PIR	Phased Implementation Roadmap
POR	Primary Operating Reserve
RA	Regulatory Authority
RES	Renewable Energy Sources
RoCoF	Rate of Change of Frequency
RRD	Replacement Reserve Desynchronised
RRS	Replacement Reserve Synchronised
SEM	Single Electricity Market
SEMC	SEM Committee
SIR	Synchronous Inertia response
SNSP	System Non-Synchronous Penetration
SOEF	Shaping our Electricity Future
SOR	Secondary Operating Reserve
TOR	Tertiary Operating Reserve
TSO	Transmission System Operator. (SONI for Northern Ireland and EirGrid for Ireland)
TSS	Temporal Scarcity Scalar

Table 1 Glossary of terms

Contents

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1. Introduction

1.1. Background

EirGrid and SONI are the Transmission System Operators (TSOs) in Ireland and Northern Ireland. It is our job to manage the electricity supply and the flow of power from generators to consumers. Electricity is generated from gas, coal and renewable sources (such as wind, solar and hydro power) at sites across the island. Our high voltage transmission network then transports electricity to high demand centres, such as cities, towns and industrial sites.

We have a responsibility to facilitate connections to the power system including increased levels of renewable sources to generate on the power system while continuing to ensure that the system operates securely and efficiently.

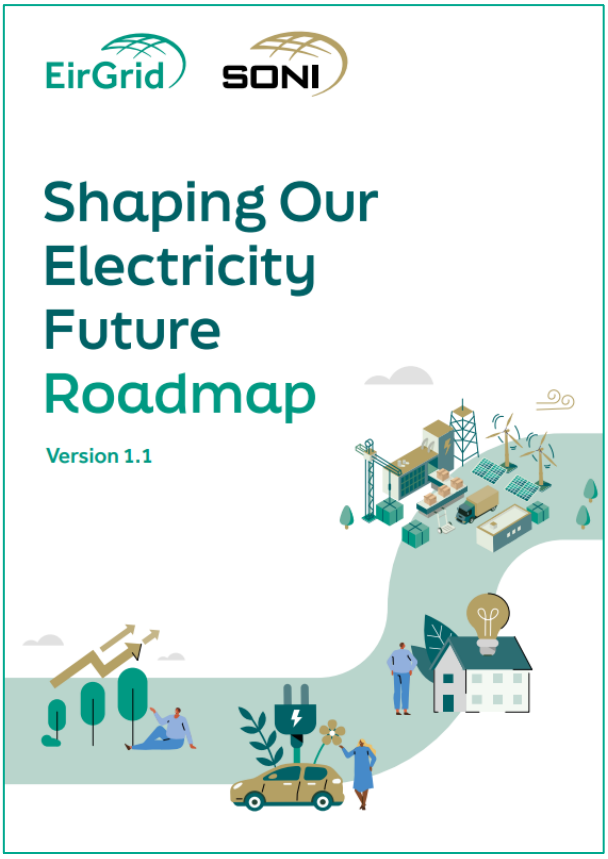
The DS3 System Services arrangements were designed to facilitate new and existing technologies and participants to provide the system services[5] required to maintain a resilient power system up to 75% SNSP. The next phase of the energy transition requires the implementation of new arrangements which are known as the Future Arrangements for System Services (FASS), which will include day ahead auction-based procurement of a subset of the System Services from 2026.

1.2. Shaping Our Electricity Future (SOEF)

In July 2023 we published an updated Shaping Our Electricity Future Roadmap[6] following consultation with stakeholders across society, government, industry, market participants and electricity consumers.

This Shaping Our Electricity Future Roadmap provides an outline of the key developments from a networks, engagement, operations and market perspective needed to support a secure transition to at least 80% electricity from renewable generation sources (RES-E) by 2030.

Inherent in this is a secure transition to 2030 whereby we continue to operate, develop and maintain a safe, secure, reliable, economical and efficient electricity transmission system.



1.3. Future Arrangement for System Services

In the SEM-22-012 High Level Design Decision on the System Services Future Arrangements[7], the SEMC specified a framework for the competitive procurement of system services. This framework consists of the following elements:

- A daily auction for the procurement of System Services within one day of energy dispatch,
- A Layered Procurement Framework for longer-term contracts and,

[5] System services are products, other than energy and capacity, that are required for the continuous, secure operation of the power system.
[6] Shaping Our Electricity Future Roadmap: Version 1.1 (eirgridgroup.com)
[7] System Services Future Arrangements High Level Design Decision Paper.pdf (semcommittee.com)

- The already established Fixed Contract Framework to remove barriers for new technologies.

The SEMC also outlined in its High Level Design Decision the need for the TSOs to review the products to be procured in such a competitive framework, and the development of a locational methodology to address operational needs as required. The motivation for this design is to put in place the necessary framework for system services to support the integration of technologies which can facilitate a reduction in the quantity of carbon-intensive conventional generation required to run at any given time on the Ireland and Northern Ireland power systems.

This reduction will facilitate the further integration of renewable generation and contribute towards achieving the 2030 RES targets set in both Ireland and Northern Ireland.

In addition, in Ireland, the Climate Action Plan 2023[8] (CAP23) launched by the Department of the Environment, Climate and Communication in December 2022 has set out ambitious actions in relation to renewable generation which will be supported by the System Services Future Arrangements.

1.4. Phased Implementation Roadmap (PIR) Deliverables

The TSOs have created this Product Review and Locational Methodology Consultation paper in line with the FASS PIR[9] and the SEMC decision paper on the PIR[10] to provide detail on the FASS product requirements. As has been agreed with the Regulators, this paper focuses on a product review and locational requirements for the services that will be the focus of the initial Auction design i.e. the Reserve services.

Services covered in this paper	Services not covered in this paper
FFR - Fast Frequency Response	RM1 - Ramping Margin 1
POR - Primary Operating Reserve	RM3 - Ramping Margin 3
SOR – Secondary Operating Reserve	RM8 - Ramping Margin 8
TOR1 – Tertiary Operating Reserve 1	FPFAPR - Fast Post Fault Active Power recovery
TOR2 - Tertiary Operating Reserve 2	SSRP- Steady State Reactive Power
RRS - Replacement reserve - Synchronised	DRR - Dynamic Reactive Response
RRD – Replacement Reserve - Desynchronised	SIR - Synchronous Inertia response

Table 2 Services covered by this paper and services not covered by this paper

In its decision paper the SEMC outlined that this Product Review should assess the following aspects;

- *The current operational constraints on the system and products that might address them;*

We have addressed this in Chapters 2, 3, 4 and 5 of this paper in relation to the reserve services under review in this paper.

- *The design of different products for a competitive process, in particular any service where there is an over-procurement;*

We have addressed this as part of the DASSA Auction design proposals that we consulted on in our paper published in March 2024[11] and provided recommendations for new and amended reserve services in Chapter 5 of this paper.

- *The locational variations in the necessity of the services, and the need for locational specific products;*

We have addressed these under Chapter 6 for the Reserve services. Future locational requirements for other products will be outlined at a later date.

[8] Climate Action Plan 2023 (www.gov.ie)
[9] FASS-TSOs-PIR-March-2024-EirGrid.pdf
[10] SEM-23-103 - SSFA Phase III - Phased Implementation Roadmap - Decision Paper.pdf (semcommittee.com)
[11] FASS-DASSA-Consultation-Paper-March-2024-EirGrid.pdf

• *Application of Scalars in a competitive landscape;*

This has been considered in line with the DASSA Auction design proposals recently consulted. We provide our recommendations on scalar removal in Chapter 7 and the quality aspects highlighted in Chapters 3 and 5.

• *Any other issues the TSOs consider appropriate in the context of maintaining system stability and security*.

Further system analysis will be required to inform the dimensioning of reserves and the design and dimensioning of other system services, as new service provision capabilities and new challenges emerge. Changes include the introduction of LCIS contracts, new HVDC interconnectors, the performance of large energy users, new RES and new BESS. Additionally, as the Distribution System Operators (DSOs) in Ireland and Northern Ireland are currently developing flexibility service procurement processes, further work on the interaction with such services and service providers will need to be more fully understood to adequately inform future System Service requirements. This paper outlines the first phase of the System Services Product Review process as outlined in Figure 1. During 2025 a second phase of a Product Review will be conducted that will consider the System Services not reviewed in this paper.

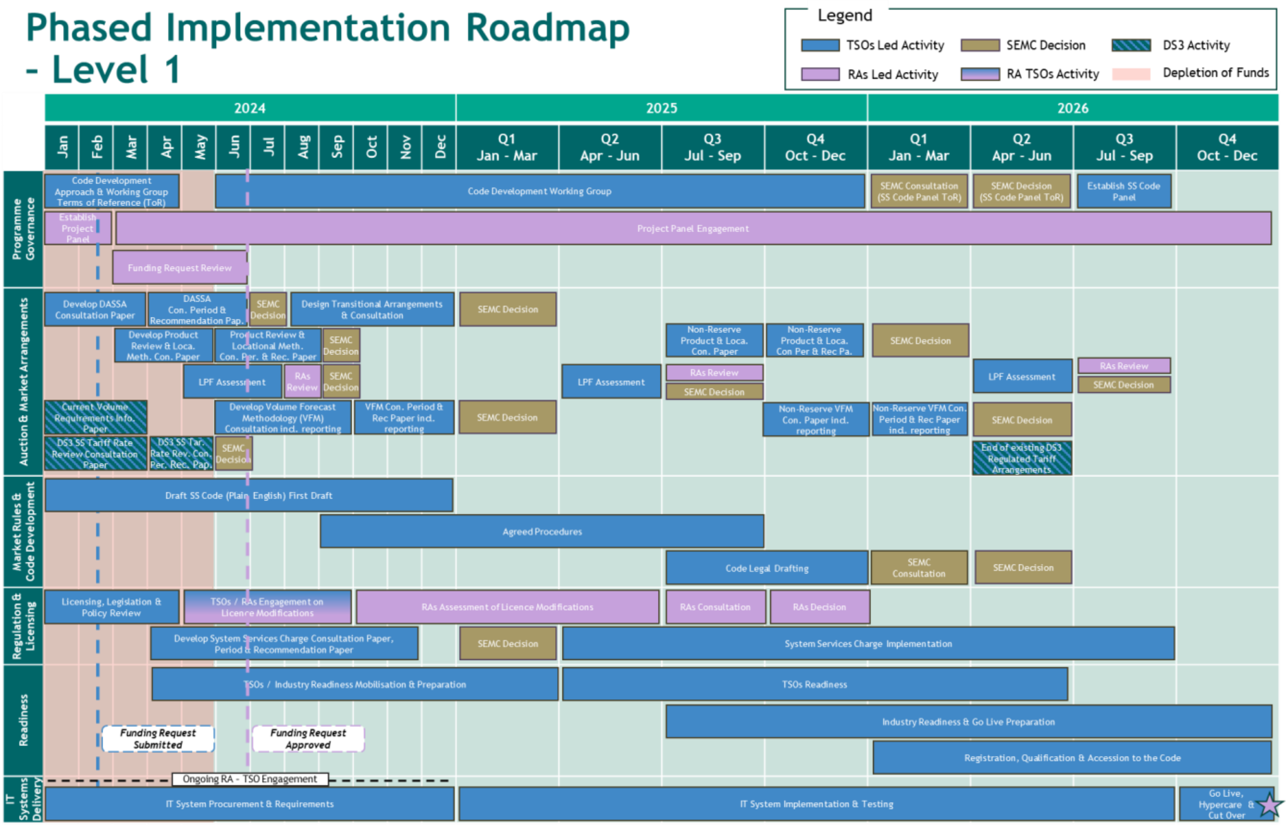


Figure 1 Level 1 Phased implementation Roadmap showing Product Reviews in 2024 and 2025

In line with the agreed roadmap timeline, later in 2024, the TSOs will issue a consultation on the Volumes Forecasting Methodology to be used to determine the procurement quantities.

The outcome of this industry consultation will help formulate the final recommendations the TSOs will make to the SEMC on the System services product definitions and scalars. These recommendations will be subject to SEMC approval, in line with the regulatory responsibility to approve any changes to terms and conditions relating to the procurement of ancillary services under the Electricity Balancing Guideline EU Regulation 2017/2195[12] and the EU Clean Energy Package[13].

[12] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R2195
[13] Clean Energy package Internal Electricity Market Regulation (EU/2019/943 and EU/2019/944)

This consultation sits within the wider framework of the Future Arrangements of System services and also considers aspects of the existing DS3 System Services arrangements. The publications listed in Table 3 may provide helpful context to the reader in their considerations of the topics covered in this paper and on the recommended products outlined.

These include the following:

Publication	Key points of relevance
DASSA Auction Design consultation paper[14]	Proposed Auction design for the Reserve services, which outlines how the auction would function, secondary trading opportunities, associated commitment obligations and the Final assignment mechanism concept to be utilised for settlement of service provision and obligations.
Current Volumes Information paper - due for publication shortly[15]	This Information Paper will 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).
DS3 System Services Tariffs[16] Consultation paper	This Tariffs consultation includes a breakdown of the contracted volume growth in System Services for each service procured (see Table 5 of this paper), a breakdown of expenditure across technology types and the impact of the Temporal Scarcity Scalar (TSS).
System Services Indicative 2030 volumes [17]	This paper provided a summary of a single case study, the assumptions made (e.g. significant volumes of fast acting reserves from Demand Response available, gas turbines flexible enough to provide ramping services from a cold state), and analysis that examined three 2030 portfolios: • Gas Turbines-Led; • Mix; • Demand-Led. (consistency across the portfolios was included in terms of estimated new BESS, Interconnectors Renewable generation and some conventional assets). The analysis undertaken for this single case study demonstrated that the Available Volume for each portfolio would be sufficient to meet the real-time Requirements assumed. The portfolios on which this analysis is based are also likely to be different based on market forces and the TSOs are committed to a technology neutral stance.

Table 3 Published papers that are relevant to this topic of product design and locational methodology.

The purpose of this Product Review Consultation is to examine a subset of the DS3 Systems Services that will be procured through the upcoming DASSA auctions which will be implemented in 2026. The products required for delivery of DASSA go-live in 2026 are the reserve services (FFR, POR, SOR, TOR1, TOR2, RRS and RRD), as outlined in more detail in Section 2 of this paper. The DASSA requirements and implementation for other System Service products will be examined at a future date.

1.5. Structure of this Paper

As outlined in the TSOs' Shaping our Electricity Future workstreams[18], our recent publication on Tomorrow's Energy Scenarios[19] and other work, the All-Island power system is changing rapidly and

[14] FASS-DASSA-Consultation-Paper-March-2024-EirGrid.pdf
[15] EirGrid SOEF document library; SONI document library.
[16] DS3-System-Services-Tariffs-Consultation-27-March-2024.pdf (eirgrid.ie)
[17] System-Services-Indicative-2030-Volumes.pdf (eirgrid.ie)
[18] Shaping Our Electricity Future overview
[19] Tomorrow's Energy Scenarios (TES) (eirgrid.ie)

becoming more complex in terms of generation and demand technologies. The consultation paper is structured as follows.

Chapter 2 describes the current Reserve Services Product definitions. As the future products shall take into account both the future system needs and the capabilities of the reserve providers, these issues are discussed in Chapter 3 (system needs) and Chapter 4 (changing capabilities of reserve providers). Chapter 5 examines the review that has been conducted by the TSOs on the Reserve Service Products and the recommended updates to Reserve Services aim to ensure that we have fit for purpose reserve services that will maintain system security from 2026 onwards. Chapter 6 reviews the locational requirements, while Chapter 7 examines the review of the Reserve Service Product Scalars. In Chapter 8 we outline the Next Steps related to the proposals in this paper and in Chapter 9 we include a consolidated list of the questions asked throughout this consultation paper.

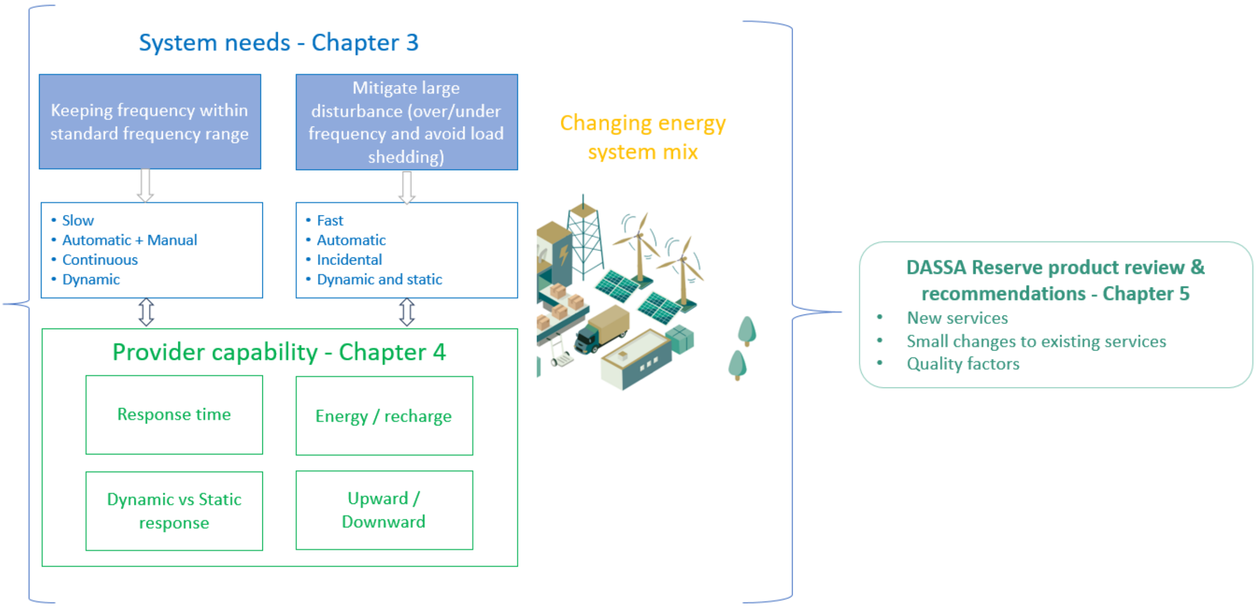


Figure 2: Overview of this consultation paper

2. Current Reserve Product Definitions

The SEMC's decision to introduce day ahead auction-based procurement focuses initially on a subset of the services procured under the DS3 prequalification and tariff-based arrangements[20]. This subset is the suite of reserve services; FFR, POR, SOR, TOR1, TOR2, RRS and RRD, which are currently only procured in an upward direction to mitigate and manage under-frequency events. Historically, reserves have been termed positive and negative in an All-Island context, however, to ensure the TSOs utilise terminology that aligns more fully with EU requirements we propose to now refer to reserves as:

- Upward reserve (positive direction i.e. provision of additional generation or a reduction of demand) to manage under-frequency events; and
- Downward reserve (negative direction i.e. reduction of generation or an increase of demand) to manage over-frequency events.

Separately, the TSOs employ mechanisms to ensure effective management of over-frequency events. These include, but are not limited to, wind farm frequency response capability, operational constraints on conventional generators (50 MW minimum required in Northern Ireland only) and over-frequency generation tripping. The availability of services and capabilities to manage both under and over-frequency occurrences are critical to the TSOs' capability to operate a secure, resilient and economic All-Island power system.

The subset of services that are currently procured through the DS3 tariff arrangements are listed below in Table 4, and further detail on the technical requirements associated with each product is provided thereafter. The current requirement as outlined in the DS3 System services agreements[21] [22]states that for services providers contracted to provide reserves "*The Service Provider must provide reserve, with the exception of Replacement Reserve, in accordance with the technical requirements of the Grid Code and the relevant Operating Parameters of the Providing Unit …*

Unless stated otherwise, all quantities used in reserve calculations are referenced at the Connection Point and conversion factors will be used to convert values that are not so provided where necessary. The Company (EirGrid/SONI) shall specify the Reserve Trigger, Reserve Droop, Reserve Step Sizes and Reserve Step Triggers as appropriate for reserve. Enabling and disabling POR, SOR and TOR1 and alterations to the Reserve Trigger, Reserve Droop, Reserve Step Sizes, Reserve Step Triggers may be requested in real-time by the Company and unless otherwise agreed by the Company, shall be implemented by the Providing Unit within 60 seconds of such request". For example, in practice this is implemented by the ability to change modes of operations on BESS units.

[20] System Services Future Arrangements Phase III: Detailed Design & Implementation. Phased Implementation Roadmap for the System Services High Level Design. Decision Paper. SEM-23-103
[21] Ire-DS3-System-Services-Regulated-Arrangements_final.pdf (eirgrid.ie)
[22] NI-DS3-System-Services_Regulated-Arrangements_final.pdf (eirgrid.ie)

Current DS3 System Service	Reserve Type (Upward /Downward)	Payment per unit	Short Description of contracted service	Current Dimensioning requirements Ireland	Current Dimensioning requirements Northern Ireland
Fast Frequency Response- FFR	Upward and some downward (via volume capped fixed contract arrangements)	MWh	MW delivered between 2 and 10 seconds following an event (incentives in place for faster delivery)	N/A[23]	N/A[23]
Primary Operating Reserve - POR	Upward	MWh	MW delivered between 5 and 15 seconds following an event	All-Island = 75% of LSI 155/150 MW minimum volumes (lower value if pumped storage hydro unit in pump mode) of which 75 MW must be regulating resources i.e. synchronous generator)	All-Island = 75% of LSI 50 MW minimum volume, of which 50 MW must be from regulating resources i.e. synchronous generator
Secondary Operating Reserve- SOR	Upward	MWh	MW delivered between 15 to 90 seconds following an event	All-Island = 75% of LSI 155/150 MW minimum volumes (lower value if pumped storage hydro unit in pump mode) of which 75 MW must be regulating resources i.e. synchronous generator)	All island = 75% of LSI 50 MW minimum volume, of which 50 MW must be from regulating resources i.e. synchronous generator
Tertiary Operating Reserve 1- TOR1	Upward	MWh	MW delivered between 90 seconds to 5 minutes following an event	All-Island = 100% of LSI 155/150 MW minimum volumes (lower value if pumped storage hydro unit in pump mode) of which 87 MW must be regulating resources i.e. synchronous generator)	All-Island = 100% of LSI 50 MW minimum volume, of which 50 MW must be from regulating resources i.e. synchronous generator

Current DS3 System Service	Reserve Type (Upward /Downward)	Payment per unit	Short Description of contracted service	Current Dimensioning requirements Ireland	Current Dimensioning requirements Northern Ireland
Tertiary Operating Reserve 2- TOR2	Upward	MWh	MW delivered between 5 minutes to 20 minutes following an event	All-Island = 100% of LSI 155/150 MW minimum volumes (lower value if pumped storage hydro unit in pump mode) of which 87 MW must be regulating resources i.e. synchronous generator)	All-Island = 100% of LSI 50 MW minimum volume, of which 50 MW must be from regulating resources i.e. synchronous generator
Replacement Reserve DeSynchronised- RRD	Upward	MWh	MW delivered between 20 minutes to 1 hour following an event	Scheduled by control centre -includes constraints on certain plant to ensure available replacement reserve that is able to be online in 20 minutes. 325 MW Ireland minimum amount of combined RRS and RRD provision	Scheduled by control centre includes constraints certain plant to ensure available replacement reserve that is able to be online in 20 minutes. 125 MW Northern Ireland minimum amount of combined RRS and RRD provision
Replacement Reserve Synchronised - RRS	Upward	MWh	MW delivered between 20 minutes to 1 hour following an event	Minimum amounts per jurisdiction 325 MW Ireland minimum amount of combined RRS and RRD provision dependent on operational situations [24], can include max MW output constraints on certain plant to ensure full quantity is dimensioned	Minimum amounts per jurisdiction 125 MW Northern Ireland minimum amount of combined RRS and RRD provision dependent on operational situations [25], can include max MW output constraints on certain plant to ensure full quantity is dimensioned

[23] 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.
[24] DS3-System-Services-Tariffs-Consultation-27-March-2024.pdf (eirgrid.ie)
[25] DS3-System-Services-Tariffs-Consultation-27-March-2024.pdf (eirgrid.ie)

Table 4 Summary of Reserve Services

The range of providers of services has been published as part of the DS3 System Services Tariffs Consultation paper and the table below provides a helpful overview outlining the types of providers and contracted volumes, as of Gate 9 procurement round.

Service	FFR	POR	SOR	TOR1	TOR2	RRS	RRD	SSRP	SIR	RM1	RM3	RM8
Unit	MW	MW	MW	MW	MW	MW	MW	MVAR	MWS2	MW	MW	MW
Conventional	375	767	1157	1363	1985	4390	2083	6339	794856	6592	7872	8459
DSU	176	206	220	284	284	0	394	0	0	661	101	83
AGU	0	0	16	61	74	10	88	0	0	88	88	88
Wind	135	268	283	279	0	0	70	1568	0	0	0	0
Interconnectors	200	200	200	200	200	0	0	350	0	0	0	0
Battery	698	708	708	708	687	0	190	502	0	139	57	36
Hybrid	2	2	2	2	2	0	0	0	0	0	0	0
Solar	3	3	3	2	0	0	0	0	0	0	0	0
Total	**1588**	**2154**	**2589**	**2898**	**3233**	**4400**	**2825**	**8759**	**794856**	**7480**	**8119**	**8666**

Table 5 Contracted volumes per unit type as of Gate 9 procurement (Oct 2023)

2.1. FFR (Fast Frequency Response)

For under-frequency 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 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 standard definition for the current FFR product is "*the additional MW Output or MW Reduction required compared to the pre-incident MW Output or MW Reduction, which is fully available from a Providing Unit within 2 seconds after the start of an Event and sustainable up to 10 seconds after the start of the Event*. Additionally, FFR includes a requirement that states that the extra energy provided in the 2 to 10 second timeframe by the increase in MW output must be greater than any loss of energy in the 10 to 20 second timeframe due to a reduction in MW output below the initial MW output (i.e. the hatched blue area must be greater than the hatched green see Figure 3 below).

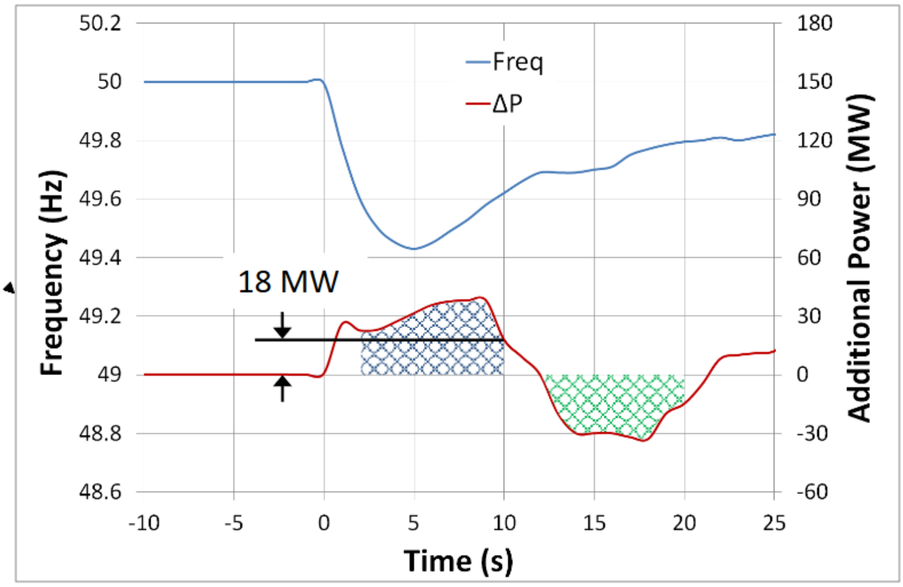


Figure 3 Energy requirements for FFR[26]

The Service Provider must provide FFR in accordance with the technical requirements of the DS3 System services agreement and the relevant Operating Parameters for the Providing Unit.

FFR timelines – standard product full activation time	2 seconds full activation time
FFR required response duration following an event	10 seconds
FFR incentives	FFR Fast Response Scalar is an amount equal to: • + 3 in the event that the FFR Response Time is ≤ 0.15 seconds; or • ((0.5 – FFR Response Time)/(0.35)) +2 in the event that 0.15 < FFR Response Time <0.5 seconds; or • ((2 – FFR Response Time)/(1.5)) +1 in the event that 0.5 seconds ≤ FFR Response Time <2 seconds

Table 6 Key FFR requirements under existing DS3 arrangements

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 units to provide a faster than 2 seconds FFR response and to recognise the benefits of such fast response, the TSOs currently utilise a product scalar for FFR which incentivises provision as quickly as 150ms after the dimensioning incident. Among the FFR providing units that typically respond within 300 ms are BESS, Demand Side Unit (DSU) and RES.

2.2. POR (Primary Operating Reserve)

As per the EirGrid Gride code[27] POR is "*the additional MW output (and/or reduction in Demand) required at the Frequency nadir (minimum), compared to the pre-incident output (or Demand), which is fully available and sustainable between 5 seconds and 15 seconds after the Event and where the nadir occurs between 5 and 15 seconds after the Event*". In the SONI Grid Code[28] POR is defined as "*the automatic response to Northern Ireland system frequency changes released increasingly from the time of frequency change and fully available by 5 seconds, and, subject to the agreed Unit Load Controller adjustment where applicable, must be sustainable until at least 15 seconds from the time of frequency change*". POR acts to arrest the under-frequency deviation caused by a system event between 5-15 seconds of the event occurring and helps to begin the recovery of frequency post event.

POR timelines – standard product full activation time	5 seconds full activation time
POR required response duration following an event	15 seconds (at least 15 seconds in NI)

Table 7 Key POR requirements under existing DS3 arrangements

The TSOs currently utilise operational constraints to obtain a portion of POR (75 MW minimum in Ireland, 50MW minimum in Northern Ireland) from regulating or synchronous generation resources[29], known as dynamic POR (DPOR). This ensures that frequency regulation (automatic adjustment of Active Power output by a Generation Unit, initiated by free governor action in response to continuous minor fluctuations of frequency on the power system) is maintained as a byproduct of the requirement for DPOR.

[26] DS3 System Services Technical Definitions Decision Paper. SEM-13-098
[27] https://cms.eirgrid.ie/sites/default/files/publications/Grid-Code-Version-13_0.pdf
[28] https://www.soni.ltd.uk/how-the-grid-works/grid-codes/SONI-Grid-Code_Apr_2024.pdf
[29] Regulating sources (currently conventional units) are those which automatically regulate their output (using narrow frequency deadbands) to maintain the frequency at 50 Hz.

2.3. 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 EirGrid Grid code defines SOR as "*the additional MW output (and/or reduction in Demand) required compared to the pre-incident output (or Demand), which is fully available and sustainable over the period from 15 to 90 seconds following an Event*". The SONI grid code defines SOR as "*the additional MW output compared to the pre-incident output, which is fully available and sustainable over the period from 15 to 90 seconds following an Event*".

SOR timelines – standard product full activation time	15 seconds full activation time
SOR required response duration following an event	90 seconds

Table 8 Key SOR requirements under existing DS3 arrangements

2.4. TOR1 (Tertiary Operating Reserve 1)

TOR1 takes over from SOR and begins to restore the frequency level following a system event. The EirGrid Grid Code definition is Tertiary Operating Reserve band 1 (TOR1) is "*the additional MW output (and/or reduction in Demand) required compared to the pre-incident output (or Demand) which is fully available and sustainable over the period from 90 seconds to 5 minutes following an Event*". The SONI Grid defines TOR1 as "*the additional MW output required compared to the pre-Event output which is fully available and sustainable from 90 seconds to 5 minutes following an Event*".

TOR1 timelines – standard product full activation time	90 seconds full activation time
TOR1 required response duration following an event	5 minutes

Table 9 Key TOR1 requirements under existing DS3 arrangements

2.5. 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. TOR2 requires manual dispatch action from the control centre to activate the service.

TOR2 timelines – standard product full activation time	5 minutes
TOR2 required response duration following an event	20 minutes

Table 10 Key TOR2 requirements under existing DS3 arrangements

2.6. RRS (Replacement Reserve Synchronised)

Replacement Reserve is defined in the DS3 Contracts as "*the additional MW output (and/or reduction in Demand) required compared to the pre-incident output (or Demand) which is fully available and sustainable over the period from 20 minutes to 1 hour following an Event*". 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, and would be manually dispatched by the control centre if required.

In DS3 procurement documentation RR (Synchronised)' means Replacement Reserve provided by the Providing Unit when: (i) synchronised to the power system in the case of a synchronous providing unit, or (ii) when connected to the power system and operating at a level greater than 0 MW in the case of an energy storage providing unit or power park module.

RRS timelines – standard product full activation time	20 minutes
RRS required response duration following an event	1 hour

Table 11 Key RRS requirements under existing DS3 arrangements

2.7. 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 dispatched by the control centre to synchronise and 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.

RR (De-synchronised)' means replacement reserve provided by the providing unit when: (i) not Synchronised to the power system in the case of a synchronous providing unit, or (ii) when connected to the power system and operating at a level less or equal to 0 MW in the case of an energy storage providing unit, or (iii) when connected to the power system in the case of a demand side unit.

RRD timelines – standard product full activation time	20 minutes
RRD required response duration following an event	1 hour

Table 12 Key RRD requirements under existing DS3 arrangements

3. System Needs

This chapter describes the development of the needs of the power system from past requirements to future requirements for two purposes:

- ‘Normal’ frequency regulation, i.e. keeping the **system frequency** within the **standard frequency range**: 49.8 to 50.2 Hz[30] (Section 3.1).
- Mitigating large disturbances to avoid a **maximum instantaneous frequency deviation** larger than 1000 mHz from the nominal frequency of 50 Hz (i.e. the system frequency shall not go below 49.0 Hz or above 51.0 Hz). If the **system frequency** is below 49.0 Hz, automatic schemes start protecting the power system by **Low Frequency Demand Disconnection** (LFDD) (Section 3.2). This includes containing any frequency deviations and replacing the reserves that have been utilised during the containment phase.

Currently the TSOs utilise a range of different processes, products and operational tools to manage the system that cover both the frequency regulation and event mitigation requirements. The following sections give an overview of these, which provides more context on how the reserve products that are under consultation in this paper sit within the wider framework of tools and operational practices to ensure the system remains balanced at all times.

3.1. Keeping Frequency Within the Standard Frequency Range

EirGrid/SONI are required to keep the system frequency within the standard frequency range, which is 49.8 Hz to 50.2 Hz. If the frequency is within this range, the power system should have sufficient reserves to handle the positive and negative **reference incidents** (the loss of the LSI or LSO (Largest single outfeed)) without reaching the **maximum instantaneous frequency deviation** and accordingly avoid tripping any load (LFDD) or generation.

To keep the **system frequency** within the **standard frequency range**, load and generation are balanced continuously, by automatic (governor) response of some reserve providers and manual actions by the TSOs (re-dispatching and/or countertrading – restoring the system balance).

Traditionally, conventional (synchronous) generation units were utilised to automatically and manually balance the continuous changes in the electricity demand. However, as the All-Island system now has large volumes of RES, and increasing levels of interconnection different operational characteristics have to be accommodated and new mechanisms enabled to manage the required continuous balance of generation, export, import and demand. In some circumstances, the inherent variability of renewable resources, particularly wind and solar generation, can cause increased volatility in system frequency.

Currently the TSOs maintain a minimum volume of regulating reserve provision in the POR, SOR, TOR1 and TOR2 timeframes through operational constraints, with minimum volumes per jurisdiction (75-87 MW in Ireland and 50 MW in Northern Ireland). These regulating reserves can currently only be provided by conventional generators through governor droop setting and with a tight frequency deadband (+/- 15mHz). In addition, the operational constraints require a minimum number of conventional units on-line (MUON) and a minimum level of inertia of 23,000 MWs which also assist in maintaining frequency stability. This ensures that frequency regulation, initiated by free governor action in response to continuous minor fluctuations of frequency on the power system) in both upward and downward directions is maintained as a byproduct of the requirement for dynamic POR. We are not proposing to remove this requirement at this time.

When moving towards the objective of at least 80% electricity from renewable generation sources (RES-E) by 2030, the challenges of frequency regulation will increase, mainly for the following reasons:

[30] As per System Operations Guideline and Synchronous Area Operational Agreement.

- *Reducing inertia* because of reducing numbers of synchronised conventional units. As inertia helps in absorbing imbalances in the system, a lower level of inertia will likely result in a more volatile system frequency, requiring faster acting and a greater volume of balancing actions.
- More intermittent generation (e.g. particularly wind and solar generation) and demand, may provide larger momentary imbalances, requiring a greater volume of balancing actions.
- Increased levels of HVDC interconnection which may ramp (rate of change of import or export) at greater speeds than today.

Based on the TSOs' current observations, the power system requires continued provision of dynamic frequency regulation both now and in the future to address these emerging challenges. We are not proposing as part of this review a new frequency regulation product, as such a product would require additional investigation and further detailed analysis. However, note that the TSOs consider that within the proposed product definitions & technical requirements (e.g. deadband capability of +/- 15mHz) outlined in Chapter 5 (Section 5.3 & 5.4 in particular) a similar dynamic response capability could be procured through the auction format. The TSOs will consider further such capability, and the minimum volumes of each product as part of ongoing work on the DASSA Reserve product volume methodology and future DASSA product reviews as outlined in the PIR.

3.2. Mitigating Large Disturbances

After an incident that suddenly affects the system balance, such as a trip of a large generation unit, demand or a HVDC interconnector, the system frequency will start increasing or decreasing quickly. In accordance with regulations[30], the largest single incident shall not cause a frequency deviation larger than 1000 mHz from the nominal frequency of 50 Hz, i.e. the system frequency shall not go below 49.0 Hz or above 51.0 Hz. If the **system frequency** is below 49.0 Hz, automatic schemes start protecting the power system by disconnecting load (LFDD).

The TSOs therefore make sure that sufficient reserves are available to prevent a frequency deviation of greater than +/-1000 mHz. These reserves can be provided by a range of technologies including BESS, synchronous generation, HVDC interconnectors, RES and demand response.

Historically for the All-Island power system, the main risk has been from an under-frequency event, where the sudden loss of a large generator or importing interconnector causes a large frequency disturbance. Figure 4 shows an illustrative example where the sudden loss of an importing interconnector results in a rapid and significant frequency drop before being contained and restored. The figure shows that FFR and POR keep the minimum frequency (nadir) within the required 1000 mHz. Accordingly, POR and SOR stabilise the frequency to a steady state value. The frequency is restored towards 50 Hz by dispatcher's 'inc' instructions during the TOR1/TOR2 timeframe. RRS and RRD are required to replace reserves and restore the necessary footroom and headroom for secure operation of the system.

Initial RoCoF is also illustrated in this example. Maintaining RoCoF within the +/- 1 Hz/s standard is mainly achieved by ensuring sufficient levels of inertia on the power system.

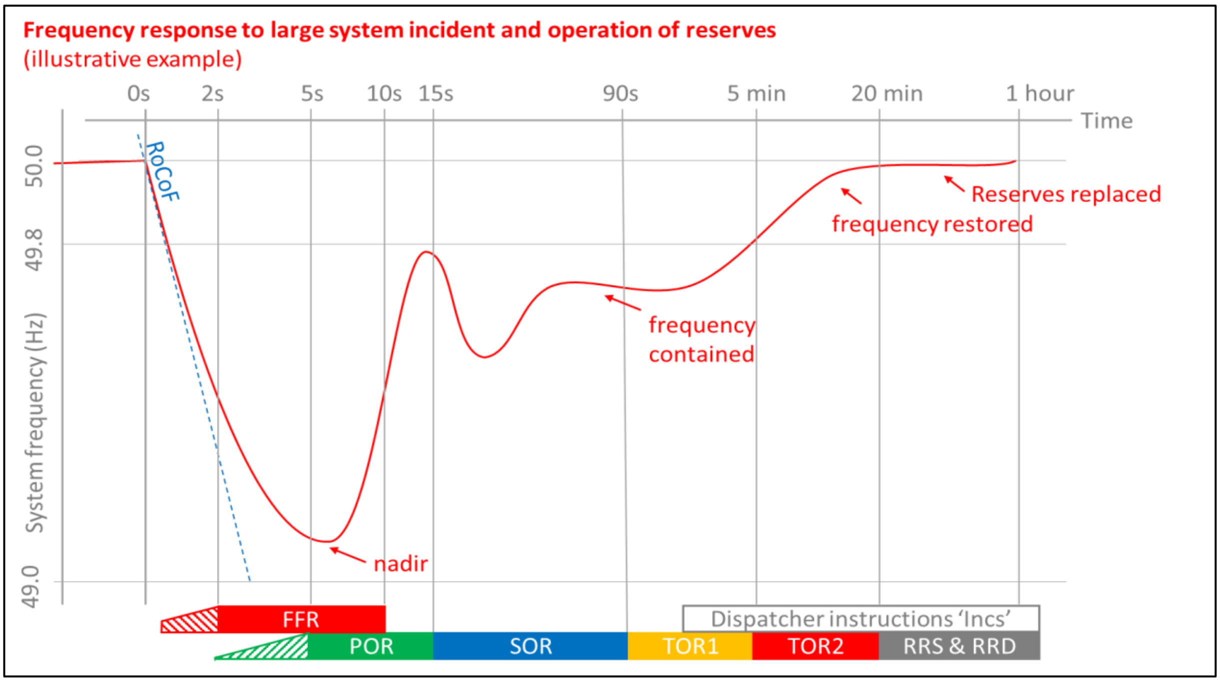


Figure 4 Illustrative example of a frequency trace following loss of largest single infeed

As noted in recent publications[31], actual system incidents and system analysis have indicated the following evolution of frequency disturbances:

- *Greater number of events, and forecasted events where the frequency nadir has occurred/will occur in a sub 5 second timeframe due to less system inertia, which has resulted in changes to performance assessment timeframes for system services provision.*
- *Fast acting response of service providers (FFR) will not only have arrested the fall in frequency before the 5 second POR assessment period but will also have returned system frequency to a nominal state.*

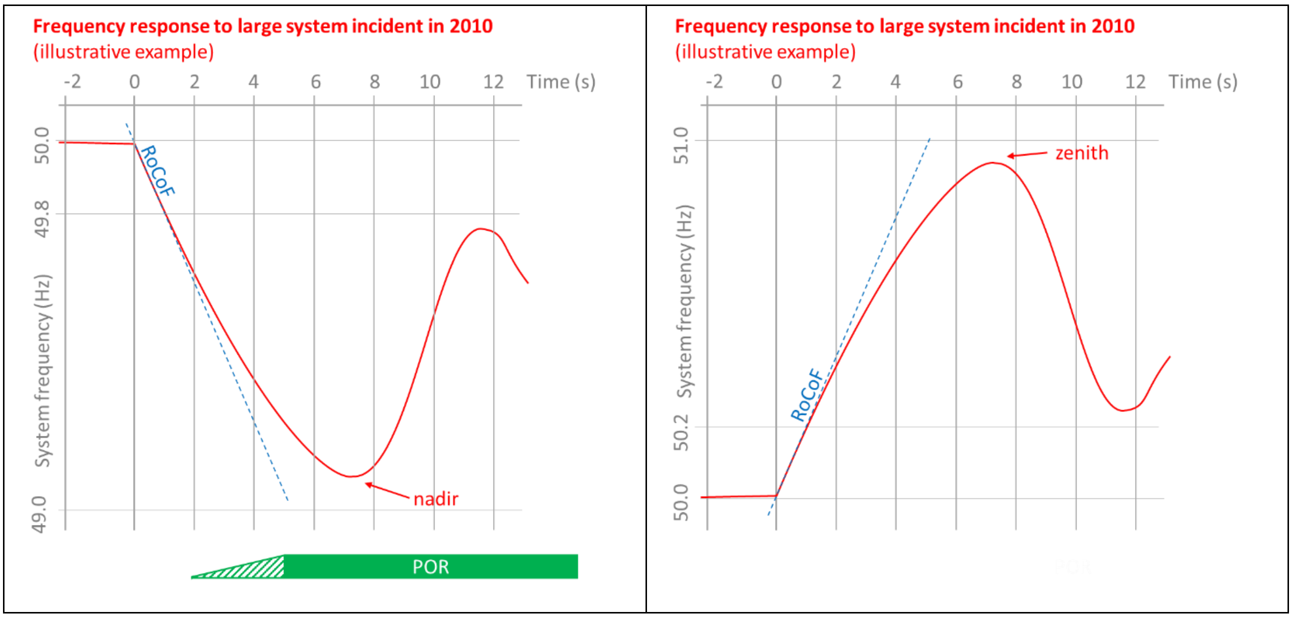


Figure 5 Illustrative example of a frequency trace following loss of largest single infeed (left) and largest single outfeed (right) in 2010

[31] https://cms.eirgrid.ie/sites/default/files/publications/DS3-SS-Protocol-Information-Session.pdf

The graph on the left-hand side of Figure 5 shows an illustrative example: the system frequency after a large trip of an infeed in 2010, e.g. a trip of 500 MW importing HVDC interconnector. The figure shows that the instantaneous RoCoF (at t = 0+ s) was about -0.15 Hz/s. Within seconds, the POR response (by the governors of the conventional units) started and was able to stop the frequency decrease (at the nadir) before it would have reached 49.0 Hz. Typically, the nadir was reached within the POR activation time frame (5-15s) and POR was considered sufficiently fast enough.

Similarly, the graph on the right-hand side of Figure 5 shows an illustrative example of a trip of a large outfeed, such as an *exporting* HVDC interconnector. The figure shows that the instantaneous RoCoF (at t = 0+ s) was about +0.15 Hz/s. Within seconds, the governor response of the conventional units started and was able to stop the frequency increase (at the zenith) before it would have reached 51.0 Hz.

It is noted that although the figures on the left and right are mirrored, the response in the high frequency example (loss of outfeed) was – strictly speaking – not by contracted POR, since POR is currently only defined in upward direction (for under-frequency). In practice though, conventional units' governors work symmetrically and, if sufficient foot and head room is available, will respond similarly (but in the opposite directions) in under-frequency and over-frequency situations.

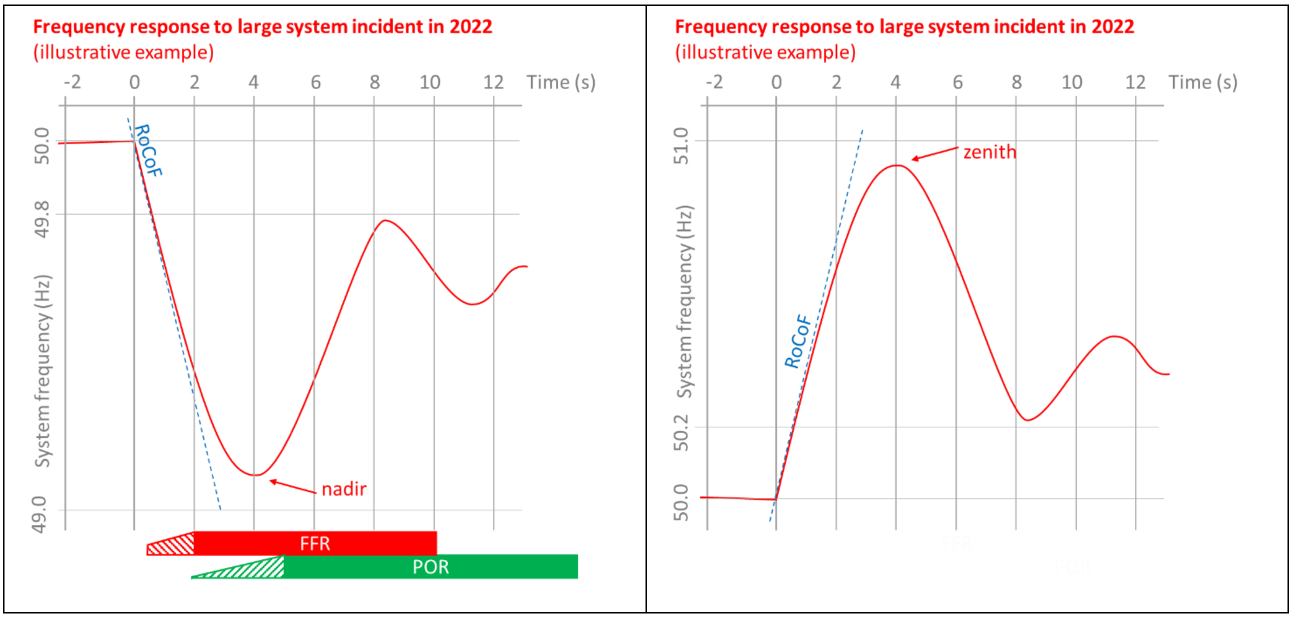


Figure 6 Illustrative example of a frequency trace following loss of largest single infeed (left) and largest single outfeed (right) in 2022

With increasing levels of renewables, and hence reducing numbers of conventional units, the levels of inherent inertia are decreasing. As shown in the graph on the left-hand side of Figure 6, the same large infeed loss would now result in a larger RoCoF, in this example 0.3 Hz/s. Consequently, if only POR would have been applied, the system frequency would have reached below 49.0 Hz even before POR had started. Accordingly, a *faster* response was required which resulted in the introduction of FFR in 2016. FFR was defined to be available within 2 seconds and incentives were created to encourage provision of a response faster than 2 seconds (≥150ms).

Also, for the case of a large outfeed loss (exporting HVDC interconnector), reduced inertia in the system requires a faster response (see right-hand graph of Figure 6). Unlike the under-frequency case, there is only a very limited amount of downward FFR contracted. Accordingly, there is a risk that the frequency rise is not stopped before reaching 51.0 Hz. For that reason, additional measures have been implemented to arrest the frequency rise. These include a wind farm over-frequency generation shedding scheme (OFGS) with staggered frequency trip settings across the portfolio of wind farms involved (50.5 - 50.8 Hz for Ireland and 50.5 – 51.5 Hz for Northern Ireland).

In addition to the reserves and measures above, a number of additional operational constraints and mitigations apply to assist in the management of frequency disturbances, including:

- Operational constraint for Minimum Units Online (MUON).
- Minimum level of inertia (currently 23,000 GWs). It is worth mentioning that future inertia requirements will increasingly be met by LCIS which will reduce the dependency on running conventional generation.
- A restriction on the scheduling of peaking conventional generators to ensure sufficient replacement reserve provision.
- Interconnector run back schemes to mitigate over-frequency events.

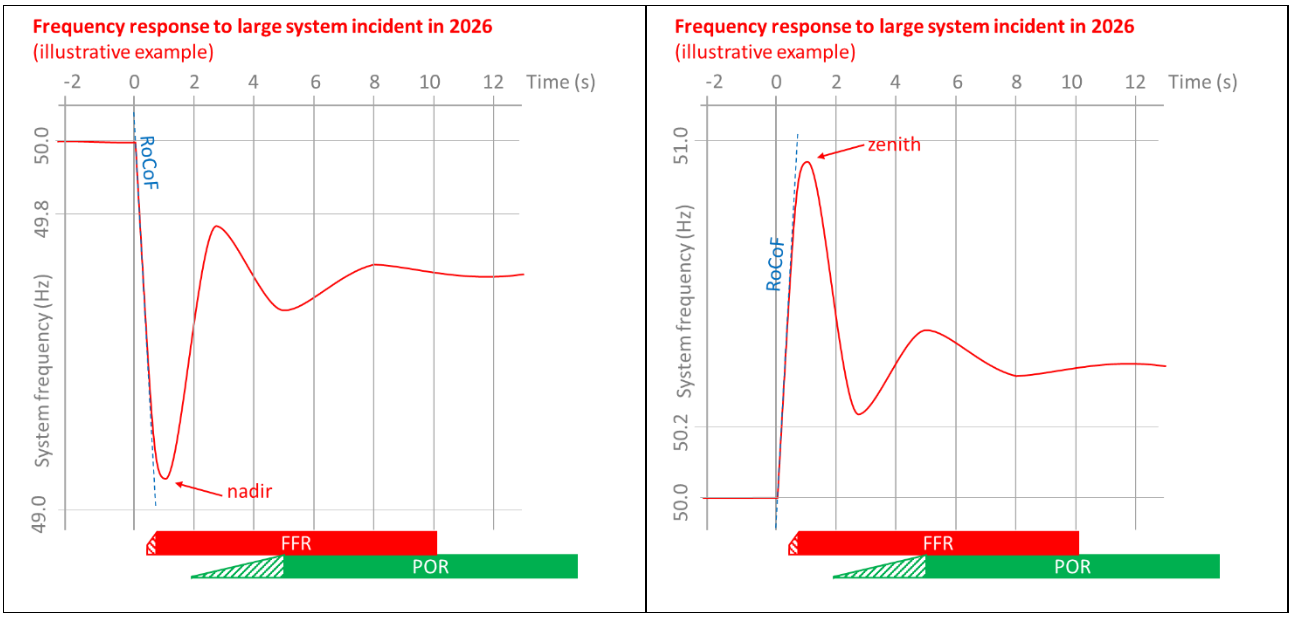


Figure 7 Illuistrative example of a frequency trace following loss of largest single infeed (left) and largest single outfeed (right) in 2026.

Another measure that supports mitigating the impact of both over-frequency and under-frequency events is the APC mode currently enabled on wind farms in Ireland, but not in Northern Ireland. For frequency response purposes, APC is normally off but is turned on under the following conditions[32]:

- During periods of high power exports over the interconnectors to Great Britain or high power transfers on the tie-line between Ireland and Northern Ireland. The frequency response provided by APC assists in managing any high frequency condition that will arise in the event of an interconnector or tie-line tripping.
- When there are frequency oscillations on the power system. The frequency response provided by APC assists in damping these oscillations.
- During trials of new system operating conditions such as reductions in the minimum number of unit constraint or increases in the SNSP limit. The frequency response provided by APC provides additional system resilience.

When moving toward 80% electricity from renewable generation sources (RES-E) by 2030, the amounts of conventional units and consequently the inherent inertia in the system will generally be lower even if we maintain a minimum inertia floor. Accordingly, a large incident could result in an even steeper frequency fall (RoCoF) as shown in the graph on the left-hand side of Figure 7. The TSOs have set limits to the minimum inertia that must be available at all times (23,000 MWs [33]) and in 2023 the All-Island system

[32] Active Power Control Groups Information Note (sem-o.com)
[33] EirGrid & SONI Operational Policy Roadmap 2023-2030

moved to an operational RoCoF of 1 Hz/s (from a previous standard of 0.5 Hz/s)[34]. Note that the TSOs are currently looking to procure LCIS to facilitate further reductions in the minimum requirement of conventional units on the system and therefore maximise renewable output and minimise future dispatch-down of RES.

However, even when taking these limits and adaptations into account, a frequency deviation of 1000 mHz could be reached within 1s if there are insufficient fast responding reserves that act within 1s to mitigate a rapid frequency deviation. Therefore, the current standard FFR product definition of a response within 2s is considered too slow for future requirements. Accordingly, the TSOs require a fast acting FFR product to meet future operational requirements, with more detailed technical aspects outlined in Section 5.

An over-frequency situation would be mitigated in a similar way (but mirrored) as an under-frequency situation (see right hand graph in Figure 7). FFR should be fast enough to keep the frequency below 51.0 Hz. As proposed for upward FFR, a downward FFR product with a response time of less than 1s is required.

3.3. Under-frequency and Over-frequency Risks and Reserve Directions

Currently the reserve products procured by the TSOs are focused on under-frequency event mitigation and the provision of upward response (i.e. generation increase or demand reduction). Previous studies conducted in 2018 indicated the risks to system frequency of a loss of an exporting interconnector. This led to the introduction of over-frequency generation shedding protocols for renewable generation as a tool for the TSOs to mitigate the severity of such incidents[35].

A greater risk of over-frequency events is now emerging with increasing levels of large loads, increased interconnection and renewable generation and, as outlined above, the types of products the TSOs will need to manage these risks also need to evolve. Moreover, reducing numbers of conventional units will not only reduce the inherent inertia in the system, but will also reduce the total governor response provided by conventional units, not only in upward, but also in downward direction. In section 5.4 the TSOs propose that downward reserve service products are implemented to mirror the upward reserve products.

Additionally, it is necessary to comply with requirements outlined in the System Operation Guideline Regulation 2017/1485 (SOGL)[36] to dimension both upward and downward products and reference incidents separately, as per SOGL Articles, 153 (FCR), 157(FRR), 160 (RR). The procurement of upward balancing capacity and downward balancing capacity must also be carried out separately as per Article 6 of Regulation 2019/943 on the Internal Market for electricity.

3.4. Quality Aspects

To be able to keep the frequency within the standard frequency range and mitigate large disturbances, several other requirements are proposed. These include:

- **Response time:** As discussed in Section 3.2, the faster time to frequency nadir/zenith necessitates faster responding FFR. In section 5 the TSOs propose that the full activation time for FFR should be no greater than 1s.
- **Dynamic vs. static reserves:** Conventional units and controllable inverter-based power sources can continuously adapt generation to the actual frequency; this is termed dynamic response. DSUs

[34] This RoCoF change following a significant programme of work across both TSOs and DSOs and required existing generators to comply with the new 1 Hz/s standard. As part of the current system services tariff-based procurement, Synchronous Inertia response (SIR) provision is incentivised through the current tariff-based arrangements which has supported the reduction of the minimum generating levels of existing fossil-based plant. Separately the TSOs are enabling the procurement of low carbon-based inertia services Contractual Arrangements for the Procurement of a Low Carbon Inertia Service (LCIS)
[35] OPI_INN_Over_Frequency_Generation_Shedding_Schedule_Summary_Report (eirgrid.ie)
[36] Regulation - 2017/1485 - EN - EUR-Lex (europa.eu)

typically respond by reducing load in blocks at specified frequency triggers and restoring this demand once frequency recovers to a frequency threshold; this is termed static response. These different response characteristics have different impacts on frequency control and stability.

- **Deadband:** Different deadband settings combined with speed of response considerations can help deliver different capabilities to the TSOs, e.g. to support minor frequency deviations and provide frequency regulation narrow deadbands (+/-15 mHz) with a slower dynamic response are required, while for containing larger event driven frequency deviations response with a wider deadband is required:
    - Very fast dynamic reserves (like FFR) may require a deadband to prevent system oscillations. The required size of the deadband depends on the actual system conditions and type of reserve product and shall therefore be configurable within a certain range (e.g. +/-15 mHz – 500 mHz).
    - Static response provision can be tailored to provide response to mitigate larger frequency excursions, with a deadband range of +/- 200 – 700 mHz to ensure demand/generation response is outside the standard frequency range.
- **Droop or Trajectory:** The response of reserves shall preferably depend on the actual frequency deviation which is traditionally specified as droop on conventional generation and RES, and as a frequency trajectory for BESS. The required droop or trajectory depends on the actual system conditions, and we propose that it is configurable within a certain range (e.g. 200 to 500 mHz for frequency trajectory or 2 to 12% for droop).

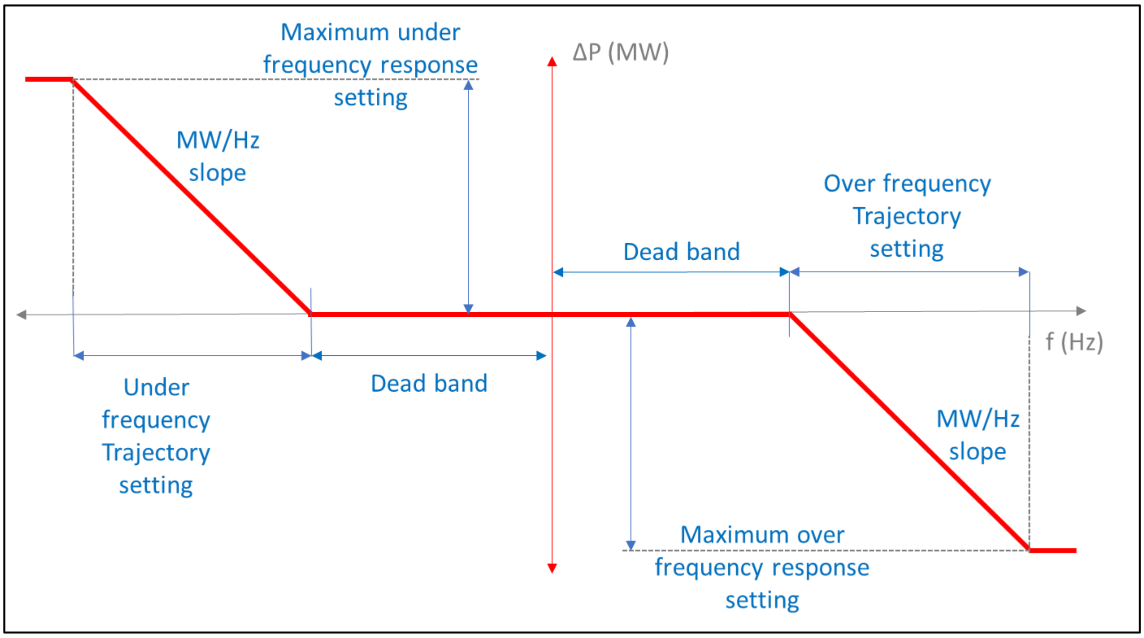


Figure 8 Quality aspects explained

- **Continuous provision**: The TSOs currently incentivise providers of FFR to continue to maintain, at the end of the FFR timeframe of 10 seconds following a frequency event, a MW response sustained beyond the FFR timeframe for the duration of the timeframe demanded of POR, SOR and TOR1, as required depending on the frequency event. Accordingly, there may be a need for reserves provided by one resource that can be continuously deployed. It is also important to note the detail outlined in the SEMC PIR decision paper which indicated that varying views on the bundling of products were expressed by stakeholders, with no clear consensus on the support for such an approach.

Consultation Questions:

Q.1 Do you agree with our assessments of the evolving system complexity, the likelihood of faster nadir and zenith occurrences and evolving risk of over-frequency?

Q.2 Are there additional considerations that you believe have not been fully explained or examined yet? Please elaborate on what you consider needs more detailed information.

Q.3 Do you agree with our conclusions that we need increased capabilities in FFR speed of response?

Q.4 Do you agree with our assessment of the need for downward reserve product definitions as part of the DASSA procurement process and to align with EU requirements?

Q.5 Do you agree with the quality aspects that we have outlined? Are there additional system need based quality aspects you believe are worthy of further consideration?

4. Changing Capabilities of Reserve Providers

The products POR, SOR, etc which have been in place for several decades are predominately designed on the characteristics of traditional providers of these services. These include conventional thermal (coal and gas) fired plant, and hydro storage. Since 2016 these have been procured under the DS3 System Services tariff based arrangements and amendments have been made to accommodate newer providers such as wind, solar, BESS and demand side response.

As noted above, with an ambition to reach an annual level of 80% renewable electricity supply in 2030 this will require the TSOs to operate the electricity system at to 95% SNSP by 2030 (see Figure 9). The All-Island system is evolving to integrate higher levels of interconnection, facilitating a changing demand mix (electrification of heat and transport and large volumes of LEUs and additional flexibility targets as required under the Climate Action plan, Demand side strategy and EU Electricity Market Design reform). This coupled with the work on the operational policy roadmap[37], for example, reductions in minimum numbers of conventional units & reductions in inertia floor levels will mean that by 2030 system services will predominately be provided by a range of low carbon technologies (RES, BESS), demand response and interconnectors.

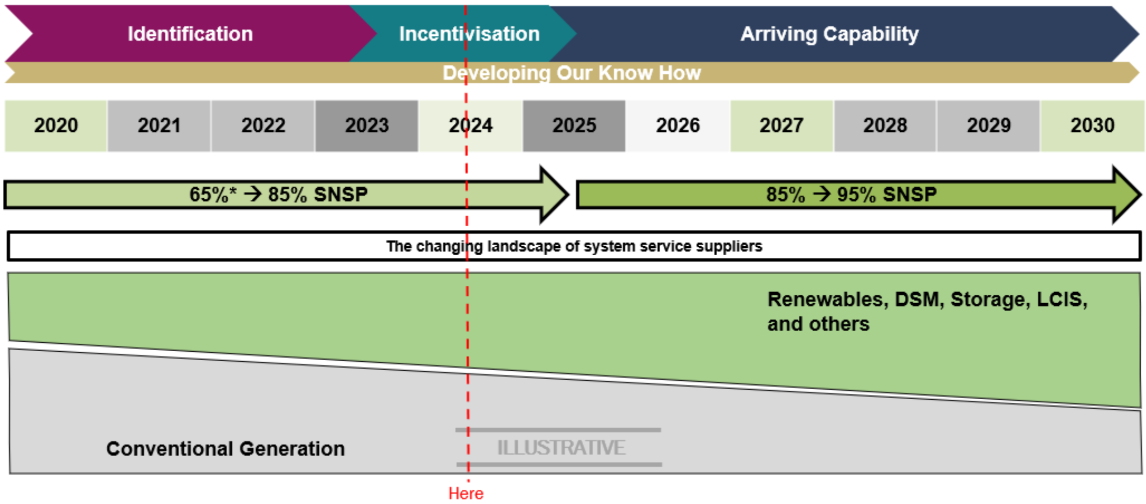


Figure 9 Increasing level of SNSP

As demonstrated under the DS3 Qualification Trial Process renewable technologies, BESS and demand response can provide the bulk of the reserve services – sometimes with different characteristics to conventional plant.

Figure 10 and Table 13 provide an overview of the different characteristics of older (conventional thermal based generation) and the future providers of system services (e.g. BESS, inverter-based non-synchronous wind and solar resources). The most apparent differences are that non-conventional (i.e. not thermal) future providers typically have a much shorter full activation time, but that in some cases the ability to sustain provision may be limited by resource capability (e.g. BESS) and needs to be accounted for in dimensioning and procurement. Furthermore, traditional dynamic response characteristics may become less frequent, and will drive the need for different approaches to procurement of upward and downward reserves and different specifications of reserve provision.

[37] Operational Policy Roadmap 2023-2030 (eirgrid.ie)

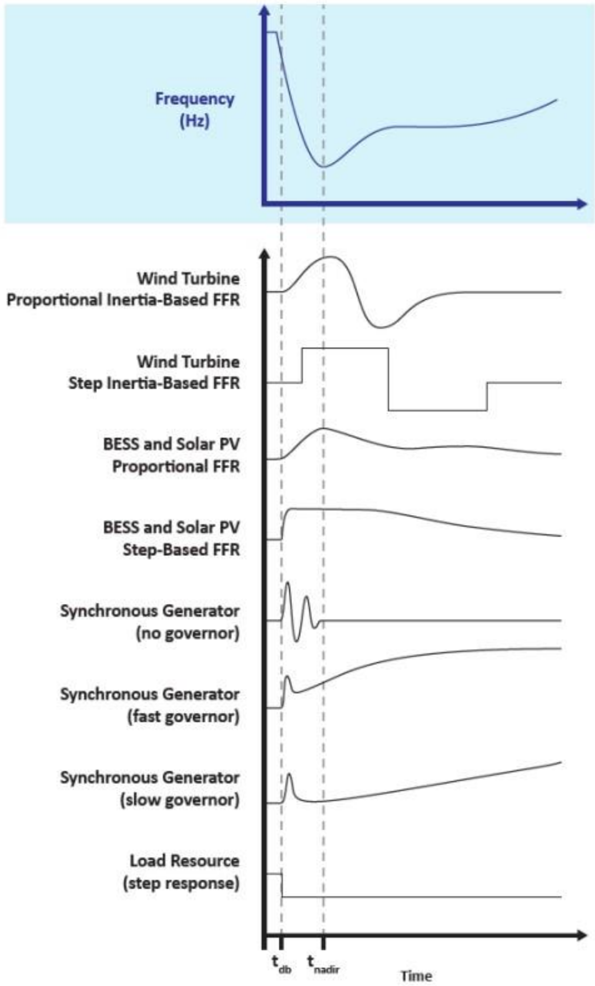


Figure 10: Illustration of Frequency Response from Different Resources (source: NERC)

Existing products based on: (Conventional plant to Wind)

Future providers of system services (Demand to Flywheel)

Plant	Full activation time	Time of sustained power	Dynamic/Static	Upward/Downward
Conventional plant	2-15s	Hours	Dynamic based on governor	Upward and Downward
Demand	< 150 ms	Seconds to hours	Static	Typically Upward
HVDC interconnector	< 150 ms - 1000 ms	Seconds to hours	Static and Dynamic	Upward and Downward
Hydro storage	<2-15s	Hours - dependant on resource availability	Dynamic based on governor	Upward and Downward
Wind	0.5-1s	Few seconds with recovery (through virtual inertia), hours if operated below max output. Ineffective at low wind speed	Static and Dynamic	Already used for downward reserve, already contracted for upward for FFR, POR, SOR etc
Solar PV	<150 ms - 1s	Seconds to hours if operated below max. output. Depending on sun.		Already contracted for POR, SOR etc in upward direction. Could provide downward
Battery Energy Storage Systems (BESS)	<150 ms-1s	Seconds to hours	Static and Dynamic	Upward and Downward - depending on state of charge
Super capacitor	<150 ms	Seconds	Static and Dynamic	
Flywheel	<150 ms	< 15 minutes	Dynamic	Upward and Downward

Table 13 Comparison of generic capability of providers of FFR, POR, SOR, TOR1[38]

[38] Sources: EirGrid/SONI and 'Overview of frequency control techniques in power systems with high inverter-based resources: Challenges and mitigation measures', Dlzar Al Kez et al., published in IET Smart Grid, 8 June 2023 and 'Amendment of the Market Ancillary Service Specification (MASS) – Very Fast FCAS' by AEMO, 7 October 2022.

These differences may be taken into account when mapping the System needs that are described in Section 3 on the required products.

Consultation Questions:

Q.6 Do you consider that we have accurately captured the generic characteristics of reserve providers? Are there additional considerations that you recommend we include?

5. Reserve Product Review

The TSOs have carried out a detailed review of the existing Reserve Service Products. This review included a high-level review of EU requirements, detailed power system simulation analysis, and consideration of current and future operational requirements. These aspects have informed the Upward reserve product definitions proposed in Section 5.3 and the Downward reserve product definitions in Section 5.4. We also provide a summary of all product definitions and technical requirements in Section 5.5.

5.1. EU Requirements

Balancing services in an EU context are separated into balancing capacity and balancing energy:

- Balancing Capacity: a volume of reserve capacity that a balancing service provider has agreed to hold and in respect to which the balancing service provider has agreed to submit bids for a corresponding volume of balancing energy to the TSO for the duration of the contract.
- Balancing Energy: energy used by TSOs to perform balancing and provided by a balancing service provider. Balancing service providers either offer balancing energy bids to their TSO following the obligation from a balancing capacity contract or voluntarily.

As outlined in the recent Consultation on FASS DASSA Auction arrangements[39] the procurement of system services is being developed in the context of the requirements related to Balancing capacity contained within relevant European Regulations and Directives:

- System Operation Guideline EU Regulation 2017/1485
  - Balancing product definitions.
  - Product dimensioning requirements- including the dimension both upward and downward products and reference incidents separately, as per Articles, 153 (FCR), 157(FRR), 160 (RR).
  - Product prequalification processes.
  - Minimum technical requirements of FCR, FRR and RR products.
- Electricity Balancing Guideline EU Regulation 2017/2195
  - Requirements to publish terms and conditions for Balancing service providers.
  - Standard balancing products and platform developments.
  - Conversion of Integrated scheduling process bids to standard balancing products.
  - Specific product requirements (for TSOs utilizing products in addition to the standard balancing products).
- Clean Energy Package Regulation 2019/943 and Directive 2019/944
  - Requirements to procure separately upward and downward balancing products (Article 6 of Regulation 2019/943).

EirGrid and SONI have detailed the load frequency control processes and dimensioning of reserves utilised on the island in the Load Frequency Control Block Operational Agreement (LFCBOA)[40] and Synchronous Area Operational Agreement (SAOA)[41] , both of which were last updated in 2022.

Also of relevance is work completed by EirGrid and SONI in relation to compliance with the Electricity Balancing Guideline and the publications on Local Balancing services Terms and Conditions in 2020[42].

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[39] FASS-DASSA-Consultation-Paper-March-2024-EirGrid.pdf

[40] S2-LFC-Block-Operational-Agreement-for-Ireland-and-Northern-Ireland-29.09.2022.pdf (eirgrid.ie)

[41] S1-SAOA-for-the-Ireland-and-Northern-Ireland-Synchronous-area-29.09.2022-(post-Title-2-approval).pdf (eirgrid.ie)

[42] EBGL Article 18 Local Terms and Conditions Proposal (eirgrid.ie)

5.1.1. Standard EU Balancing products and mapping of System service products

Previously mapping of the SEM reserve system services to the standard EU Balancing services has been undertaken within the above mentioned LFCBOA and SAOA, with additional detail available in the Weekly Operational Constraints update publication[43] . The current interpretations of the standard EU balancing products of FCR, FRR and RR utilised by the TSOs are provided below with additional detail provided in Table 14;

- Frequency Containment Reserves (FCR) means the active power reserves available to contain system frequency after the occurrence of an imbalance, and for EirGrid and SONI shall include Primary Operating Reserve (POR) and Secondary Operating Reserve (SOR) as defined in the EirGrid and SONI Grid Codes.
- Frequency Restoration Reserves (FRR) means the active power reserves available to restore system frequency to the nominal frequency, and for EirGrid and SONI shall include Tertiary Operating Reserve 1 (TOR 1) and Tertiary Operating Reserve 2 (TOR 2) as defined in the EirGrid and SONI Grid Codes.
- Replacement Reserves (RR) means the active power reserves available to restore or support the required level of FRR to be prepared for additional system imbalances. For the IE/NI synchronous area to progressively restore the activated FCR and FRR, and for EirGrid and SONI shall include Replacement Reserve as defined in the EirGrid and SONI Grid Codes.

Product	Definition in SOGL	Response timelines	Mapping by TSOs	All-Island Product response timelines
Frequency Containment Reserve	Active Power reserves available to contain system frequency after the occurrence of an imbalance	Defined per synchronous area. E.g. for CE, 50% response within 15 seconds, full response within 30 seconds, response to last 15 mins	Shall include POR and SOR as defined in EirGrid and SONI Grid codes	POR- 5-15 seconds SOR 15-90 seconds
Frequency restoration reserves (manual FRR only applicable in SEM region)	Active power reserves available to restore system frequency to the nominal frequency	Activation to start within 30 seconds, full activation time within 12.5 mins, minimum duration of product 5 mins (can be longer)	Includes Tertiary Operating Reserve 1 (TOR1) and Tertiary Operating Reserve 2 (TOR2) as defined in the EirGrid and SONI Grid Codes.	TOR1 90 sec- 5 mins TOR2 5 mins-20 mins
Replacement reserves	Active power reserves available	Full activation	Includes Replacement Reserve (RR) as	RRS 20 min - 60 mins

[43] Wk19_2024_Weekly_Operational_Constraints_Update.pdf (sem-o.com)

	to restore or support the required level of FRR to be prepared for additional system imbalances.	period of 30 mins – minimum duration of product of 15 mins, max duration is 60 mins	defined in the EirGrid and SONI Grid Codes. For the IE/NI synchronous area to progressively restore the activated FCR and FRR- for EirGrid and SONI shall include Replacement Reserve as defined in the EirGrid and SONI Grid Codes, however only with a duration of 1 hour	RRD 20 min - 60 min

Table 14 EU Standard products and FASS product mapping

Any updates to the mapping of System services to EU Balancing product definitions will be a feature of ongoing workstreams under the Future Markets EU Integration Programme[44], and any future Product Reviews.

An important aspect of both the System Operation Guideline (Articles, 153 (FCR), 157(FRR), 160 (RR)) and the Clean Energy package Internal Electricity Market Regulation (Article 6 of Regulation 2019/943) is the requirements on TSOs to separately determine the requirements for upward and downward reserves for FCR, FRR and RR, and to procure these separately.

The dimensioning of such services has to be determined by the reference incident – which is “ *the largest imbalance that may result from an instantaneous change of active power such as that of a single power generating module, single demand facility, or single HVDC interconnector or from a tripping of an AC line , or it shall be the maximum instantaneous loss of active power consumption due to the tripping of one or two connection points”.* The reference incident shall be determined separately for positive and negative direction.

As outlined in the EirGrid/SONI Load Frequency Control Block operational agreement and Synchronous Area Operational agreement the Dimensioning incident for the All-Island system is typically referred to as the imbalance that may arise from the loss of the largest single infeed (or outfeed) when determining the requirements for reserve scheduling.

Product	Dimensioning incident upward	Dimensioning incident downward
FCR- POR, SOR	75% of loss of LSI	At present negative reserve is not disaggregated, and operational constraints are utilised to ensure negative reserve is available. The TSOs also utilise an over-frequency generation shedding schedule with staggered frequency settings across the portfolio of windfarms involved (50.5-50.8 Hz for IE and 50.5 – 51.5 Hz for NI). The volume of this response is sufficient to cover LSO and has rarely been utilised. As part of this Product Review and recommendations the TSOs
FRR – TOR1 &TOR2	100% of loss of LSI	
RR- RRS& RRD	EirGrid and SONI acting in conjunction with each other consider the overall RR requirement for the IE/NI synchronous area. Due to the existing north south tie line operational constraint, EirGrid maintains a minimum level of RR in Ireland and SONI maintains a minimum level of RR in Northern Ireland. The present values of the limits are published in the Operational Constraints Update9 as part of the Active Northern	

[44] EirGrid/SONI Future Power Markets Newsletter April 2024

	Ireland Constraints table and the Active Ireland Constraints table. 2. The RR dimension rule is to ensure that there are adequate replacement reserves to restore the required amount of the FCR and the required amount of FRR in the positive direction.	are developing the requirements for downward products. The downward reserves will replicate the FCR/FRR mapping as per the upward services, with potentially further examination of this required as part of the Markets focused EU integration workstream[45].

Table 15 Dimensioning incidents for reserve products

Currently, procurement (by prequalification and tariff-based payment) of FFR, POR, SOR, TOR and Replacement reserves by the SEM TSOs is only undertaken for upward reserves. Downward reserves are currently scheduled via operational constraint protocols and system operator actions, and the current utilisation of negative reserves is not disaggregated into FRR or RR timelines, as outlined in the Load Frequency Control Block operational agreement.

5.1.2. Non-standard /Specific products

While the mapping in Table 14 above outlines the TSOs' previous mapping of the SEM system services to EU standard balancing products the TSOs recognise this does not perfectly align with the definition of EU products and additionally that the FFR product is a much faster product than the standard products. Further alignment is a topic for future work.

Within EBGL there is provision for TSOs who determine a need for additional products to ensure operational security to procure such products, but it requires additional information and a proposal to justify such products to be developed and approved by regulators.

Article 26 of the Electricity Balancing guideline outlines:

".. each TSO may develop a proposal for defining and using specific products for balancing energy and balancing capacity. This proposal shall include at least:

(a)a definition of specific products and of the time period in which they will be used;

(b) a demonstration that standard products are not sufficient to ensure operational security and to maintain the system balance efficiently or a demonstration that some balancing resources cannot participate in the balancing market through standard products;

(c) a description of measures proposed to minimise the use of specific products subject to economic efficiency;

(d) where applicable, the rules for converting the balancing energy bids from specific products into balancing energy bids from standard products;

(e) where applicable, the information on the process for the conversion of balancing energy bids from specific products into balancing energy bids from standard products and the information on which common merit order list the conversion will take place;

(f) a demonstration that the specific products do not create significant inefficiencies and distortions in the balancing market within and outside the scheduling area.

While international and European comparisons are an important aspect of the high-level review, it is also necessary to consider the unique characteristics of the All-Island Power System and the impact these can have on Reserve Product Requirements. It is a small synchronous area with only DC connections to other

[45] Future Markets Newsletter Feb 2024

power systems, high levels of renewable and intermittent generation and an increasing proportion of load that is constituted by highly sensitive (in terms of protection settings) large energy users. As a result, frequency deviations tend to be quicker and have a larger magnitude when a system event occurs on the All-Island Power System. This can lead to an increased need for fast acting reserve services, such as FFR, when compared with the large and well interconnected synchronous area of Continental Europe. The TSOs have been cognisant of these unique characteristics in the Reserve Product Review.

Further examination of the need for specific product determination and regulatory approval will be part of ongoing operational and market workstreams at the TSOs. The developments of the FASS arrangements and the proposed introduction of downward reserve (balancing capacity) products will help achieve greater alignment with EU requirements. With regard to full alignment/compliance the TSOs will work to ensure that the outcome of FASS Product Review consultation and final proposals for regulatory approval will help advance future alignment with EU requirements.

Consultation Questions:

Q.7 Do you agree with our assessment that the proposed DASSA reserve products will help achieve greater alignment with EU requirements?

5.2. Power System Simulations

The TSOs have conducted detailed power system simulation analysis to inform the recommendations on the Reserve Service Products and their definitions. This analysis was carried out using the TSOs' internal Transient Security Assessment Tool (TSAT). The purpose of this analysis was to investigate, in general, the potential need for Downward Service Products and to identify the necessary timeframes to be applied to product definitions (e.g. FFR) to securely operate the All-Island Power System. Analysis was conducted on an All-Island basis while being cognisant of any jurisdictional requirements.

The study scenarios consider the 2025 grid with the following main characteristics: one large synchronous condenser; All-Island inertia is not less than 23,000 MWs (EirGrid, March,2022)[46]; Moyle, EWIC and Greenlink HVDC interconnectors operational; new upcoming on-shore wind farms due to commission by 2025; new BESS; demand forecast for 2025 (including new LEUs), SNSP limit of 80%. Current System Service capabilities were included in the modelling.

In addition, the TSOs used the findings from previous simulation studies available, including studies conducted during the consideration and implementation of the over-frequency generation settings on windfarms to manage over-frequency.

5.3. Findings and Recommendations - Upward Reserve Services

The power system simulations and analysis highlighted the continued need for the portfolio of Upward Reserve Services to be maintained to ensure secure operation of the All-Island Power System and maintain Operating Security Standards (OSS[47]). In addition, the benefit and requirement for fast acting reserve services was identified in the simulations. This is primarily due to the increasing penetration of renewable generation and the reduction in the number of conventional generators operating on the All-Island Power System.

While we recognise that some legacy aspects of the reserve definitions as per the operational constraints requirements for regulating reserves will remain, we consider that until further studies have been conducted and analysis of potential frequency regulation products has been completed that this will not be a feature of these proposals. Additionally, the upgrades to scheduling and dispatch systems that are currently planned or underway will also enable a greater level of provision of new capabilities from

[46] EirGrid. (March,2022). *RoCoF Trial Closure Data Analyses and Studies.*
[47] Operating Security Standards (eirgrid.ie); SONI Operating Security Standards

alternative resources. Until these are in place, however, it is not possible to remove the need for these regulating resources. We will ensure that this is reviewed in later phases.

The current tariff and technical qualification-based procurement system (DS3 System services arrangements) enables providers to be contracted with individual characteristics of service provision captured in their contracts with the relevant TSO. Moving to an auction-based format requires detailed consideration of how to best procure the required system services while maintaining visibility and certainty for providers and TSOs alike. Our proposals in this section outline our considerations in how to procure standardised products while maintaining cohesion with the service provision that has enabled the transition to a system which can operate successfully with high levels of non-synchronous generation.

5.3.1. Key requirements for static and dynamic provision of Upward FFR, POR, SOR, TOR1 & TOR2

The following table outlines the key frequency trigger and trajectory capability requirements that apply to upward FFR, POR, SOR, TOR1 and TOR2 for both static and dynamic service provision.

Criteria for	*Trigger F_1*	*End of trajectory F_2*	*Reserve Steps Sizes*	*Reserve Step Triggers*
Static FFR, POR, SOR, TOR1 and TOR2	configurable for each step between: $49.3 \leq F_1 \leq 49.8$ Hz	Not applicable	1 or more steps of ≤ 75 MW for a single discrete step.	Smallest available discrete step in response at any time must be no less than 20 % of the MW value of the Providing Unit's largest available step at that time
Dynamic FFR, POR, SOR, TOR1 and TOR2	configurable in range: $49.5 \leq F_1 \leq 49.985$ Hz	configurable in range: $49.3 \leq F_2 \leq 49.8$ Hz and $F_1 - F_2 \geq 200$ mHz	Not applicable	Not applicable

Table 16 Key technical capability requirements for static and dynamic provision of FFR-TOR2

Within the ranges outlined above the TSOs can specify the following technical characteristics of a providing unit as appropriate, and these shall be implemented by the Providing Unit within 60 seconds of specification. In practice this may be implemented by, for example, the ability to change BESS modes of operations;

- Enabling and disabling of reserve response,
- Alterations to the Reserve Trigger,
- Response Trajectory,
- Reserve Step Sizes
- Reserve Step Triggers

Sections 5.3.2 - 5.3.8 provide further detail on each individual Upward product of FFR, POR, SOR, TOR1&TOR2, our recommendations on Replacement Reserve, and considerations of bundled Upward service provision.

5.3.2. Upward FFR (Fast Frequency Response)

The TSOs propose a change to the standard definition of the current FFR product to "*the additional MW Output or MW Reduction required compared to the pre-incident MW Output or MW Reduction, which is fully available from a Providing Unit within 1 seconds after the start of an Event and sustainable up to 10* *seconds after the start of the Event."* The TSOs are recommending two additional subcategories of FFR response faster than 1 second and make a distinction between static and dynamic FFR.

Table 17 provides the minimum key requirements of the three response time subcategories of Upward FFR, both for Dynamic and Static response. While this will add complexity to the auction clearing design the TSOs consider these subcategories are necessary to be able to ensure FFR procurement successfully delivers the operational characteristics of FFR support necessary to enable secure operation and facilitate service provision from a range of different technology types. As outlined in Section 5.3.1 the TSOs propose to maintain the ability to specify key technical aspects e.g. frequency trigger set points and trajectory as required for system operational needs.

Upward FFR	I	II	III	IV	V	VI
Response capability	**Dynamic**			**Static**		
Full Activation Time	**150ms**	**≤300ms**	**≤1s**	**150ms**	**≤300ms**	**≤1s**
Response sustainable up to	10s after the Event					
Reserve Trigger configurable within range (F_1 in Figure 11)	$49.5 \le F_1 \le 49.985$ Hz			Configurable for each step between: $49.3 \le F_1 \le 49.8$ Hz		
End of FFR Trajectory[48] configurable within range (F_2 in Figure 11Figure 11)	$49.3 \le F_2 \le 49.8$ Hz and $F_1 - F_2 \ge 200$ mHz			Not applicable		
Reserve Steps Sizes	Not applicable			1 or more steps of ≤ 75 MW for a single discrete step.		
Reserve Step Triggers	Not applicable			Smallest available discrete step in response at any time must be no less than 20 % of the MW value of the Providing Unit's largest available step at that time		

Table 17 Proposed key Upward FFR requirements

[48] The term FFR Trajectory is used in the table to define the frequency range in which the response needs to increase linearly from 0% to 100% of the *maximum response* contracted from the reserve providing resource. The term Reserve Droop has a strong relation with the trajectory, but relates to the *nominal capacity of the reserve providing unit*. For example, a Reserve Droop of 4% indicates that a unit of 100 MW increases its response to a frequency change with - 50 MW/Hz. For a FFR Trajectory of 500 mHz this would be equivalent of a maximum response of 25 MW. Or conversely, if a 250 mHz FFR Trajectory would be applied for the same 25 MW at the same unit, a Reserve Droop of 2% would be required.

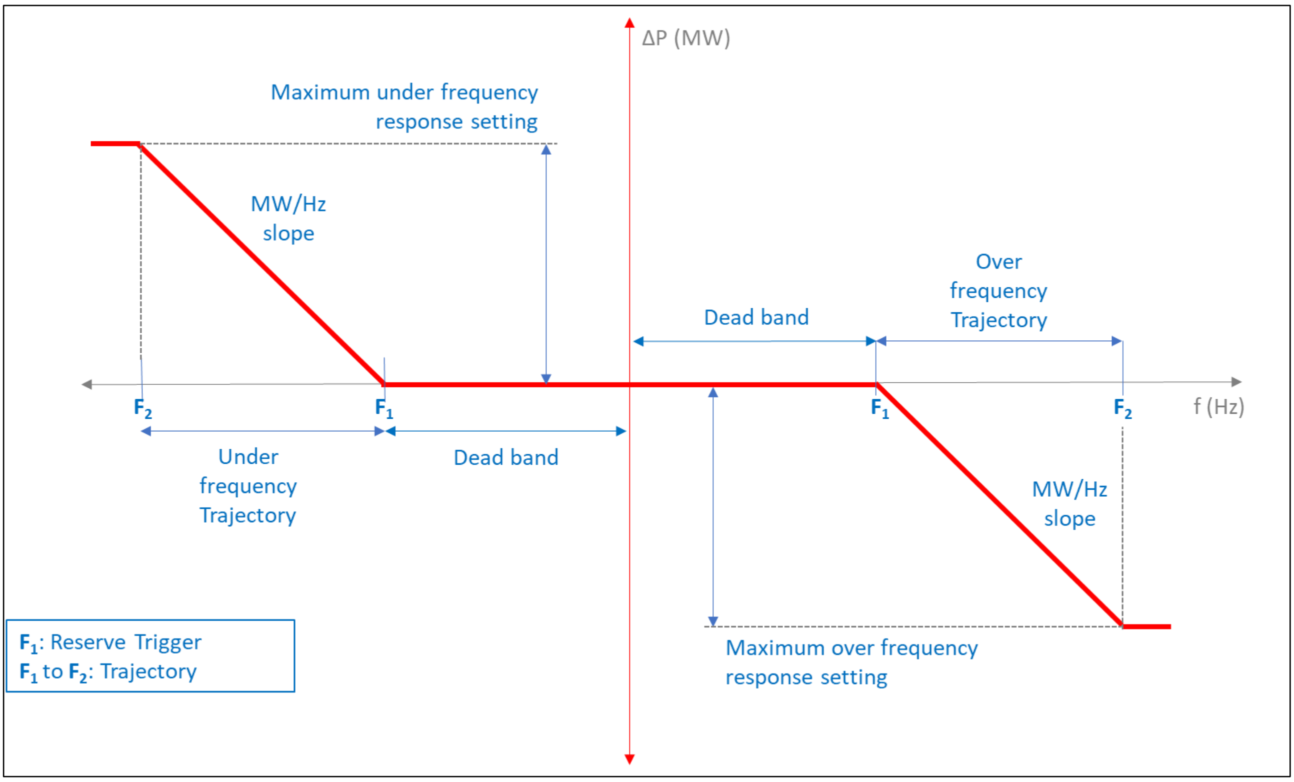


Figure 11 Illustration of Reserve Trigger (F1) and Reserve Trajectory (F_1 to F_2).

Additionally, FFR will include a requirement that states that the extra energy provided in the 1 to 10 second timeframe by the increase in MW output must be greater than any loss of energy in the 10 to 20 second timeframe due to a reduction in MW output below the initial MW output (i.e. the hatched blue area must be greater than the hatched green see Figure 12 below).

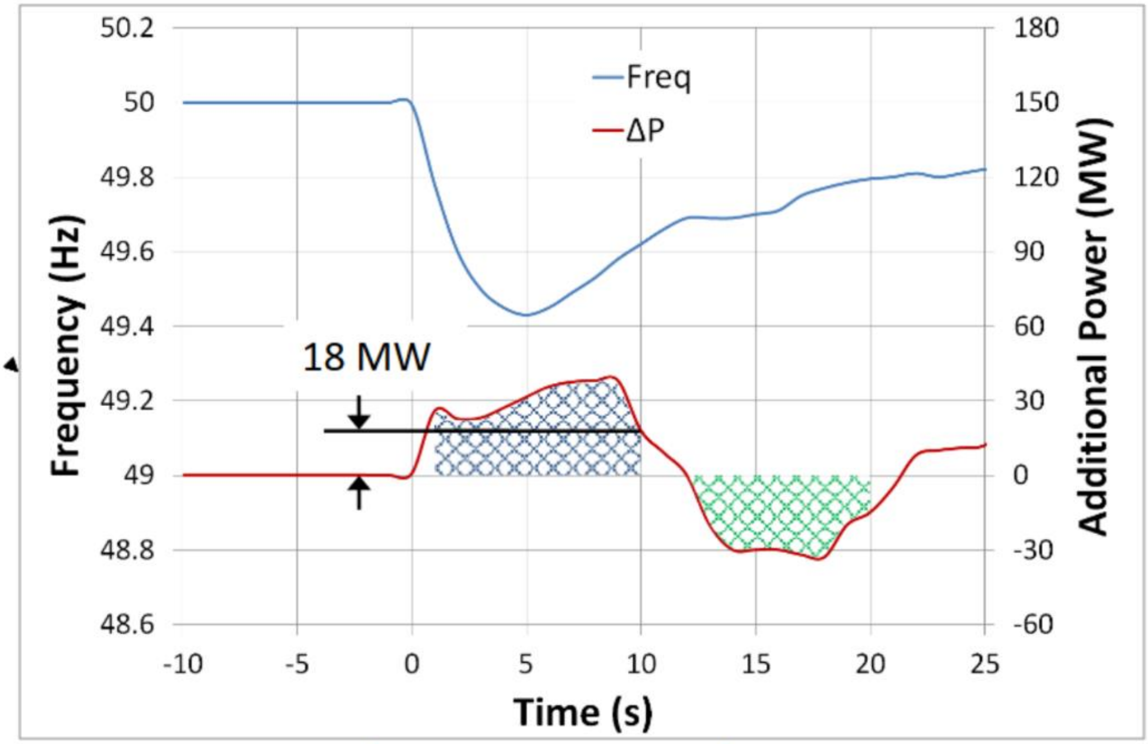


Figure 12 Energy requirements for FFR

TSOs' Proposal:

Update FFR definition:

The standard FFR definition will change to require service providers to provide their full FFR capability within 1 seconds.

Introduce subcategories of FFR to procure sufficient quantities of Fast FFR provision (FAT: 150ms, ≤300ms and ≤1s).

TSOs' Proposal:

Update Quality aspects FFR:

We are proposing to update the quality aspects of FFR. The TSOs may require different response characteristics of FFR provision. To account for this, the TSOs are proposing to update the FFR definition to require service providers' capability to provide quality aspects within a specified range, which are configurable by the TSOS, for example via a SCADA instruction or other suitable method.

- Reserve Trigger for shall be configurable between 49.5 and 49.985 Hz for Dynamic Response and between 49.3 - 49.8 Hz for Static Response.
- For dynamic FRR, trajectory shall be configurable in such a way that the response increases linearly between zero response at the Reserve Trigger to 100% response at a Frequency setting that is configurable between 49.3 and 49.8 Hz.

5.3.3. Upward POR (Primary Operating reserve)

Upward POR should act to help contain the under-frequency deviation caused by a system event following the activation of FFR, and should help to begin the recovery of frequency post event. The TSOs propose to reword the current upward POR definition to the following; "*(POR) is the automatic response (additional energy output and/or reduction in Demand) to System Frequency changes released increasingly from the time of Frequency change with a full activation time of 5 seconds, and sustainable until at least 15 seconds from the time of Frequency change.*"

Please refer to Table 16 for additional detail on Frequency trigger range capability and response trajectory etc for Dynamic and Static providers.

Upward POR	*I (DPOR)*	*II*
Response capability	**Dynamic, provided by Regulating Sources**	**Static**
Full Activation Time	≤5s	
Response sustainable up to	15s after the Event (at least 15s in NI)	

Table 18 Key POR requirements

5.3.4. Upward SOR (Secondary Operating Reserve)

Upward 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 EirGrid Grid code defines SOR as "*the additional MW output (and/or reduction in Demand) required compared to the pre-incident* *output (or Demand), which is fully available and sustainable over the period from 15 to 90 seconds following an Event*". The SONI grid code defines SOR as the additional MW output compared to the pre-incident output, which is fully available and sustainable over the period from 15 to 90 seconds following an Event.

We are not proposing any change to the definition of the Upward SOR product.

Please refer to Table 16 for additional detail on Frequency trigger range capability and response trajectory etc.

Upward SOR	*I*	*II*
Response capability	**Dynamic**	**Static**
Full Activation Time	15s	
Response sustainable up to	90s after the Event	

Table 19 Key SOR requirements

TSOs' Proposal:

No change to current SOR technical requirements of 15 seconds FAT and response duration of 90 seconds.

Clarification provided in Table 16 on Frequency response trajectory, trigger capabilities, reserve step sizes and reserve step triggers.

5.3.5. Upward TOR1 (Tertiary Operating Reserve 1)

Upward TOR1 takes over from SOR and begins to restore the frequency level following a system event. The EirGrid Grid Code definition is Tertiary Operating Reserve band 1 (TOR1) is "*the additional MW output (and/or reduction in Demand) required compared to the pre-incident output (or Demand) which is fully available and sustainable over the period from 90 seconds to 5 minutes following an Event*". The SONI Grid defines TOR1 as the additional MW output required compared to the pre-Event output which is fully available and sustainable from 90 seconds to 5 minutes following an Event.

We are not proposing any change to the definition of the Upward TOR1 product.

Please refer to Table 16 for additional detail on Frequency trigger range capability and response trajectory etc.

Upward TOR1	*I*	*II*
Response capability	**Dynamic**	**Static**
Full Activation Time	90s	
Response sustainable up to	5 minutes after the Event	

Table 20 Key TOR1 requirements

TSOs' Proposal:

No change to current TOR1 technical requirements of 90 seconds FAT and response duration of 5 mins.

Please refer to Table 16 for additional detail on Frequency trigger range capability and response trajectory etc.

5.3.6. Upward TOR2 (Tertiary Operating Reserve 2)

Upward TOR2 takes over from TOR1 and continues to restore the frequency level following a system event. The EirGrid Grid Code definition is TOR2 is "*the additional MW output (and/or reduction in*

Demand) required compared to the pre-incident output (or Demand) which is fully available and sustainable over the period from 5 minutes to 20 minutes following an Event". The SONI Grid Code defines TOR 2 as the additional MW output required compared to the pre-Event output which is fully available and sustainable from 5 minutes to 20 minutes following an 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. TOR2 is provided on the basis of automated frequency response (for a sustained frequency event) or on the basis of a dispatch instruction from the control centre.

We are not proposing any change to the definition of the Upward TOR2 product.

Please refer to Table 16 for additional detail on Frequency trigger range capability and response trajectory etc.

Upward TOR2	*I*	*II*
Response capability	**Dynamic**	**Static**
Full Activation Time	5 minutes	
Response sustainable up to	20 minutes after the Event	

Table 21 Key TOR2 requirements

TSOs' Proposal:

No change to current TOR2 technical requirements of 5 minutes FAT and 20 min of continuous response duration.

Please refer to Table 16 for additional detail on Frequency trigger range capability and response

5.3.7. Upward RR (Replacement Reserve)

We are proposing to remove the distinction between synchronised and desynchronised Replacement Reserve for the DASSA auction. This is to help align with EU standard definition[49] and to reflect the changing service provider mix, many of which now have the capability for fast activation timeframes. The proposed definition of Upward replacement reserve is "*the additional MW output (and/or reduction in Demand) required compared to the pre-event/dispatch output (or Demand) which is fully available and sustainable over the period from 20 minutes to 1 hour following an event/dispatch instruction*". Replacement reserve should take over from TOR2 and maintain the frequency at a stable level. Providers of RR will be manually dispatched by the control centre and will be required to achieve their full RR output 20 minutes after the system event/dispatch instruction occurs and to maintain this provision until 1 hour after the system event.

Upward RR	
Full Activation Time	20 minutes
Response sustainable up to	1 hour after the Event

Table 22 Key RR requirements

TSOs' Proposal:

Change the upward RRS and RRD Definitions to define a single Replacement Reserves (RR) product that will require a FAT of 20 minutes with continuous provision out to 1 hour. This proposed product does not distinguish between synchronised and desynchronised.

[49] As per Article 6 in the Implementation framework for exchange of replacement reserves.

5.3.8. Bundled Upward Products

The TSOs consider there may be a need to procure or incentivise the bundled procurement of Upward reserves that can be continuously deployed from FFR or POR up to TOR1 or TOR2 by one resource as it is the case today.

TSOs' Proposal:

Consider the introduction of a bundled reserve procurement.

We are considering the introduction in the procurement of a bundled reserve product that can be continuously deployed from FFR or POR up to TOR1 or TOR2 by a single resource.

Consultation Questions:

Q.8 Do you have any views on the outlined requirements on frequency trigger capability, response trajectory capability, reserve step size & reserve step triggers for Upward reserve products? Please elaborate on any technical concerns you may have with regard to these proposals.

Q.9 Do you consider the standard definition of the FFR product which requires delivery of response between 1s-10s as proposed provide sufficient certainty for asset operators and investors?

Q.10 Do you consider our recommendations to require procurement of sub-categories of faster response FRR with full activation times of 150ms; 300ms & 1 sec enable industry providers to have sufficient incentives to bid in the auction structures? Are there additional aspects you consider should be included in the definition? Please elaborate in your response on aspects you consider need to be included.

Q.11 Do you agree with our proposal to remove the distinction between synchronised and desynchronised replacement reserve products (current DS3 definitions) to better reflect a changing service provider mix and to achieve better alignment with EU requirements? Please elaborate in your response if you have detailed concerns.

Q.12 Do you have any views on our consideration of procurement of a bundled upward reserve product? Please outline your views and any concerns you may have on this proposal.

Q.13 The TSOs recognise the potential provision of Upward dynamic reserves with discrete reserve step-sizes. We are not proposing this type of response as part of this DASSA Reserve Product Review. Please outline your views and any concerns you may have on this proposal.

5.4. Downward Reserve Services

Historically, for the All-Island system the loss of large generation units or importing interconnector has been the largest risk to frequency stability, hence the focus on the procurement and incentivisation of upward Reserve Services. For a changing power system with larger volumes of large energy users (individual demand sites) and greater levels of interconnection (4 operational interconnectors by 2027 as opposed to 2 in 2024), the need for Downward Reserve Services is increasingly important. Furthermore, as the transition to a low carbon power system advances, and the level of conventional generation reduces, there is reduced capability for a frequency rise to be arrested by a reduction in conventional generation output. Power system simulations and operational experience highlight the need for Downward Reserve Services to be provided across all Reserve Service timeframes.

As outlined in Section 5.1 the TSOs are also obliged under EU compliance requirements to dimension and procure separately downward reserves to manage system security in line with appropriate reference incidents in both directions.

Therefore, in line with EU requirements, and evolving system security requirements the TSOs are proposing to introduce Downward Reserve versions of all the Upward Reserve Products.

TSOs' Proposal:

Introduce Downward Reserve Versions across all Reserve Services. Further detail on each service is provided in the sections below.

5.4.1. Key requirements for static and dynamic provision of Downward FFR, POR, SOR, TOR1 & TOR2

The following table outlines the key frequency trigger and trajectory capability requirements that apply to Downward Static or Dynamic FFR, POR, SOR, TOR1 and TOR2 provision.

Criteria for	*Trigger F_1*	*End of trajectory F_2*	*Reserve Steps Sizes*	*Reserve Step Triggers*
Static FFR, POR, SOR, TOR1 and TOR2	configurable in range for each step: $50.2 \leq F_1 \leq 50.7$ Hz	Not applicable	1 or more steps of ≤ 75 MW for a single discrete step.	Smallest available discrete step in response at any time must be no less than 20 % of the MW value of the Providing Unit's largest available step at that time
Dynamic FFR, POR, SOR, TOR1 and TOR2	configurable in range: $50.015 \leq F_1 \leq 50.5$ Hz	configurable in range: $50.2 \leq F_2 \leq 50.7$ Hz and $F_2 - F_1 \geq 200$ mHz	Not applicable	Not applicable

Table 23 Key technical capability requirements for static and dynamic provision of Downward FFR-TOR2

Within the ranges outlined above the TSOs can specify the following technical capabilities of a providing unit as appropriate, and these shall be implemented by the Providing Unit within 60 seconds of specification. In practice this may be implemented by, for example, the ability to change BESS modes of operations;

- Enabling and disabling of reserve response,
- Alterations to the Reserve Trigger,
- Response Trajectory,
- Reserve Step Sizes
- Reserve Step Triggers

Sections 5.4.2 - 5.4.8 provide further detail on each individual Downward product of FFR, POR, SOR, TOR1&TOR2, our recommendations on Downward Replacement Reserve, and considerations of bundled Downward service provision.

5.4.2. Downward FFR (Fast Frequency Response)

To assist in managing the increasing risk of sudden loss of the LSO (large energy user or exporting interconnector) the TSOs propose the standard definition of a downward FFR product as "*the amount of energy (MW) reduction /withdrawal (i.e. demand increase or generation decrease) compared to the pre-event unit MW Output or MW Demand, which is fully available from a Providing Unit within 1 seconds* *after the start of an Event and sustainable up to 10 seconds after the start of the Event."* The TSOs are recommending two additional subcategories of FFR response faster than 1 second and make a distinction between static and dynamic FFR.

Additionally, FFR will include a requirement that states that the reduction in energy provided in the 1 to 10 second timeframe by the decrease in MW output/or increase in demand must be greater than any subsequent increase in energy output or reduction in demand in the 10 to 20 second timeframe, essentially a mirror of the requirements of Upward FFR, as outlined in Section 5.3.2.

Table 24 provides the minimum requirements of the three subcategories of Downward FFR, both for Dynamic and Static response, recognising that this will increase complexity of the auction clearing design. The contracting TSO (SONI or EirGrid) shall have the ability to specify the Reserve Trigger, Reserve Droop, FFR Trajectory, Reserve Step Sizes and Reserve Step Triggers as appropriate and determined by system conditions, within the ranges outlined in Table 23.

Downward FFR	I	II	III	IV	V	VI
Response capability	**Dynamic**			**Static**		
Full Activation Time	**150ms**	**≤300ms**	**≤1s**	**150ms**	**≤300ms**	**≤1s**
Response sustainable up to	10s after the Event					
Reserve Trigger configurable within range (F_1 in Figure 11)	$50.015 \leq F_1 \leq 50.5$ Hz			$50.2 \leq F_1 \leq 50.7$ Hz		
End of FFR Trajectory configurable[48] within range (F_2 in Figure 11)	$50.2 \leq F_2 \leq 50.7$ Hz and $F_2 - F_1 \geq 200$ mHz			Not applicable		
Reserve Steps Sizes	Not applicable			1 or more steps of ≤ 75 MW for a single discrete step.		
Reserve Step Triggers	Not applicable			Smallest available discrete step in response at any time must be no less than 20 % of the MW value of the Providing Unit's largest available step at that time		

Table 24 Proposed key Downward FFR requirements

TSOs' Proposal:

New downward FFR definition:

The downward standard FFR definition will require service providers to provide their full FFR capability within 1 second.

Introduce subcategories of FFR to procure sufficient quantities of Fast FFR provision (150ms, 300ms and sub 1s).

TSOs' Proposal:

Quality aspects for downward FFR:

We are proposing similar quality aspects for downward FFR as for upward FRR. The TSOs may require different response characteristics of FFR provision. To account for this, the TSOs will require the quality aspects to be within a specified range, which are configurable by the TSOs, for example via a SCADA instruction or other suitable method:

- Reserve Trigger for shall be configurable between 50.015 and 50.5 Hz for Dynamic Response and between 50.2 - 50.7 Hz for Static Response.
- For dynamic FFR, trajectory shall be configurable in such a way that the response decreases linearly between zero response at the Reserve Trigger to 100% response at a Frequency setting that is configurable between 50.2 and 50.7 Hz.

5.4.3. Downward POR (Primary Operating reserve)

Downward POR should act to help contain the over-frequency deviation caused by a system event following the activation of downward FFR, and should help to begin the recovery of frequency post event. The TSOs propose to define downward POR as the following; *"Downward POR is the automatic energy output reduction (generation output decrease or increase in demand) in response to System Frequency changes, released increasingly from the time of Frequency change with a full activation time of 5 seconds, and sustainable until at least 15 seconds from the time of Frequency change"*.

Downward POR	*I*	*II*
Response capability	**Dynamic**	**Static**
Full Activation Time	≤5s	
Response sustainable up to	15s after the Event (at least 15s in NI)	

Table 25 Proposed key Downward POR requirements

Please refer to Table 23 for additional detail on Downward POR Frequency trigger range capability and response trajectory etc.

TSOs' Proposal:

Downward POR is the automatic energy output reduction (generation output decrease or increase in demand) in response to System Frequency changes, released increasingly from the time of Frequency change with a full activation time of 5 seconds, and sustainable until at least 15 seconds from the time of Frequency change."

Clarification provided in Table 23 on Frequency response trajectory, trigger capabilities, reserve step sizes and reserve step triggers.

5.4.4. Downward SOR (Secondary Operating Reserve)

Downward SOR will take over from downward 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 definition is proposed as *"Downward SOR is the additional energy output reduction (generation output decrease or increase in demand) in response to System Frequency changes, released increasingly from the time of Frequency change with a full activation time of 15 seconds and sustainable out to 90 seconds following an Event"*.

Downward SOR	*I*	*II*
Response capability	**Dynamic**	**Static**
Full Activation Time	15s	
Response sustainable up to	90s after the Event	

Table 26 Proposed key Downward SOR requirements

Please refer to Table 23 for additional detail on Downward POR Frequency trigger range capability and response trajectory etc.

TSOs' Proposal:

Downward SOR is the additional energy output reduction (generation output decrease or increase in demand) in response to System Frequency changes, released increasingly from the time of Frequency change with a full activation time of 15 and sustainable out to 90 seconds following an Event.

Clarification provided in Table 23 on Frequency response trajectory, trigger capabilities, reserve step sizes and reserve step triggers.

5.4.5. Downward TOR1 (Tertiary Operating Reserve 1)

Downward TOR1 takes over from SOR and should begin to restore the frequency level following a system event. Providers of TOR1 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 definition is proposed as "*Downward TOR1 is the additional energy output reduction (generation output decrease or increase in demand), compared to pre-incident output or demand, which is fully available within 90 seconds and sustainable for 5 minutes following an Event*".

following an Event. OC.4.6.3.5.2 Tertiary Operating Reserve band 2 (TOR2) is the additional MW output (and/or reduction in Demand) required compared to the pre-incident output (or Demand) which is fully available and sustainable over the period from 5 minutes to 20 minutes following an Event.

Downward TOR1	*I*	*II*
Response capability	**Dynamic**	**Static**
Full Activation Time	90s	
Response sustainable up to	5 minutes after the Event	

Table 27 Proposed key Downward TOR1 requirements

Please refer to Table 23 for additional detail on Downward POR Frequency trigger range capability and response trajectory etc.

TSOs' Proposal:

Downward TOR1 is the additional energy output reduction (generation output decrease or increase in demand), compared to pre-incident output or demand, which is fully available within 90 seconds and sustainable for 5 minutes following an Event.

Clarification provided in Table 23 on Frequency response trajectory, trigger capabilities, reserve step sizes and reserve step triggers.

5.4.6. Downward TOR2 (Tertiary Operating Reserve 2)

Downward TOR2 shall take over from TOR1 and continue to restore the frequency level following a system event. TOR2 will normally require a manual dispatch action from the control centre to activate the service. 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 definition is proposed as "*Downward TOR2 is the additional energy output reduction (generation output decrease or increase in demand) compared to pre-incident/dispatch output or demand, fully available within 5 minutes and sustainable for 20 minutes following an Event*".

Downward TOR2	*I*	*II*
Response capability	**Dynamic**	**Static**
Full Activation Time	5 minutes	
Response sustainable up to	20 minutes after the Event	

Table 28 Proposed key TOR2 requirements

Please refer to Table 23 for additional detail on Downward POR Frequency trigger range capability and response trajectory etc.

TSOs' Proposal:

Downward TOR2 is the additional energy output reduction (generation output decrease or increase in demand) compared to pre-incident/dispatch output or demand, fully available within 5 minutes and sustainable for 20 minutes following an Event.

Clarification provided in Table 23 on Frequency response trajectory, trigger capabilities, reserve step sizes and reserve step triggers.

5.4.7. Downward RR (Replacement Reserve)

We are proposing to procure a downward Replacement Reserve product for the DASSA auction. Replacement reserve should take over from TOR2 and maintain the frequency at a stable level. Providers of RR will be manually dispatched by the control.

The proposed definition of downward replacement reserve is "*the additional energy output reduction (Generation output decrease or increase in Demand) required compared to the pre-incident (dispatch) output or demand which is fully available and sustainable over the period from 20 minutes to 1 hour following an event/dispatch instruction*".

Downward RR	
Full Activation Time	20 minutes
Response sustainable up to	1 hour after the Event

Table 29 Proposed key RR requirements

TSOs' Proposal:

Downward replacement reserve is the additional energy output reduction (Generation output decrease or increase in Demand) required compared to the pre-incident (dispatch) output or demand which is fully available and sustainable over the period from 20 minutes to 1 hour following an event/dispatch instruction.

5.4.8. Bundled Downward Products

The TSOs consider that a continuous deployment of downward reserve response across a range of product timeframes from individual units may be of value. Accordingly, there may be a need to procure or incentivise the bundled procurement of downward reserves that can be continuously deployed from FFR or POR up to TOR1 or TOR2 by one resource.

TSOs' Proposal:

Consider the procurement of a bundled reserve product.

We are considering the introduction the procurement of a bundled downward reserve product that can be continuously deployed from FFR or POR up to TOR1 or TOR2 by a single resource.

Consultation Questions:

Q.14 Do you have any views on the outlined requirements on frequency trigger capability, response trajectory capability, reserve step size & reserve step triggers for Downward reserve products? Please elaborate on any technical concerns you may have with regard to these proposals.

Q.15 Do you consider our proposed downward reserve definitions to be appropriate for an evolving system? Are there alternative definitions that you would recommend to ensure efficient service procurement and provision?

Q.16 Do you have any views on our consideration of procurement of a bundled downward reserve product? Please outline your views and any concerns you may have on this proposal.

Q.17 The TSOs recognise the potential provision of Downward dynamic reserves with discrete reserve step-sizes. We are not proposing this type of response as part of this DASSA Reserve Product Review. Please outline your views and any concerns you may have on this proposal.

5.5. Summary Reserve Products

Table 30 summarises the response times and response duration for the different types of reserves and their categories as proposed in section 5.3 and 5.4. The table applies to both Upward and Downward Reserves which are to be contracted separately.

Reserve product	Category	FAT	Response duration
FFR - Static response	I	150 ms	Response sustainable up to up to 10 s after the event
	II	≤ 300 ms	
	III	≤ 1s	
FFR - Dynamic response	IV	150 ms	
	V	≤ 300 ms	
	VI	≤ 1s	
Static POR	I	≤ 5 s	up to 15 s after the event
Dynamic POR	II		
Static SOR	I	15 s	up to 90 s after the event
Dynamic SOR	II		
Static TOR1	I	90 s	up to 5 minutes after the event
Dynamic TOR1	II		
Static TOR2	I	5 minutes	up to 20 minutes after the event
Dynamic TOR2	II		
RR		20 minutes	up to 1 hour after the event

Table 30: Response times and response duration for Upward and Downward Reserves

Table 31 specifies additional key requirements for *Upward* FFR, POR, SOR, TOR1 and TOR2, separately for Static and Dynamic categories, while Table 32 shows similar (but mirrored) requirements for the Downward products and categories. These requirements include the capability ranges for Reserve Trigger, Trajectory[50], Reserve Step Sizes and Reserve Step Triggers, which the contracting TSOs may request to change in real-time as appropriate and determined by system conditions. Enabling and disabling of reserve response, alterations to the Reserve Trigger, Trajectory, Reserve Step Sizes and Reserve Step Triggers shall be implemented by the Providing Unit within 60 seconds of specification.

[50] The term FFR Trajectory is used in the table to define the frequency range in which the response needs to increase linearly from 0% to 100% of the *maximum response* contracted from the reserve providing resource. The term Reserve Droop has a strong relation with the trajectory, but relates to the *nominal capacity of the reserve providing unit*. For example, a Reserve Droop of 4% indicates that a unit of 100 MW increases its response to a frequency change with - 50 MW/Hz. For a FFR Trajectory of 500 mHz this would be equivalent of a maximum response of 25 MW. Or conversely, if a 250 mHz FFR Trajectory would be applied for the same 25 MW at the same unit, a Reserve Droop of 2% would be required.

Criteria for	*Trigger F_1*	*End of trajectory F_2*	*Reserve Steps Sizes*	*Reserve Step Triggers*
Static FFR, POR, SOR, TOR1 and TOR2	configurable for each step between: $49.3 \leq F_1 \leq 49.8$ Hz	Not applicable	1 or more steps of ≤ 75 MW for a single discrete step.	Smallest available discrete step in response at any time must be no less than 20 % of the MW value of the Providing Unit's largest available step at that time
Dynamic FFR, POR, SOR, TOR1 and TOR2	configurable in range: $49.5 \leq F_1 \leq 49.985$ Hz	configurable in range: $49.3 \leq F_2 \leq 49.8$ Hz and $F_1 - F_2 \geq 200$ mHz	Not applicable	Not applicable

Table 31: Additional key requirements for Upward FFR, POR, SOR, TOR1 and TOR2 (refer to Figure 13)

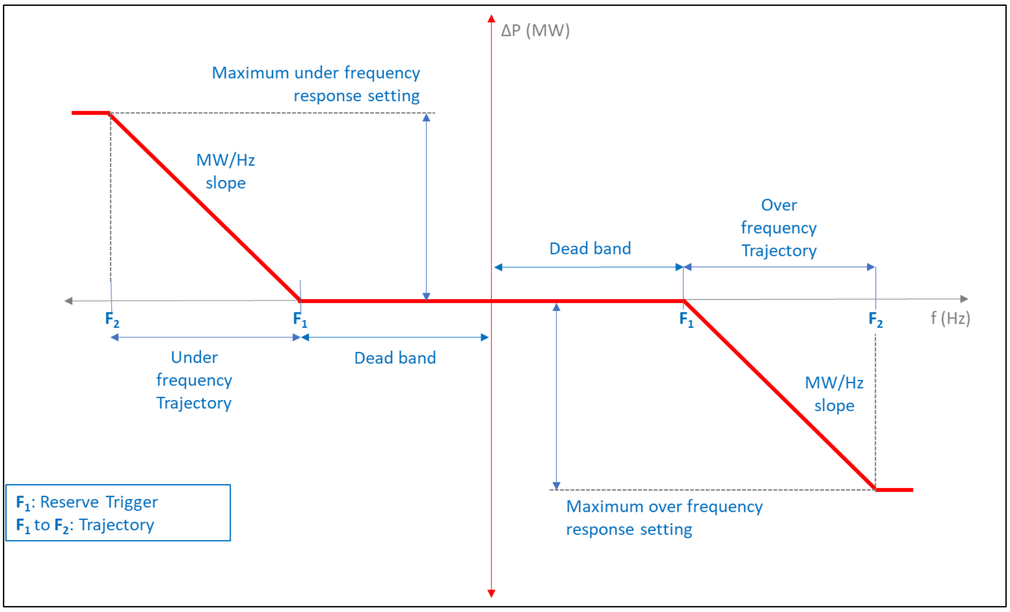


Figure 13: Illustration of Reserve Trigger F_1 and Trajectory F_1 - F_2

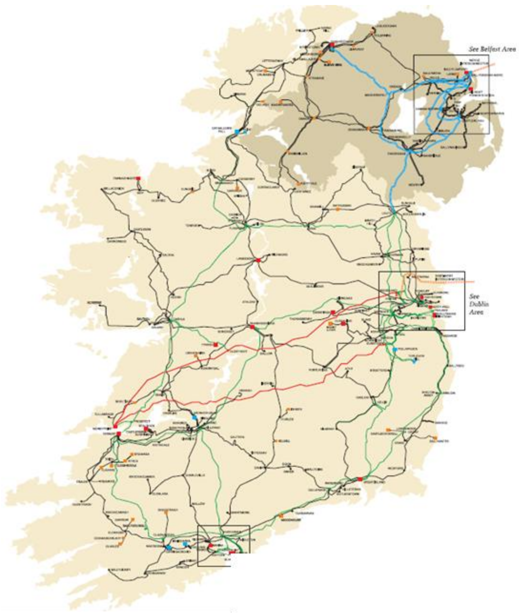
Criteria for	*Trigger F_1*	*End of trajectory F_2*	*Reserve Steps Sizes*	*Reserve Step Triggers*
Static FFR, POR, SOR, TOR1 and TOR2	configurable in range for each step: $50.2 \leq F_1 \leq 50.7$ Hz	Not applicable	1 or more steps of ≤ 75 MW for a single discrete step.	Smallest available discrete step in response at any time must be no less than 20 % of the MW value of the Providing Unit's largest available step at that time
Dynamic FFR, POR, SOR, TOR1 and TOR2	configurable in range: $50.015 \leq F_1 \leq 50.5$ Hz	configurable in range: $50.2 \leq F_2 \leq 50.7$ Hz and $F_2 - F_1 \geq 200$ mHz	Not applicable	Not applicable

Table 32: Additional key requirements for Downward FFR, POR, SOR, TOR1 and TOR2 (refer to Figure 13)

6. Locational Requirements

In the SEMC decision on the High level DASSA design a requirement was established for the TSOs to develop a locational methodology, which would allow for the procurement of services in locations where there was a specific need for such services. The PIR sets out that the Locational methodology should be a factor in the Product Review.

As the focus of this Product review paper is on the reserves services only, the locational considerations outlined in this section only relate to these services. Reserve services are required to maintain frequency within operational standards. As Ireland and Northern Ireland comprise a single, synchronous power system, frequency is assumed common across the island and reserve services are shared to manage contingency events.



Currently, the only locational requirements for reserve services are that minimum reserve capabilities must be held in each jurisdiction due to the risk of a 'system-separation' event in which the Northern Ireland and Ireland systems separate.

The following sections describe the All-Island and jurisdictional locational requirements.

This event can be triggered by a fault on the 275 kV tie-line that runs between the two jurisdictions.

6.1. All-Island Requirements

Reserve requirements for the All-Island power system are set by the LSI and LSO on the Island.

The LSI is set by the largest generating unit or HVDC interconnector import on the Island. Today this can be up to 504 MW (set by the East-West Interconnector) and will rise to 700 MW on commissioning of the Celtic Interconnector in 2027.

The LSO is normally set by an interconnector export but could also be driven by the potential loss of 'at risk' demand. Today, interconnector exports can be up to 526 MW (set by the East-West Interconnector) and will rise to 700 MW on commissioning of the Celtic Interconnector in 2027.

All-Island reserves requirements, and sharing of reserves between the jurisdictions, will remain to ensure that these contingency events can be securely and efficiently managed.

6.2. Jurisdictional Requirements

In advance of the delivery of the second North South Interconnector, a specific locational scenario to be considered is the split of the All-Island system into Ireland and Northern Ireland operating as separate 'islanded' systems. This event can be triggered by a fault and tripping of the 275 kV 'tie-line' that runs between the two jurisdictions[51].

This system split event will result in two separate, and smaller, synchronous areas with independent frequencies. The frequency impact of this event is largely driven by the magnitude and direction of the power-flow on the tie-line and drives different reserve requirements in each case as illustrated in the table below.

Pre-Trip Tie-Line Power-Flow	Post Trip Frequency Impact	Reserve Requirement
South to North	NI: frequency drops	NI: upward response

[51] The North-South Tie-Line is a 275 kV double circuit. Both circuits are carried on the same overhead towers so is considered a credible contingency.

	IE: frequency rises	IE: downward response
North to South	NI: frequency rises	NI: downward response
	IE: frequency drops	IE: upward response

Table 33 Frequency response and reserve requirement re. Tie-line trip

Limits are applied to the power-flow on the Tie-Line. The maximum power-flow from South to North is 400 MW. The maximum power-flow from North to South is 450 MW[52]. These maximum power-flow limits assist in reducing the impact of the tripping of the tie-line, the impact of which is exacerbated by the loss of inertia and reserves that are normally shared between the jurisdictions.

To manage this event, reserves must be maintained within each jurisdiction to ensure that the frequency within each jurisdiction remains within limits. The existing locational considerations for minimum quantities of upward POR, SOR, TOR1, TOR2, RRS and RRD are still valid and will remain in place. For downward reserves we consider that similarly downward reserves will require jurisdictional minimum quantities. We will provide recommendations on the minimum quantities of these products as part of the subsequent volumes methodology consultation paper to issue later in 2024.

The need for jurisdictional reserve requirements will be reviewed post commissioning of the second North-South tie-line.

TSOs' Proposal:

Maintain jurisdictional requirements:

We are proposing to maintain jurisdictional reserve requirements for upward reserves, and introduce jurisdictional requirements for downward reserves. These requirements can be reviewed in line with the delivery of the second North - South Interconnector.

6.3. Subsequent Product and Locational Review

As outlined above this paper is only focused on the reserve services. We consider that as part of a further Product Review in 2025 (as outlined in the PIR) which will focus on the non-reserve services, we will examine the need for a greater level of locational requirements for some of the other services, for example Steady State Reactive Power (SSRP).

Consultation Questions:

Q.18 Do you agree with our assessment of the locational considerations for the reserve services? Are there additional aspects that you consider may be valuable to include?

7. Reserve Product Scalars

Under the Regulated Arrangements, there are a number of scalars which apply to the reserve services. These scalars are designed to provide increased value to system services under specific circumstances. The payment to service providers is calculated as per the formula below,

$$Trading\ Period\ Payment = Available\ Volume * Payment\ Rate * Scaling\ Factor * Trading\ Period\ Duration$$

[52] These limits are pre-contingency. Post-contingency flows can be higher as a result of reserves being exchanged between the jurisdictions.

Scalars were an effective method for rewarding and incentivising providers as part of a qualification and tariff based /fixed contract arrangement. However, as we transition to daily auctions it is necessary to remove or replace these scalars in order to have an effective and efficient auction process. This section discusses each scalar, its purpose and the current thinking on how the scalars could be removed/replaced.

7.1. Temporal Scarcity Scalar (TSS)

The temporal scarcity scalar (TSS) was designed to incentivise the supply of services during periods of high System Non-Synchronous Penetration (SNSP), and the scaling factors utilised at certain SNSP levels are illustrated in the table below.

SNSP Level	TSS FFR	TSS POR – TOR2
<50%	0	1
50% - 60%	1	1
60% - 70%	4.7	4.7
>70%	6.3	6.3

Table 34 Temporal Scarcity Scalar

These scalar values were originally set in 2017 to support reaching SNSP operational levels of 75% as part of government 2020 renewable energy targets. As the system now operates frequently at an SNSP limit of 75% and as outlined in the recent DS3 System services Tariffs consultation, DS3 Tariff expenditure is considerably influenced by the volume of qualified resources able to provide services at high SNSP periods[53]. Separately, as outlined in the Operational Policy roadmap[54] the TSOs plan to relax and remove the SNSP metric over time.

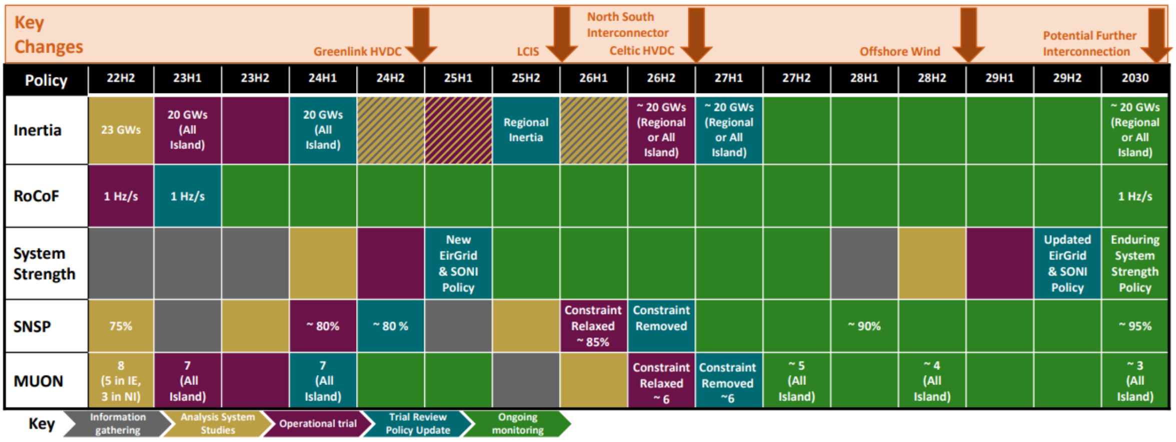


Figure 14 Operational Policy Roadmap 2023-2030

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

[54] Operational Policy Roadmap 2023-2030 (eirgrid.ie)

With this in mind, the TSOs consider the application of the TSS is no longer valid in the context of the evolving system, the existing capability to operate at high levels of SNSP and in terms of implementation within an auction design.

TSOs' Proposal:

Remove temporal scalar:

We are proposing to remove the temporal scalar based on current operational and energy system characteristics and in line with the proposed removal of the SNSP metric in the operational policy roadmap.

7.2. Performance Scalar

The performance scalar considers the accuracy of a unit's forecast of its availability and its response to a performance incident. The below formula is used to calculate the performance scalar:

$$P = P(a) * P(e)$$

Where P(a) accounts for the ability of a Providing Unit to accurately forecast its availability to provide System Services and P(e) is based on a Providing Unit's response to a Performance Incident.

As outlined in Chapter 6 of the DASSA Auction Design Consultation paper[55] the TSOs have proposed that two types of performance scalars are implemented to ensure the reliability of awarded DASSA contracted volumes is incentivised. These scalars would work to create a financial disincentive to deviate from the contracted service requirement. The two scalars proposed are:

- Availability performance scalar – aims to incentivise the holder of a confirmed DASSA order to maintain and accurately declare its availability to provide the contracted service.
- Event performance scalar – aims to incentivise the holder of a confirmed DASSA order to deliver the service when called upon to do so.

Therefore, while the DS3 existing performance scalar itself will cease to exist, two new scalars are proposed to maintain incentives on contracted providers to deliver accurate availability and service provision. An amended performance monitoring regime will also need to apply alongside the two proposed scalars. A detailed programme of work that will examine performance monitoring requirements and develop the detailed scalar design will be necessary, the timelines for which will be set out in the next iteration of the PIR, expected to be published in Q4 2024.

TSOs' Proposal:

Replace performance scalar:

We are proposing to replace the performance scalar with the new Availability performance scalar and Event performance scalar as outlined in the DASSA Auction Design consultation paper.

7.3. Faster Response of FFR Scalar

As outlined in Chapter 2 the current definition of FFR requires providing units to provide their full contracted capability within 2 seconds following a Performance Incident. However, as it was recognised that there is a system operation benefit to response being provided more quickly a Faster Response of FFR Scalar incentivises response from FFR providers from 150ms.

[55] SOEF Markets – Future Arrangements for System Services – DASSA Consultation Paper | EirGrid Consultation Portal

As outlined in detail in Chapter 3 and 5 we are proposing to procure a new standard FFR product with minimum quantities of FFR response at 150ms, ≤300ms, ≤1 second across dynamic and static provision categories. Therefore, we do not consider that an additional scalar is required to run an efficient auction, and propose to remove the scalar in line with the new product proposals.

TSOs' Proposal:

Remove the Faster response of FFR scalar:

We are proposing to create a new definition of the FFR Product and new minimum quantities of faster subcategories. Therefore, we propose to remove the existing Faster response of FFR product scalar.

7.4. Enhanced Delivery Scalar

The product scalar for the enhanced delivery of the POR, SOR and TOR1 Services is comprised of 2 component scalars:

- A trigger scalar, representing the frequency trigger capability of the providing unit;
- A type scalar, representing the type and profile of its response curve,

The transition to auction-based arrangements and the revised product definitions with dynamic and static sub-categories will no longer require an enhanced delivery scalar.

TSOs' Proposal:

Remove enhanced delivery scalar:

We are proposing to remove the enhanced performance scalar. The required system service technical requirements can most efficiently be delivered through the product design and auction mechanism.

7.5. Continuous Provision Scalar

Providing Units are currently incentivised to provide continuous provision of reserve services across the reserve categories by the continuous provision scalar. As outlined in Chapter 5 the TSOs are considering the procurement of a bundled or continuous provision of services (FFR/POR -TOR1/TOR2) The continuous provision scalar can most efficiently be accounted for directly through the auction.

TSOs' Proposal:

Remove continuous provision scalar:

We are proposing to remove the continuous provision scalar.

We are considering the introduction in the procurement of a bundled reserve product that can be continuously deployed from FFR or POR up to TOR1 or TOR2 by a single resource.

7.6. Regional Scarcity Scalar

As outlined in Chapter 6 we intend to maintain jurisdictional reserve requirements for upward reserves, and to introduce jurisdictional requirements for downward reserves based on our need to secure both the

Ireland and Northern Ireland systems in the event of a system split. This will be achieved through the procurement of minimum volumes per jurisdiction in the auctions.

The application of locational scarcity scalars will require further examination by the TSOs and SEMC as we transition to FASS. For clarity, the application of locational scarcity scalars to the products under review in this paper is not recommended based on forecasted technical requirements within the DASSA implementation timeframes.

Consultation Questions:

Q.19 Do you agree with our proposals on the removal and replacement of the above scalars? Are there aspects that you believe still warrant a scalar based approach in an auction-based procurement process? Please provide a detailed response on what you consider would be appropriate and how this would enable more efficient procurement outcomes.

8. Next Steps

This consultation paper outlines the TSOs' considerations on the required reserve products for a DASSA auction in 2026, taking into account a changing energy system and evolving generation and demand characteristics. This consultation paper will be open for responses for 6 weeks following publication and the responses received will inform the final TSO recommendations on the Reserve service product definitions that will be proposed to the SEMC for procurement through the DASSA auctions.

As part of the activities required to implement DASSA arrangements in 2026, the TSOs are also currently reviewing the Volumes Forecasting Methodology for the proposed Reserve Service products. The TSOs will consult on the outcome of this review towards the end of Q3 2024.

It is also worth noting that the enduring high-level model for managing TSO-DSO interactions related to the provision of System Services from distribution connected service providers, including management of limitations on service provision, is currently being considered as part of the TSO-DSO Future Operating Model discussions. Following the agreed high-level vision and principles, detailed design of the arrangements will follow. Note also that the TSOs (SONI and EirGrid) and DSO/DNOs (NIEN and ESBN) plan to engage with relevant stakeholders including industry and the Regulatory Authorities as part of the Future Operating Model work.

As outlined in the document this paper only focuses on the Reserve services, and therefore a separate Product Review and Locational Methodology consultation is envisaged during 2025 to examine the required product design for the other DS3 System services, any further alignment with EU requirements and any additional services that may be required for future system operation. As outlined in the paper the requirement for dynamic POR (regulating) reserve requirements is not recommended to change at this time. A future Product Review could examine the need for a new competitively procured frequency regulation product to provide this capability. It is important to note however that such a product has not been the focus of the current Product Review process and would require additional detailed analysis to determine a suitable product and contractual process, and also that such a product that has not been incorporated into the considerations for the DASSA auctions to date.

While at this stage the TSOs do not anticipate changes to the EirGrid or SONI Grid Codes associated with this review of reserve products, where relevant, any changes to the Grid Codes will be subject to the normal governance processes including consultation and regulatory approval.

8.1. Consultation Responses

SONI and EirGrid welcome feedback on the questions posed within this paper.

Responses to the questions set out in this paper should be submitted through either the EirGrid[56] or SONI[57] consultation portals by 18 July 2024.

We request that answers to the questions include justification and explanation and be submitted within the questionnaire template provided with publication of this consultation. If there are pertinent issues that are considered not to have been addressed in the questionnaire, these can be addressed at the end of the response.

It would be helpful if responses are not confidential. If you require your response to remain confidential, you should clearly state this on the coversheet of the response. We intend to publish all non-confidential responses.

[56] EirGrid consultation portal.
[57] SONI consultation portal.

8.2. Consultation Information Session

An information session will be held on 19 June 2024 from 09:30 to 11:30.

The purpose of this session will be to run through the key areas of this consultation paper and to allow time for questions and clarifications.

An email will be sent from the FASS programme mail box[58] detailing further information of the webinar. If you would like to register for the information session, please respond to the email.

Consultation Questions:

Q.20 Are there aspects that have not been covered in this paper that you feel need further consideration during the final product definition phase? Please provide a detailed response on any recommended additional considerations.

Q.21 As part of a future Product Review the TSOs will be conducting analysis that will help inform the product definitions of non-reserve System services and potentially new products. Do you have any recommendations on what needs to be included in the work programme for such future Product Reviews?

[58] FASS@Eirgrid.com or FASSProgramme@soni.ltd.uk.

9. Consultation Questions

Chapter	Questions
Chapter 3 System Needs – Explanation and current operational practices	Q.1 Do you agree with our assessments of the evolving system complexity, the likelihood of faster nadir and zenith occurrences and evolving risk of over-frequency events? Q.2 Are there additional considerations that you believe have not been fully explained or examined yet? Please elaborate on what you consider needs more detailed information. Q.3 Do you agree with our conclusions that we need increased capabilities in FFR speed of response? Q.4 Do you agree with our assessment of the need for downward reserve product definitions as part of the DASSA procurement process and to align with EU requirements? Q.5 Do you agree with the quality aspects that we have outlined? Are there additional system need based quality aspects you believe are worthy of further consideration?
Chapter 4 Changing capabilities of reserve providers	Q.6 Do you consider that we have accurately captured the generic characteristics of reserve providers? Are there additional considerations that you recommend we include?
Chapter 5 Reserve Product Review	Q.7 Do you agree with our assessment that the proposed DASSA reserve products will help achieve greater alignment with EU requirements? Q.8 Do you have any views on the outlined requirements on frequency trigger capability, response trajectory capability, reserve step size & reserve step triggers for Upward reserve products? Please elaborate on any technical concerns you may have with regard to these proposals. Q.9 Do you consider the standard definition of the FFR product which requires delivery of response between 1s-10s as proposed provide sufficient certainty for asset operators and investors? Q.10 Do you consider our recommendations to require procurement of sub-categories of faster response FRR with full activation times of 150ms; 300ms & 1 sec enable industry providers to have sufficient incentives to bid in the auction structures ? Are there additional aspects you consider should be included in the definition? Please elaborate in your response on aspects you consider need to be included. Q.11 Do you agree with our proposal to remove the distinction between synchronised and desynchronised replacement reserve products (current DS3 definitions) to better reflect a changing service provider mix and to achieve better alignment with EU requirements? Please elaborate in your response if you have detailed concerns. Q.12 Do you have any views on our consideration of procurement of a bundled upward reserve product? Please outline your views and any concerns you may have on this proposal. Q.13 The TSOs recognise the potential provision of Upward dynamic reserves with discrete reserve step-sizes. We are not proposing this type of response

	as part of this DASSA Reserve Product Review. Please outline your views and any concerns you may have on this proposal. Q.14 Do you have any views on the outlined requirements on frequency trigger capability, response trajectory capability, reserve step size & reserve step triggers for Downward reserve products? Please elaborate on any technical concerns you may have with regard to these proposals. Q.15 Do you consider our proposed downward reserve definitions are appropriate for an evolving system? Are there alternative definitions that you would recommend to ensure efficient service procurement and provision? Q.16 Do you have any views on our consideration of procurement of a bundled downward reserve product? Please outline your views and any concerns you may have on this proposal. Q.17 The TSOs recognise the potential provision of Downward dynamic reserves with discrete reserve step-sizes. We are not proposing this type of response as part of this DASSA Reserve Product Review. Please outline your views and any concerns you may have on this proposal.
Chapter 6 Locational requirements	Q.18 Do you agree with our assessment of the locational considerations for the reserve services? Are there additional aspects that you consider may be valuable to include?
Chapter 7. Reserve product scalars	Q.19 Do you agree with our proposals on the removal and replacement of the above scalars? Are there aspects that you believe still warrant a scalar based approach in an auction-based procurement process. Please provide a detailed response on what you consider would be appropriate and how this would enable more efficient procurement outcomes.
Chapter 8. Next steps	Q.20 Are there aspects that have not been covered in this paper that you feel need further consideration during the final product definition phase? Please provide a detailed response on any recommended additional considerations. Q.21 As part of a future Product Review the TSOs will be conducting analysis that will help inform the product definitions of non-reserve System services and potentially new products. Do you have any recommendations on what needs to be included in the work programme for such future Product Reviews?