FASS Programme

Day-Ahead System Services Auction (DASSA) Volume Forecasting Methodology Consultation Paper V1.0

October 2024

SONI EirGrid

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. Earlier in 2024, SONI and EirGrid, the Transmission System Operators (TSOs) in Ireland (IE) and Northern Ireland (NI), completed this review for the Reserve services, which included an industry consultation. The TSOs will publish a Product Review and Locational Methodology Recommendations paper[3] in October 2024 (which will be subject to SEMC decision), which contains the product definitions and locational requirement recommendations the TSOs consider necessary to manage larger frequency deviations (e.g., lower nadirs, higher zeniths) and higher Rates of Change of Frequency (RoCoF) with greater levels of non-synchronous generation (wind, solar and HVDC imports) and greater volumes of interconnection.

Building on the Product Review recommendations, this consultation document includes the TSOs' proposals for the Volume Forecasting Methodology (VFM) 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), and Replacement Reserve (RR).

The forecasting of volumes is a complex process, as IE and NI are 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. The Volume Forecasting Methodology presented in this paper details the TSOs' considerations in determining volume requirements on a day-ahead forecasting basis, where uncertainty on wholesale market outcomes, renewable forecasts and interconnector flows exists. This paper also sets out proposed methodologies for a weekly volume forecast and an annual, ten-year look-ahead forecast.

In order to manage these evolving challenges, the proposed Volume Forecasting Methodology takes 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 proposals for this Volume Forecasting Methodology are:

- By 10:00 each day, the TSOs will publish the required reserves volumes that will be procured in the DASSA on that day D-1 for the following day D. The TSOs will specify volume requirements for all upward and downward reserves products (FFR, POR, SOR, TOR1, TOR2, RR) separately and will specify for each product minimum volumes per jurisdiction and minimum volumes of dynamic response. For FFR, minimum volume requirements for category 1 (Full Activation Time (FAT) = 150 ms) and category 2 (150 ms < FAT ≤ 300 ms) will be specified. The required reserves volumes will be published for all transaction periods of the following day D.
- The required All Island reserve volumes for FFR, POR, SOR, TOR1, TOR2 and RR will be determined based on the system needs (e.g., aligning with the TSOs' operational policy on reserves) with the objectives of:
    - Maintaining frequency within 49.9 – 50.1 Hz range for 98% of time, as monitored and reported on annually in the All-Island Transmission Performance report. This means the

[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)

[3] DASSA Product Review & Locational Methodology Recommendation Paper (EirGrid), DASSA Product Review & Locational Methodology Recommendation Paper (SONI)

system frequency will unlikely exceed the standard frequency range (49.8 to 50.2 Hz) more than 15,000 minutes/year (2.9% of minutes/year), as required by the EU System Operation Guideline (SOGL) and Synchronous Area Operational Agreement (SAOA).

   - Mitigating large disturbances to avoid a maximum instantaneous frequency deviation larger than 1000 mHz from the nominal frequency of 50 Hz and a RoCoF larger than +/- 1 Hz/s, following the requirements in the TSOs' Operating Security Standards (OSS), SAOA, Load Frequency Control Block Operational Agreement (LFCBOA), and the SOGL.

- To meet the first objective above, the TSOs will annually review the frequency quality trend of the previous five years and assess the need for adapting the minimum volume requirements for dynamic POR, SOR, TOR1 and TOR2.
- Currently, for POR and SOR the TSOs dimension reserve requirements to ensure that sufficient reserves to cover 75% of the loss of Largest Single Infeed (LSI) are secured. To meet the second objective above in the future, and in accordance with the requirements in the SOGL, the TSOs propose that for DASSA the required downward and upward POR, SOR, TOR1, TOR2 and RR volumes shall be dimensioned to consider the Reference Incidents (RI) for outfeed and infeed losses. The TSOs consider that, at least initially, given the lack of foresight of market outcomes, and in particular interconnector schedules it will not be feasible to forecast the RIs (All Island or jurisdictional) with a reasonable accuracy before the DASSA takes place.
- In order to facilitate all possible market outcomes and in the advance of certainty of dedicated opportunities for the TSOs to procure reserve volumes after DASSA, the TSOs will take a prudent approach and assume that all system infeeds that could be in service on the next day D may feed in at their maximum capacity (i.e., RI will include the impact of the maximum LSI loss) during all trading periods of the following day. Similarly, all system outfeeds that could be in service on the next day D may feed out at their maximum capacity (i.e., RI will include the impact of the maximum Largest Single Outfeed (LSO) loss). The RI will also need to account for potential consequential losses of e.g. trips of generation or reduction of demand from demand units (as seen from the grid) triggered by the same incident. Consequential losses are typically inadvertent (from a system perspective) and caused by e.g. lack of Fault Ride Through (FRT) capability of the concerned demand/generation.
- The All Island RI will then be determined separately for outfeed and infeed losses and will be the sum of the LSI or LSO and potential consequential losses. Note that the TSOs aim for minimising consequential losses, by proposing adequate technical requirements that prevent consequential losses. Note that system defence measures are not considered as consequential losses.
- In addition to the All Island RI, the TSOs define jurisdictional RIs for both IE and NI. These jurisdictional RIs are set by the imbalance in each jurisdiction after a system separation caused by a trip of both circuits of the existing North-South (N-S) Interconnector. Consequently, the jurisdictional RIs are driven by the flow on the N-S interconnector. Also, the jurisdictional RIs will need to take into account consequential losses. The need for jurisdictional RIs will be reviewed after the second N-S Interconnector will start operation.
- Annual assessments based on detailed simulations shall determine the minimum shares of dynamic response and the minimum shares for total FFR and FFR categories 1 and 2, relative to the RI. For example, based on simulation results for 2025, the TSOs expect that the required volumes of FFR would be typically around 70% of the RI for All Island, 80% for IE and 100% for NI. However, considering that the required FFR depends on system inertia, the TSOs will evaluate inertia provision on a frequent basis and may modify these requirements accordingly.
- In addition, the TSOs consider it important to account for potential loss of reserve provision from the units setting the LSI and LSO, and will add a component to the DASSA reserve volume determination to cover this risk. Also, the TSOs need to consider in the DASSA reserve volume determination the potential unavailability of reserve providing units, for example, one or more reserve providing units becoming unavailable due to a forced outage or a transmission restriction/fault which limits the provision of their service (e.g., local constraints may limit the possibility to dispatch some reserve providing units).
- The TSOs consider that while the above volume forecasting methodology is prudent, it may result in the over procurement of reserves. Accordingly, the TSOs will aim to improve the accuracy of the reserve volumes forecasts over time and take steps to reduce the risk of consequential losses,

noting that there may be challenges with implementation. Approaches under consideration include:

  - Development of day-ahead predictions of LSI, LSO, N-S interconnector flow and inertia levels. This may allow for more accurate day ahead volume forecasts and the possibility to differentiate the volume needs per trading interval.
  - Reducing the risk of consequential losses, and accordingly the RI, through the development of new performance standards and capabilities that generation sources and demand should comply with.

- In response to the SEM Committee decisions[4] relating to a ten-year forecast, the TSOs have proposed a methodology that could enable the provision of an indicative forecast of potential future reserve volumes. Our proposals are that ten-year forecasts would be updated annually to provide an overview of indicative required reserve volumes, including the characteristics (e.g., FFR FAT, dynamic) and location (IE, NI). Such an overview should include a high-level review of the reserve requirements for the next 10 years, with consideration of anticipated changes in the system. The annual forecast is also proposed to include more detailed assessments for the next procurement year. Such detailed assessments will be supported by power system simulations which will also provide the necessary input to the subsequent weekly and daily volume determination methodologies.
- On a weekly basis, the TSOs will review the applicability of the results of the annual assessments and publish the guidelines, and parameters to be used for the day-ahead volume determination. The TSOs will aim to align this publication with the Weekly Constraint Update.
- On a daily basis, the TSOs will utilise the information from the Weekly Forecast and update as required e.g. to account for new planned or forced outages, changing constraints on N-S tie-line flow, specific adverse weather situations e.g. storms, etc, enabling the publication of required DASSA volumes by 10:00 on D-1.
- In addition, this paper sets out the TSOs' proposals for how the volume requirement of any implicit bundles of services may be determined. The context for the bundling of services is described in the TSOs' DASSA Design Consultation Paper[5] and DASSA Design Recommendation Paper[6]. The SEM Committee's DASSA Market Design Decision Paper (SEM-24-066)[7] allows for implicit bundles to be cleared in the daily auction. Setting a minimum volume requirement for an implicit bundle can ensure that a proportion of the volume requirements for the individual services that are to be part of the bundle will be procured from service providers that can provide these services consecutively. The TSOs have not identified any operational requirement to procure bundles of services; however, bundles can mitigate certain market-related issues as well as ensuring more efficient DASSA outcomes for service providers. The process to define service volumes to be procured as implicit bundles will constitute a separate step to the core service volume methodology proposed in this paper i.e. the volume requirement for each individual service will be determined before considering any requirement for implicit bundles.

Further information on the proposals can be found in the relevant chapters. Note that these proposals are based on the TSOs' consideration of the operational requirements of the power system (e.g., supported by detailed system studies), EU network code requirements, service provider capabilities and the DASSA implementation timelines as outlined in the TSOs' Phased Implementation Roadmap8 (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.

---

[4] System Services Future Arrangements High Level Design Decision Paper.pdf (semcommittee.com) and SEM-23-103 SSFA Phase III - Phased Implementation Roadmap - Decision Paper.pdf (semcommittee.com)
[5] https://cms.eirgrid.ie/sites/default/files/publications/FASS-DASSA-Consultation-Paper-March-2024-EirGrid.pdf
[6] https://cms.eirgrid.ie/sites/default/files/publications/EirGrid-and-SONI-DASSA-Design-Recommendations-Paper-September-2024.pdf
[7] https://www.semcommittee.com/files/semcommittee/2024-09/SEM-24-066%20-%20SEMC%20FASS%20DASSA%20Design%20Decision%20Paper.pdf

The TSOs will host a consultation information session on Wednesday 16 October 2024 from 10:00 to 12:00.

Responses to the questions set out in this paper should be submitted through either the SONI or EirGrid consultation portals **before 15 November 2024.**

Glossary of terms

Acronym	Meaning
AGU	Aggregated Generator Unit
APC	Active Power Control
BESS	Battery Energy Storage Systems
BMPS	Balancing Market Principles Statement
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
FCR	Frequency Containment Reserves
FFR	Fast Frequency Response
FRCE	Frequency Restoration Control Error
FRR	Frequency Restoration Reserves
LCIS	Low Carbon Inertia Service
LFCAA	Load Frequency Control Area Agreement
LFCBOA	Load Frequency Control Block Agreement
LFDD	Low Frequency Demand Disconnection
LEU	Large Energy User
LPF	Layered Procurement Framework
LSAT	Look-Ahead Security Assessment Tool
LSI	Largest Single Infeed
LSO	Largest Single Outfeed
MEC	Maximum Export Capacity
MIC	Maximum Import Capacity
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

RR	Replacement Reserves
RRD	Replacement Reserve Desynchronised
RRS	Replacement Reserve Synchronised
SAOA	Synchronous Area Operational Agreement
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
TFSS	Tie-Line Fault with System Separation
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

Disclaimer & Copyright

1. Introduction

1.1. Background

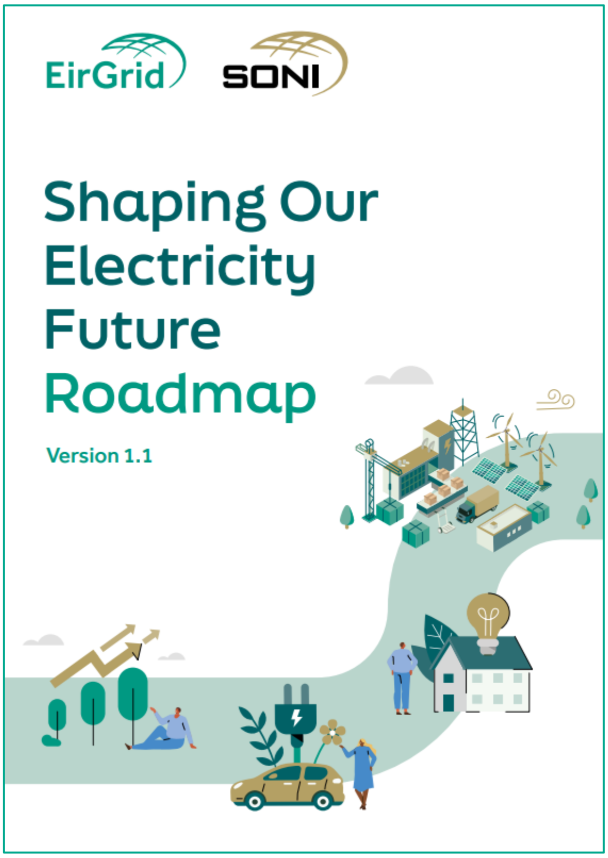
SONI and EirGrid are the Transmission System Operators (TSOs) in Northern Ireland and Ireland. It is our job to manage the electricity supply and the flow of power from generators to consumers. Electricity is generated from gas, coal and renewable sources (such as wind, solar and hydro power) at sites 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[9] 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[10] 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[11], 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,
- 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

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

address operational needs as required. Earlier in 2024, SONI and EirGrid, conducted a Product Review and locational requirements for these Reserve services, which was consulted on in June and July 2024.

The motivation for the High Level 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.

The SEMC considered in its High Level Design Decision that having an accurate forecast of the volumes of system services required across timeframes, and having accurate historical data on the volumes available and required by the TSOs is critically important both for industry to make informed investment decisions and to enable the Regulatory Authorities to assess the effectiveness of market arrangements and inform policy decisions. In accordance with the High Level Design the TSOs are required to publish forecast and historic System Services volume requirements by service, and where relevant, by location.

In addition, in Ireland, the Climate Action Plan 2023[12] (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 Volume Forecast Methodology Consultation paper in line with the FASS PIR[13] and the SEMC decision paper on the PIR[14] to provide detail on the FASS product requirements. As has been agreed with the Regulators, this paper focuses on a Volume Forecast Methodology for the services that will be the focus of the initial Auction design i.e. the Reserve services.

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

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

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

• Develop and consult on a methodology for determining system services volume requirements and the volumes to be procured across all timeframes;

We have addressed this in Chapters 3, 4 and 5.

• Annually publish a ten-year forecast of system service requirements by relevant location, and shall invite comments from stakeholders on the form of this report at least annually;

We have outlined our proposals for a ten-year forecast in Chapters 3 and 5.

• Regularly publish short-term forecasts and volume information following public consultation on the form, frequency, and granularity of these reports;

We have addressed this in Chapters 3 and welcome stakeholders views on our proposals as part of this consultation.

12 Climate Action Plan 2023 (www.gov.ie)
13 FASS-TSOs-PIR-March-2024-EirGrid.pdf
14 SEM-23-103 - SSFA Phase III - Phased Implementation Roadmap - Decision Paper.pdf (semcommittee.com)

• Publish the volumes to be procured by auction on a daily basis. The SEM Committee directs the TSOs to progress the volumes deliverables as a matter of priority as per the PIR;

We have outlined our proposals for the daily publication of volume requirements in Chapters 3, 5 and 6.

• Set-out a methodology that defines the volumes of the Reserves that are needed to be contracted after DASSA.

In the advance of certainty on dedicated opportunities for the TSOs to contract additional reserves after DASSA the TSOs have not outlined a methodology in this paper for the determination of volumes to be procured after DASSA gate closure.

Further system analysis will be required to inform 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 (LEUs), 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 development of a Volume Forecasting Methodology 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, which will be followed by the development of a Volume Forecasting Methodology for these services in Q4 of 2025 and 2026.

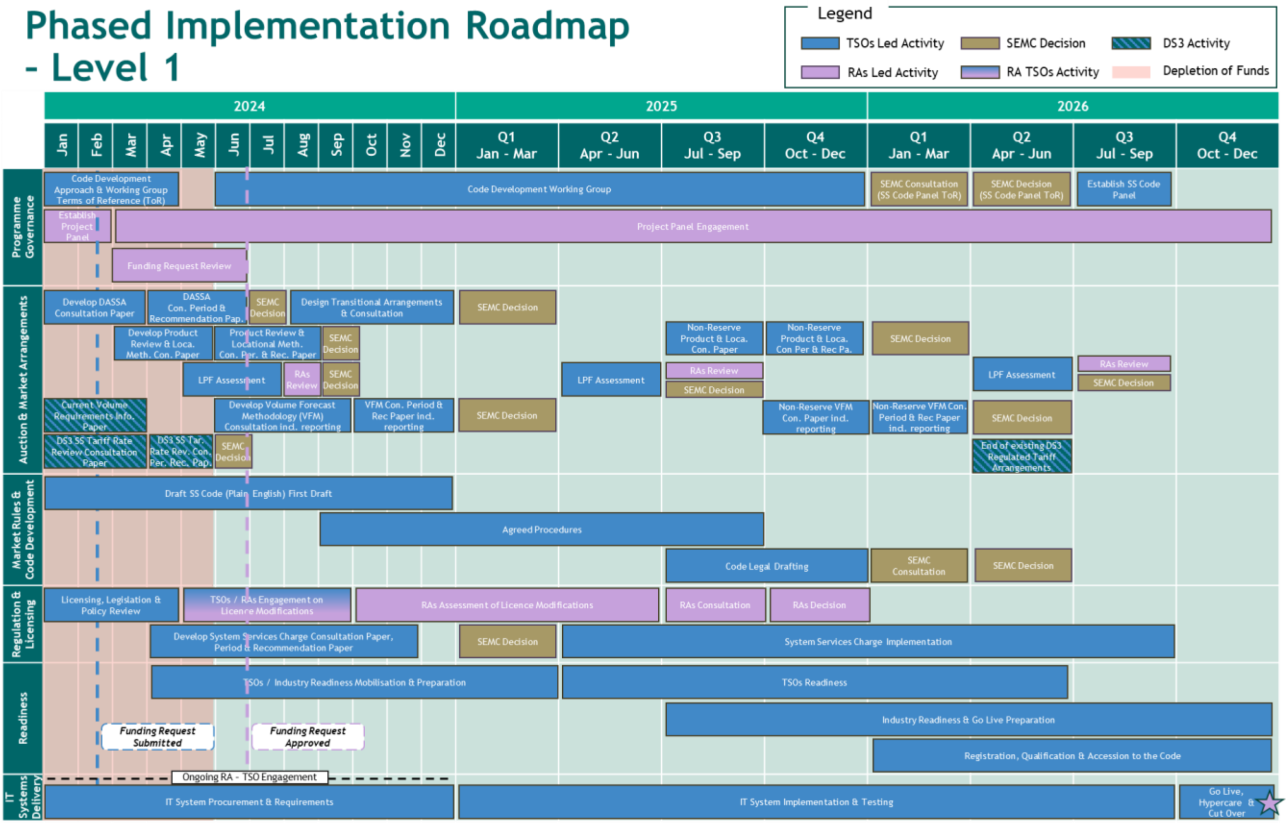


Figure 1 Level 1 Phased implementation Roadmap showing Product Reviews in 2024 and 2025

The outcome of this industry consultation will help formulate the final recommendations the TSOs will make to the SEMC on the Volume Forecasting Methodology. 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[15] and the EU Clean Energy Package[16].

[15] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R2195

[16] 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:

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

Publication	Key points of relevance
DASSA Product Review & Locational Methodology Recommendations Pape[17]	Proposed update of product definitions for DASSA, including the introduction of 'downward' reserve products; a reduction of the Full Activation Time (FAT) for FFR product to 1 second, with separate categories for a FAT of less than 300 ms and 150 ms; minimum capability requirements on configurable frequency deadbands, trajectories, reserve step sizes and reserve step triggers. The recommendations made within this paper are still subject to a SEMC Decision which will be forthcoming.
DASSA Design Recommendations paper[18]	The TSOs' recommended design for the daily auction of system services following a 10-week consultation process, including the core DASSA mechanics, secondary trading, the commitment obligations and incentives associated with holding a DASSA Order, the ex-post Final Assignment Mechanism (FAM), and related functionality.
SEM Committee DASSA Design Decision Paper SEM-024-066[19]	This paper outlines the SEM Committee's final decisions on the DASSA arrangements and considerations for TSOs and market participants. It should be read in conjunction with the TSOs' DASSA Design Recommendations paper. It covers decisions on core DASSA mechanics, secondary trading, commitment obligations and incentives associated with holding a DASSA Order, the SEM Committee's decision to not include an ex-post Final Assignment Mechanism (FAM), and other aspects.
Current System Services Volume Requirements Information Paper[20]	This Information Paper provides 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[21] Consultation paper	This Tariffs consultation includes a breakdown of the contracted volume growth in System Services for each service procured, a breakdown of expenditure across technology types and the impact of the Temporal Scarcity Scalar (TSS).
System Services Indicative 2030 volumes [22]	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;

[17] DASSA Product Review & Locational Methodology Recommendation Paper (EirGrid), DASSA Product Review & Locational Methodology Recommendation Paper (SONI)

18 https://cms.eirgrid.ie/sites/default/files/publications/EirGrid-and-SONI-DASSA-Design-Recommendations-Paper-September-2024.pdf

19 https://www.semcommittee.com/publications/sem-24-066-future-arrangements-system-services-dassa-design-decision-paper

20 Current System Services Volume Requirements Information Paper

21 DS3-System-Services-Tariffs-Consultation-27-March-2024.pdf (eirgrid.ie)

22 System-Services-Indicative-2030-Volumes.pdf (eirgrid.ie)

	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.

The purpose of this consultation on the Volume Forecasting Methodology is to set out the process by which the required volumes of the Reserve Services will be determined for the purposes of 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, RR), 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.

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. The Volume Forecasting Methodology presented in this paper details the TSOs' considerations in determining volume requirements on a day ahead forecasting basis, where uncertainty on wholesale market outcomes, renewable forecasts and interconnector flows exist.

1.5. Structure of this Paper

As outlined in the TSOs' Shaping our Electricity Future workstreams[23], our recent publication on Tomorrow's Energy Scenarios[24] and other work, the All-Island power system is changing rapidly and becoming more complex in terms of generation and demand technologies. The consultation paper is structured as follows.

Chapter 2 describes the current Reserve Volumes requirements. As the future volumes shall take into account both the future system needs and the requirements in EU legislation, these issues are discussed in Chapter 3 (system needs) and Chapter 4 (EU Dimensioning Methodologies). Chapter 5 proposes the Volume Forecasting Methodology and Chapter 6 discusses bundling. In Chapter 7 we outline the Next Steps related to the proposals in this paper and in Chapter 8 we include a consolidated list of the questions asked throughout this consultation paper.

[23] Shaping Our Electricity Future overview
[24] Tomorrow's Energy Scenarios (TES) (eirgrid.ie)

2. Current Reserve Volumes Requirement

2.1. Background

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[25]. This subset is the suite of reserve services from FFR - Replacement reserve, which are currently only procured in an upward direction[26] to mitigate and manage under-frequency events. As downward products are not currently procured, the TSOs utilise separate mechanisms to ensure effective management of over-frequency events, which are detailed further in this chapter. 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. With the transition to an auction-based day ahead procurement mechanism there is a need to ensure that clear product definitions are in place and transparency on the considerations that inform the volumes currently procured and that will be procured in future is made available to potential participants.

As the All-Island system is a central dispatch system, and as the current tariff-based arrangements for System services incentivise availability of service providers, the current real time requirements for reserve volumes are determined using operational experience, detailed technical analysis and based on considerations of the LSI and LSO. These considerations include information from Day ahead and intraday market outcomes, scheduled interconnector flows and renewable forecasts which informs optimal scheduling and dispatch to ensures system security. There is no current day ahead reservation of reserve capacity, so the move to the DASSA arrangements and the need to determine sufficient reserve capacity requirements in the day ahead timeframe constitutes a significant change for the TSOs.

The remainder of this chapter will focus on the processes and practices that are currently utilised to dimension the current reserve requirements.

2.2. Current Volume Requirements for Reserve products

It is important to note that EU Regulations outline certain dimensioning rules for TSOs to utilise when considering reserve requirements and maintaining frequency quality standards. SOGL Articles 127 describes the frequency quality defining parameters, and Articles 153, 157 and 162 highlight the required processes and parameters to use when dimensioning Frequency Containment Reserves (FCR), Frequency Restoration Reserves (FRR) and Replacement Reserves (RR) reserves respectively. These requirements, the processes to be used when dimensioning and activating the minimum volumes are outlined by the TSOs in greater detail in the Synchronous Area Operational Agreement[27] (SAOA) , the Load Frequency Control Block Operational Agreement[28] (LFCBOA) and the Load Frequency Control Area Agreement (LFCAA)[29] which are agreed between SONI and EirGrid as the relevant TSOs of the Synchronous Area and Load Frequency Control Block. SOGL requirements and considerations for DASSA volume requirements are covered in greater detail in Chapter 4 of this paper.

---

[25] System Services Future Arrangements Phase III: Detailed Design & Implementation. Phased Implementation Roadmap for the System Services High Level Design. Decision Paper. SEM-23-103

[26] To align more fully with EU requirements/terminology 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.

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

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

[29] S3-LFC-Area-Operational-Agreement-for-Ireland-and-Northern-Ireland-16.12.2019.pdf (eirgrid.ie)

An overview of the current processes utilised by the TSOs to dimension their reserve requirements is provided in Figure 2 below.

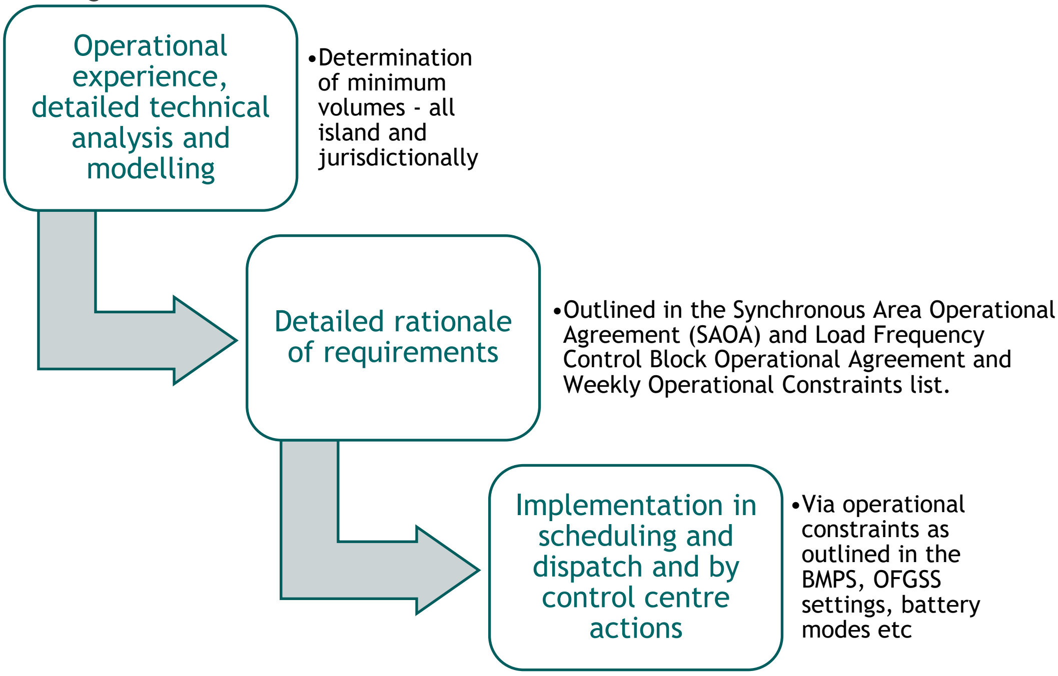


Figure 2 Overview of current reserve dimensioning processes

The rationale for the current volumes for POR-TOR2 are contained within the SAOA[30] and LFCBOA[31] documents and the minimum volume requirements are also listed in these documents. The TSOs' Weekly Operational Constraints Update[32] provides an overview of the current minimum volumes of reserves scheduled both on an all-island basis and jurisdictionally, and other operational constraints that deliver regulating and negative reserve capabilities. This is a publication that is updated weekly for the week ahead, and if conditions change (e.g. generator outage) a revised Operational Constraints Update is published.

Additionally, the Balancing Market Principles Statement (BMPS)[33] provides further detail on scheduling and dispatch actions to ensure reserve availability.

2.2.1. Minimum All Island Volume Requirements

The current dimensioning of the minimum volumes of upwards reserves (POR, SOR, TOR1, TOR2 and Replacement reserves) that the TSOs require, are primarily driven by the LSI on the island - this can be an importing interconnector or a large generator. There is currently no minimum volume of upwards FFR scheduled as part of the dispatch and scheduling process (to be enabled as part of the Updates to Scheduling and Dispatch programme[34]). However, the volume of FFR available on the system is taken into account in real-time operations through the use of the LSAT (Look Ahead Security Assessment) Tool.

While downward reserves are not specifically segregated into FFR, POR, SOR, TOR1, TOR2 or Replacement reserves, the TSOs secure the system against potential overfrequency risks e.g. the loss of the LSO (an exporting interconnector or LEU) and use mechanisms such as dispatching certain units to positions that enables the capability to provide downward reserves, depending on the system circumstances at the time.

The TSOs utilise the current dimensioning requirements to inform the scheduling of adequate reserve capacity and utilise scheduling and dispatch optimisation software to regularly calculate the most economic allocation of reserve service availability within the synchronous area subject to the limitations imposed by tie line operational constraints, frequency response availability and limits on the HVDC interconnectors.

[30] S1-SAOA-for-the-Ireland-and-Northern-Ireland-Synchronous-area-29.09.2022-(post-Title-2-approval).pdf (eirgrid.ie)
[31] S2-LFC-Block-Operational-Agreement-for-Ireland-and-Northern-Ireland-29.09.2022.pdf (eirgrid.ie)
[32] Wk37_2024_Weekly_Operational_Constraints_Update_Rev1.pdf (sem-o.com)
[33] EirGrid-and-SONI-Balancing-Market-Principles-Statement-V8.0.pdf
[34] https://www.eirgrid.ie/shaping-our-electricity-future/electricity-markets#future-power-markets-newsletters

Currently the minimum volumes of reserves held on the island at all times are outlined in **Error! Reference source not found.** below, replicated from the Weekly Operational Constraints Update[35]:

Table 4 Summary of current minimum volumes of Reserve Services

System Service	Reserve Type	Minimum Volume Requirement - All Island	
		Upward	Downward
FFR	Upward	N/A[36]	N/A
POR	Upward	75% of LSI At times more than 75% POR is held All Island (up to 80%) in order to maintain system security standards based on transient security analysis (this will remain under review by the TSOs).	N/A
SOR	Upward	75% of LSI At times more than 75% SOR is held All Island (up to 100%) in order to maintain system security standards based on real-time transient security analysis (this will remain under review by the TSOs).	N/A
TOR1	Upward	100% of LSI	N/A
TOR2	Upward	100% of LSI	N/A
RRD + RRS	Upward	325 MW Ireland + 125 MW Northern Ireland- Fixed volumes held at all times SONI and EirGrid 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.	N/A

It must also be noted that as outlined above and within the Weekly Operational Constraints Update, the TSOs ensure that during periods of adverse weather (e.g. storms) or where there is an increased risk (e.g. high impact generator or interconnector testing) the TSOs may take measures to mitigate the increased risk, which may include scheduling additional reserves.

2.2.2. Minimum Reserve Volume Requirements per Jurisdiction

In addition to the All-Island reserve requirements, minimum volumes of jurisdictional requirements are held at all times in Ireland and Northern Ireland. The current minimum Upwards reserve volumes required are outlined below;

Table 5 Minimum jurisdictional volumes of Upwards reserves

Product	Ireland	Northern Ireland

[35] Wk37_2024_Weekly_Operational_Constraints_Update_Rev1.pdf (sem-o.com)

[36] While 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 requirements for FFR are being developed as part of the FASS Programme. Available FFR is taken into account in LSAT, which informs control centre decision making.

FFR	N/A	N/A
POR	155MW/150MW[37]	50MW
SOR		
TOR1		
TOR2		
RRS + RRD	325MW	125MW

The current minimum Negative reserve volumes (that are held on conventional synchronous generation) that the TSOs ensure are available through scheduling and dispatch are:

Table 6 Current Minimum jurisdictional volumes of Downwards reserves

Product	Ireland	Northern Ireland
Negative reserve	0MW	50MW

The TSOs have indicated in the Weekly Operational Constraints update detail on the successful conclusion of a negative reserve trial in Ireland in 2021 that has resulted in a permanent removal of a 100MW Negative Reserve operational constraint in the Irish jurisdiction.

A 50MW operational constraint requirement for Negative reserve is in place for Northern Ireland.

Separately, the TSOs employ additional mechanisms to ensure effective management of over-frequency events. These include, but are not limited to, wind farm frequency response capability and over-frequency generation tripping.

2.2.3. Minimum Reserve Volume Requirements for Dynamic / Static Response

The TSOs require a certain minimum volume of reserves to be provided by dynamically regulating sources (currently synchronous generators with narrow frequency deadbands of +/-15mHz). This minimum requirement is known as dynamic POR (DPOR), dynamic SOR etc. 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. These regulating reserves are mainly 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. The current requirements are outlined below in Table 7;

[37] Lower volumes for POR, SOR, TOR1 & TOR2 apply in Ireland when there is at least one pump storage unit in pumping mode- Wk37_2024_Weekly_Operational_Constraints_Update_Rev1.pdf (sem-o.com)

Table 7 Current Minimum volumes of regulating source reserve provision

<table>
<tr><th rowspan="2">System Service</th><th rowspan="2">Reserve Type</th><th colspan="2">Minimum Volume Requirement -
Upward, from regulating resource, i.e. synchronous generator</th></tr>
<tr><th>Ireland</th><th>Northern Ireland</th></tr>
<tr><td>FFR</td><td>Upward</td><td>N/A[38]</td><td>N/A</td></tr>
<tr><td>POR</td><td>Upward</td><td rowspan="2">75 MW</td><td rowspan="2">50 MW</td></tr>
<tr><td>SOR</td><td>Upward</td></tr>
<tr><td>TOR1</td><td>Upward</td><td rowspan="2">87 MW</td><td rowspan="2">50 MW</td></tr>
<tr><td>TOR2</td><td>Upward</td></tr>
<tr><td>RRD + RRS</td><td>Upward</td><td>N/A</td><td>N/A</td></tr>
</table>

2.2.4. Minimum Reserve Volume Requirements for FFR

As outlined above there are currently no minimum volume requirements for FFR specified, either on an All-Island basis or jurisdictionally. The TSOs do take account of the volume of available FFR on the system in real time operations through the use of the LSAT tool (Look Ahead Security Assessment). DS3 Systems Services contracted volumes of FFR capability are over 1650MW[39], with a high proportion of these able to provide response within 1 second. FFR has been critical to increasing levels of renewable penetration on the All-Island power system and a minimum requirement for FFR is outlined in Chapters 3, 4&5 of this paper.

2.3. Frequency Quality

2.3.1. Normal Frequency Quality

In line with Article 127 in the System Operations Guideline[40], EirGrid and SONI's Synchronous Area Operational Agreement (SAOA)[41] requires that the maximum number of minutes of frequency occurrences outside the standard frequency range (49.8 to 50.2 Hz) should be below 15,000. Using data from 2009 onwards, Figure 3 shows the evolution of the Frequency quality within this +/- 200mHz range. In recent years the number of minutes outside the standard frequency range in the All-Island synchronous area has improved and is significantly less than 15,000 (e.g. in 2023 less than 4 minutes of frequency values outside this range occurred).

[38] There is currently no set minimum requirement for FFR.
[39] https://cms.eirgrid.ie/sites/default/files/publications/DS3-System-Services-Regulated-Arrangements-Procurement-Summary-Gate-10.pdf
[40] Synchronous Area Operational Agreement.
[41] S1-SAOA-for-the-Ireland-and-Northern-Ireland-Synchronous-area-29.09.2022-(post-Title-2-approval).pdf (eirgrid.ie)

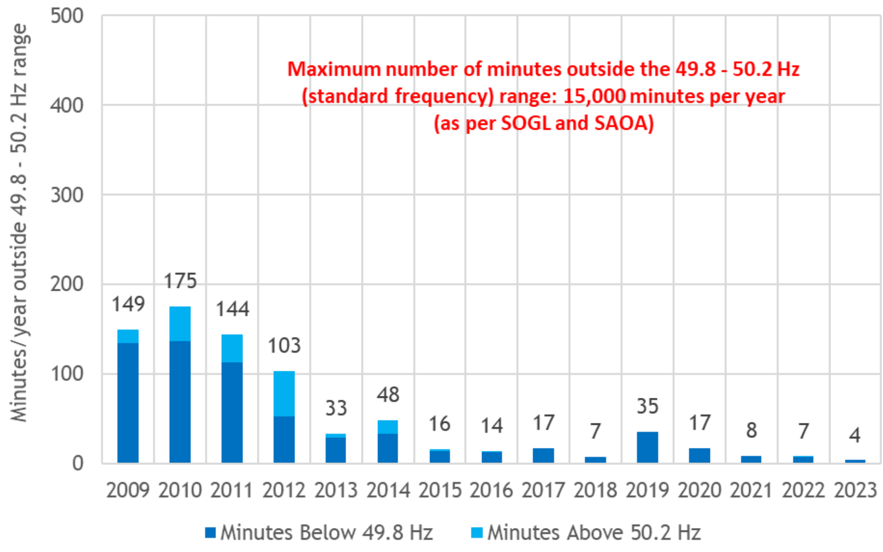


Figure 3: Evolution of minutes outside the standard frequency range (± 200 mHz) of the system frequency since 2009.

Separately, the TSOs monitor and report annually on frequency performance within a 49.9 to 50.1 Hz range in the All-Island Transmission Performance report[42] and aim to keep within this range for more than 98% of the time (the ± 100 mHz criteria). Figure 4 shows the evolution of this metric.

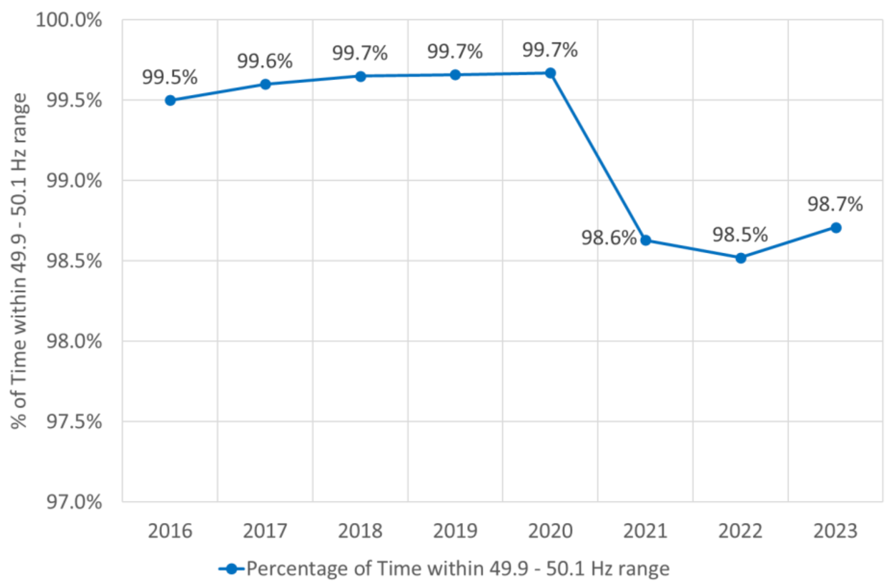


Figure 4: Evolution of time within 49.9 to 50.1 Hz range

Figure 3 shows that the frequency quality has improved since 2009. This can be explained by several measures taken in this period such as (i) the change from verbal dispatch to electronic logged dispatch of generation units, leading to improved unit operator response; (ii) newer generating units in the latter years having the latest electronic governor controls; (iii) the retrofit of the electro-mechanical control systems on older generating units with modern electronic controls; (iv) over the longer term, the increase in system inertia as a result of more generating units to meet increases in system demand; (v) the frequency response of HVDC interconnectors, BESS and wind; and (vi) a reduction in the number of large generator trips.

However, after 2019 the percentage of time within the 49.9 – 50.1 Hz range has decreased significantly (see Figure 4), but is still meeting the requirement of at least 98% of time within this range. While this is a

[42] https://cms.eirgrid.ie/sites/default/files/publications/All-Island-Transmission-System-Performance-Report-2023.pdf

negative trend, overall, the number of minutes outside the standard frequency range is still very low compared to the SOGL target of maximum of 15,000 per year, as evidenced in Figure 3.

The negative trend in **Error! Reference source not found.**is mainly due to: (i) a reduction in regulating resources (less conventional generators online); (ii) an increasing proportion of the reserves coming from inverter-based resources that are currently not configured to regulate frequency; and (iii) aging of conventional generating portfolio. This trend could continue as more wind and solar power are integrated into the system and the operational policy evolves, i.e., reducing the number of conventional units online and, consequently, also reducing the inertia.

2.3.2. Maximum Frequency Deviations (Nadir and Zenith)

In line with Article 127 in the System Operations Guideline43, EirGrid and SONI's Synchronous Area must maintain a Maximum instantaneous frequency deviation of+/- 1000 mHz. Figure 5 shows the minimum and maximum frequency occurrences in the All-Island power system between 2015 and 2023 (i.e. frequency Nadir and Zenith). Note that the frequency Nadirs and Zeniths in Figure 5 reflect the worst-case incidents in each year. Consequently, as they depend on a single incident they do not constitute a strong statistical basis to evaluate a trend. Accordingly, the figure should be considered illustrative.

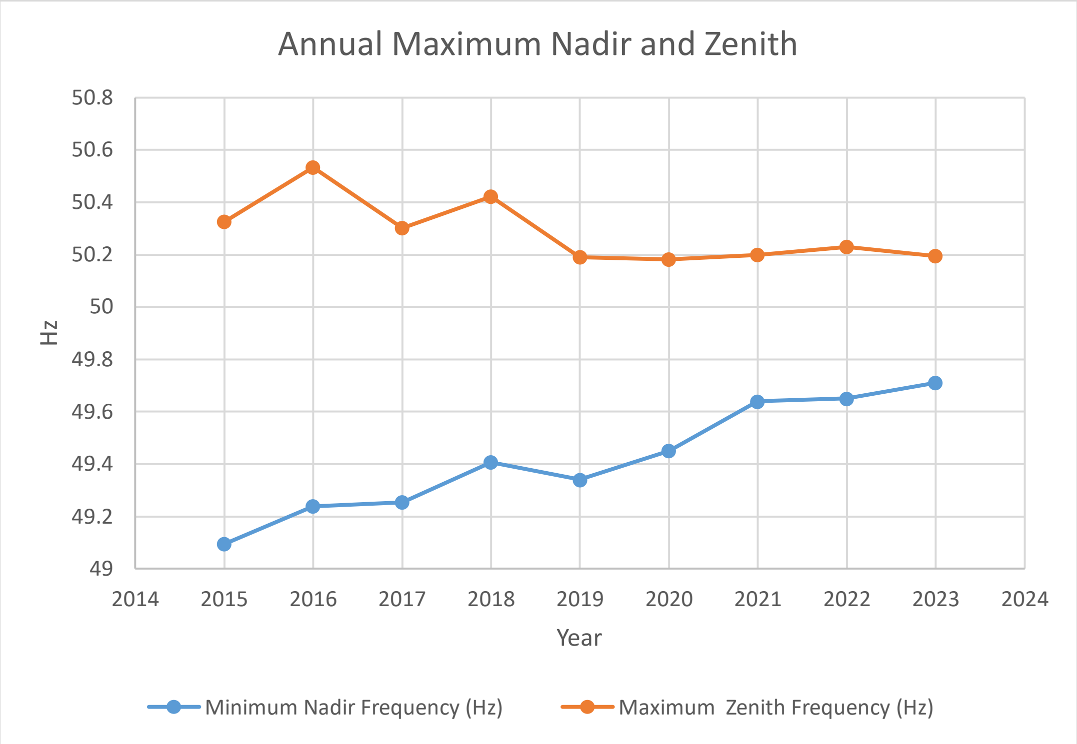


Figure 5: Maximum Annual Nadir and Zenith Values between 2015 and 2023.

Both Nadir and Zenith parameters are well within the required limits and are improving in their performance over the past number of years. There are large volumes of contracted DS3 reserve service providers currently and scalars in place that incentivise performance; this, coupled with enhanced operational procedures has resulted in the robust frequency stability characteristics within the standard frequency ranges and in managing Nadirs and Zeniths as shown in Figure 4*Figure 3* and Figure 5

It is therefore critical for the TSOs to ensure that the evolving needs of the system are fully met by day ahead contracted volumes of reserves with the change from the current tariff based DS3 System services arrangements to DASSA arrangements, to continue to deliver high quality frequency performance.

43 Synchronous Area Operational Agreement.

3. System Needs

3.1. Objectives

This chapter describes the evolution of power system reserve requirements to enable secure system operation across two aspects:

- ‘Normal’ frequency regulation, i.e. maintaining the system frequency within the standard frequency range 49.8 to 50.2 Hz44. The SOGL[45] and SAOA require that not more than 15,000 minutes/year (2.9% of minutes/year) shall be outside the standard frequency range. Figure 3 shows that Irish frequency quality is far better, with typically less than 50 minutes/year. Accordingly, as stipulated in the SAOA, the TSOs therefore ‘do not interpret the frequency quality target parameter as a target to be achieved but will endeavour to minimise the number of minutes outside the standard frequency range to a value below this.’. Additionally, the TSOs report annually in the All-Island Transmission Performance report[46] on system frequency performance within a range of 49.9 to 50.1 Hz, in line with a requirement to ensure that the system frequency shall be within the 49.9 to 50.1 Hz range for more than 98% of time[47,] measured over a year. This is a significantly tighter target than the frequency quality target parameter specified in SOGL. Figure 4 shows that this target is closer to the current frequency quality and accordingly provides a more meaningful reference.
- Mitigating large disturbances to avoid[48 49] :
    - 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) [50].
    - Exceeding the maximum time to recover frequency (1 minute) to the frequency recovery range (+/- 500 mHz).
    - A RoCoF larger than +/- 1 Hz/s measured over 500 ms.

This includes containing any frequency deviations and replacing the reserves that have been utilised during the containment phase.

As set out in the DASSA Product Review and Locational Methodology consultation paper[51], the TSOs utilise a range of reserve products (combined with other operational measures) to manage both frequency regulation and mitigation of large disturbances. The TSOs’ scheduling process ensures that for both objectives sufficient reserves will be available in real-time, considering the system constraints while also minimising the cost for deviating from the physical notifications. From 2026 onwards, the DASSA will add a layer to this, ensuring that sufficient capacity is taken out of the ex-ante markets to ensure that in real time sufficient reserves will be available. Considering that the DASSA takes place on a day-ahead basis, this necessitates that the required volumes of reserves need to be determined day-ahead, before the DASSA gate closure.

Starting from the objectives above, the following sections discuss the reserve volume needs for normal frequency regulation (section 3.2) and for mitigating disturbances (section 3.3), addressing the different types of reserves, including the need for speed, dynamic response and geographical distribution.

---

44 As per System Operations Guideline and Synchronous Area Operational Agreement.
45 Article 127 and Annex III, table 2 of SOGL (Regulation - 2017/1485 - EN - EUR-Lex (europa.eu))
46 https://cms.eirgrid.ie/sites/default/files/publications/All-Island-Transmission-System-Performance-Report-2023.pdf
47 https://cruie-live-96ca64acab2247eca8a850a7e54b-5b34f62.divio-media.com/documents/CRU20078-PR5-Regulatory-Framework-Incentives-and-Reporting.pdf
48 As per EirGrid OSS, SONI OSS, System Operations Guideline and Synchronous Area Operational Agreement.
49 Grid Code Version 14 (eirgrid.ie) and SONI-Grid-Code_Apr_2024.pdf
50 If the system frequency is below 49.0 Hz, automatic schemes start protecting the power system by Low Frequency Demand Disconnection (LFDD).
51 https://consult.eirgrid.ie/en/consultation/soef-markets-%E2%80%93-future-arrangements-system-services-%E2%80%93-dassa-product-review-locational-methodology

For additional context and as outlined in the DASSA Product Review and Locational Methodology recommendation paper[52] (which will be subject to a SEMC decision) the TSOs are recommending the procurement of both upward and downward products to cover both under-frequency and over-frequency events. These products are also to be distinguished between dynamic and static provision qualities, summarised in **Error! Reference source not found.** below.

Table 8 Summary of reserve products (upward and downward)

Reserve product	Category	FAT	Response duration
FFR - Static response	I	150 ms	Response sustainable 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

The descriptions in sections 3.2 and 3.3 discuss the system need for these reserves in terms of managing actual situations as part of the TSOs' day-day operations. Section 3.4 will address the issue of determining the reserve volumes on a day-ahead basis for DASSA, considering the low level of foresight available on system conditions in the day ahead timeframe.

3.2. Keeping System Frequency Within 49.9 – 50.1 Hz Range

As discussed in section 3.1, the VFM shall aim to keep the system frequency within the 49.9 – 50.1 Hz range. If the system frequency is within this range, the power system should have sufficient reserves or other mitigation measures to handle the **reference incidents** without reaching the **maximum instantaneous frequency deviation** and accordingly avoid any Low Frequency Demand Disconnection (LFDD) or generation shedding (see section 3.3).

Hence, the percentage of time per year that the system frequency is outside the 49.9 Hz to 50.1 Hz range shall be limited. The TSOs monitor and report annually on system frequency aiming to keep the system frequency within the 49.9 Hz to 50.1 Hz range for at least 98% of time, measured over a year. As shown in Figure 4, the percentage of time that the system frequency is within the 49.9 – 50.1 Hz range, was above 98% for all years between 2016 and 2023 and in between 98% and 99% for 2021 - 2023.

To keep the **system frequency** within the 49.9 – 50.1 Hz range, load and generation are balanced continuously, by both automatic (governor) response of reserve providers and manual dispatch instructions by the TSOs followed by the reserve providers. Traditionally, conventional (synchronous) generation units

[52] DASSA Product Review & Locational Methodology Recommendation Paper (EirGrid),
DASSA Product Review & Locational Methodology Recommendation Paper (SONI)

were utilised to balance – both automatically and manually - the continuous changes in the electricity demand, with typically limited volatility. However, as the All-Island system now has large and increasing volumes of RES, the inherent variability of renewable resources, particularly wind and solar generation adds to the imbalance and can cause increased volatility in system frequency. Furthermore, other sources of increased volatility include demand, DER and the increasing number of interconnectors, which will cause additional ramping. These changing operational characteristics must be accommodated and new mechanisms enabled to manage the required continuous balance of generation, export, import and demand.

Currently the TSOs maintain a minimum volume of dynamic reserves 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) (see 2.2.3 **Error! Reference source not found.**). These reserves are currently typically provided by conventional generators through governor droop setting and with a tight frequency deadband (+/- 15mHz). However, other resources such as wind, solar, BESS and interconnectors are or should be able to provide this response. As detailed in the TSOs' DASSA Product Review and Locational Methodology recommendation paper[53] (subject to a SEMC decision) the TSOs are recommending that for the DASSA, a minimum +/-15mHz deadband capability will be required of providers contracted for the provision of dynamic reserves.

In addition, the current 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.

As discussed in section **Error! Reference source not found.**, the current system frequency quality is well within the targets described above. However, the percentage of time within 49.9 and 50.1 Hz reduced after 2020 (see Figure 4) from 99.6% (average 2016 – 2020) to 98.6% (average 2021 – 2023). While all years to date have been above the target of 98%, it should be noted that the challenges of frequency regulation will increase, mainly for the following reasons:

- Reducing average inertia because of reducing numbers of synchronised conventional units on average. As inertia helps in absorbing imbalances in the system, a lower average level of inertia will likely result in a more volatile system frequency, requiring faster acting and a greater volume of balancing actions.
- More variable generation (particularly wind and solar generation) and demand, which increases uncertainty, volatility and accordingly may result in larger momentary imbalances, requiring a greater volume of balancing actions (see also Current System Services Volume Requirements Information Paper[54]).
- Increased levels of HVDC interconnection which may ramp (rate of change of import or export) at greater speeds than today.

Since the aggregated impact of all the future developments is impossible to predict accurately, the TSOs carefully monitor the trend in frequency quality. If the frequency quality is deteriorating significantly, mitigation measures will be required.

Further detail on the TSOs' considerations of minimum volumes of dynamic reserves for DASSA is contained in Chapter 5.

3.3. Mitigating Large Disturbances

3.3.1. Objective

The Operating Security Standards[55] (OSS) set out the requirement that the instantaneous frequency deviation shall not be larger than 1000 mHz following the loss of the largest power in-feed or the largest out-feed, or the loss of interconnectors or tie lines, including the loss of both circuits of the North-South

[53] DASSA Product Review & Locational Methodology Recommendation Paper (EirGrid), DASSA Product Review & Locational Methodology Recommendation Paper (SONI)
[54] Current System Services Volume Requirements Information Paper
[55] Operating Security Standards (eirgrid.ie) and SONI Operating Security Standards v1.pdf

interconnector (included only in SONI OSS)[56]. Furthermore, RoCoF shall not be larger than ± 1 Hz/s measured over a rolling 500 milliseconds period as per EirGrid and SONI grid codes.

If these limits are exceeded, system defence measures are triggered that protect the power system against a partial or full black-out. These actions include:

- Low Frequency Demand Disconnection (LFDD) or Under Frequency Load Shedding.
- Over Frequency trips of generation.
- RoCoF protection setting loss of generation or demand units.

In order to avoid these actions, the TSOs continuously monitor the power system and perform analysis with their Look-ahead Security Assessment Tool (LSAT). LSAT assesses the security of the power system in terms of rotor angle stability, frequency security, and voltage security. For this, LSAT runs around 800 N-1 contingencies and notifies about insecure contingencies. LSAT serves as a critical decision-support tool for control room operators and provides radar-like guidance on how to operate the power system in a safe and secure manner.

A component of LSAT called the Transient Security Assessment Tool (TSAT) conducts dynamic analyses to assess the rotor angle stability (based on the negative margin metric) and frequency security (based on Nadir, Zenith, and RoCoF criteria). For this, a security margin of 200 mHz is applied to the maximum instantaneous frequency deviation of 1000 mHz and a security margin of 0.1 Hz/s is applied for the RoCoF limit of ± 1 Hz/s (i.e., to account for potential modelling inaccuracies). Hence, effectively TSAT notifies on an insecure contingency when the incident results in an excursion outside the 49.2 to 50.8 Hz range and/or the RoCoF is outside the ± 0.9 Hz/s range.

For keeping the system frequency and RoCoF within the specified limits after the incident, the power system requires sufficient volumes of reserves, sufficiently fast response of reserves and a sufficient share of dynamic response. These issues are discussed below, but not before discussing the so-called Reference Incident (RI) i.e. the most onerous incident that needs to be taken into account when dimensioning reserve requirements.

Figure 6 below provides an overview of the components that together determine the required upward and downward reserve volumes on a Day-Ahead basis. Each of the components is discussed in the referred sections. The figures shows that initially the RI is determined, based on the maximum infeed loss (sum of the Maximum potential LSI and potential Consequential Loss of Infeed (CLI)), and the maximum outfeed loss (sum of the LSO and potential Consequential Loss of Outfeed (CLO)). The RI determines the required volumes of POR, SOR, TOR1, TOR2 and RR, taking into account also a potential loss of reserve provision from the unit setting the LSI or LSO. As the DASSA volumes are to be determined and published by 10:00am D-1, the TSOs consider it prudent to include an additional reserve volume requirement to cater for unavailability of reserve providers in real-time (e.g. due to a forced outage of a reserve provider or a transmission restriction/local constraint on the collective response of a group of reserve providers).

Figure 6: Overview of the factors contributing to the determination of required upward and downward reserves as discussed in this section 3.3.

[56] The fault outage of a 'double circuit overhead line on the 275 kV network' needs to be considered in accordance with section 2.1 of the SONI Operating Security Standards v1.pdf. In practice this applies to the North-South interconnector.

3.3.2. Reference Incidents

For the NI/IE synchronous area, two types of reference incidents need to be considered:

1. All Island reference incidents, considering that after the incident the IE/NI area is still operated synchronously.
2. Island split reference incidents[57], considering that a trip of a fully loaded double circuit tie-line between IE and NI resulting in the system being split into two synchronous areas, which results in a positive imbalance in one jurisdiction and a negative imbalance in the other jurisdiction.

Both types are detailed below:

All Island Reference Incidents

Article 3(58) of SOGL defines Reference Incident as 'the maximum positive or negative power deviation occurring instantaneously between generation and demand in a synchronous area, considered in the FCR dimensioning'. Article 153(2)(b)(ii) clearly outlines that for the IE/NI synchronous area, the reference incident shall be 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'.

The TSOs consider that the imbalance that may occur as a result of an instantaneous change of active power from a single infeed or outfeed (e.g. HVDC interconnector trip) includes the consequential loss of other outfeeds or infeeds that may react to the instantaneous change of power. Therefore, the TSOs propose the following formula for determining the reference incident for infeed and outfeed losses, which align with the TSOs' OSS:

$$RII^{AI} = LSI^{AI} + CLI^{AI} \quad [1]$$

$$RIO^{AI} = LSO^{AI} + CLO^{AI} \quad [2]$$

In which:

$$RII^{AI} = All\ Island\ Reference\ Incident\ for\ loss\ of\ Infeeds$$

$$RIO^{AI} = All\ Island\ Reference\ Incident\ for\ loss\ of\ Outfeeds$$

$$CLI^{AI} = All\ Island\ Consequential\ Loss\ of\ Infeed$$

$$CLO^{AI} = All\ Island\ Consequential\ Loss\ of\ Outfeed$$

$$LSI^{AI} = \text{All Island}\ Largest\ Single\ Infeed$$

$$LSO^{AI} = \text{All Island}\ Largest\ Single\ Outfeed$$

With these formulas we are taking a prudent approach, in that the size of the reference incident will be the sum of the LSI or LSO and Consequential Loss of Infeed (CLI) or Consequential Loss of Outfeed (CLO). CLI and CLO are trips of generation or changes in demand of demand units triggered by the LSI or LSO. CLI and CLO are typically inadvertent (from a system perspective) and mainly caused by a lack of Fault Ride Through (FRT) capability of the units. This means that generation can disconnect and/or demand units can reduce demand automatically (e.g., switching to backup supply systems) because ofprotection devices/settings (e.g., under voltage or over/under frequency protection) responding to frequency/voltage resulting from the incident. The TSOs aim to minimise consequential losses by proposing adequate requirements that prevent consequential losses, including:

- Grid Code change to introduce FRT capability for LEUs[58]. This is critical considering the current and expected share of LEU demand (e.g., could account for 30% of peak demand by 2030).
- Developing standards for FRT capability of small DER (e.g., roof-top PV).

Note that the consequential response does not include:

[57] Note that this island split reference incident will be reviewed when the 2nd North-South interconnector becomes operational.
[58] Shaping Our Electricity Future Roadmap Version 1.1

- Runback schemes and frequency response service on HVDC interconnectors, responding to the system frequency during the incident.
- Response of demand to a frequency deviation, typically reducing demand when the system frequency is reducing and vice versa.
- System defence measures.

Island Split Reference Incidents

In addition to the RI for outfeed and infeed losses discussed in the previous section, SONI's OSS[59] also stipulates that the system frequency and RoCoF shall stay within the specified limits, after a fault and tripping of the 275 kV 'North-South tie-line' that runs between the two jurisdictions[60]. As this trip results in a system split into two synchronous areas, both areas need to mitigate the imbalance, which can be positive or negative, depending on the direction of the flow on the N-S tie-line before the trip. The Island Split RIs for outfeed and infeed losses for both IE and NI are defined by the following formulas.

$$RIO_{NI} = Flow_{\ N\rightarrow S} + CLO^{NI} \quad [3]$$

$$RII_{NI} = Flow_{\ S\rightarrow N} + CLI^{NI} \quad [4]$$

$$RIO_{IE} = Flow_{\ S\rightarrow N} + CLO^{IE} \quad [5]$$

$$RII_{IE} = Flow_{\ N\rightarrow S} + CLI^{IE} \quad [6]$$

In which:

$$RII_{NI} = Reference\ Incident\ for\ loss\ of\ Infeeds\ to\ Northern\ Ireland$$

$$RIO_{NI} = Reference\ Incident\ for\ loss\ of\ Outfeeds\ from\ Northern\ Ireland$$

$$Flow_{N\rightarrow S} = Flow\ on\ North - South\ tie - line\ in\ direction\ North\ to\ South$$

$$Flow_{S\rightarrow N} = Flow\ on\ South - North\ tie - line\ in\ direction\ South\ to\ North$$

The formulas show that the main driver of these reference incidents is the flow on the N-S interconnector. In addition, CLIs and CLOs are considered in the same way as for the All Island RIs.

It is noted that the formulas above apply to the situation until the delivery of the second N-S tie line. After delivery of the second N-S Interconnector, the jurisdictional reserve requirements will be reviewed by the TSOs.

Summary and Examples

Table 9 shows an overview of both types of reference incidents, including the impact on the frequency. At least until the second N-S interconnector becomes operational, these types of reference incidents need to be taken into account.

Table 9 - Types of reference incidents

Type of Reference incident	RI type	Example of Reference Incident	Area	Resulting frequency
All Island LSI and consequential loss	RI^-	EWIC fault and trip while importing 504 MW and consequential loss of generation	All island	Under frequency
All Island LSO and	RI^+	EWIC fault and trip while exporting 526 MW and consequential loss of demand	All island	Over frequency

[59] Operating Security Standards (eirgrid.ie) and SONI Operating Security Standards v1.pdf
[60] 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.

consequential loss				
Island split, when flow N→S	RI_{IE}^{-}	Trip of North-South Interconnector[61] while flow is North → South and consequential losses	IE	Under frequency
	RI_{NI}^{+}		NI	Over frequency
Island split, flow S→N	RI_{IE}^{+}	Trip of North-South Interconnector while flow is South → North and consequential losses	IE	Over frequency
	RI_{NI}^{-}		NI	Under frequency

Future outlook for 'All-Island' reference incidents.
Currently the capacities of the Moyle and EWIC interconnectors limit the potential reference incidents for outfeed and infeed losses to approximately 500 MW. In the near future, additional and larger interconnectors are due to connect that would increase the 'All-Island' largest single infeed or outfeed losses to 700 MW. Moreover, the number of HVDC Interconnector events that may constitute the reference incidents will also increase. In addition to HVDC interconnectors, future off-shore wind farm connections, and potentially LEUs could be of the size that they need to be considered in the determination of the reference incident. Section 3.4.2 provides further information on this. Table 12

3.3.3. Required Volume and Speed of FFR

Figure 7 shows the different stages of a sudden imbalance, caused by a loss of a large infeed. In this section we focus on the period up to the Nadir and Zenith. The Nadir, Zenith and the RoCoF are mainly determined by the size of the imbalance, the system inertia, and the characteristic of the reserves, including volume, speed and the specific response of the reserves (dynamic/static, deadband, droop/trajectory). Considering that the system inertia is kept at a certain minimum level, the speed, volume and response of the reserves are the parameters that need to be tuned in a way that the limits for Nadir or Zenith and RoCoF are not exceeded.

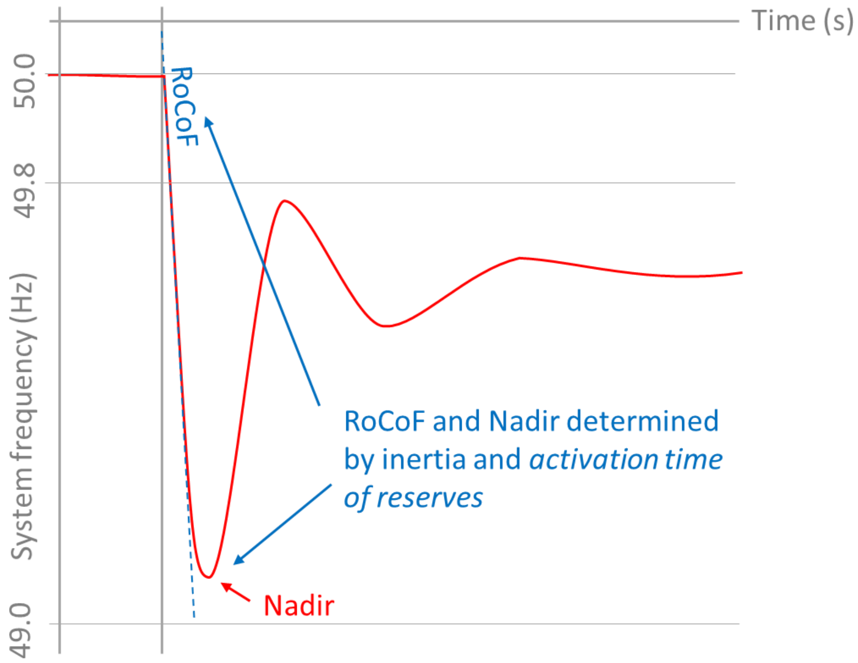


Figure 7: Illustrative example: RoCoF and Nadir determined by inertia and activation time over reserves.

Dependent on the reference incident, the requirements for reserve speed may be different. For example, TSOs' studies for the 2025 situation revealed that trips of the N-S interconnector may easily result in

[61] Double circuit, relevant until the completion of the second North-South interconnector.

exceeding RoCoF or frequency limits if the FFR response is not fast enough, most notably in NI (see for example Table 10).

Table 10 - Study results, 2025 scenario for most onerous under frequency events

Reference incident	Jurisdiction	Scenario	Nadir	Time to Nadir	RoCoF
All-Island	All-Island	Importing EWIC trip	49.72 Hz	1.8 s	-0.51 Hz/s
Island split, flow N→ S	Ireland	N-S interconnector trip, flow N→ S	49.73 Hz	1.9 s	-0.41 Hz/s
Island split flow S→ N	Northern Ireland	N-S interconnector trip, flow S→ N	48.33 Hz	1.8 s	-1.81 Hz/s

Accordingly larger shares of very fast FFR are required to mitigate a trip of the N-S Interconnector. However, additionally with the need to cater for an HVDC interconnector trip, over two-thirds of the All Island FFR may need to be very fast. Table 11 provides an example of the required FFR and the potential share of very fast reserves.

Table 11 – Study results, 2025 scenario, required upward FFR and share of very fast reserves

Reference incident	Jurisdiction	Imbalance	Required FFR - up (share of Imbalance)	Required Cat. 1 FFR (share of required FFR)
All-Island	All-Island	500 MW	331 MW (66%)	213 MW (64%)
Island split, flow N→ S	Ireland	450 MW	412 MW (82%)	295 MW (72%)
Island split flow S→ N	Northern Ireland	404 MW	390 MW (97%)	334 MW (86%)

An interesting observation in the table is that the volumes of FFR required for 'All Island' are smaller than the volumes of FFR required for IE and NI. This is also the case for the very fast FFR.

In order to maintain stability in the power system, the system requires a certain minimum share of reserves with dynamic response. This dynamic response makes sure that the activation of the reserves reduces when the frequency deviation decreases. Current analysis for a 2025 scenario indicates that the share of dynamic response was of the order of 80%. Future analysis for DASSA scenarios in the yearly process will identify the required share of dynamic response for the DASSA auctions.

3.3.4. Required Volume of POR - TOR2 Reserves

Figure 8 shows the different stages of a sudden imbalance, caused by a loss of a large infeed. In this section we focus on the period in which the frequency is stabilised and recovered to the frequency recovery range of +/- 500 mHz as stipulated in the SAOA and SOGL[62]. At this stage, the power balance is restored which means that the activated reserves are compensating the imbalance resulting from the incident. In other words, to stabilise the frequency after an event, sufficient reserves should be available to compensate the imbalance resulting from this incident. This means that the volume of reserves should be at least equal to the imbalance resulting after the most onerous incident that needs to be taken into account, i.e. the reference incident.

This volume should be fully available from the time that the frequency is being stabilised, hence typically in the POR or SOR timeframe.

[62] Article 5 of the SAOA requires that the system frequency shall recover within 1 minute to the frequency recovery range +/- 500 mHz. Hence, within the time period that SOR is active, the system frequency shall return to the +/- 500 mHz. It is noted that this requires sufficient reserves that are activated in the +/- 500 mHz. As recommended in the Product Review paper, all dynamic and static reserve products should have this capability.

The volume needs to be available until the reserves are de-activated. As the reserves are activated and de-activated by local controllers that act on local measurements of the system frequency (droop control or a frequency trajectory) the reserves will only be de-activated when the system frequency returns to 50 Hz. This requires frequency restoration actions by e.g. manual instructions by the TSOs to the reserve providers and activation of these reserves. Accordingly, full activation may take more than 5 minutes which means that the volume of reserves to cater for the reserves should be available up to the TOR2 activation period of 5 – 20 minutes.

Consequently, the required volume of reserves should be the same for POR, SOR, TOR1 and TOR2 and should be at least 100% of the RI (as defined in section 3.3.2).

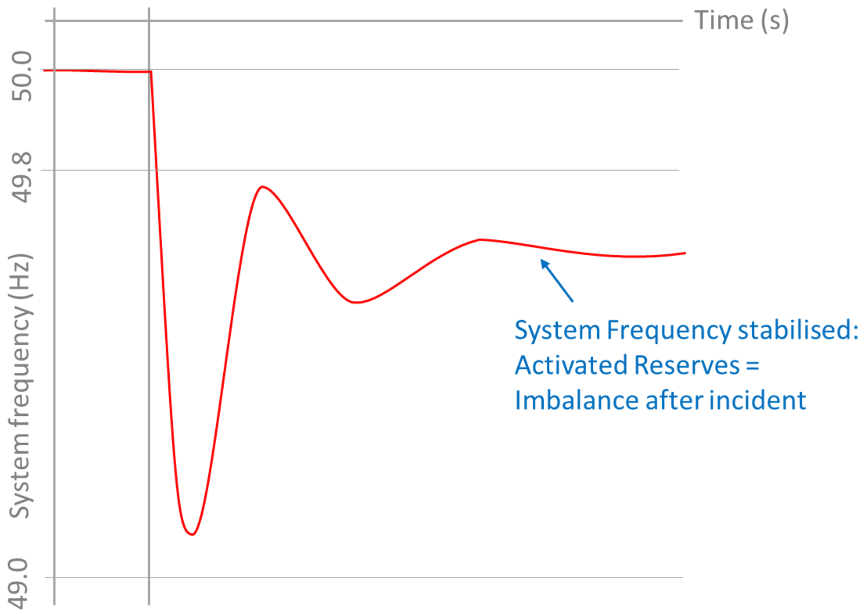


Figure 8: Illustrative example: Activated reserves vs imbalance after the incident.

3.3.5. Required Volume of RR

Article 11 of the LFCBOA [63] provides the dimensioning rules for RR in accordance with SOGL Article 160(2). It is stipulated that '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.'. Hence, the TSOs require for upward RR the maximum of the volumes required for upward FCR and upward FRR. As POR, SOR, TOR1 and TOR2 are mapped to FCR and FRR in article 2 of the LFCBOA, the volume required for upward RR will be at least the maximum of the volumes required for upward POR, SOR, TOR1 and TOR2.

As outlined in the DASSA Product Review and Locational Methodology recommendation paper[64] (subject to SEMC decision), the TSOs will also implement downward RR, for which the same logic applies. Accordingly, the volume required for downward RR will be at least the maximum of the volumes required for downward POR, SOR, TOR1 and TOR2.

3.3.6. Potential Loss of Reserves of RI

The TSOs need to take into account the potential provision of reserves from a unit that may set one of the RIs as reserve capacity provided by an RI setting unit will also be lost if this RI takes place. This could pose additional risk to system security if the potential shortfall in reserve capacity is not accounted for in the volume determination process.

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

[64] DASSA Product Review & Locational Methodology Recommendation Paper (EirGrid), DASSA Product Review & Locational Methodology Recommendation Paper (SONI)

Therefore, the TSOs propose that where a unit that sets one of the RIs can provide reserves, a volume to ensure sufficient reserve capacity is available to cover the potential loss of reserves from such a unit shall be included in the determination of the reserve volumes.

3.3.7. Additional reserves for unavailability

To cater for circumstances where, after the DASSA auction has concluded, reserve providing units may become unexpectedly unavailable or local constraints may limit the possibility to dispatch some reserve providing units, actual available reserves may be lower than the reserves contracted in DASSA. The TSOs therefore require an additional reserve volume component that mitigates unexpected unavailability of reserve providers that appears after DASSA. This allowance shall apply to FFR, POR, SOR, TOR1, TOR2 and RR.

3.3.8. Consideration of Pre-DASSA Contracted Volumes

In line with the requirements of the SEM Committee's DASSA Design decision paper[65] , the TSOs will take account of any reserve products and volumes that are already contracted and available at the time of a DASSA auction. Such pre-procured volumes could be the result of products procured in the Layered Procurement Framework (LPF) or Fixed Contracts framework as applicable, or other pre-existing reserve service contracts e.g. DS3 System Services Volume capped contracts[66].

3.3.9. Summary of Proposed DASSA Minimum Reserve Volumes

Formula 7 shows the volume of Reserves.

$$Reserve_{DASSA} = RI + C_{loss\ of\ reserves\ of\ RI} + C_{unav} \qquad [7]$$

In which:

$$Reserve_{DASSA} = Reserves\ to\ be\ contracted\ in\ DASSA$$

$$C_{loss\ of\ reserves\ of\ RI} = Additional\ reserves\ to\ account\ for\ potential\ loss\ of\ reserves\ from\ unit\ setting\ the\ RI$$

$$C_{unav} = Additional\ reserves\ to\ mitigate\ unavailability\ of\ one\ or\ multiple\ reserve\ provider\ units$$

Figure 9 shows a theoretical example of the FFR – TOR2 volumes required to mitigate the reference incident for infeed losses. As discussed in the section above and illustrated in this figure, the required volumes of POR, SOR, TOR1 and TOR2 will be close to 100% of the reference incident. This is not necessarily true for FFR which may require less volume for the All-Island reference incident and the Irish case reference incident. For defining minimum volumes per jurisdiction, minimum levels of dynamic response and minimum speed of FFR detailed simulations are required, which will be undertaken as part of the annual assessment process.

[65] https://www.semcommittee.com/publications/sem-24-066-future-arrangements-system-services-dassa-design-decision-paper
[66] DS3 Programme | Shaping Our Electricity Future | EirGrid

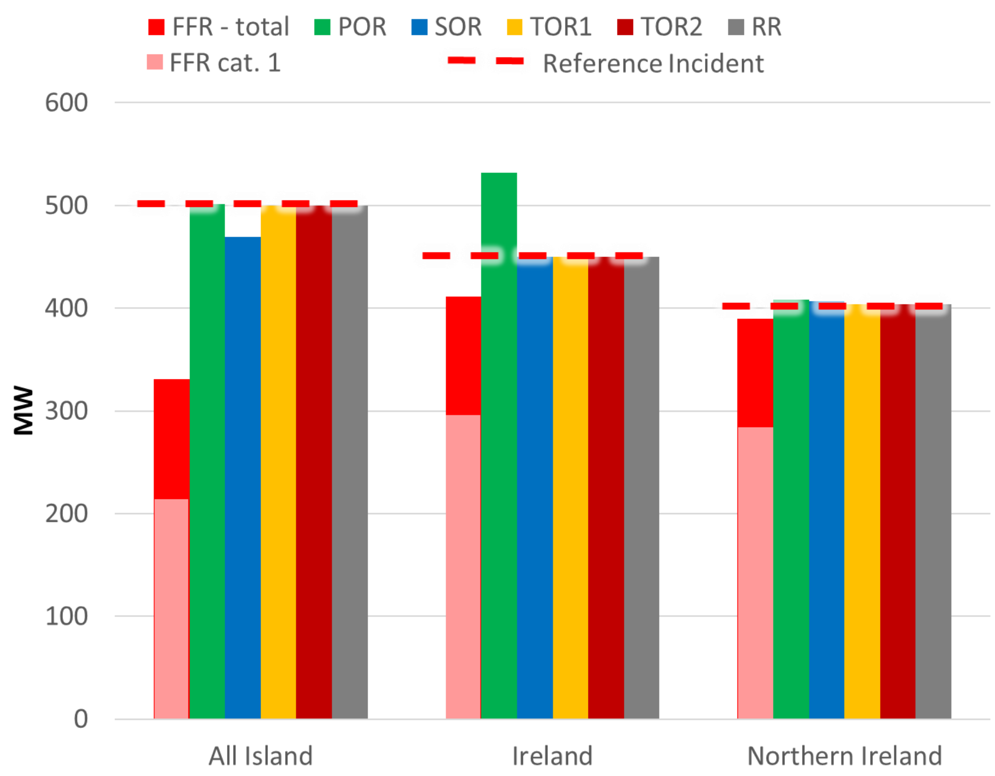


Figure 9: Example of reference incidents and required volumes reserves per product for under frequency events in Ireland, Northern Ireland and All Island scenarios (source: EirGrid/SONI simulations for 2025)

3.4. Day-ahead Reserves Volumes Forecast

3.4.1. Introduction

As discussed in the previous section, the main drivers for the reserve volumes are the historical average frequency quality (time outside the 49.9 – 50.1 Hz range, see section 3.2) and the actual reference incident (see section 3.3). While the historical frequency quality is measured on a long term basis (annually, monthly), the reference incident depends on the actual power system situation and may continuously change. Accordingly, the reserve requirements will change continuously. Close to real time, the TSOs' scheduling and dispatch processes adapt the reserve volumes to the system need, based on the LSI and LSO which are determined by the latest PNs (scheduling) or real-time measurements (dispatch). However, for DASSA, reserve volume forecasts are required on a day-ahead basis, which means that the input to the volume forecasting methodology needs to be available even before and with as reasonable an accuracy as possible.

In this section, we first discuss the possibility to forecast the most important drivers for the reserve volume need for contingencies on a day-ahead basis (section 3.4.2). After that, we present our considerations on the timing of the publication of the DASSA volume requirements (section 3.4.3).

3.4.2. Forecasting Drivers for Reserve Volumes for Mitigating Contingencies

As discussed in section 3.3, the most important driver for reserve volumes for mitigating contingencies are the reference incidents. For FFR volumes, the level of inertia may also be important. Table 12 provides an indicative overview of potential units that could contribute to the RI categorised to different types. Apart from potential reference incidents related to existing assets, the table also shows future potential reference incidents, related to new HVDC interconnectors, off-shore wind farms or LEUs that will or may be commissioned in the coming years. The right-hand column provides the drivers for the actual maximum size of the reference incidents. For example, the price difference between the SEM and France will determine the flow on the Celtic interconnector to France. If this interconnector is on full export to France, a trip of this interconnector will be the reference incident in negative direction, if there is no other potential reference incident that causes a larger imbalance.

Table 12: Indicative overview of contributing units to potential reference incidents and key drivers

Potential contribution to Reference Incident, trip of	Year	Max LSI	Max LSO	Driver for actual size of the LSI/LSO
All Island				
Interconnectors to Great Brittain				
Moyle[67]	Existing	410 MW	441 MW	Determined by ex-ante markets Driven by price difference between SEM and GB
EWIC[67]	Existing	504 MW	526 MW	
Greenlink[68]	2024	500 MW	500 MW[69]	
Future Interconnector 1[70]	2029	TBC MW	TBC MW[69]	
Future Interconnector 2[71]	2029	TBC MW	TBC MW[69]	
Interconnectors to France				
Celtic[72]	2026	700 MW	700 MW[69]	Determined by ex-ante markets Driven by price difference between SEM and EU markets
Wind farms				
Several Off-shore wind farms connected between 2028 and 2033	> 2028?	Up to 500 MW per single connection	N/A	Driven by wind availability and market dynamics
Large generators				
Large Generator 1	Existing	e.g. 450 MW	N/A	Determined by ex-ante markets Driven by market dynamics
Large Generator 2	Existing	e.g. 465 MW	N/A	Determined by ex-ante markets Driven by market dynamics
Large Generator 3	Existing	e.g. 410 MW	N/A	Determined by ex-ante markets Driven by market dynamics
Other potential LSI/LSO				
LEU 1		N/A	≤ TBC MW	
LEU 2		N/A	≤ TBC MW	

[67] Source: Wk39_2024_Weekly_Operational_Constraints_Update.pdf (sem-o.com)
[68] Source: Greenlink Interconnector | energy infrastructure | Ireland and Wales
[69] HVDC cable losses are not yet included
[70] Source: All Island Ten-Year Transmission Forecast Statement 2022 (eirgrid.ie)
[71] Source: All Island Ten-Year Transmission Forecast Statement 2022 (eirgrid.ie)
[72] Source: Celtic Interconnector | Projects | EirGrid

TFSS **Tie-Line Fault with System Separation** [73] LSO/LSI (until 2nd North- South Interconnector)				
Determining North - South Interconnector requirements				
North - South Interconnector	*Until second North -South interconnector*	IE: 450 MW NI: 400 MW	IE: 400 MW NI: 450 MW	Driven by RES, demand, and market dynamics

Table 12 shows that an increasing number of assets may determine the reference incident, both for outfeed and infeed losses. For example, in 2023 Moyle and EWIC determined the LSI during 46% of time, whereas in future the reference incident may well be determined by new and larger interconnectors. Moreover, also new off-shore wind farms connections may be of large enough size (e.g. ≤500MW) to also determine the LSI.

As in real-time, the LSI/LSO will be determined by the actual setpoint of e.g. the interconnectors (or the generation units, or LEU), therefore to such forecast LSI/LSO/N-S flows requires the forecasting of such setpoints. Table 12also shows anticipated drivers for such setpoints. As indicated above, flows on the HVDC interconnectors between the SEM and GB are determined by market outcomes. Currently (in 2024), the SEM is only coupled with GB markets through intraday auctions (IDA). Consequently, it will not be until after the first IDA (IDA1) results are published at around 18:10h that firm interconnector schedules are known. Moreover, IDA1 provides firm results until 11:00h on the next day and indicative schedules for 11:00 until 23:00. Hence, before 18:10h the TSOs do not have any confidence in interconnector schedules. Unfortunately, this also affects the first Day ahead Long term Schedule (DA LTS) run, for which results are published by 16:00 and will have EWIC and Moyle flows set to a 0 MW fixed profile. If, in the future, day ahead market coupling is enabled between SEM and GB, we will ensure that the forecasting methodology takes account of any greater level of certainty on interconnector flows. Future developments on potential changes to SEM-GB market arrangements are shared with industry through our Future Power Market industry workshops74.

Alternatively, other drivers for the LSI and LSO have been evaluated. Figure 10: Correlation All Island Wind - LSI in 2023 based on 15 min. intervals. Source data: EirGridFigure 10 shows the correlation between the LSI and wind, while Figure 11 Figure 11shows the correlation between the LSI and demand, both in 2023.

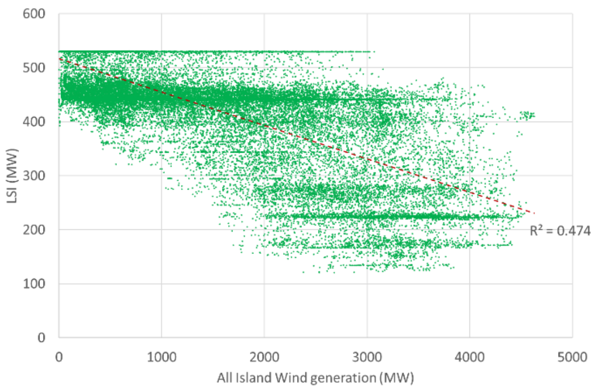


Figure 10: Correlation All Island Wind - LSI in 2023 based on 15 min. intervals. Source data: EirGrid

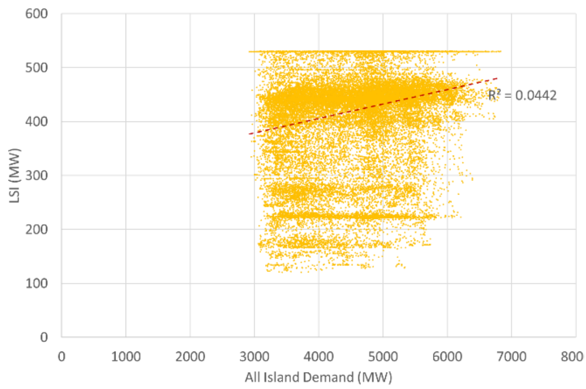


Figure 11: Correlation All Island Demand - LSI in 2023 based on 15 min. intervals. Source data: EirGrid

Figure 12 shows the correlation between all Island Wind and the N-S interconnector in 2023. Furthermore, Figure 13Figure 13 Figure 13 shows an example of the flow on the North-South interconnector, which is typically very volatile. Consequently, the TSOs consider that it is – at least currently - not feasible to predict on a day-ahead basis with a reasonable accuracy.

[73] Loss of the North-South Tie-line (due to a fault) between Ireland and Northern Ireland splitting the two power systems
[74] https://www.sem-o.com/documents/general-publications/Future-Power-Markets-Industry-Workshop-Presentation-11-September-2024.pdf

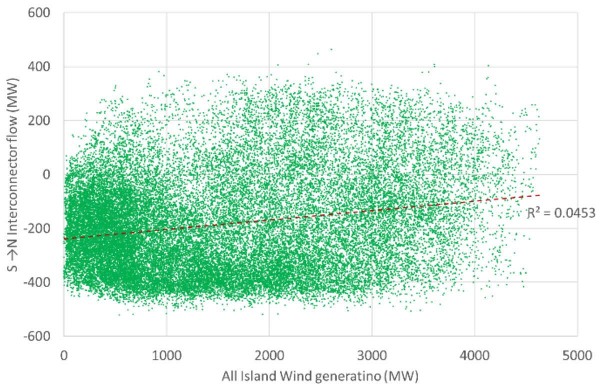


Figure 12: Correlation All Island Wind – N-S interconnector flow in 2023

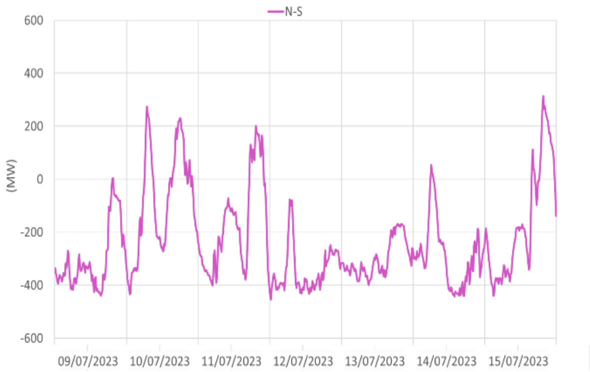


Figure 13: Example of flow on North-South interconnector for one week in 2023

Hence, the TSOs conclude that there is – at this moment – no meaningful way to accurately predict the LSI, LSO, N-S Interconnector forecast before 18:10h (and only up to 11:00). Furthermore, in advance of certainty on dedicated opportunities for the TSOs to procure reserve capacity after the DASSA auction the TSOs propose a prudent approach to volume procurement.

Consequently, the TSOs conclude that, at day-ahead, they should seek to procure reserve volumes to facilitate all potential all-island and jurisdictional infeeds and outfeeds that could result from market outcomes. Hence reserve should be procured to ensure that all interconnectors could be scheduled on either full import or full export. Accordingly, the ‘All-Island’ reference incidents shall consider the potential trips of the interconnectors that can facilitate the largest import and/or export. Moreover, the ‘Island split’ reference incidents shall take into account both full import and export to/from Ireland and full import and export to/from Northern Ireland, as limited by the Weekly Constraint Update.

This approach has the potential to result in over-procurement of reserves as illustrated in Figure 14 and Figure 15 Figure 15 that show the duration curves of LSI and LSO in 2023.

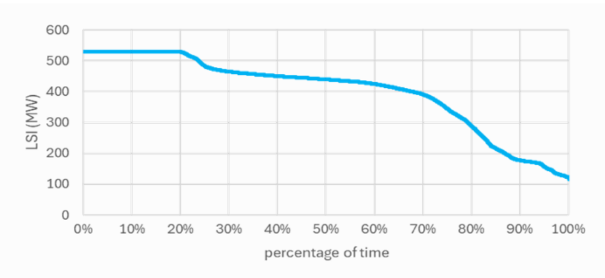


Figure 14: Duration Curves All Island LSI for 2023 based on 15 min. intervals. Source data: EirGrid

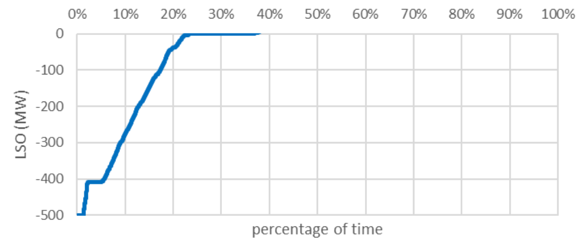


Figure 15: Duration Curves All Island LSO for 2023 based on 15 min. intervals. Source data: EirGrid

Similarly, assuming that both full import and export would be possible on the next day, could lead to more reserve procured, as shown in Figure 16.

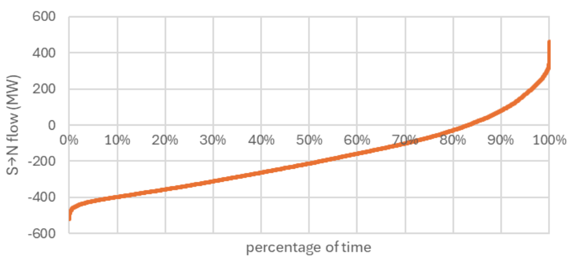


Figure 16: Duration Curves N-S Interconnector flow for 2023 based on 15 min. intervals. Source data: EirGrid

As the forecasts of LSI and LSO would directly impact the reserve volume to be procured in DASSA, the TSOs conclude that there is a risk of over-procurement of reserves. As discussed in section 3.3.2, the system response to the most onerous incident is never the same, but depends on the system conditions. Different system conditions will result in different consequential losses. Close to real-time LSAT runs may monitor the impact of the reference incidents to the system, considering the real-time situation in the system. However, considering the unpredictability of the system on a day-ahead basis, the system conditions will need to be considered in the day-ahead reserve volume forecast in a more generic way for DASSA, and therefore the procurement of reserves will be based on a block value for reserves across the 24 hour trading period.

3.4.3. Timing of the Publication of the DASSA Volume Requirement

Initially, the TSOs propose publishing the reserve volume to be procured in the day ahead DASSA auction by 10:00 on day D-1. The reasons for this are:

- To allow service providers sufficient time to determine their bidding strategies for both the DASSA and DAM.
- Considering that the LSI, LSO and the North-South Interconnector flows are not predictable on a day-ahead basis with reasonable accuracy before the DASSA gate closure, there is limited value in waiting for the DAM results.

The timing of the Volume publication may be reconsidered if the sizes of the reference incidents become predictable with a greater degree of accuracy closer to the DASSA in future (e.g. because of DAM coupling between SEM and GB) and if there will be a mechanism that allows the TSOs to procure additional reserves after DASSA.

TSOs' Proposal:

The TSOs propose to procure reserves as summarised below;

Keeping system frequency within 49.9-50.1Hz:- The TSOs will maintain a minimum requirement for dynamic provision of reserves, and through continual monitoring will ensure sufficient quantities of dynamic reserve provision are dimensioned

Mitigating Large Disturbances:- The TSOs have outlined the considerations that will determine the volumes of reserves to manage large disturbances, as summarised below.

The TSOs propose to publish the Day ahead Volume Requirements for Reserve services at 10.00 on D-1 .

Question 1. Do you agree with our considerations in terms of future system requirements and yearly, weekly and day ahead volume forecasting and relevant publications. Are there any additional aspects you believe should be included? Please provide a detailed rationale in your response.

Question 2. Do you agree with our proposal on the publication timing of the daily D-1 DASSA Volume Requirement? If you consider an alternative time should be considered, please provide a rationale in your response.

4. SOGL Requirements for Reserve Dimensioning

4.1. Introduction

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 DASSA Design Recommendations paper[75] 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(9) 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)[76] and Synchronous Area Operational Agreement (SAOA)[77] , both of which were last updated in 2022.The Load Frequency Control Area Agreement (LFCAA)[78] also contains relevant information on replacement reserve considerations. A consultation was recently held on updated amendments to the LFCBOA[79] , this proposed amendment and any additional future amendments will be published on the TSOs' websites.

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[80].

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

---

[75] https://cms.eirgrid.ie/sites/default/files/publications/EirGrid-and-SONI-DASSA-Design-Recommendations-Paper-September-2024.pdf
[76] S2-LFC-Block-Operational-Agreement-for-Ireland-and-Northern-Ireland-29.09.2022.pdf (eirgrid.ie)
[77] S1-SAOA-for-the-Ireland-and-Northern-Ireland-Synchronous-area-29.09.2022-(post-Title-2-approval).pdf (eirgrid.ie)
[78] S3-LFC-Area-Operational-Agreement-for-Ireland-and-Northern-Ireland-16.12.2019.pdf (eirgrid.ie)
[79] Amendment to LFCOA following ramping trials | EirGrid Consultation Portal
[80] EBGL Article 18 Local Terms and Conditions Proposal (eirgrid.ie)

Operational Constraints update publication[81] . 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 **Error! Reference source not found.**;

- 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.
- 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.
- 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.

Table 13 EU Standard products and FASS product mapping

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 to restore or support the required level of FRR to be prepared for additional system imbalances.	Full activation period of 30 mins - minimum duration of product of 15 mins, max duration is 60 mins	Includes Replacement Reserve (RR) as 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	RRS 20 min - 60 mins RRD 20 min - 60 min

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 volumes for upward and downward reserves for FCR, FRR and RR, and to procure these separately. Sections 4.2, 4.4 and 4.5 describe these dimensioning requirements for FCR, FRR and RR and suggest how to apply them on the Irish situation. However, before doing that, the terms ‘reference incident’ and ‘dimensioning incident’ are discussed.

81 Wk19_2024_Weekly_Operational_Constraints_Update.pdf (sem-o.com)

4.2. Dimensioning and Reference Incident

The dimensioning of such services has to be determined by the reference incident – which is according to SOGL " 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"[82]. The reference incident shall be determined separately for outfeed and infeed losses, as outlined in **Error! Reference source not found.** below.

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. This is illustrated in **Error! Reference source not found.** below.

Table 14 Outline of Dimensioning requirements from SOGL

Reserve capacity product	Dimensioning requirements outlined in SOGL	Upward and Downward dimensioning
FCR	The reserve capacity for the synchronous area shall cover at least the reference incident – i.e. the largest imbalance that may result from an instantaneous change of active power such as; a single power generation module single demand facility single HVDC interconnector or tripping of an AC line, or, the maximum instantaneous loss of active power consumption due to the tripping of one or two connection points	Must be determined separately for upward and downward requirements.
FRR	The TSOs of an LFC Block shall determine the reference incident – i.e. the largest imbalance within the LFC Block that may result from an instantaneous change of active power such as; a single power generation module single demand facility single HVDC interconnector or tripping of an AC line,	The TSOs shall determine the upward FRR reserve capacity which shall not be less than the upward/positive dimensioning incident of the LFC block. The TSOs shall determine the downward FRR reserve capacity which shall not be less than the upward/positive dimensioning incident of the LFC Block.
RR	For the GB and IE/NI synchronous areas there shall be sufficient positive reserve capacity on RR to restore the required amount of positive FCR and positive FRR; For the GB and IE/NI synchronous areas, there shall be sufficient negative reserve capacity on RR to restore the required amount of negative FCR and negative FRR; there shall be sufficient reserve capacity on RR, where this is taken into account to dimension the reserve capacity on FRR in order to respect the Frequency Restoration Control	

[82] System Operations Guideline

	Error (FRCE) quality target for the period of time concerned; and (d) compliance with the operational security within a LFC block to determine the reserve capacity on RR	

Table 15 Dimensioning incidents for reserve products as outlined in the SAOA and LFCBOA

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 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[83].
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 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.	

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. Small volumes of negative (downward) reserves are also contracted under the DS3 Systems Services Volume Capped procurement process which has resulted in contracted and operational BESS that are required to provide 15% of their capability for downward reserve provision. 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.

4.3. POR and SOR Dimensioning in Accordance with SOGL Article 153 FCR Dimensioning

SOGL[84] Article 153(1) requires that ‘all TSOs of each synchronous area shall determine, at least annually, the reserve capacity for FCR required for the synchronous area and the initial FCR obligation of each TSO’. In accordance with SOGL Article 153(2), EirGrid and SONI’s SAOA includes the dimensioning rules for FCR which have been approved by the NRAs. Considering that the SAOA[85] maps POR and SOR as FCR, these

[83] Future Markets Newsletter Feb 2024
[84] System Operation Guideline - Regulation - 2017/1485 - EN - EUR-Lex (europa.eu)
[85] Article 2 of S1-SAOA-for-the-Ireland-and-Northern-Ireland-Synchronous-area-29.09.2022-(post-Title-2-approval).pdf (eirgrid.ie)

rules determine the required POR and SOR capacity for the IE/NI synchronous area (equal to the All Island power system).

EirGrid and SONI shall determine the required FCR capacity in accordance with SOGL Article 153(2), which provides specific requirements for each synchronous area. For the IE/NI synchronous area, 'the reserve capacity for FCR required for the synchronous area shall cover at least the reference incident.' in which 'the size of the reference incident shall be [..] 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;'

Considering that the reference incident sets the minimum requirement for POR and SOR capacity for the All Island power system, the SAOA[86] defines the 'Reference incident for the purposes of dimensioning FCR' as 'In IE/NI this 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.'

More generically, the TSOs are also bound by their Operating Security Standards (OSS[87]), which define the contingencies that should not result in breaching the frequency quality defining parameters. The (ordinary) contingencies specified in both OSS – in principle – align with the definition in the SAOA and the examples mentioned in SOGL Article 153(2). In addition, SONI's OSS requires that a trip of a double circuit overhead line on the 275 kV network shall not result in unacceptable frequency conditions. Consequently, the trip of the double circuit 275 kV overhead North-South tie-line needs to be considered in the determination of the reference incident. The TSOs' interpretation of the requirements in SOGL Article 153 is that the reference incident shall be based on the credible contingencies defined in the TSOs' OSS.

Furthermore, the TSOs' interpretation of the requirements in SOGL Article 153 is that reference incident shall reflect the system imbalance resulting from the most onerous incident. This does not only include the change of active power resulting directly from the loss of the largest single infeed/outfeed, but also the direct response of the power system to the incident, including the reduction of demand (as seen by the grid) or tripping of generation as a result of lack of fault ride-through capability.

In addition, the TSOs consider prudent that on top of the minimum requirement for the reference incident as specified in SOGL Article 153(2), the TSOs need to specifically take into account that:

- Dynamic response of the system shall not result in a Nadir or Zenith larger than 1000 mHz and a RoCoF larger than 1 Hz/s as may be determined using a dynamic model of the power system.
- The unit associated with the reference incident may be holding reserve capacity and will not be able to provide reserves if such a reference incident occurs.

To summarise, the TSOs interpretation of the FCR dimensioning requirements as stipulated in SOGL Article 153 is that;

- The required FCR (POR and SOR) capacity shall be determined at least once a year.
- FCR shall be determined separately for positive and negative direction.
- The FCR dimensioning criteria specify the minimum reserve capacity for FCR
- Required FCR (POR and SOR) capacity shall be sufficient to cover at least the largest possible imbalance after the most onerous single contingency event (the reference incident).
- The imbalance related to the reference incident will take into account the immediate response of the system to the trip, by e.g. response of demand/generation to a frequency and/or voltage deviation.

[86] Article 2 of S1-SAOA-for-the-Ireland-and-Northern-Ireland-Synchronous-area-29.09.2022-(post-Title-2-approval).pdf (eirgrid.ie)
[87] Operating Security Standards (eirgrid.ie); SONI Operating Security Standards

4.4. TOR1 and TOR2 Dimensioning in Accordance with SOGL Article 157 FRR Dimensioning

SOGL[88] Article 157(1) requires that 'All TSOs of a LFC Block shall set out FRR dimensioning rules in the LFC Block operational agreement.'. Considering that EirGrid and SONI's LFCBOA[89] mapped TOR1 and TOR2 as FRR, this means that the TSOs shall determine required TOR1 and TOR2 capacity for the IE/NI LFC block (equal to the All Island power system).

SOGL Article 157(2) specifies that the minimum requirements for the FRR dimensioning rules, which are different for LFC blocks in different synchronous areas. It is the TSOs interpretation that for the IE/NI LFC block the following paragraphs do not apply: (a), (b)[90], (h)[91] and (i)[91], (j $_{(i)}$)and (k $_{(i)}$). Furthermore, articles 157(2)(c)[92], (j)[93] and (k)[93]; and 157(4)[94] are (currently) not applicable or not within the scope of this Volume Forecasting consultation paper. The other (applicable) paragraphs are discussed below.

Article 157(2)(d) requires the TSOs to '*determine the size of the reference incident which shall be the largest imbalance that may result from an instantaneous change of active power of a single power generating module, single demand facility, or single HVDC interconnector or from a tripping of an AC line within the LFC block;'*. This requirement is very similar to the determination of the reference incident for the determination of the FCR, as described in ##.

Accordingly, Article 157(2)(e) requires that 'all TSOs of a LFC block shall determine the positive reserve capacity on FRR, which shall not be less than the positive dimensioning incident of the LFC block', in which SOGL Article 3(109) defines dimensioning incident as 'the highest expected instantaneously occurring active power imbalance within a LFC block in both positive and negative direction.'. Similarly, Article 157(2)(f) requires that ´all TSOs of a LFC block shall determine the negative reserve capacity on FRR, which shall not be less than the negative dimensioning incident of the LFC block'. The TSOs' interpretation is that the 'dimensioning incident' for the IE/NI LFC block is the same as the 'reference incident' mentioned in Article 157(2)(d).

Article 157(2)(g) stipulates that 'all TSOs of a LFC block shall determine the reserve capacity on FRR of a LFC block, any possible geographical limitations for its distribution within the LFC block and any possible geographical limitations for any exchange of reserves or sharing of reserves with other LFC blocks to comply with the operational security limits;'. EirGrid and SONI's LFC BOA, include the geographical limits by specifying minimum amounts of FFR in EirGrid and SONI's area, which have 'been determined on an experiential basis following the reconnection of the North-South tie line.'

In line with Article 157(3), the LFC BOA (Article 12) allocates the responsibilities of each TSOs by stating that 'EirGrid and SONI consider the total requirements for FRR and RR in Ireland and Northern Ireland as defined by the dimensioning rules.' Article 157(4) is not within the scope of the Volume Forecasting methodology[95].

To summarise, the TSOs' interpretation of the FRR dimensioning requirements as stipulated in SOGL Article 157 is that:

- FRR shall be determined separately for positive and negative direction.
- The FRR dimensioning criteria specify minimum reserve capacity for FRR.

---

[88] System Operation Guideline - Regulation - 2017/1485 - EN - EUR-Lex (europa.eu)
[89] Article 2 of S1-SAOA-for-the-Ireland-and-Northern-Ireland-Synchronous-area-29.09.2022-(post-Title-2-approval).pdf (eirgrid.ie)
[90] The last sentence of 157(2)(b) may be literally interpreted as applicable to all TSOs. However, given the context of paragraph (2)(b), the interpretation shall be that this sentence only applies to TSOs of a LFC block in the CE and Nordic synchronous areas.
[91] Because the reference paragraph 2(a) does not apply to IE/NI, paragraphs 2(h) and 2(i) are meaningless for IE/NI.
[92] As the TSOs currently do not apply automatic FRR (as per CRU21039-CRU-Decision-on-aFRP-under-Article-145-of-SOGL.pdf (divio-media.com)), determining the ratio of automatic FRR, manual FRR, and the automatic FRR full activation time is not meaningful. Furthermore, the manual FRR full activation time is not within the scope of this Volume Forecast paper.
[93] Article 157(2)(j) and (k) address FRR sharing with other LFC blocks and sharing and the associated risk of non-delivery shall be processed. Sharing of FRR is considered not within the scope of the Volume Forecast methodology.
[94] Article 157(4) assesses the escalation procedure for managing severe risk of insufficient FRR, which is considered not within the scope of the Volume Forecast methodology.
[95] Article 157(4) requires that all TSOs shall have sufficient reserve capacity at any time in accordance with the FRR dimensioning rules and addresses the requirement for an escalation procedure for managing severe risk of insufficient FRR.

- Required FRR (TOR1 and TOR2) capacity shall be sufficient to cover at least the largest possible imbalance after the most onerous single contingency event (the reference or dimensioning incident of the LFC block).
- The imbalance related to the reference incident will take into account the immediate response of the system to the contingency event, by e.g. (system) protection, or response of demand /generation to a frequency deviation.

4.5. RR dimensioning in Accordance with SOGL Article 160 RR Dimensioning

SOGL Article 160(1) states that the TSOs have the right – but are not obliged - to implement a reserve replacement process (RRP). EirGrid and SONI have implemented an RFP. The TSOs mapped Replacement Reserve as defined in the EirGrid and SONI Grid Codes as RR as mentioned in SOGL[96]. Article 160(2) requires that EirGrid and SONI shall perform 'a combined dimensioning process of FRR and RR to fulfil the requirements of Article 157(2) and that the RR dimensioning rules shall be defined in the LFC BOA. However, minimum requirements for the RR dimensioning rules are stipulated in Article 160(3). For the IE/NI synchronous area these include in paragraph (a) and (b) that 'there shall be sufficient positive reserve capacity on RR to restore the required amount of positive FCR and positive FRR' and 'there shall be sufficient negative reserve capacity on RR to restore the required amount of negative FCR and negative FRR'. Considering that in the IE/NI FCR (POR and SOR) is released by FRR (TOR1 and TOR2), RR shall effectively restore FRR. Accordingly, the minimum required RR volume shall not be different from the FRR volumes, hence it shall at least be equal to the reference incident.

In addition, paragraph (c) requires that 'there shall be sufficient reserve capacity on RR, where this is taken into account to dimension the reserve capacity on FRR in order to respect the FRCE quality target for the period of time concerned', and paragraph (d)requires 'compliance with the operational security within a LFC block to determine the reserve capacity on RR'. The FRCE quality target is effectively defined by Article 128[97] and is of a lower requirement than current operational practice for IE and NI so will not affect the RR dimensioning methodology.

Article 160(5) is considered less relevant for the Volume Forecast methodology as it relates to the sharing of RR which is not within the scope of this methodology. Furthermore, in accordance with Article 160(6), the LFC BOA (Article 12) allocates the responsibilities of each TSOs by stating that 'EirGrid and SONI consider the total requirements for FRR and RR in Ireland and Northern Ireland as defined by the dimensioning rules.'. Article 160(7) is not within the scope of the Volume Forecast methodology[98].

To summarise, the TSOs interpretation of the RR dimensioning requirements as stipulated in SOGL Article 160 is that:

- RR shall be determined separately for positive and negative direction.
- The RR dimensioning criteria will specify minimum reserve capacity for RR
- Required RR capacity shall be sufficient to at least restore the required amount of FCR and FRR.

4.6. Rules for FFR

SOGL does not specify rules for dimensioning of FFR.

4.7. Summary of SOGL Requirements for Reserve Dimensioning

Table 16 summarises the requirements specified in SOGL for the dimensioning of reserves in the IE/NI synchronous area and LFC block. The table shows that the dimensioning requirements for POR, SOR, TOR1 and TOR2 are very similar. Hence, dimensioning shall be done separately for both outfeed and infeed losses and the capacity shall at least cover the reference incident. The imbalance that constitutes the reference incident shall consider both the instantaneous change of active power with the initial loss of a

[96] Article 2 of S2-LFC-Block-Operational-Agreement-for-Ireland-and-Northern-Ireland-29.09.2022.pdf (eirgrid.ie)
[97] Time intervals outside Level 1 FRCE range (at least ± 200 mHz) ≤ 3 % of time intervals per year. Time intervals outside Level 2 FRCE range (at least ± 500 mHz) ≤ 1 % of time intervals per year.
[98] Article 160(7) requires that all TSOs shall have sufficient reserve capacity at any time in accordance with the RR dimensioning rules and addresses the requirement for an escalation procedure for managing severe risk of insufficient RR.

power generation module/ demand facility/ HVDC interconnector/tripping of an AC line etc, and the immediate response of the system to the loss by e.g. (system) protection, or response of demand/ generation to a frequency and/or voltage deviation.

Dimensioning of RR will also need to be undertaken separately for outfeed and infeed losses and the requirement will be based on the need to cover at the required amount of FCR and FRR, hence will also at least cover the reference incident.

Table 16: Summary of TSOs' interpretation of SOGL requirements for reserve dimensioning

EirGrid /SONI Products	FFR	POR	SOR	TOR1	TOR2	RRS	RRD
EU Product	N/A	FCR		FRR		RR	
Dimensioning frequency	No rules in SOGL	At least once a year					
Direction		Separate dimensioning in upward and downward direction					
Minimum Requirement		Reference incident (same for Synchronous Area and the LFC block)				Reference incident	
System response		The reference incident takes into account immediate response of the system, by e.g. system protection.					

TSOs' Proposal:

The TSOs propose to procure reserves in line with the requirements of the SOGL, including;

Separate dimensioning of upward and downward reserves,

Securing sufficient reserves to manage anticipated reference incidents.

5. Volume Forecasting Methodology

5.1. Introduction

This chapter outlines the TSOs' proposals on a Volume Forecasting Methodology (VFM) for dimensioning reserve requirements, across different timeframes. The timeframes requested by the SEM Committee span from day-ahead forecasts to a period of 10 years ahead, for the reserve products FFR, POR, SOR, TOR1, TOR2 and RR. The methodologies outlined in this chapter aim to provide clarity on the TSOs' proposals for annual, weekly and daily forecasting processes, considering locational requirements, requirements for dynamic vs static response and requirements for FFR subcategories.

The TSOs are seeking to create a methodology that will facilitate the go-live of DASSA auctions in 2026 and adapt to the changes expected in the years after. Such changes may include the commissioning of new HVDC interconnectors and the second North-South interconnector, the increasing share of RES (both off-shore an on-shore), increasing sizes of LEUs and any future changes to the market coupling arrangements (e.g. EU, GB).

The TSOs note that the proposed methodology is new and will require the introduction of new TSO processes and capabilities, therefore the implementation timelines and scope will require further consideration by the TSOs and RAs.

This chapter commences with a general overview of the proposed processes in section 0. Sections 5.3, 5.4 and 5.5 provide more in-depth detail on the considerations for the Annual, Weekly and Daily processes. The methodologies outlined in this paper will drive changes to the current SAOA, LFCBOA and LFCAA, and regulatory decisions on the volume forecasting methodologies will be required on the sections of these documents that are subject to regulatory approval.

5.2. Process Overview

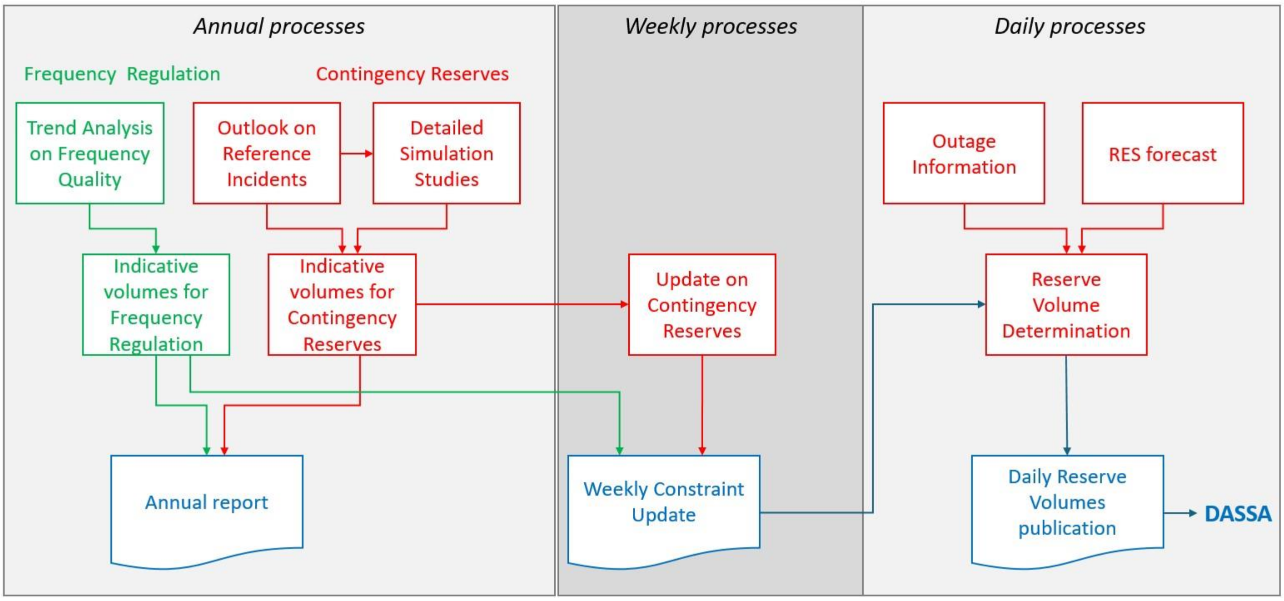


Figure 17 provides a high-level overview of the proposed reserve volume forecast processes, which are detailed in the sections below. The TSOs propose a 'front-loaded' process in which most analysis will be performed annually. In the weekly and daily processes, the volume forecasts may then be updated to accommodate more up to date information. The TSOs consider this is the most appropriate approach and outlines some reasons for this below:

- Day ahead (before 10 am), there is only limited additional information available in comparison to week-ahead/year-ahead) (see section 3.4).
- Conducting detailed technical simulations to determine reserve requirements is a very specialised and time consuming task. Given the uncertainty of likely market and network related flows at the proposed time of publication of the required DASSA reserve volume requirements, additional simulations would be unlikely to yield better volume forecasts. Hence, for the daily process, it is

proposed that the volume forecasts are determined by applying rule-based approaches based on parameters determined in the annual process.

- The normal frequency quality (percentage of time outside 49.9 – 50.1 Hz range) is typically evaluated on an annual basis. While the TSOs continually monitor frequency quality, and reserve the right to take action to quantify reserve requirements to remedy significant deteriorating frequency quality more than annually, the current proposal is that minimum volume requirements for reserves for this purpose will reviewed and updated, where necessary, as part of the annual forecasting process.

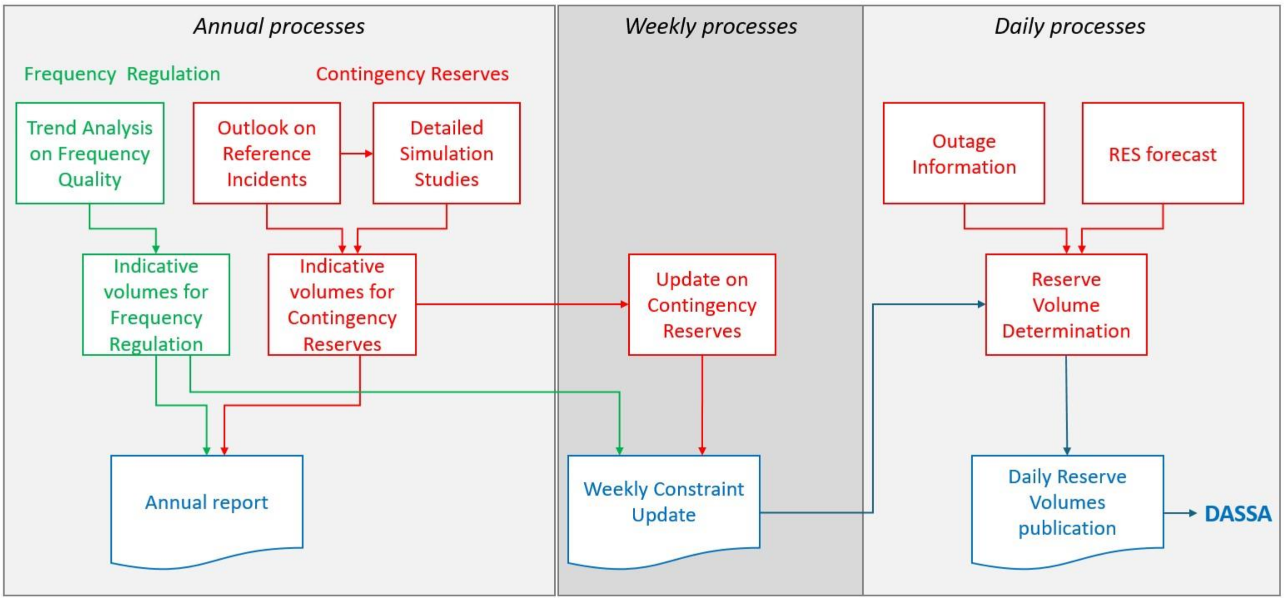


Figure 17: High-level overview of proposed Volume Forecast processes

The TSOs propose the following timing of the processes:

- Annual Process: the TSOs will prepare a ten-years forecast which will include an indicative overview of the required reserve volumes, including characteristics (e.g., FFR FAT, dynamic) and locational requirements (IE, NI). In preparing such a forecast, the TSOs consider that it would be based on a high-level review of the system needs for the next 10 years, considering anticipated changes in the system (e.g. taking on board the separate EirGrid and SONI Transmission Development Plans, and the joint TSO Ten Year Transmission Forecast Statement, and Generation Capacity Statement considerations). The annual process will include a more detailed assessment for the forthcoming DASSA procurement year, 'year+1'. This detailed assessment of year+1 would be supported by historical trend analysis and power system simulations which will also provide the necessary input to the subsequent weekly and daily volume requirements. The annual process is proposed to address the two main purposes of reserves: requirements for maintaining frequency close to nominal under normal conditions and requirements for mitigating contingencies.
- Weekly process: the TSOs will provide a weekly update of requirements in the Weekly Operational Constraints Update document. This update will consider the impact of planned outages and the applicability of the results of the annual assessments to provide the parameters that are expected to be used in the next week's daily process.
- Daily process: By 10:00 each day, the TSOs will publish the required reserve volumes that will be procured in the DASSA on that day (D-1) for the following day (D). Considering the output from the weekly processes, and utilising updated information e.g. outages, RES forecasts, adverse weather warnings etc. The daily process will specify volumes for all upward and downward reserves products (FFR, POR, SOR, TOR1, TOR2, RR) separately and their requirements on specific characteristics.

5.3. Annual Process

The objectives of the annual process are to prepare the annual report and to provide input to the weekly processes. The annual process addresses the two main purposes of reserves (see sections 3.2 and 3.3) separately. Firstly, section 5.3.1 describes the annual methodology to determine the minimum reserve volumes for continuously maintaining sufficient frequency quality. Section 5.3.2 addresses the methodology for determining the minimum reserve volumes required for mitigating contingencies. Section 5.3.3 illustrates the content of the annual report and the output to the weekly processes.

5.3.1. Maintaining System Frequency Within 49.9 - 50.1 Hz Range

As discussed in section 3.2, the TSOs aim to maintain the system frequency within the 49.9 – 50.1 Hz range for at least 98% of time and therefore the TSOs require sufficient suitable reserves to provide this capability. Suitable reserve providers shall be capable of responding continuously, act with a small deadband (+/- 15 mHz) and be able to provide a dynamic response to frequency. The existing terminology of Dynamic POR, SOR, TOR1 and TOR2 are aligned with the requirements required for this purpose. Hence, the VFM shall define the methodology to determine the minimum volumes of Dynamic POR, SOR, TOR1 and TOR2 to be provided with a +/- 15 mHz deadband[99].

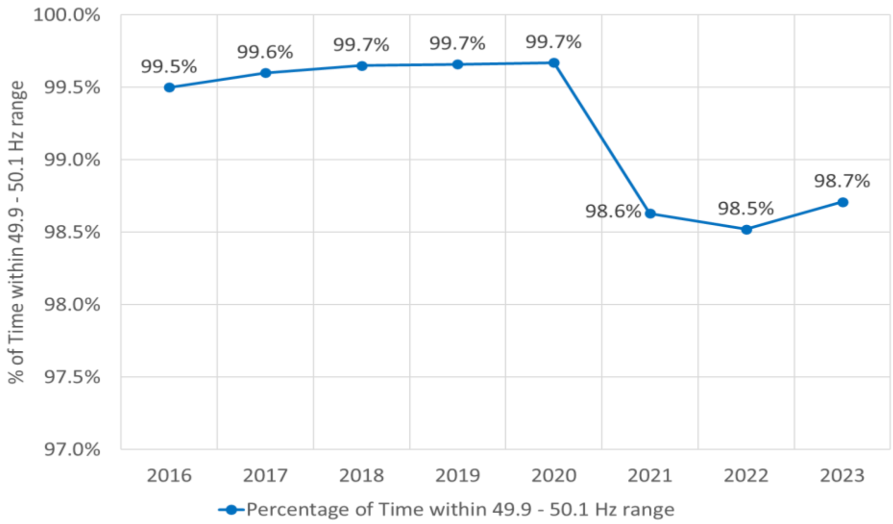
Considering that the frequency quality is impacted by many system parameters that are not easy to predict, the TSOs propose applying trend analysis for forecasting the required minimum volumes of Dynamic POR, SOR, TOR1 and TOR2. As frequency quality typically only changes gradually over years, the review and update of these requirements are proposed to be performed on an annual basis, based on the following input:

A. Historical frequency quality, expressed in percentage of time that the system frequency is within the 49.9 – 50.1 Hz range.

Historical declarations of reserve providing capabilities, forthcoming DASSA contracted capacities, and available dynamic POR, SOR, TOR1 and TOR2 as experienced in real-time, both on average and as percentage of time that available All Island DPOR is below the current minimum DPOR requirement (Dynamic POR provided with a +/-15mHz deadband). It is noted that for this purpose, the focus shall mainly be on the DPOR available within the +/- 100 mHz range since these reserves help keep the frequency within the 49.9 – 50.1 Hz range.

B. Future developments that may impact frequency quality (as mentioned in section 3.2) or the available dynamic POR, SOR, TOR1 and TOR2 in real-time.

Figure 18, Figure 19 and Figure 20 provide examples of the input to the determination of the minimum volumes of dynamic POR, SOR, TOR1 and TOR2 for continuous frequency quality purpose. The figures refer to upward DPOR only, but should also apply to downward DPOR and to upward and downward dynamic SOR, TOR1 and TOR2.



[99] As the TSOs recommend in the DASSA Product Review & Locational Methodology Recommendation Paper, all dynamic POR, SOR, TOR1 and TOR2 providers shall be capable of operating with a +/- 15 mHz deadband.

Figure 18: Percentage of time that the system frequency is within the 49.9 – 50.1 Hz range.

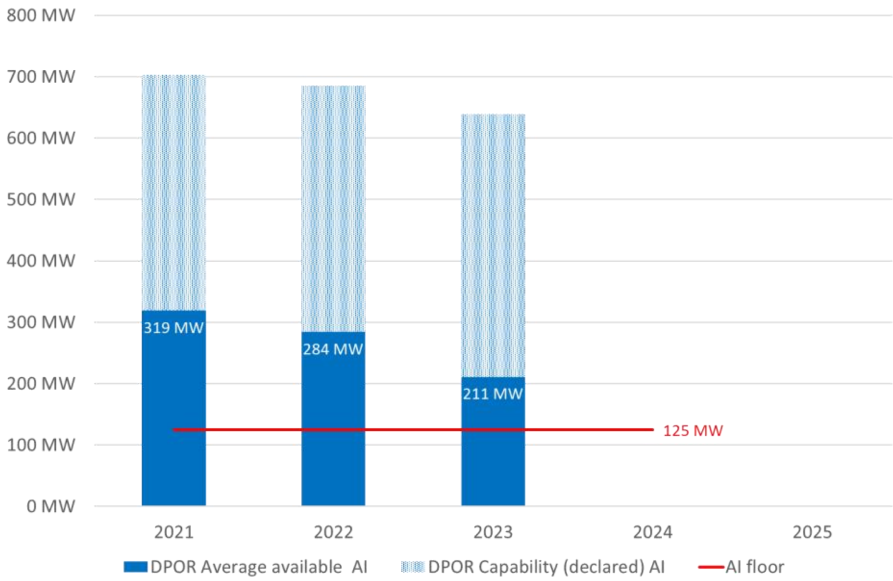


Figure 19: Historical volumes of average availability and declared capability of Upward Dynamic POR (DPOR)[100].

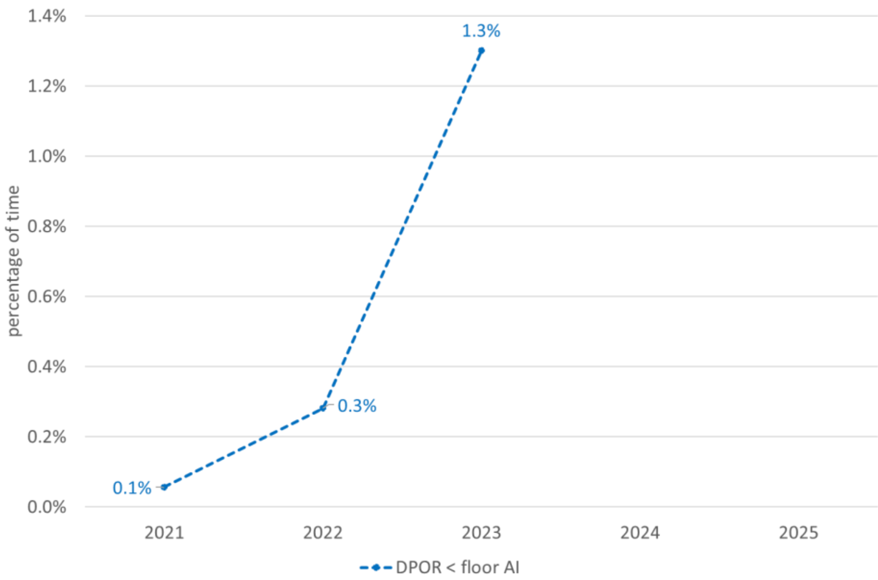


Figure 20: Percentage of time that available All Island DPOR is below 125 MW floor.

Figure 18 shows the percentage of time that the system frequency is within the 49.9 – 50.1 Hz range. The figure shows that although the percentage reduced stepwise in 2021 (see section 2.3), the frequency quality did not further deteriorate afterwards. Figure 19 shows a trend towards a lower volume of declared DPOR. Also, the average available DPOR decreased from 319 MW in 2021 to 211 MW in 2023. Although this average is still well above the minimum requirement for DPOR of 125 MW[101], Figure 20

[100] The values in this graph show the total upward DPOR, which is not entirely provided in the 49.9 to 50.0 Hz range, but also between 49.9 and 49.8 Hz and below, depending on the reserve providing unit and their droop or trajectory settings.

[101] Currently, minimum volumes of Dynamic POR, SOR, TOR1 and TOR2 are specified in the weekly constraints update per jurisdiction, for example, in Ireland DPOR shall be at least 75 MW while in Northern Ireland, DPOR shall not be lower than 50 MW. As frequency regulation is an 'All Island' process, the sum of these values is used as a reference here.

indicates that the percentage of time in which available All Island DPOR is below the current minimum DPOR requirement of 125 MW is increasing.

Graphical representations like Figure 18, Figure 19 and Figure 20 provide the TSOs with an indication of historical trends, both with respect to frequency quality and availability of dynamic POR. The figures also show that while the volume of available DPOR is reducing in 2022 and 2023, the frequency quality is not further deteriorating. Further assessment of frequency quality trends, and available dynamic reserves will be required to determine required future volumes of dynamic reserves. Therefore, the TSOs propose to undertake such an evaluation on an annual basis.

The annual evaluation will assist the TSOs to determine indicative volume requirements for y+1 of minimum volumes of reserve provision with a narrow deadband. If the historical trend shows a deteriorating frequency quality, an increase in the minimum volume for dynamic POR, SOR, TOR1 and TOR2 may be required in the next year. On the other hand, if the historical trend shows an improving frequency quality, the volumes may be reduced.

Considering that the actual frequency quality has been determined by the historical volumes of dynamic regulation available, rather than the operational minimum requirement, required volumes may be specified with reference to the actual historical volumes. For example, if the TSOs conclude that the actual DPOR volumes provided in 2025 would also be needed in 2026, the TSOs may specify an (average) upward DPOR requirement equivalent to the DPOR provision in 2025. . The TSOs will not procure this minimum volume of DPOR as a specific product in the DASSA, but will utilise the ability (as outlined in the TSOs DASSA Product Review Recommendations paper) to configure the deadband settings of providers that have been awarded DASSA contracts for dynamic reserve provision for POR-TOR2 in the D-1 auction to ensure sufficient reserve capacity is available to the TSO for ensuring system frequency remains within the 49.9 – 50.1Hz range. The TSOs will outline further details on the process of configuring settings within the ongoing work to align the new System Services Code development and the Grid Code with DASSA requirements.

Furthermore, the TSOs propose defining the same volumes for upward dynamic SOR, TOR1 and TOR2 as for DPOR, because frequency regulation by these products should be active until the frequency is restored by manual dispatch actions by the TSOs (INCs and DECs). As such manual actions may only become active in the TOR2 timeframe, the requirements for dynamic POR, SOR, TOR1 and TOR2 should be the same.

Similarly, the volumes for downward dynamic POR, SOR, TOR1 and TOR2 should be the same as for their upward counterparts, assuming a symmetrical behaviour of imbalances in the 49.9 to 50.1 Hz range (caused by demand forecast errors, sudden increase and decrease of RES etc.).

For the outlook up to 10 years ahead, the TSOs will consider future drivers impacting frequency quality. These include changes to the level of variable renewable generation on the power system and potential changes to operational policy such as reductions in MUON as set out in the TSOs' Operational Policy Roadmap[102].

Accordingly, based on a trend analysis on the issues above, the TSOs will define:

- The minimum volumes of upward and downward dynamic POR, SOR, TOR1 and TOR2 for the next year. The TSOs propose that these minimum volumes will be fixed for a year unless there are unforeseen reasons to change. This result is input to the Weekly processes (see section 5.4);
- An outlook up to ten years ahead for the minimum volumes of upward and downward dynamic POR, SOR, TOR1 and TOR2, based on a consideration of future developments.

Both outputs and the results of the analysis will be included in the annual report on reserve volumes (see section 5.3.3).

5.3.2. Mitigating Large Disturbances

Referring to section 3.3, the TSOs shall have sufficient suitable reserves to prevent an instantaneous frequency deviation of more than 1000 mHz, or a RoCoF of larger than +/- 1 Hz/s, after the loss of the largest power in-feed or the largest out-feed, or the loss of interconnectors or tie lines, including the loss of both circuits of the North-South interconnectors and any consequential losses. Hence, the TSOs need to assess the requirements for:

- Volumes of FFR, POR, SOR, TOR1, TOR2 and RR;

[102] Operational Policy Roadmap 2023-2030

- The minimum volumes for the three FFR categories;
- The minimum volumes of dynamic POR, SOR, TOR1 and TOR2;
- The minimum volumes for Ireland and Northern Ireland.

Figure 21 shows the proposed annual process to support the identification of these requirements, which are discussed below.

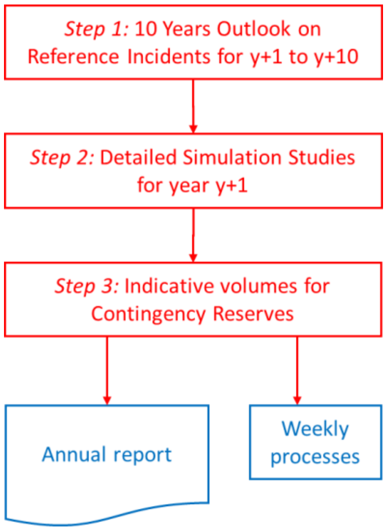


Figure 21: Proposed annual process for volume forecast of reserves for mitigating large disturbances

Step 1: 10-year outlook on potential Reference Incidents

To inform the 10-year forecast, the TSOs propose to utilise information and assessments from other established processes (e.g. Generation Capacity Statements, Ten Year Transmission Forecast statements and the Transmission Development Plans), operational knowledge and expert engineering judgement. Our proposal includes the preparation of an annual update of potential reference incidents for the forthcoming 10 years which would include a publication of a list of potential units that could set the reference incidents as shown in Table 12.

Step 2: Detailed simulation studies for year y+1

Step 2 would focus on a subset of potential reference incidents for year y+1 only. In this step, detailed power system simulation studies are performed for the following reference incidents:

- All Island reference incident for infeed losses, considering the largest potential reference incident in positive direction applicable to year y+1.
- All Island reference incident for outfeed losses, considering the largest potential reference incident in negative direction applicable to year y+1.

And, at least until the second North-South interconnector is in operation:

- Island split when the North-South interconnector is flowing at full capacity in the direction Northern Ireland to Ireland, considering the impact in both Ireland and Northern Ireland.
- Island split when the North-South interconnector is flowing at full capacity in the direction Ireland to Northern Ireland, considering the impact in both Ireland and Northern Ireland.

The requirements and assumptions for the power system simulation model include:

- A power system model for year y+1 that includes dynamic models of all relevant generation and demand sources.
- Total POR, SOR, TOR1 and TOR2 volumes will be set equal to 100% of the Reference Incident as proposed in section 3.3.4.
- A share of dynamic reserves based on last year's minimum for dynamic reserves, an evaluation of historical experience and engineering judgement.
- Over-frequency, under-frequency, over-voltage and under-voltage protection schemes implemented in the model and enabled (see section 3.4.2).

The output of the power system simulation studies will be:

- The minimum shares of FFR, FFR category 1 and FFR category 2 for which the instantaneous frequency deviation at the Nadir or Zenith will not exceed +/- 800 mHz[103] and the RoCoF will not exceed +/- 0.9 Hz/s[104].
- A confirmation of the minimum dynamic POR and SOR for which the frequency will stabilise(Current dynamic simulation capabilities are limited to POR and SOR timelines).

Table 17 provides an illustrative example of the potential output of the simulation studies.

Table 17: Example of output of step 2: Output of the simulation studies for Upward Reserves

Upward	All Island		Ireland		Northern Ireland	
	Minimum Volume	Minimum dynamic	Minimum Volume	Minimum dynamic	Minimum Volume	Minimum dynamic
Reference Incident RI	EWIC Importing 500 MW + 0 MW Consequential losses[105]		Trip of North-South Interconnector while flow is 450 MW N→ S + 0 MW Consequential losses		Trip of North-South Interconnector while flow is 400 MW S→ N + 0 MW Consequential losses	
FFR	70% of RI	80% of FFR	80% of RI	80% of FFR	100% of RI	80% of FFR
FFR, cat. 1	60% of FFR	80% of FFR cat.1	70% of FFR	80% of FFR cat.1	80% of FFR	80% of FFR cat.1
FFR, cat. 2 or faster	70% of FFR	80% of FFR cat.2	80% of RI	80% of FFR cat.2	90% of FFR	80% of FFR cat.2
POR-TOR2	100% of RI	80% of POR-TOR2	100% of RI	80% of POR-TOR2	100% of RI	80% of POR-TOR2
RR	100% of RI	N/A	100% of RI	N/A	100% of RI	N/A

Step 3: Indicative reserve volumes for mitigating large disturbances.

In addition to the volume of reserve needed to ensure that frequency is maintained within limits in a simulation study (the output of step 2), additional volumes of reserve will be required to mitigate against reductions in service provider availability between gate-closure of the DASSA and real-time (see section 3.3.7).

Table 18 therefore also includes an additional allowance for subsequent unavailability of reserve services from one or a group of reserve service providers (C_{unav} = 75 MW in the example) which applies to FFR, POR, SOR, TOR1, TOR2 and RR.

Table 18: Example step 3 output: Indicative Upward Reserve Dimensioning for mitigating Large Disturbances for year y+1

Upward	All Island		Ireland		Northern Ireland	
	Minimum Volume	Minimum dynamic	Minimum Volume	Minimum dynamic	Minimum Volume	Minimum dynamic
Reference Incident RI	EWIC Importing 500 MW + 0 MW Consequential losses		Trip of North-South Interconnector while flow is 450 MW N→ S + 0 MW Consequential losses		Trip of North-South Interconnector while flow is 400 MW S→ N + 0 MW Consequential losses	

[103] Reflecting the maximum instantaneous frequency deviation of 1000 mHz and an accuracy margin of 200 mHz.
[104] Reflecting the maximum RoCoF of +/- 1 Hz and an accuracy margin of 0.1 Hz/s.
[105] CLI^{AI} = 0 MW

FFR	70% of RI + C_{unav}	80% of FFR	80% of RI + C_{unav}	80% of FFR	100% of RI + C_{unav}	80% of FFR
FFR, cat. 1	60% of FFR	80% of FFR cat.1	70% of FFR	80% of FFR cat.1	80% of FFR	80% of FFR cat.1
FFR, cat. 2 or faster	70% of FFR	80% of FFR cat.2	80% of RI	80% of FFR cat.2	90% of FFR	80% of FFR cat.2
POR-TOR2	100% of RI + C_{unav}	80% of POR-TOR2	100% of RI + C_{unav}	80% of POR-TOR2	100% of RI + C_{unav}	80% of POR-TOR2
RR	100% of RI + C_{unav}	N/A	100% of RI + C_{unav}	N/A	100% of RI + C_{unav}	N/A

The final output of this process will be a table of indicative reserve volume requirements for year y+1, including the required minimum levels of FFR, FFR categories, dynamic response and jurisdictional requirements. Table 19 presents an example of theoretical results for upward reserves. This table will be an input to the weekly process. As outlined in Section 5.2.1 the TSOs will configure the deadband settings of providers that have been awarded DASSA contracts for dynamic reserve provision for POR-TOR2 in the D-1 auction to ensure sufficient reserve capacity is available to the TSO for ensuring system frequency remains within the 49.9 – 50.1Hz range. The TSOs will outline further details on the process of configuring settings within the ongoing work to align the new System Services Code development and the Grid Code with DASSA requirements.

Note that for the purposes of this illustration, no consequential losses have been included and a fixed allowance of 75 MW has been made for service providers unavailability (i.e., Equation 7, $Reserve_{DASSA} = RI + 0 + 75$).

Table 19: Example Step 3 output: Indicative Upward Reserve Volumes for mitigating Large Disturbances for year y+1

Upward	**All Island**		**Ireland**		**Northern Ireland**	
	Minimum Volume	**Minimum dynamic**	**Minimum Volume**	**Minimum dynamic**	**Minimum Volume**	**Minimum dynamic**
Reference Incident RI	500 MW		450 MW		400 MW	
FFR	425 MW	340 MW	435 MW	348 MW	475 MW	380 MW
FFR, cat. 1	255 MW	204 MW	305 MW	244 MW	380 MW	304 MW
FFR, cat. 2 or faster	298 MW	238 MW	348 MW	278 MW	428 MW	342 MW
POR-TOR2	575 MW	460 MW	525 MW	420 MW	475 MW	380 MW
RR	575 MW	N/A	525 MW	N/A	475 MW	N/A

For years y+2 and y+10 the reference incident, the TSOs will provide an indicative overview of POR-RR volumes based on the development of the reference incident.

5.3.3. Annual Report

The annual report will combine and summarise the findings of the annual processes detailed in section 5.3.1 and 5.3.2. The draft table of content for this report is proposed as:

1. Introduction
2. Required reserves for frequency regulation
3. Required reserves for mitigating large disturbances (outlook for reference incident for y+1-y+10, indicative volumes, including minimum jurisdictional, dynamic, fast FFR).
4. Reserves outlook (for y+1 in detail, indicative for y+2 – y+10)

5.4. Weekly Process

The objective of the weekly processes is to use up to date information to determine the likely required volumes as outlined in the annual report. The results will be included in the Weekly Process Update and shall be applied as a guideline in the daily processes to determine the volumes to be procured in the DASSA. The weekly processes address the two main purposes of reserves, in section 5.4.1 we describe the methodology for continuously maintaining the system frequency within the 49.9-50.1 Hz range, while in section 5.3.2 the methodology for mitigating large disturbances is addressed. Section 5.4.3 lists the content that shall be included in the Weekly Constraints Update and accordingly be input to the daily processes.

5.4.1. Maintaining System Frequency Within 49.9 - 50.1 Hz Range

As discussed in section 5.3.1, the TSOs' reserve requirements for continuous frequency regulation are determined from the simulations undertaken as part of the annual process and are recommended as fixed for a year. Accordingly, the weekly update on reserve requirements will take the requirements for the minimum volumes of Dynamic POR, SOR, TOR1 and TOR2 directly from the annual report. However, there may be reasons to change the minimum volumes if the system circumstances so dictate (e.g. if frequency quality is seen to deteriorate).

As discussed in Section 5.2.1 the TSOs will configure the settings on units who have been awarded DASSA contracts at D-1 for dynamic POR-TOR2 provision to ensure the required volumes of dynamic reserve provision with a +/- 15m Hz deadband is available.

5.4.2. Mitigating Large Disturbances

As discussed above, the most important input for the determination of the minimum reserve volumes for mitigating contingencies is the RI and the system inertia, which are largely driven by market outcomes. As these are highly unpredictable on a week-ahead basis, there is limited new information that can be used to update the tables resulting from the annual process (See example for upward in Table 19). Accordingly, a similar table is included in the Weekly Constraint Update, and will be updated if (one of the) reference incidents is changed because of e.g. a planned or forced outage, changed constraints on tie-line flow or abnormal events that increase risk such as a major storm or solar eclipse. Note that Table 19 includes an additional allowance for subsequent unavailability of services from one or a group of reserve service providers (C_{unav} = 75 MW in the example) which applies to FFR, POR, SOR, TOR1, TOR2 and RR.

5.4.3. Weekly Constraint Update

The Weekly Constraint update will include the results presented in sections above. An example of a table is provided below in Table 20.

Table 20: Indicative example of table in Weekly Constraint update for Upward Reserves

Upward	All Island		Ireland		Northern Ireland	
	Minimum Volume	Minimum dynamic	Minimum Volume	Minimum dynamic	Minimum Volume	Minimum dynamic
FFR	70% of RI + C_{unav}	80% of FFR	80% of RI + C_{unav}	80% of FFR	100% of RI + C_{unav}	80% of FFR
FFR, cat. 1	60% of FFR	80% of FFR cat.1	70% of FFR	80% of FFR cat.1	80% of FFR	80% of FFR cat.1
FFR, cat. 2 or faster	70% of FFR	80% of FFR cat.2	80% of RI	80% of FFR cat.2	90% of FFR	80% of FFR cat.2
POR-TOR2	100% of RI + C_{unav}	80% of POR-TOR2	100% of RI + C_{unav}	80% of POR-TOR2	100% of RI + C_{unav}	80% of POR-TOR2
RR	100% of RI + C_{unav}	N/A	100% of RI + C_{unav}	N/A	100% of RI + C_{unav}	N/A

5.5. Daily Process

5.5.1. Maintaining System Frequency Within 49.9 - 50.1 Hz Range

In the daily process, the TSOs will normally apply the information from the weekly process, unless observed frequency quality requires the TSOs to procure additional volumes of dynamic reserves.

5.5.2. Mitigating Large Disturbances

As discussed in section 3.4.3, the TSOs consider that - at least initially - before the execution of the DASSA only limited new information will be available compared to information available for the weekly processes. Accordingly, the TSOs determine the required reserves by applying the parameters specified in the weekly constraint update. However, similar to the weekly process, the reference incident value will be updated if (one of the) a reference incident is changed because of e.g. a forced or unforced outage, changed constraints on tie-line flow or abnormal events that increase risk such as a major storm or solar eclipse. Table 21provides an example.

In comparison to Table 20, the daily considerations will include an additional row. This row specifies the potential reserve loss from a LSI/LSO contributing unit for the situation that RI takes place. In this case, the remaining reserves provided by other providing units shall be sufficient to balance the loss of the RI. In this case, the reserve requirements for FFR, POR, SOR, TOR1, TOR2 and RR shall be increased with this value. In the example of Table 21Table 20, the interconnector is on full import and cannot provide upward reserves. Therefore, the 'Potential Reserve Loss of RI' in this example is set to zero (i.e., Equation 7, $Reserve_{DASSA} = RI + 0 + 75$).

Table 21: Example minimum reserve volume for large disturbances, to be prepared in the daily process

Upward	All Island		Ireland		Northern Ireland	
	Minimum Volume	Minimum dynamic	Minimum Volume	Minimum dynamic	Minimum Volume	Minimum dynamic
Reference Incident	500 MW		450 MW		400 MW	
Potential Loss of Reserves from RI	0 MW		0 MW		0 MW	
FFR	425 MW	340 MW	435 MW	348 MW	475 MW	380 MW
FFR, cat. 1	255 MW	204 MW	305 MW	244 MW	380 MW	304 MW
FFR, cat. 2 or faster	298 MW	238 MW	348 MW	278 MW	428 MW	342 MW
POR-TOR2	575 MW	460 MW	525 MW	420 MW	475 MW	380 MW
RR	575 MW	N/A	525 MW	N/A	475 MW	N/A

5.5.3. Day-ahead Volume Requirements for DASSA

Finally, the TSOs specify the volumes to be procured in DASSA for the next day, by taking for each of the products the largest value resulting from the processes described in sections 5.5.1 and 5.5.2.

Table 22 provides an example for upward reserves. A similar table would be prepared for downward reserves for each day ahead auction. As outlined in Section Consideration of Pre-DASSA Contracted Volumes3.3.8 the TSOs will take account of any reserve products and volumes that are already contracted and available at the time of a DASSA auction, and reduce the final volumes required by an equivalent amount.

Table 22: Example of Theoretical Volume requirements for Upward Reserves in DASSA

	All Island		Ireland		Northern Ireland	
	Minimum Volume	Minimum dynamic	Minimum Volume	Minimum dynamic	Minimum Volume	Minimum dynamic
Upward						
FFR	425 MW	340 MW	435 MW	348 MW	475 MW	380 MW
FFR, cat. 1	255 MW	204 MW	305 MW	244 MW	380 MW	304 MW
FFR cat. 2 or faster	298 MW	238 MW	348 MW	278 MW	428 MW	342 MW
POR	575 MW	460 MW	525 MW	420 MW	475 MW	380 MW
SOR	575 MW	460 MW	525 MW	420 MW	475 MW	380 MW
TOR1	575 MW	460 MW	525 MW	420 MW	475 MW	380 MW
TOR2	575 MW	460 MW	525 MW	420 MW	475 MW	380 MW
RR	575 MW	N/A	525 MW	N/A	475 MW	N/A

<u>TSOs' Proposal:</u>

The TSOs proposals include Annual, Weekly and Daily Forecasting proposals, which will ultimately result in the publication of the required volumes to be procured in each DASSA auction at D-1.

The Annual Forecast is a proposed to include a 10 year outlook forecast, with a more detailed forecast for the year ahead (y+1).

The Weekly Forecast will build upon the Annual forecast for y+1 and include, where relevant, updated information such as planned or forced outages, changed constraints on tie-line flow or abnormal events that increase risk such as a major storm or solar eclipse. We propose to align the publication of the weekly Volume Forecast with the current Weekly Operational Constraint Update publication.

The Daily Forecast will align with the weekly Volume Forecast for dynamic requirements unless exceptional circumstances require a change in volumes to mitigate observed frequency quality changes. The daily forecast will also outline the minimum volumes of FFR, POR,SOR, TOR1, TOR2 and RR to manage anticipated reference incidents and system split events. The daily forecast will take account of any updated information e.g. forced outage, abnormal weather events (e.g. storm).

The TSOs will take account of any reserve products and volumes that are already contracted and available at the time of a DASSA auction, and reduce the final volumes required by an equivalent amount.

Question 3. Do you agree with our methodology as presented in this Chapter ? Do you consider there are other aspects that need consideration or whether there are amendments to the methodology you would recommend? Please provide detailed recommendations and a rationale for such recommendations in your response.

6. Implicit Bundles

As outlined in the TSOs' DASSA Design Recommendations Paper[106] and approved in SEM-24-066, the DASSA allows for the procurement of:

- Individual reserve services,
- An explicit bundle of reserve services,
- An implicit bundle of reserve services.

However, for the go-live of the DASSA, it is intended that only implicit bundles of services will be procured through the daily auction.

An explicit bundle of services would be defined as an individual product to be procured in the DASSA: service providers would be able to submit bids specifically for these bundles. However, in the DASSA Product Review & Locational Methodology Recommendation Paper[107] (subject to a SEMC decision), the TSOs have not recommended the procurement of reserve services through an explicit bundled product in the daily auction at this time. The rationale for this is that the TSOs' studies have not identified a specific operational need for an explicit bundled product.

With regard to implicit bundling, bundles of services can be established from individual bids for individual services (e.g. FFR, POR, SOR and TOR1) in the clearing of the DASSA. Implicit bundles are described in Section 4.10.3 of the DASSA Design Consultation paper[108] and further discussed in Section 3.12.3 of the DASSA Design Recommendations paper[109]. The TSOs consider that implicit bundles can address certain market inefficiencies, which are described in Section 6.1 below.

It should be noted that the DASSA volume requirement for each individual service will be determined before considering any requirement for implicit bundles.

The minimum requirements for implicit bundles will be included in the auction information pack enabling service providers to consider the designated minimum requirements while submitting their bids for the DASSA.

6.1. Rationale for Implicit Bundles

From a power system operation perspective, there is no requirement to procure an implicit bundle of services in DASSA. However, the TSOs consider that market-based concerns (as outlined below) necessitate establishing a minimum requirement for such bundles of services. A minimum volume requirement for implicit bundles will ensure that a proportion of the volume requirements for the individual services that are considered part of an implicit bundle will be procured from service providers that can provide these services consecutively. An example of a volume requirement for an implicit bundle of selected services of those being procured in the DASSA is illustrated in Figure 22.

[106] https://cms.eirgrid.ie/sites/default/files/publications/EirGrid-and-SONI-DASSA-Design-Recommendations-Paper-September-2024.pdf

[107] DASSA Product Review & Locational Methodology Recommendation Paper (EirGrid), DASSA Product Review & Locational Methodology Recommendation Paper (SONI)

[108] https://cms.eirgrid.ie/sites/default/files/publications/FASS-DASSA-Consultation-Paper-March-2024-EirGrid.pdf

[109] https://cms.eirgrid.ie/sites/default/files/publications/EirGrid-and-SONI-DASSA-Design-Recommendations-Paper-September-2024.pdf

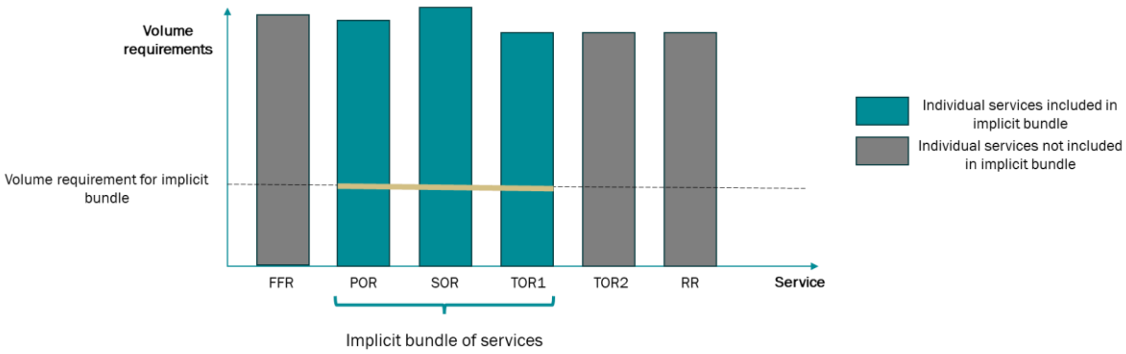


Figure 22- Example volume requirement for an implicit bundle of services

Setting non-zero minimum requirement for implicit bundles could:

1) Prevent exclusion of excess volumes from ex-ante energy markets. This could occur whereby services are procured from multiple service providers, who are required to exclude this capacity from the ex-ante energy markets, when these services could have been provided by a single service provider in a continuous manner.
2) Prevent unnecessary excess volumes to be activated in the balancing energy market by submitting compatible FPNs. This could potentially decrease the amount of incremental/decremental deviations, that would need to be allocated to service providers in the balancing market, and reduce the total activation costs.

Setting a zero-volume requirement for implicit bundles in the DASSA does not mean that no implicit bundles will be procured. However, it will limit the procurement of these bundles to the outcomes of market clearing, which will depend on the value and objective functions and bidding behaviours of the service providers. Setting a non-zero requirement for implicit bundles guarantees that, regardless of the value functions, a minimum volume will be procured as implicit bundles in DASSA.

Procuring volumes above the designated minimum requirements for implicit bundles remains possible, depending on the value functions and service providers' bidding behaviour in DASSA, which are explained in Section 2.12.3 of the DASSA Design Recommendations Paper.

6.2. Considerations in Setting the Minimum Volume Requirement for Implicit Bundles

There are a number of factors that must be considered in determining how much volume should be procured using implicit bundles out of the volume requirements for each individual service. These include but may not be limited to the following:

- The impact on the ex-ante energy markets and Balancing Market as highlighted in Section 6.1 above,
- The capabilities of different technology types and the need to ensure broad participation,
- The volume requirements for each individual service,
- The willingness of service providers to provide services in a continuous manner. This is related to the concerns raised by service providers in response to the DASSA consultation regarding the clearing risk in the DASSA due to the lack of interdependency between bids for individual services. The bundling of services and setting a non-zero minimum requirement was proposed to mitigate this risk across services.

These factors and objective functions will be considered as part of the Parameters and Scalars Consultation Paper in establishing the parameters which are referenced in each of the Options below in determining the volume requirement for implicit bundles. The timelines for the Parameters and Scalars Consultation are set out in the Phased Implementation Roadmap (PIR).

6.3. Options

In this section, two different approaches are proposed to introduce methodologies for setting the minimum requirements for implicit bundles. These methodologies may include parameters that need to be determined to establish the exact minimum requirements for implicit bundles. However, the values for these parameters are not in the scope of this consultation and will be consulted upon separately, as noted above.

6.3.1. Option 1 - Simple Percentage of Individual Requirements

Option overview

This option describes a methodology for setting static minimum volume requirements for implicit bundles.

Option details

Since each individual service will have its own day-ahead volume requirement, as described in Section 5.5.3, the minimum requirement for a bundle of services must be no larger than the minimum requirement for any of the services comprising it.

This option suggests setting the minimum requirement for a bundle to be a percentage of the smallest of the minimum requirements for the reserve service constituting a bundle. The value of this percentage would be determined by the TSOs based on the considerations listed above in Section 6.2.

It is noteworthy that, in order to avoid excluding some service providers who may not be able to contract for services as a bundle, the value of this percentage should be suitably lower than one hundred percent. This consideration creates a cap on the minimum requirement for implicit bundles.

A benefit of this approach is that it is relatively simple to understand and calculate.

6.3.2. Option 2 – No Minimum Requirement

Option overview

This option would set a minimum volume requirement of zero for implicit bundles of services.

Option details

The resultant effect of setting a volume requirement of zero would be that the quantity of implicit bundles acquired would be determined solely by the objective function in the optimisation problem.

As noted above, not setting a minimum requirement for implicit bundles could result in volume being excluded from the ex-ante markets (as without continuous provision there is a need for more units to provide volume to meet the volume requirements for capacity).

This could result in higher prices in the ex-ante markets, and also could lead to excess activated balancing energy in the Balancing Markets (via submitted compatible FPNs), which could result in a higher number of incremental/decremental deviations and potentially increase activation costs.

Setting volume requirement at zero will also result in less information being available ex-ante for both service providers and the TSOs as to the volume of implicit bundles that is likely to be awarded.

TSOs' Proposal:

The TSOs have not identified a technical need for explicit bundles.

The TSOs have outlined options in determining a minimum requirement for implicit bundles to be calculated ex-ante based on either:

- A Percentage of Individual Requirements
- No Minimum Requirement

The auction information pack will include the minimum requirement value as determined by the methodology to facilitate informed bidding strategies in DASSA for service providers.

The auction design will allow for the definition of new products if required in the future, including explicit bundles.

Question 4. Do you have any comments on the proposed considerations and options for setting the minimum requirements for implicit bundles? Please provide a detailed rationale if you consider additional aspects need to be considered.

7. Next Steps

This consultation paper outlines the TSOs' considerations on the Volume Forecasting Methodology for 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 Volume Forecasting Methodology that will be proposed to the SEMC for the Reserve Service products that will be procured through the DASSA auctions, as outlined in the PIR[110]. The final methodologies will drive changes to the current SAOA, LFCBOA and LFCAA, which will require separate regulatory decisions on the sections of these documents that are subject to regulatory review.

As outlined in the document this paper only focuses on the Volume Forecasting Methodology for a subset of system services -i.e. FFR, POR, SOR, TOR1, TOR2 and RR. During 2025 a second phase of a Product Review process (including an industry consultation and a final TSO recommendations paper) will be conducted that will consider the System Services not reviewed in this paper. This later Product Review will be followed by the development of a separate Volume Forecasting Methodology for such products in Q4 of 2025 and 2026.

It is anticipated that implementation of this reserve focused Volume Forecasting Methodology would commence in 2026 with the publication of the first ten-year look-ahead forecast covering the period 2027 to 2036. Weekly forecasts and daily auction requirements would then follow closer to DASSA go-live.

Separate to the considerations on volume forecasting, the TSOs note that work on Grid Code and System Services code developments to ensure compatibility with DASSA arrangements will be ongoing in the preparation for DASSA go live.

7.1. Consultation Responses

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

Responses to the questions set out in this paper should be submitted through either the EirGrid[111] or SONI[112] consultation portals by 15 November 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.

7.2. Consultation Information Session

A consultation information session will be held on Wednesday 16 October 2024 from 10:00 to 12:00.

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[113] detailing further information of the webinar. If you would like to register for the information session, please respond to the email.

Question 5. Do you consider there are other aspects that need to be taken into account as part of a Volume Forecasting methodology for the reserve services? Please provide detailed rationale for any recommendations you wish the TSOs to consider.

[110] FASS-TSOs-PIR-March-2024-EirGrid.pdf
[111] EirGrid consultation portal.
[112] SONI consultation portal.
[113] FASS@Eirgrid.com or FASSProgramme@soni.ltd.uk.

8. Consultation Questions

Chapter	Questions
Chapter 3 System Needs	Question 1 Do you agree with our considerations in terms of future system requirements and yearly, weekly and day ahead volume forecasting and relevant publications. Are there any additional aspects you believe should be included? Please provide a detailed rationale in your response. Question 2 Do you agree with our proposal on the publication timing of the daily D-1 DASSA Volume Requirement? If you consider an alternative time should be considered, please provide a rationale in your response.
Chapter 5 Volume Forecasting Methodology	Question 3. Do you agree with our methodology as presented in this Chapter? Do you consider there are other aspects that need consideration or whether there are amendments to the methodology you would recommend? Please provide detailed recommendations and a rationale for such recommendations in your response.
Chapter 6. Implicit Bundles	Question 4. Do you have any comments on the proposed considerations and options for setting the minimum requirements for implicit bundles? Please provide a detailed rational if you consider additional aspects need to be considered.?
Chapter 7. Next Steps	Question 5 Do you consider there are other aspects that need to be taken into account as part of a Volume Forecasting methodology for the reserve services? Please provide detailed rationale for any recommendations you wish the TSOs to consider.