Volume Calculation Methodology and Portfolio Scenarios

DECISION PAPER

DS3 System Services Implementation Project

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27 July 2016

EIRGRID SONI

Disclaimer

Executive Summary

Introduction and Background

The objective of the DS3 Programme, of which System Services is a part, is to meet the challenges of operating the electricity system in a safe, secure and efficient manner while facilitating higher levels of renewable energy.

One of the key workstreams in the DS3 Programme is the System Services (or Ancillary Services) workstream. The aim of the System Services workstream is to put in place the correct structure, level and type of service in order to ensure that the system can operate securely with higher levels of non-synchronous generation such as variable wind penetration (up to 75% instantaneous penetration). This will reduce the level of curtailment for wind farms and will deliver significant savings to consumers through lower wholesale energy prices.

In December 2014, the SEM Committee published a decision paper on the high-level design for the procurement of DS3 System Services (SEM-14-108). The SEM-14-108 Paper followed a number of consultative processes run separately by the TSOs and the SEM Committee between 2011 and 2014 as well as a number of independent reports, including an economic analysis, and system services valuation.

The SEM Committee's decision framework aims to achieve the following:

- Provide a framework for the introduction of a competitive mechanism for procurement of system services;
- Provide certainty for the renewables industry that the regulatory structures and regulatory decisions are in place to secure the procurement of the required volumes of system services;
- Provide certainty to new providers of system services that the procurement framework provides a mechanism against which significant investments can be financed;
- Provide clarity to existing providers of system services that they will receive appropriate remuneration for the services which they provide;

- Provide clarity to the TSOs that the required system services can be procured from 2016 onwards in order to maintain the secure operation of the system as levels of wind increase;
- Provide clarity to the Governments in Ireland and Northern Ireland (and indeed the European Commission) that appropriate structures are in place to assist in the delivery of the 2020 renewables targets;
- Ensure that Article 16 of Directive 2009/28/EC is being effectively implemented (duty to minimise curtailment of renewable electricity);
- Provide assurance to consumers that savings in the cost of wholesale electricity which can be delivered through higher levels of wind on the electricity system, can be harnessed for the benefit of consumers; and
- Provide assurance to consumers that they will not pay more through system services than the benefit in terms of System Marginal Price (SMP) savings which higher levels of wind can deliver.

One of the central workstreams included in the DS3 System Services project plan is WS2 – System Services Volumes. The objective of this workstream is to determine the volume of System Services required to operate the system securely while facilitating increased levels of non-synchronous generation. For those services deemed to be competitive, this information will feed into the Capability Volume Requirements used in the auction.

In this paper, we are presenting our decision, which has been approved by the SEM Committee, on the methodology for calculating the Capability Volume Requirements for each DS3 System Service.

It should be noted that this will be our first time undertaking such analysis and there will therefore be an element of learning. In addition, we are not aware of any other system/ancillary services market in the world that procures for capability and pays for realisable volume. Therefore, we may need to review the volumes calculation methodology in the future to ensure it is fit for purpose.

Consultation

In October 2015 we published a consultation paper on the Volume Calculation Methodology and Initial Portfolio Scenarios. The paper set out our proposals on the methodology we intended to use to calculate the volumes of system services required and the starting portfolios of plant that would be used. We received 19 responses to the consultation.

There was broad agreement among the majority of respondents that the proposed approach to determining the capability volume requirements was reasonable. However, there were a large number of queries, comments and suggestions relating to the specifics of the methodology and the portfolio scenarios. We have addressed the majority of these queries, comments and suggestions in this paper.

The decision presented in this paper is broadly in line with our proposals in the consultation paper.

Methodology for Calculating Volume Requirements

The SEM-14-108 paper requires the TSOs to determine System Services volumes for five years, beginning with the Tariff/Auction year 2017/18. We will carry out detailed analysis of volume requirements for the first year, 2017/18, and the third year, 2019/20; the latter is the year in which the 2020 renewable electricity targets should be achieved. We will interpolate the results of the 2017/18 and the 2019/20 analysis to determine the 2018/19 volume requirements, and the volume requirements for 2020/21 and 2021/22 will be set to be the same as the 2019/20 values.

The detailed analyses for 2017/18 and 2019/20 will involve iterative Plexos studies on two portfolio scenarios to fine tune their capabilities to match system requirements. We will calculate the volume requirements for each System Service from the service capabilities contained within the refined portfolio scenarios, with the exception of Steady-State Reactive Power (SSRP), Dynamic Reactive Response (DRR) and Fast Post-Fault Active Power Recovery (FPFAPR) which will be calculated from the initial portfolio scenarios.

Initial Portfolio Scenarios

We have created initial portfolio scenarios that we will use in the Volume Requirement calculations for 2017/18 and 2019/20. The initial portfolio scenarios presented in this paper have been developed solely for the purpose of determining the appropriate volume requirement for each of the services and do not represent desired, expected or optimal portfolios. The initial portfolio scenarios will have no bearing on the outcome of the competitive procurement process other than informing the volumes to be procured.

The initial portfolio scenarios that will be used in the volume calculation methodology can be summarised as follows:

2017/18 – One portfolio scenario

- **2017/18**: a portfolio scenario based largely on the capabilities of the existing service providers with small additional volumes of services provided by new providers.

2019/20 – Two portfolio scenarios, which aim to cover a wide range of potential outcomes

There are a number of potential ways that the system services market may evolve over the next few years. Different portfolios of service providers may result in different volumes of services being required. We are therefore using two very different scenarios here in an effort to capture the volume requirements for all potential eventualities:

- **Enhanced Capability:** In this scenario we assume that the majority of the additional flexibility required is obtained from the enhancement of the existing portfolio. In addition to these enhancements, a significant volume of services are provided by wind farms, Demand Side Management (DSM) and interconnectors.
- **New Service Providers:** In this scenario we assume that new service providers contribute significantly to the additional volume of System Services required. Significant provision is also obtained from interconnectors, with a

lower provision from wind farms and DSM as compared to the Enhanced Capability portfolio above.

Contents

1 Introduction

In December 2014, the SEM Committee published a decision paper on the high-level design for the procurement of DS3 System Services (SEM-14-108). Following on from this, EirGrid and SONI ('the TSOs') worked together with the Commission for Energy Regulation and Utility Regulator ('the Regulatory Authorities') to develop a project plan[1] for delivery of the market arrangements in line with the key milestones set out in the SEM-14-108 paper. We have published a number of Quarterly Updates to the project plan since then.[2][3]

One of the central workstreams included in the plan is WS2 – System Services Volumes. The objective of this workstream is to determine the volumes of System Services which are required within the portfolio to ensure that sufficient real-time volume requirement is technically realisable across a year to operate the system securely while facilitating an increased level of non-synchronous generation by 2020. For those services deemed to be competitive, this information will feed into the Capability Volume Requirements used in the auction.

In October 2015, the TSOs issued a paper for consultation on the proposed methodology for calculating the Capability Volume Requirements for each DS3 System Service. The document provided stakeholders with information about our proposals and a guide to the consultation process. The document included consideration of different scenarios for estimating required volumes.

Following consideration of the responses to the consultation we are publishing this decision paper which has been approved by the SEM Committee. The decision presented in this paper is broadly in line with our proposals in the consultation paper. Based on the volume calculation methodology and initial portfolio scenarios outlined in this paper we will publish estimated capability volume requirements for the

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[1] DS3 System Services Project Plan (Detailed Design and Implementation Phase): http://www.allislandproject.org/en/transmission_decision_documents.aspx?article=332ac31a-1224-44c7-97b6-00a7b6c8a8b9

[2] DS3 System Services Project Plan – Quarterly Update October 2015: http://www.eirgridgroup.com/site-files/library/EirGrid/DS3-System-Services-Quarterly-Update-FINAL.pdf

[3] DS3 System Services Project Plan – Quarterly Update December 2015: http://www.eirgridgroup.com/site-files/library/EirGrid/DS3-System-Services-Dec-15-Quarterly-Update.pdf

services for the auction/tariff years 2017/18, 2018/19, 2019/20, 2020/21 and 2021/22 later in 2016.

It should be noted that this is our first time undertaking such analysis and there will therefore be an element of learning. In addition, we are not aware of any other system/ancillary services market in the world that procures for capability and pays for realisable volume. Therefore, we may need to review the volumes calculation methodology in the future to ensure it is fit for purpose.

To comply with our respective statutory and licence obligations as TSOs, we are required to procure the System Services necessary to securely operate the power system and may need to procure additional services where system conditions require it.

1.1 Workstream 2 - System Services Volumes Plan

It is anticipated that following the SEMC decision on the volumes methodology, the DS3 System Services TSO Procurement Strategy[4] (Part D) will be updated to reflect the methodology.

The finalised volume calculation methodology will be used to determine the quantities to be procured in the first System Service auction. Further information regarding auction design and the use of the published volumes in the System Services auctions were discussed in the recent SEM Committee Auction Design consultation[5] and the accompanying DotEcon auction design report[6].

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[4] DS3 System Services Draft TSO Procurement Strategy: http://www.eirgrid.com/media/Draft%20TSO%20Procurement%20Strategy%20-%20Published%2004062014.pdf

[5] SEM Committee consultation on DS3 System Services Auction Design: http://www.allislandproject.org/GetAttachment.aspx?id=1b2db9a0-e492-495d-8dbb-4319ad72dcbf

[6] DotEcon auction design report: http://www.allislandproject.org/GetAttachment.aspx?id=b2cd4771-1401-4b44-adc8-8dcf19076f65

1.2 Terminology relating to Volumes

A number of important terms are used throughout this decision paper and their respective meanings are listed below:

- **Capability Volume Requirements**

  These are the volumes of System Services which are required within the portfolio to ensure that sufficient real-time volume requirement is technically realisable across a year. These will be used to set the quantity to procure in the System Services auctions.

- **Real-Time Volume Requirements**

  These are the volumes of System Services which are required at any point in time to ensure that system security is not jeopardised. These requirements vary depending on system conditions.

- **Realisable Volume**

  This is the volume of service that can be provided by a service provider at any point in time. Remuneration is based on this volume.

For clarity, it should be noted that we are contracting based on ***capability*** but paying for ***realisable volume***.

1.3 Structure of Paper

Section 2 highlights the issues raised by respondents to the consultation and sets out our views on each issue and our associated decision. Based on these decisions, the methodology for calculating the capability volume requirements is described in Section 3 while the initial portfolio scenarios are set out in Section 4.

2 Responses to Volume Calculation Methodology and Portfolio Scenarios Consultation

There were nineteen responses to the consultation on Volume Calculation Methodology and Portfolio Scenarios. Of these, three responses were marked confidential. The sixteen non-confidential responses were received from:

- AES
- Bord Gáis Energy
- Bord na Móna
- Brookfield Renewable Ireland Limited
- Coillte
- Electric Ireland
- Energia
- ESB
- Gaelectric Holdings Plc.
- IWEA Ltd.
- Power NI PPB
- Renewable Energy Systems Ltd.
- SSE
- Tynagh Energy Ltd.
- Owen Martin
- Nigel de Haas

The views of respondents have been summarised and addressed in the narrative below. A number of respondents provided a much more specific reply, often reflecting the respondents' particular circumstances. In keeping with previous System Service consultation papers, all responses that were not marked as confidential have been published by the TSOs.

There was broad agreement among the majority of respondents that the proposed approach to determining the capability volume requirements was reasonable. There was also widespread support for the proposal to set the requirement for each service to be the maximum value from the two portfolio scenarios studied. No alternative methodology for determining the capability volume requirements was proposed.

A number of respondents replied with comments outside of the scope of this consultation. These may be dealt with, as appropriate, in other consultations. These include:

- the co-optimisation of energy and system services for scheduling plant in real-time (as opposed to use of co-optimisation in the volumes calculation methodology);
- auction, qualification, procurement, contracting and payment issues;
- financial certainty to investors;
- treatment of system services revenues under the REFIT;
- differentiation between TSO- and DSO-connected service providers;
- regulated tariffs / glide path / expenditure cap;
- the need to ensure that services are delivered from the correct mix of generation as the value would be eroded if the delivery is accompanied with high dispatch balancing costs or running conventional units that require curtailment of renewable power; and
- the assertion that the DS3 programme is in contravention of Aarhus Convention and the SEA Directive.

2.1 Volume Calculation Methodology

Sensitivities

A number of respondents requested that a range of sensitivities for each initial portfolio scenario be carried out to assess the impact of assumption errors. Sensitivities regarding demand, interconnector flow, installed wind, wind load factor, wind profile, planned and forced outages, plant capability, fuel prices, forecast errors,

high impact low probability events, a wider range of technology solutions, modelling wind using stochastic methods were suggested.

TSOs' decision

To satisfy our statutory obligations to procure sufficient services to operate a secure system we will be performing a number of prudent sensitivities and checks. These will include but are not limited to a sensitivity on merit order and the removal of the provider that provides the largest realisable volume of services.

Real-time operational constraints

A number of respondents requested that the real-time operational requirements for system services which will be applied as constraints in the Plexos model be published, including any locational or jurisdictional constraints and how they will be accounted for/applied given binding network constraints.

TSOs' decision

The real-time operational constraints to be used in the Plexos model for both the 2017/18 and 2019/20 scenarios are now listed in Section 3.4 of this document. It should be noted that the listed constraints are for the purposes of modelling only. While they are our current best estimate, they will be evaluated on an annual basis for the auctions and are subject to change based on the outcome of studies and operational experience.

Outages

A number of respondents stated that forced outages and long-term outages should be taken account of in the modelling and that the assumptions should be published.

TSOs' decision

The Forced Outage Rates and Scheduled Outage Rates used in the All-Island Generation Capacity Statement 2016-2025 analysis will be used as the basis for the volumes analysis. Please see Section 3.7 Plant Availability of the All-Island Generation Capacity Statement 2016-2025 for more detail.

North South 400 kV Interconnector

A number of respondents were of the belief that the 2019 completion date for the North-South 400 kV Interconnector was optimistic. It was suggested that either it should be assumed that the North-South 400 kV Interconnector would not be in place by 2019 or to include a sensitivity where it is not in place.

TSOs' decision

We are proceeding with the assumption in the volumes analysis that the North-South 400 kV Interconnector will be in place by 2019 based on the best available information on planning and construction timelines in both jurisdictions.

The auction design proposed in the recent SEM Committee Auction Design consultation involves holding separate auctions contributing to meeting volume requirements over two distinct timeframes. One-year contracts would cover the entire volume requirement for the following year (Year+1) while longer-term contracts would be available for some fraction of the volume requirement for a future year (Year+X). The nature of this auction design is such that there will be a further opportunity to procure the remaining volume requirements for the Year+X in a future auction held after the initial auction but prior to Year+X. Should there be a delay to delivery of the North-South 400 kV Interconnector, then the volume requirements can be adjusted to reflect the impact.

Rate-of-Change-of-Frequency (RoCoF)

A number of respondents requested that the volume analysis be performed also with an assumed maximum RoCoF of 0.5 Hz/s as they believed the 1 Hz/s is not guaranteed and it would provide valuable information to investors on the likely need for services in this eventuality.

TSOs' decision

Based on the most up-to-date information available to the TSOs, we are confident that we will be able to operate a system with a RoCoF of up to 1 Hz/s calculated over 500 ms in the timeframes outlined. If at any stage it becomes apparent that it may not be possible, we will revisit the volumes. Indicative analysis in the event that the

RoCoF standard does not move to 1 Hz/s calculated over 500 ms can be found in the RoCoF Alternative & Complementary Solutions Project Phase 2 Study Report[7].

Fuel Prices

One respondent stated that it is important to carry out scenarios with different fuel mixes and to cover the situation where coal is no longer the cheapest fossil fuel.

TSOs' decision

We will perform a check with a different merit order, e.g. gas plant ahead of coal plant in the merit order.

Interconnectors

A number of respondents questioned how the HVDC interconnectors with Great Britain (Moyle and EWIC) are modelled. It was stated that it is important that these are modelled with different scenarios particularly with full flow in both directions and with an extensive range of variants in between, including scenarios with volatile swings between full import and full export which is the likely outcome of market coupling.

TSOs' decision

A reduced model of the Great Britain market will be used in the analysis. The flows on the interconnectors will be based on marginal prices in both markets which will lead to swings between full import and full export. The fuel price check described above will also act as a check on interconnector flows. Interconnectors will be used primarily for energy flows with their availability to provide reserve-type system services a function of the energy flow.

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[7] RoCoF Alternative & Complementary Solutions Project Phase 2 Study Report: http://www.eirgridgroup.com/site-files/library/EirGrid/RoCoF-Alternative-Complementary-Solutions-Project-Phase-2-Report.pdf

Forecast Errors

One respondent stated that forecast errors are an important driver of system services volumes and suggested that current statistical data for wind and demand forecast errors are used in the model.

TSOs' decision

Assumptions regarding wind forecast error, demand forecast error and unexpected loss of generation/interconnector import are based on recent statistical analysis of two years' data and will be used for the Ramping Margin products volume calculation. Forecast errors are less of an issue for the non-Ramping Margin services and therefore will not be taken into account in the calculation for these services.

Largest Service Provider

It was requested by one respondent that a methodology or criterion for the largest service provider be agreed with stakeholders in advance of the full simulation study being carried out.

TSOs' decision

Table 1 below outlines the proposed maximum service provision of each service from a single provider that will be assumed for the modelling. These figures are being evaluated and the annual procurement process will separately state the maximum to be procured from any single provider.

As TSOs, we have a statutory obligation to ensure sufficient services are available at all times to run the system safely and securely. To fulfil this duty we have to ensure that the loss of any one service provider does not cause the system to become insecure. To date, we have not run with units providing more than the volumes outlined below. For the faster reserve products the values proposed typically ensure that no more than 25% of the requirement is held by any one unit and the system has classically been run with these approximate values. Having to cover the loss of a unit providing more than the volumes outlined below may become inefficient and uneconomical. As the power system evolves these values will be re-evaluated.

Table 1: Maximum provision of each service from a single provider

Service	Largest Provision from a single provider	Service	Largest Provision from a single provider
SIR	120,000 MWs[2]	RR(S)	300 MW
FFR	100 MW	RM1	400 MW
POR	100 MW	RM3	500 MW
SOR	125 MW	RM8	500 MW
TOR1	150 MW	SSRP	400 Mvar
TOR2	150 MW	FPFAPR	No Limit
RR(D)	300 MW	DRR	No Limit

DRR and FPFAFR services

There were a number of queries and viewpoints expressed by respondents in relation to eligibility to contract for the DRR and FPFAFR services and the volume requirements. The following concerns were expressed:

- clarity required on eligibility and expected volume of services to be provided by different technologies;
- the system might be stable and secure with lesser volumes of these services but this is not tested. Therefore there is a risk that excessive volumes of these services might be procured;
- if the new non-synchronous generation displaces synchronous generation in both capability volume and in real-time volume, there will be insufficient capability procured as not all new technologies are capable of providing these services and plant unsuccessful in CRM auction could well exit;
- if the additional volume requirement comprises of any new non-synchronous generation connected to the system, then the volume requirement is purely dependent on the portfolios analysed; and

- if the volume requirement is to be set at this amount then both existing and future conventional generation must be excluded from bidding to provide these services.

TSOs' decision

The Dynamic Reactive Response and Fast Post-Fault Active Power Recovery services relate to desired performance of service providers during and after a transmission fault to manage the stability of the system. Traditionally, conventional generation units provide these services due to the nature of synchronous machines. At high levels of non-synchronous penetration these services become scarce.

We require the appropriate response from the majority of new generation connecting to the system. We propose that all proven providers of these services should be eligible for a contract for provision of the services if it is realisable and useful to the transmission system. Section 3.6 of this paper outlines how the volumes will be calculated.

It should be noted that a temporal scarcity scalar is proposed which would target payment at times of potential shortage, i.e. at times of low penetrations of synchronous generation. For more details please see the Section 2.4 of Consultation on DS3 System Services Scalar Design[8].

As stated previously, as this is our first time undertaking such analysis there will therefore be an element of learning and therefore this decision may be subject to review as the power system evolves.

Minimisation of curtailment

A number of respondents questioned the criteria for minimising curtailment and had concerns regarding the 5% curtailment target mentioned at the industry forum in Dundalk and whether it satisfies the obligations of the TSO under Article 16 of Directive 2009/EC/28. A number of respondents believed that the target should be 0%. One respondent suggested that system services should be procured up to the

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[8] Consultation on DS3 System Services Scalar Design: http://www.eirgridgroup.com/site-files/library/EirGrid/DS3-System-Services-Scalar-Design-Consultation-FINAL.pdf

point where the additional fuel cost of procuring further services outweighs the fuel saving of avoided wind curtailment.

TSOs' decision

In accordance with Article 16 of Directive 2009/EC/28 we work to minimise curtailment. All analysis performed and published to date in the DS3 Programme was predicated on a 5% curtailment figure in 2020. Clearly there will be times when potential wind generation will exceed 75% of the demand and HVDC exports and the TSOs will have to curtail wind generation to keep the system secure. In this instance adding more service provision will not lead to a reduction in curtailment. There are also other times that adding more service provision does not reduce curtailment depending on the mix of services required at that time and the type of plant providing those services, e.g. adding more POR at a time when we have the required real-time volume requirement will not lead to a reduction in curtailment.

Steady-state reactive power

There were a number of queries and viewpoints expressed by respondents in relation to the methodology for calculating the SSRP volume requirement:

- there was concern that although the process for determining the volume of steady-state reactive power appeared logical it may be sub-optimal;
- it was stated that relying on the investment in numerous static compensation devices might be more expensive than further altering the refined portfolio to deliver more reactive power provision from conventional generation and/or demand side providers and may result in under-procurement of the service;
- it was suggested that a 'refined portfolio' with enhanced steady-state reactive power provision might be considered within the proposed process against an assessment of the cost of additional network devices;
- there was concern in relation to the use of STATCOMs in the modelling stating that a STATCOM in a particular location on the network can provide a certain amount of reactive power to solve a problem. However, a much higher level of reactive power may be required from other sources to solve the same problem due to their different location(s);
- it was questioned why there was no Belfast area included in the methodology;

- it was recommended that a future grid with all known changes included be used for the analysis; and
- it was stated that it is difficult to see how this process can guarantee an optimal outcome in terms of the determination of plant portfolios and it may therefore be better to dynamically consider the impact of network constraints as part of the plant selection process and respondents would welcome further consideration of this or a more detailed explanation of why the current approach has been proposed.

TSOs' decision

Following review of the comments received and further consideration, we believe that this product should incentivise units to maximise their performance rather than incentivise specific investment in new sources of reactive power.

From a TSO perspective, it is important to have access to reactive power from generators and other service providers at all times, and over a wide active power range. We believe that SSRP payments should aim to incentivise all providers to maximise their reactive power capability and that all eligible providers should be paid for this capability if it is realisable and useful to the transmission system. We can then account for providers' expected capabilities in our network planning. Section 3.5 of this paper outlines an updated methodology on how the volumes will be calculated.

As stated previously, as this is our first time undertaking such analysis there will be an element of learning and therefore this decision will be subject to review.

Number of Initial Portfolio Scenarios

There were differing views regarding the number of initial portfolio scenarios. A number of respondents believed that using two starting portfolios for the 2019/20 year is not adequate to ensure the results are not unduly influenced by the starting conditions, while another respondent believed that two were sufficient. Those in favour of increasing the number of starting portfolios suggested that the number should be sufficient to adequately stress test the assumptions behind the starting portfolio scenarios and should also be sufficient to allow for the identification and management of any potential bias in the modelling results when drawing conclusions.

One respondent suggested that an initial portfolio scenario with a reduced number of units having reduced minimum generation levels and a reduced number of additional network devices should also be included to prove the volumes are not affected by the starting assumptions or to select the worst case scenario as a starting point.

One respondent suggested that a new initial portfolio scenario for 2019/20 could be introduced that would be a hybrid of Enhanced Capability and New Service Provider scenarios, provided by a mixture of enhancements and new technology.

TSOs' decision

It is our duty to ensure that we procure sufficient system services to ensure the secure operation of the system. We are confident that one portfolio scenario for 2017/18 and two initial portfolio scenarios for 2019/20 and the checks outlined are appropriate to determine the Capability Volume Requirements.

While we will always strive to produce the most accurate estimate of volume requirements possible, as outlined previously, the nature of the auction design proposed in the recent SEM Committee Auction Design consultation is such that there will be an opportunity in a future auction (the auction held the year prior to Year+X) to take account of any identified changes to the volume requirements in Year+X.

Volumes post-2020 and publication of future volumes

A number of respondents were opposed to the proposal to keep volume requirements for 2020/21 and 2021/22 the same as 2019/20 citing the ambition outlined in the EU Commission's 2030 Energy Framework and the forecasts contained in the Generation Capacity Statement as arguments. Respondents suggested calculating the volumes for 2021/22 and interpolating for 2020/21, and continued extrapolation out to 2021/22.

A number of respondents believed that the full five years should be modelled to reduce the inaccuracy in the model outcomes and to account for the changing effects over the years given the potential for step changes, e.g. lower coal fired generation, the introduction of the North South 400 kV Interconnector.

A number of respondents also requested clarity on the publication of future volumes beyond 2021/22. One respondent requested that the TSOs consider providing indicative volumes for the next ten years while another believed that they should be published annually on a five year rolling basis.

TSOs' decision

In line with the proposal for auction design by the SEM Committee, there will be an annual process to calculate volumes for the following year and a future year. The annual process will utilise the most up-to-date information available. As the System Services market develops and the actual portfolio changes, calculating the annual volumes should become a more accurate process. This accuracy is important not only for system security and facilitating renewable generation but also to drive value for the consumer in procurement of system services. Therefore, we intend to keep the proposal as was outlined in the consultation paper, i.e. to keep the volume requirements for 2020/21 and 2021/22 the same as 2019/20.

2016/7 Volume Requirements

A small number of respondents queried the volume requirements for 2016/17.

TSOs' response

2016/17 falls under the interim arrangements and therefore no volume requirements will be published as all eligible providers will be contracted.

Ramping Margin

One respondent queried the method for calculating the Ramping Margin products volume requirement and at what level of accuracy we would be satisfied with achieving at any given time.

TSOs' decision

For each hour of the Plexos run, a 1, 3 and 8 hour ramping requirement will be calculated. This will be calculated from the ramping duty (where we expect to be in 1, 3 and 8 hours given forecasts) and uncertainty associated with wind forecast error, demand forecast error, unexpected forced outage of generation or interconnection

and unexpected changes to flows on the interconnectors. The forecast errors and forced outage rates will be based on recent statistical analysis of the last two years' data.

Substitutability between products

A small number of respondents questioned how the substitutability between individual DS3 System Services would be handled in the model and that it would be helpful for the level of substitutability to be calculated as part of the methodology and published with the results. Participants could then see how firm the volume requirements are, and the extent to which these could be substituted by other services. Where there is substitutability, it would be useful to show how the relative volume requirements for these services would vary with price.

TSOs' decision

We acknowledge that there may be substitutability between individual services in real-time, e.g. an increase in FFR may lower the POR requirement. However, the practicality of real-time operation (dispatch and scheduling) of the system does not lend itself to substituting products. The real-time requirement for each product will be fixed in the modelling.

Dispatch Costs

A number of respondents requested the TSOs to clarify what was meant by "very high dispatch costs" and how re-dispatch costs will be taken into account in the process of refining scenarios. It was also stated that it was unclear from the consultation what level of Dispatch Balancing Costs constitute a need for additional services.

It was also stated that given that curtailed wind is effectively free to the TSO, more clarity on how both constraint and curtailment costs are being reflected in the model was required.

Another respondent strongly recommended that "very high re-dispatch costs" cover the scenarios where there is large amount of wind curtailment or alternatively where

the resulting energy prices are unreasonably high due to excessive dispatch balancing costs.

TSOs' decision

We acknowledge that the term “very high dispatch costs” is subjective and not clear. As TSOs we have an obligation to run a secure system. To fulfil this duty, where appropriate, we dispatch the system away from the market schedule which incurs dispatch costs. We also have an obligation to minimise costs and we continually work to reduce the costs associated with dispatching away from the market schedule.

However, this methodology is just a means to calculate volumes and following further consideration we have decided that we will not take dispatch costs into account in the process of calculating volumes. Ultimately, dispatch costs will be a function of plant portfolio and transmission constraints among other things. It should be noted that transmission constraints, apart from the jurisdictional Ireland - Northern Ireland constraint in the 2017/18 scenario, will not be included in the Plexos model.

Publication of Plexos models / results

A number of respondents requested that the final Plexos models with assumptions used for real-time requirements and limits, refined portfolios, criteria used, the execution of the methodology and detailed documentation should be made available to market participants in sufficient detail and plain English to give all parties confidence in the process. It was suggested that if the detailed Plexos models cannot be made available, the assumptions and constraints used in the modelling should be published to enable service providers to undertake their own analysis.

TSOs' decision

We intend to publish all non-confidential and non-commercially sensitive information. Modelling assumptions are already available in Section 3 and Section 4 of this paper. We will also have the results reviewed by an independent professional expert to ensure accuracy and that the methodology presented has been followed. Similar levels of information will be published in future years.

It should be noted that contracted service provision from each provider that is successful in becoming a party to the Interim Framework Agreement will be published also.

Interaction between System Services and CRM and Capacity Adequacy

One respondent queried the interaction between the DS3 System Services and reliability options under the I-SEM. The respondent stated that there are two contradictory principles with system services designed to incentivise low output from service providers whilst maintaining a high degree of service while the reliability options incentivise capacity providers to ensure peak output during peak hours. The respondent requested that the SEM Committee give further consideration to how the programmes will operate in parallel and to work with industry on this.

Another respondent queried whether the possibility of system services being unavailable due to CRM requirements would be factored into the scenario calculations.

Another respondent was concerned that there is not a sufficient correlation with the I-SEM Capacity Remuneration Mechanism (CRM) and the associated Generation Adequacy calculation to determine if the capacity secured through that process can also deliver the levels of services in the required timeframe.

TSOs' response

We would first like to note that there are only two products that incentivise a provider to have the capability to provide the service at low output; SIR and SSRP. It is the *capability* to provide these services at low output that is incentivised not the actual provision of the service at low output. Both services are required to be provided at high output also. The principles are complementary rather than contradictory.

Regarding the possibility of system services being unavailable due to CRM requirements, we acknowledge that there may be interaction between both designs with regard to the provision of reserves from some providers. The designs have not yet been finalised and this interaction is being examined. In terms of the analysis for calculating the capability volume requirements we will always ensure that we have

enough generation to meet demand and sufficient services in real-time to ensure a secure system.

It is our understanding that the SEM Committee are also planning to explore the possibility of combining the CRM and System Services into a single auction in the future.

Procurement of Additional Services

One respondent requested that the TSOs clarify what conditions would give rise to procuring additional system services and how participants would be remunerated in such circumstances.

TSOs' decision

One of our primary statutory duties is to procure sufficient ancillary services to maintain the resilience and reliability of the power system. In particular, if the enduring arrangements do not deliver the necessary services, or in the event of unexpected circumstances, we have an obligation to enter into contracts for services to take into account the needs of the system and policy objectives. However, we do not currently foresee the need and we will not exercise this right without demonstrating that the proposed system services approach cannot deliver the necessary services in a timely manner to maintain system security.

Plexos model and I-SEM

Two respondents queried the ability of the Plexos model to give an accurate representation of system dispatch under I-SEM conditions.

TSOs' response

The Plexos model is a production cost model. A production cost model dispatches plant to reflect the underlying economics of plant and should therefore closely align with the dispatch produced by an efficient market i.e. an efficiently operating market should provide the same outcome. Ultimately, the final dispatch has to have at least the required level of services. These can be provided through I-SEM participants positioning themselves to provide services or TSO actions in the balancing market.

Further information can be found at https://www.semcommittee.com/i-sem and http://www.sem-o.com/isem/Pages/Home.aspx

Iterative Refinement Methodology

A number of respondents raised concerns regarding the iterative refinement methodology proposed. One stated that the over-reliance on iterative refinement could undermine the outcome of the entire process if the results are no longer aligned with real-time operation. In their view, continually refining the portfolios with the aim of reaching a theoretical ideal rather than a more realistic/optimised scenario may not be the best approach.

Another respondent stated that the proposed methodology does not guarantee or even make likely that the auction result will arrive at the same solution and therefore it is not clear that the volumes determined using the proposed methodology will be sufficient to cover all possible dispatch scenarios when taking the auction result into account.

TSOs' decision

We acknowledge these points, however, we do note that there was broad agreement among the majority of respondents that the proposed approach to determining the capability volume requirements was reasonable and no alternative methodology was proposed.

In line with the proposal for auction design by the SEM Committee, there will be an annual process to calculate volumes for the following year and a future year. The annual process will utilise the most up-to-date information available. Therefore, if the methodology under/over-estimates volumes in the future year there is scope for refinement in the intervening time period. We would only expect to adjust the methodology if there is a material challenge to the security of the system or following review if the needs of the system are found to be fundamentally different.

As stated previously, it should be noted that this is our first time undertaking such analysis and there will therefore be an element of learning. In addition, we are not aware of any other system/ancillary services market in the world that procures for capability and pays for realisable volume. Therefore, we may need to review the

volumes calculation methodology in the future to ensure that it is fit for purpose. A process for this review will be established and made public.

Under/over-estimation of volumes

A number of respondents commented on the situation where there is under- or over-estimation of volumes.

One respondent queried the situation where an over-estimation of volumes were to materialise and whether there would be any scope to recalculate the volumes (and the associated tariffs) within the five-year period and if so what the impact would be on investor confidence.

Another respondent stated that if the assumptions made by the TSOs are incorrect, this could result in a shortfall of system services, a delay to new build and further delay to the DS3 programme. They stated that by presenting a range of portfolio scenarios and setting the volume requirement to the maximum value from the portfolio scenarios analysed, this should mitigate this exposure.

TSOs' response

In line with the proposal for auction design by the SEM Committee, there will be an annual process to calculate volumes for the following year and a future year. The annual process will utilise the most up-to-date information available. Therefore, if there is an under/over-estimation of volumes it can be adjusted in the following year. We would only expect to adjust volumes if there is a material challenge to the security of the system or following review if the needs of the system are found to be fundamentally different.

Governance, accountability, transparency, quality assurance and stakeholder engagement

One respondent stated that given the importance of the modelling approach, a high degree of transparency and robust governance arrangements are required to ensure its integrity. They recommended that there should be a further consultation on the assumptions and suggested that a dedicated working group is formed to allow for meaningful engagement across all stakeholders.

Another respondent also believed that a working group should be established to develop the scenarios and assumptions to make sure the modelling is sufficiently robust.

One respondent queried the quality assurance arrangements stating that given the timelines and that this is a new and complex modelling process it is essential that the quality assurance on the modelling results is prioritised and is robust.

One respondent suggested that the Volume Capability Requirements could be validated by identifying the most extreme operational conditions the TSOs are likely to encounter during periods of high renewable output. They suggested that full network models with technical analysis/control room planning tools could be used to determine the real-time requirements necessary to minimise wind curtailment under these conditions and the Volume Capability Requirement contracted should exceed this real-time requirement with an adequate margin to cater for unavailability.

TSOs' decision

As stated previously, it is our duty and responsibility as TSOs, under statutory and licence obligations, to procure system services to ensure sufficient services are available at all times to run the system safely and securely.

We agree with the respondents that governance, accountability, transparency, quality assurance and stakeholder engagement are important aspects of the volume calculation methodology approach. We are currently considering the right balance with respect to this element of the System Services implementation and we will revert to the SEM Committee and industry.

It should be noted that governance arrangements on all aspects of System Services implementation are already in place with the SEM Committee. The consultation process is very transparent and that there are many opportunities for stakeholder engagement in the DS3 Programme through consultations, industry fora, bi/tri-lateral meetings, Advisory Council meetings and through our website. As mentioned previously, there will be an independent review of the results prior to publication to ensure quality, accuracy and that the methodology presented has been followed.

Energy Costs

One respondent stated that the volume analysis also needs to take into account the energy costs of providing each service from different providers.

TSOs' response

The initial portfolio scenarios and volume calculation methodology presented in this paper have been developed solely for the purpose of determining the appropriate volume requirement for each of the services. The final portfolio scenarios, which will evolve based on the methodology outlined, will not be representative of desired, expected or optimal portfolios and will have no bearing on the outcome of the competitive procurement process other than informing the volumes to be procured.

For the purposes of calculating volumes, the energy cost associated with different providers is unlikely to significantly affect volumes. However, the energy cost of a provider being on-line would be an important consideration for real-time deployment of services.

SMP

One respondent queried if the market SMP is taken into account in the analysis

TSOs' response

The market SMP is not taken into account in the analysis. The Plexos model is a production cost model.

Transmission Infrastructure

One respondent stated that it is essential that the expectation of transmission infrastructure build in the assumptions is realistic and that consideration also needs to be given to other technologies which will enable better use of the existing infrastructure.

TSOs' decision

Transmission constraints other than those specified in Section 3.4 are not taken into account in the model.

Generation meeting demand

One respondent stated that it is important as part of this iterative process, where some providers have very low or zero utilisation and will be removed, that all system demand continues to be met by the generation that is selected.

TSOs' response

It is only the service capability of the unit that will be removed, not the unit itself.

Taking on board industry responses

One respondent queried the ability of DS3/I-SEM project teams to take on board industry responses on this and other DS3/I-SEM consultations stating that models are likely to need to be in development prior to the decision to facilitate meeting the stated timeline. The respondent also stated that there is a risk that the importance of the modelling processes to the efficacy and efficiency of both the auction and the regulated tariffs is being underestimated. They are concerned that the fundamental importance of implementing robust modelling processes to ensure the success of the DS3 programme is not fully acknowledged in the consultation paper and that there is therefore an increased risk that it may not be receiving due consideration given the extremely challenging timelines.

TSOs' response

We acknowledge that the timelines are challenging, but we will ensure that due process is followed at all times and that quality standards are appropriate.

Plexos model matching system dispatch

One respondent stated the importance of the Plexos model matching the reality of the system dispatch and replicating the unit commitment in the same way the control rooms tools will dispatch plant.

TSOs' response

The Plexos model is a close representation of actual system dispatch. However, as we do not have perfect foresight, we must plan and operate the system to account for possible variations in demand, wind output and generator availabilities.

For example, if a generator is dispatched to synchronise by the TSO but fails to synchronise, this is ‘known’ by the Plexos model and it will take into account the unavailability of this unit in the production of the unit commitment. We, however, may respond to the event in real-time by re-dispatching fast-acting generation to maintain system security until the affected generator is available to synchronise onto the system. Therefore there are times when Plexos dispatch and actual dispatch will vary. It should be noted though that the accuracy of the model has been validated on an annual basis through its use in Dispatch Balancing Costs forecasting.

Sharing of system services with GB

One respondent stated that under the Network Codes there is also potential to share ancillary services with Great Britain but there is no indication as to what assumptions have been made about this.

TSOs’ response

The purpose of this analysis is to ascertain capability volume requirements for system services on the island. As such, sharing of services will not affect the requirement on the island.

2.2 Initial Portfolio Scenarios

There were a large number of comments received about the composition of the initial portfolio scenarios and the service capability of the different groupings. These initial portfolio scenarios should not be construed as predetermining or forecasting the technologies which will be, or should be, successful in a system services procurement process.

For clarity, the TSOs are absolutely not representing that the initial portfolio scenarios are the only portfolios, optimal portfolios or preferred outcomes. The initial portfolio scenarios are just a means to calculate volumes. The TSOs believe that there are myriad credible portfolios and ultimately, the actual portfolio will be driven by market forces. To the extent that we could, we used what be believed to be reasonable starting points that are broadly achievable.

Notwithstanding that the initial portfolio scenarios are just a means to calculate volumes; we have taken on board comments and adjusted the initial portfolio scenarios to ensure that they are reasonable starting points.

A number of respondents pointed out a small number of typographical errors which have been corrected.

FFR assumptions

A number of respondents questioned the assumption regarding the volume of FFR provided by CCGTs as 50% of POR for non-enhanced plant and 60% for enhanced plant suggesting that the figure should be much lower.

TSOs' decision

Based on analysis of Phasor Measurement Unit (PMU) data for CCGTs during a number of events, the figures of 50% of contracted POR for non-enhanced CCGTs and 60% of contracted POR for enhanced CCGTs are appropriate. We do acknowledge, however, that the inertial response may influence these figures with differing volumes being provided depending on the rate-of-change-of-frequency (RoCoF) observed.

Demand Side Management (DSM)

One respondent stated that the provision of services from demand side may be under-estimated and it is feasible that DSM could provide many, if not all, of the fourteen services defined.

TSOs' response

We do not envisage DSM being capable of providing the following services:

- FPFAPR – this only applies to plant that are exporting active power to the system. As DSM does not export active power to the system it does not qualify for this product; and
- DRR – this product only applies to plant with a registered capacity and therefore is not available to DSM.

It is unlikely that there will be a significant volume of service provision from DSM for the following products for the reasons outlined:

- SSRP – due to the requirement to have the capability to provide reactive power control and that the majority of demand sites are deeply embedded in the distribution system where local constraints will severely limit their realisable capability and usefulness to the transmission system; and
- SIR – due to the requirement that the load must be synchronous and directly dispatchable by the TSOs.

More generally, the large scale deployment of non-energy system service provision from new technologies through the DS3 System Services enduring arrangements is intended to reduce total costs and facilitate the delivery of public policy objectives. However, we will need to be confident that this deployment will not inadvertently undermine the resilience and security of the power system. As TSOs, we have a duty to maintain system stability and avoid loss of supply. We therefore need to take steps to identify the associated risks, obtain information about the capability of new types of service provider and manage this transition in a prudent fashion.

We are currently developing a technology trial process that will provide potential providers with an opportunity to demonstrate the capabilities of technologies that have not previously delivered system services on a system with similar characteristics to that of the all-island system which we operate.

2017/8 Assumptions

One respondent believed that the storage capability was low given there are already plans for a greater volume of storage to be in-situ. They suggested that the assumption should be re-examined with the storage capability adjusted upwards by an amount in the region of 5-10 MW.

TSOs' decision

We have taken this comment on board and increased the DSM, Interconnector and Storage grouping in the 2017/18 scenario by 5 MW with associated increase in service provision.

CCGT Assumptions

A small number of respondents questioned the assumptions regarding the enhancements (shorter start up times, improved reserve capability with a reduction in minimum load) to six existing CCGTs. They expressed concerns that CO_2 emissions requirements and the nature of the existing plants may not accommodate this enhancement and that the uncertainty created by the current market reform process may discourage new investment in the required timeframe.

One respondent stated that given achieving a significant improvement in minimum generation will required a sizable capital investment, any plant making this type of capital investment would seek to maximise the level of services it could deliver. It would therefore be illogical for a plant to not achieve a cold start in less than three hours. As such it would seem prudent to assume that enhanced CCGTs would deliver RM3 capability.

One respondent stated that the assumption that no CCGTs will be able to provide RM1 and RM3 is incorrect as any CCGT with open cycle potential will be able to provide both these and that RM8 should also be much greater than 734 MW.

One respondent queried why the total capacity of CCGTs was reduced in the 2019/20 scenarios.

One respondent queried if the increase in SIR for CCGTs in the Enhanced Capability Portfolio was technically feasible.

TSOs' decision

Based on comments received, we have reduced the number of enhanced CCGTs in the Enhanced Capability Portfolio scenario from six to four. We have also assumed that the enhanced CCGTs will be capable of delivering their full capacity for the RM3 service from cold. In all scenarios we have assumed that a number of CCGTs are capable of operating in open-cycle mode and are therefore capable of providing the RM1 and RM3 services.

The reduction in the total capacity of CCGTs in the Enhanced Capability Portfolio Scenario is due to a typographical error which has now been corrected. The reduction in the New Service Providers Portfolio Scenario is due to minor degradation over the years in line with the methodology used in the Generation Capacity Statement.

The increase in SIR in the Enhanced Capability Portfolio is based on a reduction of minimum generation to 35% of registered capacity.

CHP Capacity

One respondent queried the small increase in CHP capacity of only 6 MW over two years between the 2017/19 scenario and both 2019/20 scenarios given the current focus on the Renewable Heat Incentive (RHI) and new renewable electricity scheme from the Department of Communications, Energy and Natural Resources.

TSOs' decision

In line with the Generation Capacity Statement 2016-2025[9] the 2019/20 scenarios will be updated to include an extra 150 MW of CHP.

OCGTs

One respondent questioned the validity of the assumption that the Enhanced Capability Portfolio scenario includes two new OCGTs connecting to the system by

[9] Generation Capacity Statement 2016-2025: http://www.eirgridgroup.com/site-files/library/EirGrid/Generation_Capacity_Statement_20162025_FINAL.pdf

2019. Another respondent queried why the existing OCGTs in the Enhanced Capability Portfolio Scenario had a lesser capacity but the same SIR.

TSOs' decision

Regarding the assumption of two new OCGTs, as stated previously these scenarios are just a means of calculating capability volume requirements and do not represent the final outcome. Given the relatively quick lead time associated with the construction of OCGTs we believe it to be a reasonable assumption.

Regarding the query relating as to why the existing OCGTs in the Enhanced Capability Portfolio Scenario had a lesser capacity but the same SIR, this is because the OCGTs that were deemed to have improved reserve characteristics and therefore moved into the OCGT Enhanced Category were assumed not to provide any SIR in the first instance.

Solar

One respondent stated that the total of 100 MW for non-wind renewables may need to be reassessed given the recent growth in solar.

TSOs' decision

In line with the Generation Capacity Statement 2016-2025 the assumption regarding solar has been increased to 239 MW in the 2019/20 scenarios.

Interconnectors

Respondents queried the assumption regarding full interconnector export capacity availability given that the Moyle Interconnector export capacity is forecast to be limited to 80 MW from 2017 according to the Generation Capacity Statement 2015-2024.

A respondent queried if the volume of service provision from the interconnectors is technically or commercially feasible and stated that it may be clearer for the Capability Volumes Requirement to be defined as that available to the competitive market, excluding mandated Grid Code services and interconnector volumes.

TSOs' decision

The assumptions regarding the full interconnector export capacity have been updated to match the Generation Capacity Statement 2016-2025, i.e. a reduced export capacity of 80 MW for Moyle.

The assumed values of service provision from the interconnectors have been reduced to take account of the assumed maximum service provision of each service to be contracted from a single provider and the likely ability of interconnectors to provide certain services given technical, commercial and regulatory considerations.

Storage

One respondent queried the assumptions regarding the performance of the assumed storage capacity in terms of energy storage capability, endurance and round-trip efficiency. The respondent suggested that the assumed performance could have a big bearing on the study results. The same respondent also queried how the storage/DSM/IC category provided SIR.

TSOs' decision

The analysis will take account of the energy storage capability and round-trip efficiency.

SIR can be provided by synchronous dispatchable storage or demand.

STATCOMs, synchronous compensators and flywheels

One respondent stated that there was a large volume of services in 2019/2020 scenarios delivered from STATCOMs and Synchronous Compensators and flywheels, and while from a modelling perspective this may be a useful assumption, in reality the connection of this number of devices in such a timeframe is questionable.

One respondent queried if the assumption of 50 MW of primary and secondary reserve capability from synchronous compensators with flywheels was based on commercially available devices.

TSOs' decision

As stated previously, the initial portfolio scenarios are just a means to calculate volumes and are not necessarily representative of the final outcome which will be driven by market forces.

Demand

A respondent queried the assumption regarding demand ranging from 2,000 MW to 7,000 MW given the increased demand arising from the connection of data centres and suggested using information from the Generation Capacity Statement 2016-2025 which will be taking additional demand from data centres into account.

TSOs' decision

The analysis will be based on the Ireland and Northern Ireland median demand assumptions in the Generation Capacity Statement 2016-2025 which takes into account increased demand arising from the connection of data centres.

Wind Capacity

The wind capacity in the both the 2017/18 and 2019/20 scenarios was questioned. A number of respondents believed that it should be increased given the connection deadline of 31 December 2017 for up to 4,000 MW of wind capacity under REFIT 2 and the potential impact of CER/14/047 which allows additional capacity to be installed at each wind site, and that higher levels of wind may be required to cater for increased levels of demand and to cater for a shortfall in targets in the area of heating and transport.

Respondents also questioned the basis of the assumptions and validity regarding the level of Fast Frequency Response, Fast-Post Fault Active Power Recovery and Dynamic Reactive Response from wind. They recommended that effort should be made with industry to validate these assumptions and that the feasibility of achieving this outcome is investigated before the scenarios are finalised.

TSOs' decision

As per the Generation Capacity Statement 2016-2025, 4,489 MW of wind generation will be assumed for the 2017/18 scenario and 5,352 MW for the 2019/20 scenarios.

Regarding the level of DRR and FPFAPR products available from wind generation, we propose that all proven providers of these services should be eligible for a contract for provision of the services if it is realisable and useful to the transmission system. For clarity, Section 3.6 of this paper outlines how the volumes will be calculated.

Regarding the level of FFR available we have made the assumption that a proportion of new build will be capable of providing it based on discussions with wind turbine OEMs.

I-SEM CRM

One respondent stated that using information from the Generation Capacity Statement 2015-2024 as a starting point for all portfolio scenarios is fundamentally flawed as it assumes that plant is operating in current market conditions as opposed to the I-SEM. They believed that the change in the Capacity Remuneration Mechanism from capacity payments to reliability options will likely lead to the closure of old unreliable plant and that this is not reflected in the Generation Capacity Statement.

TSOs' decision

As previously stated in the paper, the initial portfolio scenarios are just a means to calculate volumes. To the extent that we can, we are using what we believe to be reasonable starting points. We do acknowledge however that the change in CRM from capacity payments to reliability options may lead to a change in the actual portfolio.

Replacement Reserve

One respondent queried how the quantity of RR(S) and RR(D) added up to more than the total capacity for all scenarios where both products exist.

TSOs' response

The tables in the paper detail the capability of each technology grouping. Technologies will have a replacement reserve capability when synchronised or

connected, and when not synchronised or connected. The capability to provide each of the products is treated separately and therefore can add up to more than the total capacity of each technology grouping.

SIR

One respondent queried the TSOs' assumptions around calculating the SIR volumes in the enhanced portfolio and requested an explanation through numeric examples.

TSOs' response

The calculations were performed based on the SIR product definition. Detailed numerical examples can be found on pages 48 and 49 of the DS3: System Services Consultation – Finance Arrangements paper[10].

Technology neutrality

One respondent stated that consistency with being technology neutral is not evidenced by the portfolio selection. They questioned how the TSOs claim to adopt a neutral stance if the incumbents have first rights to the provision of the services. They stated that existing service providers with their inherent cost competitive advantages of amortized plant of up to 40% are pitted directly against new entrants.

TSOs' response

As stated previously the initial portfolio scenarios are just a means to calculate volumes. They should not be construed as predetermining or forecasting the technologies which will be, or should be, successful in a system services procurement process. For clarity, the TSOs are absolutely not representing that the initial portfolio scenarios are the only portfolios, optimal portfolios or preferred outcomes. The TSOs believe that there are myriad credible portfolios and ultimately the actual portfolio will be driven by market forces. To be clear, the presence or not

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[10] DS3: System Services Consultation – Finance Arrangements: http://www.eirgridgroup.com/site-files/library/EirGrid/System-Services-Consultation-Financial-Arrangements-December_2012.pdf

of plant in the initial portfolio scenarios does not give a right to the provision of the services.

Detail around assumptions

A number of respondents requested more details around the portfolio assumptions, specifically details of all figures in the tables, the modelled characteristics of all plant in each portfolio, a breakdown of each technology grouping and whether the proposed portfolio scenarios include committed plant additions, modifications and retirements.

TSOs' decision

In order to protect confidential information with respect to plant performance we had to group plant into different technology groupings. Therefore we are not in the position to detail the assumptions around the figures in the tables or the modelled characteristics of plant. We have used the Generation Capacity Statement 2016-2025 as a basis for both initial portfolio scenarios including committed plant additions, modifications and retirements for the years in question.

Energy costs and capital costs

One respondent queried whether the TSOs have taken the energy costs and capital costs of plant into account in deriving the assumptions.

TSOs' response

We have not taken the energy costs and capital costs of plant into account in deriving the assumptions. The production cost model is based on short run marginal costs (predominantly fuel costs).

Inclusion of fast flexible plant in New Service Providers portfolio

One respondent stated that no new conventional or fast flexible plant is included in the New Service Providers portfolio scenario and yet 390 MW of storage technology is assumed. The respondent urged that an additional portfolio scenario is presented with new conventional or fast flexible plant included in the scenario.

TSOs' response

As previously stated in the paper, the initial portfolio scenarios are just a means to calculate volumes.

3 Methodology for Calculating Capability Volume Requirements

3.1 Approach to Calculating Capability Volume Requirements

The SEM Committee's SEM-14-108 paper stated that "*volumes should be forecast for a minimum of a five year period*". The first year of the five year period envisaged by the SEM Committee was 2017/18; the final year envisaged was 2021/22[11]. In May 2016, the SEM Committee announced that it will be necessary to revise the date for the first auction to the first half of 2018, for delivery of the service(s) in October of 2018. For the benefit of stakeholders, we will conduct the analysis for the period originally envisaged. In advance of the first auction, the analysis will be conducted again to set the appropriate volumes.

To determine the volumes efficiently, we will carry out detailed analysis of volume requirements for the first year, 2017/18, and the third year, 2019/20; the latter is the year in which renewable electricity targets should be achieved. We will interpolate between these results to determine the 2018/19 Capability Volume Requirements, and in the absence of certainty regarding the build of renewable generation capacity beyond 2020 at present, we will set the Capability Volume Requirements for 2020/21 and 2021/22 to the 2019/20 values.

The detailed analyses for 2017/18 and 2019/20 will involve iterative Plexos studies of portfolio scenarios to fine tune their capabilities to match system requirements. The initial portfolio scenarios are described in detail in Section 4 of this paper.

The approach that we will take to calculate the volume requirements for 2017/18 and 2019/20 is outlined in Figure 1. This approach will be used for calculating volume requirements for eleven of the services. Sections 3.5 and 3.6 outline the approach for the remaining three services; Steady-State Reactive Power (SSRP), Fast Post-Fault Active Power Recovery (FPFAPR) and Dynamic Reactive Response (DRR).

In this approach, the initial portfolio scenarios presented in Section 4 of this paper will form the starting point for the detailed analysis. We will test the capability of these portfolio scenarios in facilitating increased System Non-Synchronous Penetration (SNSP) levels.

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[11] The Tariff/Auction year runs from 1st October to 30th September of the following year.

SNSP has been identified as a useful proxy for the capability to operate the system safely, securely and efficiently while minimising curtailment of renewable generation. It covers a number of fundamental system requirements, namely: inertia/RoCoF, ramping, reactive power and transient stability.

Where necessary, we will refine the capability of the portfolio scenarios using the approach described in Section 3.2.

The volumes to be procured will be calculated based on the System Services capability of the refined portfolios, as described in Section 3.3.

For the year 2020, analysing two portfolio scenarios will result in more than one set of volume requirements being compiled for the various System Services. We will set the volume requirement for each service to the maximum value from the two portfolio scenarios studied. This approach will ensure that prudent volumes of System Services are procured to cover the range of plausible scenarios.

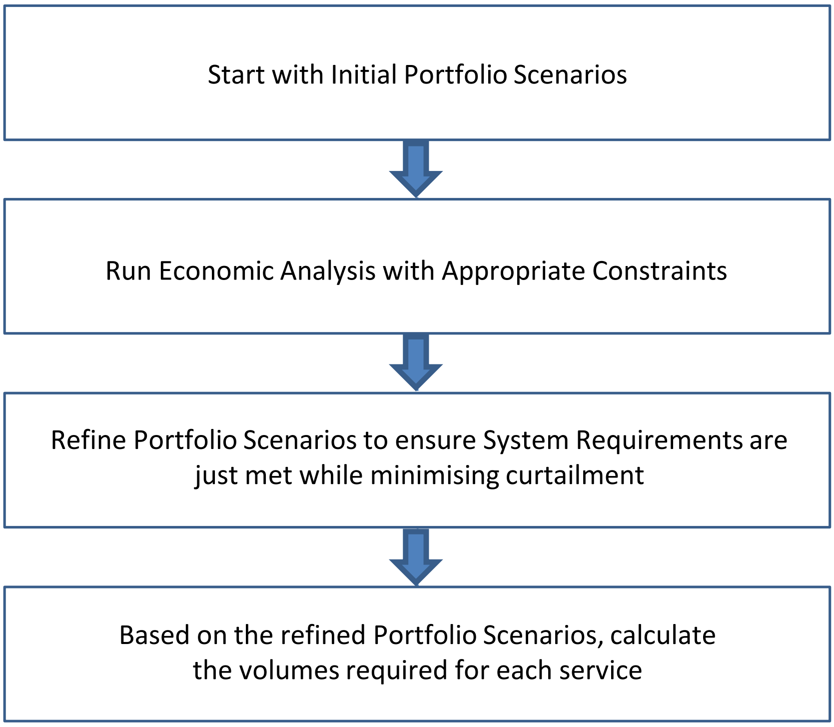

Figure 1: High-Level Approach to Volume Calculations

3.2 Methodology to Refine Portfolio Scenarios

We have developed real-time requirements for System Services and set out the maximum volume of each service from a single service provider to ensure operational security that will be used in the modelling. These real-time requirements and limits will be input to the Plexos models as constraints and are outlined in Section 3.4 below. An example of a constraint is the requirement to carry sufficient Primary Operating Reserve to cover a certain percentage of the largest single infeed.

The methodology to refine the portfolio scenarios is illustrated in Figure 2. The process involves running the economic dispatch production cost modelling program, Plexos, to determine the deployment of System Services throughout the year. We will iteratively refine the composition of the portfolio scenarios as follows:

- Where some of the providers have very low or zero utilisation, we will remove their service provision from the portfolio scenario;
- Where there is not enough of a particular service, we will add further service capability in line with the theme of the scenario, e.g. for the New Service Providers Portfolio Scenario, we could add capability in the storage category.

We will continue to refine the portfolios until they just meet the system requirements throughout the year while minimising curtailment levels.

3.3 Calculation of Capability Volume Requirements

The final refined portfolio scenarios will be used for calculating volume requirements. For each system service, we will initially calculate the Capability Volume Requirement as the sum of the service capability from each service provider in the portfolio scenario.

However, not all services may be binding within the Plexos run. If we sum the capabilities of each provider, we may overestimate the volumes required for these services. For example, if Primary Operating Reserve is generally binding there may be an over-provision in Secondary Operating Reserve due to inherent plant capabilities. We therefore intend to examine each service for potential over-provision by removing in turn the provision of the service from the provider that provides the least amount of service throughout the year,

and checking whether we still meet the requirement for that particular service throughout the year. This calculation process is illustrated in Figure 3.

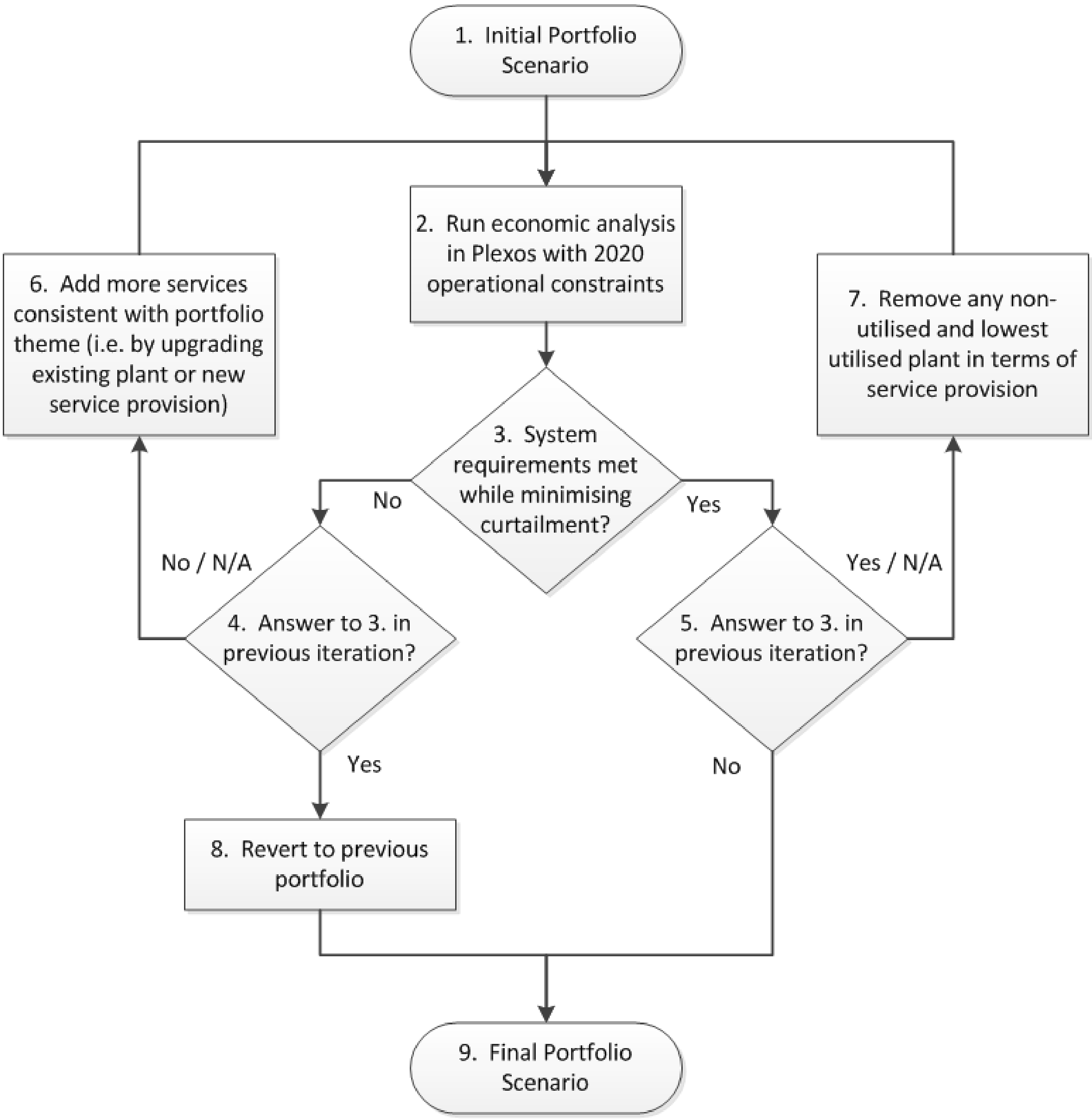

Figure 2: Methodology for Refining Portfolio Scenarios

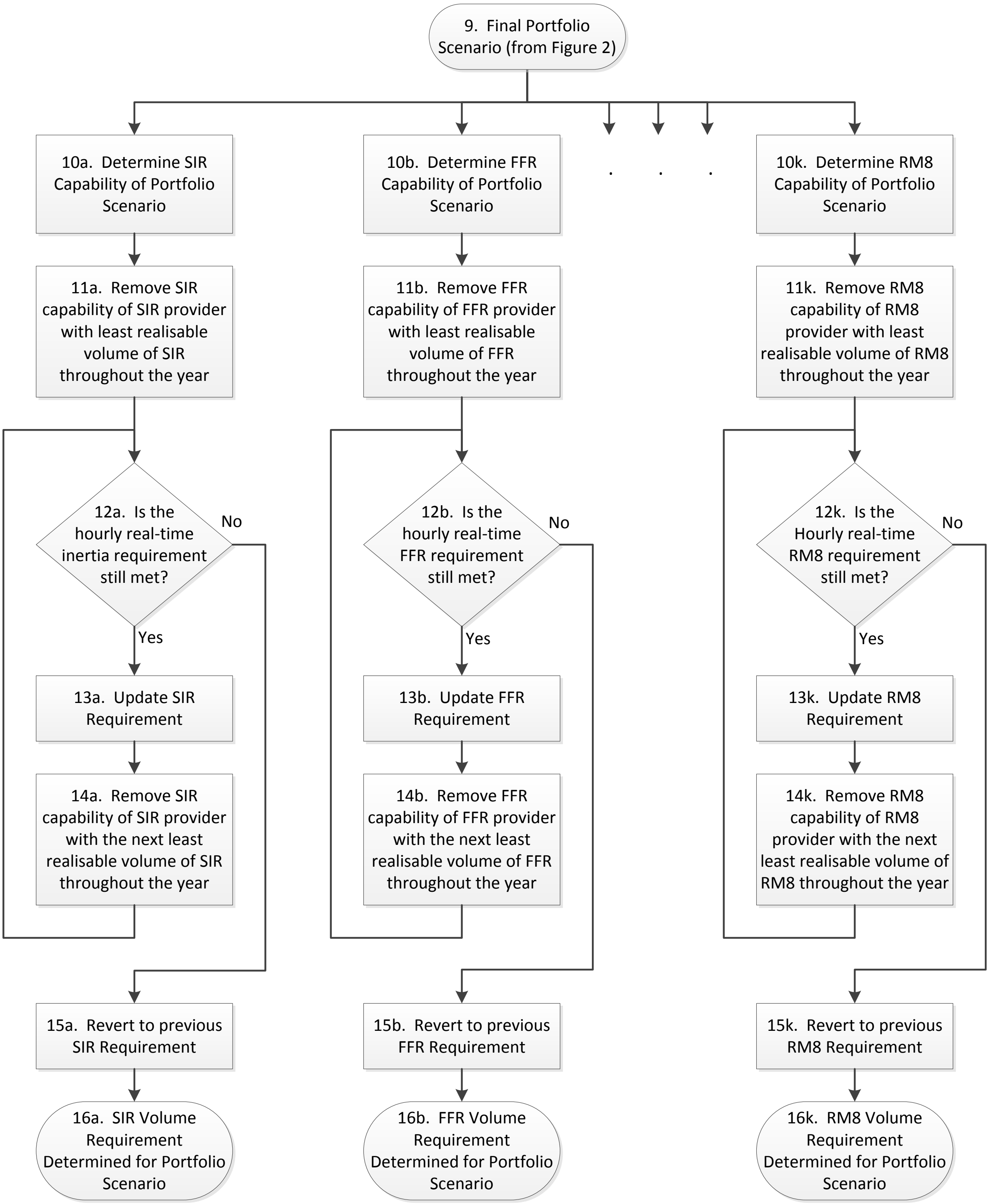

Figure 3: Methodology for Calculating Volume Requirements

3.4 Real-time Operational Constraints including locational considerations

Table 2 details the real-time operational constraints that will be used in the Plexos analysis. Jurisdictional Capability Volume Requirements will be considered for all of the System Services in the years prior to the commissioning of the North South Interconnector, i.e. while the risk exists of the two systems separating because of a fault. To examine the requirements separately in each jurisdiction, specific local operational constraints as per Table 2 below will be input to Plexos for Ireland and Northern Ireland.

It should be noted that the constraints below are for the purposes of modelling only. While they are our current best estimate, they will be evaluated on an ongoing basis and are subject to change based on the outcome of studies, operational experience and network upgrades.

Table 2: Real-time Operational Constraints

Constraint	**2017/8**			**2019/20**
	All-Island	**Ireland**	**Northern Ireland**	
FFR	50% of Largest Single Infeed[12]			
POR	75% of Largest Single Infeed[10]			
SOR	75% of Largest Single Infeed[10]			
TOR1	100% of Largest Single Infeed[10]			
FFR (Dynamic)	Minimum of 25% of FFR requirement from a dynamic source[13]			
POR (Dynamic)	Minimum of 25% of POR requirement from a dynamic source[11]			
SOR (Dynamic)	Minimum of 25% of SOR requirement from a dynamic source[11]			
TOR1 (Dynamic)	Minimum of 25% of TOR1 requirement from a dynamic source[11]			
TOR2	100% of Largest Single Infeed			
RR	100% of Largest Single Infeed			
Negative Reserve		100 MW	50 MW	150 MW
Inter-Area Flow (S-N)	400			
Inter-Area Flow (N-S)	450			
SNSP	65%			75%
RoCoF	1 Hz/s			
Inertia	17,500 MWs			15,000 MWs

[12] EirGrid analysis suggests that the FFR, POR and SOR requirement depends on the nature of the plant providing those services. Therefore, the requirement may be adjusted during the volumes calculation process.

[13] Assumes that reserve provided from static sources is provided in a staggered manner.

Constraint	2017/8			2019/20
	All-Island	**Ireland**	**Northern Ireland**	
System Stability	Requirement for at least three of C30, B31, B32, B10, B4, B5, K1 and K2 to be on load at all times. Requirement for at least four of AD1, AD2, DB1, GI4, HNC, HN2, MP1, MP2, MP3, PBA, PBB, TB3, TB4, TYC and WG1 to be on load at all times.			Requirement for at least five of C30, B31, B32, B10, B4, B5, K1, K2, AD1, AD2, DB1, GI4, HNC, HN2, MP1, MP2, MP3, PBA, PBB, TB3, TB4, TYC and WG1 to be on load at all times
Coolkeeragh Generation	Requirement for C30 to be on load when Northern Ireland system demand exceeds 1,000 MW			
Moyle (Import)	442 MW			
Moyle (Export)	80 MW			
Dublin Generation	Requirement for at least two of DB1, HNC, HN2 and PBA, or at least two of DB1, HNC, HN2 and PBB to be on load at all times			
Dublin Generation (1)	Requirement for at least one of PBA, PBB and HNC to be on load when Ireland system demand exceeds 4,000 MW			
Dublin Generation (2)	Requirement for at least one of PBA and PBB to be on load when Ireland system demand exceeds 4,600 MW			
Dublin North Generation	Requirement for at least one of PBA, HNC and HN2 to be on load at all times			
Dublin South Generation	Requirement for at least one of PBB and DB1 to be on-load at all times			
EWIC (Import)	504 MW			
EWIC (Export)	526 MW			
Turlough Hill Generation	>0 MW by day, <0 MW by night			
Please note that all other constraints not referenced in this table but contained in the monthly Operational Constraints Update published on the EirGrid/SONI websites will also be included				

3.5 Steady-State Reactive Power

The Steady-State Reactive Power service is important for the control of system voltages. Both synchronous and non-synchronous sources can contribute to this requirement. The design of the Steady-State Reactive Power service is aimed at encouraging each service provider to maximise the active power range across which they can provide their reactive power capability, thus improving overall system voltage performance. Voltage issues that require addition of reactive power capability are likely to be very location specific.

Following review of the comments received and further consideration, we believe that this product should incentivise units to maximise their performance rather than incentivise specific investment in new sources of reactive power capability and that all eligible providers should be paid for this capability if it is realisable and useful to the transmission system. Therefore, the SSRP capability volume will be calculated from the initial portfolio scenarios by summing the capabilities of all transmission-connected providing units, Type A- and B-distribution-connected providing units in Ireland and cluster-connected[14] providing units in Northern Ireland[15]. For 2019/20 the higher of the two volumes from each of the portfolio scenarios will set the volume.

3.6 Dynamic Reactive Response and Fast Post Fault Active Power Recovery

The Dynamic Reactive Response and Fast Post Fault Active Power Recovery services relate to desired performance of service providers during and after a transmission fault to manage the stability of the system. All conventional generation units and some non-synchronous generators (e.g. some wind farms) provide the desired response. We need the appropriate response from the majority of new non-synchronous generation connecting to the system. We propose that all proven providers of these services should be eligible for a contract for provision of the services if it is realisable and useful to the transmission system.

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[14] Cluster-connected service providers mean distribution-connected service providers that feed into a transmission station with no load

[15] The inclusion of Type B-distribution-connected service providers in Ireland and cluster-connected service providers in Northern Ireland is made on the assumption that nodal controllers are in place

Therefore, the DRR and FPFAPR capability volumes will be calculated from the initial portfolio scenarios by summing the capabilities of all providing units greater than 1 MW. Assumptions have been made regarding the capability of the existing portfolio and new providers which can be found in Section 4. For 2019/20 the higher of the two volumes from each of the portfolio scenarios will set the volume.

It should be noted that a temporal scarcity scalar is proposed which would incentivise provision at times of potential shortage, i.e. at times of low penetrations of synchronous generation. For more details please see the Section 2.4 of Consultation on DS3 System Services Scalar Design[16].

[16] Consultation on DS3 System Services Scalar Design: http://www.eirgridgroup.com/site-files/library/EirGrid/DS3-System-Services-Scalar-Design-Consultation-FINAL.pdf

4 Initial Portfolio Scenarios

4.1 Overview

We aim in so far as possible to treat all technologies and service providers in a fair and impartial manner. In this regard, we wish to stress that the inclusion or exclusion of any service provider or technology from any of the portfolio scenarios should not be viewed as pre-empting the outcome of the qualification and procurement process. We have developed the scenarios of service provider portfolios solely for the purpose of determining the appropriate volume requirement for each of the services. They form an input into the volume analysis, rather than an output.

It should be noted that these scenarios are assumed to be adequate for meeting the System Services requirements of the future power system. This is based on the information and analysis performed in the Facilitation of Renewables studies and subsequent work as part of the DS3 Programme. These scenarios will act as starting points for the analysis presented in Section 3, which will refine and optimise the composition of their capabilities.

For each of the portfolio scenarios, a level of investment in enhanced/improved technology that will be adequate to enable the delivery of the needed System Services in 2017/18 and 2019/20 has been assumed.

Each portfolio scenario has to be capable of resolving the four fundamental challenges identified, namely: inertia/RoCoF, ramping, reactive power and transient stability. In this regard, the TSOs have taken a view of possible sources of the required services from investment in different technologies.

The portfolio scenarios should be considered in the following context:

1. Any portfolio should be capable of meeting real-time system service requirements which will facilitate the increased SNSP levels. For example, in 2020:
    - Wind ranging from 0 MW to 4,489 MW (2017/8) and 5,352 MW (2019/20)
    - Demand ranging from 2,200 MW to 6,938 MW (2017/8) and 7,038 MW (2019/20)

- Full import to full export on interconnectors (export limited to 80 MW on Moyle)
- Largest single infeed/outfeed: up to 530 MW

The real-time requirements for System Services will vary with these system conditions.

2. There are a range of potential portfolio solutions which would allow the system to be operated at 75% SNSP – the System Services capability of these portfolios will likely be different from those detailed in this report.

4.2 Portfolio Scenarios

We have presented portfolio scenarios for two years:

- 2017/18 – This is the first year of the five year period. Given the short lead time, one portfolio is presented; and
- 2019/20 – This will be the primary focus of the System Services volume analysis, with two portfolios presented. They reflect the many credible portfolios that could come to fruition.

The following are high-level assumptions for all portfolios presented in this paper:

- Information from the Generation Capacity Statement 2016-2025 is used as the starting point for all portfolio scenarios. This includes the renewable generation build out, future plant closures and new plant connections;
- Rate-of-Change-of-Frequency (RoCoF) Grid Code requirement is assumed to be 1 Hz/s (calculated over 500 ms) in line with the RoCoF Grid Code modification[17], which has been approved in principle in both jurisdictions. We expect this to come into effect from the end of 2017. If this change in Grid Code standard is not achieved, the volume requirements for Synchronous Inertial Response and Fast Frequency Response would need to be re-evaluated, but we would reasonably expect them to be higher;

[17] 2015 RoCoF Workstream Plan: http://www.eirgrid.com/media/DS3_RoCoF_Workstream_Plan_2015.pdf

- The SNSP limit will increase as per the most recent version of the TSOs' Operational Capability Outlook[18], accruing to a maximum of 75% in 2020;
- The North-South 400 kV Interconnector is assumed to be built and operational from the end of 2019 onwards;
- Fast Frequency Response capability is set at 50% of the corresponding Primary Operating Reserve figure for non-enhanced plant, 60% for enhanced plant;
- The heat status for conventional plant for the purposes of the Replacement Reserve (De-synchronised) and Ramping Margin services is assumed as cold; and
- It is assumed for the purposes of this analysis that wind farms will not contribute to reserve. However, the TSOs acknowledge that in the future wind generation should have the capability of providing these reserve services when curtailed, which is consistent with the European RES Directive.

The values listed in Table 3, Table 4 and Table 5 relate to the capability of each technology group. For the Plexos analysis using the real-time requirements described in Section 3.4 of this paper, we need to also take account of the ability of each technology to provide the services when in different states, e.g. offline or in-service. For example, it is clear that thermal units must be operational to provide Primary Operating Reserve, whereas some new technologies may be able to provide Primary Operating Reserve from an off-line state.

4.2.1 2017/18 Portfolio Scenario

The 2017/18 portfolio is largely based on existing and planned connections of plant. We believe that the required lead times to build and commission new plant or to enhance existing units limit the extent that these can be considered in this scenario. However, we have added a small quantity of new storage to learn how it may be utilised, without its inclusion materially impacting on the overall analysis.

[18] DS3 Operational Capability Outlook: http://www.eirgrid.com/media/DS3_Programme_Operational_Capability_Outlook_2015.pdf

The key differences between the current plant portfolio and the 2017/18 Portfolio Scenario are:

- Additional 140 MW of DSM capacity, with reserve capability similar to that delivered by the current Short Term Active Response (STAR)[19] scheme;
- Additional 5 MW of new build storage devices offering reserve capabilities; and
- 4,489 MW of wind farms connected to the system.

The key differences between the 2017/18 Portfolio Scenario presented in this decision paper and in the consultation paper are:

- Starting point was the Generation Capacity Statement 2016-2025 as opposed to Generation Capacity Statement 2015-2024;
- Dublin Waste to Energy and Mayo Biomass CHP added;
- Wind capacity increased from 3,800 MW to 4,489 MW;
- Solar, tidal, small-scale hydro, biomass, biogas and landfill gas capacity included – assumed non-dispatchable and therefore not capable of providing services;
- Additional 5 MW of new build storage devices offering reserve capabilities;
- Some CCGTs assumed to be capable of operating in open-cycle mode and therefore capable of providing the RM1 and RM3 services;
- Maximum provision of each service from a single provider as per Table 1 above;
- Interconnectors are assumed not to provide Replacement Reserve or Ramping Margin services; and
- All plant capability updated with most up-to-date information.

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[19] STAR is a scheme operated by EirGrid whereby electricity consumers are contracted to make their load available for short term interruptions.

Table 3: 2017/18 Plant Portfolio Scenario

Product	CCGT	OCGT	Wind, Solar & Tidal	Thermal	Hydro, CHP, Biomass, Biogas & Landfill Gas	DSM, I/C & Storage
Capacity (MW)	4,282	1,104	4,673	2,855	796	1,761
SIR (MWs^2)	78,853	37,216	0	129,359	3,440	37,066
FFR (MW)	169	94	0	88	8	647
POR (MW)	338	187	0	175	17	647
SOR (MW)	477	243	0	218	36	697
TOR1 (MW)	587	267	0	243	75	747
TOR2 (MW)	655	349	0	265	167	747
RR (S) (MW)	1,908	872	0	841	259	410
RR (D) (MW)	0	635	0	0	216	352
RM1 (MW)	1,639	1,104	0	0	216	656
RM3 (MW)	1,639	1,104	0	17	413	387
RM8 (MW)	2,373	1,104	0	125	456	387
FPFAPR (MW)	4,282	1,104	2,051	2,855	722	1,361
DRR (MW)	4,282	1,104	1,986	2,855	722	911
SSRP (Mvar)	2,426	892	1,134	1,801	285	659

4.2.2 2019/20 Portfolio Scenarios

There are a number of potential ways that the System Services market may evolve over the next few years. Different portfolios of service providers may result in different Capability Volume Requirements. For example, we may need to contract greater volumes of capability with a portfolio of providers with low availabilities in comparison to an alternative portfolio of providers with higher availabilities. We are therefore using two very different 2019/20 portfolio scenarios here in an effort to capture the volume requirements for all potential eventualities:

- **Enhanced Capability:** the majority of the additional flexibility required is obtained from the enhancement of the existing portfolio. In addition to these enhancements, a significant volume of services are provided by wind farms and interconnectors; and
- **New Service Providers:** new service providers contribute significantly to the additional volume of System Services required. Significant provision is also obtained from interconnectors and DSM, with reduced provision from wind farms as compared to the Enhanced Capability portfolio above.

4.2.3 2019/20 Enhanced Capability Portfolio Scenario

In this portfolio scenario, it is envisaged that most of the required services will be provided by generation sources. The key differences between the 2017/18 Portfolio Scenario and the 2019/20 Enhanced Capability Portfolio Scenario are:

- Four of the existing Combined Cycle Gas Turbines (CCGTs) will provide more flexible performance through shorter start up times (i.e. capable of providing RM8), improved reserve capabilities and a reduction in minimum load;
- Six of the existing Open Cycle Gas Turbines (OCGTs) will also provide more flexible performance through improved reserve capabilities;
- Two new OCGTs with replacement reserve and ramping capabilities will also connect to the system;
- 145 MW of additional DSM capacity, with reserve capabilities approximately 50% of that provided in the New Service Providers Portfolio Scenario;

- 920 MW of additional wind and solar PV generation;
- 65 MW of additional CHP, biomass, biogas & landfill gas generation;
- Retirement of 250 MW of thermal generation; and
- Additional network devices delivering SIR.

The key differences between the 2019/20 Enhanced Capability Portfolio Scenario presented in this decision paper and in the consultation paper are:

- Starting point was the Generation Capacity Statement 2016-2025 as opposed to Generation Capacity Statement 2015-2024;
- Four of the existing Combined Cycle Gas Turbines (CCGTs) are assumed to be enhanced as opposed to six;
- Dublin Waste to Energy and Mayo Biomass CHP added;
- Wind capacity increased from 4,805 MW to 5,352 MW;
- Solar, tidal, small-scale hydro, biomass, biogas and landfill gas capacity included – assumed non-dispatchable and therefore not capable of providing services;
- Some CCGTs assumed to be capable of operating in open-cycle mode and therefore capable of providing the RM1 and RM3 services;
- Maximum provision of each service from a single provider as per Table 1 above;
- Interconnectors assumed not to provide Replacement Reserve or Ramping Margin services; and
- All plant capability updated with most up-to-date information.

Table 4: 2019/20 Enhanced Capability Portfolio Scenario

Product	CCGT	CCGT Enhanced	OCGT	OCGT Enhanced	OCGT New	Wind, Solar & Tidal	Thermal	Network Devices	Hydro, CHP, Biomass, Biogas & Landfill Gas	DSM, I/C & Storage
Capacity (MW)	2,941	1,336	780	324	200	5,593	2,605	0	861	1,906
SIR (MWs^2)	52,406	82,523	37,216	0	3,000	0	121,743	60,000	3,440	37,066
FFR (MW)	88	110	81	31	25	600	63	0	8	582
POR (MW)	176	184	162	52	41	0	127	0	17	582
SOR (MW)	307	190	218	52	41	0	151	0	36	632
TOR1 (MW)	406	190	238	60	57	0	175	0	75	682
TOR2 (MW)	430	190	238	124	170	0	198	0	167	682
RR (S) (MW)	1,193	704	636	236	170	0	699	0	259	515
RR (D) (MW)	0	0	311	324	200	0	0	0	216	352
RM1 (MW)	1,327	312	780	324	200	0	0	0	216	866
RM3 (MW)	1,327	1,336	780	324	200	0	17	0	413	387
RM8 (MW)	1,758	1,336	780	324	200	0	125	0	456	387
FPFAPR (MW)	2,941	1,336	780	324	200	2,895	2,605	0	779	1,361
DRR (MW)	2,941	1,336	780	324	200	2,809	2,605	400	779	911
SSRP (Mvar)	1,453	946	690	201	173	1,343	1,615	400	285	659

4.2.4 2019/20 New Service Providers Portfolio Scenario

In this portfolio scenario, it is assumed that there is limited investment in enhanced performance by generation developers and as a consequence investment alternatives must be found that deliver the system capability to manage higher levels of renewables.

The key differences between the 2017/18 Portfolio Scenario and the 2019/20 New Service Providers Portfolio Scenario are:

- 390 MW of additional storage technology capability. This is delivered by a range of storage technologies connected at both transmission- and distribution-level. Combined, these technologies deliver significant capability across all System Services;
- 1000 MWs of synchronous compensators with flywheels connecting at various locations on the system delivering SIR and faster reserve services;
- Additional network devices delivering SIR;
- 145 MW of additional DSM capacity, with significant reserve capabilities;
- Five of the existing CCGTs assumed to also provide more flexible performance through shorter start up times (i.e. capable of providing RM8);
- 920 MW of additional wind and solar PV generation;
- 65 MW of additional CHP, biomass, biogas & landfill gas generation; and
- Retirement of 250 MW of thermal generation.

The key differences between the 2019/20 New Service Providers Portfolio Scenario presented in this decision paper and in the consultation paper are:

- Starting point was the Generation Capacity Statement 2016-2025 as opposed to Generation Capacity Statement 2015-2024;
- Dublin Waste to Energy and Mayo Biomass CHP added;
- Wind capacity increased from 4,805 MW to 5,352 MW;
- Solar, tidal, small-scale hydro, biomass, biogas and landfill gas capacity included – assumed non-dispatchable and therefore not capable of providing services;

- Some CCGTs assumed to be capable of operating in open-cycle mode and therefore capable of providing the RM1 and RM3 services;
- Maximum provision of each service from a single provider as per Table 1 above;
- Interconnectors assumed not to provide Replacement Reserve or Ramping Margin services; and
- All plant capability updated with most up-to-date information.

Table 5: 2019/20 New Service Providers Portfolio Scenario

Product	CCGT	CCGT Enhanced	OCGT	Wind, Solar & Tidal	Thermal	Network Devices	Hydro, CHP, Biomass, Biogas & Landfill Gas	DSM, I/C & Storage
Capacity (MW)	2,449	1,828	1,104	5,593	2,605	50	861	2,296
SIR (MWs^2)	36,936	41,917	37,216	0	121,743	60,000	3,440	46,066
FFR (MW)	70	99	94	600	63	50	8	707
POR (MW)	140	198	187	0	127	50	17	747
SOR (MW)	207	260	243	0	151	50	36	797
TOR1 (MW)	266	320	267	0	175	0	75	927
TOR2 (MW)	317	338	349	0	198	0	167	927
RR (S) (MW)	941	967	872	0	699	0	259	812
RR (D) (MW)	0	0	635	0	0	0	216	352
RM1 (MW)	1,027	612	1,104	0	0	0	216	1,171
RM3 (MW)	1,027	612	1,104	0	17	0	413	717
RM8 (MW)	1,761	1,828	1,104	0	125	0	456	387
FPFAPR (MW)	2,449	1,828	1,104	2,895	2,605	0	779	1,691
DRR (MW)	2,449	1,828	1,104	2,809	2,605	400	779	1,241
SSRP (Mvar)	1,344	1,035	892	1,343	1,615	400	285	973

We have created scenarios with different service provider portfolios that we will use in the volume requirement calculations for 2017/18 and 2019/20. The initial portfolio scenarios presented in this paper have been developed solely for the purpose of determining the appropriate volume requirement for each of the services and do not represent desired, expected or optimal portfolios. The initial portfolio scenarios will have no bearing on the outcome of the competitive procurement process other than informing the volumes to be procured.

Appendix: Links to Related Documents

Facilitation of Renewables Study - Published by: TSO (June 2010)

Ensuring a Secure, Reliable and Efficient Power System - Published by: TSO (July 2011)

First Consultation paper (System Services Review - Preliminary Consultation) - Published by: TSO (December 2011)

Second Consultation paper (New Services and Contractual Arrangements) - Published by: TSO (June 2012)

Third Consultation paper (Financial Arrangements) - Published by: TSO (December 2012)

TSO System Services Recommendations paper - Published by: TSO (May 2013)

DS3 System Services Consultation Paper - Published by: SEMC (SEM-13-060) (September 2013)

System Services Technical Definitions Decision Paper - Published by: SEMC (SEM-13-060) (December 2013)

Pöyry Paper on Procurement Options - Published by: SEMC (Consultant (Pöyry)) (SEM-14-007) (January 2014)

SEMC System Services Procurement Design Consultation Paper - Published by: SEMC (SEM-14-059) (July 2014)

Economic Appraisal of DS3 System Services - Published by: SEMC (Consultant (IPA)) (SEM-14-059b) (July 2014)

System Services Valuation Further Analysis - Published by: TSO (July 2014)

SEMC System Services Procurement Design Information Paper - Published by: SEMC (SEM-14-075) (August 2014)

System Services Portfolio Capability Analysis - Published by: TSO (November 2014)

DS3 System Services SEMC Decision Paper - Published by: SEMC (SEM-14-108) (December 2014)

DS3 System Services Project Plan (Detailed Design and Implementation Phase) - Published by: TSO / SEMC (May 2015)

DS3 System Services Draft TSO Procurement Strategy - Published by: TSO (June 2015)

DS3 System Services Consultation on Volume Calculation Methodology and Portfolio Scenarios - Published by: TSO (October 2015)