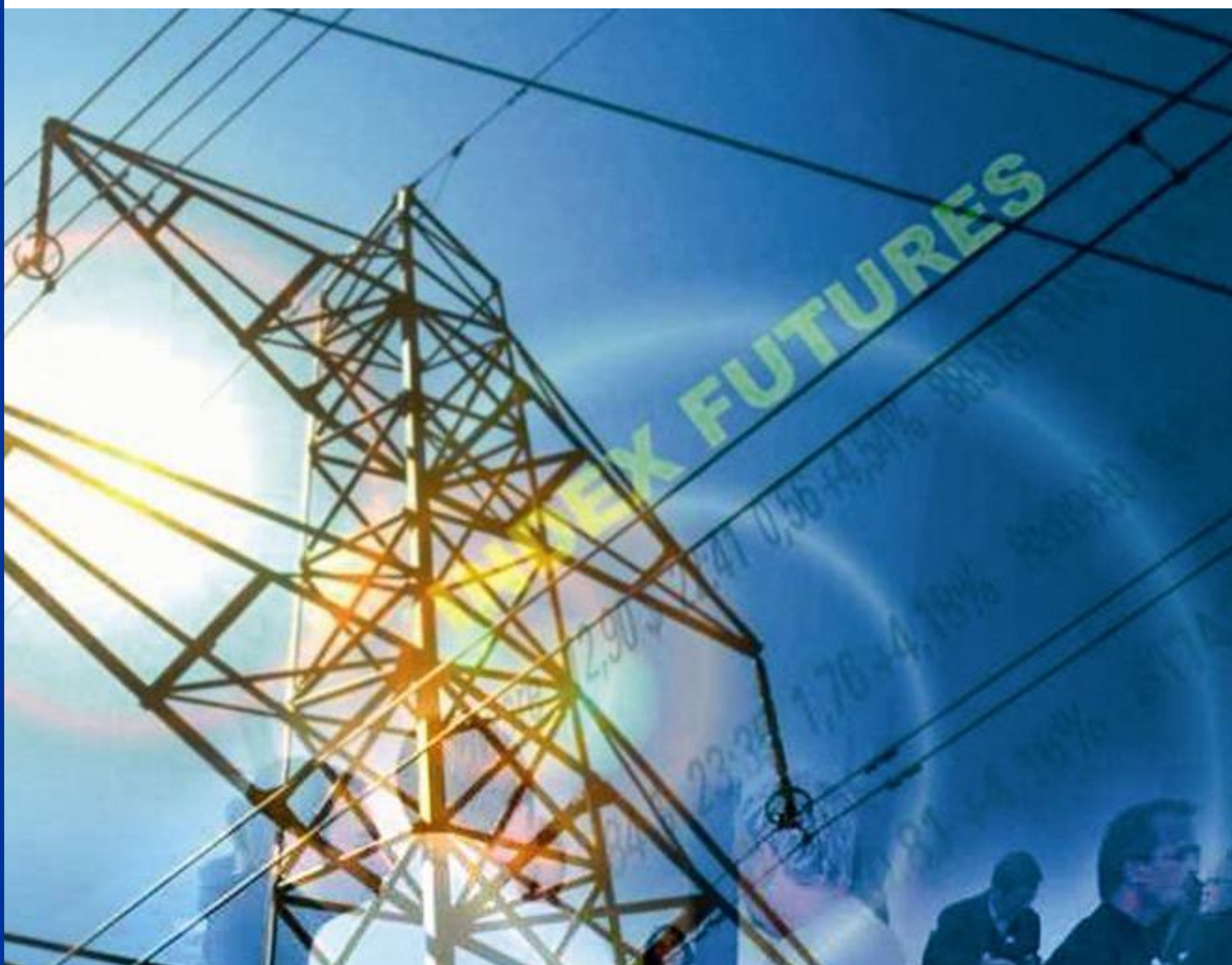
HIGH LEVEL PRINCIPLES OF SCALARS FOR DS3 SYSTEM SERVICES

A report to EirGrid and SONI

February 2016

HIGH LEVEL PRINCIPLES OF SCALARS FOR DS3 SYSTEM SERVICES



Contact details

Name	Email	Telephone
Gordon McFadzean	gordon.mcfadzean@tnei.co.uk	+44 (0) 1612334810
Gareth Davies	gareth.davies@poyry.com	+44 (0) 1865812204

Pöyry is an international consulting and engineering company. We serve clients globally across the energy and industrial sectors and locally in our core markets. We deliver strategic advisory and engineering services, underpinned by strong project implementation capability and expertise. Our focus sectors are power generation, transmission & distribution, forest industry, chemicals & biorefining, mining & metals, transportation, water and real estate sectors. Pöyry has an extensive local office network employing about 6,000 experts. Pöyry's net sales in 2014 were EUR 571 million and the company's shares are quoted on NASDAQ OMX Helsinki (Pöyry PLC: POY1V).

Pöyry Management Consulting provides leading-edge consulting and advisory services covering the whole value chain in energy, forest and other process industries. Our energy practice is the leading provider of strategic, commercial, regulatory and policy advice to Europe's energy markets. Our energy team of 200 specialists offer unparalleled expertise in the rapidly changing energy sector.

TABLE OF CONTENTS

[This page is intentionally blank]

EXECUTIVE SUMMARY

Overview of Scalars

SEM Committee Aims of Scalars

The SEM Committee decision on DS3 System Services Procurement requires that EirGrid and SONI ("The TSOs") should apply "scalars" to unit prices, in order to increase the efficiency and reliability of the procurement design and ensure that the correct signals are provided for providers. In addition, the TSOs have advised that implementation of scalars is unlikely to be possible for "Go-Live" of the interim tariff arrangements in October 2016. Therefore, this report has been prepared principally with the enduring arrangements ("Go-Live" in October 2017) in mind.

The SEM Committee's objective for the use of scalars is "*to increase the efficiency and reliability of the procurement design ensuring that the correct signals are provided for system services providers.*"

The four types of scalar proposed by the SEM Committee, and the purpose of each as set out in the decision paper, is given in Table 1.

Table 1: Scalars proposed by the SEM Committee

Scalar	Purpose of the scalar as set out by the SEM Committee
Performance	*"To reward and incentivise high levels of performance" and "to ensure lower payments from the consumer for a lower level of performance"*
Scarcity	*"To create marginal incentives for providers to make themselves available during periods or in locations of scarcity, therefore enhancing the performance of the system where it is most needed"*
Volume	*"To ensure consumers are protected from unnecessarily high prices and maintain the integrity of the overall procurement process"*
Product	*"Incentivising both the more effective delivery of a service and for faster response times for certain services."*

Assessment of Scalars

The high-level objectives of scalars are set out by the SEM Committee in its decision paper on system services procurement. When making decisions on whether or not to implement scalars, the TSOs should consider the following criteria:

1. Simplicity in the design of scalars should be maintained and ensured to the greatest degree possible. This will help to ensure that operational complexity is reduced for the TSOs and that the arrangements are as simple as possible to understand for the TSOs, market participants, and consumers;
2. The TSOs need to consider how scalars may introduce uncertainty for service providers and how this could impact on investments. This is particularly true for scalars which will be applied to services required from new providers and for services procured through the auction;

3. Scalars should improve the efficiency of price signals and incentivise better quality of provision. This should help to ensure that the system is operated in a cost effective manner. In many cases, this will be realised by scalars which directly reduce the total expenditure on system services;
4. The TSOs will need to consider the barriers to implementation when deciding whether to implement certain scalars. Practicalities of implementation will largely be informed by the TSOs' experience; however comments are provided when clear difficulties are identified for the implementation of specific scalars.

Types of Scalars

Performance Scalar

This scalar is intended to reduce system service payments to unreliable providers and to stop paying providers that are unacceptably unreliable. The high level design of this scalar is being completed separately by the TSOs – therefore, it is not considered further in this report.

Product Scalar

The product scalar is intended to reward providers that can offer products with technical performance greater than that required by the base product description and where such performance is of value to the system. This can be in the form of a faster delivery time or an enhanced performance. An example of the former could be a response time for Fast Frequency Response of faster than 2 seconds. An example of the latter could be the ability to provide Steady-state Reactive Power with an automatic voltage regulator (AVR) or Power System Stabiliser (PSS).

Scarcity Scalar

The purpose of this scalar is to give marginal incentives to providers to make themselves available during times (temporal) and locations (locational) of scarcity. It is not intended to provide a locational investment signal. Locational scarcity could be used to define zonal prices for procurement of reactive power, or to reflect geographic constraints in the provision of reserve services. Temporal scarcity could reflect intraday or seasonal variations in the value of services by, for example, setting day/night and summer/winter tariffs, or could track other metrics such as inertia or System Non-Synchronous Penetration (SNSP).

Volume Scalar

The objective of the volume scalar is to protect consumers from overpayments. The function of the volume scalar, as described in the SEM Committee decision, varies and is dependent on whether a service is procured via the auction or via the regulated tariff.

For services procured via an auction, the SEM Committee outlined a high-level design for a scalar aimed at protecting the consumer from high clearing prices set by new entrants who would not be operating and active in the system services market in the target year. The use of a scalar in this context was predicated on the view of the auction design and the price-setting process envisaged in the SEM Committee decision paper. This operation of the volume scalar does not work with the proposed framework for the auction that is being progressed in the detailed design phase.

The SEM Committee decision paper makes the following observation about the use of the volume scalar:

"It is also noted that as the tariff will be paid to all providers it is possible that the aggregate payments could exceed the expenditure cap and/or overly reduce the revenues available for competitive procurement."

This implies that the volume scalar should also be used to ensure that overall expenditure is managed appropriately.

Interactions with Auctions

The principles behind the auction/scalar interaction are still being developed and will need to be considered during the development of the detailed auction rules and associated contracts. Therefore, this report should largely be read and understood in the context of procurement via the regulated tariff.

Emerging thinking on how scalars will apply to products procured in the auction is set out in Section 2.5. The principles of scalars for products procured under the auction may, in many cases, be very similar for those procured under the tariff. In general, scalars do not pose a significant issue for the auction, as long as they are clear to bidders in advance and policies are laid out prior to the auction.

Recommendations

Four scalars are recommended for implementation. These are:

- **A product scalar for faster response of FFR**;
- **A product scalar for enhanced delivery of FFR, POR, SOR and TOR1** for dynamic, static and emulated dynamic behaviour;
- **A scarcity scalar for temporal variation in the value of DRR and FPFAPR**, which varies with SNSP;
- **A volume scalar to manage expenditure –** two options for this are discussed in more detail.

In addition, there are potentially benefits of using **a scarcity scalar to reflect the temporal variation in the value of reserve products**. However, more analysis would need to be carried out in order to determine whether a scalar should be introduced, as this scalar could be complex to implement and may introduce uncertainty for providers.

Nine other potential scalars (three scarcity scalars and six product scalars) are also presented for the TSOs' consideration, with more detailed discussion in Annex B. The case for implementing each of these scalars is less clear, especially when considering the cumulative complexity (for both the TSOs and their customers) of larger numbers of scalars being introduced.

The impact of each scalar has been considered in terms of three criteria:

- **Expenditure:** What impact will the scalar have on system services expenditure and could it lead to a reduction in other TSO costs;
- **Operations:** How significant are the operational benefits which the scalar will introduce, and how difficult will the scalar be to implement;
- **Complexity:** How does the scalar affect revenue certainty for providers.

Table 2 summarises the impact which each scalar may have for each of these criteria, and also the recommendation of this report on implementation.

Table 2: Scalar Impacts

Product Scalars	Payments	Expenditure	Operations	Complexity	Recommendation
Faster Response of FFR	Increase	🟡	🟢	🟢	**Implement**
Enhanced Delivery of FFR, POR, SOR, TOR1	Increase	🟡	🟢	🟢	**Implement**
SSRP with Watt-less VArs	Increase	🟠	🟡	🟢	**Consider**
Enhanced Delivery of DRR with more reactive current	Increase	🟠	🟠	🟢	**Consider**
Enhanced Delivery of SSRP with an AVR	Increase	🟠	🟠	🟢	**Consider**
Delivery of SSRP without an operational PSS	Decrease	🟢	🟢	🟢	**Consider [1]**
SIR with Reserve	Increase	🟠	🟡	🟢	**Consider**
Faster Response of FPFAPR	Increase	🟠	🟢	🟢	**Consider**
Scarcity Scalars	**Payments**	**Expenditure**	**Operations**	**Complexity**	**Recommendation**
Temporal Variation of DRR and FPFAPR	Decrease	🟢	🟢	🟠	**Implement [2]**
Temporal Variation of Reserve Products	Varies	🟡	🟡	🟡	**Further analysis required †**
Locational Variation for SSRP	Varies	🟡	🟠	🟢	**Consider**
Temporal Variation for SIR	Varies	🟡	🟡	🟠	**Consider †**
Temporal Variation for FFR	Varies	🟡	🟡	🟠	**Consider †**
Volume Scalar Options	**Payments**	**Expenditure**	**Operations [3]**	**Complexity**	**Recommendation**
Targeted, expenditure-based, annual, ex-ante (forecast)	Decrease	🟢	🟢	🟢	**Implement †**
Targeted, requirement based, trading period, ex-post (actual)	Decrease	🟢	🟡	🟠	**Implement ‡**

†‡ Those scalars marked with a † and ‡ are mutually exclusive, as it would be prohibitively complex to have multiple scalars which vary across trading periods applied to any single service.
[1] This may be more appropriate to implement as a variant of the performance scalar
[2] The benefits for expenditure and operations are so significant that this scalar has been recommended for implementation, despite the impact on complexity for providers and for the TSOs
[3] A green indicator here for a volume scalar means that no potential adverse impacts on operations have been identified

Table 3 summarises the emerging thinking on the form of each scalar.

Table 3: Summary of Design of Scalars

Product Scalars	Magnitude*	Form	Granularity	Notes
Faster Response of FFR	≥1	Sliding Scale	Set with Tariffs	Trade off between speed and size of response
Enhanced Delivery of FFR, POR, SOR, TOR1	≥1	Sliding Scale	Set with Tariffs	Range of possible values for static, dynamic and emulated dynamic responses
SSRP with Watt-less Vars	≥1	Binary	Set with Tariffs	
Enhanced Delivery of DRR with more reactive current	≥1	Sliding Scale	Set with Tariffs	
Enhanced Delivery of SSRP with an AVR	≥1	Binary	Set with Tariffs	
Delivery of SSRP without an operational PSS	≤1	Binary	Set with Tariffs	
SIR with Reserve	≥1	Binary	Set with Tariffs	Could take multiple values to differentiate between different types of reserve
Faster Response of FPFAPR	≥1	Sliding Scale	Set with Tariffs	
Scarcity Scalars	**Magnitude**	**Form**	**Granularity**	**Notes**
Temporal Variation of DRR and FPFAPR	≤1	Sliding Scale	Trading Period	Varies with SNSP, could take values between 0 and 1
Temporal Variation of Reserve Products	≤1 ≥1	Sliding Scale	Trading Period	Could be seasonal/daily or could vary with SNSP
Locational Variation for SSRP	≤1 ≥1	Sliding Scale	Annual	Could be based on locational volume requirements
Temporal Variation for SIR	≤1 ≥1	Sliding Scale	Trading Period	Could be seasonal/daily but more likely to vary with SNSP
Temporal Variation for FFR	≤1 ≥1	Sliding Scale	Trading Period	Could be seasonal/daily but more likely to vary with SNSP
Volume Scalar	**Magnitude**	**Form**	**Granularity**	**Notes**
Targeted, expenditure-based, annual, ex-ante (forecast)	≤1	Sliding Scale	Annual	
Targeted, requirement based, trading period, ex-post (actual)	≤1	Sliding Scale	Trading Period	

* The TSO's should retain the option to have all product scalars take values ≤1, noting that this effectively redefines the enhanced service delivery (with the scalar) as the default product, and that this may need to be accounted for in the determination of the tariffs (e.g. when undertaking a cost consultation).

The impact of each scalar (in Table 2) has been considered in terms of three criteria as set out in Table 4:

- **Expenditure:** What is the impact which the scalar will have on system services expenditure and could it lead to a reduction in other TSO costs;
- **Operations:** How significant are the operational benefits which the scalar will introduce (with some thought given to practicalities of implementation);
- **Complexity:** How does the scalar affect revenue certainty for providers.

Table 4: Interpretation of Traffic Light Indicators

Indicator	Expenditure	Operations	Complexity
Green	Scalar will decrease system services expenditure by directly decreasing payments	Scalar would introduce significant operational benefits	Scalar is set ex-ante with full visibility of variables
Amber	Scalar increases System Services expenditure in the short term. Likely to decrease TSO costs in the medium-long term, or will redistribute payments while keeping system services expenditure the same	Scalar may introduce some operational benefits	Providers may not have visibility of all variables (E.g. may be set ex-post or may vary with system conditions)
Orange	Scalar increases payments. No definite mechanism for reducing system services expenditure and impact on other TSO costs is hard to quantify	The TSOs have no clear requirement for the operational flexibilities introduced by the scalar	Providers will not have visibility of all variables (E.g. will be set ex-post or will be likely to vary with system conditions)

1. INTRODUCTION

The SEM Committee decision on DS3 System Services Procurement[1] requires that EirGrid and SONI ("The TSOs") should apply "scalars" to unit prices, in order to increase the efficiency and reliability of the procurement design and ensure that the correct signals are provided for providers. This report presents the high level principles for three of the four scalars proposed by the SEM Committee: the product scalar, the scarcity scalar, and the volume scalar.

The principles set out in this report have been guided by the SEM Committee decision regarding the High Level Design for DS3 System Services procurement. The report represents TNEI and Pöyry's independent view of a practical approach for implementing the scalars which have been proposed, although this view has been informed by, and benefited from, significant input from the TSOs.

The report considers both procurement through the regulated tariff and procurement in the auction. However, the majority of the discussion should be read and interpreted in the context of the regulated tariff, as the detail on how scalars will interact with the auction procurement is still being determined. In certain sections, specific reference is given to how scalars could interact with the auction.

In addition, the TSOs have advised that implementation of scalars is unlikely to be possible for "Go-Live" of the interim tariff arrangements in October 2016. Therefore, this report has been prepared principally with the enduring arrangements ("Go-Live" in October 2017) in mind.

The report is structured as follows:

- Chapter 2 provides some background on DS3 System Services, gives an overview of the SEM Committee decision relating to scalars, and gives more detail on the general principles which underpin each scalar;
- Chapter 3 presents the results of a filtering exercise to determine where it might be appropriate to implement a scalar. This is done by considering each System Service in turn with respect to each scalar in order to determine whether it could be beneficial. Full discussion is presented in Annex A;
- Chapter 4 discusses some of the common design options for scalars;
- Chapter 5 sets out recommendations on which scalars should be implemented, and which scalars should be considered in more detail by the TSOs. The scalars which are recommended are discussed in more detail in Chapter 5, and the remainder are discussed in more detail in Annex B.

This report also includes a third Annex, Annex C, which gives some illustrative options for scalars which may be implemented and provides simple example calculations of tariff adjustments based on indicative scalar values and tariffs.

[1] SEM-14-108, DS3 System Services Procurement Design and Emerging Thinking, Dec 2014

[This page is intentionally blank]

2. BACKGROUND

2.1 Overview of System Services under DS3

In December 2014, the SEM Committee published a decision on the transitional and the enduring arrangements for System Services under the DS3 (Delivering a Secure, Sustainable Electricity System) programme[2]. In summary, a regulated tariff is to be in place for all System Services by October 2016. Procurement will move to a multi-product auction from October 2017 onwards, for products where competition would be sufficient.

The new System Services and their technical characteristics have already been defined[3]. Both new and existing products are summarised in Table 5. New services are highlighted in yellow. Existing services which have been modified are highlighted in blue.

Table 5: Categorisation of System Services proposed

Category	Product	Short definition
Voltage control	Steady-State Reactive Power ('SSRP')	MVAr capability*(% of capacity that capability is provided)
	Dynamic Reactive Response ('DRR')	MVAr capability during large (>30%) voltage dips
Inertial response	Synchronous Inertial Response ('SIR')	(Stored kinetic energy)* (SIR Factor – 15)
	Fast Post-Fault Active Power Recovery ('FPFAPR')	Active power >90% within 250 ms of voltage >90%
	Fast Frequency Response ('FRR')	MW delivered between 2 and 10 seconds
Reserve	Primary Operating Reserve ('POR')	MW delivered between 5 and 15 seconds
	Secondary Operating Reserve ('SOR')	MW delivered between 15 to 90 seconds
	Tertiary Operating Reserve – 1 ('TOR1')	MW delivered between 90 seconds to 5 minutes
	Tertiary Operating Reserve – 2 ('TOR2')	MW delivered between 5 minutes to 20 minutes
	Replacement Reserve - sync'ed ('RRS')	MW delivered between 20 minutes to 1 hour
	Replacement Reserve - desync'ed ('RRD')	MW delivered between 20 minutes to 1 hour
Ramping	1 hour Ramping Margin ('RM1')	The increased MW output that can be delivered with a good degree of certainty for the given time horizon
	3 hour ramping margin ('RM3')	
	8 hour ramping margin ('RM8')	

Source: SEM-14-059

2 SEM-14-108, DS3 System Services Procurement Design and Emerging Thinking, Dec 2014

3 SEM-13-098, DS3 System Services Technical Definitions: Decision Paper, Dec 2013

2.2 Overview of Scalars

The SEM Committee decision on DS3 System Services Procurement requires that EirGrid and SONI ("The TSOs") should apply "scalars" to unit prices, in order to increase the efficiency and reliability of the procurement design and ensure that the correct signals are provided for providers.

The SEM Committee's objective for the use of scalars is "*to increase the efficiency and reliability of the procurement design ensuring that the correct signals are provided for system services providers."*

The four types of scalar proposed by the SEM Committee, and the purpose of each as set out in the decision paper, is given in Table 6.

Table 6: Scalars proposed by the SEM Committee

Scalar	Purpose of the scalar as set out by the SEM Committee
Performance	*"To reward and incentivise high levels of performance" and "to ensure lower payments from the consumer for a lower level of performance"*
Scarcity	*"To create marginal incentives for providers to make themselves available during periods or in locations of scarcity, therefore enhancing the performance of the system where it is most needed"*
Volume	*"To ensure consumers are protected from unnecessarily high prices and maintain the integrity of the overall procurement process"*
Product	*"Incentivising both the more effective delivery of a service and for faster response times for certain services."*

Scalars are to be applied during settlement to the payment of each system service, both for procurement under the regulated tariff and through the auction. Where they apply, scalars will be multiplied by the unit price of each service (the auction clearing price or the tariff). A scalar >1 indicates that the provider delivers additional value to consumers and a scalar <1 indicates that lower value is being delivered to consumers. This is in line with the SEM Committee decision, which states that:

"Scalars will reduce the level of payment to service providers where value is not being delivered to the consumer and may increase the level of payment to those services providers delivering additional value to the consumer."

A scalar value of zero would result in no payment for the system service. Where a system service is modified by multiple scalars, they would be applied multiplicatively to the unit price during settlement, i.e. the product of the combined scalars will be applied to the payment.

2.3 Assessment of Scalars

The high-level objectives of scalars are set out by the SEM Committee in their decision paper on system services procurement. When making decisions on whether or not to implement scalars, the TSOs should consider the following criteria:

1. Simplicity in the design of scalars should be maintained and ensured to the greatest degree possible. This will help to ensure that operational complexity is reduced for the TSOs and that the arrangements are as simple as possible to understand for the TSOs, customers, and consumers;

2. The TSOs need to consider how scalars may introduce uncertainty for service providers and how this could impact on investments. This is particularly true for scalars which will be applied to services required from new providers and for services procured through the auction;

3. Scalars should improve the efficiency of price signals and incentivise better quality of provision. This should help to ensure that the system is operated in a cost effective manner. In many cases, this will be realised by scalars which directly reduce the total expenditure on system services;

4. The TSOs will need to consider the barriers to implementation when deciding whether to implement certain scalars. Practicalities of implementation will largely be informed by the TSOs' experience; however comments are provided when clear difficulties are identified for the implementation of specific scalars.

2.4 Types of Scalar

2.4.1 Performance Scalar

This scalar is intended to reduce system service payments to unreliable providers and to stop paying providers that are unacceptably unreliable. The scalar may be set to one for units with reliability in excess of 90% and set to zero for those with reliability of below 50%. A sliding scale between one and zero may be applied for a reliability of between 50% and 90%. In practice, this would mean that there would be no change to the payment of providers that maintained 90% reliability while providers that fell below 50% would receive no payment for that specific system service. A period over which reliability is measured will need to be defined. The TSOs would reserve the right to terminate a contract for continued poor performance – the conditions and circumstances which would lead to contract termination will be developed separately and are outside the scope of this report.

The high level design of this scalar is being completed separately by the TSOs – therefore, it is not considered further in this discussion.

2.4.2 Product Scalar

The product scalar is intended to reward providers that can offer products with technical performance greater than that required by the base product description, where such performance is of value to the system. This can be in the form of a faster delivery time or an enhanced performance. No recommendation is given by the SEM Committee on the possible values of this scalar, although they note that the scalar can either be binary, or could be applied on a sliding scalar.

Two separate product scalars have been considered – a **product scalar for enhanced delivery** and a **product scalar for faster response**. An example of the former could be the ability to provide Steady-state Reactive Power with an automatic voltage regulator (AVR) or Power System Stabiliser (PSS). An example of the latter could be a response time for Fast Frequency Response of faster than 2 seconds.

The form and magnitude of the product scalars may be different for each system service to which they are applied. In some instances it may be appropriate to apply the scalar on a sliding scale to reflect enhancements that have an incremental improvement.

2.4.3 Scarcity Scalar

The purpose of this scalar is to give marginal incentives to providers to make themselves available during times (temporal) and locations (locational) of scarcity. It is not intended to provide a locational investment signal. Furthermore, locational scarcities[4] and constraints are temporary in nature[5] and may be better addressed directly by the TSOs through network planning.

The SEM Committee decision envisages that the scarcity scalar would be set to one at times of no scarcity and at less than two at times and/or locations of scarcity. There may also be merit in allowing for scarcity scalars with values <1 or with values >2. This is due to interactions between base tariffs and scalars – if values are constrained between 1 and 2 then the incentives for providers may not be set at the right level.

This scalar is considered as two separate scalars - a **locational scarcity scalar** and a **temporal scarcity scalar**. Locational scarcity could be used, for example, to define zonal prices for procurement of reactive power, or to reflect geographic constraints in the provision of reserve services. Temporal scarcity could reflect intraday or seasonal variations in the value of services by, for example, setting day/night and summer/winter tariffs, or could track other metrics such as inertia or System Non-Synchronous Penetration (SNSP).

2.4.4 Volume Scalar

The objective of the volume scalar is to protect consumers from overpayments. The function of the volume scalar, as described in the SEM Committee decision, varies and is dependent on whether a service is procured via the auction or via the regulated tariff. Again, this has led to consideration of two distinct volume scalars - an **expenditure management volume scalar** and an **auction procurement volume scalar**.

2.4.4.1 Auction Procurement

For services procured via an auction, the SEM Committee outlined a high-level design for a scalar aimed at protecting the consumer from high clearing prices set by new entrants who would not be operating and active in the system services market in the target year. This could happen if procurement for both long-term and short-term contracts were

[4] Locational scarcities are most likely to be relevant for Steady-state Reactive Power and Dynamic Reactive Response, although locational factors could also affect some of the frequency services (particularly Fast Post Fault Active Power Recovery). Locational scarcity scalars are considered for Steady-state Reactive Power only in this report.

[5] Any locational scarcity scalars introduced to account for temporary constraints would also have to be temporary in nature.

conducted in the same auction, or if the auction design allows for different long-term contracted providers to begin operating in different years.

The use of a scalar in this context was predicated on the view of the auction design and the price-setting process envisaged in the SEM Committee decision paper. For example, that paper suggested that current and future providers would compete in a single auction, without adjustments to bids to reflect varying lead times or contract lengths. However, the volume scalar design outlined in the SEM Committee decision paper does not work with the proposed framework for the auction that is being progressed in the detailed design phase.

2.4.4.2 Expenditure Management

The SEM Committee decision paper makes the following observation about the use of the volume scalar:

“It is also noted that as the tariff will be paid to all providers it is possible that the aggregate payments could exceed the expenditure cap and/or overly reduce the revenues available for competitive procurement.”

This implies that the volume scalar should also be used to ensure that overall expenditure is managed appropriately.

The SEM Committee decision paper sets out a method by which the volume scalar could be used to mitigate the risk of over-procurement of a particular service:

“In the case of services that are priced through the tariff methodology, those services will have a scalar applied to them where, notwithstanding the lack of sufficient competition, there is a surplus volume of the service.”

This could be implemented in a similar way to a scarcity scalar, based on available volumes and real time requirements. For example, if the TSOs have a real-time volume requirement for 600 MW, yet 800 MW has been made available[6], then a scalar of 0.75 could be applied to the value of the tariff to ensure that consumers do not end up overpaying. This is one possible option for the design of the volume scalar.

However, managing expenditure based on volumes does not give the TSOs certainty on the overall scale of payments. This is because the total expenditure is not explicitly factored into the tariff setting calculation. For example, the tariff methodology could result in a tariff of €10 /MWh for a service, and there could be a requirement for 500 MW. If 1000 MW was available, then a requirement based volume scalar of 0.5 would apply, maintaining total expenditure to €5,000. This would have protected consumers to a certain degree, but if the total allowance was only €2,500, then the volume scalar would not have achieved its aims.

In the high level design of the regulated tariff methodology[7], some ideas were given as to how expenditure could be managed:

---

[6] This could happen if (a) the TSOs have procured significantly more volume of a service than is required, due to providers bundling services together or (b) if the TSOs enter into contracts with all providers.

[7] Consultation on Regulated Tariff Calculation Methodology: DS3 System Services Implementation Project, Nov 2015

- A uniform ex-post adjustment to base tariffs. The option described above is one version of this, based on volumes. It would also be possible to implement a version which was based on total expenditure;
- A targeted ex-post adjustment to base tariffs;
- An ex-ante adjustment to base tariffs.

These ideas have been used to develop a number of additional options for the volume scalar which are discussed in subsequent sections.

2.5 Interaction with Auctions

The principles behind the auction/scalar interaction are still being developed and will need to be considered during the development of the detailed auction rules and associated contracts. Therefore, this report should largely be read and understood in the context of procurement via the regulated tariff.

However, emerging thinking on how scalars will apply to products procured in the auction is set out in this section. The principles of scalars for products procured under the auction may, in many cases, be very similar for those procured under the tariff. In general, scalars do not pose a significant issue for the auction, as long as they are clear to bidders in advance and policies are laid out prior to the auction.

2.5.1 Product Scalars

Two initial options have been identified for the interaction between the product scalars and the auction:

1. Scalars are explicitly considered in the auction algorithm;
2. Scalars give a revenue uplift which is applied to the clearing price in the auction.

For Option 1, a series of rules would be incorporated into the auction algorithm which would allow for “enhanced” volumes to be converted into “default” volumes. For example, the TSOs may decide that FFR which is available in 500ms is worth twice as much as the base service. If a provider entered 20 MW of FFR which could respond within 500ms into the auction, then the auction algorithm would treat the faster 20 MW as if it were 40 MW of the base service. The distinction between different capabilities would then collapse and allow for a single clearing price to be set. This Option would be appropriate in cases where the TSOs can establish robust rules for handling product scalars which can be used in the auction algorithms.

Option 2 would be used if it was not possible to determine equivalent volumes of the base product for enhanced deliveries. Under this option, the enhanced capability of the provider would not be considered in the auction – the scalar would simply be applied afterwards as a revenue uplift on the clearing price. In a competitive auction, the providers with enhanced capabilities should reflect this uplift by reducing their bids into the auction (as long as the values of the scalar are clear in advance).

2.5.2 Scarcity Scalars

Scarcity scalars introduce price volatility and revenue uncertainty for providers in the auction. This may be acceptable if there is good visibility of both the scalar values and the nature of the variation. For example, scalars which take values on seasonal/daily cycles

may be acceptable as providers can reflect these in their bids. However, scalars which vary with system conditions (e.g. SNSP) may be too difficult for providers to forecast and, therefore, would likely not be appropriate for procurement in the auction.

2.5.3 Volume Scalars

As discussed previously, the proposed design of the auction would see procurement carried out separately for short-term and long-term contracted providers. Therefore, the auction procurement function of the volume scalar will not be necessary.

The use of a volume scalar to manage expenditure by scaling down prices may not be appropriate for products procured through the auction as it introduces significant revenue uncertainty for providers.

In particular, a scalar based on required versus available volumes may not be required for products procured in the auction. The auction should allow the TSOs to procure appropriate volumes – a volume scalar would only be required if providers are making much larger volumes available than they stated in their bids. However, this would not be expected to happen very often, as it would be in a provider's interest to reflect their highest possible availability in their initial bid. If an individual provider did end up having much greater availability than stated in their bid, then it may be better to scale down the payments to that provider only, rather than penalising all providers.

[This page is intentionally blank]

3. APPLICABILITY AND MATERIALITY OF SCALARS

In this section, the applicability and materiality of each different type of scalar to each of the fourteen products is discussed. This is based on the high level views of TNEI and Pöyry, following extensive discussion with the TSOs.

- **High Materiality:** This describes those scalars which will provide clear benefit to the system. Implementation of these scalars is recommended in Section 5;
- **Medium Materiality:** This describes those scalars which may bring some benefit to the system, or scalars which will provide clear benefit but could be difficult to implement. These scalars are discussed for the TSOs' and other stakeholders' consideration in Section 5;
- **Low Materiality:** This describes scalars which could be implemented, but are unlikely to provide significant benefits to the system;
- **None (Not Applicable):** This describes scalars which are not applicable for technical reasons (e.g. faster responses for static services or for services with overlapping timescales, enhanced delivery where no enhancements are feasible).

For each scalar that has a medium or high materiality, recommendations are discussed in Sections 4 and 5. Scalars that have low materiality or are not applicable are not considered in further detail in Section 4 and Section 5.

3.1 Product Scalar

The purpose of the product scalar is to incentivise enhanced delivery (e.g. dynamic as opposed to static behaviour) or faster response of a service where such delivery / response is of value to the system – the product scalar has therefore been considered in the following analysis as two separate scalars. The applicability and materiality of each scalar to each service is discussed below, and summarised in Table 7.

Table 7: Materiality of Product Scalars

Service	Faster Response	Enhanced Delivery	Service	Faster Response	Enhanced Delivery
SSRP	None	Medium	TOR1	None	High
DRR	Low	Medium	TOR2	None	None
SIR	None	Medium	RRS	None	None
FPFAPR	Medium	None	RRD	None	None
FFR	High	High	RM1	None	None
POR	None	High	RM3	None	None
SOR	None	High	RM8	None	None

3.2 Scarcity Scalar

The purpose of the scarcity scalar is to incentivise availability in locations or periods of scarcity for a particular service – the scarcity scalar has therefore been considered in the following analysis as two separate scalars. The applicability and materiality of each scalar to each service is discussed below, and summarised in Table 8.

Table 8: Materiality of Scarcity Scalars

Service	Temporal Scarcity	Locational Scarcity	Service	Temporal Scarcity	Locational Scarcity
SSRP	Low	Medium	TOR1	Medium	Low
DRR	High	Low	TOR2	Medium	Low
SIR	Medium	Low	RRS	Medium	Low
FPFAPR	High	Low	RRD	Medium	Low
FFR	Medium	Low	RM1	Low	Low
POR	Medium	Low	RM3	Low	Low
SOR	Medium	Low	RM8	Low	Low

3.3 Volume Scalar

The purpose of the volume scalar is to protect consumers from overpayment for system services. As discussed in 2.4.4, the role of the volume scalar can be described separately for expenditure management and for auction procurement.

Expenditure Management: High Materiality

To successfully manage expenditure, the volume scalar may have to be applicable to many services procured through the regulated tariff[8]. If all providers of services are paid (e.g. the TSOs contract with all available providers) then, without a volume scalar, it would be difficult to control the overall scale of DS3 System Services payments.

However, it may be necessary to exclude those new services which have tariffs based on the costs of necessary investments from the volume scalar. This could include, for example, Fast Post-Fault Active Power Recovery, Dynamic Reactive Response and other services as required. If an accurate cost-based tariff is set, then any reduction in this tariff would reduce the incentive for the desired investments from industry.

[8] The interactions between auctions and scalars is still being developed, however, at this stage, it seems unlikely that any volume scalars could be applied to products procured with long-term contracts. A volume scalar for expenditure management could potentially be used for products procured on short-term contracts.

Auction Procurement: Not Applicable

Applying a scalar to auction procurement, as described in Section 2.4.4.1, will not be possible with the current proposed auction design, as each package bid will not include separate individual bids for each service. Furthermore, such an application of the volume scalar, as described by the SEM Committee, would not be relevant for the recommended auction design, which would differentiate between auctions for procuring current and future requirements. Variation of prices across the years within the long-term contract period will be handled through the auction mechanism.

[This page is intentionally blank]

4. COMMON PRINCIPLES FOR THE HIGH LEVEL DESIGN OF SCALARS

This section sets the common principles for the high level design of scalars. These are summarised in Table 9.

Table 9: Options for the High-Level Design of Scalars

<table>
<tr><th>Design of Scalar</th><th colspan="12">Options</th></tr>
<tr><td>Magnitude</td><td colspan="4">Greater than or equal to one

Applicable to most scalars</td><td colspan="4">Values above and below one

Applicable to some temporal scarcity scalars</td><td colspan="4">Less than or equal to one

Applicable to volume scalar, some scarcity scalars and an option for product scalars</td></tr>
<tr><td>Scale</td><td colspan="4">Binary scalar

Applicable to most enhanced delivery product scalars</td><td colspan="4">Sliding-scale

Could be applied to all other product and scarcity scalars</td><td colspan="4">Calculation

Applicable to the volume scalar, which will neither be binary nor on a sliding scale</td></tr>
<tr><td>Granularity</td><td colspan="4">With Tariffs

Set once only but could be subject to review when tariffs are recalculated.

Recommended for product scalars</td><td colspan="4">Annual

Takes one value for each year.

Recommended for locational scarcity scalars and an option for volume scalar</td><td colspan="4">Trading Period

Takes a different value in every trading period

Recommended for temporal scarcity scalars and another option for volume scalar</td></tr>
<tr><th>Impact of Scalar</th><th colspan="12">Options</th></tr>
<tr><td>Impact on Payments</td><td colspan="4">Increase Payments

Scalars which are greater than one</td><td colspan="4">Minimum impact on payments

Scalars which take values both greater than and less than one (e.g. based on rules developed through modelling)</td><td colspan="4">Decrease Payments

Scalars which are less than one</td></tr>
<tr><td>Impact on TSO Expenditure</td><td colspan="3">Decrease Payments

Scalars which decrease per unit payments will directly reduce TSO System Services expenditure</td><td colspan="3">Decrease volumes

Product scalars could lead to reduced volume requirements in future years, reducing TSO expenditure</td><td colspan="3">Decrease other costs

Some scalars may reduce other system costs – this is harder to quantify</td><td colspan="3">Does not reduce volumes or other costs

Some scalars may not reduce any system costs – these are difficult to justify</td></tr>
</table>

<table>
<tr><td>Impact on operations</td><td colspan="6">Scalars should incentivise behaviour from providers which increase the flexibility/stability of the system and/or reduce overall costs.

Impact of scalars on TSO systems will vary – e.g. product scalar is a variable that does not need to change, whereas temporal scarcity scalars require new data feeds and calculations in settlement calculations</td></tr>
<tr><td>Impact on tariff complexity and visibility</td><td colspan="2">Ex-Ante with Complete Visibility

Applicable to all product scalars and locational scarcity scalars. Could also include seasonal or peak/off-peak temporal scarcity scalars, where values are set in advance. Could be used if a volume scalar is set in advance based on anticipated expenditure

Providers have complete knowledge of their tariffs – limited risk</td><td colspan="2">Ex-Ante with Limited Visibility

Applicable to temporal scarcity scalars, where range of values is set in advance and scalar takes a different value dependent on certain variables such as SNSP or Inertia, of which providers will have limited visibility

Introduces risk for providers</td><td colspan="2">Ex-Post

Could be applicable to the volume scalar, which may be set ex-post

Introduces significant risk for providers</td></tr>
<tr><td>Volume Scalar</td><td colspan="6">Options</td></tr>
<tr><td>Adjustment</td><td colspan="3">Uniform

Applied to all services procured through the tariff.

Services procured through the auction may be excluded.</td><td colspan="3">Targeted

Certain services are excluded (e.g. potentially those that aim to incentivise specific investment such as FPFAR, DRR, etc</td></tr>
<tr><td>Calculation Basis</td><td colspan="3">Requirement Based

Adjustment based on available versus required volumes.

Requires half-hour granularity.

Would not guarantee that expenditure could be effectively managed.</td><td colspan="3">Expenditure Based

Adjustment based on system services expenditure.

Could be set every year.

Would help to effectively manage expenditure but may introduce more risk for providers.</td></tr>
<tr><td>Visibility</td><td colspan="2">Ex-Post

Adjustment carried out ex-post, introducing considerable uncertainty for providers.

Increases risk for providers but helps to more effectively manage expenditure.</td><td colspan="2">Ex-Ante

Adjustment carried out ex-ante based on forecast volumes or expenditure

Decreases risk for providers but would not guarantee that expenditure could be effectively managed.</td><td colspan="2">Ex-Ante with correction

Adjustment carried out ex-ante, with a correction included for any error in the forecast for the previous year</td></tr>
</table>

4.1 Design of Scalars

This section outlines options for the design of scalars including the values which scalars could take, the potential forms of scalars, and the options for the granularity of scalars. No preferences are expressed within this section but these options are considered further for each proposed scalar in the recommendations of Section 5.

4.1.1 Magnitude

There are three options for the magnitude of each scalar. The scalars can either:

- Take values equal to or greater than 1;
- Take values equal to or less than 1; or
- Take values both less than, greater than, or equal to 1.

It is important to note that some scalars therefore represent downside reductions in the base product rate for providers.

1. **Greater than or equal to one:** Product scalars will, in general, aim to result in increased prices and tariffs – these scalars will almost all have values ≥1.

   The SEM Committee decision envisages that scarcity scalars will have values between one and two. If possible, scarcity scalars should be implemented with more flexibility (e.g. also values less than one). If this was not possible, then tariffs would need to be adjusted before scalars were applied.

2. **Both less than and greater than one:** The value of the tariffs for Synchronous Inertial Response, Fast Frequency Response and the reserve products will be informed by the outputs of Plexos modelling (as outlined in the separate report on the Regulated Tariff Calculation Methodology). Scalars for these products could therefore result in variation of the tariff above and below this average value and could therefore take values both less than and greater than one. This could also apply to a locational scarcity scalar for Steady-state Reactive Power.

3. **Less than or equal to one:** By definition, volume scalars will always decrease tariffs and will have values <1.

   A product scalar designed to encourage the correct operation of a PSS should take values less than or equal to one. There may be other cases where it would be useful to have product scalars with values ≤ 1, however, it is worth nothing that this will effectively redefine the enhanced delivery (with the scalar) as the default product - any providers not offering the enhanced service would then receive lower payments. If the TSOs choose to pursue this option, then they may have to account for this when setting tariffs.

   Scarcity scalars for Dynamic Reactive Response and Fast Post-Fault Active Power Recovery would, ideally, have values ranging from zero to one, to target payments to times of scarcity of the services.

4.1.2 Form

Product and scarcity scalars will either take values on a sliding scale, or will be binary scalars, with only one of two possible values. Volume scalars will need to be determined through calculation.

4.1.2.1 Binary Scalar

A binary scalar, as the name suggests, takes one of two values depending on the nature of service provision. For product scalars, this would be dependent on some capability of the provider. Binary scalars should be used for many product scalars relating to enhanced delivery including:

- Steady-state Reactive Power with Watt-less VArs;
- Steady-state Reactive Power with an AVR;
- Steady-state Reactive Power with a PSS;
- Synchronous Inertial Response with Reserves.

A binary approach could be used for pricing reserve products with a temporal scarcity scalar if a simple peak and off-peak tariff were to be utilised.

4.1.2.2 Sliding-scale Scalar

This form will be applicable to some product scalars (e.g. relating to faster response) and to scarcity scalars. An enhanced delivery product scalar for the provision of dynamic or emulated dynamic reserves/response could also take values on a sliding scale.

The simplest way to implement a sliding scale scalar would be:

1. Determine the lowest value of the scalar associated with some system condition or some minimum product capability;
2. Determine the highest value of the scalar associated with some alternative system condition or some maximum product capability;
3. Allow the scalar to take a set of discrete values on a linear sliding scale for all intermediate system conditions or intermediate product capabilities.

For example, for a faster response of Fast Frequency Response, the scalar could take a value of 1 for the basic response of 2s and could take a value of 2 for a response time of 500ms. Then, the sliding scale could be set as follows:

- *1.7s would take a value of 1.2;*
- *1.4s would take a value of 1.4;*
- *1.1s would take a value of 1.6;*
- *800ms would take a value of 1.8.*

Note that these are indicative values for illustrative purposes only.

The scalar would therefore take a set of discrete values along this linear sliding scale such that, when graphed, it resembles a step-wise approximation to a straight line. This is represented in Figure 1*.*

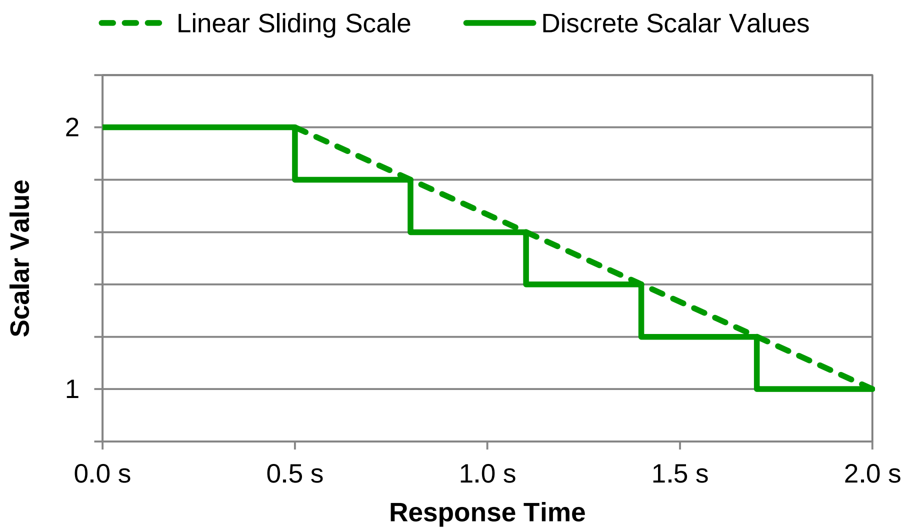


Figure 1: Indicative form of Sliding Scale for FFR Faster Response Scalar

In the longer term, the TSOs may undertake detailed analysis (e.g. power systems analysis or economic modelling) to determine the relative value of scalars. This may lead to non-linear sliding-scales, where the value of the scalar is determined exactly for each system condition or provider capability. Note that this may already be possible in the short term for any temporal or locational scalars which are based on either tariff or volume modelling (Fast Frequency Response, Synchronous Inertial Response, Reserves and Steady-state Reactive Power respectively).

4.1.2.3 Analysis Methods

For simplicity and for ease of implementation, it is likely that high-level analysis would need to be used to set the values of most scalars in the short-term. The exceptions to this are:

- **Temporal scarcity scalars for SIR, FFR, and Reserves:** The tariffs for these products will be set by carrying out year-round studies in Plexos, and then setting a tariff based on a volume weighted average. The detailed trading period values of the tariff could be used to set possible values of the scalar which would vary around this average. This could be done based on system conditions (e.g. by determining the average value of the scalar for every value of SNSP) or based on periodic cycle (e.g. by determining the average value of the scalar for peak and off-peak periods);

- **Locational scarcity scalars for SSRP:** The volume requirements for Steady-state Reactive Power are calculated by determining the equivalent size of reactive compensation equipment that would need to be installed in different geographic locations. A scalar could be calculated by looking at the variation in size for each location above and below the average size.

In the long term, detailed analysis could potentially be used to set the values of all scarcity scalars as well as product scalars. Options would include:

- Cost based assessments (e.g. incremental costs for providers to meet requirements of product scalars);
- Value based assessment (e.g. Plexos modelling);
- Volume requirements (e.g. comparison of required volumes for different product capabilities).

Any detailed modelling of this nature is likely to be very complicated to implement and will only be possible in the long-term, if at all.

4.1.2.4 Volume Scalar

The volume scalar will not take binary values or values on a sliding scale, but will instead be explicitly calculated based on either required volumes or expenditure.

4.1.3 Granularity

There are three principal options for scalar granularity:

- **With tariff**: The value of the scalar is set when tariffs are recalculated e.g. every five years. This is applicable to all product scalars. This is the most simple for integrating into the TSOs' systems and is also the easiest for providers to understand / predict;
- **Annual:** The value of the scalar is set every year. This is applicable to locational scarcity scalars and is also an option for the volume scalar. This is also relatively simple for integrating into the TSOs' systems and is also easy for providers to understand / predict;
- **Trading Period:** The value of the scalar may vary in every trading period. This is applicable to temporal scarcity scalars and is also an option for the volume scalar. This is the most complicated to implement into the TSOs' settlement systems. Depending on how the scalar varies, the impact on revenues could be quite complex for providers to understand / predict (e.g. if temporal scarcity scalars are peak/off-peak then this should not be too complex, however, if the scalars take a different value for each level of SNSP then it could be very difficult).

4.2 Impact of Scalars

This section outlines the possible impacts which scalars have on the TSOs, their customers and consumers including the impact on payments, the impact on system services expenditure and other costs, and the impact on investor/customer certainty.

4.2.1 Impact on Payments

Scalars which increase tariffs/prices (e.g. with values greater than one) will increase unit (e.g. per MW) payments, whereas scalars which decrease tariffs/prices (e.g. with values less than one) will decrease payments.

Scarcity scalars that take values both greater than and less than one would aim to keep average payments roughly consistent, with greater payments in times of scarcity and reduced payments in times of less scarcity.

4.2.2 Impact on TSO Expenditure

Scalars which take values less than or equal to one will lead to a reduction in TSO System Services expenditure.

Scalars which take values greater than one will need to be considered in more detail, as they may increase System Services expenditure. Often, these scalars will result in operational benefits which are difficult to quantify. For example, scalars may encourage certain flexibilities from providers, and the provision of these flexibilities in turn may allow the TSOs to manage system constraints in a more cost effective manner thus resulting in reduced total expenditure over a yearly basis[9]. The TSOs will need to consider such operational benefits when deciding whether or not to introduce scalars which may increase System Services expenditure.

For product scalars, which are more likely to be >1, there could be a justification that adoption of scalars will lead to the TSOs lowering their costs. In some cases, this could be reflected in future volume analysis. For example, a high uptake of faster responses of Fast Frequency Response may reduce the total volume requirement for other frequency services (e.g. Synchronous Inertial Response), which could then impact on System Services expenditure.

In other cases, the ways in which scalars will reduce TSO expenditure are more opaque – for example, it is not immediately obvious how encouraging Synchronous Inertial Response providers to be able to provide reserve would directly impact on volume calculations[10]. Therefore, scalars may sometimes lead to operational benefits that can only be described qualitatively.

4.2.3 Impact on Operations

In general, scalars should improve the security of the system, either through improved delivery (product scalars) or by targeting products in areas/times of scarcity. However, in some cases, the benefit to the TSOs may be relatively small or there may not currently be a strong need for it. In rare cases, a scalar may have potential for adverse impacts on system operation if it encourages the wrong type of behaviour from providers.

Scalars are likely to have a significant impact on operational complexity for the TSOs. Implementing and setting scalars will be very complex especially if detailed modelling or analysis is used to determine scalar values. Scalars may also introduce complexity into the TSOs' systems e.g. settlement. Product scalars and locational scarcity scalars, for example, will be simpler – these will take a fixed value. However, temporal scarcity scalars could be more complex to integrate with the TSOs' systems and may require other data in-feeds, e.g. information about the value of inertia or SNSP on the system in each trading period.

---

[9] E.g., under I-SEM, certain scalars may lead to the TSOs having to take fewer actions in the Balancing Market, which will reduce overall TSO costs even if it increases System Services Expenditure.

[10] This scalar could, for example, encourage more competitive bids in an auction or reduce Balancing Market costs.

4.2.4 Impact on Tariff Complexity and Visibility

Providers should have as clear a view as possible of the payments which they will receive for system services. There are two principal factors which could impact the complexity of the tariff from the perspective of service providers – when the magnitude of the scalar is set (e.g. ex-post or ex-ante) and whether providers have visibility of all of the variables which could affect the magnitude of the scalar.

As a general point, the complexity of tariffs/prices will increase as more scalars are implemented. A large number of simple scalars could make tariffs very complex if they are all applied to the same product.

4.2.4.1 Ex-post vs. Ex-ante

Scalars can either be set in advance, before the relevant year begins, or could be set retrospectively. In practice, it should be possible to determine the range of possible values for all scarcity and product scalars ex-ante. This maximises certainty for providers.

4.2.4.2 Visibility of Variables

Once product and locational scarcity scalars have been set, providers should have complete visibility over how their payments will be affected, as they should know both the capability of their own equipment (which affects the product scalar they will receive) and where in the network they will be connected.

Providers may be able to predict the impact that temporal scarcity scalars will have on their payments – however this depends on the way in which temporal scarcities are classified. If this is done based on time of day (e.g. day-time vs. night-time) or seasonal variation (summer vs. winter) then providers would be able to forecast how their payments may be affected – some of the existing reserve products could be scaled in this way. However, if locational scarcity scaling is done based on some other metric relating to inertia or SNSP, then providers will not have a very clear idea of how their payments could be affected, even if the range of values of the scalar is set ex-ante.

4.3 Volume Scalar Options

Some considerations which are unique to the volume scalar are discussed below.

4.3.1 Uniform or targeted adjustment

The volume scalar could either be uniformly applied to all products, or it could be targeted at certain products. Targeting the volume scalar may be necessary so that providers are still incentivised to make the necessary investments needed for certain services such as Fast Post-Fault Active Power Recovery, Dynamic Reactive Response etc.

Similarly, a decision would need to be made on whether the volume scalar should be uniformly applied to all contracts (e.g. tariff procurement, short-term auction contracts, long-term auction contracts), or targeted at a subset of these. At a minimum, providers with long-term contracts from the auction procurement may have to be exempt from the volume scalar.

4.3.2 Requirement or expenditure based

The volume scalar could be calculated based on required volumes, or based on expenditure.

4.3.2.1 Requirement Based

The various options are discussed in more detail in later sections, but at a high level, a requirement-based volume scalar could be calculated as:

$$Volume\ Scalar_i = \frac{Required\ volume\ in\ interval\ i}{Available\ volume\ in\ interval\ i}$$

"Interval" in this context could refer to any defined length of time. However, for a requirement based volume scalar, trading periods would likely be the most appropriate time interval, as required and available volumes are harder to define over an annual timescale (e.g. calculations could be based on time-weighted average required and available volumes, or maximal values).

A volume scalar of this form, based on requirements, is in line with the SEM Committee proposal in their decision paper on the use of the volume scalar to manage expenditure.

A decision would need to be taken on which volumes should be used in this calculation. For example, this could be based on time weighted average values or maximum values. The most appropriate volume is likely to be the real time volume requirement. The volume scalar would then be based on (for example) the time weighted average required volume in that trading period compared to the time weighted average available volume.

If volume scalars are calculated based on requirements, then this may need to be considered in the tariff setting exercise in order to ensure that the overall scale of payments can be managed. For example, for many of the reserve products, tariffs will be set based on the average value of the service across the year. Scaling down this tariff may then remove incentives for providers to offer these services in certain periods. Ultimately, this type of adjustment may be less efficient than simply changing the payment basis or the granularity of contract periods for service procurement.

4.3.2.2 Expenditure Based

Alternatively, an expenditure-based volume scalar could be calculated as:

$$Volume\ Scalar_i = \frac{Budgetary\ allowance\ in\ interval\ i}{Actual\ (or\ forecast) expenditure\ in\ interval\ i}$$

"Interval" in this context could refer to any defined length of time. However, for an expenditure based volume scalar, years would likely be the most appropriate time interval, as the budgetary allowance would be set on an annual basis. With a volume scalar of this form, it would be simpler to control the overall scale of payments. If the SEM Committee's objective is to ensure that overall expenditure is kept within the total allowance, then an expenditure-based scalar may be the best way to achieve this.

4.3.3 Ex-post or ex-ante

The volume scalar could be determined ex-post, based on actual expenditure or actual available/required volumes, or could be set ex-ante, based on forecasts. An ex-ante adjustment provides greater certainty for providers; however it does introduce some issues. Specifically, the TSOs would need to have accurate forecasts of:

1. Generation portfolios for the coming year, to underpin modelling
2. Demand and generation dispatch to determine market and system conditions;

3. The actual volumes which providers will make available (as compared with the volumes the TSOs require).

If set ex-ante based on forecasts, there is a risk that inaccurate forecasts could make it difficult to control the overall scale of payments, or that the scale of required volume adjustment could be overestimated leading to an unnecessary penalty for providers. To mitigate this risk, there could be a corrective term included in the volume scalar to account for any over- or under-spend in the previous year e.g. the volume scalar could be based on an effective budgetary allowance where:

$$\begin{aligned} & Effective\ Budgetary\ Allowance \\ & \qquad = Actual\ Budgetary\ Allowance - Previous\ Year\ Overspend \end{aligned}$$

Or:

$$\begin{aligned} & Effective\ Budgetary\ Allowance \\ & \qquad = Actual\ Budgetary\ Allowance + Previous\ Year\ Underspend \end{aligned}$$

5. RECOMMENDATIONS

Four scalars are recommended for implementation. These are:

- **A product scalar for faster response of FFR**;
- **A product scalar for enhanced delivery of FFR, POR, SOR and TOR1** for dynamic, static and emulated dynamic behaviour;
- **A scarcity scalar for temporal variation in the value of DRR and FPFAPR**, which varies with SNSP (or other suitable metric);
- **A volume scalar to manage expenditure** – two options for this are discussed in more detail.

In addition, there are potential benefits of using a **scarcity scalar to reflect the temporal variation in the value of reserve products**. However, more analysis would need to be carried out in order to determine whether this scalar should be introduced, as it could be complex to implement and may introduce uncertainty for providers.

Nine other potential scalars (three scarcity scalars and six product scalars) are also presented for the TSOs' consideration, with more detailed discussion in Annex B. The case for implementing each of these scalars is less clear, especially when considering the cumulative complexity (for both the TSOs and their customers) of larger numbers of scalars being introduced.

The impact of each scalar has been considered in terms of three criteria as set out in Table 10:

- **Expenditure:** What is the impact which the scalar will have on system services expenditure and could it lead to a reduction in other TSO costs;
- **Operations:** How significant are the operational benefits which the scalar will introduce (with some thought given to practicalities of implementation);
- **Complexity:** How does the scalar affect revenue certainty for providers.

Table 10: Interpretation of Traffic Light Indicators

Indicator	Expenditure	Operations	Complexity
Green	Scalar will decrease system services expenditure by directly decreasing payments	Scalar would introduce significant operational benefits	Scalar is set ex-ante with full visibility of variables
Amber	Scalar increases System Services expenditure in the short term. Likely to decrease TSO costs in the medium-long term, or will redistribute payments while keeping system services expenditure the same	Scalar may introduce some operational benefits	Providers may not have visibility of all variables (E.g. may be set ex-post or may vary with system conditions)
Orange	Scalar increases payments. No definite mechanism for reducing system services expenditure and impact on other TSO costs is hard to quantify	The TSOs have no clear requirement for the operational flexibilities introduced by the scalar	Providers will not have visibility of all variables (E.g. will be set ex-post or will be likely to vary with system conditions)

Table 11 summarises the impact which each scalar may have for each of these criteria, and also the recommendation of this report on implementation.

Table 11: Scalar Impacts

Product Scalars	Payments	Expenditure	Operations	Complexity	Recommendation
Faster Response of FFR	Increase	🟡	🟢	🟢	**Implement**
Enhanced Delivery of FFR, POR, SOR, TOR1	Increase	🟡	🟢	🟢	**Implement**
SSRP with Watt-less VArs	Increase	🟠	🟡	🟢	**Consider**
Enhanced Delivery of DRR with more reactive current	Increase	🟠	🟠	🟢	**Consider**
Enhanced Delivery of SSRP with an AVR	Increase	🟠	🟠	🟢	**Consider**
Delivery of SSRP without an operational PSS	Decrease	🟢	🟢	🟢	**Consider [1]**
SIR with Reserve	Increase	🟠	🟡	🟢	**Consider**
Faster Response of FPFAPR	Increase	🟠	🟢	🟢	**Consider**
Scarcity Scalars	**Payments**	**Expenditure**	**Operations**	**Complexity**	**Recommendation**
Temporal Variation of DRR and FPFAPR	Decrease	🟢	🟢	🟠	**Implement [2]**
Temporal Variation of Reserve Products	Varies	🟡	🟡	🟡	**Further analysis required †**
Locational Variation for SSRP	Varies	🟡	🟠	🟢	**Consider**
Temporal Variation for SIR	Varies	🟡	🟡	🟠	**Consider †**
Temporal Variation for FFR	Varies	🟡	🟡	🟠	**Consider †**
Volume Scalar Options	**Payments**	**Expenditure**	**Operations [3]**	**Complexity**	**Recommendation**
Targeted, expenditure-based, annual, ex-ante (forecast)	Decrease	🟢	🟢	🟢	**Implement †**
Targeted, requirement based, trading period, ex-post (actual)	Decrease	🟢	🟡	🟠	**Implement ‡**

†‡ Those scalars marked with a † and ‡ are mutually exclusive, as it would be prohibitively complex to have multiple scalars which vary across trading periods applied to any single service.
[1] This may be more appropriate to implement as a variant of the performance scalar
[2] The benefits for expenditure and operations are so significant that this scalar has been recommended for implementation, despite the impact on complexity for providers and for the TSOs
[3] A green indicator here for a volume scalar means that no potential adverse impacts on operations have been identified

Table 12 summarises the emerging thinking on the form of each scalar.

Table 12: Summary of Design of Scalars

Product Scalars	Magnitude*	Form	Granularity	Notes
Faster Response of FFR	≥1	Sliding Scale	Set with Tariffs	Trade off between speed and size of response
Enhanced Delivery of FFR, POR, SOR, TOR1	≥1	Sliding Scale	Set with Tariffs	Range of possible values for static, dynamic and emulated dynamic responses
SSRP with Watt-less VArs	≥1	Binary	Set with Tariffs	
Enhanced Delivery of DRR with more reactive current	≥1	Sliding Scale	Set with Tariffs	
Enhanced Delivery of SSRP with an AVR	≥1	Binary	Set with Tariffs	
elivery of SSRP without an operational PSS	≤1	Binary	Set with Tariffs	
SIR with Reserve	≥1	Binary	Set with Tariffs	Could take multiple values to differentiate between different types of reserve
Faster Response of FPFAPR	≥1	Sliding Scale	Set with Tariffs	
Scarcity Scalars	**Magnitude**	**Form**	**Granularity**	**Notes**
Temporal Variation of DRR and FPFAPR	≤1	Sliding Scale	Trading Period	Varies with SNSP, could take values between 0 and 1
Temporal Variation of Reserve Products	≤1 ≥1	Sliding Scale	Trading Period	Could be seasonal/daily or could vary with SNSP
Locational Variation for SSRP	≤1 ≥1	Sliding Scale	Annual	Could be based on locational volume requirements
Temporal Variation for SIR	≤1 ≥1	Sliding Scale	Trading Period	Could be seasonal/daily but more likely to vary with SNSP
Temporal Variation for FFR	≤1 ≥1	Sliding Scale	Trading Period	Could be seasonal/daily but more likely to vary with SNSP
Volume Scalar Options	**Magnitude**	**Form**	**Granularity**	**Notes**
Targeted, expenditure-based, annual, ex-ante (forecast)	≤1	Sliding Scale	Annual	
Targeted, requirement based, trading period, ex-post (actual)	≤1	Sliding Scale	Trading Period	

* The TSO's should retain the option to have all product scalars take values ≤1, noting that this effectively redefines the enhanced service delivery (with the scalar) as the default product, and that this may need to be accounted for in the determination of the tariffs (e.g. when undertaking a cost consultation).

5.1 Product Scalars

Two product scalars are recommended for implementation:

- A product scalar for faster response of FFR;
- A product scalar for enhanced delivery of FFR, POR, SOR and TOR1 for dynamic, static and emulated dynamic responses;

Six additional product scalars are presented for the TSOs to consider in Annex B.1.

5.1.1 Faster Response of FFR

This scalar would incentivise delivery of Fast Frequency Response in timeframes quicker than the 2s default of the product definition.

5.1.1.1 Design of the scalar

Magnitude

This scalar would be greater than or equal to one.

Form

This scalar could take values on a sliding scale, with values of one for the base service, and values greater than one for providers who could respond faster than the minimum requirement of 2s.

The definition of the product volume is based on the provider’s active power output in a payment window between 2s and 10s after a frequency event. One option for the form of this scalar would be to increase per MW payments (through a scalar) for providers who volunteer to start their “payment window” earlier, e.g. they could volunteer for their output to be paid based on their minimum output for the period between 500ms and 10s after a frequency event. Providers would then have to consider the trade off between the speed of their response, and the MW output level to which they can ramp in this faster timeframe. The scalar could take values on a linear sliding scale. Alternatively, the TSOs may wish to weight the scalar more heavily for very fast responses (e.g. by using an exponential sliding scale).

The upper limit on the speed of the response could be set through consultation with industry, or based on the TSOs’ requirement – for example, if there is no need for responses faster than 1s, then there should be no incremental incentives for providers to increase the speed of their response from 1s to 500ms.

Granularity

The value of this scalar should be set once, with potential for review when tariffs are recalculated in following years. The scalar would take this fixed value in all trading periods. This value would be based on the proven capability of the provider.

5.1.1.2 Impact of the Scalar

Payments

This scalar will increase payments as it has values greater than one. The scalar would have to be considered when setting the tariffs so as to reduce the risk of overspend.

Expenditure

In the long term, the scalar should reduce the volumes of Fast Frequency Response required. If this reduction in volumes is accounted for in future years, then it should not have a significant impact on the total expenditure for Fast Frequency Response.

This is particularly true if the scalar is set based on detailed analysis. If high level analysis is used then it is harder to estimate what impact it might have on expenditure.

The wider operational flexibilities which the scalar may lead to other cost reductions. For example, if the scalar allows the TSOs to operate the system at higher levels of SNSP, then wind curtailment costs may be reduced.

Operations

This scalar will increase system stability by reducing the Rate of Change of Frequency (RoCoF) caused by infeed losses. With higher SNSP, the frequency nadir following a frequency event may occur within 2s of the event. Therefore, it is important that the Fast Frequency Response occurs as fast as possible.

There may be a technical trade-off between the speed of the response and the accuracy/appropriateness of the response (e.g. a smooth RoCoF response) - if incentives are too great for faster Fast Frequency Response, it may lead to other operational issues if the accuracy of the response suffers (e.g. poorer dynamic response) although it may be possible to mitigate this using the performance scalar.

Complexity

The scalar will be set ex-ante with annual (or longer) granularity and so will not impact on complexity or visibility of tariffs.

5.1.1.3 Recommendation

This scalar should be implemented, as Fast Frequency Response faster than 2s is likely to be required in order to operate the system at high SNSP. If the value of the scalar is set at an appropriate level, and faster responses can be considered in some way in future volume analysis, then this scalar may not have a big impact on the overall system services expenditure of the TSOs, and may even reduce curtailment costs if it allows the TSOs to operate the system at higher levels of SNSP.

5.1.2 Enhanced Delivery of FFR, POR, SOR and TOR1

This scalar would incentivise dynamic, or emulated dynamic, provision of Fast Frequency Response and the short timescale reserve services.

5.1.2.1 Design of the scalar

Magnitude

This scalar would be greater than or equal to one.

This scalar could, alternatively, take values less than or equal to one. This would effectively define a dynamic response as the default type of response. This is an option for the TSOs, although the additional cost of dynamic provision may then have to be considered when setting the base tariff.

Form

This scalar could take values on a sliding scale. The highest value would be for providers who can provide a dynamic response, and the lowest value would be for providers with a static response. Providers with an emulated dynamic response would receive a scalar with an intermediate value. The exact value for emulated dynamic responses would depend on the granularity of the response, e.g. how closely it resembles a true dynamic response. This could be based on the step size of the response and/or characteristics.

For example, if the scalar took values greater than or equal to one, then dynamic providers could have a scalar of 2 and static providers could have a scalar of 1. Emulated dynamic responses could take values of 1.25, 1.5 or 1.75 depending on how closely they emulated the true dynamic response.

Granularity

The value of this scalar should be set once, with potential for review when tariffs are recalculated in following years. The scalar would take this fixed value in all trading periods. This value would be based on the proven capability of the provider.

5.1.2.2 Impact of the Scalar

Payments

This scalar will increase payments if it takes values greater than or equal to one. The scalar would have to be considered when setting the tariffs so as to reduce the risk of overspend.

Expenditure

The scalar increases payments and it will therefore increase system services expenditure in the short term. However, a greater volume of dynamic response/reserve should help the TSOs to operate the system in a more cost effective manner generally, and could possibly reduce the total volume of response/reserve required. For example, if it helps the TSOs to operate the system at higher levels of SNSP then it may lead to a reduction in curtailment costs.

Operations

Provision of dynamic frequency and reserve services should help to keep frequency as close as possible to the nominal value of 50Hz and will therefore improve the security of the system. The TSOs have a minimum requirement for dynamic response and reserve and this scalar should incentivise providers to offer this.

Complexity

The scalar will be set ex-ante with annual (or longer) granularity and so will not impact on complexity or visibility of tariffs.

5.1.2.3 Recommendation

A scalar of this form seems like a simple mechanism by which the TSOs can prioritise the procurement of dynamic reserve, which is required in order to operate the system. This scalar does introduce some risk for overspend which will have to be considered.

5.2 Scarcity Scalars

One scarcity scalar is recommended for implementation:

- A scarcity scalar for temporal variation in the value of DRR and FPFAPR, which varies with SNSP (or other suitable metric).

In addition, a scarcity scalar for temporal variation in the value of reserve products would be beneficial - however, more analysis needs to be undertaken before making a decision on whether or not to implement this scalar.

Three additional scarcity scalars are presented for the TSOs to consider in Annex B.2.

5.2.1 Temporal Variation of DRR and FPFAPR

This scalar would reduce payments for Dynamic Reactive Response and Fast Post-Fault Active Power Recovery when SNSP (or other suitable metric related to non-synchronous generation levels) is low. This would help the TSOs to manage expenditure on procurement of these two services, and also further incentivise provision from those which are expected to be on the system when SNSP is high.

5.2.1.1 Design of the scalar

Magnitude

This scalar would be less than or equal to one.

Form

This scalar would take values on a sliding scale with the value of the scalar proportional to SNSP (or other suitable metric related to non-synchronous generation levels). It could be structured similar to the performance scalar, for example, taking a maximum value of 1 at some upper threshold (e.g. 65%) and dropping to 0 at some lower threshold (e.g. 40%). In between these two thresholds, a linear sliding scale would be the most simple to implement and the most transparent for providers to understand. This is indicated in Figure 2.

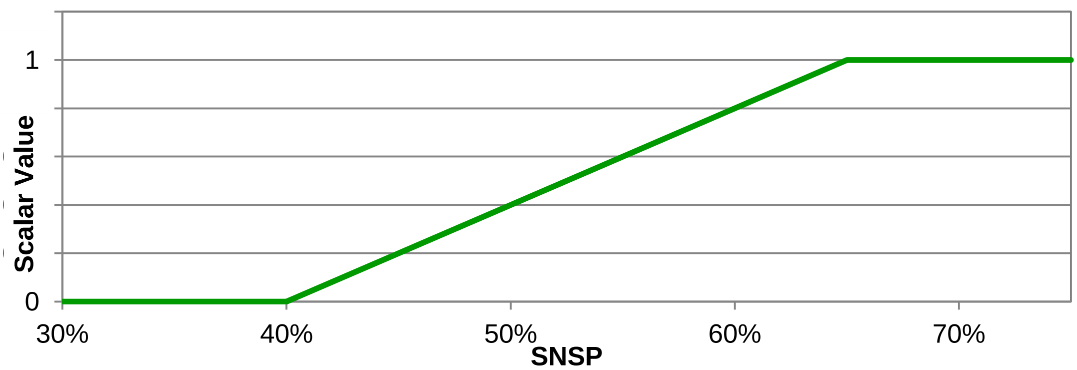


Figure 2: Indicative form of Sliding Scale for Scalar

Granularity

The value of this scalar would have to be determined on a trading period basis, based on average or maximum SNSP during the trading period. Basing it on average SNSP in a day, for example, would not work - if system conditions resulted in high SNSP in the morning and low SNSP in the evening, then generators would receive a much lower payment for the comparatively higher value service which they provided in the morning.

5.2.1.2 Impact of the Scalar

Payments

This scalar would decrease payments as it takes values less than one.

Expenditure

This scalar would directly reduce expenditure. If it did not exist, then there would be a serious risk of over-expenditure on these two products, as providers would still be paid for provision of the service even when SNSP was low enough that the service did not need to be incentivised.

Operations

This scalar would result in operational benefits to the TSOs, as it will further encourage those providers who are most likely to be on the system at times of high SNSP (e.g. non-synchronous providers) to make the necessary investments to provide Fast Post-Fault Active Power Recovery and Dynamic Reactive Response. This may help the TSOs to operate the system at higher levels of SNSP.

In the long term, the TSOs may need to consider using a different metric other than SNSP as the variable for this scalar, as provision of Synchronous Inertial Response may break the correlation between SNSP and inertia.

Complexity

The scalar would introduce a lot of complexity for providers. Although the range of values which the scalar can take would be set ex-ante, providers would have very little knowledge of how exactly SNSP could vary from trading period to trading period throughout a year. This is due to uncertainty in wind forecasting and interconnector flows (although providers may be able to take comfort that wind generation will average out in the long term). In addition, SNSP and inertia are metrics that would not necessarily be easy for industry stakeholders to interpret and understand.

When setting the tariffs, the TSOs would have to consider how the scalar would vary throughout the year to ensure that it is set at an appropriate level to incentivise providers to make the required investments.

5.2.1.3 Recommendation

This scalar will be one of the most important to implement for the rollout of DS3 system services. Without this scalar, it would be very difficult to control the overall scale of payments as large payments could be made to providers who offer this service at times when it does not need to be incentivised. However, the TSOs will need to be wary of the uncertainty which this scalar could introduce, especially for those non-synchronous providers who need to make investments in order to provide these services. Despite the

uncertainty, this scalar will incentivise those providers who are more likely to be on the system when SNSP is high (e.g. non synchronous providers) to provide FPFAPR and DRR, which will be beneficial to the operation of the system.

5.2.2 Temporal Variation of Reserve Products (POR, SOR, TOR1, TOR2, RRS, RRD)

This scalar would reflect the temporal variation in the value of reserve products and would encourage providers to position themselves to provide reserve when the TSOs need it the most.

Implementation of this scalar would be incompatible with the requirement-based volume scalar (Section 5.3.1) as it would be overly complex, for both the TSOs and their customers, to understand if there were two scalars which vary across trading periods applied to any single service.

The discussion on this scalar is applicable to all the products identified above – however, the scalar does not necessarily have to be applied to all of these services. The TSOs should retain the flexibility to apply this scalar to a subset of these services as they see fit.

5.2.2.1 Design of the Scalar

Magnitude

This scalar should take values both less than and greater than one.

Form

This scalar would take values on a sliding scale, based on a correlation between some system conditions, or some seasonal/daily cycles, and the average value of each service for those conditions or in those periods. For some products, the value of the scalar may vary with, for example, SNSP. For others, it may take peak and off-peak values and/or summer/winter values. This would be decided when carrying out the tariff modelling, which would also be used to set the related value of the scalar (e.g. based on an average value for peak periods, or for each value of SNSP).

To be fully cost reflective, there should be no upper or lower limit on the range of possible values of the scalar. Note that this may lead to scalars which take values close to zero, or values greater than two. However, when determining the averages, it would be possible to discard any extreme values or outliers from the outputs of the tariff modelling.

Granularity

The scalar would need to be able to take a different value in each trading period.

5.2.2.2 Impact of the Scalar

Payments

This scalar could increase or decrease unit payments as it would take values greater than and less than one. However, average payments should remain approximately the same (since it is proposed that the base tariff would be based on a volume weighted average).

Expenditure

This scalar would not directly decrease expenditure, but it would instead redistribute system services expenditure amongst providers so that those providers who give most value to the system receive greater compensation.

Operations

This scalar should help to ensure that the TSOs have sufficient flexibility to operate the system at times when reserve services would otherwise be scarce. Specifically. Under I-SEM, it should reduce the extent of non-energy actions which the TSOs will need to take in the Balancing Market, as providers would be more likely to position themselves to provide reserve when the scalar takes a higher value (and the service is scarcer). This may be beneficial for I-SEM's ex-ante markets. If the scalar takes peak/off-peak values then this should be relatively easy for providers to understand and forecast, and they will be able to incorporate the varying value of reserve services into their bids in the Balancing Market.

If the scalar varies with system conditions (e.g. SNSP) then providers may not be able to accurately forecast system conditions so that they are available to offer reserve at appropriate times. Under I-SEM, the system operator will have flexibility in the balancing market to dispatch providers so that they are in a position to provide reserve when the TSOs need it. However, if providers are not able to forecast SNSP, then they will not have an accurate view of the payments which they would receive for reserves, and therefore may not be able to bid cost-reflectively into the Balancing Market.

Complexity

The scalar may introduce complexity for providers, depending on whether it varies with system conditions, or whether it is defined for certain seasonal and/or daily cycles. If it varies with seasonal and/or daily cycles, then it should not introduce significant uncertainty for providers (although it does add an extra layer of complexity to arrangements which are already quite complex). However, if the scalar varies with system conditions (e.g. SNSP) then it is likely to be prohibitively complex. Ultimately, the scalar should not be implemented if it would act as a deterrent to potential investors.

5.2.2.3 Recommendation

This scalar could be implemented and applied to all (or some) of the reserve products (Primary Operating Reserve, Secondary Operating Reserve, Tertiary Operating Reserve - 1, Tertiary Operating Reserve - 2, Replacement Reserve - Synchronised and Replacement Reserve - Desynchronised) as it more accurately reflects the varying value of these services to the system operator. Implementation of the scalar can be integrated with the tariff modelling for these products. However, greater analysis is needed in order to determine whether it should be implemented. Specifically, the TSOs should investigate:

1. If the variation in the value of each service is significant enough to justify the implementation of a scalar;
2. If the value of each service varies in a consistent way;
3. If the value of each service varies with system conditions, or if it varies with seasonal/daily cycles in a way which providers may be able to more easily understand and forecast.

It may be possible to investigate these issues when carrying out the modelling to determine the base tariff values, as this modelling will reveal the time varying value of each service for every trading period in the year. Implementation of this scalar could then be considered for any of the reserve products where the value of the service varies consistently in a way which providers are able to understand and forecast, and this variation is significant enough that the use of a scalar would reduce the extent of TSO actions in the Balancing Market.

This scalar is incompatible with any other scalars which vary in every trading period, particularly the requirement based volume scalar discussed in Section 5.3.1, as it would be overly complex, for both the TSOs and their customers, if there were two scalars which vary across trading periods applied to any single service.

5.3 Volume Scalars

The decision on how to implement the volume scalar should be considered in parallel with decisions on which temporal scarcity scalars to implement.

The two principal options are:

- **Option 1:** A volume scalar based on requirements;
- **Option 2:** A volume scalar based on expenditure.

5.3.1 Volume Scalar Based on Requirements

This is one option for the design of the volume scalar.

Implementation of this scalar would be incompatible with some of the other scalars discussed in this report:

- The expenditure-based volume scalar (Section 5.3.2), as only one form of volume scalar is required,
- Scalars for temporal variation of reserve, Synchronous Inertial Response and Fast Frequency Response (Sections 5.2.2, B.2.2 and B.2.3). It would be overly complex, for both the TSOs and their customers, if there were two scalars which vary across trading periods applied to any single service.

5.3.1.1 Design of the Scalar

Targeted

This volume scalar could be targeted so that certain products are exempt. Exempt products may include Fast Post-Fault Active Power Recovery and Dynamic Reactive Response, as providers of these services will already face uncertainties due to the temporal SNSP scalar, and because these products require specific investments to be made. The TSOs should retain some flexibility to target more or fewer services e.g. there may be other services which would also benefit from being exempt from the volume scalar if there are particular investments required in order to provide the service.

The scalar would almost definitely not be applied to products procured under long-term contracts, but it could potentially apply to short-term contracted auction providers (although this may not be required, as discussed in Section 2.5).

Requirements

The value of the scalar would be calculated in every trading period based on required volumes. For period i, for a given service x, the calculation would take the form of:

$$\mathrm{Scalar}_{\mathrm{i,x}} = \frac{\mathrm{Required\ Volume}_{\mathrm{i,x}}}{\mathrm{Available\ Volume}_{\mathrm{i,x}}}$$

The scalar would not be applied to exempt products, and long- and/or short-term contracted products from the auction could also be exempted.

The scalar would take a maximum value of one, i.e. it would only apply when the required volume is less than the available volume. There could also be a percentage threshold, below which the scalar would not apply, e.g. the scalar may not be applied unless available volumes were 20% greater than required volumes. This would reflect the benefit to the TSOs of having some additional capability on the system above the minimum requirements.

Ex-post

Setting this scalar ex-ante would require accurate forecasting for each trading period of both (i) system conditions and real time requirements, and (ii) the volumes which providers will make available. Therefore, for practicality of implementation, this scalar would need to be set ex-post.

5.3.1.2 Impact of the Scalar

Payments

This scalar will decrease payments as it takes values less than one.

Expenditure

This scalar will reduce expenditure. However, it is less direct than a scalar that is calculated based on expenditure, which means that the TSOs could not guarantee that they will be able to effectively manage expenditure. In order to manage expenditure as effectively as possible, consideration would need to be given to the interactions between the tariff modelling, the volume calculations, and the volume scalar.

Operations

This scalar has the potential to indirectly affect system operation, as providers may change their behaviour across each trading period based on their expectations of what other system service providers will be doing. In order to maximise revenues, providers may seek to avoid offering services at those times when they expect many other providers to offer services[11]. It is unclear exactly what implications this could have for the operation of the system, but there is potential for it to cause unforeseen complications.

[11] This is very similar to TRIAD avoidance in the UK energy market. Demand customers pay network charges based on their consumption in the three TRIAD periods. These periods are determined ex-post and are the three highest demand periods in a year. If demand customers can successfully reduce their consumption in TRIAD period then they reduce their operational costs. TRIAD avoidance therefore has the positive effect of reducing peak demand.

Complexity

This scalar would introduce significant risk and complexity for providers for all targeted services. Arguably, this risk is greater than the risk associated with temporal scarcity scalars driven by SNSP - not only do providers need to estimate the condition of the system, but they also need to estimate how their competitors will behave. One way to mitigate this uncertainty would be to set a "floor" on the potential range of values of the scalar (e.g. 0.5). This would at least help to ensure that providers can make decisions based on a minimum revenue expectation, although it would increase the risk that the TSOs are unable to effectively manage expenditure. However, it may be more appropriate that this risk is shared between service providers and consumers – without a floor, service providers would be bearing all of this risk.

5.3.1.3 Interaction with Temporal Scarcity Scalars

This scalar should not be applied to any services which already have temporal scarcity scalars applied, as this would be onerous to implement and overly complex for providers to understand.

5.3.2 Volume Scalar Based on Expenditure

This is another option for the design of the volume scalar.

Implementation of this scalar would be incompatible with the requirement-based volume scalar (Section 5.3.1) as only one form of volume scalar is required.

5.3.2.1 Design of the Scalar

Targeted

This volume scalar could be targeted so that certain products are exempt. Exempt products may include Fast Post-Fault Active Power Recovery and Dynamic Reactive Response, as providers of these services will already face uncertainties due to the temporal SNSP scalar, and because these products require specific investments to be made. The TSOs should retain some flexibility to target more or fewer services e.g. there may be other services which would also benefit from being exempt from the volume scalar if there are particular investments required in order to provide the service.

The scalar would probably not be applied to products procured under long-term contracts, but short-term contracted auction providers could be affected by it.

Expenditure

The value of the scalar would be calculated every year based on expenditure. For year y, the calculation would take the form of:

$$\mathrm{Scalar}_{\mathrm{y}} = \frac{\mathrm{Budgetary\ Allowance}_{\mathrm{y}} - \mathrm{Exempt\ Expenditure}_{\mathrm{y}}}{\mathrm{Non-exempt\ Expenditure}_{\mathrm{y}}}$$

Exempt expenditure would be the services and procurement methods which were not targeted (as discussed above).

The scalar would take a maximum value of one, i.e. it would only apply when total expenditure exceeds the budgetary allowance. If exempt expenditure exceeded the allowance, then the scalar would take some agreed lower value.

Ex-ante

This scalar could be set ex-ante, based on TSO forecasts of expenditure. This would decrease the risk for providers.

However, an ex-ante scalar could not guarantee that the TSOs will be able to manage expenditure effectively. This could be mitigated by, for example, applying a correction to the scalar calculation which accounted for overspend in the previous year. This correction would also return payments to industry in the event that actual expenditure was lower than the TSOs forecasted.

$$\text{Effective Expenditure Cap} = \text{Actual Expenditure Cap} - \text{Previous Year Overspend}$$

$$\text{Effective Expenditure Cap} = \text{Actual Expenditure Cap} + \text{Previous Year Underspend}$$

There are issues with implementing this type of correction, however, as if contracted providers change from one year to the next, then remuneration is being made to the wrong parties. In addition, the complexity which this introduces may be unnecessary if TSOs forecasts prove to be accurate. It may be better to not take a decision on whether or not to apply such a correction until the TSOs can assess how accurate their forecasting is (e.g. after a few years of enduring operation of DS3 System Services).

The scalar could alternatively be calculated ex-post, which would improve the TSOs' ability to manage expenditure. However, System Service providers are remunerated a month in arrears and the scalar would therefore have to be calculated on a monthly basis (the scalar could also be calculated at a more granular level e.g. weekly, daily, trading period). Therefore, the TSOs would have to take a view on how the System Services budgetary allowance is apportioned between the twelve months of the year.

Although this form of the scalar would be useful for the TSOs, it would introduce greater risk for providers. However, if this scalar was only applied to a certain set of services which were available under the regulated tariff, which would presumably be non-competitive and may be more likely to be provided by existing providers, then making large ex-post adjustments to their payments may be less of an issue.

5.3.2.2 Impact of the Scalar

Payments

This scalar will decrease payments as it takes values less than one.

Expenditure

This scalar is designed to reduce expenditure. Specifically, its form will help to ensure that the scale of expenditure is controlled as accurately as possible whilst maximising certainty for investors and providers.

Operations

This scalar should not have any significant impact on system operation. In the medium to long term, providers will know what scalar will be applied to their tariffs and will be able to act accordingly. If the value of the scalar is too low then it may discourage investment, which would have a negative impact on system operation, however, it will not affect the way in which providers behave in the energy market or the system services market.

Complexity

The scalar does not introduce much complexity for providers in the short-term, particularly if it is set ex-ante. However, it could potentially introduce long-term uncertainty, as providers will have no visibility on what values the scalar could take in future years. One way to mitigate this uncertainty would be to set a “floor” on the potential range of values of the scalar (e.g. 0.5). This would at least help to ensure that providers can make decisions based on a minimum revenue expectation, although it would introduce risk to the overall scale of payments. However, it may be more appropriate that this risk is shared between service providers and consumers – without a floor, service providers would be bearing all of this risk.

[This page is intentionally blank]

ANNEX A DISCUSSION ON THE APPLICABILITY AND MATERIALITY OF SCALARS

A.1 Product Scalar

The purpose of the product scalar is to incentivise enhanced delivery (e.g. dynamic as opposed to static behaviour) or faster response of a service where such delivery / response is of value to the system – the product scalar has therefore been considered in the following analysis as two separate scalars. The applicability and materiality of each scalar to each service is discussed below.

A.1.1 Steady-state Reactive Power (SSRP)

Faster Response: Not Applicable

Steady-state Reactive Power is a steady-state service and therefore a product scalar for faster response is not applicable.

Enhanced Delivery: Medium Materiality

A product scalar could be applied for providers of Steady-state Reactive Power who are able to provide "watt-less VArs", i.e. those with an RP factor of 1. This is with a view to encouraging converter connected non synchronous providers to be able to provide Steady-state Reactive Power when their active power output is low, whether due to environmental conditions (e.g. low wind) or market positions. Currently, the Grid Code requires that wind in particular should be able to provide its full reactive power range down to 12% active power output. To go from an RP factor of 0.88 to 1 would increase payments by 13.6% ($^{1}/_{0.88} = 1.136$). If watt-less VArs are required by the TSOs, and this was not a significant enough increase in the tariff/price to incentivise investment, then a product scalar would be applicable.

A product scalar could be applied to providers of Steady-state Reactive Power who have an AVR installed – this exists currently under the Harmonic Ancillary Services (HAS) arrangements[12]. A scalar here would reflect the fact that it is more valuable if a generator has an automatic response compared to one which needs to be dispatched by the TSOs. However, the TSOs have advised that most providers already have an AVR installed.

The TSOs have also proposed that a product scalar could be used for providers who have specific obligations (e.g. under the Grid Code or through their Connection Agreement) to operate with a Power Systems Stabiliser (PSS). If they do have obligations, then a product scalar <1 could be applied in the event that their PSS is not operating correctly. This could also be implemented in the design of the performance scalar.

A.1.2 Dynamic Reactive Response (DRR)

Faster Response: Low Materiality

A faster response of Dynamic Reactive Response may be useful. However, provision of the Dynamic Reactive Response service is required with a rise time of 40ms. Providing

[12] Harmonised All-Island arrangements for ancillary services were introduced in 2010. These are referred to as Harmonised Ancillary Services (HAS).

this in a timeframe faster than 40ms is likely to prove to be difficult. This would require providers to respond after measurement of just one waveform (which has a period of 20 ms in a 50 Hz system) which will, for example, not allow for any filtering of noise.

Enhanced Delivery: Medium Materiality

The Dynamic Reactive Response product requires providers to inject reactive current (as a percentage of the requirement at nominal voltage) which is greater in percentage terms than the voltage dip (e.g. 31% for a voltage dip of 30%.) There is potential to enhance the delivery of this service by injecting even greater quantities of reactive current during a fault which may be of benefit to the system (as long as the reactive power injection is proportional).

A.1.3 Synchronous Inertial Response (SIR)

Faster Response: Not Applicable

Delivery of Synchronous Inertial Response is not defined over any timescales, and therefore a product scalar for faster response is not applicable.

Enhanced Delivery: Medium Materiality

In their recommendation paper[2], the TSOs proposed that a product scalar could apply to providers of Synchronous Inertial Response to incentivise them to be able to provide other reserve services when operating at their Minimum Stable Generation. A scalar that introduces an incentive to provide Primary Operating Reserve and other services at Minimum Stable Generation is therefore considered in more detail in subsequent sections.

A.1.4 Fast Post-Fault Active Power Recovery (FPFAPR)

Faster Response: Medium Materiality

Fast Post-Fault Active Power Recovery requires that providers return to 90% of their pre-fault active power output within 250ms of the fault clearing. It would be possible to implement a scalar that incentivises providers to return to 90% of their pre-fault active power output in even faster timescales.

However, many providers already recover their output after faults with response times much less than 250ms. The TSOs have advised that certain wind turbine manufacturers can respond in less than 100ms, and synchronous generators will recover their output as soon as the grid voltage recovers.

Therefore, whether or not a scalar of this nature is adopted may depend on how many Fast Post-Fault Active Power Recovery providers already have a faster response. If this proportion is significant, then it may not be desirable to use a scalar to increase payments for an enhancement which is already being offered.

Enhanced Delivery: Not Applicable

Unlike the Dynamic Reactive Response service, where the TSOs could consider requiring greater injections of reactive power, there is no scope to encourage Fast Post-Fault Active Power Recovery providers to increase their active power level following a fault, as asking a provider to return to a higher MW output within 250ms is equivalent to asking them to provide a faster response for 90% of their active power, which is equivalent to a product scalar for faster response.

A.1.5 Fast Frequency Response (FFR)

Faster Response: High Materiality

Providers are only paid for their MW output between 2s and 10s. Some providers will have to ramp up to provide a meaningful level of output. For some converter connected non-synchronous providers, such as wind or batteries, this could take anything up to 500ms. However, the product definition does not incentivise providers to respond faster than 2s. This may result in the capabilities of some providers, whether synchronous or non-synchronous, being underutilised if they could have responded faster than 2s. In the future, on the Irish system, the nadir of a frequency excursion could occur within 2 seconds when SNSP is at around 75%. Therefore, if the purpose of Fast Frequency Response is to arrest frequency, it is very important to have providers responding in a controlled manner as fast as possible.

Enhanced Delivery: High Materiality

There is nothing within the high-level definition of the product to define how the size of the response should vary with the level of frequency or with the Rate of Change of Frequency (RoCoF). This could lead to, for example, providers injecting unnecessarily large volumes of active power onto the system when the frequency drops, leading to an over-frequency response. It is possible to distinguish between three types of response:

1. Dynamic response, where the provider’s output varies constantly, either in proportion to frequency or to RoCoF as soon as the fast frequency response action is triggered;

2. Emulated dynamic response, where the provider has a highly controlled, triggered static response which mimics a dynamic response by injecting or absorbing incremental amounts of power at varying frequency setpoints;

3. Static response, where the provider’s output is fixed and will be provided in full once a fast frequency response is triggered.

A scalar could be used to distinguish between these three types of response. Furthermore, a scalar could also distinguish between different levels of accuracy/ granularity of emulated dynamic response.

A.1.6 Primary Operating Reserve, Secondary Operating Reserve & Tertiary Operating Reserve 1 (POR, SOR, TOR1)

Faster Response: Not Applicable

The timescales for Fast Frequency Response, Primary Operating Reserve, Secondary Operating Reserve and Tertiary Operating Reserve - 1 are aligned so that they provide reserve over complementary timescales. Although faster responses for Primary Operating Reserve, Secondary Operating Reserve and TOR 1 would be possible, they would be unlikely to provide benefit to the operation of the system. For example, Fast Frequency Response is designed to “fill the gap” between a frequency excursion, and Primary Operating Reserve coming on the system, in the event that inertia is low. Therefore, the existence of the Fast Frequency Response service means that the system has no need for a faster response from Primary Operating Reserve, even if it could be provided.

Enhanced Delivery: High Materiality

The same point that was made for the enhanced delivery of Fast Frequency Response also applies to Primary Operating Reserve, Secondary Operating Reserve and Tertiary Operating Reserve 1.

A.1.7 Other Reserve & Ramping Services (TOR2, RRS, RRD, RM1, RM3, RM8)

Faster Response: Not Applicable

The timescale for each of these products is consecutive and therefore a faster response for any of the products is not required / applicable. Although faster ramping is possible for each service, it would be unlikely to provide benefit to the operation of the system as the products have been designed so that the timescales align and provide margin over complementary timescales.

Enhanced Delivery: Not Applicable

Over the timescales for these products, the TSO should have enough control over dispatched capacities that the type of the response is not as important. This is particularly true for the ramping products - the timescales for these are long enough such that the nature of the response (static or dynamic) should not matter.

A.2 Scarcity Scalar

The purpose of the scarcity scalar is to incentivise availability in locations or periods of scarcity for a particular service – the scarcity scalar has therefore been considered in the following analysis as two separate scalars. The applicability and materiality of each scalar to each service is discussed below, and summarised in Table 8.

A.2.1 Steady-state Reactive Power (SSRP)

Temporal Scarcity: Low Materiality

The need for reactive power on an electrical system varies constantly throughout the day, as power flows on the network change. This is driven by the changes to electrical demand and varying dispatch of generation. Varying dispatch from converter connected non synchronous providers will play a part in this, as non synchronous providers, particularly wind, tend to be located in different areas of the network than synchronous generation providers. However, this variation is not fundamentally dependent on the non-synchronous nature of some providers.

Although there is a strong variation in the need for reactive power, the way the product is defined reduces the scope for a scalar to be used. Payments are based on reactive and active power ranges rather than on actual export and/or import of VArs. As providers will be unable to change their capabilities in real time, there will be no way for them to respond to changes in scarcity by adjusting their available volumes. Furthermore, the TSOs have not expressed a strong need to use scarcity scalars to ‘target’ Steady-state Reactive Power payments at specific types of provider under specific network conditions (as is the case for Dynamic Reactive Response and Fast Post-Fault Active Power Recovery).

Locational Scarcity: Medium Materiality

Steady-state Reactive Power is an inherently locational service, and there is therefore scope to include a scalar which reflects the scarcity of reactive power in different areas.

However, the TSOs see Steady-state Reactive Power as a solution to a 'global' requirement for reactive power. A scalar for Steady-state Reactive Power could potentially act as a geographic investment signal for the provision of reactive power. This is not appropriate for three reasons:

1. Scarcity scalars are to be used as availability incentives, rather than as investment incentives;

2. Locational variation in the need for reactive power should be addressed by the adequacy of the TSOs' network planning;

3. Locational variations in requirements should be temporary and scarcity scalars which incentivised investment could therefore lead to an oversupply in future years once the product was less scarce (e.g. once a particular network issue or constraint was resolved).

Therefore, a locational scarcity scalar would only be appropriate if the range of values of the scalar was low enough so as to not act as a signal for investment.

A.2.2 Dynamic Reactive Response (DRR)

Temporal Scarcity: High Materiality

Synchronous generators will intrinsically provide Dynamic Reactive Response during a voltage dip. Therefore, this service is not scarce when there is a lot of synchronous generation on the system. It is only when SNSP is high that this service becomes scarce, as not all converter-connected non-synchronous providers offer this response automatically.

Under the DS3 system services arrangements set out in the SEM Committee decision paper, synchronous generators will receive payments for an inherent service which they are already providing. This would make it difficult to control the overall scale of payments if tariffs are set based on service provision from other technologies.

A temporal scalar could be used which could be linked to inertia or to SNSP, so that payments are lower when there is a large volume of synchronous generation on the system. This would reduce the payments to those providers who are generating at times of higher inertia, although not to zero.

Linking a temporal scalar to SNSP, rather than to seasonal or daily cycles, reflects the fact that the key driver in the variation of value of this service is the penetration of converter connected non synchronous generation

Locational Scarcity: Low Materiality

The requirement for Dynamic Reactive Response will vary depending on the characteristics of the local network, as different areas will experience differing frequencies and magnitudes of voltage dips following faults:

1. In areas where the network is weak, voltage dips are likely to be larger compared to areas where the network is stronger. An increase in the magnitude of voltage dips would therefore increase the risk of equipment tripping and voltage collapse;

2. With a simplified assumption of a uniform failure rate across the whole, weak network areas would be more likely to experience large voltage dips due to remote faults and outages.

The strength of the network in any area could depend on:

- The size of the largest infeed and likelihood of transmission faults in the area;
- The amount of non-synchronous providers connected in the area;
- The local short circuit level.

Implementation of a scalar based on any of these metrics is likely to be very complicated. In addition, a temporal scarcity scalar would already have a secondary locational effect. At high values of SNSP, the non-synchronous providers offering this service are likely to be diversely spread around the Island, away from load centres, in those locations where the network is expected to be weak.

A.2.3 Synchronous Inertial Response (SIR)

Temporal Scarcity: Medium Materiality

Inertia is required on the system at all times. In a system with mostly conventional synchronous generation, there would be no requirement for the Synchronous Inertial Response product as the conventional generators would provide inertia. Therefore, the Synchronous Inertial Response product is only required to facilitate operation of a system with high penetration of non-synchronous generation. By extension, the relative scarcity of Synchronous Inertial Response on the Irish system may be greater at times of higher penetration of non-synchronous generation. Therefore, the scarcity of this product is likely to be strongly correlated to the time-varying value of SNSP. This could be reflected by using a temporal scalar which could be linked to SNSP. The range of values of this scalar may be informed by the tariff modelling exercise which will involve the calculation of hourly prices for this product.

Linking a temporal scalar to SNSP, rather than to seasonal or daily cycles, reflects the fact that the key driver in the variation of value of this service is the penetration of converter-connected non-synchronous providers[13].

Locational Scarcity: Low Materiality

As frequency is consistent throughout a synchronised system, and considering the timescales over which Synchronous Inertial Response is expected to act, locational constraints should not materially impact on the scarcity of Synchronous Inertial Response in different areas.

[13] This is true of the system under current conditions, as inertia is largely provided by providers of active power, leading to a correlation between inertia and SNSP. Therefore, linking a temporal scalar to SNSP could be less appropriate in the future if, for example, provision of the SIR service breaks the correlation between SNSP and inertia.

There may be scenarios in which faults or outages cause the system to separate, with areas of network becoming islanded. In such cases, there may be a need to ensure that both areas of the network have high enough inertia such that safe operation can continue. However, under such a scenario, it should be possible to decrease the level of SNSP on each of the two separated systems, such that they could continue to operate, until the systems are re-connected. Additionally, this is a rare and complex event and may not be an appropriate justification for the inclusion of a scalar.

A.2.4 Fast Post-Fault Active Power Recovery (FPFAPR)

Temporal Scarcity: High Materiality

Synchronous generators will intrinsically provide Fast Post-Fault Active Power Recovery following a fault. Therefore, this service is not scarce when there is a large volume of synchronous generation on the system. It is only when SNSP is high that this service becomes scarce, as not all non-synchronous providers can produce this response.

Under the DS3 system services arrangements, synchronous generators will receive payments for an inherent service which they are already providing. This could make it difficult to control the scale of payments if tariffs are set based on service provision from other technologies.

A temporal scalar could be used which could be linked to inertia or to SNSP, so that payments are lower when there is a large volume of synchronous generation on the system. This would reduce the payments to those providers who are generating at times of higher inertia, although not to zero.

Linking a temporal scalar to SNSP, rather than to seasonal or daily cycles, reflects the fact that the key driver in the variation of the value of this service is the penetration of wind and other non synchronous generation.

Locational Scarcity: Low Materiality

The requirement for Fast Post-Fault Active Power Recovery is different in different parts of the network as, depending on the characteristics of the local network, different areas will experience different magnitudes of voltage dips following faults. Even though Fast Post-Fault Active Power Recovery is an active power service and frequency is global for the system, locational scarcities could still exist and could be used to target payments for Fast Post-Fault Active Power Recovery to the providers in areas where the network is weak. With a simplified assumption of a uniform failure rate across the whole, weak network areas would be more likely to experience large voltage dips due to remote faults and outages. Therefore, providers in these areas are more likely to experience faults which require the Fast Post-Fault Active Power Recovery service.

The scarcity of the service in any area could depend on:

- The size of the largest infeed and likelihood of transmission faults in the area;
- The amount of non-synchronous providers connected in the area;
- The local short circuit level.

Implementation of a scalar based on any of these metrics is likely to be very complicated. In addition, a temporal scarcity scalar will already have a secondary locational effect. At high values of SNSP, the non-synchronous providers offering this service are likely to be

diversely spread around the Island, away from load centres, in those locations where the network is expected to be weak.

A.2.5 Fast Frequency Response (FFR)

Temporal Scarcity: Medium Materiality

Fast Frequency Response is particularly required at times of low inertia, therefore, the scarcity of this product is strongly correlated to the time-varying value of SNSP. This could be reflected by using a temporal scalar which could be linked to SNSP or inertia. The range of values of this scalar may be informed by the tariff modelling exercise which will involve the calculation of hourly prices for this product.

Linking a temporal scalar to SNSP, rather than to seasonal or daily cycles, reflects the fact that the key driver in the variation of value of this service is the penetration of wind and other non synchronous generation.

Locational Scarcity: Low Materiality

The timescales for Fast Frequency Response are such that a locational scarcity scalar does not seem to be appropriate. This is supported by analogy with Synchronous Inertial Response – if the goal of Fast Frequency Response is to simulate an inertial response when inertia is low and SNSP is high, then locational scarcity should not matter as frequency is global throughout the entire system.

There may be scenarios in which faults or outages cause the system to separate, with areas of network becoming islanded. In such cases, there may be a need to ensure that both areas of the network have enough Fast Frequency Response to ensure that safe operation can continue. However, under such a scenario, it should be possible to decrease the level of SNSP on each of the two separated systems, such that they could continue to operate, until the systems are re-connected. Additionally, this is a rare and complex event and may not be an appropriate justification for the inclusion of a scalar.

A.2.6 Reserve Services (POR, SOR, TOR1, TOR2, RRS, RRD)

Temporal Scarcity: Medium Materiality

The value of reserve services will vary with a number of factors such as system demand, generation mix and the size of the Largest Single Infeed (LSI). Temporal scarcity scalars could be used to reflect this varying value.

For procurement via the tariff, the current recommendation is for a uniform annual price. Therefore, there is scope to use a scalar to reflect the temporal variation in prices. This would probably still require some “smoothing” of prices as the relative peak prices of some reserve products is likely to be too large to reflect with scalars (which the SEM Committee envisages will run between 1 and 2.) A temporal scalar for the reserve products could either be set based on SNSP or based on daily/seasonal cycles (e.g. with peak and off-peak values for winter and summer).

Alternatively, this temporal variation in prices could be reflected through the use of a volume scalar with a half hour granularity.

Locational Scarcity: Low Materiality

Currently, there are distinct real-time volume requirements for reserve in Northern Ireland and in Ireland due to the constrained capacity of the North-South connection. However, reflecting these different requirements with a scalar would not necessarily offer any operational benefits to the TSOs. However, the TSOs may reconsider the use of such a scalar if these locational requirements are included as constraints in the tariff modelling exercise and lead to significantly different tariffs.

In the auction, there could be a single procurement to cover the full SEM requirement or two separate procurements (leading to two separate prices). Either way, a locational scarcity scalar would not be applicable or appropriate.

A.2.7 Ramping Services (RM1, RM3, RM8)

Temporal Scarcity: Low Materiality

The purpose of the ramping margin products is to give the TSOs flexibility to operate the system in the face of uncertainty about the levels of variable generation, demand, dispatchable generation availability and, to a lesser extent, interconnector flows (which are expected to be set in the day ahead and intraday markets). Therefore, if a temporal scalar was to be applied to the ramping products, it would have to be based on the time-varying uncertainty of these drivers. The requirement for ramping is likely to be higher at times when wind is forecast to be high – at such times, forecast errors in absolute MW terms would be more significant and so higher levels of ramping capability may be required. However, a scalar which takes different values based on wind forecasting would likely be very complicate to implement and would introduce uncertainty for service providers. Additionally, it is not clear at this point that the variation in the value to the system of the ramping products would be significant enough to justify the use of a temporal scalar.

Locational Scarcity: Low Materiality

The key driver for the ramping margin products is uncertainty about the output from variable renewable generators. Therefore, an argument could be made that providers would offer more value if they are located close to interconnectors or areas with a high concentration of variable generation. However, over the timescales relevant for the products (which are greater than one hour and thus inter-trading period), the TSO should have sufficient control over the operation of the system that locational constraints should not affect the use of the ramping margin products.

[This page is intentionally blank]

ANNEX B SCALARS FOR THE TSOS TO CONSIDER

B.1 Product Scalars

Six product scalars are presented for the TSOs to consider further:

- A product scalar for enhanced deliver of Steady-state Reactive Power with Watt-less VArs;
- A product scalar for enhanced delivery of Dynamic Reactive Response with more reactive current;
- A product scalar for enhanced delivery of Steady-State Reactive Power with an AVR;
- A product scalar for enhanced delivery of Steady-State Reactive Power with a power system stabiliser;
- A product scalar for enhanced delivery of Synchronous Inertial Response with other reserve services;
- A product scalar for faster response of Fast Post-Fault Active Power Recovery;

B.1.1 Enhanced Delivery of SSRP with Watt-less VArs

This scalar would increase the incentive for Steady-state Reactive Power providers to offer their full range of reactive power right down to a 0 MW output.

B.1.1.1 Design of the scalar

Magnitude

This scalar would be greater than or equal to one.

Form

This could be a binary scalar, with a value greater than one for those that can offer their full range of reactive power at 0 MW, and a value of one for those that cannot.

Granularity

The value of this scalar should be set once, with potential for review when tariffs are recalculated in following years. The scalar would take this fixed value in all trading periods. This value would be based on the proven capability of the provider.

B.1.1.2 Impact of the Scalar

Payments

This scalar would increase payments as it takes values greater than one. The scalar would have to be considered when setting the tariffs so as to reduce the risk of overspend.

Expenditure

Since providers are based on a defined range, and paid based on availability, then there is limited scope for this scalar to reduce volume requirements or system services expenditure. However, there may be some situations where larger reactive power ranges (from wind, in particular) mean that other providers do not have to be on the system at all, which may reduce expenditure. This could also reduce the extent of TSO actions in the balancing market. The scalar may help to reduce other TSO costs in the long term, for example, it may reduce the extent of required TSO investment in reactive power compensation equipment.

Operations

The scalar should improve the TSOs' ability to control voltages, particularly in areas of high wind concentrations at times when the active power output of wind is low.

Complexity

The scalar would be set ex-ante with annual (or longer) granularity and so would not impact on complexity or visibility of tariffs.

B.1.1.3 Recommendation

The TSOs could consider implementation of this scalar if they were confident that the system operation benefits were great enough to balance out any potential increase in overall expenditure.

B.1.2 Enhanced Delivery of DRR with more reactive current

B.1.2.1 Design of the scalar

Magnitude

This scalar would be greater than or equal to one.

Form

This scalar could take values on a sliding scale, equal to one for the minimum injection as defined in the base product definition, and with a magnitude of X>1 for the maximum possible injection of reactive current. Intermediate responses would take values on a discrete sliding scale.

Granularity

The sliding scale of values for this scalar should be set once, with potential for review when tariffs are recalculated in following years. The scalar would take one fixed value from this sliding scale in all trading periods. This value would be based on the proven capability of the provider.

B.1.2.2 Impact of the Scalar

Payments

This scalar would increase payments as it takes values greater than one.

Expenditure

This scalar may cause system services expenditure to increase, as it increases payments. If providers are able to offer larger injections of reactive power during faults then this may reduce the total number of providers with whom the TSOs need to hold contracts. However, this would need to be confirmed through analysis.

Operations

This scalar could benefit system operation as it may help to support system voltages during particularly onerous faults. This could be of benefit to the TSOs, for example, if a provider is able to inject additional reactive power and they are located close to another non-synchronous generator who is not able to meet the minimum requirements of the service. However, there is not yet a clear need for this scalar which has been identified by the TSOs.

Complexity

The scalar would be set ex-ante with annual (or longer) granularity and so would not impact on complexity or visibility of tariffs.

B.1.2.3 Recommendation

There is currently no clear need from the TSOs for larger amounts of reactive power during faults above that required in the basic product definition. Therefore, this scalar should only be implemented if the TSOs identify a clear need for this type of enhanced response.

B.1.3 Enhanced Delivery of SSRP with an AVR

B.1.3.1 Design of the scalar

Magnitude

This scalar would be greater than or equal to one.

Form

This would be a binary scalar, with a value greater than one for Steady-state Reactive Power providers who have an AVR installed, and a value of one for Steady-state Reactive Power providers who don’t.

This scalar could, alternatively, take values less than or equal to one. This would effectively define an AVR as the default type of provision. This is an option for the TSOs, although this would have to be considered when setting the base tariff.

Granularity

The value for this scalar should be set once, with potential for review when tariffs are recalculated in following years. The scalar would take this fixed value in all trading periods. The TSOs would have to confirm that the provider’s AVR was installed and operational in order to benefit from the scalar.

B.1.3.2 Impact of the Scalar

Payments

This scalar will increase payments as it takes values greater than one.

Expenditure

This scalar will not directly decrease expenditure, as it will increase payments for the service. AVRs do allow the TSOs to operate the system with greater flexibility, and these operational benefits may be worth rewarding. Additionally, more providers with AVRs, may reduce the total number of providers with whom the TSOs need to contract for Steady-state Reactive Power. This should, in the medium to long term, reduce expenditure.

Operations

This scalar could benefit system operation if it encourages Steady-state Reactive Power providers to install AVRs who do not already have AVRs installed. However, the majority of Steady-state Reactive Power providers already operate with AVRs installed, and therefore, implementing this scalar might increase expenditure without much benefit.

If the TSOs were to decide not to continue to use this scalar, there may be some pushback from industry, as it exists under the current HAS arrangements.

Complexity

The scalar would be set ex-ante with annual (or longer) granularity and so will not impact on complexity or visibility of tariffs.

B.1.3.3 Recommendation

The TSOs could consider implementation of this scalar if they were confident that it would encourage providers to install AVRs. However, if the majority of Steady-state Reactive Power providers already have an AVR installed, then it may not be required. However, if the scalar was not implemented then the TSOs would need to ensure that this was acceptable to industry, as providers have historically received this scalar under the current HAS arrangements.

B.1.4 Enhanced Delivery of SSRP with an PSS

This scalar would encourage providers with an obligation to have a PSS installed to ensure that their PSS is operating correctly.

B.1.4.1 Design of the scalar

Magnitude

This scalar would be less than or equal to one.

Form

This could be a binary scalar, with a value of one for those with obligations to have a PSS installed and for whom it is operating correctly, and a value less than one for those with obligations to have a PSS installed and for whom it is not operating correctly.

For any providers without an obligation to have a PSS installed, this scalar would take a value of 1.

Granularity

The value of this scalar should be set whenever the TSOs can confirm that a provider's PSS has ceased to operate correctly, or that their PSS has begun operating correctly.

B.1.4.2 Impact of the Scalar

Payments

This scalar will decrease payments as it takes values less than one.

Expenditure

This scalar will reduce TSO expenditure, as it will ensure that the TSOs are not overpaying Steady-state Reactive Power providers who are not fulfilling their obligations (as defined in their individual agreements with the TSOs).

Operations

The scalar should help to preserve the stability of the system by encouraging providers who have obligations to operate with a PSS to make sure that it is working correctly.

Complexity

The scalar will be set ex-ante and so will not impact on complexity or visibility of tariffs.

B.1.4.3 Recommendation

This scalar may fall outside of the scope of a product scalar – it is not designed to encourage enhanced delivery, but instead aims to ensure that providers are meeting a minimum standard of performance. Therefore, it may be better to implement it as a variant of the performance scalar.

B.1.5 Enhanced Delivery of SIR with Reserve

This scalar would encourage providers of Synchronous Inertial Response to also provide reserves to the TSOs.

B.1.5.1 Design of the scalar

Magnitude

This scalar would be greater than or equal to one.

Form

This could be a binary scalar, with a value of one for those that cannot provide reserve when operating at their minimum stable level, and a value greater than one for those that can.

Alternatively, the scalar could take multiple values to distinguish between different types of reserve.

Granularity

The value of this scalar should be set once, with potential for review when tariffs are recalculated in following years. The scalar would take this fixed value in all trading periods. This value would be based on the proven capability of the provider.

B.1.5.2 Impact of the Scalar

Payments

This scalar will increase payments as it takes values greater than one.

Expenditure

There is no obvious way in which this scalar would reduce future volume requirements and, therefore, it may lead to an increase in TSO system services expenditure. However, it may allow for Synchronous Inertial Response or Reserve providers to bid more competitively for some or all of these products in competitive auctions.

The scalar may lead to reduction in other TSO costs. For example, minimising the required volumes of conventional generation on the system could reduce the costs of TSO actions in the balancing market – e.g. the TSOs may have to constrain units on to provide reserve less often.

Operations

There is clear benefit to the operation of the system if providers can provide reserve at lower levels of output as, if the TSOs can procure reserve and Synchronous Inertial Response from the same conventional generators, then it should help to increase SNSP, provide greater “headroom” for renewables and lower costs.

However, this scalar has potential to distort the behaviour of conventional generators in a way which could adversely impact on the operation of the system and reduce some of the flexibility available to the TSOs. In particular, this scalar could further reduce the incentives for conventional generators to operating in “parking” mode.

Generators may offer a “parking mode” to the TSOs by reducing their output below their minimum generation. This helps to keep inertia high and may allow for higher SNSP.

Under the DS3 system services arrangements, the Synchronous Inertial Response product will reward providers for being able to operate at a low output, which may indirectly encourage the capability of providers to operate in parking mode – further reductions in output will increase their Synchronous Inertial Response Factor (SIRF), increasing their payments.

However, if parking was to reduce generation to a level at which the provider could no longer offer reserve, then they would not receive payments for reserve. This represents a large opportunity cost. Ideally, the SIR service would encourage providers to lower their Minimum Stable Generation as far as possible, and then this scalar would encourage them to invest so that they can offer reserves at this output level. However, providers may instead choose to declare a higher Minimum Stable Generation so that they can more easily provide reserves (e.g. without having to make additional investments).

This is true of the existing design for the procurement arrangements for this service. However, this scalar would exacerbate the problem, as providers would have even greater

incentive to favour reserve provision over lowering their Minimum Stable Generation and operating in parking mode.

Complexity

The scalar will be set ex-ante with annual (or longer) granularity and so will not impact on complexity or visibility of tariffs.

B.1.5.3 Recommendation

The TSOs could consider implementation of this scalar if they were confident that the system operation benefits were great enough to balance out any potential increase in overall expenditure. In particular, the trade-offs between provision of reserves and lower minimum stable generation and flexible modes of operation such as parking need to be examined in more detail, especially if this would lead to a requirement for large payments to incentivise parking modes or lower available volumes of Synchronous Inertial Response.

B.1.6 Faster Response of FPFAPR

B.1.6.1 Design of the scalar

Magnitude

This scalar would be greater than or equal to one.

Form

This scalar would take values on a sliding scale, equal to one for the minimum response of 250ms and with a magnitude of X>1 for the fastest possible response. Intermediate responses would take values on a discrete sliding scale.

A linear sliding scale would be the most simple to implement. Detailed analysis could, in the long term, be used to set the values and sliding scale for this scalar but this would be very complex to implement.

The upper limit on the speed of the response could be set through consultation with industry, or based on the TSOs' requirement - for example, if there is no need for responses faster than 100ms, then there should be no incremental incentives for providers to increase the speed of their response from 100ms to 50ms.

Granularity

The sliding scale of values for this scalar should be set once, with potential for review when tariffs are recalculated in following years. The scalar would take one fixed value from this sliding scale in all trading periods. This value would be based on the proven capability of the provider.

B.1.6.2 Impact of the Scalar

Payments

This scalar would increase payments as it takes values greater than one.

Expenditure

In the long term, this scalar may reduce the required volumes of Fast Post-Fault Active Power Recovery. If this reduction in volumes is accounted for in future years, then it should not have a significant impact on the total expenditure for Fast Post-Fault Active Power Recovery.

This is particularly true if the scalar is set based on detailed analysis. If high level analysis is used then it is harder to estimate what impact it might have on expenditure.

However, if Fast Post-Fault Active Power Recovery payments are available to all generators, then synchronous generators will be likely to achieve the maximum value of the scalar as they can recover their active power output very quickly after faults. This would increase the payments to these generators but would not provide any benefit to the operation of the system. This would increase the risk of exceeding the budgetary allowance for system services, particularly if the increase in payments was very significant.

Operations

This scalar may help to mitigate high RoCoF by reducing the potential for frequency cascades after transmission faults and losses of infeeds. However, it will only benefit the system at times when SNSP is high. When SNSP is low, conventional generators will be providing this service inherently, and the scalar will not lead to them modifying their behaviour or changing their provision of the service.

Complexity

The scalar would be set ex-ante with annual (or longer) granularity and so would not impact on complexity or visibility of tariffs.

B.1.6.3 Recommendation

The TSOs could consider implementation of this scalar if they were confident that the system operation benefits were great enough to balance out any potential increase in overall expenditure. Particular thought would have to be given to the way in which this scalar could significantly increase the payments made to synchronous generators, and whether this increase in expenditure was justifiable in order to secure a faster response from non-synchronous providers.

B.2 Scarcity Scalars

Three scarcity scalars are presented for the TSOs to consider further:

- A scarcity scalar for locational variation in the value of Steady-State Reactive Power;
- A scarcity scalar for temporal variation in the value of Synchronous Inertial Response;
- A scarcity scalar for temporal variation in the value of Fast Frequency Response.

B.2.1 Locational Variation of SSRP

This scalar would provide greater remuneration to those providers of Steady-state Reactive Power who are located in areas where volume requirements are greater.

B.2.1.1 Design of the Scalar

Magnitude

This scalar should take values both less than and greater than one.

Form

The TSOs will define distinct volume requirements for a number of regions for Steady-state Reactive Power. These volume requirements could be used to determine the relative scarcity of Steady-state Reactive Power in each region. A scalar of 1 could be applied for the average volume requirement across all regions, and then the scalar in each region could reflect variation above and below this average.

Alternatively, the region with the lowest volume requirement could take a scalar with a value of 1 and all other regions with higher volume requirements could take scalars with values >1.

Granularity

The values of this scalar would be set annually when the TSOs complete their volume analysis.

B.2.1.2 Impact of the Scalar

Payments

This scalar would increase payments to some providers and decrease payments to others. Average payments should remain approximately the same (if the scalar of 1 is applicable to the average volume requirement).

Expenditure

This scalar may not have a significant impact on overall TSO expenditure. Instead it would redistribute expenditure in order to provide greater remuneration to providers who are offering the greatest operational benefit to the system.

Operations

When deciding on implementation, the TSOs would have to consider what sort of behaviour this scalar would encourage from those in areas of scarcity. It may transpire that this scalar ends up acting as an investment signal, which is not the intention of the SEM Committee, even when applied to short-term contracted providers and procurement through the tariff. There are issues with using a one-year scalar as an investment signal. It is unclear what other operational benefits or flexible behaviours this scalar would incentivise.

This scalar may bring some operational benefit if it encourages providers to position themselves to be available to provide Steady-state Reactive Power in areas of scarcity, as this may mean that, in some cases, the TSOs do not have to constrain providers on to provide Steady-state Reactive Power.

Complexity

The value of this scalar should be set ex-ante so as to give certainty to providers. However, they may still face uncertainty if they do not know what value the scalar will take in subsequent years. This would reduce the ability of this scalar to act as a locational investment signal.

B.2.1.3 Recommendation

If this scalar is introduced in order to act as an investment signal, then scalar values would likely have to be set for periods longer than a year in order to attract investment. This may be acceptable when procuring for long-term contracts, but would seem to be at odds with the goal of the tariff procurement and short-term contracts in the auction.

Therefore, if the scalar isn't to act as an investment signal, then it is not clear what other operational benefits it would introduce for the system or for the TSOs. It would redistribute some of the total payment for Steady-state Reactive Power, arguably rewarding those providers who give more value to the system. However, it is not clear that this incentive would lead to any other beneficial behaviour changes.

B.2.2 Temporal Variation of SIR

Implementation of this scalar would be incompatible with the requirement-based volume scalar (Section 5.3.1) as it would be overly complex, for both the TSOs and their customers, if there were two scalars which vary across trading periods applied to any single service.

B.2.2.1 Design of the Scalar

Magnitude

This scalar would take values both less than and greater than one.

Form

This scalar would take values on a sliding scale based on a correlation between some system conditions and the average value of Synchronous Inertial Response for those conditions. In the short term, it is likely that this would be based on SNSP. However, in the long term, a high penetration of this service could break the correlation between SNSP and inertia. The range of values of this scalar would be determined when carrying out the tariff modelling – the results of this modelling could also be used to confirm that the value of this product does vary with SNSP (rather than with, for example, peak/off-peak periods).

To be fully cost reflective, there should be no upper or lower limit on the range of possible values of the scalar. Note that this may lead to scalars which take values close to zero, or values greater than two. However, when determining the averages, it would be possible to discard any extreme values or outliers.

Granularity

The scalar would need to be able to take a different value in each trading period.

B.2.2.2 Impact of the Scalar

Payments

This scalar could increase or decrease payments in totality as it may take values greater than and less than one. However, average payments should remain approximately the same (since the base tariff is based on a volume weighted average).

Expenditure

This scalar may not have a significant impact on overall TSO System Services expenditure. Instead it will redistribute expenditure in order to provide greater remuneration to providers who are offering the greatest operational benefit to the system.

Operations

This scalar should further increase incentives for SIR providers to be on the system at high levels of SNSP. This should encourage providers to reduce their minimum generation as much as possible. If they are operating when SNSP is high, then they will receive payments for Synchronous Inertial Response at the times when the scalar takes its highest value.

If this scalar was linked to inertia, rather than to SNSP, then this would lead to cannibalisation – by offering Synchronous Inertial Response, providers would increase system inertia which would reduce the payments they received for this service.

Complexity

Unless this scalar can be linked to seasonal or daily cycles then it is likely to introduce complexity and significant uncertainty for providers as, if they cannot forecast system conditions accurately, then they will not necessarily be able to make the necessary investments in order to provide the service.

B.2.2.3 Recommendation

The TSOs could consider implementation of this scalar if they are confident that it won't discourage investment in the provision of Synchronous Inertial Response. It would potentially bring operational benefits, as it would encourage providers to make sure that they are available for SIR when SNSP is high, but if the complexity (e.g. difficulty in forecasting SNSP) is an investment deterrent, then these operational benefits may not be realised.

B.2.3 Temporal Variation of FFR

Implementation of this scalar would be incompatible with the requirement-based volume scalar (Section 5.3.1) as it would be overly complex, for both the TSOs and their customers, if there were two scalars which vary across trading periods applied to any single service.

B.2.3.1 Design of the Scalar

Magnitude

This scalar should take values both less than and greater than one.

If the TSOs were concerned about over-expenditure for this product, then a scalar which takes values less than one (similar to the Dynamic Reactive Response and Fast Post-Fault Active Power Recovery temporal scarcity scalar) could be appropriate.

Form

This scalar would take values on a sliding scale based on a correlation between some system conditions and the average value of Fast Frequency Response for those conditions. In practice, it is possible that this scalar would be based on SNSP. However, in the long term, a high penetration of Synchronous Inertial Response could break the correlation between SNSP and inertia, in which case a correlation with inertia may be more appropriate. In addition, some future providers of Fast Frequency Response (e.g. batteries) may provide the service 24/7 – such providers would be unlikely to respond to time-varying price signals.

The range of values of this scalar could be determined when carrying out the tariff modelling – the results of this modelling could also be used to confirm that the value of this product does vary with SNSP (rather than with, for example, peak/off-peak periods).

To be fully cost reflective, there should be no upper or lower limit on the range of possible values of the scalar. Note that this may lead to scalars which take values close to zero, or values greater than two. However, when determining the averages, it would be possible to discard any extreme values or outliers.

If the scalar was to take values less than one in order to manage expenditure, then it could be structured similar to the performance scalar, taking a maximum value of 1 at some upper threshold (e.g. 65%) and dropping to 0 at some lower threshold (e.g. 40%). In between these two thresholds, a linear sliding scale would be the most simple to implement and for providers to understand.

Granularity

The scalar would need to be able to take a different value in each trading period.

B.2.3.2 Impact of the Scalar

Payments

This scalar will increase or decrease payments as it may take values greater than or less than one. However, average payments should remain approximately the same (since the base tariff is based on a volume weighted average).

If the scalar took values less than one, then it would reduce payments.

Expenditure

This scalar may not have a significant impact on overall TSO System Services expenditure. Instead it would redistribute expenditure in order to provide greater remuneration to providers who are offering the greatest operational benefit to the system.

If the scalar took values less than one, then it would directly reduce System Services expenditure.

Operations

This scalar may help to ensure that the TSOs have sufficient flexibility to operate the system at times when Fast Frequency Response would otherwise be scarce. However, if the scalar varies with SNSP, then providers may find it difficult to estimate system conditions and ensure that they are providing the service at the right times. In the future, Fast Frequency Response may come from new technologies which could be offering the service all the time. These providers may be less likely to respond to varying price signals.

If this scalar was to take values less than one, then it would introduce an incentive for those providers who are likely to be on the system at times of high SNSP to be able to provide fast frequency response. This may be appropriate if the TSOs want to encourage (for example) wind turbine providers to offer synthetic inertia as Fast Frequency Response.

Complexity

The complexity and uncertainty which this scalar would introduce for providers depends on exactly how it is introduced. If, for example, it took peak and off-peak values and varied above and below an average, then uncertainty would be minimised. However, if it varied with system condition (as expected) then it would increase uncertainty for providers, particularly if it took values less that one.

B.2.3.3 Recommendation

When deciding whether or not to introduce this service the TSOs should consider the types of providers that they would expect to offer the service, particularly under the regulated tariff. A scalar of this type would introduce risk for providers who were seeking to make investments in order to provide this service. This risk would probably be prohibitive, especially if the value of the scalar varied with system conditions like SNSP.

However, this scalar may be appropriate if the TSOs want to target provision of Fast Frequency Response from providers who are more likely to be dispatched at high SNSP. The tariff modelling exercise should reveal whether the value of the service changes enough across trading periods to justify a scalar, and whether this variation could be forecasted by the TSOs and by providers (e.g. SNSP versus peak/off-peak).

[This page is intentionally blank]

ANNEX C INDICATIVE EXAMPLES OF SCALAR IMPLEMENTATION

The following tables provide simple worked examples of different ways in which scalars could be implemented. This is not a summary of recommendations and other implementation options exist for the TSOs:

- **Example 1:** An expenditure-based volume scalar is used, all scalars for which the TSOs should consider implementation are rejected, Dynamic Reactive Response and Fast Post-Fault Active Power Recovery are exempt from the volume scalar, a temporal scarcity for reserve products is not implemented;
- **Example 2:** A requirement-based volume scalar is used, all scalars for which the TSOs should consider implementation are rejected, Dynamic Reactive Response and Fast Post-Fault Active Power Recovery are exempt from the volume scalar;
- **Example 3:** An expenditure-based volume scalar is used, all scalars for which the TSOs should consider implementation are implemented, Dynamic Reactive Response and Fast Post-Fault Active Power Recovery are exempt from the volume scalar, a temporal scarcity for reserve products is implemented;
- **Example 4:** A requirement-based volume scalar is used, all scalars for which the TSOs should consider implementation are implemented, Dynamic Reactive Response and Fast Post-Fault Active Power Recovery are exempt from the volume scalar.

It is assumed in every case that all providers have reliability in excess of 90%.

All scalar values presented are indicative and are not representative of final values which may be used in the ultimate scalar design.

Table 13: Indicative Example 1

Service	Faster Response	Enhanced Delivery	Temporal	Locational	Volume	Performance	Total
SSRP					Yes	Yes	2
DRR			SNSP			Yes	2
SIR					Yes	Yes	2
FPFAPR			SNSP			Yes	2
FFR	Yes	Dynamic			Yes	Yes	4
POR		Dynamic			Yes	Yes	4
SOR		Dynamic			Yes	Yes	4
TOR1		Dynamic			Yes	Yes	4
TOR2					Yes	Yes	3
RRS					Yes	Yes	3
RRD					Yes	Yes	3
RM1					Yes	Yes	2
RM3					Yes	Yes	2
RM8					Yes	Yes	2

Primary Operating Reserve provider:

Enhanced Delivery: The provider has an emulated dynamic response and receives a scalar of 1.5.

Volume Scalar: Annual expenditure is forecast to be 25% higher than the expenditure cap. Therefore a scalar of 100%/125% = 0.8 is applied.

Performance Scalar: With reliability in excess of 90%, the scalar is set to 1.

The Primary Operating Reserve provider receives a tariff of $€X\ /MW \times 1.5 \times 0.8 \times 1 = €1.2X/MW$.

This scaled tariff applies in the relevant trading period only.

Table 14: Indicative Example 2

Service	Faster Response	Enhanced Delivery	Temporal	Locational	Volume	Performance	Total
SSRP					Yes	Yes	2
DRR			SNSP			Yes	2
SIR					Yes	Yes	2
FPFAPR			SNSP			Yes	2
FFR	Yes	Dynamic			Yes	Yes	4
POR		Dynamic			Yes	Yes	3
SOR		Dynamic			Yes	Yes	3
TOR1		Dynamic			Yes	Yes	3
TOR2					Yes	Yes	2
RRS					Yes	Yes	2
RRD					Yes	Yes	2
RM1					Yes	Yes	2
RM3					Yes	Yes	2
RM8					Yes	Yes	2

Fast Frequency Response provider:

Faster Response: The provider has a fast enough response to justify a scalar of 1.2.

Enhanced Delivery: The provider has an emulated dynamic response and receives a scalar of 1.25.

Volume Scalar: The real time volume requirement in the relevant trading period for Fast Frequency Response is 300 MW but 400 MW.are available. A scalar of 0.75 applies.

Performance Scalar: With reliability in excess of 90%, the scalar is set to 1.

The Fast Frequency Response provider receives a tariff of $€X\ /MW \times 1.2 \times 1.25 \times 0.75 \times 1 = €1.125X/MW$.

This scaled tariff applies in the relevant trading period only.

Table 15: Indicative Example 3

Service	Faster Response	Enhanced Delivery	Temporal	Locational	Volume	Performance	Total
SSRP		AVR, PSS, Watt-less VArs		Volumes	Yes	Yes	6
DRR		More MVArs	SNSP			Yes	3
SIR		Reserve	Modelling/ SNSP		Yes	Yes	4
FPFAPR	Yes		SNSP			Yes	3
FFR	Yes	Dynamic	Modelling/ SNSP		Yes	Yes	5
POR		Dynamic	Modelling		Yes	Yes	4
SOR		Dynamic	Modelling		Yes	Yes	4
TOR1		Dynamic	Modelling		Yes	Yes	4
TOR2			Modelling		Yes	Yes	3
RRS			Modelling		Yes	Yes	3
RRD			Modelling		Yes	Yes	3
RM1					Yes	Yes	2
RM3					Yes	Yes	2
RM8					Yes	Yes	2

Steady-state Reactive Power provider:

Enhanced Delivery: The provider has an AVR so receives a scalar of 2.

Their PSS is operating incorrectly, however, so they receive a scalar of 0.5.

They cannot provide Watt-less VArs and so receive a scalar of 1.

The overall product scalar for enhanced delivery is 1.

Locational Scalar: The provider is located in an area where reactive power is less scarce and so receives a locational scalar of 0.9.

Volume Scalar: Annual expenditure is forecast to be 5% higher than the expenditure cap. Therefore a scalar of 100%/105% = 0.95 is applied.

Performance Scalar: With reliability in excess of 90%, the scalar is set to 1.

The Steady-state Reactive Power provider receives a tariff of $€X/MVar \times (2 \times 0.5 \times 1) \times 0.9 \times 0.95 \times 1 = €0.855X/MVar$.

This scaled tariff applies in all trading periods for that year.

Table 16: Indicative Example 4

Service	Faster Response	Enhanced Delivery	Temporal	Locational	Volume	Performance	Total
SSRP		AVR, PSS, Watt-less VArs		Volumes	Yes	Yes	6
DRR		More MVArs	SNSP			Yes	3
SIR		Reserve			Yes	Yes	3
FPFAPR	Yes		SNSP			Yes	3
FFR	Yes	Dynamic			Yes	Yes	4
POR		Dynamic			Yes	Yes	3
SOR		Dynamic			Yes	Yes	3
TOR1		Dynamic			Yes	Yes	3
TOR2					Yes	Yes	3
RRS					Yes	Yes	3
RRD					Yes	Yes	3
RM1					Yes	Yes	2
RM3					Yes	Yes	2
RM8					Yes	Yes	2

Fast Post-Fault Active Power Recovery provider:

Faster Response: The provider has the fastest possible Fast Post-Fault Active Power Recovery response and so receives a scalar of 2

Temporal Scalar: The provider is generating at a time of low SNSP, so the scalar is set to 0.2.

Performance Scalar: With reliability in excess of 90%, the scalar is set to 1.

The Fast Post-Fault Active Power Recovery provider receives a tariff of $€X/MW \times 2 \times 0.2 \times 1 = €0.4X/MW$

This scaled tariff applies in the relevant trading period only.

[This page is intentionally blank]

QUALITY AND DOCUMENT CONTROL

Quality control		Report's unique identifier: **2016/10343-07**
Role	Name	Date
Author(s):	Gordon McFadzean Alan Mason	February 2016
Approved by:	Gareth Davies	February 2016
QC review by:	Anna Ferguson	February 2016

Document control			
Version no.	Unique id.	Principal changes	Date
R0	2015/10343-07	Initial client release	September 2015
R1	2015/10343-07	First Revision	November 2015
R2	2015/10343-07	Second Revision	December 2015
R3	2016/10343-07	Third Revision	January 2016
R4	2016/10343-07	Fourth Revision	February 2016

Pöyry is a global consulting and engineering firm.

Our in-depth expertise extends across the fields of energy, industry, transportation, water, environment and real estate.

Pöyry plc has c.6000 experts operating in 50 countries and net sales of EUR 571 million (2014). The company's shares are quoted on NASDAQ OMX Helsinki (Pöyry PLC: POY1V).

Pöyry Management Consulting provides leading-edge consulting and advisory services covering the whole value chain in energy, forest and other process industries. Our energy practice is the leading provider of strategic, commercial, regulatory and policy advice to Europe's energy markets. Our energy team of 200 specialists, located across 12 European offices in 10 countries, offers unparalleled expertise in the rapidly changing energy sector.

Pöyry Management Consulting

King Charles House
Park End Street
Oxford, OX1 1JD
UK

Tel: +44 (0)1865 722660
Fax: +44 (0)1865 722988
www.poyry.co.uk
E-mail: consulting.energy.uk@poyry.com