DASSA parameters and scalars

A report to EirGrid and SONI

JUNE 2025

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1 Executive Summary

In line with commitments to deliver 2030 Renewable Energy Source (RES) targets and to align with EU requirements, the SEM Committee (SEMC) outlined in its High-Level Design Decision[1] on the System Services Future Arrangements[1] the need to move to a day-ahead auction-based procurement of appropriate system services.

Following the publication of the decision paper on the Day-Ahead System Services Auction (DASSA) Market Design by the SEMC[2], the TSO have initiated a 'Parameters and Scalars' workstream to consider some of the DASSA design aspects. We (AFRY) have been supporting the TSOs in their thinking on some of these DASSA design considerations and parameters. This report sets out this thinking and recommendations to the TSOs on some these key DASSA design aspects.

DASSA auction parameters

Bid Cap and Floor

Price caps are used in electricity markets to protect consumers and mitigate exercise of market power at times of scarcity. However, the price cap should, at the same time, not distort long-run and short-run efficiency. Any cap applied must at least allow for short-run cost operational costs to be recouped, and when considering remuneration over a longer timeframe, efficient providers should be in a position to recover long-run marginal costs.

To help inform Bid Cap choice for the DASSA, we have looked at the potential actual and opportunity costs faced by 'traditional' reserve providers – thermal generating units and BESS. Capacity is an option to deliver energy – ultimately when a unit chooses to provide upward reserve, it is foregoing the option to deliver firm energy in the ex-ante markets. When it chooses to provide downward reserve, it is foregoing the option to trade out if prices are lower in the ex-ante energy markets.

We have attempted to estimate this potential opportunity cost under different scenarios. The focus of this 'inframarginal rent' analysis is focused on thermal units, but we have also considered and accounted for other

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[1] SEMC, SSFA High Level Design Decision, SEM-22-012
[2] SEMC, FASS DASSA Market Design Decision Paper – SEM-24-066, 16 September 2024

technologies (such as BESS) to ensure the proposed Bid Cap allows for opportunity costs to be recovered in most circumstances.

We have also assessed the cost structure of a BESS dedicated to reserve provision, to understand what the Bid Cap should be to allow such providers to recover their LRMC through the DASSA given a certain operating profile.

We propose the use of a 'total' Bid Cap of 500EUR/MW/h. This is in line with the 'indirect' electricity price cap most resources face – the RO Strike Price. We then recommend spreading this 'total' Bid Cap across the individual reserve products on the basis of the relative scarcity given the expected supply margin for each service given an underlying generation portfolio ('Reserve availability approach'). This then means a greater share of the 'total' Bid Cap is assigned to 'scarcer' reserve products. The proposed Bid Cap values for the individual reserve products are presented in Exhibit 1 below.

Exhibit 1 – Proposed Bid Cap values for the individual upward and downward reserve products

Service	FFR	POR	SOR	TOR1	TOR2	RR
'Total' Bid cap at 500EUR/MW						
Reserve availability approach	135	94	81	74	72	44

Notes: The Bid Cap value for the reserve products apply consistently to all the subcategories and the two response types (Dynamic and Static)

We do recognise the relative scarcity can change as the generation mix and the capabilities of the different technologies evolve. The individual Bid Cap values should, therefore, be periodically reviewed.

When it comes to the Bid Floor, we cannot foresee circumstances where there is an economic rationale for bidding negative. Our analysis shows that reserve provision costs can, at times, drop down to 0. We, therefore, recommend, a Bid Floor of 0EUR/MW/h for each reserve product.

Scarcity Price

The TSOs can use the Scarcity Price to manage volume insufficiency in the DASSA. The Scarcity Price should 'kick in' once procured volumes fall below a specific Volume Insufficiency Threshold.

We believe the Bid Cap can act as a reasonable 'scarcity price' signal. However, energy market prices may rise above the RO Strike Price (and as a result above the 'total' Bid Cap), resulting in an inconsistency between the energy markets and the Scarcity Price. In this event, we propose for the 'total' Scarcity Price to increase to the Day-Ahead Market (DAM) clearing price. Effectively, the 'total' Scarcity Price is the maximum of the Day-Ahead Market (DAM) clearing price and the 'total' Bid Cap.

$$SP_{total} = \max(BC_{total}, DAM_{CP})$$

where:

SP_{total} is the 'total' Scarcity Price across all the upward or downward reserve products

BC_{total} represents the 'total' Bid Cap applied in the DASSA for all reserve products with the same direction of response (either upward or downward).

DAM_{CP} is the clearing price of the Day-Ahead Market (DAM) in the SEM

For spreading the 'total' Scarcity Price across the different reserve products, we propose to apply the same relative ratios used in the case of the 'total' Bid Cap.

As stated by the SEMC in SEM-24-066, the TSOs will resolve volume insufficiency by participating in the secondary trading and matching buy and sell orders on an economic merit basis.

DASSA Fallback Procedures

The Fallback Procedures are in place in case of technical issues with the DASSA. In the event of a potential DASSA suspension, the TSOs will settle payments for reserve volumes made available in real-time ex-post. Our assumption is that the RAD will be in place and will be used for remunerating alternative reserve volumes in case of DASSA Order unavailability. Our recommended approach is to:

- use the price and volumes from the Residual Availability Determination (RAD) mechanism in the first instance (should the DASSA not be operational);
- in the case the RAD is not operational either, all available volumes should be paid at a pre-defined regulated price.

Commitment obligations and availability and performance incentives

Exhibit 2 summarises our proposed availability and performance incentive structure for DASSA Orders.

Exhibit 2 – Summary of pre and post-Gate Closure incentives

<table>
<tr><th colspan="3">Pre BM Gate Closure availability incentive</th></tr>
<tr><th>Incentive</th><th>Which volumes are impacted?</th><th>What is the incentive?</th></tr>
<tr><td rowspan="3">Compensation Payment</td><td>— Self-lapsed DASSA Order
— Submission of incompatible FPN
— Exemptions[1]: 1) Lapsed orders as a result of TSO instructions; 2) DASSA Orders for the Trading Periods falling within the Grace Period, post a response delivery by the unit</td><td>— DASSA payments for the lapsed volumes are suspended and the lapsed volumes have to pay a Compensation Payment.
— The Compensation Payment[2], as proposed, is to be calculated as the difference between the adjusted DASSA price and the DASSA Clearing Price.
— In the proposed approach, the ‘adjusted’ DASSA price is the theoretical clearing price excluding the DASSA Orders that were eventually unavailable.</td></tr>
<tr><th colspan="2">Objective / Rationale:</th></tr>
<tr><td colspan="2">— Incentivise service providers to make DASSA Order volumes available by submitting a compatible FPN or find replacement volumes in the secondary market. The Compensation Payment is an estimate of the counterfactual cost faced by the TSOs.</td></tr>
<tr><th colspan="3">Post BM Gate Closure availability incentive</th></tr>
<tr><th>Incentive</th><th>Which volumes are impacted?</th><th>What is the incentive?</th></tr>
<tr><td rowspan="3">Availability Performance Scalar

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Compensation Payment</td><td>— Unavailable confirmed DASSA Order volumes
— Exemptions[1]: 1) Unavailable confirmed DASSA Order volumes as a result of TSO instructions; 2) Confirmed DASSA Orders for the Trading Periods falling within the Grace Period, post a response delivery by the unit</td><td>— DASSA payments for the unavailable volumes are suspended and the unavailable volumes have to pay a Compensation Payment[2] for the concerned Trading Periods.
— Reduced DASSA settlement payments, with the application of the scalar ranging between 0 and 1. The value of the scalar depends on the weighted average monthly performance of the unit and impacts payments for all the Trading Periods in the months falling in the persistence duration of the scalar.</td></tr>
<tr><th colspan="2">Objective / Rationale:</th></tr>
<tr><td colspan="2">— Incentive to maintain availability for the contracted volumes.
— Post Gate Closure incentive for volume availability is stronger than the pre–Gate Closure incentive. This is to maintain a hierarchy and avoid situations where providers can arbitrage between ‘lapsing’ and post Gate Closure unavailability.</td></tr>
</table>

Post BM Gate Closure service delivery incentive		
Incentive	**Which volumes are impacted?**	**What is the incentive?**
Event Performance Scalar	— Failure to respond and deliver the volumes cleared in the DASSA and made available by the unit — This may also extend to the RAD[3] should this be eventually adopted	— Reduced DASSA settlement payments, with the application of the scalar ranging between 0 and 1 in value. — Reduced RAD[3] (should the RAD be adopted) settlement payments, with the application of the scalar ranging between 0 and 1 in value. — The value of the scalar depends on the monthly performance of the unit and impacts payments for all the Trading Periods in the months falling in the persistence duration of the scalar.
	Objective / Rationale:	
	— Incentivise delivery of a service in response to a frequency event or a dispatch instruction, when available to do so. — The scalar has been structured to provide strong incentives to perform in most circumstances.	

Notes: (1) For all the exemptions noted in the table above, the suspension of DASSA payment will continue to apply, in line with the SEMC's decision paper[3] (SEM-24-066); (2) The proposed approach for determining the Compensation Payment as the different between the adjusted DASSA price and the DASSA Clearing Price is the TSOs' preferred option among the approaches considered. It remains subject to change pending the outcome of industry consultation and the subsequent SEMC's decision; (3) Residual Availability Determination (RAD) is the proposed DASSA top-up mechanism option by the TSOs. However, the option and the structure of the DASSA top-up mechanism remains subject to change pending the outcome of industry consultation and the subsequent SEMC's decision.

[3] SEMC, FASS DASSA Market Design Decision Paper – SEM-24-066, 16 September 2024

2 Introduction

The SEM Committee (SEMC) has directed the TSOs (EirGrid and SONI) to introduce a Day-Ahead System Service Auction (DASSA) to replace the current System Services procurement arrangements. In the first instance, the DASSA will be used for reserve products, with the target date for the auction go-live set for December 2026.

In March 2024, the TSOs consulted on the DASSA design with the industry and subsequently submitted a recommendations paper to the SEMC in July 2024. The SEM Committee, in September 2024, published the DASSA Market Design decision paper[2]. Most of the TSOs' recommendations were approved by the SEM Committee. There were, however, two notable exceptions:

- The Final Assignment Mechanism (FAM), which was designed to incentivise real-time availability, and potentially acting as an 'imbalance' price for System Services, was not approved. Design of an alternative framework to renumerate service providers for their real-time availability is now part of a separate work stream, which is being consulted upon and will be subject to SEMC decision.
- The SEMC reserved its decision on the application of a Compensation Payment, which is payable to the TSOs in the event of a lapsed DASSA Order, and directed the TSOs to conduct a consultation on the valuation and application of Compensation Payments.

The TSOs have initiated the "DASSA Parameters and Scalars" work package in the revised PIR v2.0[4] to address elements of the DASSA design that have not yet been finalised, or on which the SEMC decided to reserve judgement (per above).

This report provides the design methodology, supporting analysis, and recommendations on each of those DASSA design elements, considering the underlying objectives and the pertinent market and system constraints.

2.1 Structure of this report

This report is structure as follows:

- Section 3 focuses on the potential DASSA Auction Parameters, in particular:

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[4] FASS-TSOs-PIR-September-2024-EirGrid.pdf

  - price/bid cap and floor;
  - scarcity price;
  - bundling of reserve products;
- Section 4 describes the envisaged commitment obligations and the applicable performance incentives;

2.2 Conventions

All monetary values quoted in this report are in Euros in real 2023 prices, unless otherwise stated. Annual data relates to calendar years running from 1 January to 31 December, unless otherwise identified. Plant efficiencies throughout this report are defined at the Higher Heating Value (HHV) basis. Fuel prices are similarly quoted on a gross (HHV) basis.

2.2.1 Sources

Unless otherwise attributed the source for all tables, figures and charts is AFRY Management Consulting.

3 DASSA auction parameters

3.1 Purpose of Price Cap and Floor

Price caps are typically used to ensure consumer protection, especially in cases where there are competition concerns. These exist in almost all electricity markets. For example:

- there is a price cap in the DAM; and
- a price cap is used in the capacity market auctions.

The DASSA will be a daily auction, and we expect there will be sufficient competition for reserve provision on most days. However, there may still be periods when scarcity emerges, and competition is more limited. In one-shot auctions for annual or multi-year contracts (such as capacity market auctions), the price cap is typically informed by the net cost of new entry, allowing for some contingency. A price cap that is too low can have significant consequences, limiting the income available to providers and, as a result, deterring new entry or resulting in plant exit. A price that is set at a very high level can have little impact in cases of significant competition – competitive pressures can keep the resulting price level well below the price cap. However, when there is market concentration, a high price cap can translate into disproportionate cost to consumers.

The calculation of a price cap and floor must be guided by the expectation of the role these design parameters will play in the market. We have to take into account, on the one hand, market efficiency (allowing bids to reflect actual operating and opportunity costs), and, on the other hand, managing cost to consumers and minimising any potential impact from exercise of market power.

The price cap level should be set at a level that allows long-run marginal cost signals to emerge and helps facilitate efficient short-run operation. This cost estimation is challenging, as there is a wide range of providers with different cost structures and new types of provision may emerge in the future. This uncertainty should be factored into any price cap estimates, and it may be prudent to take a more conservative approach towards potential future costs and income.

3.2 Price caps global overview

Several energy markets have adopted price caps and floors worldwide. For instance, most of the countries across Europe, Australia and the US use a price cap in their wholesale electricity markets. The methodology for calculating or the rationale behind these values often remains undisclosed or is not explicitly defined. Exhibit 3 shows how price caps and floors vary across some selected countries/markets, and the calculation methodology if available.

Exhibit 3 – Overview of price caps and floors

Country and market	Price cap	Price floor	Methodology
Electricity wholesale markets:			
European Markets traded at EPEX Spot[5]	4,000EUR/MWh	-500EUR/MWh	Undisclosed
Spain & Portugal – DA wholesale market[6]	4,000EUR/MWh	-500EUR/MWh	Undisclosed
Spain & Portugal – ID market	9,999EUR/MWh	-9,999EUR/MWh	Undisclosed
Australia – DA Wholesale market[7]	17,500AUD/MWh	Not defined	Considers the price cap from 2010 as a reference, then adds the effect of inflation
Reserve markets			
Canada (AESO) – Reserve markets[8]	100 – 3,000CAD/MWh, depending on the reserve product	Not defined	Undisclosed
PJM	850USD/MWh for each of the reserve products[9]	Not defined	Undisclosed
Ukraine – Reserve markets[10]	32EUR/MW/h for FCR and FRR	Not defined	Undisclosed – formula approved by the NEURC

[5] ACER, HARMONISED MAXIMUM AND MINIMUN CLEARING PRICES FOR SINGLE DAY-AHEAD COUPLING, January 2023
[6] ACER, HARMONISED MAXIMUM AND MINIMUM CLEARING PRICES FOR INTRADAY COUPLING, January 2023
[7] AEMC, 2024-2025 MARKET PRICE CAP, February 2024
[8] AESO, PRICING AND RESERVE MARKET, 16th August, 2024
[9] Monitoring Analytics, ANSWER OF THE INDEPENDENT MARKET MONITOR FOR PJM, 2nd February, 2022
[10] Integrites, FIRST LONG TERM AUCTION FOR ANCILLARY SERVICES, 14th August, 2024

ENTSOE sets a Price Cap and floor of 15,000 €/MWh and -15,000 €/MWh[11], respectively, for the balancing energy markets.

3.3 Price Cap vs Bid Cap

Caping can be achieved either through restricting the bids submitted or an explicit price cap. A price cap limits the auction clearing price, incorporating the cap value into the auction optimisation. This ensures the clearing price does not exceed the set value. As this is known to all participants in advance, there is little incentive to bid above this. A bid cap restricts the maximum bid that can be submitted by a participant, acting effectively as an indirect price cap.

In practice, a bid and a price cap should both deliver equivalent results. We assume for the purposes of this report that a Bid, rather than a Price, Cap and Floor are used.

3.4 Bid Cap

3.4.1 Approach to value determination

We need to understand the **actual variable and opportunity costs faced by different providers** for informing the Bid Cap and a Bid Floor choice. Any cap or floor should not prevent service providers from reflecting such costs in their bids. For this analysis, our focus is more on 'traditional' providers – CCGTs and BESS. **We do, however, recognise that reserve can come from a very diverse set of providers, including the demand-side and RES**.

Our approach focuses on identifying the unit incurring the highest cost—both operational and opportunity—at the time of making reserve capacity available. The objective then is to ensure that:

— any cap or floor applied is at least equal to the short-run cost of operation, so that all providers can recover such costs in any given period; and

— when considering remuneration over a longer period, efficient providers can recover their long-run marginal costs.

Actual and opportunity cost for a synchronised CCGT

A CCGT (and other thermal generating units) has to make a decision at the DAM – should it offer its headroom to the DAM or allocate this to the DASSA? It will then adapt its DAM offer accordingly accounting for the expected income from the DASSA and the subsequent ex-ante energy markets. This expected income from subsequent energy and reserve markets can also influence the synchronisation decision.

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[11] ENTSO-e, EXPLANATORY NOTE ON TO THE METHODOLOGY FOR PRICING BALANCING ENERGY, January 2024

Once a synchronisation decision has been made in the DAM, there are three possibilities:

- the CCGT is partially loaded, but above its minimum stable generation, and has available headroom and footroom;
  - in this case, the CCGT can provide both upward and downward reserve;
- the CCGT is fully loaded and does not have any headroom, but has footroom;
  - in this case, the CCGT can provide downward reserve, but not upward reserve;
- the CCGT is partially loaded, but is at its minimum stable generation, and does not have any available footroom;
  - in this case, the CCGT can provide upward reserve, but not downward reserve.

At the DASSA stage, the CCGT must decide whether to offer its capacity (headroom) for upward reserve provision or allocate it to sell energy in the intraday market. The expected inframarginal rent (intraday price minus variable operating costs) influences this decision and should be informing the bid price for upward reserve provision. A CCGT will effectively participate in the DASSA only if it can secure an economic rent that meets or exceeds the inframarginal rent achievable in the subsequent energy markets.

Exhibit 4 – Factors driving the 'actual' and opportunity costs for a CCGT in providing upward and downward reserves

	Upward reserve	Downward reserve
'Actual' cost (change in variable operating cost as a result of efficiency at different loading levels)	Higher average variable operating cost (operating at lower loading level)	Lower average variable operating cost (operating at higher loading level)
Opportunity cost (foregone inframarginal rent)	Depends on expected intraday market prices and variable operating cost	Depends on expected intraday market prices and variable operating cost

Exhibit 5 – Simplified 'actual' and opportunity cost for a CCGT in providing upward and downward reserves

	Upward reserve	Downward reserve
'Actual' cost (change in variable operating cost as a result of efficiency at different loading levels)	$VOC_{ik} - VOC_{il}$	$VOC_{in} - VOC_{im}$
Opportunity cost (foregone inframarginal rent)	$P^{IDM} - VOC_{il}$	$P^{IDM} - VOC_{im}$

We have assumed the following for the above:

VOC_{ik}, VOC_{il}, VOC_{im}, VOC_{in} are the variable operating costs of provider i at loading levels k, l, m and n with $k<l<m<n$

P^{IDM} is the expected intraday price (noting that there may be various intraday prices for a given settlement period)

We have classed the change in variable operating cost as 'actual' – however, it can also be seen as an opportunity cost. A unit has a scheduled position from the DAM, and it is not making a choice to move away from that in the DASSA. This can only happen in the energy markets.

The above table highlights that when a unit is committing to provide upward reserve it is foregoing any potential energy income and at the same time may be facing higher variable operating costs on a per unit basis (assuming it could generate more at a later stage and increase its relative efficiency). The latter may not apply to all providers. When it comes to downward reserve provision, on the one hand, some providers may benefit from relatively lower variable operating costs but may also miss out on buying back some of the energy in the intraday market in case prices are expected to drop below their variable operating cost.

In a competitive market, electricity prices can rise up to the short-run marginal cost of operation of the most expensive provider. At times, prices may also partially or fully include quasi-fixed costs (such as start-up costs), and even a mark-up at times of scarcity.

The cap should, **at minimum**, reflect the delta between the variable cost of the most efficient CCGT (and at the most efficient point of the heat rate curve) and the least efficient CCGT/GT (and at the most inefficient point of the heat rate curve) on the system. The latter is a proxy for what the intraday electricity price may be assuming short-run marginal cost bidding. As already mentioned, prices can rise above this level if providers include a mark-up in their bidding especially at times of scarcity. This is why we also suggest that the delta between the cheapest and most expensive short-run marginal cost is the minimum level.

The introduction of downward reserve, does, on the other hand, complicate the incentives – as the provider that generates in the DAM does have more 'footroom' for the provision of downward reserves. In the table above we have assumed that upward and downward reserve are not provided simultaneously at a given loading level. The rationale is, however, similar. At some loading levels, providers can offer upward and downward reserve simultaneously.

Actual cost of provision from an unsynchronised CCGT/GT

A CCGT/GT could be 'out of merit' and may not be scheduled in the DAM. In this case, the CCGT/GT would either not participate in the DASSA or would submit a DASSA bid that allows it to recover the entirety or part of the start-up cost. In practice, we expect unsynchronised CCGTs/GTs to be uncompetitive in the DASSA in most cases, especially given the potential provision from alternatives providers, such as storage. The only exception are some of the 'slower' reserve products (such as Replacement Reserve) – some fast-ramping generating units may be in a position to provide such products from an 'off' state.

We also understand that typically the expectation is that such synchronisation costs are recovered through the energy markets (either in the ex-ante markets or the Balancing Market). However, it is still important to test what the potential bid may be for CCGTs and other thermal units that may be attempting to recoup quasi-fixed costs through the DASSA.

An unsynchronised CCGT/GT may also be foregoing intraday energy income. The same rationale as for the opportunity cost for a synchronised CCGT/GT applies in this case with the foregone inframarginal rent being equal to the expected intraday price net of the operating costs.

Cost recovery of dedicated storage

Another 'traditional' reserve resource is storage. Battery Energy Storage Systems (BESS), in particular, been extensively deployed and are used for reserve provision over the last few years. Some short duration batteries are more geared towards reserve provision with their business model centred around frequency response and reserve markets, rather than energy arbitrage. In our analysis of any potential caps we should test whether such units can fully recover their costs (including fixed costs). To achieve this, any Bid Cap should be sufficiently high to allow storage to fully recover its long run marginal costs, given a certain operating profile.

We do not expect that the DASSA will always clear at prices reflecting the reserve provision costs (actual and opportunity) as described further below. We use the below analysis to inform the Bid Cap determination. As we have already pointed out, it is important for the Bid Cap to be set at a level that allows market participants to recover short-run marginal costs in all periods and long-run marginal costs assuming a reasonable operating pattern, while preventing exploitative bidding practices.

3.4.2 Allocation of cap across reserve types

When a provider allocates part of its headroom (or footroom) to reserve, **this volume can be partially or fully used to meet the requirement for more than one reserve products**. This means that a unit may be foregoing some income or incurring a cost, and by doing this can provide and be eligible for payment for more than one reserve products.

We may, therefore, need to allocate a 'total' Bid Cap value, initially calculated for all six reserve products in any one direction, across the different reserve products. We have explored three approaches:

- Battery incremental cost-based approach: Building on the cost recovery approach for reserves for a dedicated storage unit, we analyse how the costs vary for different incrementally defined hypothetical battery durations.
- Reserve availability approach: Analysing the projected total reserve availability, we establish their relative scarcity given an underlying provision portfolio.
- DS3 tariff ratio approach: We consider a simple relativity approach based on the value assigned to each of the product under the current volume DS3 regulated tariff arrangement.

We do recognise, however, that not all technologies can contribute equally and with their headroom (or footroom) to all reserve products.

3.4.3 Value determination exercise

3.4.3.1 Assumptions

Case definition

Commodity prices are an important driver of the short-run operating cost of some of the generating units. We define three cases, each of them with a different combination of gas and carbon prices:

- Case 1 broadly corresponds to current market conditions;
- Case 2 is more in line with AFRY's mid-term view; and
- Case 3 is a more extreme set of assumptions, informed by the recent gas crisis.

Exhibit 6 – Fuel assumptions

Case	Gas price ROI (EUR/MWh fuel)	Gas price NI (EUR/MWh fuel)	Carbon price (EUR/ton CO2)	Carbon emissions for gas (ton CO2/MWh fuel)
Case 1	54	58	80	0.181764
Case 2	42	46	120	0.181764
Case 3	191	196	83	0.181764

Source: AFRY assumptions

CCGT specific parameters

Exhibit 7 shows efficiencies and minimum stable generation of different CCGTs on the All-Island system. Alongside the CCGT parameters we are also presenting parameters for a generic and relatively inefficient GT.

Exhibit 7 – Thermal unit parameters

Thermal Unit (Unit type – Seq.)	Full load efficiency (%, HHV)	Minimum stable generation, MSG (%, nameplate)
CCGT - A	52.70%	48.6%
CCGT - B	52.40%	39.1%
CCGT - C	51.90%	35.6%
CCGT - D	51.50%	48.8%
CCGT - E	49.80%	34.1%
CCGT - F	48.80%	50.5%
CCGT - G	48.70%	29.4%
CCGT - H	51.30%	63.1%
CCGT - I	45.40%	47.1%
CCGT - J	45.40%	47.1%
CCGT - K	46.50%	62.4%
CCGT - L	44.50%	45.7%
CCGT - M	44.50%	45.7%
CCGT - N	44.50%	45.7%
GT - A	35%	30%

The third set corresponds to other operational parameters and assumptions in terms of the operation and can be found in Exhibit 8.

Exhibit 8 – Other CCGT operational parameters

Parameter	Value
Fixed start-up cost	41.1EUR/MW-start
Variable start-up cost	1.2MWh fuel/MW-start
Variable opex	3.2EUR/MWh
Minimum reserve availability, MRA	10% of nameplate capacity**
Assumed minimum on time (MOT)	24 hrs*

* This is not the technical minimum on time, rather an assumed minimum on time to allow us to spread the start-up cost across more than on settlement periods
** A CCGT cannot provide its entire headroom for each of the reserve products. We have assumed that it can only offer 10% of the registered capacity (equal to the Grid Code minimum requirement for TOR1 and TOR2) and all start-up costs have to be recovered from a reserve volume equal to that 10% of the registered capacity.

For the total start-up cost of a thermal unit, we consider the following formula:

$$\text{Start-up cost}_k \left[\frac{\text{EUR}}{\text{MW}}\right] = \text{Var Start-up cost}*(\text{Gas price}_{X,K} + \text{Carbon emissions} * \text{Carbon price}_X) + \text{Fixed Star-up cost}$$

where K correspond to a CCGT in the system and X corresponds to the chosen case

BESS parameters

We have created 'hypothetical' battery sizes to reflect units that have the exact capabilities to provide the different services incrementally. These are presented in Exhibit 9.

Exhibit 9 – BESS parameters

Battery duration	Reserves availability	Capex (EUR/MW)	Opex (EUR/MW-yr)	Hurdle rate (%)	Financial lifetime (years)	Build time (years)	Asset operation cost (%)	Revenues from reserves
1.5-MIN	FRR, POR, SOR,	426,371	3% of capex	11.5%	17	2	5%	100%
5-MIN	FRR, POR, SOR, TOR1,	463,850	3% of capex	11.5%	17	2	5%	100%
20-MIN	FRR, POR, SOR, TOR1, TOR2,	484,108	3% of capex	11.5%	17	2	5%	100%
1-HR	FRR, POR, SOR, TOR1, TOR2, RR	544,884	3% of capex	11.5%	17	2	5%	100%

Source: AFRY assumptions

3.4.3.2 Opportunity cost analysis for CCGT and GTs

The formula for estimating the short-run marginal cost of a CCGT/GT is as follows:

$$\text{Energy Bid}_k \left[\frac{\text{EUR}}{\text{MWh}}\right] = \frac{\text{Gas price}_{X,K} + \text{Carbon emissions} * \text{Carbon price}_X}{\text{Efficiency}_K} + \text{Variable Opex}$$

where K correspond to a CCGT in the system and X corresponds to the chosen case

We recognise that this is the variable cost of a unit at full load efficiency, and the average variable cost would be different at different loading levels.

The associated results for each individual CCGT are then shown in Exhibit 10.

Exhibit 10 – Short-run marginal cost for different CCGTs and a GT (EUR/MWh)

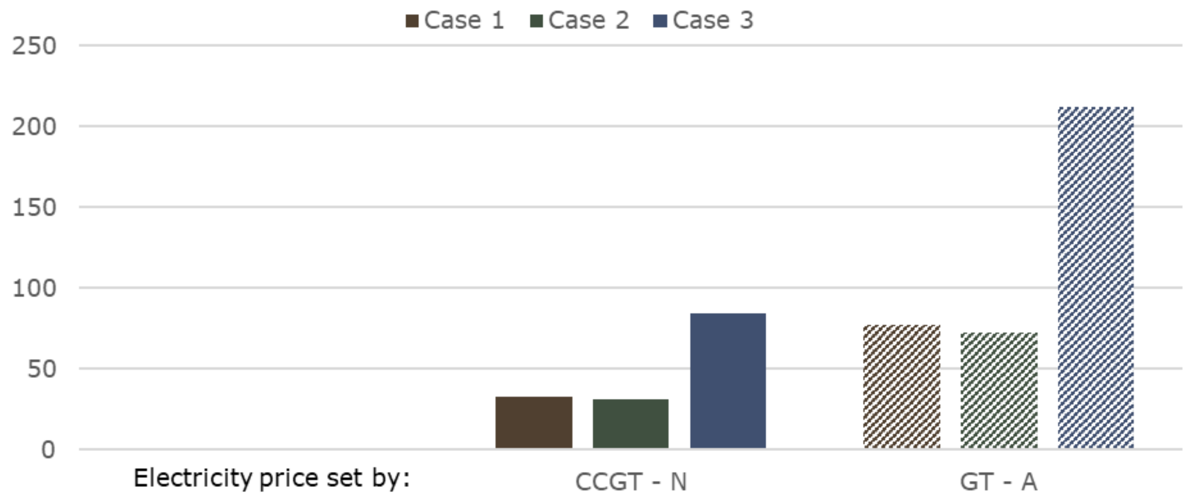
Calculated values based on the representative marginal costs formula and assumptions

Thermal Unit (Unit type – Seq.)	Case 1	Case 2	Case 3
CCGT - A	133.26	124.00	393.88
CCGT - B	134.00	124.69	396.11
CCGT - C	135.26	125.86	399.90
CCGT - D	136.29	126.81	402.98
CCGT - E	140.83	131.03	416.63
CCGT - F	143.65	133.65	425.10
CCGT - G	143.94	133.92	425.96
CCGT - H	144.70	135.19	415.06
CCGT - I	154.17	143.42	456.69
CCGT - J	154.17	143.42	456.69
CCGT - K	159.31	148.82	457.58
CCGT - L	166.33	155.36	478.00
CCGT - M	166.33	155.36	478.00
CCGT - N	166.33	155.36	478.00
GT - A	210.46	196.95	606.30

Given these values, we can then determine the relevant inframarginal rent for each unit on the assumption that the electricity price is set by the short run marginal cost of the most expensive CCGT on the system. The range of inframarginal rent assuming the electricity price is set by the most expensive CCGT for each of the defined cases is presented in Exhibit 11.

Assuming that the price is set at the short-run marginal cost of the 35% efficient GT, the opportunity costs for the most efficient CCGT on the system would be 77.2EUR/MWh in Case 1, 72.95EUR/MWh in Case 2 and 212.42EUR/MWh in Case 3. This is significantly higher than the inframarginal rent presented in Exhibit 11.

Exhibit 11 – Opportunity costs of the most efficient CCGT, when synchronised (EUR/MWh)



Note: Cases 1 and 2 represent values similar to those expected in AFRY's modelling in the medium term (assuming no scarcity rent), whilst Case 3 reflects a more extreme gas price scenario. The assumption is that the electricity price is set at the level of the short-run marginal cost of the most expensive CCGT or a GT on the system, depending upon considered scenario.

Source: AFRY analysis

The rationale for downward reserve provision is similar. A unit providing reserve may be foregoing expected profit from participating in the intraday market, should prices in the intraday market drop below its variable cost of operation. Using the above approach of the differences in variable cost of operation between the cheapest and most expensive unit on the system, the results would be the same. The only difference is we would be comparing the variable operating cost of the most expensive unit against an intraday price set by the 'cheapest' unit.

Assuming that there is abundant RES generation in the DAM, and no thermal units are scheduled in the DAM, DAM prices will most likely be very low – zero or even negative. This then means that thermal units will be much less competitive in the DASSA, and we explore the potential offers below, assuming a need to recoup their entire cost of operation through the DASSA.

For unsynchronised units we need to also consider start-up costs. The adjusted equation is as follows:

$$\text{Energy Bid}_{K}\left[\frac{\text{EUR}}{\text{MWh}}\right]=\frac{\text{Gas price}_{X,K}+\text{Carbon emissions}*\text{Carbon price}_{X,K}}{\text{Efficiency}_{K}}+\text{Variable Ope}x+\frac{\text{SUC}_{K}}{\text{MRA}*\text{MOT}}$$

where K corresponds to a CCGT in the system and X corresponds to the chosen case

start-up costs are fully allocated as a cost of reserve provision;

SUC: Start-up cost;

MRA: Minimum reserve availability; and

MOT: Minimum on time

The associated results, including both the values for the short-run marginal costs previously calculated and the variable operating costs (including start-up costs) for unsynchronised units are presented in Exhibit 12. As previously noted, this approach seeks to only provide a view of the full cost of activating a unit just for reserve provision, and we are not necessarily implying that all costs should be recouped from reserve provision, even if from a pure economics perspective there may be times when the value of energy is low (or even zero) and the value of reserve is high.

Exhibit 12 – Variable operating cost including start-up cost (EUR/MWh)

Calculated values based on the representative marginal costs formula and assumptions

Unit	Case 1		Case 2		Case 3	
	SYNC	UNSYNC	SYNC	UNSYNC	SYNC	UNSYNC
CCGT - A	133.26	210.36	124.00	196.83	393.88	591.15
CCGT - B	134.00	211.10	124.69	197.52	396.11	593.39
CCGT - C	135.26	212.36	125.86	198.69	399.90	597.17
CCGT - D	136.29	213.39	126.81	199.64	402.98	600.26
CCGT - E	140.83	217.93	131.03	203.86	416.63	613.90
CCGT - F	143.65	220.75	133.65	206.48	425.10	622.37
CCGT - G	143.94	221.04	133.92	206.75	425.96	623.24
CCGT - H	144.70	225.35	135.19	211.56	415.06	617.06
CCGT - I	154.17	231.27	143.42	216.25	456.69	653.97
CCGT - J	154.17	231.27	143.42	216.25	456.69	653.97
CCGT - K	159.31	239.95	148.82	225.19	457.58	659.58
CCGT - L	166.33	246.97	155.36	231.73	478.00	680.00
CCGT - M	166.33	246.97	155.36	231.73	478.00	680.00
CCGT - N	166.33	246.97	155.36	231.73	478.00	680.00
GT - A	210.46	621.56	196.95	608.05	606.30	1017.4

Note: Column SYNC corresponds to costs for synchronised units (does not include start-up cost); column UNSYNC covers unsynchronised units (and includes start-up cost)

For the GT we have assumed that the entirety of the start-up costs is recovered in a single hour, whereas for the CCGT we assume this is spread over 24 hours

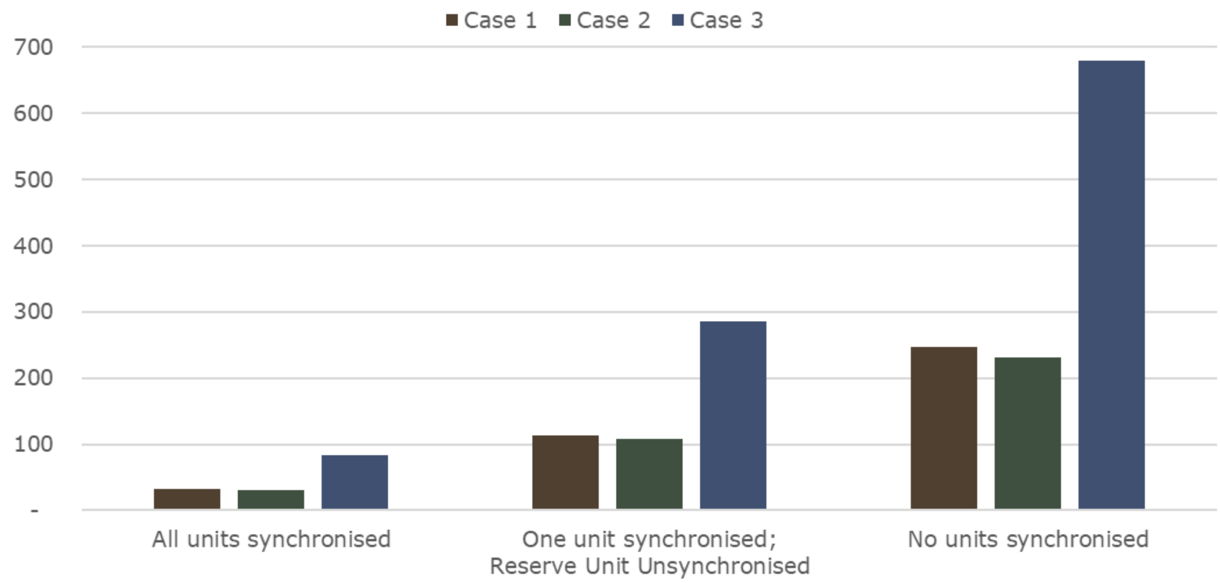
Source: AFRY analysis

Based on these, we then estimate the CCGT opportunity costs under two ‘conditions’:

- when there is at least one CCGT synchronised, but the unit that provides reserve is not – in this case, the delta corresponds to the difference between the maximum energy bid of the unsynchronised units and the minimum energy bid of a synchronised unit; and
- when there are no synchronised CCGTs, we take the maximum energy bid of the unsynchronised units and assume that the price of energy is set zero.

The ranges under the different 'conditions' and for the different commodity cases can be seen in Exhibit 13. For reference, we also include the results for synchronised units. If we were to also include the GT in this analysis, the equivalent range would have been around 500EUR/MWh for Cases 1 and 2 and around 600EUR/MWh in Case 3.

Exhibit 13 – CCGT opportunity costs (EUR/MWh)



Source: AFRY analysis

Cost recovery for dedicated BESS

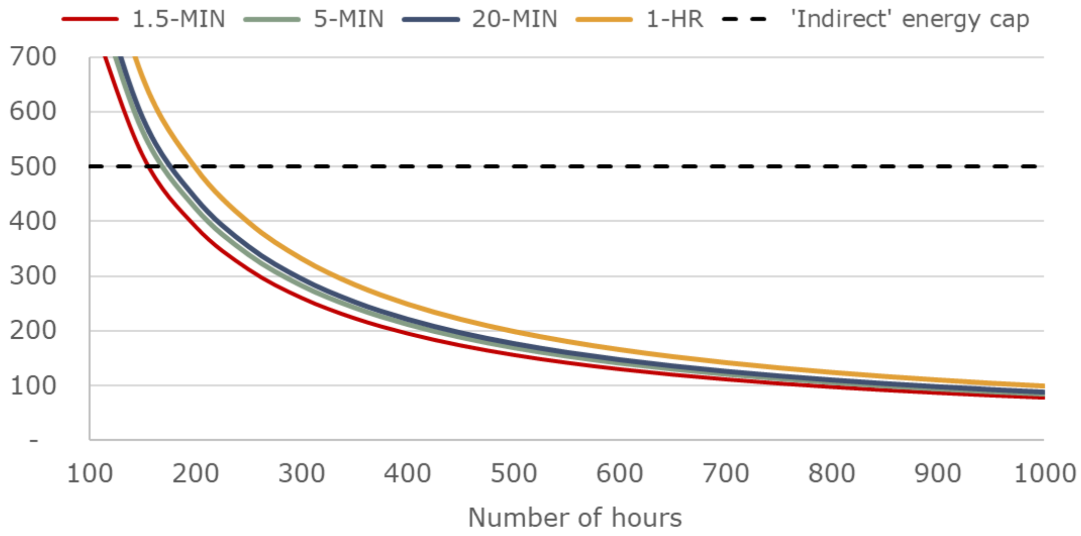
The annualised capex of a BESS unit can be calculated based on the formula:

$$\text{Annualised cost}\left[\frac{\text{EUR}}{\text{kW}}\right] = \frac{\text{Capex}}{\text{Build time}} * \frac{\sum_{t=1}^{\text{Build time}}(1+\text{HR})^t}{\sum_{t=1}^{\text{Financial lifetime}}\frac{1}{(1+\text{HR})^t}}$$

Exhibit 14 shows the required price to ensure full cost recovery (including a reasonable rate of return) as a function of 'DASSA' operating hours. Full cost recovery means that the annualised capex and the fixed opex can be recovered solely from DASSA income ignoring any potential income from energy arbitraging.

Obviously, a dedicated BESS can offer reserve over a much more extended period of time in a year, well above the 1000h cut-off we are presenting below. For example, a 1h BESS with 95% availability and 1 cycle per day (for energy arbitraging), can provide reserve for 7227h in a year. Assuming that the annualised cost can be recouped over 7227h, then the required hourly price would be significantly lower than what is presented in the curves of Exhibit 14.

Exhibit 14 – Required 'total' DASSA price to ensure cost recovery (EUR/MW/h)
Required total reserve payment for a period per type of battery, as a function of the number of hours receiving payment at that level



Note: Virtual batteries to provide incremental services; 1.5-min for FRR-SOR, 5-min covering up to TOR1, 20-min covering up to TOR2 and 1-hr up to RR.

3.4.3.3 Allocation of a 'total' Bid Cap across reserve products

Potential reserve providers can simultaneously cover more than one of the reserve products. Once we have estimated a 'total' Bid Cap, we then need to determine how that is allocated across the different reserve products. We have explored three different options.

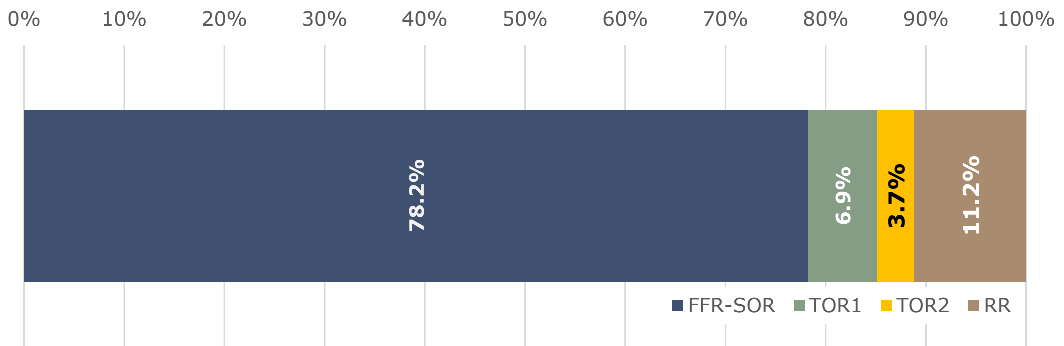
Relativity of BESS incremental costs

We have already presented the annualised cost for BESS of different durations. Using this, we can differentiate the cost of providing a service by the difference in annualised cost between BESS durations as follows:

- a 1.5-min BESS can cover the bundle of FFR to SOR;
- the gap in cost between 5-min and 1.5-min batteries reflects the incremental cost of providing TOR1;
- the gap between 20-min and 5-min BESS reflects the incremental cost for providing TOR2; and
- the gap between 1-hr and 20-min BESS reflects the additional cost for RR provision.

Most of the value is concentrated in the FFR to SOR bundle. However, a further split into each of the services included is not possible with this methodology.

Exhibit 15 – Allocation based on BESS relative incremental cost



Source: AFRY analysis

Relative availability of reserves per product

Alternatively, we can consider spreading the total value of the 'total' Bid Cap depending on the total available reserves for each product. This would be based on the inverse proportion of the 'margin; for each reserve, assigning greater value, where there is scarcity. We have estimated the total available volumes for a given generation portfolio in 2027, as shown in Exhibit 16. The inverse proportion is calculated based on the formula in Exhibit 17. The results of the inverse proportion calculation exercise are shown in Exhibit 18.

Exhibit 16 –Available reserve volumes estimates per service (MW) for 2027

Unit	FFR	POR	SOR	TOR1	TOR2	RR
Conventional thermal	435	981	1450	1710	2656	5660
DSR	213	247	262	339	349	483
Wind and solar	0	394	411	403	0	0
Interconnection	225	225	225	225	225	0
Batteries	1320	1320	1320	1320	884	608
Total	**2193**	**3167**	**3669**	**3997**	**4113**	**6751**

Source: AFRY analysis

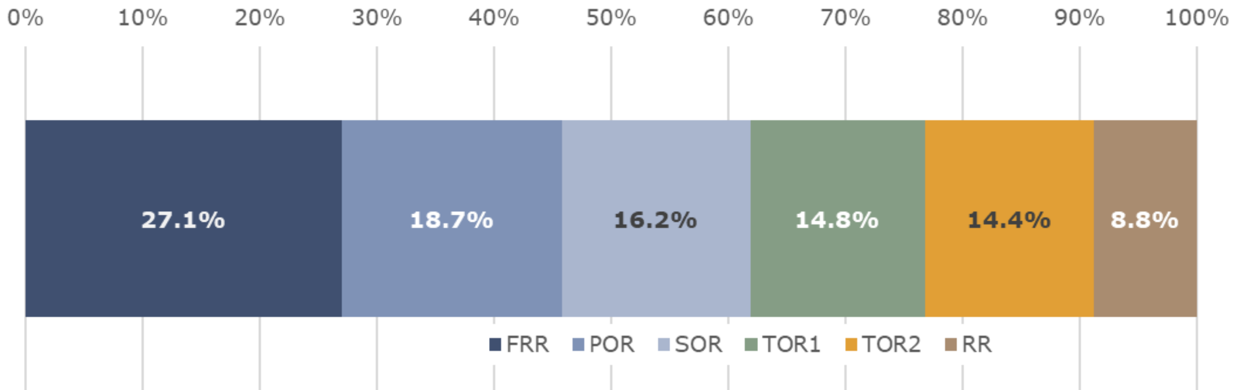
Exhibit 17 – Calculation of split factors through inverse proportion

Formula for split factors using inverse proportion

$$Split\ factor_K\ [\%] = \frac{\frac{1}{ARy_K}}{\sum_{Services} \frac{1}{AR_I}}$$

Note: AR_K corresponds to the total available reserve for product K, with the products corresponding to FFR, POR, SOR, TOR1, TOR2 and RR

Exhibit 18 – Split factors based on total availability of reverses per product



Source: AFRY analysis

This relative scarcity in the 'faster response' products, such as FFR and POR, is driven by the significantly lower contribution to these products from conventional units, and the relatively lower levels of short-duration storage in 2027. This relativity is likely to change in the future if additional storage is added to the system and conventional units are gradually removed. We would therefore expect this to be periodically reviewed and the Bid Cap allocation changed if there are significant changes in the underlying generation portfolio.

Ratio of existing DS3 tariff rates

As an alternative to the previously described methodologies, we consider the approach of maintaining the ratio currently applied for reserve payments under the DS3 regulated arrangements. The values for the split factors following this logic are shown in Exhibit 19.

Exhibit 19 – DS3 reserve service payments (EUR/MW)

Service	FFR	POR	SOR	TOR1	TOR2	RR (D)
Payment	1.94	2.92	1.76	1.40	1.12	0.56
Split factor	20%	30%	18%	14%	12%	6%

Source: DS3 System Services Statement of Payments, Aug-2022
Note: The regulated tariff values considered for each reserve product exclude the applicable scalars under the DS3 regime.

3.4.4 Recommended value for the Bid Cap

Throughout this section we have presented what the actual and opportunity costs are for some more 'traditional' providers of reserve. This analysis is used to help us determine the potential Bid Cap. We believe that the 'total' Bid Cap should be set at a level, such that it ensures consistency with the energy markets. Reserve capacity is ultimately an option to deliver energy.

There is currently an 'indirect' cap in the effective price that most resources can capture and that is the RO Strike Price. We believe this should be the starting point for the overall 'total' Bid Cap. If this changes in the future and is increased, this should also trigger an increase in the reserve Bid Caps.

This 500EUR/MW/h Bid Cap is equivalent to the price a dedicated BESS unit would need in 200 hours to recover its annualised capex and fixed opex. We believe this strikes a good balance between consumer protection from high price spikes and ensuring there is scope for reserve providers to recover their costs and capturing a reasonable return. It also represents a significant increase from the current regulated tariffs.

In Exhibit 20 below we then compare the values determined when combining the 500EUR/MW/h 'total' Bid Cap with the different allocation approaches and the Bid Cap needed for even the most efficient synchronised CCGT to fully capture its opportunity cost under the different cases we have explored further above, assuming the electricity price is set at the level of the most expensive CCGT and that of a GT respectively.

Exhibit 20 – Bid Cap per reserve product (EUR/MW/h)

Service	FFR	POR	SOR	TOR1	TOR2	RR
'Total' Bid Cap at 500EUR/MW						
BESS incremental cost-based approach (1)	174	116	100	34	19	56
Reserve availability approach	135	94	81	74	72	44
DS3 tariff ratio approach (2)	100	151	91	72	58	29
Required Bid Cap value to recoup CCGT opportunity assuming electricity price set by CCGT (3)						
Case 1	-	-	32	27	18	8
Case 2	-	-	31	26	17	8
Case 3	-	-	82	70	45	21
Required Bid Cap value to recoup CCGT opportunity assuming electricity price set by GT (4)						
Case 1	-	-	75	64	41	19
Case 2	-	-	71	60	39	18
Case 3	-	-	207	176	113	53

Note: (1) For the BESS approach the methodology does not cover the breakdown into FFR, POR and SOR; we have split the values using the same ratio as for the reserve availability approach; (2) DS3 scalars were not considered in the approach of spreading the 'total' cap across different reserve products proportionate to the respective tariffs under the DS3 volume uncapped regime; (3) We have allocated the cap for the CCGT based approach assuming all the revenues come from SOR, TOR1, TOR2 and RR, and divide the 'total' foregone income uniformly across these products. We then adjust by a relative contribution to each service: for every 1MW of RR, 0.47MW of TOR2, 0.30MW of TOR1 and 0.26MW of SOR can be provided; (4) This assumes the intraday price is set by a GT rather than a CCGT. The Bid Cap value is allocated as per above.

We recommend setting the 'total' Bid Cap at 500EUR/MW/h[12] with this cap spread across the different reserve products either as per the BESS incremental cost-based approach or the reserve availability approach. The same overall value and spreading across products should apply also to downward reserve.

It is recognised that there are significant differences in the capacity mix between the two jurisdictions, particularly with respect to battery storage, as illustrated in Exhibit 21. These differences are expected to influence the composition of reserve provision by technology type, at least in the near term. In Northern Ireland (NI), thermal units are anticipated to contribute a larger share of reserve requirements, whereas in the Republic of Ireland (ROI), battery storage is expected to provide the majority share.

Exhibit 21 – Installed capacity mix for Ireland and Northern Ireland in 2025 (GW)

Technology Type	Installed capacity	
	Northern Ireland	Ireland
Battery	0.2	1.0
Demand Shedding	0.2	0.6
Thermal[1]	2.0	5.4
Renewable[2]	1.7	8.0
Pumped Storage	0.0	0.3
Hydro[3]	0.0	0.2
Interconnection	0.5	1.0

Notes:
(1) 'Thermal' plant type includes Aggregated Small CHP, Biomass, CCGT, Engine, GT, and Waste capacity.
(2) 'Renewable' plant type includes Onshore, Offshore, and Solar PV capacity.
(3) 'Hydro' plant type includes run-of-river and reservoir capacity.
Source: AFRY analysis

The recommended Bid Cap value supports the recovery of both actual and opportunity costs for 'traditional' reserve providers across both jurisdictions within the SEM. This is because the underlying costs of reserve provision are broadly consistent between the jurisdictions. As such, the recommended Bid Cap is considered appropriate for application across both the jurisdictions.

Based on operational experience, if there is market concentration in a certain jurisdiction, Bid Cap may be introduced on jurisdictional basis. This would need input and approval from the Regulatory Authorities.

The 'total' Bid Cap and the Bid Caps for each individual reserve products:

— allow for a **provider that can equally contribute to all reserve products and offer its capacity for the entire FFR-RR 'bundle' to**

[12] In event of revision of the RO strike price, the Bid Cap should be set as per the prevailing RO strike price.

capture an overall payment equal to the effective energy payment at times of scarcity;

- we recognise, however, that when and if electricity prices are above the RO Strike Price, this creates an incentive for providers to move to energy provision, and we are accounting for this in our approach to scarcity pricing;

- there is more scope for price to be higher for the short duration products, and these are the ones where there is greater scarcity given the underlying generation portfolio;
  - we do recognise however, that this may change as the generation portfolio changes, and the relativity across the different services may need to be revisited in the future;
- it **allows a synchronised CCGT to recoup its foregone revenue under most circumstances**;
  - we do appreciate, however, that in cases of high commodity prices this may not be achieved, and we could see merit in potentially having higher caps for TOR2 and RR.

We recognise, as can also be seen by our analysis above, that there are circumstances when some thermal units may be unable to recoup their entire cost of operation through the DASSA. This can happen when there is abundant RES generation and there is limited scope for thermal generation, and thermal units would need to be ‘turned on’ subsequently to provide reserve. We expect that in such circumstances alternative providers will be more competitive. If such provision is not sufficient to meet the reserve requirements, the TSOs can use scarcity pricing to procure further reserve.

3.5 Bid Floor

In electricity markets prices can drop below zero. Some typical drivers for negative prices emerging are:

- units with high start-up costs may bid negative in an attempt to avoid shutting down and having to subsequently incur start-up costs;
- government supported RES can reflect the support payment in their energy bids; and
- units reflecting other potential revenues sources from operating in the energy markets (for example heat revenues or ancillary services income from forward contracts).

Being awarded a DASSA Order does not entail any guarantee or priority that such volumes will be activated in the Balancing Market. If this was the case, then providers could attempt to adjust their offers in the DASSA to reflect such expected future income. We can therefore not foresee circumstances where a provider has an incentive to bid below zero in the DASSA.

3.5.1 Methodology

Our starting is that there is no evidence that any provider would have an incentive to bid below zero for reserve. We therefore wish to explore if there is any merit in having a positive Bid Floor. This can only be justified if there is a minimum cost (actual or opportunity) level for all providers.

When it comes to storage units, any foregone income can be as low as zero, assuming flat (or close to flat) within-day prices and no energy arbitrage opportunities.

We should attempt to find the minimum foregone inframarginal rent, rather than the maximum, given the difference in efficiency across different CCGTs. With this we are trying to test if there is merit in having a positive Bid Floor. Our starting point is that there is no evidence that any provider would have an incentive to bid below zero for reserve.

In our analysis below, we are again using the parameters and assumptions defined in Sections 3.4.3.1.

3.5.2 Value determination exercise

3.5.2.1 Assumptions

The assumptions for the analysis to help inform the Bid Floor determination are equivalent to those used in the Bid Cap. More details on the defined parameters can be found in Section 3.4.3.1.

3.5.2.2 Calculations

As described in Section 3.5.1, the calculation of Bid Floor considers the delta in marginality between synchronised CCGTs. In order to do so, we use the same information and logic applied in the Bid Cap analysis, as seen in Section 3.4.3.2.

Based on the results shown in Exhibit 12, we now analyse the difference in marginal cost for synchronised units, ordering from highest to lowest. This is presented in Exhibit 22. The difference in marginal cost is the delta between the marginal cost of each unit and the unit with the next highest variable cost.

Exhibit 22 –Marginal costs gap (EUR/MWh)

Calculated values based on the representative marginal costs formula and assumptions

Unit	Case 1		Case 2		Case 3	
	Marginal cost	Difference in marginal cost	Marginal cost	Difference in marginal cost	Marginal cost	Difference in marginal cost
CCGT - A	133.26	0.74	124.00	0.69	393.88	2.23
CCGT - B	134.00	1.26	124.69	1.17	396.11	3.79
CCGT - C	135.26	1.03	125.86	0.95	399.90	3.08
CCGT - D	136.29	4.54	126.81	4.22	402.98	13.65
CCGT - E	140.83	2.82	131.03	2.62	416.63	8.47
CCGT - F	143.65	0.29	133.65	0.27	425.10	0.86
CCGT - G	143.94	0.76	133.92	1.27	425.96	10.9
CCGT - H	144.70	9.47	135.19	8.23	415.06	41.63
CCGT - I	154.17	0	143.42	0	456.69	0
CCGT - J	154.17	5.14	143.42	5.4	456.69	0.89
CCGT - K	159.31	7.02	148.82	6.54	457.58	20.42
CCGT - L	166.33	0	155.36	0	478.00	0
CCGT - M	166.33	0	155.36	0	478.00	0
CCGT - N	166.33	0.74	155.36	0.69	478.00	2.23

Note: All units are assumed to be synchronised; the gap column corresponds to the difference in marginal cost between the referred unit and the unit in the row right below.

Source: AFRY analysis

3.5.3 Recommended value for the Bid Floor

The above analysis shows there are credible circumstances where the marginal cost of provision is near or even zero, and we recommend for the Bid Floor to be set to zero.

3.6 Revision of the Bid Cap and Floor

The proposed methodologies (described in the above sections) for the Bid Cap and Floor are informed by underlying cost data (including commodity prices). This means that the levels should be reviewed periodically, especially over periods when there are significant shifts in market costs: We propose: an annual review to check if there have been any significant changes to generation costs and/or commodity prices, which would create a need to revise of the Bid Cap and Floors.

3.7 Fundamentals modelling of reserve prices

In addition to our case-based analysis for helping inform the recommendation for the Bid Cap and the Bid Floor, discussed in the sections above, we have used our own in-house electricity market model, BID3, for modelling the DASSA auction. We have extracted modelled reserve prices and can compare the modelled price formation with the Bid Cap and Bid Floor we have chosen.

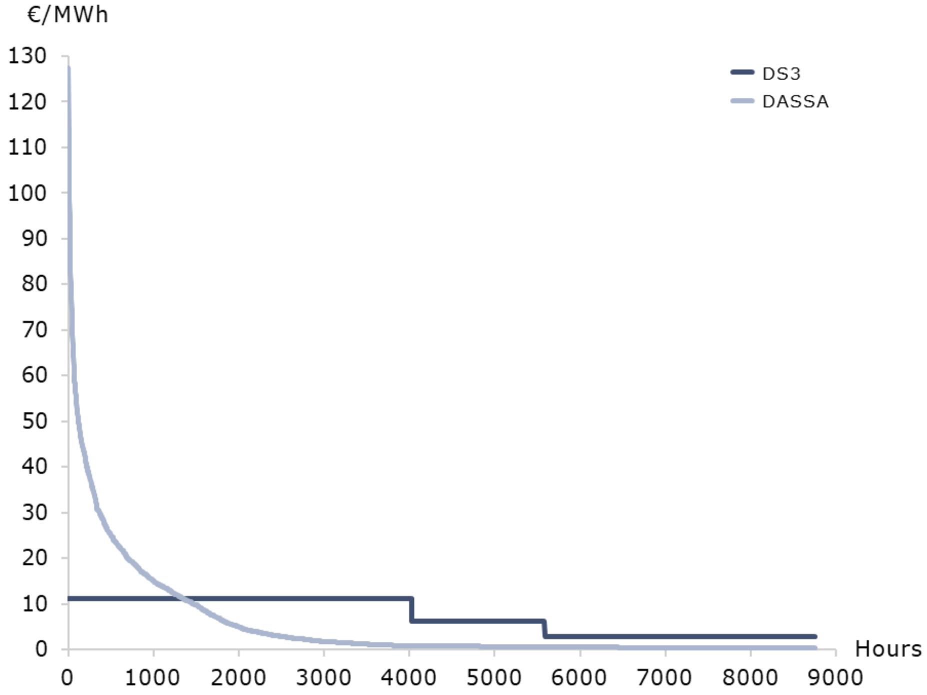
3.7.1 Modelling platform

BID3 is a fundamentals-based economic dispatch model based on least-cost optimisation. It simulates the hourly generation of all power stations on the system, taking into account the technical characteristics of each plant, fuel prices and operational constraints (e.g. demand, reserves, plant dynamics, etc.). It accurately models intermittent sources of generation, such as wind and solar PV, using detailed and consistent historical wind speed and solar radiation. It fully models all sources of flexibility on the system such as pumped storage, batteries and demand side response.

We model each future year under alternative weather patterns represented by five historical weather years (2012, 2014, 2015, 2017 and 2018) to capture as accurately as possible the variation in weather and the impact this has on renewable generation.

3.7.2 Modelled price curves of reserve products

Exhibit 23 – POR price duration curve under modelled DASSA and DS3 (real 2023 prices)



Note: We show the modelled POR price alongside the current DS3 tariff accounting for the impact of the temporal scarcity scalar given the underlying hourly SNSP

Source: AFRY analysis

The above illustrates a comparison between the DASSA modelled POR price and available hourly payments under DS3 for a BESS unit. The modelling suggests the number of hours with scarcity (hours with high prices) for POR is expected to be low. At the same time, there is a greater price range with the DASSA when compared to the regulated tariff approach under DS3. It is important that the Bid Cap and the Bid Floor introduced in the DASSA design allow for the market to give appropriate price signals at times for scarcity and therefore, that the modelled price range is, to the extent possible, accommodated within the proposed cap and floor limits to the bids.

Exhibit 24 shows the modelled price range for 2027. In our modelling, we see:

- some high prices, generally in the order of magnitude we have set the cap at;
- prices clear at much lower levels in the majority of the periods;
  - we do recognise, however, that in these model runs we have not captured the risk attached to any potential compensation payments, and this may have an impact on price formation, and, in particular, may result in far less zero prices; and
- the number of hours with modelled prices above the cap is not greater than 0.35% for any of the modelled products.

Exhibit 24 – Price range for reserve products for the modelled year 2027[1]

Reserve Product	Highest modelled clearing[2] (EUR/MW)	BESS incremental cost-based approach		Reserve availability approach	
		Proposed cap (EUR/MW)	Modelled hours above the cap[2] (%)	Proposed cap (EUR/MW)	Modelled hours above the cap[2] (%)
FFR	95	174	0.00%	135	0.00%
POR	156	116	0.09%	94	0.35%
SOR	27	100	0.00%	81	0.00%
TOR1	27	34	0.00%	74	0.00%
TOR2	18	19	0.00%	72	0.00%
RR	580	56	0.05%	44	0.11%

Note: (1) AFRY's modelling of the DASSA clearing prices was performed before the SEMC decision on the Volume Forecasting Methodology was published. Hence, it is based on AFRY's view on volume requirements prior to the decision paper; (2) The numbers provided in the "Highest Clearing" and "Modelled hours above the cap" columns are the largest across all the 5 different weather years modelled by AFRY for the DASSA clearing price projections.
Source: AFRY analysis

3.8 Value functions for different quality variations of the reserve products

The TSOs have decided that any requirement for different quality variations of a given reserve product will be captured through minimum volume requirements for such quality variations set in the DASSA. There may also be provisions for setting a preference for different qualities of a reserve product beyond the minimum requirement. This can be achieved through value functions.

After careful consideration, the TSOs have advised they believe there is no need to use the value functions in the first phase of the DASSA implementation. This means the Value Functions will be set to zero for all the quality variations. As a result, the DASSA clearing function will not have a preference for specific quality variations.

3.9 Scarcity Price

The DASSA may fail to procure the required volumes, resulting in volume insufficiency. However unlikely this scenario may be, its impact and the associated risk exposure may be unacceptable for the TSOs, as insufficient reserve volumes raise system security concerns.

A scarcity price can be used in secondary trading to provide sharper signals and encourage more capacity to become available. The SEMC in the DASSA Market Design decision paper[13], published in September 2024, made the

[13] SEM Committee, SEM-24-066: Future Arrangements for System Services DASSA Market Design – Decision Paper, 16th September 2024

following provisions for the TSOs to tackle volume insufficiency in the DASSA:

- the Scarcity Price Cap will apply to all completed DASSA Orders in instances of volume insufficiency for a service;
- the TSOs will address instances of volume insufficiency by procuring the volume deficit in secondary trading by issuing Sell Orders at a Secondary Trading Price of zero and assigning the DASSA Scarcity Price Cap to the additional volumes procured in secondary trading;
- in the event of an oversubscription of volumes the TSOs will select matches based on, firstly, if the submitted buy orders are technically feasible, and secondly, on the basis of the value of the buy order starting at the highest submitted order.

The SEMC also decided that matching of buy and sell orders in secondary trading will be done on a batch matching basis. It is our understanding that TSOs have expressed concerns regarding the implementation of economic merit-based batch making in the secondary trading and maintain their preference for first-come-first-served rolling matching, as expressed in their recommendation paper[14], with a merit order applied to the selection of bids, so as to limit the overall procurement costs.

3.9.1 Design approach for Scarcity Price

As we develop the design approach for the scarcity pricing to be implemented for DASSA go-live in alignment with the SEMC decision paper[4], we have considered linking the following three parameters:

- maximum bidding value (Bid Cap);
- DASSA clearing price at times of scarcity, linked with DAM prices; and
- procurement price for additional volumes required by the TSOs in secondary trading.

Aligning the DASSA clearing price and the price offered by the TSOs in secondary trading with the Scarcity Price establishes a clear incentive structure. This framework encourages service providers to make their capacities available in the DASSA, minimising the risk of capacity withholding during periods of reserve scarcity.

Volume insufficiency refers to a situation in which the volumes offered in the DASSA are less than the requirement. This would then mean that the DASSA clearing price for a given reserve product would be the Bid Cap. However, the TSOs may not declare market scarcity and implement the below described Scarcity Pricing approach under every instance of volume insufficiency, if the ‘missing’ reserve volumes are within a tolerance threshold, the Volume Insufficiency Threshold. This should be determined by the TSOs.

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[14] EirGrid/SONI, DASSA Design Recommendations Paper V1.0

The Volume Insufficiency Threshold can be used by the TSOs to avoid declaring scarcity for a given reserve product, and, in turn, preventing available market volumes from clearing at the Scarcity Price, when the shortfall does not suggest a material impact on system security and operation. In this case, the TSOs will not procure additional reserve volumes through any other ex-ante market to cover the shortfall. For the avoidance of doubt, once the Volume Insufficiency Threshold is breached and market scarcity is declared, the TSOs will procure volumes in secondary trading to fully satisfy the minimum reserve volume requirement constraint, disregarding the threshold.

The Volume Insufficiency Threshold for any product / subproduct / implicit bundle will be defined with respect to the corresponding minimum reserve volume requirement set in the DASSA. It will be set at a value that the TSOs consider manageable from the perspective of system operation and security, as the system may have to run at a shortfall up to the applicable reserve threshold. We understand that this threshold value will be determined and published by the TSOs, alongside each corresponding minimum volume constraint applicable in the DASSA.

In the case of volume insufficiency beyond the applicable Volume Insufficiency Threshold, all volumes offered in the DASSA will get paid at the Scarcity Price, in line with the SEMC decision[13]. The 'total' Scarcity Price is determined by the following expression:

$$SP_{total} = \max(BC_{total}, DAM_{CP})$$

where:

SP_{total} is the 'total' Scarcity Price across all the upward or downward reserve products

BC_{total} represents the 'total' Bid Cap applied in the DASSA for all reserve products that provide response in the same direction (either upward or downward).

DAM_{CP} is the clearing price of the Day-Ahead Market (DAM) in the SEM

The prices for each of the individual reserve products in the time of scarcity will be calculated proportionately to their share in the 'total' Bid Cap, as expressed below:

$$SP_i = \frac{BC_i}{BC_{total}} \times SP_{total}$$

where:

SP_i is the Scarcity Price for an individual reserve product, i

BC_i is the Bid Cap implemented in the DASSA for an individual reserve product, i.

The 'total' Bid Cap has been set at a level that allows a dedicated reserve provider, which can offer the same level of reserve for each product, to recoup opportunity costs up to the level of the RO Strike Price, which can be viewed as an indirect price cap. However, DAM prices may, at times, rise above the RO Strike Price (and the 'total' Bid Cap), increasing the electricity income potential.

Recognising the trade-offs between the energy and reserve markets, we have indexed the Scarcity Price to the DAM price if this rises above the RO Strike Price. This ensures that the reserve providers can earn comparable returns in both markets. The option of adding an intraday price index in the determination of the Scarcity Price should also be considered by the TSOs in the future.

Subsequently, the TSOs will participate in the secondary trading by meeting any unmatched buy orders or by submitting sell orders at a Secondary Trading Price of zero and assigning the value of (effectively paying) the Scarcity Price to any reserve volumes procured. We expect there will, at times, be additional reserve availability in secondary trading when compared to the DASSA, as certain providers may have greater clarity around their energy market schedules and their availability.

As instructed by the SEMC decision, in the case of oversubscription, the TSOs will select matches based on, firstly, if the submitted buy orders are technically feasible, and secondly, on the basis of the value of the buy order starting at the highest submitted order.

3.9.2 Scenarios of Scarcity Price implementation

We can foresee the following more typical situation when volume insufficiency may take place.

Volume insufficiency in a subcategory reserve product of higher quality

This scenario can arise when there is a shortfall in one of the higher quality subcategories of a reserve product, beyond the missing volumes allowed by the Volume Insufficiency Threshold. Such a situation can occur across multiple reserve products, each of which has a minimum volume requirement for dynamic reserve response.

For example, consider the POR product. Suppose the total volume requirement for the POR reserve in a given DASSA Trading Period is 1,050MW, with a minimum requirement of 350MW for dynamic POR response. Now, if only 300MW of dynamic POR response capacity is available during that period—while 1,000MW of static POR response capacity is offered in the DASSA—the market is missing 50MWof for dynamic POR. In our example, we assume that the defined Volume Insufficiency Threshold for dynamic POR response is set at a value lower than the actual volume insufficiency.

Even though the total available capacity for POR response in the DASSA amounts to 1,300MW (combining static and dynamic responses), the shortfall arises because the lower quality static response cannot substitute for the required higher quality dynamic response. In this scenario, the TSOs will clear the DASSA for static POR response at 700MW, based on the intersection of offered volumes and satisfiable demand. For dynamic POR response, the TSOs will apply the volume insufficiency resolution approach outlined in section 3.8.1, procuring available volumes within the DASSA first and subsequently sourcing additional capacity in secondary trading at the Scarcity Price for the POR product. For the avoidance of any doubt, under this scenario the TSOs will only procure POR from dynamic response providers.

Volume insufficiency in a subcategory reserve product of lower quality

This scenario can materialise in a similar fashion as the one previously discussed, but with volume insufficiency of the lower quality response category of a reserve product.

As an example for this scenario, we consider the FFR product and its three subcategories, along with static and dynamic response differentiation. Let us suppose that the total volume requirement for FFR product is 1050MW, with the minimum reserve requirements and the corresponding available capacities in a DASSA Trading Period for those products as per Exhibit 25 below.

Exhibit 25- Assumed minimum volume requirements and available capacity for FFR product subcategories

Quality variations for FFR	Min. requirement constraints (MW, cumulative)	Capacities made available in the DASSA (MW, cumulative)
Total FFR response	1050	1340
Total Dynamic Response	840	890
Total Static Response	0	450
FFR Subcategory 1	630	654
Dynamic Response	504	504
Static Response	0	150
FFR Subcategory 2 or faster (i.e. cumulative with FFR Sub-category 1)	735	790
Dynamic Response	588	540
Static Response	0	250
Remaining volumes – can be provided by any provider (FFR subcategory 1 , 2 , and 3)	315	550
FFR Subcategory 3 or faster (i.e. cumulative with FFR Sub-category 1 & 2)	0	1340
Dynamic Response	0	890
Static Response	0	450

Note: The values presented in the table above have been arbitrarily selected for this example. These do not represent our expectation of the volume constraints set in the DASSA by the TSOs.

Based on the above, the DASSA will fail to procure sufficient volumes to meet the FFR subcategory 2 dynamic response constraint. Only faster response subcategories can substitute for slower ones, and the dynamic FFR subcategory 1 would have been able to contribute towards the minimum volume requirements for dynamic subcategory 2, if any additional capacity had been available. As only 504MW of dynamic FFR category 1 is available in the DASSA, there is no surplus of eligible volumes that can be used to satisfy the remaining 48MW volume requirement for dynamic response under the subcategory 2.

Assuming that the applicable Volume Insufficiency Threshold has been breached in this situation, the TSOs will satisfy the dynamic response of FFR product subcategory 2 volume insufficiency by implementing the Scarcity Price for dynamic FFR response across both the eligible subcategories 1 and 2, as per the approach defined in Section 3.8.1. In this example, the TSOs can satisfy the 48MW of the subcategory 2 response requirement by an appropriate dynamic response provider for either category 1 or category 2.

In scenarios with volume insufficiency in a subcategory reserve product of lower quality, the Scarcity Price will apply to all the subcategories that can provide substitute volumes, and not only the subcategory facing shortage of available volumes. This is in alignment with the DASSA objective function design outlining that the clearing price for a higher quality product must always be greater than equal to the lower quality product. It also provides appropriate price signals in the DASSA and secondary trading for higher quality reserve response.

Jurisdictional volume insufficiency in reserve products

As noted in the Volume Forecasting Methodology (VFM)[15] consultation paper, the TSOs will set minimum volume requirements for different reserve products on a jurisdictional basis. There may also be volume insufficiency on a jurisdictional basis for a reserve product. The Scarcity Price will be used in the corresponding jurisdiction in this case.

For example, let us consider POR product with jurisdictional requirements set at 700MW and 500MW for Ireland and Northern Ireland respectively. Under a scenario where the available POR volumes in the DASSA are 1000MW in Ireland and 400MW in Northern Ireland – even though the All-Island POR volume requirement can be satisfied, there are not sufficient volumes to meet the Northern Ireland requirement (assuming a threshold of 50MW). The TSOs will address this by applying a Scarcity Price in the DASSA and the secondary trading for the POR product in Northern Ireland Jurisdiction, as described in in section 3.8.1.

[15] EirGrid/SONI, DASSA Volume Forecasting Methodology Consultation Paper V1.0, October 2024

Volume insufficiency in reserve requirement

In other cases, the volume available in the DASSA for a reserve product is less than the overall All-Island volume requirement. Assuming that the shortfall in the reserve volumes is beyond the allowed Volume Insufficiency Threshold, the TSOs will apply the scarcity pricing approach on the reserve product on an All-Island basis.

Let us assume the jurisdictional requirements are set at 700MW and 500MW for Ireland and Northern Ireland respectively, while the All-Island POR requirement is 1400MW. Assuming the available POR volumes in the DASSA are 700MW in Ireland and 500MW in Northern Ireland, even though the jurisdictional volume requirements are met, there is still a shortfall in POR volumes on an All-Island shortfall of POR volumes. Assuming that the volume insufficiency is greater than the applicable Volume Insufficiency Threshold, the TSOs will implement scarcity pricing for the POR product on an All-Island basis, clearing all volumes procured.

3.9.3 Recommendations for the Scarcity Price

We recommend the above approach to be implemented when there is volume insufficiency. This approach defines the Scarcity Price to be used in the DASSA and offered in the secondary trading by the TSOs through submitting sell orders priced a zero.

The value offered by the TSOs in both the DASSA and secondary trading remains consistent between the two markets – allowing the TSOs to send appropriate prices signals reflecting market scarcity.

3.10 Default price

3.10.1 Purpose of default pricing

Default prices, also known as fallback or backup prices, are aimed at ensuring the continuous operation of reserve markets even when the clearing algorithm fails to produce, completely or partially, results in a timely manner. Default prices can be triggered by the TSOs in the events of DASSA suspension, which could be due to technical issues, such as software malfunctioning or data unavailability, among others.

3.10.2 Default price global overview

Fallback procedures is a broad concept that can cover a wide range of processes to cover for different events. In this section, we focus on fallback procedures triggered by failure of the clearing algorithm failure (i.e. the algorithm is unable to deliver results within the corresponding time frame obligations).

For the EPEX Spot trading platform[16], fallback procedures depend on whether the decoupling is partial, i.e. one or more bidding areas and/or interconnectors do not participate in the SDAC, or full. Furthermore, Partial Decoupling can be either during the Pre-Coupling Process or during the Coupling Process. In the event of Partial Decoupling during the Pre-Coupling Process, Shadow Auctions are used as Fallback Allocation mechanism in most of the bidding areas. Shadow Auctions are conducted by the Joint Allocation Office (JAO) and the bids are submitted in advance by market participants.

The other decoupling scenario involves the Partial Decoupling during the Coupling Process and, similarly to the event described before, most of the areas employ Fallback Allocation mechanisms involving Shadow Auctions. Nonetheless, if the Nordic region is decoupled from SDAC, Nordic NEMOs will have to arrange a Nordic regional coupling and, if results are not available before 20:00h, a reference price is used (Exhibit 26).

Exhibit 26 – Reference Day determination criteria for the Nordic markets

Delivery day affected by auction failure	Reference day
Working day (i.e. Monday to Friday not including public holidays, according to calendar)	Previous working day (i.e. Thursday is Reference Day, if Friday is affected by auction failure)
Saturday	Previous Saturday
Sunday	Previous Sunday
Public holiday	Previous Sunday or nearest public holiday, whichever is the nearest

Note: The Reference Day cannot be older than seven days
Source: EPEX Spot

[16] EPEX Spot Spot, Single Day-Ahead Coupling (SDAC), valid from: 29th January 2025

Other countries that use historical prices to calculate default prices to deal with technical failures are:

- Spain and Portugal (OMIE) – As outlined in the Day-Ahead and Intraday Electricity Market Operating Rules, historical data are used to clear the market if the pricing algorithm fails to produce results[17];
- Australia (AEMO) – The Market Suspension Pricing Methodology, based on historical values from the previous 4 weeks, is one of the routes when the pricing algorithm fails to produce a solution[18].

3.10.3 DASSA fallback procedure

In case the DASSA is not operational, the secondary trading platform appears to be the most obvious choice for procuring reserve volumes. The TSOs could then enter the secondary trading at a Default Price. However, we do recognise that the industry has raised concerns around TSO participation in secondary trading.

Given these concerns, we have excluded the secondary market as a potential fallback option. The proposed fallback procedure is based on ex-post settlement of the service providers that were available in real-time, settled either through the resulting price formation in the DASSA Top-Up Mechanism[19] or at the pre-defined tariffs. We believe one credible choice for the level of the pre-defined tariffs is to use the Long Run Marginal Cost (LRMC) of a battery dedicated to reserve at all times when it is available in a year.

The DASSA fallback procedure for the procurement of reserves from service providers will depend on the nature of the failure that impacted on the operation of the DASSA. We can see two potential cases.

Suspension of the DASSA only

In the event of a DASSA suspension, the TSOs will use the DASSA Top-up Mechanism to settle the reserve volumes made available by the service providers in real-time. Under this scenario, the reserve volumes will be settled at the prices determined by the methodology defined for the DASSA Top-Up Mechanism.

As there is no obligation on the service providers to position themselves for reserve provision under the DASSA Top-Mechanism, it is our understanding that the TSOs will issue dispatch instructions, if required, to ensure that the system always has the required reserve volumes.

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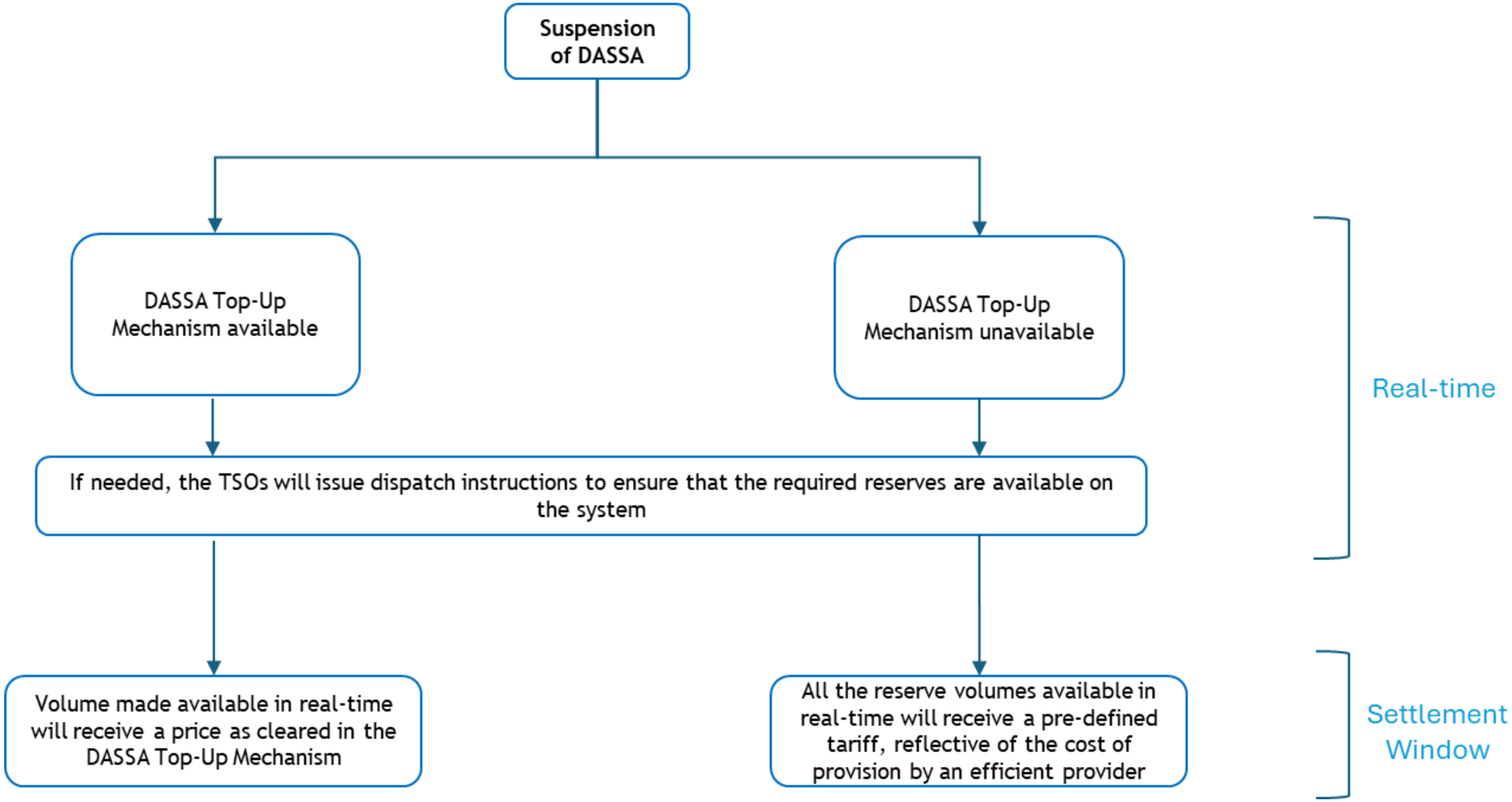
[17] CNMC, BOE, June 2024
[18] AEMO, MARKET SUSPENSION PRICING METHODOLOGY, October 2023
[19] EirGrid/SONI, FASS: DASSA Top-Up Mechanism - Consultation Document, 24th March 2025

Unavailability of the DASSA and the Top-up Mechanism

This scenario represents a situation under which a system failure extends to both the DASSA and any potential Top-up Mechanism. With no ex-ante procurement of reserve volumes possible due to the failure of the DASSA, the TSOs will have to settle the reserve volumes made available in real-time ex-post. In this situation, the TSOs can settle all the service providers with reserve volumes made available in real-time on the basis of pre-defined tariffs for each of the reserve products. These pre-defined tariffs can be set based on the Long Run Marginal Cost (LRMC) of a battery service dedicated to reserve provision at all times when available in a year.

Exhibit 27 – Process map for the implementation of the DASSA Fallback Procedure



4 Commitment obligations and performance incentives

The TSOs wish for the DASSA Order to be an **obligation**, rather than an **option**. This means a DASSA Order Holder needs to have appropriate incentives to:

- make the DASSA Order volumes available; or
- find replacement volumes in the secondary market.

The envisaged process for incentivising a DASSA Order Holder to fulfil its obligations includes:

- a Compensation Payment;
  - this is a payment from the DASSA Order Holder to the TSOs in the case of a lapse, and is aimed at ensuring DASSA Orders are treated as an obligation, rather than an option;
- Availability and Event Performance Scalars;
  - the Availability Performance Scalar helps incentivise confirmed DASSA Order Holders to maintain and accurately declare their availability;
  - the Event Performance Scalar is aimed at incentivising the confirmed DASSA Order Holder to deliver the service when called upon to do so.

The SEMC in the DASSA Market Design decision paper[20] commented that they remain unconvinced on the need for performance scalars in an auction-based framework, particularly because of the possibility of scalars to cause distortions to the clearing prices in case poorly performing units adjust their bids to the scalars and still continue to win. SEMC has directed the TSOs to further consult on measures to address the issues of unit availability and event performance.

On the other hand, the SEMC expects the Compensation Payment to become the primary mechanism to incentive DASSA Order Holders to maintain availability and has suggested that the Compensation Payment could be

[20] https://www.semcommittee.com/files/semcommittee/2024-09/SEM-24-066%20-%20SEMC%20FASS%20DASSA%20Design%20Decision%20Paper.pdf

linked to the full cost to consumers, while increasing the payable amount based on the level of notice provided by the lapsing units.

4.1 Review of performance incentives in other markets

We have reviewed other System Services markets to understand the approach adopted to incentivise availability and performance by different providers. We recognise there may be fundamental design differences between the DASSA and other System Services markets – most notably in terms of product definitions. We have focused our review on markets that procure System Services at the day-ahead stage through a competitive auction.

Most of the markets we have looked at have adopted a penalty-based approach to discourage non-delivery of contracted services. An overview is presented below.

Exhibit 28 – Overview of availability and performance incentives in other markets

Market	Availability incentives	Performance incentives
mFRR and RR in France	• Marginal price of Balancing Capacity and spot price in the energy market	• Marginal price of Balancing Capacity and spot price in the energy market
aFRR and FRR services in Belgium	• Based on lapsed volumes and reserve capacity price • Time period considered – 30 days	• Based on share of under delivered response and remuneration for the reserve capacity • Time period considered – 1 week
Dynamic Regulation in the UK	• Scalar-based incentive • Binary (0 or 1) scalar to the service payment	• Scalar-based incentive
aFRR in Finland	• Lapsed volumes do not receive any remuneration • Sanctions are applied on the basis of lapsed volumes of reserve capacity	• Temporary and permanent exclusion if the performance does not adhere to the required standards
mFRR in Finland	• Same as in the case of aFFR • Inclusion of an adjustment scalar for some reserve providers	

Sources: Various

French market for mFRR and RR

In France, manual Frequency Restoration Reserve (mFRR) and Replacement Reserve (RR) are procured through annual and day-ahead tenders. There is a penalty in place to incentivise providers to remain available up to end of the contracted period and deliver the required quality of response[21]. The penalties are defined on a 'Declared' and a 'Failure Found' basis, which can largely be seen as equivalent to availability and performance-based categorisation under the DASSA design, respectively. The applicable penalties are:

— **Base Penalty term**: this term serves as a multiplier (€/MW) in the expression for penalties, defined under different categories. This term appears to be defined by a fixed scalar multiplied to the max of the marginal price of the Balancing Capacity and the reference spot price in the French DAM.

— **Declared Failure Penalties**: This category encompasses multiple scenarios relating to failure in making compatible or timely declarations to the TSO related to the commitments. This includes requirement set out in the rules to submit bids in the Balancing Market for the Balancing Capacity commitments held by the provider. The penalties across most of these different scenarios are varied by the approach defined to calculate the volumes of failed Balancing Capacity that are multiplied to the Base Penalty term to give the final amount levied on the provider. Interestingly, rules apply an 80% scalar to the Base Penalty, in case of a declared failure prior to the System Access Deadline (set at 16:30 on D-1[22]) by the service provider. There is also a fixed penalty applied on day-to-day frequency if the provider fails to make the required declarations at System Access Deadline, under which the Base Penalty term is replaced by a fixed 15 €/MW value.

— **Failure Found Penalties**: This category concerns the applicable penalties relating to failure of the activation for the Balancing Capacity commitments held by the service provider and failure to comply with the requirements for the technical systems. The price multiplier (€/MW) used in the penalty for the failure to activate for the contracted Balancing Capacity is defined as the sum of the Base Penalty term and Marginal Balancing Price.

Belgium Market for aFRR and mFRR

In the Belgian market, automatic and manual Frequency Restoration Reserves (aFRR and mFRR) are procured through daily auctions. The market incentivises the service providers to maintain high availability and delivery of good quality FRR services through the application of penalties, with different timeframes and hierarchy between them. There are three different penalties proposed in the Elia consultation[23]:

— **Penalty for volume made available**: once the reserve capacity is awarded to the service provider in the capacity auction, there is an obligation on the provider to submit contracted energy bids in the

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[21] RTE, Manual frequency restoration reserve and replacement reserve terms and conditions, 1 January 2023
[22] RTE, Terms and Conditions relating to Scheduling, the Balancing Mechanism and Recovery of Balancing Charges, 1st September 2022
[23] Elia Group, Incentive on Prequalification, Control, and Penalties for the aFRR and mFRR Services, 22nd September 2023

balancing energy auction for the corresponding time periods and for the volumes equal to the awarded Balancing Capacity. Failure to make the awarded reserve capacity available will result in the application of a penalty. The penalty is 'tiered' with the applicable scalar informed by the average compliance level (over a 30-day period) of the service provider. The penalty is applied to the lapsed reserve volumes and priced at the weighted average price of the reserve volumes awarded to the provider for the concerned time block. The levelled scaling factors used are 1.5 and 3, with the higher factor used when the average compliance drops below 95%. This penalty is calculated on a monthly basis.

— **Penalty for missing reserve volumes during activation**: this penalty is used to ensure that Balancing Capacity bids are reliable (i.e. the capacity obligation is fulfilled). It is designed to be punitive as the contracted bids are seldomly activated. The penalty is defined as a product of the remuneration for the awarded capacity and the share of the underdelivered capacity from the total capacity requested by Elia. A fixed scalar of value 2.5 is applied to the product to provide a strong incentive for performance. It must be noted that the total capacity requested term used in the penalty formula is capped to the reserve capacity obligation held by the service provider. The penalty for missing reserve volumes during activation is calculated on a weekly basis.

— **Penalty for missing energy volumes during activation**: This penalty relates to the discrepancy in the energy response and is dependent on the remuneration requested in the Balancing Energy auction. This penalty applies to aFRR energy bids only and follows a similar calculation expression to the penalty for missing reserve volume during activation, but with terms representing energy volumes instead of reserve volumes. We do not believe this penalty is of interest in relation to the DASSA design and therefore, did not explore it further.

DR and DC in Great Britain

NESO procures Dynamic Regulation (DR) and Dynamic Containment (DC), among others, through daily auctions. Based on the service terms[24,25], the incentives for availability and performance quality are integrated in the payment formula that service providers will receive for the provision of services in the awarded time period. There does not seem to be any further penalty or past performance-based scalar adopted by NESO:

— **Availability Scalar**: The methodology adopted for the availability scalar is relatively simple – with the scalar being zero for any period or periods of unavailability. This then means that the provider does not receive any payment in case of unavailability, but there is no further compensation paid to the TSO.

— **Performance Scalar**: There are well-defined expected response criteria for both the services, which is used to compare performance delivery and produce a performance score. The scalar value is defined by a conditional

[24] NationalGridESO, Dynamic Moderation Service Terms, 11th March 2022
[25] NationalGridESO, Dynamic Containment Service Terms, 01st October 2021

expression assuming values of 1, 0 or a linear interpolation between them based on the performance score. This scalar is calculated and applied to the settlement payment for the entire contracted EFA (Electricity Forward Agreement) block. This is different from the applicability of the Availability Scalar, which currently only applies to the settlement period.

In the case of these frequency response products, NESO appears to be one of the few (if not the only) TSO that does not have any additional penalties for unavailability, other than removing the applicable payment. NESO does, however, have rules in place to suspend a provider from subsequent auctions and even de-registering a unit in the case of persistent breaches.

NESO have recently consulted on the performance penalties for Dynamic Regulation[26]. They have decided to move towards stricter performance penalties with a 'tiered' approach. For small number of breaches, it is only the settlement period payment that would be removed. However, if there are more than a set number of breaches and/or there is 'strategic' unavailability, then the provider would not be paid for the entire EFA block. If the provider is consistently unavailable, then there are provisions for a temporary suspension and even a complete de-registration of the unit.

Finnish market for aFRR

As described in the terms and conditions document[27], Fingrid procures up and down regulation for aFRR in the aFRR Capacity Market for the following day through a day-ahead auction. In the aFRR Capacity Market, the service provider undertakes to offer the volume of reserves approved in the bidding competition to the aFRR Energy Market for the corresponding Market Time Units. Fingrid pay a Capacity Fee in exchange. Fingrid uses a penalty-based approach to incentivise service providers to fulfil their reserve capacity obligations:

- **Sanction for unavailability**: The Balancing Service Provider shall pay a compensation to Fingrid for reserve capacity that is not maintained. The compensation is priced at the higher of the Day-ahead Market price and the aFRR capacity market price multiplied by a scalar of 3. The product of undelivered reserve capacity and the sanction price provides the compensation amount levied on the service provider for the concerned hour in question.
- **Performance Incentive**: Fingrid, instead of direct financial penalties, can exclude providers temporarily and even cancel the service provider agreement to ensure providers adhere to the envisaged performance requirements. If Fingrid during its verification of control properties of the provider unit finds significant deficiency, a temporary ban from the market is imposed. In the event the service provider repeatedly fails to activate aFRR in accordance with Fingrid's instruction, a temporary exclusion of one to three months, depending on the nature of violation, can be imposed. Material break of the contract can also lead to

[26] ESO, Dynamic Response Services June 2024 Consultation, 27th June 2024
[27]

cancellation of the aFRR Market Agreement, effectively excluding the provider from participating in the reserve market.

Finnish market of mFRR

The mFRR procurement process is similar to that for aFRR. The performance incentives and sanctions for unavailability largely mirror those for aFFR. However, for mFRR procured under the tendering process, Fingrid not only applies sanctions (as those are defined above) but also adjusts the capacity fee paid to the service provider for the contracted reserve volumes made available. The adjustment period is one week. The adjustment to the capacity fee is applied through a Permanence Coefficient, which depends on the ratio of the volume of capacity made available in the Balancing Energy market for mFRR and the mFRR contracted capacity with the ratio capped at 100% for any single hour. The permanence of the entire adjustment period is the average of the hourly review. Notably, the Permanence Coefficient becomes zero once the input ratio becomes 50% or lower.

4.2 Commitment obligation and performance incentives

The TSOs expect DASSA Order Holders to confirm such DASSA Orders and submit compatible FPNs at Gate Closure. Subsequently, providers should maintain availability to provide the contracted volumes and be in a position to respond in the case of a system frequency event.

In some cases, the DASSA Order Holder may not be in a position to fulfil their obligation. The expectation then is for the DASSA Order Holder to participate in secondary trading and attempt to sell the DASSA Order. If the DASSA Order Holder is unsuccessful in selling the order in the secondary market, it should declare its unavailability to the TSOs and lapse the DASSA Order. The envisaged incentives are summarised in the Exhibit 29 below.

Exhibit 29 – Availability and service quality incentives[14]

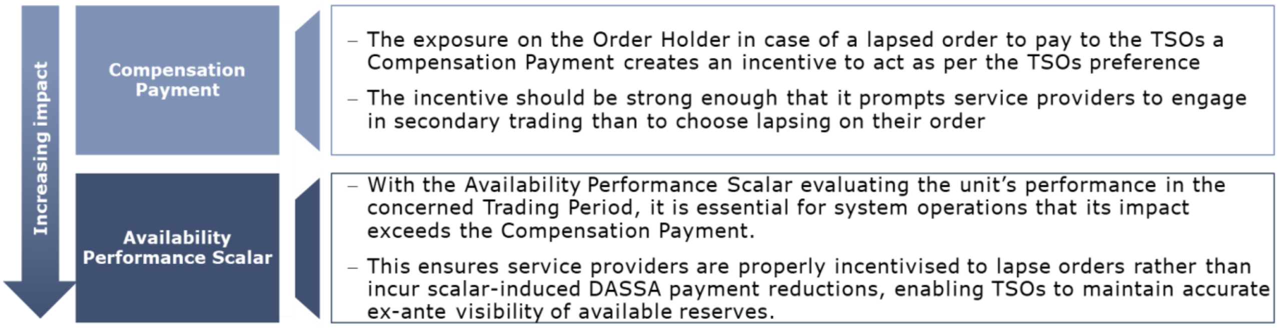
Design element	Financial impact	Applicability	Objective
Compensation Payment	Payment to TSOs	At BM Gate Closure	Incentive to make DASSA Order volumes available by submitting a compatible FPN or find replacement volumes in the secondary market
Availability Performance Scalar	Reduced DASSA payments	Post Gate Closure	Incentive to maintain availability for the contracted DASSA volume for the entire Trading Period
Event Performance Scalar	Reduced DASSA payments	Post Gate Closure	Incentivise to deliver the required response as per the contracted DASSA volume

4.2.1 Hierarchy of commitment obligation and Availability Performance Scalar

The DASSA design proposed by the TSOs[14] suggested that the Compensation Payment should only apply to lapsed DASSA Orders (up to Gate Closure). On the other hand, the Availability Scalar was to apply on confirmed DASSA Orders post Gate Closure.

The TSOs have a preference for units to declare any potential unavailability before Gate Closure in the case this is known in advance. The overall structure should therefore incentivise this behaviour. This means the impact of the Availability Performance Scalar and any other incentive post Gate Closure should be greater than the Compensation Payment. Providers should not be encouraged to submit a compatible FPN, even though they are aware of an upcoming unavailability.

Exhibit 30 – Required hierarchy between the impact of the Compensation Payment and the Availability Performance Scalar



4.2.2 Analysis to inform relative impact of the Compensation Payment and the Availability Performance Scalar

We have performed analysis to help inform the relative level of the Compensation Payment and the Availability Performance Scalar, including parameters "a" and "b" in the Availability Performance Scalar (S_A) linear formula. This analysis does not cover all potential cases depending on the relative design and level of the Compensation Payment and the Availability Performance Scalar, as well as results given expected DASSA clearing prices and electricity prices. **The analysis is aimed at helping the reader understand the potential for arbitrage opportunities in the case of inconsistent incentives.**

We used the following inputs and assumptions for this analysis:

- upward reserve product DASSA clearing price and imbalance prices in 2027 are based on our own analysis of the DASSA clearing prices for the six (FFR-TOR2) upward reserve products;
- the DASSA Trading Period has a 30-minute duration, but we have performed this exercise assuming hourly settlement periods;
- a service provider is assumed to have a DASSA Order for the entire 'bundle' (FFR-TOR2);
- we recognise that there could be various reasons behind a unit being unavailable, however, for the purposes of this analysis, we focus solely on commercial choices by providers given the underlying incentives;

- a lapsed DASSA Order faces a Compensation Payment in addition to foregoing the DASSA payment;
- to calculate the impact of the Availability Performance Scalar, we assume that the unit becomes unavailable after submitting a compatible FPN;
- we consider two different technologies, storage and thermal providers; and
- to simplify the analysis, we have made assumptions regarding the costs and rationale for the decisions to become unavailable, as noted in the Exhibit 31 below.

Exhibit 31 – Assumptions concerning the costs and unavailability of the two technology types considered in our analysis

Technology Type	DASSA bid (€/MW)[1]	Short Run Marginal Cost (€/MWh)	Rationale for becoming unavailable for reserve provision[2]
Thermal	Depends on selected scenario	100	— The unit is assumed to become unavailable in the hours when the margin available in the BM is greater than the DASSA clearing price, irrespective of whether it has a DASSA Order or not.
Battery Storage	Depends on selected scenario	Reflective of wear because of cycling	— The unit is assumed to become unavailable when the spread it can capture in the BM exceeds a pre-defined threshold value[3]. — The unit is assumed to be limited to only one cycle per day. This is intended to represent a typical operational profile for a BESS.

Notes:
1) We assume a scenario dependent DASSA bid by the units, allowing us to investigate the impact of the incentives mechanisms as the number of awarded DASSA contracts to the unit varies.
2) For the purposes of this analysis, we are using modelled imbalance prices in the BM as a proxy for the spreads available to the considered unit through energy trading. We recognise that if a unit has confirmed its DASSA Order through the submission of a compatible FPN, it would have to be 'imbalanced' without receiving a dispatch instructions and would capture a scaled down imbalance price. This has been accounted for in the analysis to determine the spreads available to the units in the case of analysis the impact of Availability Performance Scalar.
3) The threshold of the spread in the imbalance prices at beyond which the battery unit will choose to become unavailable at lapse its order is set at 50€/MWh in the analysis. However, since the battery is limited to one cycle a day, primarily the hour of unavailability for the unit in a day is guided by the maximum imbalance price of the day,

Modelled availability performance of the units

Given the above assumptions, we can estimate the availability performance for the BESS and thermal units. The below data relates to a scenario, under which the unit is assumed to clear DASSA for all Trading Periods. This assumption varies depending on different scenarios considered in our analysis, however, we are not presenting the data for all these scenarios in this report.

Exhibit 32 – Availability Performance Scalar for the modelled units

Month	No. of Orders not fulfilled	Total no. of Orders	Ratio of unavailability	Availability Factor	Availability Performance Scalar[1]
BESS					
1	62	744	8%	0.97	100%
2	54	672	8%	0.95	96%
3	58	744	8%	0.94	93%
4	60	720	8%	0.92	90%
5	58	744	8%	0.92	89%
6	56	720	8%	0.92	90%
7	54	744	7%	0.92	90%
8	54	744	7%	0.92	90%
9	54	720	8%	0.93	91%
10	58	744	8%	0.92	90%
11	58	720	8%	0.92	90%
12	62	744	8%	0.92	89%
Thermal generating unit					
1	216	744	29%	0.90	86%
2	246	672	37%	0.80	64%
3	295	744	40%	0.71	45%
4	163	720	23%	0.71	44%
5	69	744	9%	0.76	56%
6	18	720	3%	0.84	73%
7	30	744	4%	0.90	86%
8	52	744	7%	0.93	92%
9	52	720	7%	0.94	94%
10	160	744	22%	0.89	83%
11	156	720	22%	0.84	73%
12	234	744	31%	0.78	60%

Notes:
1) The Availability Performance Scalar has been calculated assuming constants a = 0.50 and b = 0.97 in the given formula under section 4.4.3

Comparison of the incentives faced by the service provider unit

Based on the above availability profile, we can determine the impact of the Compensation Payment and the Availability Scalar, as follows:

$$Impact_{Comp..Payment} = \sum_{month} (P_{DASSA} + \ Comp.Payment \ ) \times Volumes_{unavailable}$$

where:

P_{DASSA} refers to the DASSA clearing price

$Comp.Payment$ refers to the applied Compensation Payment based on an adjusted DASSA minus the DASSA clearing prices – we assume that the adjusted DASSA clearing price is 150% of the DASSA clearing price for the purposes of this analysis). This can also be seen as a Compensation Payment equal to 50% of the DASSA clearing price.

$$Impact_{Availability\ Scalar} = (1 - S_A) \times \sum_{month} (P_{DASSA} \times Volumes_{contracted})$$

where:

P_{DASSA} refers to the DASSA clearing price

S_A represents the Availability Performance Scalar

$Volumes_{contracted}$ refers to the confirmed DASSA Order volumes

For determining the impact of the Compensation Payment or the Availability Performance Scalar, we assume that the unit chooses to only subject itself to the considered incentive mechanism for all the Trading Periods of its unavailability. For example, for calculating the impact of the Compensation Payment, it is assumed that the unit lapses all its DASSA Orders for which it chose to become unavailable and never subjects itself to the Availability Scalar.

When it comes to the DASSA clearing price, for simplicity we assumed a 'total' DASSA clearing price of 20EUR/MW/h for all six reserve products (FFR-TOR2) and for upward provision.

The summary of the incentives faced by the unit is presented in Exhibit 33 below.

Exhibit 33 – Summary of different incentives faced by the considered unit

Month	Impact of the Compensation Payment[1] (€/MW)	Impact of the Availability Performance Scalar (€/MW)	Required hierarchy of incentives met?[2]
BESS			
1	1860	0	**No**
2	1620	544	**No**
3	1740	1079	**No**
4	1800	1402	**No**
5	1740	1585	**No**
6	1680	1505	**No**
7	1620	1483	**No**
8	1620	1426	**No**
9	1620	1362	**No**
10	1740	1436	**No**
11	1740	1445	**No**
12	1860	1573	**No**
Thermal generating unit			
1	6480	2114	**No**
2	7380	4845	**No**
3	8850	8163	**No**
4	4890	8062	Yes
5	2070	6609	Yes
6	540	3849	Yes
7	900	2067	Yes
8	1560	1156	**No**
9	1560	928	**No**
10	4800	2595	**No**
11	4680	3861	**No**
12	7020	6013	**No**

Notes:
1) Compensation Payment is calculated assuming that the adjusted DASSA clearing price is 150% of the DASSA clearing price for the purposes of this analysis
2) It is recognised that due to the persistent design of the Availability Performance Scalar, a monthly comparison of the impact with the Compensation Payment does not provide a complete picture. Therefore, to inform our design process, we considered the impact of the two incentive mechanisms across the entire modelled period of one year.

4.2.3 Interaction between the Compensation Payment and Availability Performance Scalar

From the above example, we can see that in some cases providers are better off adopting a strategy that entails a future DASSA payment reduction through the Availability Performance Scalar than declaring unavailability by lapsing their Orders and subjecting themselves to the Compensation Payment. This obviously depends on the level of the Compensation Payment and the relative reduction through the Availability Performance Scalar.

By testing different values for the constants "a" and "b" in the Availability Performance Scalar formula under various assumptions—specifically, changing the number of DASSA Orders awarded in a settlement month—we found that the resulting incentives could be aligned in the correct order across more Trading Periods than what is presented in Exhibit 33.

However, it proved challenging to establish a consistent hierarchy of Availability Performance Scalar over the Compensation Payment, without making the Availability Performance Scalar extremely 'penal' and sensitive to very small deviation from the required availability performance. For the preferred curve of the Availability Performance Scalar, irrespective of the Compensation Payment designs considered, we found there were always situations where arbitrage between the incentive mechanisms was possible. For example, a service provider who frequently clears the DASSA may find the impact of the Compensation Payment too punitive compared to that of the Availability Performance Scalar, when the unit is unavailable for only a small number of Trading Periods. In this situation, the service provider is no longer incentivised to report unavailability, but face the Availability Performance Scalar instead.

Considering the above, we have concluded that instead of creating an implicit hierarchy between the two design elements, implementing an explicit connection will prove to be a simpler and more effective solution that remains binding under all situations and also avoid the need for punitive incentive structures.

Therefore, **we recommend that the Compensation Payment applies even after Gate Closure, alongside the Availability Performance Scalar**. Keeping both incentives in place post-Gate Closure ensures that the necessary hierarchy across incentives for post-Gate Closure availability and pre-Gate Closure Order confirmation is maintained, making it an intrinsic feature of the design. For the avoidance of doubt, **our recommendation is to extend the applicability of the commitment obligation framework to post Gate closure on unavailable contracted volumes (i.e. application of the Compensation payment and suspension of the DASSA payment for the unavailable volumes)**.

4.2.4 Hierarchy between the Event Performance Scalar and the incentives for availability

The Event Performance Scalar assesses the delivered response of a service provider against the expected response in case of a system frequency event. It does not evaluate the reserve volumes made available against its commitments and, therefore, does not directly provide any conflicting incentives to the Compensation Payment or the Availability Performance Scalar within the same Trading Period.

Activation of energy happens automatically in shorter timescales. However, it has come to our attention that some units may be in a position to disable the control systems in an attempt to avoid being activated. Energy storage units may have an incentive to avoid delivering a response even when available. This is because an energy storage unit faces a risk of being unavailable for its DASSA Order obligation in the subsequent Trading Periods or because a price spike is expected in one of the subsequent periods and the unit wishes to capture this.

The TSOs obviously expect units that have a DASSA Order and are available to respond to any potential frequency events. It is therefore important to have strong incentives for providers to respond. Providers should face the appropriate consequences if it turns out they were unavailable during a frequency event. System frequency events are relatively infrequent, and the incentive established for the required response performance should be sufficiently strong.

Exhibit 34 – Event Performance Scalar objective

Event Performance Scalar	
	– For system security, it is critical that the service providers deliver the expected reserve response when available to do so. – It is only prudent to design the incentive to activate and perform in the case of a frequency event such that it strongly discourages poor/subpar response. – The design of the scalar should restrict situations with misplaced incentives to occur by establishing a clear hierarchy between the incentives for service delivery and availability in the subsequent Trading Periods.

4.2.5 Analysis to inform the impact of the Event Performance Scalar

The design of the Event Performance Scalar should consider its interaction with mechanisms in place to incentivise availability of contracted reserve volumes by the DASSA Order Holders. In particular, the design must account for the following situation.

Let us assume that Unit A holds DASSA Orders for the Trading Periods from time 'T' to 'T + X'. Unit A is an energy storage unit. If it delivers the response associated with its DASSA contract, it will no longer be in a position to be available for subsequent Trading Periods, until it manages to re-establish its charge state. In case of a frequency event in Trading Period 'T', Unit A has the following options:

- deliver a response in line with its availability and DASSA Order volumes;
  - Unit A will not be affected by the Event Performance Scalar, but will then be unavailable for its subsequent DASSA Orders up to the Trading Period 'T + Y' and may have to face a Compensation Payment and the Availability Performance Scalar (some of this can be mitigated through secondary trading);
- avoid delivering a response, even when available to do so;
  - Unit A will face scaling down of its DASSA payments as per the Event Performance Scalar provisions, but it will continue to remain available for the subsequent Trading Periods and avoid having to pay any Compensation Payments and impact of the Availability Performance Scalar.

We do recognise, however, that the DASSA design as proposed by the TSO[14] allows for a Grace Period, also discussed in section 4.6 of this report, that exempts units impacted by a dispatch instructions or response to a frequency event from being subjected to the Compensation Payment for the subsequent Trading Periods falling within a defined period. The presence of a Grace Period would obviously change the incentives and the behaviour, at least when considering the Compensation Payment. However, we have assumed the absence of such a Grace Period in our example to account for a more 'onerous' situation under which the Unit A is unable to re-establish its availability within the allowed Grace Period.

Determination of the impact of incentives faced by Unit A

In the option where Unit A delivers the service and becomes unavailable for the subsequent Trading Periods, we can determine the total impact of the other incentives in place as follows:

$$Impact_{unavailability} = Incremential\ Impact_{S_A} + \sum_{T+1}^{T+Y} (P_{DASSA} + Impact_{Comp.Payment})$$

where:

$Incremental\ Impact_{S_A}$ refers to the incremental increase of the Availability Performance Scalar impact due to unavailability of Unit A in 'T+1' Trading Period. This assumes that the Unit A had already confirmed the DASSA Order for 'T+1' period by the time frequency event occurred

$Impact_{Comp.Pay}$ refers to the impact of the Compensation Payment, based on the recommended approach under section 0

P_{DASSA} refers to the DASSA clearing price

In the option where Unit A decides not to deliver the required service, the resulting economic impact is as follows:

$$Impact_{service\ non-delivery} = \sum_{m=M}^{M+P_E} (1 - S_{E,m}) \times\ Pay_{DASSA,m}$$

where:

$Pay_{DASSA,m}$ refers to the DASSA Payment for the month m, due to Unit A after accounting for any impact of the Availability Performance Scalar and the suspension of payment for any unavailable reserve volumes in the concerned month.

$S_{E,m}$ represents the Event Performance Scalar in the month m, which in this case will account for the non-delivery of the service response in the Trading Period 'T'.

P_E refers to the persistence period of the Event Performance Scalar

To simplify the formula above, we assume that unit A only clears DASSA and does not receive any compensation from the ex-post settlement of the DASSA Top-up Mechanism.

Design options considered for the Event Performance Scalar

To achieve the required hierarchy with a 'stronger' incentive for service delivery, we considered the following two options:

- applying **only an Event Performance Scalar**;
  - Assessing the delivered service by the unit in response to a dispatch instruction or a frequency event and scaling the payments made to the unit for volumes cleared under DASSA and RAD, as described in section 4.5. Under this design, we cannot change the assessment criteria since we use the Performance Assessment methods defined under the Regulated Tariff Arrangements[31], but there are two levers that we can 'pull' to adjust the impact of the Event Performance Scalar: persistence duration of the scalar and weighting assigned to the considered months under the Dynamic Time Scaling Factor.
- **Event Performance Scalar alongside the Availability Incentive Mechanisms**;
  - This design builds on the previous option of applying the Event Performance Scalar, but also concurrently uses the Compensation Payment and Availability Performance Scalar by counting undelivered volumes as unavailable as well. Under this design of the service delivery incentive, a unit that does not deliver a service faces all three commitment obligation and performance incentive mechanisms. The DASSA payment for the undelivered volumes is also suspended.

We performed a detailed analysis of both design options for the service delivery incentive mechanism to evaluate their effectiveness in maintaining the required hierarchy.

We used the following inputs and assumptions for this analysis:

- the DASSA reserve product clearing prices in 2027 are based on our analysis;
- the DASSA Trading Period has a 30-minute duration, but we have performed this exercise assuming hourly Trading Periods;
- a service provider is assumed to have a DASSA Order for the entire 'bundle' (FFR-TOR2);
- a service provider is assumed to delivery or not deliver a service in entirety of its contract volume. Partial delivery of a service is not considered;
- we recognise that there could be various reasons behind a unit not delivering a service, however, for the purposes of this analysis, we focus solely on commercial choices by providing units given the underlying incentives;
- we only consider energy storage units for this analysis;
- once a unit delivers a service in response to a frequency event, it becomes unavailable for 'n' subsequent Trading Periods;
- we do not directly consider any Grace Period in this analysis, but this accounted for when selecting different values of 'n' for the analysis;

- Compensation Payment applies to unavailable volumes both pre and post Gate Closure, in addition to the foregone DASSA payment;
- the value of the Compensation Payment is based on the proposed approach under the section 0. For simplicity, we assumed that it is 50% of the DASSA clearing Price;
- to calculate the incremental impact of the Availability Performance Scalar, we assume that the unit had already submitted a compatible FPN for 'T+1' Trading Period, when delivering a service in 'T' Trading Period;

We have analysed the design options over a range of specific case defining assumptions that impact the resulting incentives, and stress tests the considered options. Some of the key assumptions are noted below:

- we explored two different sets of persistence duration and Dynamic Time Scaling Factor for defining the Event Performance Scalar, with the intention to optimise the configuration of the scalar for maintenance of the hierarchy and not being overly penal;
- the assumed unavailability of a service provider unit post delivering a service was varied between 1 to 5 subsequent Trading Periods;
- it was assumed that the subsequent Trading Periods for which the service provider unit becomes unavailable experiences the highest DASSA clearing prices in the month for which the service provider cleared the market. This was assumed to stress test the hierarchy, as high DASSA prices increases the impact of the suspended DASSA payment and the Compensation Payment.

Observations from the analysis

Based on the above defined approach and assumptions, we determined the incentives under both design options, through a detailed calculation model. We are not presenting the calculations in this report, but describe our key conclusions from this analysis below.

Both the design options for the Event Performance Scalar cannot maintain an ever-binding hierarchy with the overall availability and performance incentive mechanisms. This is because of the dissonance in the considered Trading Periods. While the Event Performance Scalar assesses the service delivery at 'T' Trading Period, the incentives for maintaining availability apply in the subsequent periods. Therefore, depending on the DASSA clearing prices and system tightness in the subsequent periods, the impact of the Compensation Payment and suspended DASSA payment for unavailable periods could result in perverse incentives for the service providers under some circumstances.

The second design option considers subjecting the non-delivered service volumes to the Compensation Payment and Availability Performance Scalar, was found to have limited benefits in achieving the required hierarchy. This is because the impact of the availability incentive mechanisms at 'T' Trading Period is largely independent of the impact in the subsequent Trading Periods. There may also be implementation challenges with this option, that would arise as a result of subjecting non-delivered reserve volumes to penalties related to both non-delivery and unavailability. This option would have added further complexity when it comes to reserve volumes cleared in the RAD, as the RAD is resolved ex-post, with no real-time availability obligation. We have, therefore, not considered this option further

Lastly, the proposed design of the Event Performance Scalar is found to satisfy the required hierarchy between the incentives for service delivery and for availability in the subsequent periods in most cases. In certain market conditions, however, the hierarchy may not be respected. The key market parameters that impact the Event Performance Scalar are:

- Number of system frequency events within a month: If the system experiences multiple frequency events, it is possible that the average performance of the unit becomes less sensitive to a single event of non-delivery by the unit;
- Number of DASSA Orders: if a service provider rarely clears in the DASSA, the impact of the Event Performance Scalar is limited to the small revenues it generates from the market;
- DASSA Clearing Prices: If DASSA has cleared at very high prices for the subsequent Trading Periods for which the unit remains unavailable, even after accounting for the Grace Period, the impact of the suspended DASSA payment for these Trading Periods could be quite high.

In general, we observed the proposed design of the Event Performance Scalar, as described under section 4.5, provides a sufficient incentive for the units to deliver the service in response to a frequency event, when available to do so. It maintains the required hierarchy in most cases.

It is crucial to understand that the design of the Event Performance Scalar does not cover for a situation where an energy storage unit may decide to not deliver a service in response to a frequency event, in the anticipation of high price spreads available in the energy markets. Further consideration may need to be given when such behaviour is observed by providers.

4.3 Compensation Payment

The Compensation Payment objectives, which we will use to assess the different approaches, are:

- appropriate incentives to make DASSA Order volumes available by submitting a compatible FPN or find replacement volumes in the secondary market;
- there is a desire for the Compensation Payment value to reflect a best estimate of the cost borne by the TSOs in securing replacement for the reserve volumes lapsed by the DASSA Order Holder;
- implementable given the wider requirements imposed and decisions made by the SEMC; and
- allow market participants to be in a position to predict the potential Compensation Payment.

We also explore the option of scaling the Compensation Payment levied on the DASSA Order Holder based on the notice provided by the lapsing unit, such that it incentivises earlier notification to the TSOs, while avoiding discouraging participation in the secondary trading.

4.3.1 The rationale for the FAM

Our starting point would have been the presence of a real-time market/price for reserve. Reserve could be procured forward in the DASSA and then any deviations would be settled in this real-time market – a balancing market for reserve. The FAM was intended to act as such a real-time market. However, it was decided that the FAM was not needed and a substitute should be used.

The Compensation Payment should be such that it turns a DASSA Order into a meaningful obligation, but, at the same time, does not block more efficient provision that may emerge after the DASSA to be used. The principle behind the FAM acting as the deviation market/price was as follows:

- if some of the DASSA Orders became unavailable and no new provision emerged, the FAM clearing price would be higher than that in the DASSA;
  - 'replacement' volumes would be rewarded at a price reflective of the cost of provision, and, at the same time, DASSA Order Holders that were unavailable would be facing that cost;
- if there was additional provision (for example from wind), then the FAM clearing price could be lower than that in the DASSA;
  - in this case, DASSA Order Holders could lapse their Orders, potentially providing energy instead.

The FAM was one aspect of the originally proposed design that has now been abandoned based on a recommendation by the SEMC. We, therefore, need to explore alternative approaches for the Compensation Payment.

4.3.2 Compensation Payment applicability

We can see three reasons for the DASSA Order Holder submitting a non-compatible FPN and being unavailable for the provision of the service:

- the provider is facing a forced outage;
- the provider makes a commercial choice to not deliver the service (for example because energy provision intraday is more attractive;
- pre-GC TSO instructions means the provider is not in a position to provide the committed volumes.

Providers have no control over forced outages. The incentive to be available and operational comes from a range of markets – the energy market, the capacity market, but also from the DASSA in the future. When units are not operational, they are not in a position to capture income from any of these markets.

They also have no control over TSO actions. On many occasions, the TSOs will have to take early actions (ahead of GC) to dispatch units to ensure secure system operation. Such actions can be for a multitude of reasons, including voltage control, network congestion, minimum level of inertia etc. The need for some of these early actions will be reduced over time as new innovative provision emerges, but it is unlikely it will completely disappear at least in the short to medium term.

Providers are not always in a position to foresee such TSO actions. Should compensation payments apply to DASSA volumes that become unavailable because of TSO instructions?

We believe that all lapsed DASSA Orders should be liable for a Compensation Payment with the exception of unavailability as a result of TSO instructions. It may be disproportionate to request a Compensation Payment in this case given that providers have limited control and would not be in a position to manage this. The Compensation Payment could be indirectly recouped by adapting Balancing Market bidding. However, there is a BCOP in the SEM, which may restrict the types of costs that can be reflected in the technoeconomic data used for non-energy actions. More importantly, extending the Compensation Payments to volumes that become unavailable because of TSO instructions does not necessarily result in more efficient dispatch decisions. This is explained with the use of simplified worked examples in Annex A.

4.3.3 Market participant consideration when bidding in the DASSA

Before the DASSA, a provider will offer its capacity for energy provision in the DAM, taking into account its actual and opportunity costs. The opportunity costs are informed by the expected DASSA income, the potential intraday trading income and ultimately the imbalance price. The imbalance price is reflective of the real-time value of electricity provision. The expectation of the imbalance price drives the price formation across all ex-ante energy markets.

The DASSA takes place after the DAM, but before the intraday market and the LTS. With sequential markets, a provider needs to account for subsequent opportunity costs when offering its capacity. This would happen even in the absence of DASSA. A provider would be offering its capacity in the DAM accounting for potential future income.

Once the DAM is cleared, all scheduled volumes become financially firm. A provider will know its scheduled position and its ability to provide System Services given this position. As is the case when bidding in the DAM, it can take into account expected future income from the intraday market, and shape its bidding into the DASSA accordingly. The income from participating and being awarded DASSA Orders is as follows:

$$R_i^{DASSA} = \sum_j V_{i,j} \times P_{i,j}$$

Where:

$V_{i,j}$ is the volume awarded for a System Service j in period i

$P_{i,j}$ is the price for System Service j in period i

The expected income from 'reserving' its capacity for use later in the intraday market is assumed to be:

$$R_i^{IDM\ expected} = V_i^* \times P_i^{IDM\ expected}$$

where:

V_i^* is the volume that can be offered to the IDM

$P_i^{IDM\ expected}$ is the expected IDM price at the DASSA stage

It is important to note that not all providers can provide their entire 'headroom' (or 'footroom') for reserve provision. BESS may be able to do this, but the contribution to different reserve products from thermal providers can restrict their ability to offer their entire 'headroom'. When offering energy to the IDM, a provider will also face some variable operating costs:

$$C_i^{IDM\ expected} = V_i^* \times VOC_i^{IDM\ expected}$$

where:

V_i^* is the volume that can be offered to the IDM

$VOC_i^{IDM\ expected}$ is the variable operating cost for each MWh provided

The resulting expected margin from potential provision of energy in the IDM then is:

$$GM_i^{IDM\ expected} = V_i^* \times \left[P_i^{IDM\ expected} - VOC_i^{IDM\ expected}\right]$$

If the expected income in the DASSA is greater than the potential from selling energy in the IDM, then the provider would choose to be awarded DASSA Orders. This can be managed through its bidding in the DASSA.

We first want to highlight what the incentives would look like in the absence of any compensation payment or alternative incentive to ensure that the DASSA Order Holder FPN is compatible with the contracted volumes.

In the absence of any form of compensation payment, providers can treat DASSA Orders as an option – there are no consequences in the event of incompatible FPN submission, and holders can simply choose to submit incompatible FPNs. The one obvious situation this can happen is if intraday prices are high, and these imply a greater margin for the provider when compared to the DASSA clearing price.

After the DASSA, market conditions continue to change throughout the day. In the absence of any compensation payment, a provider would choose to forego the DASSA payments as soon as the intraday prices are at a level that suggest a greater return:

$$GM_i^{IDM} > R_i^{DASSA}$$

At the same time, the DASSA Order Holders can post sell orders in secondary trading. Considering that intraday energy margin may be sufficient on their own to push a provider to lapse their DASSA Order, they may even post 0 priced sell order in the secondary market.

We have explored a range of different option for a potential compensation payment:

- no compensation payment with the DASSA Order Holder simply foregoing the DASSA payment in case of a lapse;
- compensation payment equal to the DASSA clearing price;
- a dynamic compensation payment that is linked to the counterfactual income captured through trading in the intraday market; and
- a compensation payment equal to the delta between an adjusted DASSA clearing price and the DASSA clearing price;
- a compensation payment equal to the cost from alternative reserve through the RAD.

There a lot of other options that can be considered for the compensation payment. We believe the above captures a reasonable range of options, and is much more extensive than what is typically used in other reserve markets across Europe.

Let us assume the following to help explain the mechanics and incentives with the different approaches to the compensation payment:

- for simplicity, we assume there is only one reserve product; and
- the capacity is fully interchangeable across reserve and energy provision.

The table below shows the pay-off for the DASSA Order Holder with the different Compensation Payments and for different strategies for upward reserve. We assume that the intraday price is greater than the variable cost of providers i and j. In case the intraday price is lower, then there is no scope for provider i to 'strategically' lapse, and all inframarginal rent terms would effectively become zero. In the same table we also present the pay-off for the alternative provider.

Exhibit 35– Pay-off table for different Compensation Payment options (upward reserve)

	No Compensation	Dynamic compensation	DASSA	Adjusted DASSA – DASSA	RAD
Confirmed DASSA Order	P^{DASSA}	P^{DASSA}	P^{DASSA}	P^{DASSA}	P^{DASSA}
Lapse DASSA Order	$P^{IDM} - VOC_i$	$P^{IDM} - VOC_i - [P^{IDM} - VOC_i\ ]$	$P^{IDM} - VOC_i - P^{DASSA}$	$P^{IDM} - VOC_i - [P^{adj\ DASSA} - P^{DASSA}]$	$P^{IDM} - VOC_i - P^{RAD}$
Sell DASSA Order in secondary market	$P^{IDM} - VOC_i + [P^{DASSA} - (P^{IDM} - VOC_j\ )]$	$P^{IDM} - VOC_i + [P^{DASSA} - (P^{IDM} - VOC_j\ )]$	$P^{IDM} - VOC_i + [P^{DASSA} - (P^{IDM} - VOC_j\ )]$	$P^{IDM} - VOC_i + [P^{DASSA} - (P^{IDM} - VOC_j\ )]$	$P^{IDM} - VOC_i + [P^{DASSA} - (P^{IDM} - VOC_j\ )]$
Pay-off for alternative provider	$P^{IDM} - VOC_j$	$P^{IDM} - VOC_j$	$P^{IDM} - VOC_j$	$P^{IDM} - VOC_j$	$P^{IDM} - VOC_j$

In the above, the price at which the DASSA Order is sold from provider i to provider j in the secondary market is assumed to be determined by provider j (alternative provider) and is equal to the DASSA clearing price net of the foregone intraday income. This can then become negative with provider i paying provider j to be entitled to the DASSA clearing price if the intraday margin is greater than the DASSA clearing price.

This same table can then be adapted for the purposes of downward reserve. The table is similar to that for upward reserve. The difference is in the foregone energy ‘income’. If the IDM price is below the variable operating cost of a unit, it can then benefit from buying back at the IDM price and avoiding the variable costs. We assume that the intraday price is lower than the variable cost of providers i and j. In case the intraday price is higher, then there is no scope for provider i to ‘strategically’ lapse, and all inframarginal rent terms would effectively become zero.

Exhibit36 – Pay-off table for different Compensation Payment options (downward reserve)

	No Compensation	Dynamic compensation	DASSA	Adjusted DASSA – DASSA	RAD
Confirmed DASSA Order	P^{DASSA}	P^{DASSA}	P^{DASSA}	P^{DASSA}	P^{DASSA}
Lapse DASSA Order	$-P^{IDM}+VOC_i$	$-P^{IDM}+VOC_i - \left[-P^{IDM}+VOC_i\ \right]$	$-P^{IDM}+VOC_i - P^{DASSA}$	$-P^{IDM}+VOC_i - \left[P^{adj\ DASSA} - P^{DASSA}\right]$	$-P^{IDM}+VOC_i - P^{RAD}$
Sell DASSA Order in secondary market	$-P^{IDM}+VOC_i + \left[P^{DASSA} - \left(P^{IDM}-VOC_j\ \right)\right]$	$-P^{IDM}+VOC_i + \left[P^{DASSA} - \left(P^{IDM}-VOC_j\ \right)\right]$	$-P^{IDM}+VOC_i + \left[P^{DASSA} - \left(P^{IDM}-VOC_j\ \right)\right]$	$-P^{IDM}+VOC_i + \left[P^{DASSA} - \left(P^{IDM} - VOC_j\ \right)\right]$	$-P^{IDM}+VOC_i + \left[P^{DASSA} - \left(P^{IDM} - VOC_j\ \right)\right]$
Payoff for alternative provider	$-P^{IDM}+VOC_j$	$-P^{IDM}+VOC_j$	$-P^{IDM}+VOC_j$	$-P^{IDM}+VOC_j$	$-P^{IDM}+VOC_j$

We have used the following terms in the above table:

P^{DASSA} is the DASSA clearing price for the specific reserve product

P^{IDM} is the intraday energy price in a given point in time within-day, and for simplicity we assume there is no other intraday trading opportunities

$P^{adj\ DASSA}$ is the adjusted DASSA clearing price for the specific reserve product (this would be the theoretical clearing price excluding the DASSA offers that were eventually unavailable)

P^{RAD} is the RAD clearing price for the specific reserve product

VOC_i is the variable operating cost of provider i, which is also a DASSA Order Holder, for an additional MWh of energy produced (for simplicity we assume there are no actual costs for provision of reserve)

VOC_j is the variable operating cost of provider j, which is not a DASSA Order Holder, but is in a position to participate in secondary trading, for an additional MWh of energy produced (for simplicity we assume there are no actual costs for provision of reserve)

From the above table, we can see the following:

- the pay-off for provider i is the same if it opts to sell its DASSA Order in the secondary market and use its capacity to sell energy in the intraday market irrespective of the Compensation Payment;

  - this highlights the importance of secondary trading, which effectively allows the provider to pass on the DASSA Order to another provider and avoid any Compensation Payment;
- the pay-off for the alternative provider is also always the same and equal to the DASSA clearing price plus the foregone inframarginal rent that it could have captured in the intraday market;
  - this is not surprising given that the payment in the secondary market is influenced by the Buy Order submitted by the alternative provider;
- the pay-off for confirmed DASSA Orders is always the DASSA clearing price; and
- the pay-off changes in the case of a lapse with different approaches to the Compensation Payment.

In the case of no compensation, the incentive is for the DASSA Order Holder to lapse as long as the energy market margin is greater than the DASSA clearing price. In the case of the DASSA clearing price acting as the effective Compensation Payment then this threshold becomes wider and the DASSA Order Holder would lapse as long as the energy market margin is greater than two times the DASSA clearing price. In general, any 'fixed' compensation payment would impose a certain 'level' beyond which the intraday energy market margin would need to exceed for the DASSA Order Holder to choose to lapse.

From all the above approaches, it is only the dynamic approach that makes a DASSA Order Holder indifferent to what is happening in the intraday energy market. Any potential income from intraday trading would be removed and lapsing would never be a dominant strategy.

Let us now assume the following to better explain the potential outcomes and the pay-offs for a DASSA Order Holder:

P^{DASSA} = 10 €/MW/h

P^{IDM} = 120 €/MW/h

$P^{adj\ DASSA}$ = 35 €/MW/h

P^{RAD} = 5 €/MW/h

VOC_i = 90 €/MWh

VOC_j = 85 €/MWh

The adjusted DASSA price is assumed to be equal to the above table becomes as show in the table below.

Exhibit 37 – Worked example pay-off table for different Compensation Payment options

	No Compensation	Dynamic compensation	DASSA	Adj. DASSA – DASSA	RAD
Confirmed DASSA Order	10	**10**	10	**10**	10
Lapse DASSA Order	**30**	0	**20**	5	**25**
Sell DASSA Order in secondary market	5	5	5	5	5
Payoff for alternative provider	*35*	*35*	*35*	*35*	*35*

In the case of no compensation payment and the case of the DASSA price used as the compensation payment, the provider improves its financial position if it lapses and sells in the intraday market. Given the lower variable cost of the alternative provider, it also is not in its interest to accept a trade in the secondary market to take on the DASSA obligation.

In the previous example, we assumed that the variable operating cost of the alternative provider was lower than that of the DASSA Order Holder. Let us now assume an alternative provider with higher variable operating costs and all other assumptions equal:

P^{DASSA} = 10 €/MW/h

P^{IDM} = 120 €/MW/h

$P^{adj\ DASSA}$ = 25 €/MW/h

P^{RAD} = 5 €/MW/h

VOC_i = 90 €/MWh

VOC_j = 95 €/MWh

The pay-offs then are as per the table below.

Exhibit 38 – Worked example pay-off table for different Compensation Payment options

	No Compensation	Dynamic compensation	DASSA	Adj. DASSA – DASSA	RAD
Confirmed DASSA Order	10	10	10	10	10
Lapse DASSA Order	**30**	0	**20**	**15**	**25**
Sell DASSA Order in secondary market	15	**15**	15	**15**	15
Payoff for alternative provider	*25*	*25*	*25*	*25*	*25*

The dominant strategy for the DASSA Order Holder remains to lapse in the same three cases as above (no compensation, DASSA and RAD). As discussed above, this will be the case as long as the expected energy margin is greater than the DASSA clearing price, and in the absence of an alternative provider with significantly higher variable operating costs.

With the dynamic compensation and the Adjusted DASSA approaches, the dominant strategy is to sell the DASSA Order in the secondary market. This is also desirable from a wider system perspective. The alternative provider has a higher variable operating cost, and it is more efficient for the DASSA Order being taken over by that provider with the energy coming from the original DASSA Order Holder.

The above analysis relies on:

- the price in the secondary market set by the counterfactual provider j – the price can, however, be set by an alternative provider assuming a pay-as-cleared approach;
- the adjusted DASSA price is assumed to be such that it reflects the foregone income from the alternative provider j on the basis of having perfect foresight of what the intraday prices will be.

In practice, it is unlikely that units will have perfect foresight, and the adjusted DASSA price will be reflective of the costs and expectations of different providers at the DASSA stage. This, in turn, means that the use of the delta of the adjusted DASSA and the DASSA clearing prices may not always provide appropriate incentives, as described above.

4.3.4 Options for Compensation Payment

In the previous section we have already introduced a range of different options for the Compensation Payment. All these options were more 'dynamic' with the Compensation Payment level changing from one settlement period to the next depending on market conditions. In this section, we are providing further details on the different approaches (as the focus was on understanding the incentives in the previous section) and complementing this with an additional more 'static' Compensation Payment option.

Fixed payment based on the threat to system security

This approach uses the underlying threat of a system black-out as a result of insufficient reserve to quantify the value of the Compensation Payment. This is based on the rationale that the loss incurred by the innocent party (TSOs) is the cost of losing the system multiplied by the probability of occurrence of this event. The Compensation Payment could be defined as follows:

$$P_{Comp,Base} = VOLL \times Volume_{system} \times P_{system-loss}$$

where
$P_{Comp,Base}$ represents the Compensation Payment's base value, i.e. without any multipliers applied to scale the value to account for lapsed volumes and notice period provided to the TSOs, among any other considerations
$VOLL$ refers to the Value of Loss Load, as given by the prevailing value issued by the SEM Committee[28]
$P_{system-loss}$ represents the probability of system-wide loss due to the lack of reserves on the system. We recognise that lack of reserve won't in itself lead to a system failure and will consider the possibility of frequency events in defining the probability.
$Volume_{system}$ refers to a representative figure of system demand that would be affected under a system black-out in the case of insufficient reserves on the system

The cost of a black-out can be in the order of multiple million Euros depending on how long a black-out lasts. However, having insufficient reserve does not immediately entail that there is a risk of a black-out. There is a probability of this happening, and there are alternative actions the TSOs would take before reaching the point of a black-out. The resulting Compensation Payment would rely on the associated probability of losing the load as a result of insufficient reserve.

DASSA clearing price

This approach essentially uses the DASSA clearing price as the Compensation Payment.

[28] SEM Committee, Information Paper: Calculation of Single Value of Lost Load within the Single Electricity Market, SEM-23-072, 29th September 2023

RAD clearing price

This approach uses the RAD clearing price as the Compensation Payment.

Delta between ex-post adjusted DASSA and DASSA clearing prices

Under this approach the Compensation Payment is equal to the delta between an adjusted DASSA and the DASSA clearing prices, attempting to reflect the cost of replacement faced by the TSOs. The adjusted DASSA clearing price is defined by clearing again the DASSA, excluding, however, volumes that subsequently did not submit compatible FPNs.

Delta between ex-ante adjusted DASSA and DASSA clearing prices

Under this approach the Compensation Payment is equal to the delta between an ex-ante adjusted DASSA and the DASSA clearing prices, attempting to reflect an expected cost of replacement faced by the TSOs. The ex-ante adjusted DASSA clearing price is determined by clearing the DASSA excluding an ex-ante estimate of lapsed volumes that submit incompatible FPNs[29]. This estimate can be based on historical data, and this adjusted DASSA price can be produced at the same time as the DASSA price.

Dynamic compensation

The dynamic compensation requires the DASSA Order Holder to return to the TSOs any margin captured through trading in the intraday markets. The DASA Order Holder is effectively not allowed to retain any margin for the volumes allocated to reserve provision in case of a lapse.

4.3.5 Assessment of different Compensation Payment options

We have explored a wide range of options for the Compensation Payment. There are obviously additional options, including having multiples of a reference price, such as the DASSA, but also linking the compensation payment to the imbalance price.

When it comes to the latter, we did consider this as a credible option. However, in practice, the level of the imbalance price is likely to be disproportionately higher than the DASSA price. We felt this may likely entail a significant risk for providers and have excluded this option from further assessment.

We have assessed the options based on some key objectives:

- appropriate incentives – Does the Compensation Payment promote efficient dispatch decision? Does it help facilitate secondary trading and submitting incompatible FPNs in case of unavailability?

[29] In practice, this can be achieved by inflating the requirement by the estimate of the lapsed volumes to avoid having to take a view as to which volumes would be unavailable.

- cost-reflectivity – Does the Compensation Payment reflect the costs faced by the TSOs in the case of a DASSA Order lapse or in the case of unavailability?
- implementable – Can this be implemented? What is the required effort and cost?
- predictable – Can providers easily predict the resulting level of the Compensation Payment?

Exhibit 39 – Assessment of different Compensation Payment options

	No Compensation	Dynamic compensation	DASSA	Ex-post adjusted DASSA – DASSA	RAD	System security cost	Ex-ante adjusted DASSA - DASSA
Appropriate incentives	○	◑	◔	◕	◔	◔	◑
Cost-reflectivity	○	○	◑	◕	◑	◑	◑
Implementable	●	◔	●	◔	◕	◔	◔
Predictable	●	●	◕	◑	◑	●	●

The options that provide more consistent incentives to DASSA Order Holders to deliver on their DASSA commitments or attempt to trade in the secondary market are the dynamic compensation and the ones based on the presence of an adjusted DASSA clearing price. Incentives are weaker in all other options. The dynamic compensation does discourage providers from lapsing under all circumstances, including on occasions when it may be more efficient from an overall system perspective for the unit to be used for provision of energy and be replaced by an alternative provider. In the presence of a highly liquid secondary market however, this should happen infrequently (if at all).

We believe that appropriate incentives should be the key objective of the Compensation Payment. Unfortunately, the dynamic compensation cannot be easily adopted. On the one hand, it is actually very predictable, as providers would know that, should they choose to lapse and trade intraday, then they would need to forego all income from the energy markets. On the other hand, this relies on having information on the costs incurred by different providers and the Compensation Payment is not necessarily cost-reflective.

The ex-post adjusted DASSA net of the DASSA option may provide improved incentives compared to other options, but it may be seen as more difficult to predict by market participants, and there may be implementation challenges.

The Compensation Payment can become known after the DASSA with the ex-ante adjusted DASSA option. However, the challenges on implementation remain, given there is a need for additional data and an additional software run.

On balance, the ex-post adjusted DASSA attempts to capture the costs faced by the TSOs in case alternative reserve needs to be procured, and, as a result, should provide the most appropriate incentives. Defining the adjusted DASSA price ex-ante means the Compensation Payment, but is at the same time an estimate so may not be reflective of actual conditions. Other options, such as the DASSA or the RAD, provide 'weaker' incentives. They are, however, implementable and can be, to different degrees, predicted by market participants.

4.3.6 Proposed design of the Compensation Payment

Our current thinking is to adopt the delta of the adjusted DASSA clearing price and the DASSA clearing price as the Compensation Payment. As can be seen from our assessment, it is not a simple choice:

- we can safely conclude that a compensation payment is needed to strengthen incentives for DASSA Order Holders;
- the adjusted DASSA minus the DASSA clearing price option has the potential to have the most appropriate incentives compare to the other choices, but predictability may be a concern – should intraday prices shift significantly within-day when compared to day-ahead expectations then DASSA Order Holders are likely to lapse even in cases when this is inefficient from a system perspective;
  - predictability can be improved by using an ex-ante expectation of potential lapse DASSA Orders with the Compensation Payment known after the DASSA stage;
- the use of the DASSA clearing price is easier to implement and more predictable, but incentives may prove weaker – should intraday prices shift significantly within-day when compared to day-ahead expectations then DASSA Order Holders are likely to lapse even in cases when this is inefficient from a system perspective;
- using the RAD price as the Compensation Payment is easily implementable, but harder to predict and incentives may also be weaker. Furthermore, there is also a risk that the service providers may try to game the market by exploiting the dependence of the Compensation Payment on the RAD prices.

We have also considered the possibility of a discount to this applied in the case of early notification of a lapsed DASSA Order. The Compensation Payment would then take the following form:

$$P_{comp} = S_{lapse-time} \times [P^{adj\,DASSA} - P^{DASSA}] \times V_{Lapsed}$$

where:

P_{comp} refers to the Compensation Payment for a Trading Period
$P^{adj\,DASSA}$ is the adjusted DASSA clearing price

P^{DASSA} is the DASSA clearing price
V_{lapsed} is the total lapsed volume by the DASSA Order Holders

with $S_{lapse-time}$ defined as follows:

$$S_{lapse-time} = \begin{cases} 0.8\,, & x > 4 \\ 0.8 + 0.2 \times \dfrac{4-x}{4}, & 0 \leq x \leq 4 \end{cases}$$

where:

x is notice period provided by the lapsing unit to the TSOs, measured in hours

However, we believe this feature of a lower payment with early notice risks undermining the secondary market. It may be that providers choose to lapse DASSA Orders early to avoid paying the full Compensation Payment, potentially limiting activity in the secondary market. On balance, we believe the same Compensation Payment should apply irrespective of timing of the lapse.

4.4 Availability incentives

As already discussed, the purpose of the Compensation Payment is to incentivise availability declaration at Gate Closure. It is important, however, for the reserve volumes to remain available up to real-time, and there needs to be an incentive to ensure providers attempt to maintain availability. We have explored the following options:

- the sole application of a 'one-off' payment equivalent to the Compensation Payment (noting that we have already proposed for the Compensation Payment to volumes that become unavailable post Gate Closure);
- the application of a scalar on future DASSA income; and
- temporary exclusion of a provider from subsequent DASSA auctions for a time-limited period.

4.4.1 Assessment of high-level options for the availability incentive

We evaluated each of the considered options using the following assessment criteria:

- appropriate incentives – Does the measure incentivise availability in operational timeframes, as well as long-term availability? Does it support efficient dispatch?
  - we have assume that under all options the Compensation Payment applies in addition to the availability incentive or the incentive has a greater financial impact than the Compensation Payment;
- proportionality – is the availability incentive proportional to the impact the unavailability has on the wider system efficiency and secure operation of the system?

- implementable – can the measure be easily implemented? What is the required effort and cost?
- predictable – can providers easily predict the resulting impact of the incentive?

Exhibit 40 – Assessment of different availability incentive options

	Availability Performance Scalar	Temporary exclusion	One-off payment
Appropriate incentives	◕	◑	◑
Proportionality	◕	◑	◑
Implementable	◕	●	●
Predictable	◕	●	◕

All measures have the potential to provide appropriate availability incentives. The detailed parameters of the measure will determine whether the incentives are appropriate or not. For example, a one-off payment that is disproportionately high may, on the one hand, encourage improved availability from some providers, but may deter other providers from participating and reduce overall availability of reserve volumes. Conversely, if, for example, the threshold for a temporary exclusion is set too high, then availability signals will be 'weaker'.

It is only the availability scalar that has been scored slightly higher than the other measures. This is because we expect this scalar to be more 'dynamic', scaling down future DASSA payments more as a provider becomes less available. This can also be achieved with the use of a one-off payment, assuming this one-off payment increases in line with past volume unavailability.

The scalar approach can be adapted to be more proportionate as an incentive. There can be some tolerance with some unavailability within a given timeframe not attracting any 'scaling down'. At the other extreme, at high levels of unavailability the scalar could drop down to zero, effectively acting as a temporary exclusion from subsequent auction. The temporary exclusion is a more 'binary' solution. The relative impact from a one-off payment is the same for all providers irrespective of their relative reliability. As was the case with the previous criterion, the details matter for the resulting scoring.

The implementation of the Availability Performance Scalar is expected to be more involved than that of the alternative options considered. However, a scalar-based performance mechanisms is currently in place under the current Regulated Tariff Arrangements, and the TSOs have experience with this. Still, both the one-off payment and the temporary exclusion appear to be more easily implementable solutions.

As we have already discussed, the detailed parameters of each option are important for understanding which is the most suitable solution to incentivise availability from reserve providers in the context of the SEM. The TSOs have a preference for an availability incentive with some persistence, and we believe that, on balance, a scalar-based approach can better meet the TSO objectives.

4.4.2 Availability Performance Scalar

The application of a scalar does not feel like a natural fit for an auction-based procurement process. One could also argue that this risks increasing prices in the DASSA as providers that face a scalar will offer volumes at higher prices to counteract the impact of the scalar. Price increases would also happen with any temporary exclusion. As some cheaper volumes are no longer available in the auction, we would expect DASSA prices to clear higher. One could ask why exclude volumes or include scalars if this then means higher DASSA clearing prices. This higher price reflects improved reliability. And in any case, a low clearing price in the DASSA means very little if subsequently the TSOs need to pay a lot more to find replacement reserve volumes.

Prices can increase also in the case of high one-off compensation payments. We, therefore, do not share the view that the application of scaling down payments has an even greater impact on price formation than other approaches, such as excluding providers or high compensation payments when volumes become unavailable.

With the use of a scalar, units are still expected to participate in the DASSA and can even clear the market in situations of system tightness. The scalar-based approach can be designed in a way that some volumes are effectively excluded, particularly for units with poor availability record. That said, it allows the TSOs to provide an incentive to the service providers for maintaining availability and strike a balance between ensuring that the reserve volumes procured in the DASSA remain available while limiting the risk of triggering volume insufficiency.

The benefits of a scalar-based approach are:

- the impact can be more proportionate;
  - a scalar applied on the monthly payments received by a service provider ensures that the impact on the unit is proportional to the revenues earned by the unit in the DASSA. This translates into units that often clear the DASSA having a stronger incentive in absolute terms than a unit that rarely wins a DASSA contract. The Compensation Payment is aimed at recovering counterfactual cost of provision and ensuring that a DASSA Order acts as a meaningful

obligation. The intention with the Availability Performance Scalar is not to recover counterfactual costs, but to provide an incentive to retain availability;

- a scalar-based approach allows the TSOs to set an incentive that is less sensitive to the DASSA clearing price on a Trading Period to Trading Period basis, and the overall impact can be 'smoother' with minimal or even no impact in case of limited unavailability;
- duration of persistence;
  - adding a degree of persistence to the incentive mechanism allows for the TSO to assess the performance of the unit over a more extended period – this design can help discourage consistently poor performance.

In addition to satisfying the key objective that the scalar must incentivise DASSA Order Holders to maintain and accurately declare their availability for confirmed DASSA Orders, we have also considered the following for the Availability Scalar:

- the scalar must account for the diverse scenarios under which a service provider may have its DASSA Order confirmed and any mitigating factors that may have impacted a unit's availability in line with DASSA Order post Gate Closure; and
- the impact of the Availability Scalar should be greater than the Compensation Payment to maintain the correct hierarchy between the different incentives and promote accurate submission of unit availabilities at Gate Closure by the service providers.

While the Compensation Payment encourages the service providers to submit compatible FPNs in line with the DASSA Orders awarded to them, the Availability Scalar provides an incentive for real-time availability.

The initial DASSA design by the TSOs[14] envisaged that the Compensation Payment only applies to the lapsed DASSA Orders, and the Availability Scalar applies on confirmed DASSA Orders post the Gate Closure.

Our recommendation, however, is for the Compensation Payment to apply even for volumes that become unavailable after Gate Closure, alongside the Availability Scalar. This helps ensure that the required hierarchy between incentives for post Gate Closure availability and pre Gate Closure DASSA Order confirmation is maintained. Otherwise, there is a risk that arbitrage opportunities may arise between the different incentives. For example, it may be more attractive for a provider to submit a compatible FPN and face the Availability Scalar, even though it may be aware of an upcoming unavailability. For the avoidance of doubt, the Compensation Payment will apply only to the relevant Trading Period, and the DASSA payment for the unavailable volumes will be suspended, similar to the treatment of a lapsed DASSA Order.

4.4.3 Design Methodology

The value of the Availability Performance Scalar (S_A) varies between 0 and 1, with values less than 1 resulting in the reduction of the DASSA Payment to the service provider. The formula considers previous months of availability performance of the service providing unit to determine the resulting value.

The methodology defines two key elements for the Availability Performance Scalar (S_A):

Availability Factor (F_A)

The Availability Factor (F_A) is the term that assesses the unit's performance against the confirmed DASSA volumes for a service, feeding that into the determination of the Availability Performance Scalar (S_A). It is defined as the weighted average of the unit's monthly availability performance, considering a time-period of 5 months. It is calculated as shown below:

$$F_A = \left(\sum_{m=M}^{M-4} \left[1 - \frac{capacity\ unavailable_m}{confirmed\ capacity_m} \right] \frac{V_m}{3} \right)$$

where:

F_A is the Availability Factor, feeding into the calculation of the Availability Scalar

$Confirmed\ capacity_m$ refers to the total volume of the confirmed DASSA Orders held by the service provider in the month m

$Capacity\ unavailable_m$ represents the total volume of confirmed DASSA Orders that the service provider did not make available during the corresponding Trading Period in month m. However, if the unavailability is due to a post-Gate Closure instruction issued by the Transmission System Operator (TSO), preventing the service provider from delivering its contracted reserve volume, those volumes will be excluded from this calculation.

M represents the current settlement month

V_m is the Dynamic Time Scaling Factor weighting allocated to month m. It is further discussed below:

Dynamic Time Scaling Factor (V_m)

The Dynamic Time Scaling Factor (V_m) are pre-defined weightings assigned to the current settlement month and the last 4 months. These weightings create an emphasis on more recent performance incidents in the formula for the Event Performance Scalar. A total of three months of performance history for a service-providing unit is considered, with each month's weight decreasing progressively from the current settlement month (M) to the earliest month considered (M-2).

Exhibit 41 – Dynamic scaling for Availability Factor

Number of months between the unavailability incident month and the settlement month (M)	Dynamic Time Scaling Factor (V_m)
M	1
M-1	0.8
M-2	0.6
M-3	0.4
M-4	0.2

Availability Performance Scalar (S_A)

The Availability Performance Scalar (S_A) is defined as:

$$S_A = \begin{cases} 1, & F_A > b \\ \dfrac{F_A - a}{b - a}, & F_A > a \\ 0, & a > F_A \end{cases}$$

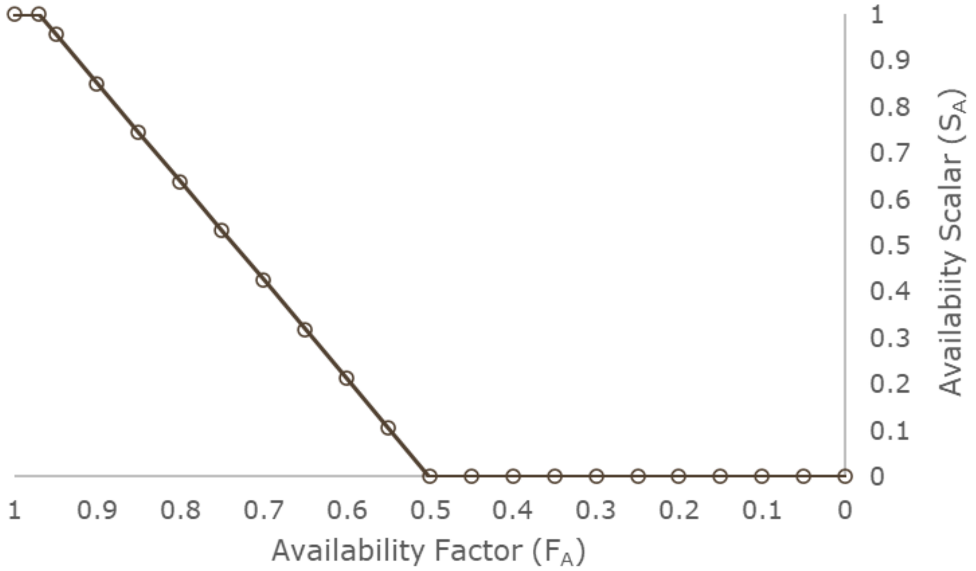
where:

b and a constants are set at 0.97 and 0.50 respectively

The resulting Availability Factor (F_A) and Availability Scalar (S_A) will be rounded-off two the nearest two decimal places.

As per the above formula, the relationship between the Availability Performance Scalar (S_A) and the Availability Factor (F_A) can be represented by the curve provided below in Exhibit 42.

Exhibit 42 Relationship between the Availability Scalar (S_A) and the Availability Factor (F_A)



The above defined formula for the Availability Performance Scalar works as follows:

- the Availability Performance Scalar follows a linear curve reducing in line with the monthly weighted average availability considering a unit's confirmed DASSA Order volumes;
- the weighted average Availability Factor takes into the account the last 5 months of availability performance of the service provider, with more recent months having a higher weightage assigned to them in order to include a bias for the recent performance history;
- there is a tolerance with some small levels of unavailability not resulting in the application of a scalar (the scalar is 1); and
- if the availability of a unit drops to 0.5 of its contracted DASSA Orders or below, then the scalar becomes 0.

We acknowledge a potential argument that by defining the consideration of a unit's performance on a time-period basis of monthly frequency, the Availability Scalar might not have the desired impact on the service provider that only infrequently clears in the DASSA. To address this situation, we explored various other designs, such as basing the performance evaluation on the number of awarded DASSA Orders or on a certain pre-defined DASSA volumes. However, we believe that using a time unit as the basis for considering a unit's performance provides the best combination of consistency across scalar implementation for different units over a settlement period and design simplicity.

We are proposing a tolerance of 3% for the weighted average unavailability of a unit over the 5 months considered. This has been incorporated into the formula to allow for any reasonable forced outages that a unit may face. It is important to note that as per our recommendation, the Compensation Payment will continue to apply concurrently to the Availability Performance Scalar on every instance of unavailability post Gate Closure.

Applicability of Availability Performance Scalar

We have considered various plausible scenarios that may lead to a service provider becoming unavailable for a portion or the entirety of its committed volumes under a confirmed DASSA Order. We propose to only exempt volumes that became unavailable as a direct result of a TSO instruction issued post-Gate Closure from the application of the scalar. This then means that if a unit receives an instruction in the Balancing Market to increase or decrease its output with a corresponding impact on its availability for fulfilling the DASSA Order obligation, the unit will be considered available for the purposes of the Availability Performance Scalar. If such a TSO instruction, however, means it can still be available for meeting the DASSA Order volumes, then the Availability Performance Scalar should apply.

For the avoidance of any doubt, this also includes TSO instructions issued post Gate Closure in a previous Trading Period to the one associated with the confirmed DASSA Order. For example, if a storage unit receives a dispatch instruction from the TSO limited to a previous Trading Period, but the dispatch instruction affects the ability of the storage unit to fulfil its availability commitment in a subsequent Trading Period, the resulting unavailable volumes because of the dispatch instruction will be excluded from the scalar calculation. This is based on the same rationale for our position to exempt lapsed DASSA Order volumes at the Gate Closure from the application of the Compensation Payment, if the unavailability of the contracted reserve volumes by the DASSA Order Holder is due to a TSO instruction.

The service providers that are awarded DASSA Orders may lapse the order entirely or partially. TSOs in the DASSA design consultation paper[30] expressed their intention to only subject the portion of the DASSA Order to the Availability Scalar that has been confirmed by the service provider. This has been accounted for in the design of the scalar formula by grounding the assessment of the monthly performance of the unit on the $Confirmed\ capacity_m$, which represents the confirmed volumes of the DASSA Order only.

4.4.4 Worked example for a confirmed DASSA Order

In the following example we show how the Availability Scalar (S_A) is calculated for different months. Calculation of the Compensation Payment, applicable as per the recommended design, has not been included below. This example assumes a service provider with a certain number of confirmed DASSA Orders and some unavailability for the contracted capacity.

[30] EirGrid/SONI, FASS Programme: DASSA Design Consultation Paper v1.0, March 2024

During the first operational month the service providing unit fails to become fully available on 4 different occasions out of 10 confirmed DASSA Orders, each for 100MW of a reserve product. Let us assume that for the 4 occasions of partial unavailability, the unit satisfies availability criteria for 30%, 40%, 50% and 60% of the contracted reserve volumes. Further the unit fails again once in February for the entire DASSA confirmed DASSA Order of 50MW, out of the combined confirmed DASSA Order volume of 200MW in that month. For all the remaining months, we assume that the unit was available for the entirety of the confirmed DASSA Order volumes.

When the Scalar Assessment Month, M, refers to December 2026 then the Availability Scalar (S_A) is calculated to be 0.91. For M=December, months M-1, M-2 etc. are assumed to have a number of failures equal to zero as there is no historical data. For M=January 2027, the number of failures is zero, however, the 4 events of partial availability over December will still impact the calculation of the factor with less weight which results in a resulting Availability Scalar (S_A) of 0.94. For M=February, where one failure occurs, the Availability Scalar (S_A) drops again to 0.79 and then gradually increases to 1.0 over the following months given that no further failures occur.

Exhibit 43 - Example calculation of Availability Factor (F_A) and Availability Scalar (S_A)

Month	Total confirmed DASSA Order volume (MW)	Volumes unavailable (MW)	Availability Factor (F_A)	Availability Scalar (S_A)
Oct 2026	n/a	n/a	n/a	n/a
Nov 2026	n/a	n/a	n/a	n/a
Dec 2026	100X10 = 1000	70+60+50+40= 220	$(1 \times 0.2 + 1 \times 0.4 + 1 \times 0.6 + 1 \times 0.8 + 0.78 \times 1) \times \frac{1}{3} = 0.93$	$\frac{0.93 - 0.5}{0.47} = 0.91$
Jan 2027	1000[1]	1000[1]	$(1 \times 0.2 + 1 \times 0.4 + 1 \times 0.6 + 0.78 \times 0.8 + 1 \times 1) \times \frac{1}{3} = 0.94$	$\frac{0.94 - 0.5}{0.47} = 0.94$
Feb 2027	200	50	$(1 \times 0.2 + 1 \times 0.4 + 0.78 \times 0.6 + 1 \times 0.8 + 0.75 \times 1) \times \frac{1}{3} = 0.87$	$\frac{0.87 - 0.5}{0.47} = 0.79$
Mar 2027	1000[1]	0	$(1 \times 0.2 + 0.78 \times 0.4 + 1 \times 0.6 + 0.75 \times 0.8 + 1 \times 1) \times \frac{1}{3} = 0.90$	$\frac{0.90 - 0.5}{0.47} = 0.85$
Apr 2027	1000[1]	0	$(0.78 \times 0.2 + 1 \times 0.4 + 0.75 \times 0.6 + 1 \times 0.8 + 1 \times 1) \times \frac{1}{3} = 0.94$	$\frac{0.94 - 0.5}{0.47} = 0.94$
May 2027	1000[1]	0	$\left(1 \times 0.2 + 0.75 \times 0.4 + 1 \times 0.6 + 1 \times 0.8 + 1 \times 1 \times \frac{1}{3}\right) = 0.97$	$\frac{0.97 - 0.5}{0.47} = 1$
Jun 2027	1000[1]	0	$(0.75 \times 0.2 + 1 \times 0.4 + 1 \times 0.6 + 1 \times 0.8 + 1 \times 1) \times \frac{1}{3} = 0.98$	1
Jul 2027	1000[1]	0	$(1 \times 0.2 + 1 \times 0.4 + 1 \times 0.6 + 1 \times 0.8 + 1 \times 1) \times \frac{1}{3} = 1$	1

Note: 1) Arbitrary value used for the confirmed DASSA Order volume

4.5 Real-time performance incentives

It is important that the real-time performance incentive encourages service providers to meet the TSOs requirements. This incentive needs to be relatively 'sharp' given the infrequent occurrence of system frequency events requiring activation of reserves. It should also act as a stronger signal for service delivery than the applicable availability incentive mechanisms in the subsequent trading periods during which an energy storage unit may then become unavailable following the provision of a service.

We have considered a range of different design options to incentivise DASSA Order Holders to be in a position to respond to frequency events in real-time, including:

- performance scalar applied on future DASSA income;
- temporary exclusion of a service provider from subsequent DASSA auctions; and
- one-off payment.

As was the case with the availability incentive, we assume that any of these incentives is in addition to a Compensation Payment and/or structured in a way that they have a greater impact than all preceding incentives.

We evaluated each of the considered options using the following assessment criteria:

- appropriate incentives – Does the measure incentivise providers to be in a position to respond in line with their contracted volumes and technical capabilities?
- proportionality – is the performance incentive proportional to the impact the 'non-delivery' has on the wider system efficiency and secure operation of the system?
- implementable – can the measure be easily implemented? What is the required effort and cost?
- predictable – can providers easily predict the resulting impact of the incentive?

Exhibit 44 – Assessment of different event performance incentive options

	Event Performance Scalar	Temporary exclusion	One-off payment
Appropriate incentives	◕	◑	◑
Proportionality	◕	◑	◑
Implementable	◕	●	●
Predictable	◕	●	◕

The one-off payment can be structured in a way that the desired hierarchy is fully respected with a provider incentivised to declare its unavailability to avoid facing a greater financial compensation. For this to be achieved, however, any such one-off payment should be sufficiently high given the relatively low frequency of such events. Similarly, a temporary exclusion can be deterrent assuming that it would not take many instances of 'non-performance' for triggering an exclusion. The scalar can be designed in a way that it entails a temporary exclusion after a set number of instances of non-performance and applying a reduction of subsequent income from the DASSA for a more limited number of instances.

However, none of the considered options are able to maintain the required hierarchy between the incentives for service delivery and availability in the subsequent trading periods, under all the possible circumstances, unless the incentives become extremely sharp. This is because some storage units can choose to avoid responding to a frequency even if electricity prices in subsequent periods are sufficiently.

The scalar approach can be adapted to be more proportionate as an incentive. There can be some tolerance with some non-performance within a given timeframe not attracting any 'scaling down' (even though such tolerance should probably be very limited in the case of event performance). On the other hand, if a provider exceeds a certain threshold, the scalar could drop down to zero, effectively acting as a temporary exclusion from subsequent auction. The temporary exclusion is a more 'binary' solution. The relative impact from a one-off payment is the same for all providers irrespective of their relative reliability. The details of the incentive are important for informing the resulting scoring.

The implementation of an Event Performance Scalar is expected to be more involved than that of the alternative options considered. However, a scalar-based performance mechanisms is currently in place under the current Regulated Tariff Arrangements, and the TSOs have experience with this. Still, both the one-off payment and the temporary exclusion appear to be more easily implementable solutions.

The detailed parameters of each option are important for understanding which is the most suitable solution to incentivise real-time performance from reserve providers in the context of the SEM. The TSOs have a preference for event performance incentive with some persistence, and we believe that, on balance, a scalar-based approach can better meet the TSO objectives.

4.5.1 Event Performance Scalar

The Event Performance Scalar is aimed at incentivising an available confirmed DASSA Order holder to deliver the service when called upon to do so. For the design we also consider the following:

- when a service provider has a partially confirmed DASSA Order – and is partially available – that portion of the order will be subject to the Event Performance Scalar;
- the evaluation of whether a service provider's response to a frequency event or dispatch instruction is acceptable should ideally leverage existing performance monitoring methods used under the Regulated Tariff Arrangements[31]; and
- the TSOs are also of the view that the application of the scalar shall extend to the payments made for the volumes procured by the TSOs through the DASSA Top-Up mechanism, namely the Residual Availability Determination (RAD).

As already discussed, the impact of the Event Performance Scalar should be greater than that expected under the availability incentive mechanisms in the subsequent trading periods during which an energy storage unit may then become unavailable following the provision of a service.

While the Grace Period partially mitigates this issue, units continue to face suspension of DASSA Payments for any unavailable or lapsed DASSA Orders during these Trading Period. The below proposed design of the Event Performance Scalar accounts for these factors and ensures a sufficient incentive for units to deliver the required service when called upon and available. It also preserves, to a given extent, the intended hierarchy of incentives under the expected market conditions.

4.5.2 Design methodology

Our proposed methodology is largely based on the existing formula for the calculation of the Performance Incident Response Factor under the current

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[31] EirGrid/SONI, DS3 System Services Protocol v4.1 - Regulated Arrangements, 1st October 2024

Regulated Tariff Arrangements. We found this calculation approach to align well with the intended design objectives and guardrails, defined above, for the Event Performance Scalar in the DASSA. We have, however, made some necessary modifications to ensure applicability under the DASSA.

The Event Performance Scalar (S_E) value between 1 and 0 will be calculated on a monthly basis, where values less than 1 will result in reduced payment for awarded DASSA and RAD contracts. The formula considers previous months of performance of the service providing unit in line with the Performance Assessment methodologies to determine the resulting value.

There are two key elements for the Event Performance Scalar (S_E) calculation:

- Monthly Scaling Factor (K_m); and
- Dynamic Time Scaling Factor (V_m).

Monthly Scaling Factor (K_m)

Under the Regulated Tariff Arrangements31, for every Performance Incident, a Performance Incident Scaling Factor (Q_i) is calculated based on the service providing unit's response in line with the Performance Assessment methodologies. A Q_i of 0 represents a Pass and a Q_i of 1 represents a Fail, whilst other values between 0 and 1 represent Partial Passes.

The Monthly Scaling Factor (K_m) is defined as the average of the Q_i values resulting from all applicable performance assessments undertaken within each calendar month.

$$K_m = average(Q_{i,m})$$

where:

M refers to the month within which the performance incidents occurred

i refers to the performance incident number of that month (e.g. 1, 2, etc.)

Q refers to the Performance Incident Scaling Factor (Q_i)

The Performance Assessment methodologies are discussed in detail under the Regulated Tariff Arrangements31 and are not under the remit of this report. For Q_i to be used in the context of DASSA, it is essential that the Expected Response calculation, which feeds into the calculation of Q_i is updated. This update is required to include the term "confirmed DASSA Order volumes and any volumes cleared ex-post through a DASSA Top-Up Mechanism for the specific response service", alongside other terms, in the minimum value determination condition defining Expected Response. This change ensures the calculation of the Performance Incident Scaling Factor is only applicable to the confirmed DASSA Order volumes and the reserve volumes cleared by the service provider in the DASSA Top-Up Mechanism.

The Dynamic Time Scaling Factor (V_m)

The Dynamic Time Scaling Factor (V_m) are pre-defined weightings assigned to the current settlement month and the last 2 months. These weightings create an emphasis on more recent performance incidents in the formula for the Event Performance Scalar. A total of three months of performance history for a service-providing unit is considered, with each month's weight decreasing progressively from the current settlement month (M) to the earliest month considered (M-2).

This is a shift from the currently defined methodology in the Regulated Tariff Arrangements, under which past the 4 months of performance history is considered. The main reason behind this change is to make the Event Performance Scalar (S_E) less persisting and limiting its long-term impact. Excessive weighting of past months or considering historical performance over long periods can disproportionately penalise a unit for poor performance for an extended period. Since the Event Performance Scalar (S_E) can also indirectly lead to a unit's exclusion from the DASSA if reflected in bid submissions, a prolonged impact could result in unnecessarily extended exclusion.

The Dynamic Time Scaling Factor (V_m) is defined as per the Exhibit 45 below.

Exhibit 45 – Dynamic Time Scaling Factor ($\boldsymbol{V_m}$)

Number of months between the performance incident month and the settlement month (M)	Dynamic Time Scaling Factor (V_m)
M	1
M-1	0.5
M-2	0.1

Source: Regulated Tariff Arrangements[31]

Event Performance Scalar ($\boldsymbol{S_E}$)

The Event Performance Scalar ($\boldsymbol{S_E}$) is subsequently calculated based on the sum of the products of the Monthly Scaling Factor (K_m) and the Dynamic Time Scaling Factor ($\boldsymbol{V_m}$) defined above. It is calculated based on the formula outlined below.

$$S_E = max\left(1 - \sum_{m=M}^{M-2} [\, K_m \times V_m], \qquad 0\right)$$

The calculated values for the Monthly Scaling Factor (K_m) and the Event Performance Scalar ($\boldsymbol{S_E}$) will be rounded to the next two decimal places.

The above defined formula for the Event Performance Scalar adheres to the design objective and other considerations as follows:

- incentivises delivery of the service;
- the impact is proportional;
  - using a scalar applied on the monthly payments received by a service provider ensures that the impact on the unit is proportional to the revenues earned by the unit in the DASSA. This translates into units

that often clear the DASSA having a stronger incentive (in absolute terms) than a unit that rarely wins a DASSA contract.

- duration of persistence;
  - in the case of the Event Performance Scalar, it is crucial that the mechanisms incentivises sufficiently the provider and it maintains a hierarchy between the incentives for delivering a response and for availability in the subsequent Trading Period, in case the unit is an energy unit. With the impact of the Event Performance Scalar limited by the payment received by the unit under DASSA and the RAD, it could prove difficult to maintain a strong incentive for providers that may only clear the market infrequently. Adding persistence to the design of the scalar allows it to have a greater impact window, while also adhering to the proportionality principle.

The Event Performance Scalar (S_E) relies on the criteria defined in the Regulated Tariff Arrangements31 to assess the delivery performance of a service providing unit. It is through the Performance Incident Scaling Factor (Q_i) that this assessment feeds into the Event Performance Scalar.

We believe the Performance Incident Scaling Factor (Q_i) correctly and appropriately reflects the delivered response by a service provider against the required response by the TSOs, while allowing acceptable tolerance, thereby ensuring that the resulting Event Performance Scalar (S_E) is setup to provide the right incentives.

Applicability of Event Performance Scalar

The calculation of the Event Performance Scalar considers the delivered response by a service providing unit against the expected response through the Performance Incident Scaling Factor (Q_i). As currently defined in the Regulated Tariff Arrangements31, the Performance Incident Scaling Factor (Q_i) does not consider the volumes in a confirmed DASSA Order or cleared in any DASSA Top-Up Mechanism ex-post. However, this is a key modification proposed for the use of the factor in the context of the DASSA. With the proposed modification, the Performance Incident Scaling Factor (Q_i), will be defined as the minimum of: (i) the total volumes specified in a confirmed DASSA Order and cleared through any DASSA Top-Mechanism, and (ii) other parameters reflecting the technical capabilities and real-time position of the service-providing unit. More details on the other parameters are available in the Regulated Tariff Arrangements31.

This update ensures that only reserve volumes for which the service providing unit is compensated through either a confirmed DASSA Order or through ex-post clearing in any DASSA Top-Up Mechanism are used to assess the delivery performance of the unit. Furthermore, definition of the Performance Incident Scaling Factor (Q_i) ensures that only the reserve volumes that the unit was in the position to deliver at the time of the performance incident are used to assess the delivery performance. This prevents duplication of incentives on the reserve volumes, as any volumes related to a confirmed DASSA Order that were not made available, will be subjected to the Availability Performance Scalar and, as proposed, the Compensation Payment.

For example, if a service providing unit is positioned in the energy markets such that it has 60MW of available reserve volume for a service. Let us assume that the unit won and confirmed a DASSA Order of 50MW for the service. In the case of a performance incident in the Trading Period for which this unit holds the DASSA Order, the Performance Incident Scaling Factor (Q_i) shall only consider the volumes contracted under the confirmed DASSA Order (i.e. 50MW).

Under this same example, assume that the position of the unit has shifted due to its commercial decision to trade energy post GC without a dispatch instruction from the TSOs, such that it has only 30MW of reserve capacity available for the contracted service. In this situation, the Performance Incident Scaling Factor (Q_i) shall only consider the actual availability of the unit (i.e. 30MW). The remaining 20MW reserve volume which was not made available will be subjected to the Availability performance Scalar and the Compensation Payment.

The Event Performance Scalar (S_E) shall be applied to both the DASSA and the RAD payments to the service providing unit for reserve volumes made available.

It must be noted that for the performance assessment criteria while we suggest using the Regulated Tariff Arrangements31 as a starting point, it may be updated to expand the scope and adapt further, as the TSOs gain operational experience with the DASSA. Inclusion of over delivery of a required response in the assessment criteria, along with more frequent performance assessments, is an example of things that may be continually monitored and considered for adapting in the DASSA protocol document.

4.5.3 Worked example of the application of the Event Performance Scalar

In the following example we show how the Event Performance Scalar (S_E) would be calculated for different months.

The below example assumes a service provider with confirmed DASSA Orders experience some failures to deliver the required service when called upon to do so. The example assumes a go-live date of 1st of December 2026 for the DASSA with the example running until 30th April of the next year. During the first operational month, there occur 3 performance incidents to which the service providing unit successfully meets the required response for 2 of the events while only delivering 80% of the required response on average over the 3rd performance event. The corresponding Performance Incident Scaling Factors (Q_i) for the first month are 0, 0, and 0.5 respectively, calculated as set out in the Regulated Tariff Arrangements[31].

There are no performance incidents triggered for the month of January. The unit fails once in February to deliver a response in the event of a performance incident, with a resulting Performance Incident Scaling Factor (Q_i) of 1. For all the remaining months, we assume that no performance incidents are triggered.

When the Scalar Assessment Month, M, refers to December 2026 then the Event Performance Scalar (S_E) is calculated to be 0.83. For M=December, months M-1, M-2 etc. are assumed to have a Monthly Scaling Factor (K_m) equal to zero as there is no historical data.

For M=January 2027, as there are no performance incidents the Event Performance Scalar (S_E) would be expected to increase, however, the subpar delivery response over December will still impact the calculation of the scalar with less weight which results in a final value of 0.92.

In the month of February, a single failure to deliver the required service response results in reducing the Event Performance Scalar (S_E) down to zero, eroding away all the receivable payment for the service provider under the DASSA and any DASSA Top-up Mechanism. This highlights the significant impact a single underperformance event can have on expected revenues, strongly incentivizing service providers to maintain a high-quality response. The unit's failure to meet the required response in February gradually loses influence over the next two months before becoming insignificant, as per the weightings assigned by the Dynamic Time Scaling Factor (K_m).

Exhibit 46 - Example calculation for the Event Performance Scalar (S_E)

Month (M)	Performance Incident Scaling Factors (Q_i)[1]	Monthly Scaling Factor (K_m)	Event Performance Scalar (S_E)
Oct 2026	n/a	0	n/a
Nov 2026	n/a	0	n/a
Dec 2026	0; 0; 0.5	Average(0, 0, 0.5) = 0.17	$\mathrm{Max}([1 - 0.17 \times 1], \quad 0) = 0.83$
Jan 2027	n/a	0	$Max(1 - [\{0 \times 1\} + \{0.17 \times 0.5\}], \ 0) = 0.92$
Feb 2027	1	Average(1) = 1	$Max(1 - [\{1 \times 1\} + \{0 \times 0.5\} + \{0.17 \times 0.1\}], \ 0) = 0$
Mar 2027	n/a	0	$Max(1 - [\{0 \times 1\} + \{1 \times 0.5\} + \{0 \times 0.1\}], \ 0) = 0.50$
Apr 2027	n/a	0	$Max(1 - [\{0 \times 1\} + \{0 \times 0.5\} + \{1 \times 0.1\}], \ 0) = 0.90$

Note: 1) The calculation of the Performance Incident Scaling factor is done as set out in the Regulated Tariff Arrangements[31]. Since, it is assumed to be determined through the established performance assessment regime and directly inputted into the Event Performance Scalar, we have not included the calculation steps for it in this example.

4.6 Grace Period

The TSOs, in their proposed design for the DASSA[14], have allowed for a Grace Period when a service provider was impacted by a previous dispatch instruction or response to a frequency event that resulted in its asset becoming unavailable to fulfil its obligation to provide the service for subsequent Trading Periods. In this case, a service provider will not be subject to a Compensation Payment and may receive scaled payments for its DASSA Order depending on the remaining duration of the Grace Period.

SEMC, in their DASSA Design Decision paper[13], published a decision that no unit will be eligible for a partial / scaled DASSA payment.

We see benefit of having a Grace Period with respect to the commitment obligation and performance incentive mechanisms in the DASSA. This would allow units some time to re-establish their availability in the periods subsequent to them having delivered a service. For example, particularly in the situation of an energy storage unit, if there is a risk to the unit of becoming unavailable and be subjected to the Compensation Payment and Availability Performance Scalar, it could encourage behaviour that limits response in frequency events and/or discourage some providers from participating in the DASSA or increasing theirs offer prices in the DASSA.

As noted by the TSOs in their DASSA Design Recommendation Paper, the Grace Period could be applied to all energy storage units participating in the DASSA, to mitigate the risk of these units facing the Compensation Payment and being subjected to Availability Performance Scalar for subsequent Trading Periods following any activation in response to a frequency event.

The TSOs propose for the Grace Period to have a duration of eight hours from the time of the response to the frequency event. This is consistent with the approach currently used for DS3 Fixed Contract service providers.

Annex A Application of Compensation Payment

Prior contractual obligations influence bidding behaviour in subsequent markets. There are numerous examples:

- supported RES will offer output in the DAM at a zero or even negative price if a support payment is indexed against the DAM price and payment is based on output; or
- generating units with ancillary services contracts will offer their output in the energy markets reflecting such obligations and opportunity costs.

Once a provider has a DASSA Order, we can only expect that their bidding in subsequent markets, such as the intraday market, will be influenced by the DASSA clearing price and all other incentives entailed by a DASSA Order (potential compensation payment and different scalars).

There are, however, circumstances when providers are moved away from their scheduled position through TSO actions for reasons other than managing power supply and demand balance. This can be because of network congestion, voltage control issues etc. Such instructions are deemed as non-energy actions and may mean a unit with a DASSA Order is no longer in a position to meet its obligations under the DASSA Order. This then raises a question as to whether such unavailability as a result of TSO non-energy instructions should face a compensation payment or not.

When it comes to energy payments and inframarginal rent captured in ex-ante markets, there is 'firmness' of payments in the SEM. A unit that was competitive on an unconstrained basis in the DAM and was in a position to be scheduled and capture inframarginal rent, will keep this rent even if the TSOs instruct it to 'turn off'. It only has to pay back the actual costs it is saving from not having to operate.

We can ensure firmness of the DASSA payment either directly by allowing 'TSO instructed unavailable' DASSA Orders to retain DASSA payments and exempt them from any compensation payments or indirectly allowing units to reflect such opportunity costs in the commercial bids to the TSO. There is a middle ground solution – 'TSO instructed unavailable' DASSA Orders could be exempt from compensation payments, and also not be eligible for a DASSA payment. This would then mean that they would still have an incentive to enter secondary trading and attempt to sell the DASSA Order to another provider. However, this incentive will be weaker in the absence of a compensation payment.

When it comes to pre Gate Closure examples, it is simple to understand what the two options would mean. In the absence of a compensation payment and the continuation of the BCOP as it is today, there would be no change to unit bidding. The difference then would be that if a unit has a DASSA Order and it can no longer have a compatible FPN because of a TSO instruction, then it will no longer capture the DASSA payment, but it will also not face a compensation payment.

With the compensation payment applying to all volumes and the ability to include such opportunity costs in the bidding, the unit may be instructed to an incompatible FNP, but, should that happen, it can recoup the compensation payment and the foregone DASSA payment through its bidding. This does not however mean we have a more efficient dispatch – the resulting dispatch may be less efficient. It may also appear as if it is reducing costs given that all units have to pay a compensation payment, but it is at the same time increasing dispatch balancing costs.

Below we present an example of a 'TSO instruction' post Gace Closure – this is effectively the case when the TSOs use the 'simple' bids and offers in the BM.

Post GC worked example

Let us suppose a system with power demand of 700MW and a POR (upward) requirement of 30MW. There are 4 CCGTs on the system, all of which have a capacity of 400MW, maximum POR contribution of 20MW and a minimum stable generation of 200MW. For simplicity, we assume that the CCGTS do not have any start-up costs and the heat rate curve is linear. This means the variable cost does not change depending on the relative loading level.

We want to understand the impact of potential exemptions from compensation payments in case of 'TSO instructed unavailability' for post gate closure unavailability.

Units are assumed to offer their energy at their variable cost and offer upward POR at a price equal to the counterfactual foregone inframarginal rent. So, for CCGT A, as an example, if the expected electricity price is 120 EUR/MWh and its variable cost is 100 EUR/MWh then the POR offer price is 20 EUR/MW/h.

We have two options in terms of compensation payment applicability:

- Option 1- exempting any volumes that become unavailable because of a TSO instruction; and
- Option 2 – the compensation payment[32] applying even if this is a result of a TSO instruction.

Post Gate Closure, any activated Balancing Energy is based on bids and offers in the BM. Obviously, some units may also deviate from their FPNs as a result of an outage, changes in weather conditions or because they may be NIV chasing. We want to focus on the case of TSO instructions in the BM (ie. when the TSOs activate Balancing Energy).

With Option 1 the BM bids remain unaffected for increasing or decreasing output to any loading level and are equal to the variable cost. With Option 2, however, the bidding changes as the units reflect foregone DASSA payments and compensation payments.

[32] We are ignoring any additional availability incentive for the purposes of this example

Exhibit 47 – Worked example assumptions, market scheduled and participant bidding

	CCGT A	CCGT B	CCGT C	CCGT D
Capacity (MW)	400	400	400	400
POR contribution (MW)	20	20	20	20
Var cost (€/MWh)	100	120	130	150
Scheduled position (MW)	390	310	0	0
Upward POR (MW)	10	20	0	0
DASSA offer (€/WM/h)	20	0		
BM free bids (€/MWh) - Option 1	100	120	130	150
BM free bids (€/MWh) - Option 2				
CCGT A – [390-400] / CCGT B – [380-400]	140	160	130	150
CCGT A – [200-390] / CCGT B – [200-380]	100	120	130	150
All CCGTs [0-200]	98	116	130	150

At the DAM stage, CCGTs A and B were scheduled to meet the 700MW demand, and to meet the 30MW POR requirement. The resulting market schedule presented in the table above is the one that delivers the least cost solution. In the table below we also show the resulting DAM, DASSA and RAD prices. The compensation payment is assumed to be equal to the DASSA price.

In real-time, we assume demand changes dramatically and there is a need for an additional 300MW.

Exhibit 48 – System-wide results

	DAM	Real-time
Demand (MW)	700	1000
POR requirement (MW)	30	30
DAM price (€/MWh)	120	
DASSA price (€/MW/h)	20	
RAD price (€/MW/h)	20	
Compensation payment (€/MW/h)	20	

We then also present the offer price at different loading levels for the CCGTs:

- CCGT A would offer its capacity from 390MW to any loading level up to 400MW at 140 EUR/MWh – the cost of production is 100 EUR/MWh, it foregoes a DASSA payment of 20 EUR/MW/h and a Compensation Payment of 20 EUR/MW/h;

- the same rationale applies for CCGT B for any incremental volumes offered from 380MW to 400MW;
- they would both then offer to ‘drop’ to a lower loading level down to MSG at their actual variable cost, as they can continue to meet their reserve obligation; and
- they would pay back less than their variable cost if they were to be shut down – they would reflect the foregone DASSA payment and the applicable compensation payment in their bidding.

Exhibit 49 shows the resulting dispatch and payments with Option 1. The dispatch is efficient. Demand is met by the most efficient resources given the requirement for 30MW of POR that comes from the less efficient CCGTs.

Exhibit 49 – Resulting dispatch and payments with Option 1

	CCGT A	CCGT B	CCGT C	CCGT D
Capacity (MW)	400	400	400	400
POR contribution (MW)	20	20	20	20
Var cost (€/MWh)	100	120	130	150
Scheduled position	390	310	0	0
Upward POR (MW)	10	20	0	0
DASSA offer (€/MW/h)	20	0		
BM free bids (€/MWh) - Option 1	**100**	**120**	**130**	**150**
Dispatch (MW)	400	390	210	
Payment to units				
DAM	46800	37200	0	0
DASSA	200	400	0	0
DBC	1000	9600	27300	0
Compensation payment & DASSA pay-back				
RAD			400	
Total	48000	47200	27700	0
Gross margin	8000	400	400	0

The overall cost to consumers in this example, and assuming no compensation payment applying in the case of a move as a result of a TSO instruction (ie. activating Balancing Energy in the BM) is EUR 122,900. This assumes that CCGT A retains the DASSA payment. If it did not, the overall cost to consumers would be EUR 122,700. The breakdown of the cost is as follows:

- EUR 84,00 is paid through the DAM;

- EUR 600 is paid through the DASSA (or EUR 400 assuming CCGT A does not receive a DASSA payment);
- the DBC cost if EUR 37,900; and
- an additional EUR 400 is paid to CCGT C through the RAD for replacing the reserve volumes from CCGT A.

Exhibit 50 shows the resulting dispatch and payments with Option 2. The dispatch is inefficient in this case with demand met by less efficient resources in this case, increasing carbon emissions and gas use. This is a direct result of the incentives created by the compensation payment.

Exhibit 50 – Resulting dispatch and payments with Option 2

	CCGT A	CCGT B	CCGT C	CCGT D
Capacity (MW)	400	400	400	400
POR contribution (MW)	20	20	20	20
Var cost (€/MWh)	100	120	130	150
Scheduled position	390	310	0	0
Upward POR (MW)	10	20	0	0
DASSA offer (€/MW/h)	20	0		
BM free bids (€/MWh) - Option 1	100	120	130	150
BM free bids (€/MWh) - Option 2				
390-400/380-400	**140**	**160**	**130**	**150**
200-390/200-380	**100**	**120**	**130**	**150**
0-200	**98**	**116**	**130**	**150**
Dispatch (MW)	**390**	**310**	**300**	
Payment to units				
DAM	46800	37200	0	0
DASSA	200	400	0	0
DBC			39000	0
Compensation payment & DASSA pay-back				
RAD				
Total	47000	37600	39000	0
Gross margin	8000	400	0	0

The overall cost to consumers in this example, and assuming no compensation payment applying in the case of a move as a result of a TSO instruction (ie. activating Balancing Energy in the BM) is EUR 123,600. The breakdown of the cost is as follows:

- EUR 84,00 is paid through the DAM;
- EUR 600 is paid through the DASSA; and
- the DBC cost is EUR 39,000.

Overall, consumers end up paying more with Option 2 in this example, an additional EUR 700.

Generally, any ex-ante contracting that affects bidding in the closer to real-time markets can only result in more efficient dispatch to the extent the forward contract value and incentives are still appropriate and efficient closer to real-time.

TABLE OF EXHIBITS

We don’t care much about making history.

We care about making future.

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