AURORA ENERGY RESEARCH

I-SEM near-term DS3 expenditure

7th December 2022

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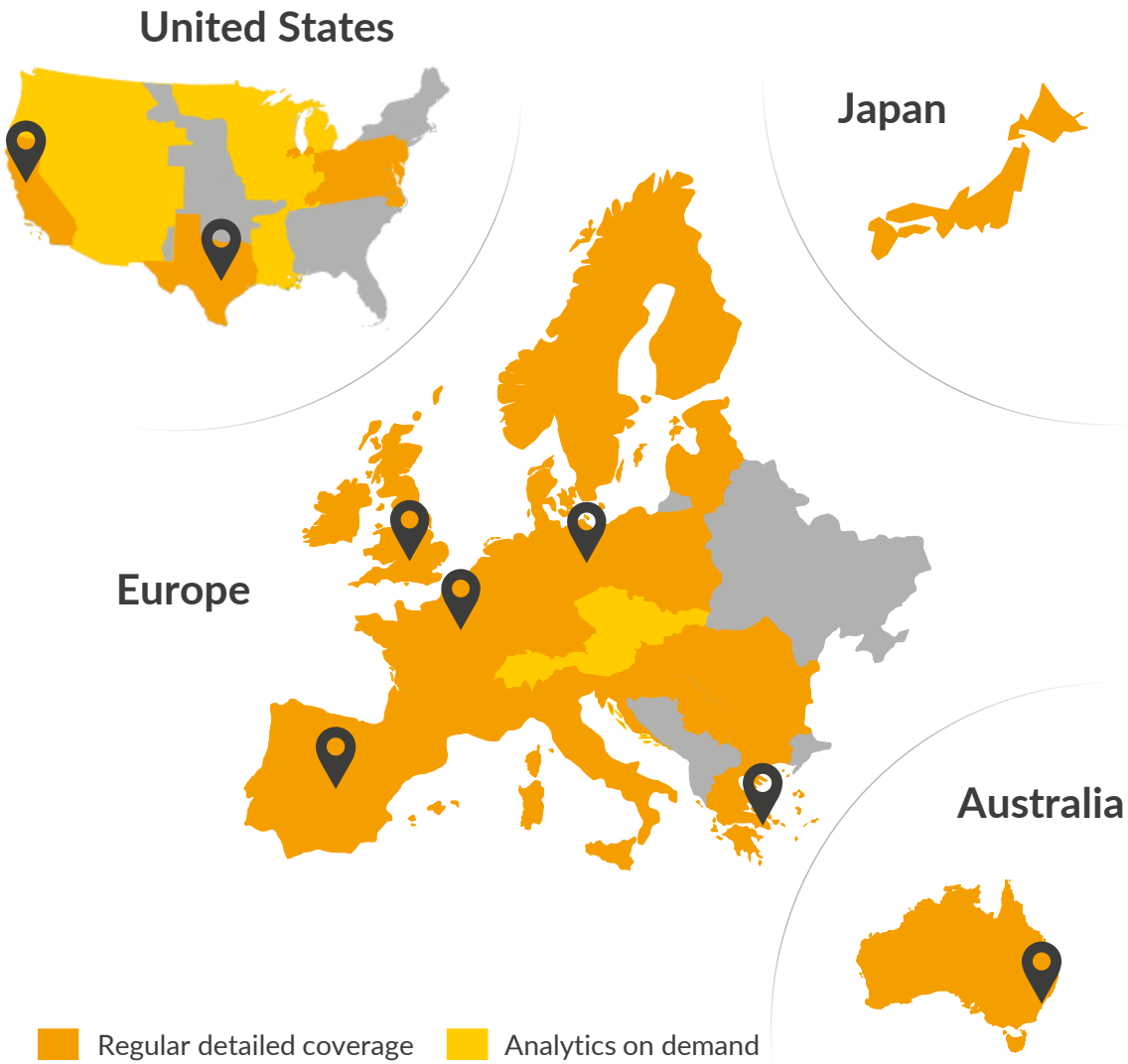

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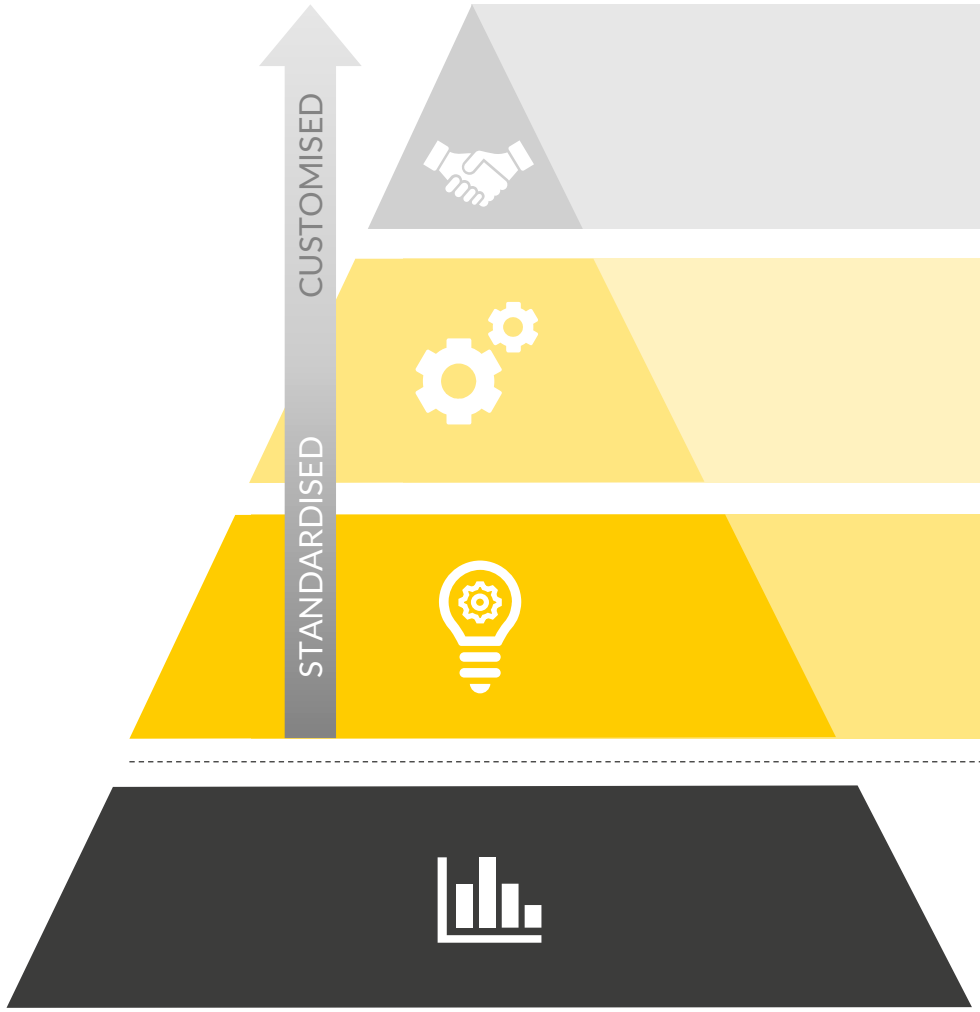

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Source: Aurora Energy Research

These slides explore the market impact of four options being considered to reduce ancillary service expenditure in I-SEM

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Background & DS3 Overspend Risk

- The current method being used for setting payment rates for DS3 services risks breaching a €235m/year expenditure budget
- Expenditure is based on pre-determined tariffs and scalars, paid to an 'uncapped' volume of providers
- The TSOs therefore need to take action to hedge against the risk of overspend

DS3 expenditure is forecast to breach its annual budget of €235m

DS3 Consultation Process

- A consultation was launched on 16 September 2022 to address the risk of overspend and has concluded in October
- Four changes have been proposed, affecting either DS3 service tariffs, the Temporal Scarcity Scalar, or a combination of both
- One of the four options is set to be implemented by Q1 2023

Consultation process has identified four options to lower DS3 spending

Market Impact

- All options will bring expenditure within budget until 2024, however a delay to competitive arrangements could result in a breach
- All options will reduce battery revenues by differing amounts
- Factors such as weather and new-entrant capacity can materially influence total expenditure and revenues for providers

Aurora has analysed the impact of each option on DS3 expenditure and battery asset revenues

Sources: Aurora Energy Research, National Grid ESO

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Aurora's bespoke offerings

For more information on **DS3 price forecasts** and **scenario analysis**, **site-specific asset economics including comparison of revenue models, bespoke forecasting, competitor analysis and auction bidding support**, please contact our commissioned projects team or Ireland Senior Commercial Associate, Cara Valentine.

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I. DS3 System Services overview

II. DS3 Consultation on Expenditure

III. Analysis of proposed options to reduce DS3 expenditure

IV. Analysis of future uncertainties

The DS3 programme was introduced in 2018 to reinforce the power system and accommodate a greater renewables penetration

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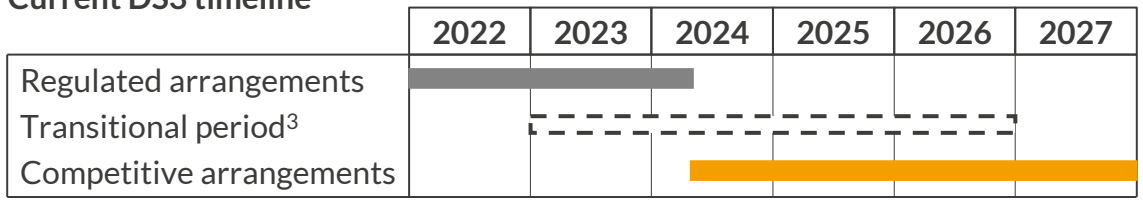
DS3 – Delivering a Secure, Sustainable Electricity System

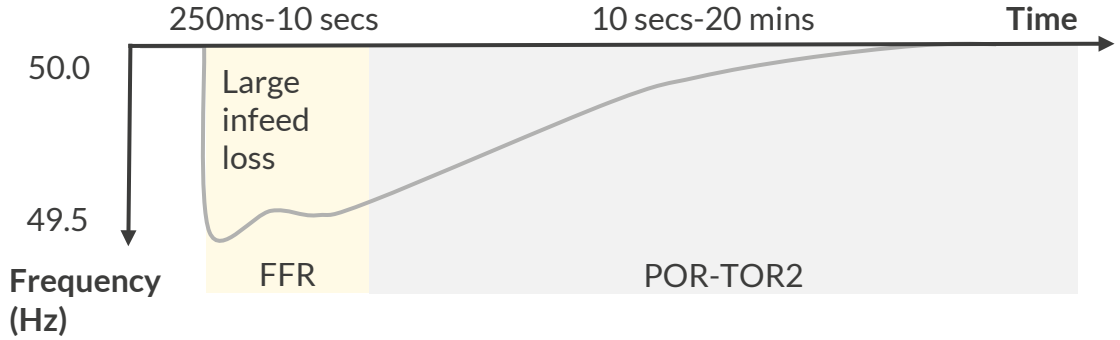
- Maintaining a stable and safe I-SEM will become more challenging as a greater share of generation comes from renewables on the path to 2030 targets, leading the TSOs to introduce the DS3 programme to incentivise the buildout of additional ancillary services
- There are 14 DS3 System Services, of which 12 have so far been procured[1], including the provision of frequency response, ramping, reactive power, inertia and voltage control
- DS3 capacity has recently come online through procurement gates, occurring every six months since May 2018, with approximately 0.5GW of fast-acting[2] capacity has come through these gates to date. Prior to this, I-SEM capacity was funnelled into DS3 services through two 'phases' when the DS3 programme was launched
- Further capacity has come online through fixed introduced in a tender that took place in autumn 2019. Capacities under these contracts commit to being online for the duration of their 6-year contracts

Current DS3 timeline



Frequency maintenance (fast-five) FFR POR SOR TOR1 TOR2

- Necessary to maintain system frequency at 50Hz over the short-medium timeframe, by ensuring sufficient fast reacting generation



Ramping services RRS RRD RM1 RM3 RM8

- Designed to regulate voltage on the system at 400kV, 275kV, 220kV or 11kV to maintain system operability, by increasing generator output for anywhere between 20 minutes and eight hours

Other services SIR SSRP

- Procured to maintain grid inertia and reactive power within the system

1) The two services that have not yet been procured are Fast Post-Fault Active Power Recovery (FPFAPR) and Dynamic Reactive Response (DRR). 2) Fast-acting capacity refers to technologies that can respond rapidly to changes in grid frequency, including batteries; these can be awarded FFR contracts. 3) The transitional period refers to EirGrid's proposal of a staggered transition to competitive arrangements where some services may remain regulated, or some services could be procured through fixed tenders.

Sources: Aurora Energy Research, EirGrid, SONI

The DS3 regulated arrangements payment structure is in place until 2024, and is comprised of available volume, scalars and service tariffs

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DS3 payment = **Available volume** X (**Scalar** X **Tariff**)

Under review as part of the Consultation on Expenditure

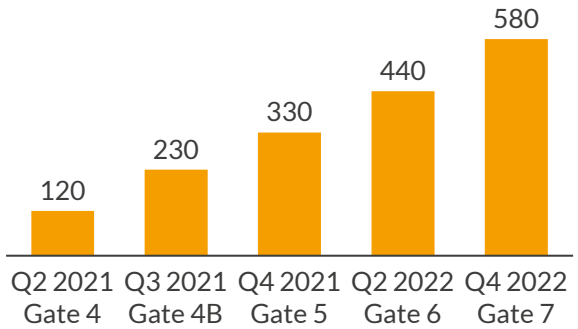
- Current remuneration for DS3 System Services comes via **availability payments** and is volume uncapped
- Expenditure therefore rises as DS3 capacity on the system increases
- There is a cap on total DS3 expenditure of **€235m/year nominal**, which applies until end of DS3 regulated arrangements[1]
- The current DS3 **regulated arrangements** are set to become competitive in **April 2024**[2]

- The available volume refers to the capacity of the generator, measured in MW for the energy-based services
- Fast response and reserve services are typically contracted to batteries, whereas ramping is typically provided by thermal assets

- Applied to incentivise asset performance when the system is tight or penalise assets for unreliability
- Scalars relate to performance, SNSP-level, location, fast-acting service provision and continuous procurement of frequency services in series

- Administratively set tariffs based on the perceived 'value' of each System Service
- In order to mitigate against potential overspend through the standard contracts, the TSOs reserve the right to review tariffs every six months, or cancel participants' standard contracts with 12 months notice

Fast-acting technology deployment[3]
MW



DS3 scalar ranges

Scalar	Description	Value
TSS[4]	Incentivises during high RES periods	0-6.3
Locational	Incentivises at valuable locations	1-1.5
Performance	Incentivises reliability	0-1

Fast 5 tariff rates[5]
EUR/MWh

Service	Value
FFR	1.94
POR	2.92
SOR	1.76
TOR1	1.40
TOR2	1.12

1) The decision on the expenditure cap of €235M after 2020 did not include provision for inflationary adjustment 2) SEM Committee published System Services Future Arrangements - High Level Design Consultation Paper SEM-21-069 in August 2021. 3) Fast-five service standard contract capacity as of November 2022 according to Eirgrid and SONI. 4) Temporal scarcity scalar. 5) Inclusive of 10% reduction from January 2022.

Sources: SEM Committee, EirGrid, Aurora Energy Research

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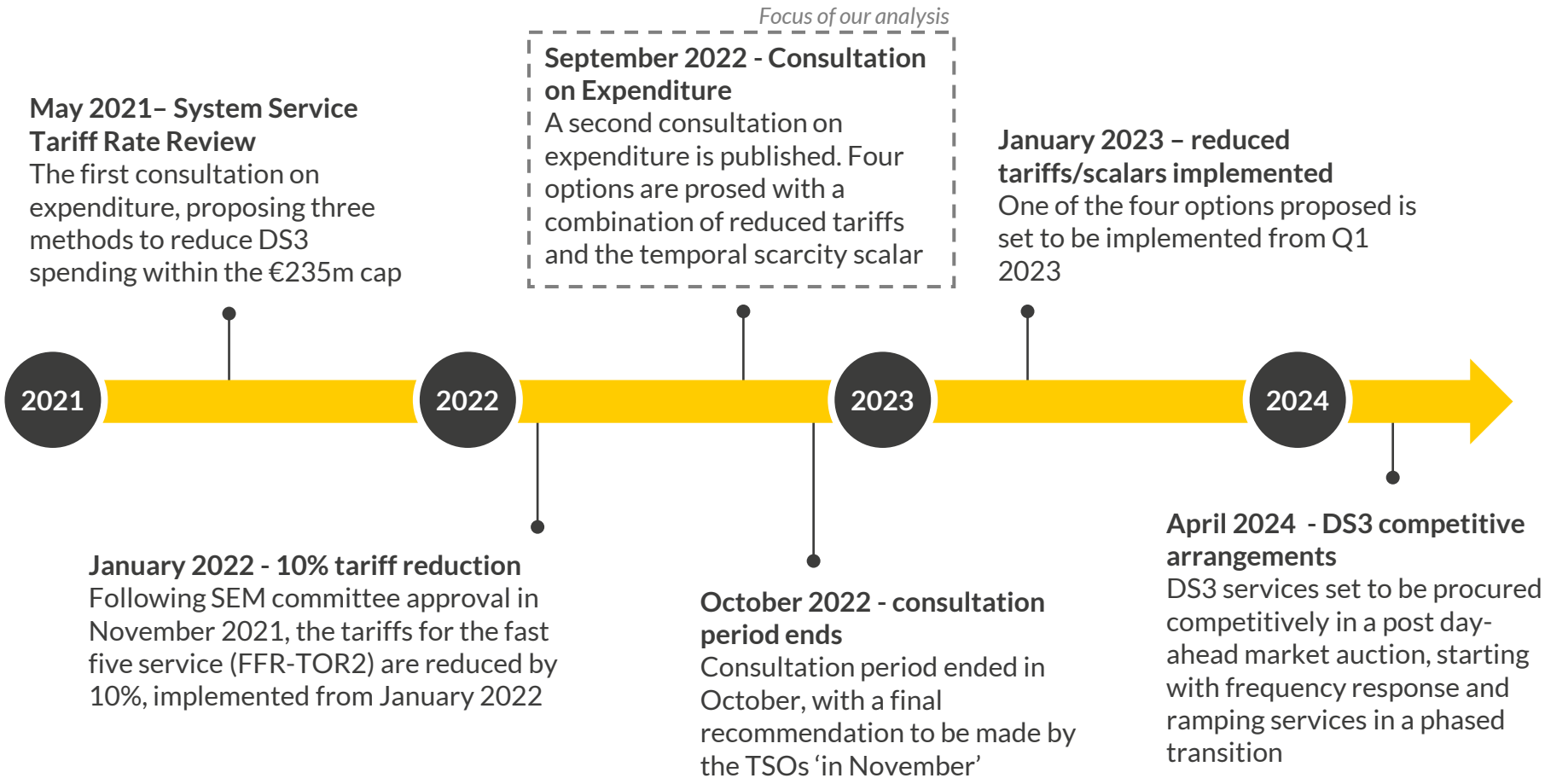
In September 2022, EirGrid launched a consultation to further reduce DS3 regulated arrangements expenditure



- The chosen option of the latest consultation is expected to be implemented from Q1 2023
- This would impact all existing assets in the I-SEM participating in DS3, as well as future plants set to come online through Gate 8 in May 2023
- The TSOs can further reduce the DS3 tariffs every six months, if total expenditure is expected to exceed the €235m budget cap
- The TSOs can also cancel standard contracts with 12 months notice

Sources: Aurora Energy Research, EirGrid

The consultation explores isolated tariff and temporal scarcity scalar reductions, as well as a combination of both

Proposed DS3 tariff and scalar changes

Variable	Option 1	Option 2	Option 3	Option 4
Immediate tariff reduction	35% reduction in tariffs for *fast-five services*[1]	25% reduction in tariffs for *all services*	None	10% reduction in tariffs for *fast-five services*
Volume-dependent tariff reduction	10% reduction in tariffs for *fast-five services* per 100MW of fast acting services procured	7% reduction in tariffs for *all services* per 100MW of fast acting services procured	None	None
Temporal Scarcity Scalar reduction	None	None	TSS values *for all services* reduced from 6.3 to 2.5 when SNSP exceeds 70% and from 4.7 to 1.5 when SNSP is between 60% and 70%	TSS values *for all services* reduced from 6.3 to 3.5 when SNSP exceeds 70% and from 4.7 to 2.5 when SNSP is between 60% and 70%

1) FFR, POR, SOR, TOR1, TOR2. 2) DS3 System Services Tariffs Consultation Document.

Sources: SEM Committee, Aurora Energy Research, EirGrid, SONI

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- The September consultation proposes four options to reduce DS3 expenditure[2]
- The consultation document proposes changes to tariffs, options 1 and 2, and scalars, option 3, as well as a combination of both in option 4
- Consultation on the options has now concluded. Results have not yet been published but it is proposed that implementation will begin from Q1 2023

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Aurora has analysed the impact of the four proposed options on total DS3 expenditure and battery investment cases

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X Deep dive on following slides

	1 Market level	2 Asset level

Focus	▪ Total DS3 expenditure	▪ Half-hour and one-hour batteries:
		  ▪ Gross margins
		  ▪ IRRs

Assumptions	▪ Expenditure cap is not index linked and is therefore lower in real terms in 2024 (as confirmed by SEM Committee[1])	▪ Located in the Republic of Ireland ▪ No battery degradation ▪ IRRs are pre-tax, unlevered and including cycle degradation, for batteries with a 2023 entry year. Capex costs of 0.5hr and 1hr batteries are €[redacted]/kW and €[redacted]/kW respectively

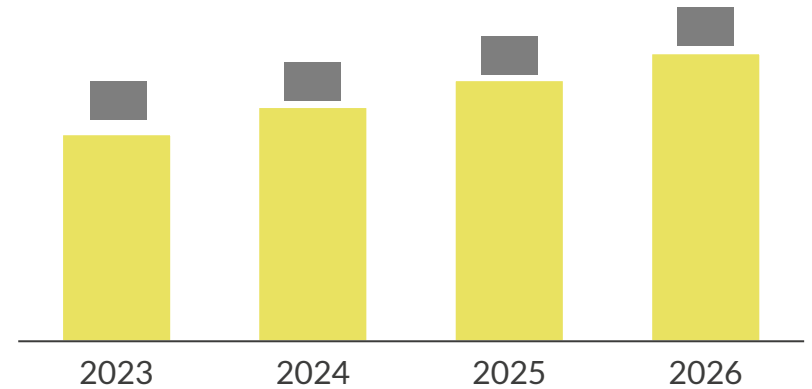
Modelling methodology

- Analysis is based on the Aurora Central scenario from October 2022
- The status quo scenario in this section assumes that none of the options are implemented; DS3 scalars and tariffs remain at their current levels and are not changed[2]

General assumptions

- 100MW of battery capacity becomes operational in the I-SEM every year from 2023
- DS3 regulated arrangements apply in 2023 and 2024; competitive arrangements begin in January 2025
- Close-to-optimal performance of each DS3 asset, no performance scalar reductions are assumed
- Options 1 and 2 reduce tariffs as a function of additional fast acting capacity that becomes operational after 2023
  - Only battery capacity is considered for these reductions
  - Percentage reductions are applied consecutively[3]

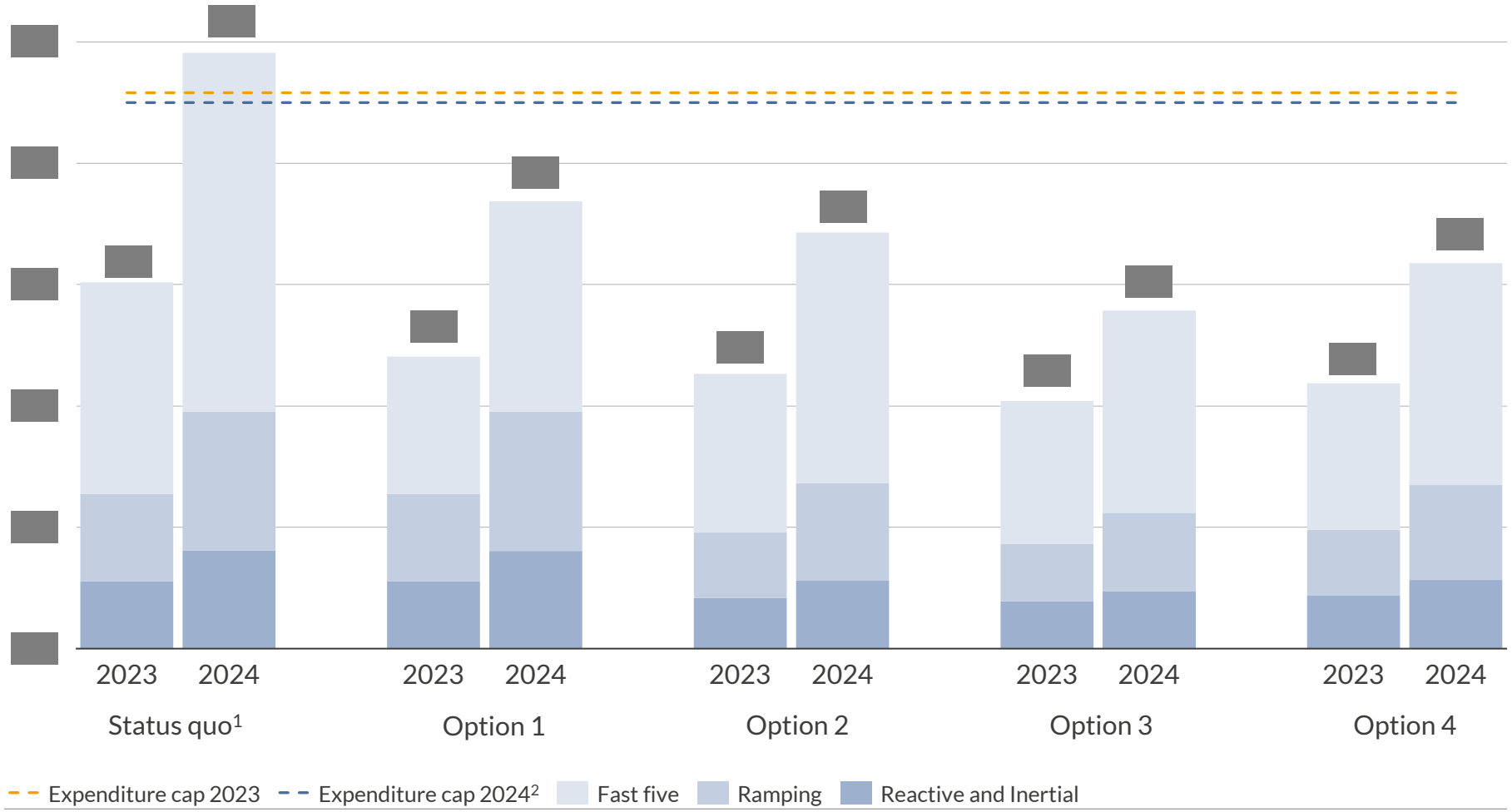
Modelled standard contract battery capacity assumed



1) In SEM-17-80: "The expenditure cap for DS3 System Services Expenditure will remain at €235m/annum post 2020 until decided otherwise by the SEMC following public consultation". 2) This is equivalent to the Aurora Central scenario without tariff downscaling when the expenditure cap is breached. 3) For example, if 100MW of batteries deploy in the first year followed by 100MW in the second year, triggering two 10% reduction to fast five tariffs under option 1, the first 10% reduction occurs, then the second occurs consecutively at 10% of the resulting value from the first reduction. Sources: SEM Committee, Aurora Energy Research

1 Option 3 reduces expenditure for all services the most between now and the end of regulated DS3 arrangements in January 2025

Total DS3 expenditure in 2023 and 2024
EUR million, real 2021

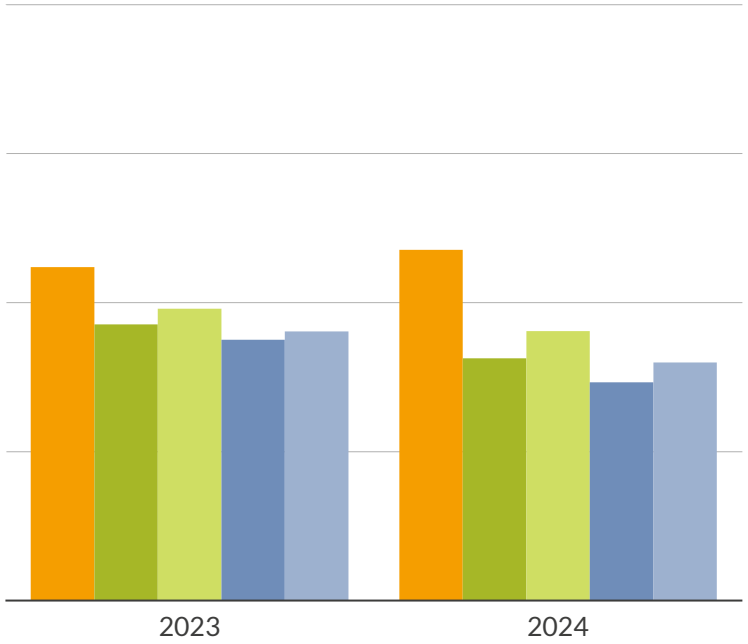


1) No change in tariffs or scalars. This is different from Aurora's Central Scenario which assumes a scaling down of tariffs 2) Expenditure cap is not index linked and is therefore lower in real terms in 2024
Sources: Aurora Energy Research, EirGrid, SONI

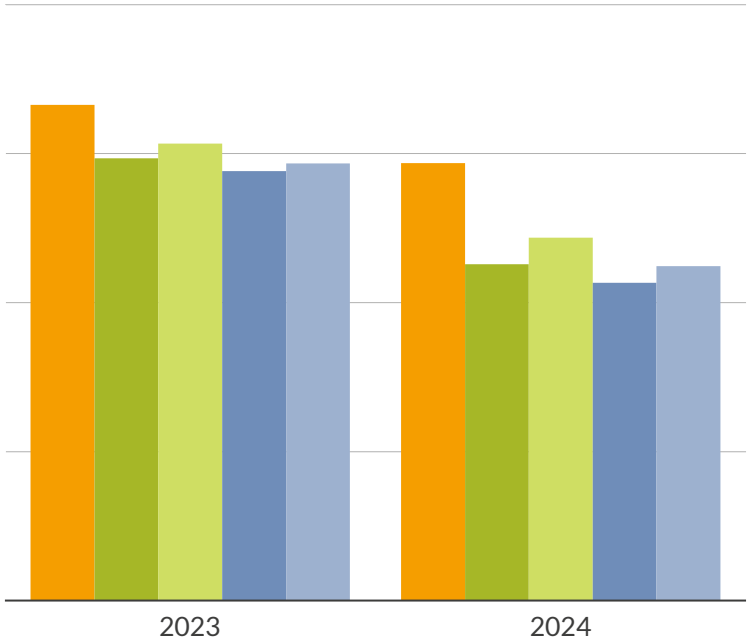
- We assume 24 months of expenditure in regulated DS3 arrangements between implementation of the chosen option (Jan-23) and the start of competitive arrangements (Jan-25)
- Expenditure is lowest for option 3 and highest for option 1 in both 2023 and 2024
- Cumulative expenditure to the end of regulated DS3 arrangements for options 1 through 4 is [redacted], respectively
- Options 3 and 4, which involve a reduction in the temporal scarcity scalar (TSS), result in significantly less expenditure than options 1 and 2, highlighting the sensitivity of total expenditure to the TSS

2 Option 3 could reduce total gross margins for an existing half-hour battery by 30% on average across 2023-24 relative to Status Quo

Half-hour battery total gross margins[1]
EUR/kW, real 2021



One-hour battery total gross margins[1]
EUR/kW, real 2021



0.5hr battery IRR, 2023 entry[2]
CAPEX = €[redacted]/kW

1hr battery IRR, 2023 entry[2]
CAPEX = €[redacted]/kW

Status Quo[3] | Option 1 | Option 2 | Option 3 | Option 4

1) Assuming undegraded revenues, located in the Republic of Ireland. 2)IRRs are pre-tax, unlevered and including cycle degradation, for batteries with January 2023 go-live. 3)The Status Quo scenario assumes there is no change in tariffs or scalars

Source: Aurora Energy Research

- All four options proposed in the consultation reduce battery DS3 revenues, with the impact more pronounced on shorter duration battery margins, where ancillary services make up a greater share of the revenue stack
- Reducing all tariffs by 7% (option 2) has the smallest impact on total gross margins and IRRs
- A sharp reduction to the TSS (option 3) has the biggest negative impact on mattery margins, reducing IRRs by [redacted] and [redacted], relative to the Status Quo scenario, for half-hour and one-hour duration batteries respectively
- This analysis uses our hybrid battery dispatch modelling, where the asset maximises total gross margins in all markets under each of the four options

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We explore the impact of three sensitivities on DS3 regulated arrangements expenditure under the four options

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X Deep dive on following slides

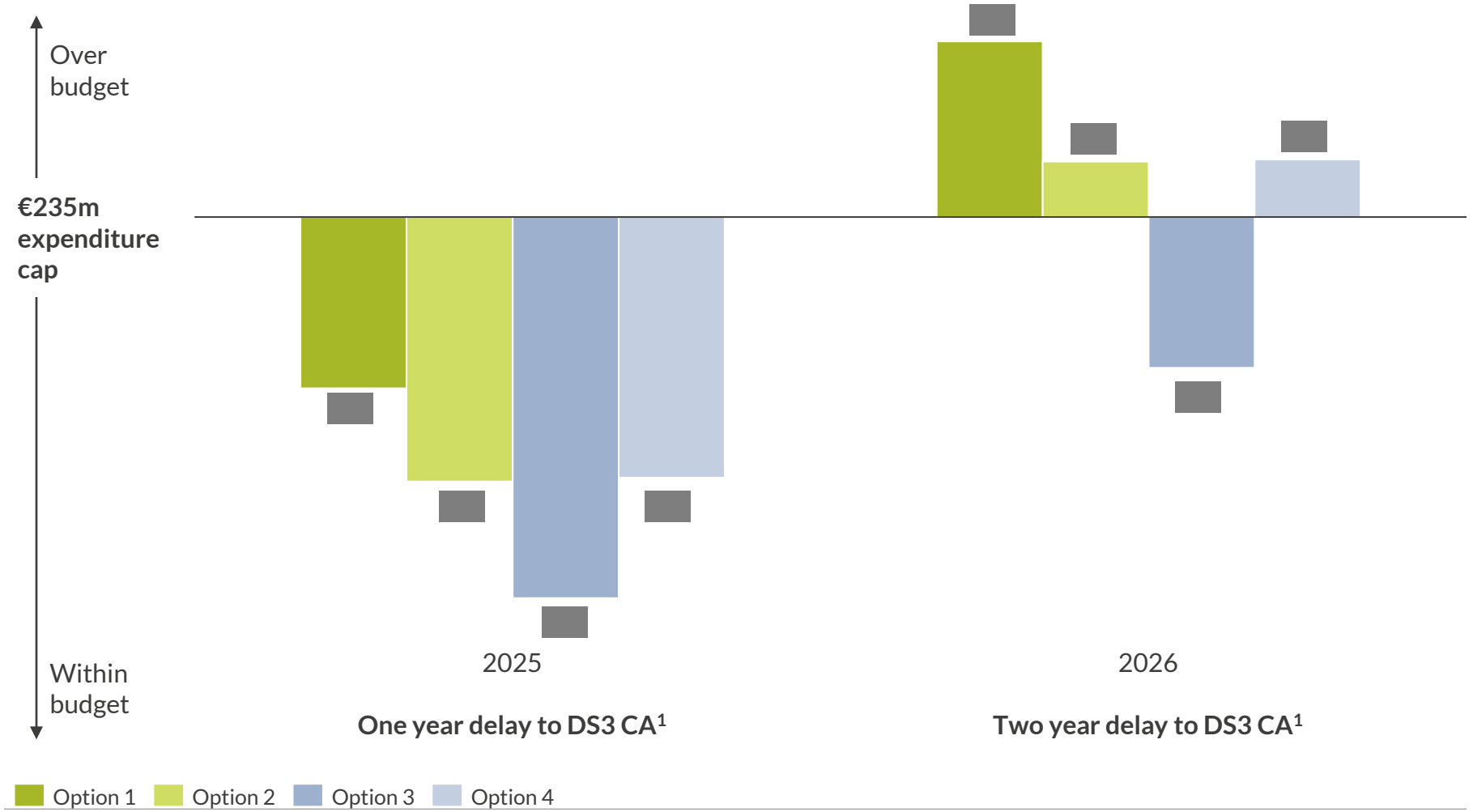
Sensitivity	1 Competitive arrangements start year	2 Battery buildout	3 Weather
Central assumption	▪ Competitive arrangements to begin in **2025**	▪ 100MW of battery capacity comes online each year	▪ Median weather year[1]
High sensitivity	▪ A two year delay to competitive arrangements; starting in **2027**	▪ 200MW of battery capacity comes online each year	▪ High wind year[2]
Low sensitivity	▪ A one year delay to competitive arrangements; starting in **2026**	▪ 0MW of battery capacity comes online each year	▪ Low wind year[3]
Context	▪ A delay to the competitive arrangements start date could result from unforeseen administrative, regulatory or technical complications	▪ Uncertainty around the rate of battery deployment in the I-SEM	▪ More or less wind results in variable SNSP levels, leading to a range of TSS values and DS3 payments. The expenditure cap is raised by €20m in a high wind year[4]

1) Based on 2013 weather and demand data. 2) Based on 2015 weather and demand data. 3) Based on 2016 weather and demand data. 4) A high wind year is defined by the SEM Committee as a year with an average wind capacity factor above 31.8% (SEM-17-80). 2016, used as the high wind year in this analysis, had an average wind capacity factor of 32.5% and thus meets the SEM Committee definition of a high wind year.

Sources: SEM Committee, Aurora Energy Research

1 Only consultation option 3 would keep expenditure within the budget if the competitive arrangements were delayed until 2027

Delta between total expenditure and the expenditure cap
EUR million, real 2021



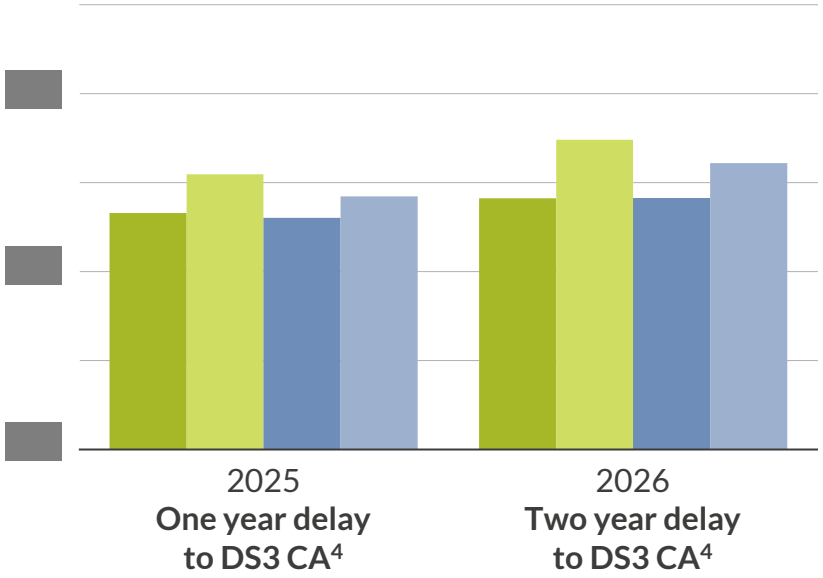
1) Competitive Arrangements.

Sources: Aurora Energy Research, EirGrid, SONI

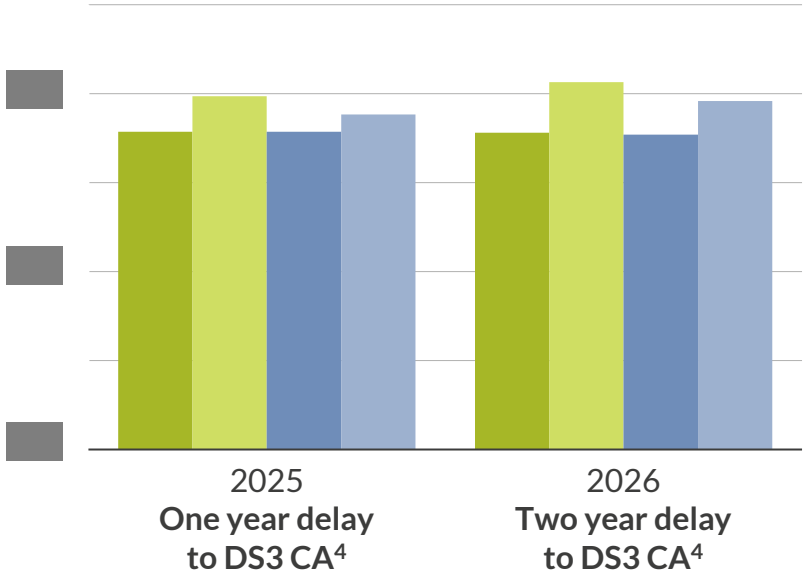
- A delay to the competitive arrangements would cause total DS3 expenditure to continue increasing as more flexible capacity is deployed and the average system non-synchronous penetration (SNSP) increases
- If regulated DS3 arrangements persist beyond 2024, the existing expenditure cap would not be breached under any of the four options in 2025
- If the competitive arrangements were delayed to start in 2027, only option 3 would keep spending below the €235m cap, with option 1 exceeding the expenditure cap in that year by 29million euros

1 Option 3 remains the most harmful option for battery IRRs under any delay to competitive arrangements

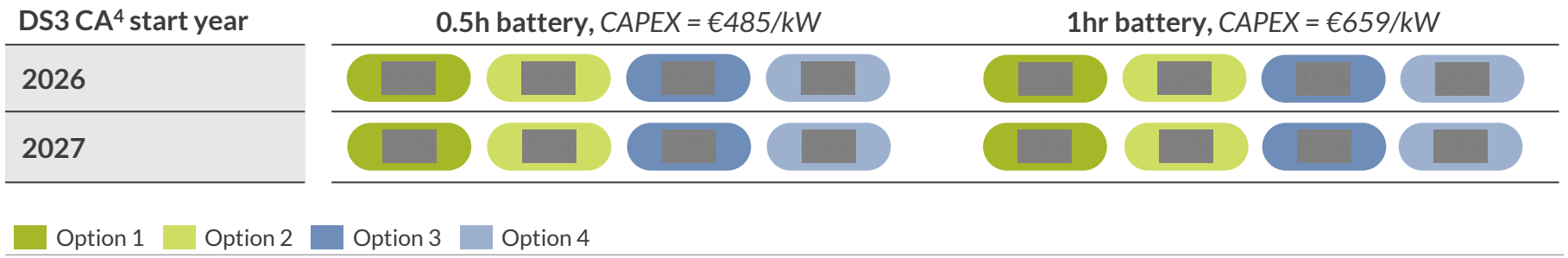
Half-hour duration battery total gross margins[1]
EUR/kW, real 2021



One-hour duration battery total gross margins[1]
EUR/kW, real 2021



Battery IRR[3], 2023 entry year



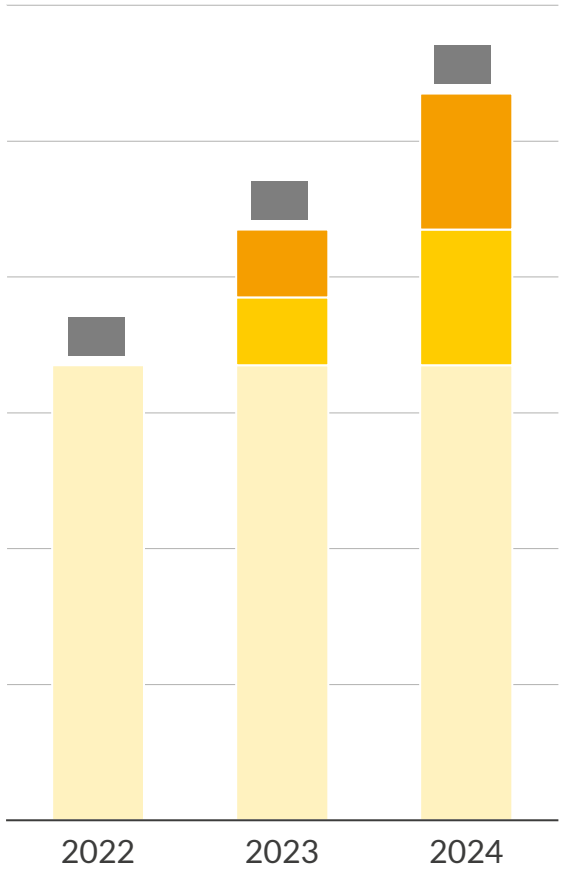
1) Assuming undegraded revenues, located in the Republic of Ireland. 2) The Status Quo scenario assumes there is no change in tariffs or scalars. 3) IRRs are pre-tax, unlevered and including cycle degradation, for new build batteries located in the Republic of Ireland. 4) Competitive arrangements.

Source: Aurora Energy Research

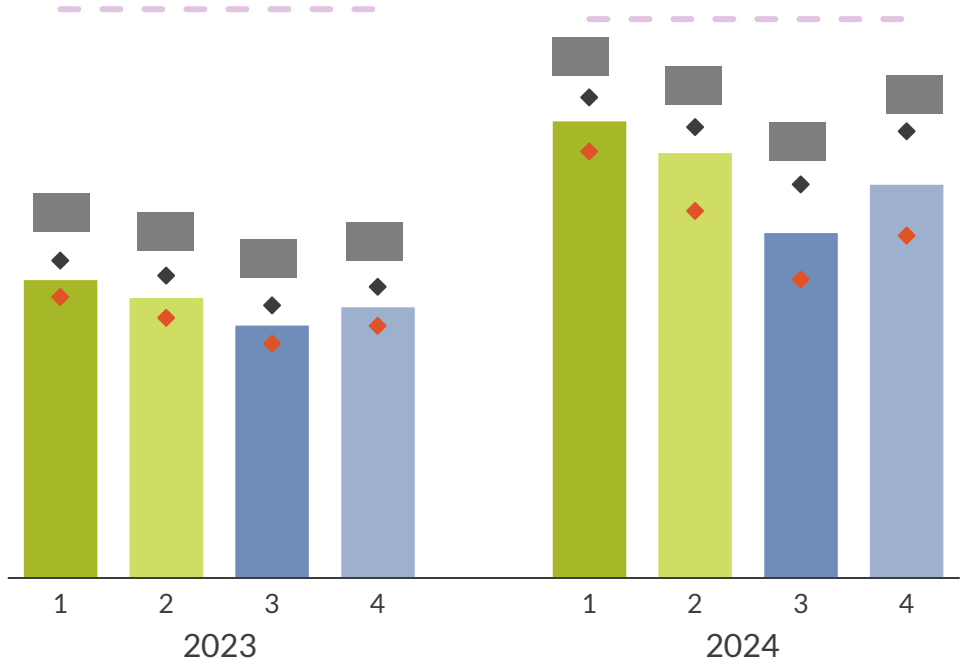
- A delay to the start year of DS3 competitive arrangements greatly supports battery margins and IRRs, due to the high profitability of availability payments
- A two year delay to the start of competitive arrangements could cause battery IRRs to increase by up to 8ppts
- If batteries continue to deploy at a rate of 100MW per year, option 3 could be most harmful to battery IRRs, under both a one year and a two year delay to the start of competitive arrangements, while option 4 remains the best option for battery IRRs

2 Greater battery deployment would increase DS3 spending in 2024 by €10m (5%) for options 1 and 2, and by €20m (13%) for 3 and 4[1]

I-SEM battery capacity
MW



Total DS3 expenditure[2]
EUR million, real 2021



Expenditure deviation[3]
EUR million, real 2021

High sensitivity Central Low sensitivity

Expenditure Cap Central High sensitivity Low sensitivity

1) Figures are averages across the relevant options. 2) Central, High and Low scenarios assume annual battery buildouts of 100MW, 200MW and 0MW, as shown in the bottom left chart. No percentage reductions in tariffs are assumed in 2023 for options 1 and 2, since the chosen option will only come into force in 2023. Percentage reductions in 2024 are applied cumulatively (eg 10% of the previous value is deducted, not from the original value) 3) The average of the absolute deviations of the expenditure, under High and Low, from Central

Source: Aurora Energy Research

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- Faster buildout of batteries would increase expenditure under all options in both years, as spending on fast five services would increase. Conversely, spending is lower when battery build-out is slower
- Options 1 and 2 are less sensitive to changes in battery capacity than options 3 and 4, because they stipulate further tariff reductions if additional fast acting capacity comes online
- In 2024, the expenditure deviation under high and low battery scenarios is on average €[redacted] for options 3 and 4 and only €[redacted] for options 1 and 2

3 DS3 expenditure increases by up to 5% in a high wind year, due to the TSS coupling expenditure with wind penetration

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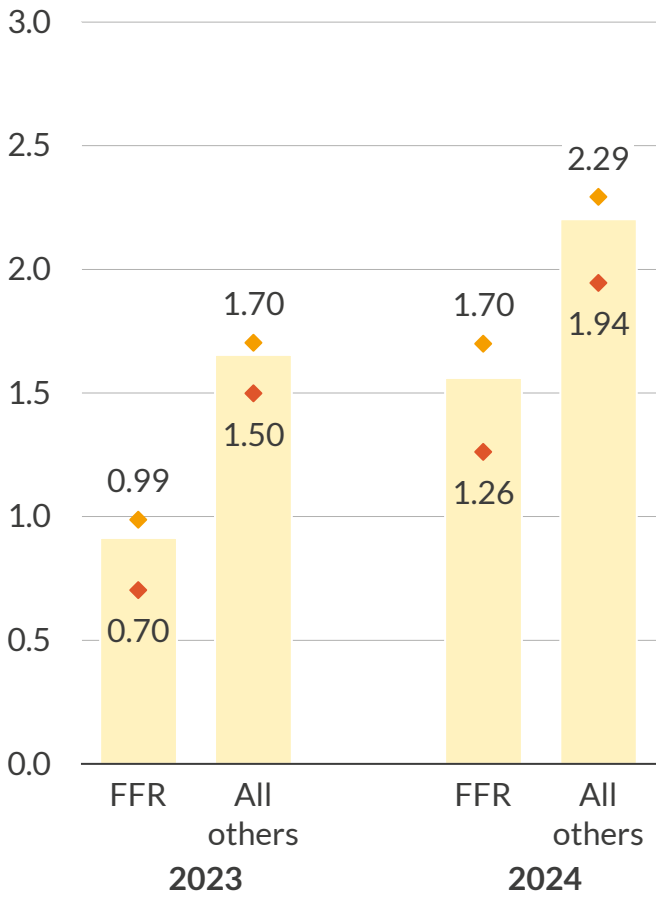
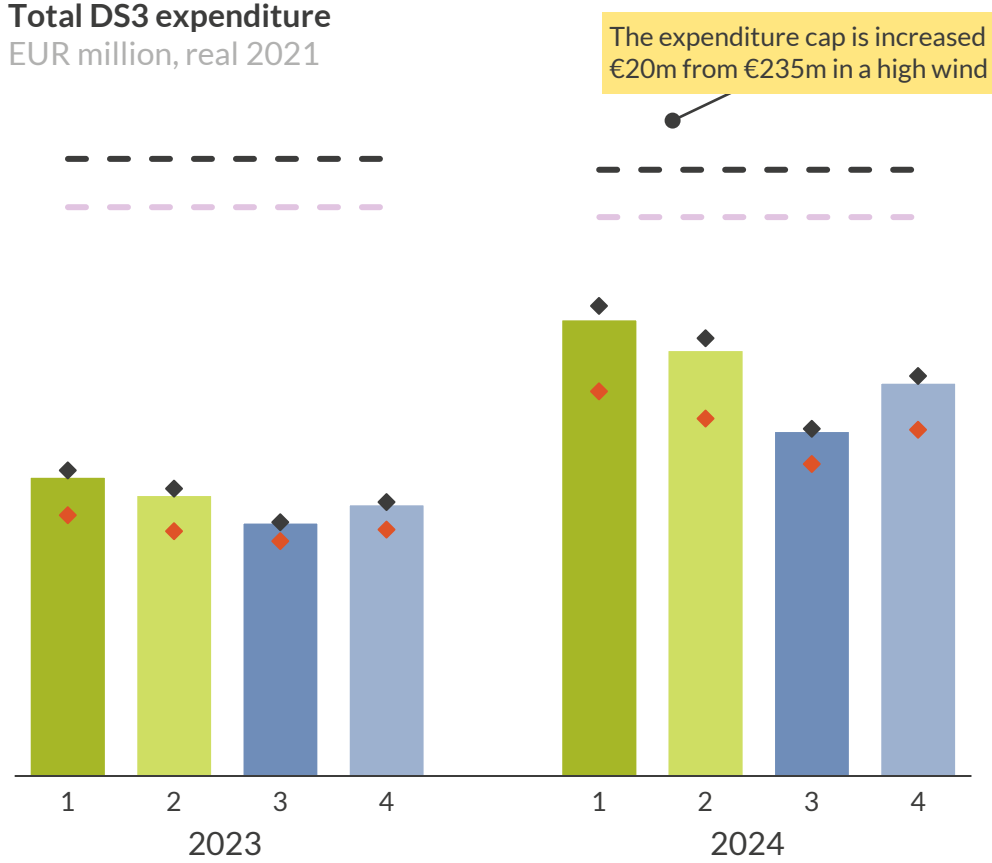
Average annual TSS variation, high and low wind year



Total DS3 expenditure
EUR million, real 2021



Expenditure deviation[1]
EUR million, real 2021

Central | High sensitivity | Low sensitivity | Expenditure Cap | Central | High sensitivity | Low sensitivity

1)The average of the absolute deviations of the expenditure, under High and Low, from Central. 2) SEM Committee, SEM-017-080 3)DS3 System Services Tariffs Consultation Document

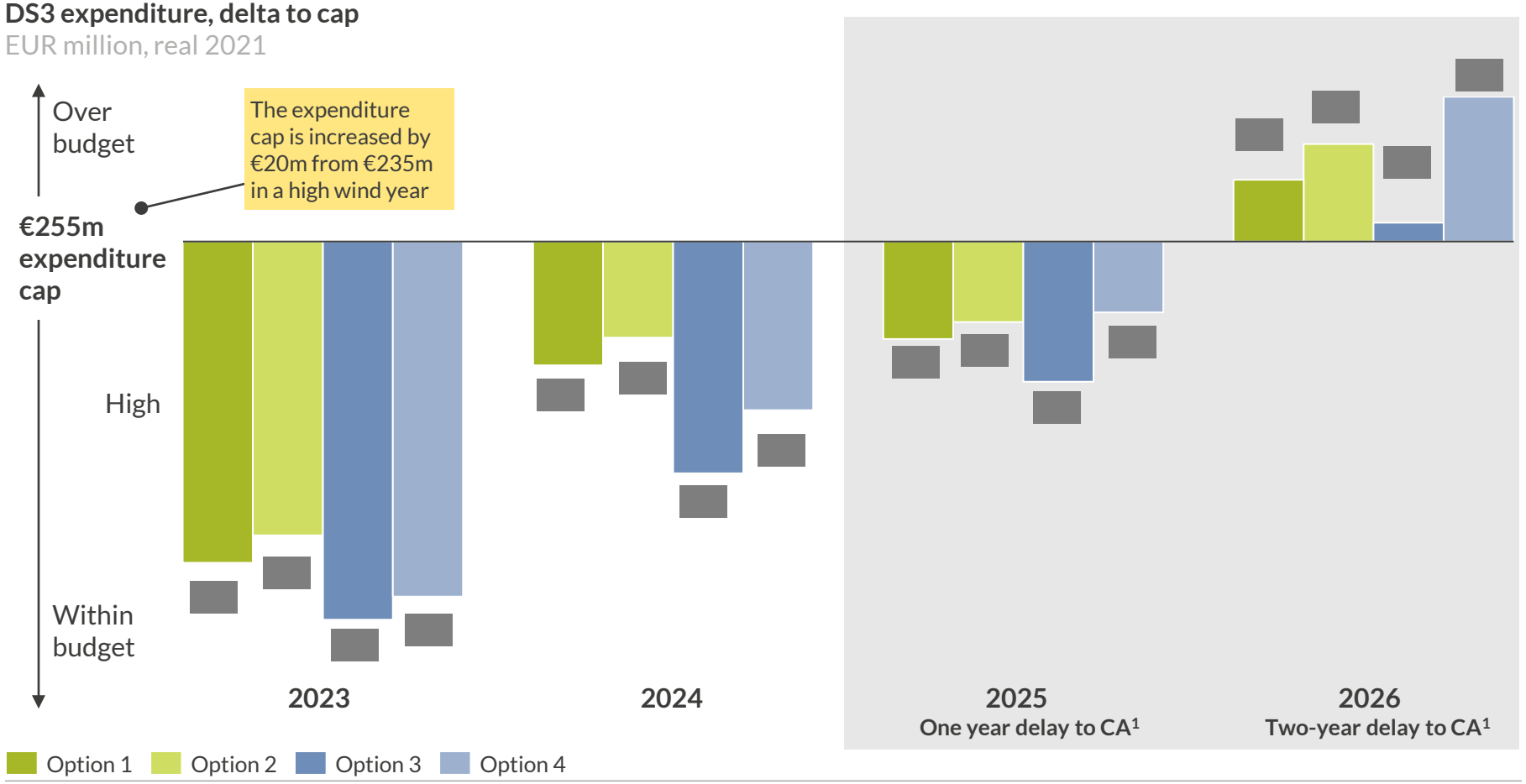
Sources: Aurora Energy Research, SEM Committee

- The DS3 expenditure cap includes an additional €20 million[2], during a high wind year, which is defined as a year with an average fleet load factor of over 31.8%[3], a clause which our high wind year satisfies
- A high wind year primarily increases expenditure across options 1 and 2 which maintain the original TSS scalar
- In a high wind year, 2024 expenditure is increased by [redacted] for options 1 and 2 on average, and [redacted] for options 3 and 4
- The average expenditure deviation show options 3 and 4 are less sensitive to weather year changes due to the expenditure consultation reducing the scarcity scalars of these options

Expenditure is maximised by a combination of rapid battery deployment, high wind and a delay to competitive arrangements

1 Delay to competitive arrangements + 2 200MW per year battery buildout + 3 High wind year

DS3 expenditure, delta to cap
EUR million, real 2021



1) DS3 Competitive Arrangements.

Source: Aurora Energy Research

- Under a combination of downside sensitivities, expenditure increases further but remains below the cap for all options in 2023, 2024 and 2025
- The cap is breached by all options in 2026, as the increased expenditure due to high wind and additional battery capacity outweighs the reductions in tariffs and scalars, despite a €20m increase in the expenditure cap
- High battery deployment and high wind increase expenditure by an average of [redacted] in 2025 and [redacted] in 2026
- The €20m increase in the expenditure cap in high wind years is not impactful on an annual basis, as options that do not result in a breach of the expenditure cap in some years would not do so even without this provision

Key takeaways

1. The September 16th Consultation on Expenditure, released by the I-SEM TSOs Eirgrid and SONI, proposed four options to reduce DS3 regulated arrangements expenditure before the proposed transition to competitive arrangements in April 2024. These options target individual DS3 service tariffs, the Temporal Scarcity Scalar, and a combination of both.

2. Option 3, the option reducing the Temporal Scarcity Scalar only, is the most effective at reducing DS3 regulated arrangements expenditure based on the Aurora October 2022 Central scenario. The least effective is option 1, which proposes reductions to just the fast five DS3 service tariffs.

3. Analysing short duration battery margins, option 2 would result in the highest gross margins in the DS3 regulated arrangements, despite this option leading to the second highest expenditure after option 1. This is because a battery earns the majority of DS3 revenue in the fast five services, leading to greater margins when all service tariffs are reduced by 7% as opposed to just the fast five reduced by 10% in option 1.

4. Total expenditure under all options can vary under different weather conditions or DS3 capacity deployment rates. High battery deployment results in more volume-linked spending, but under option 1 and 2, tariffs continue to decrease as new fast-acting capacity deploys, which reduces revenues for all providers. Conversely, options 3 and 4 are less sensitive to wind variations as they propose a reduced TSS scalar, which is linked to the wind penetration.

5. Finally, a combination of faster DS3 capacity buildout, high wind and a delay to DS3 regulated arrangements would lead to overspend under all options with a two year delay to DS3 competitive arrangements. Option 4 leads to the most expenditure by 2026, as a result of a higher TSS than option 3 and no protection from additional deployment through volume-dependant tariff reductions.

1) Assuming the setup outlined in the European Commission's proposal for the RED II Delegated Act.

Source: Aurora Energy Research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