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BESS business model in Spain
Is investment in BESS profitable?

Storage business model in Spain

September 2024

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1. Identifying drivers of BESS profitability in Spain

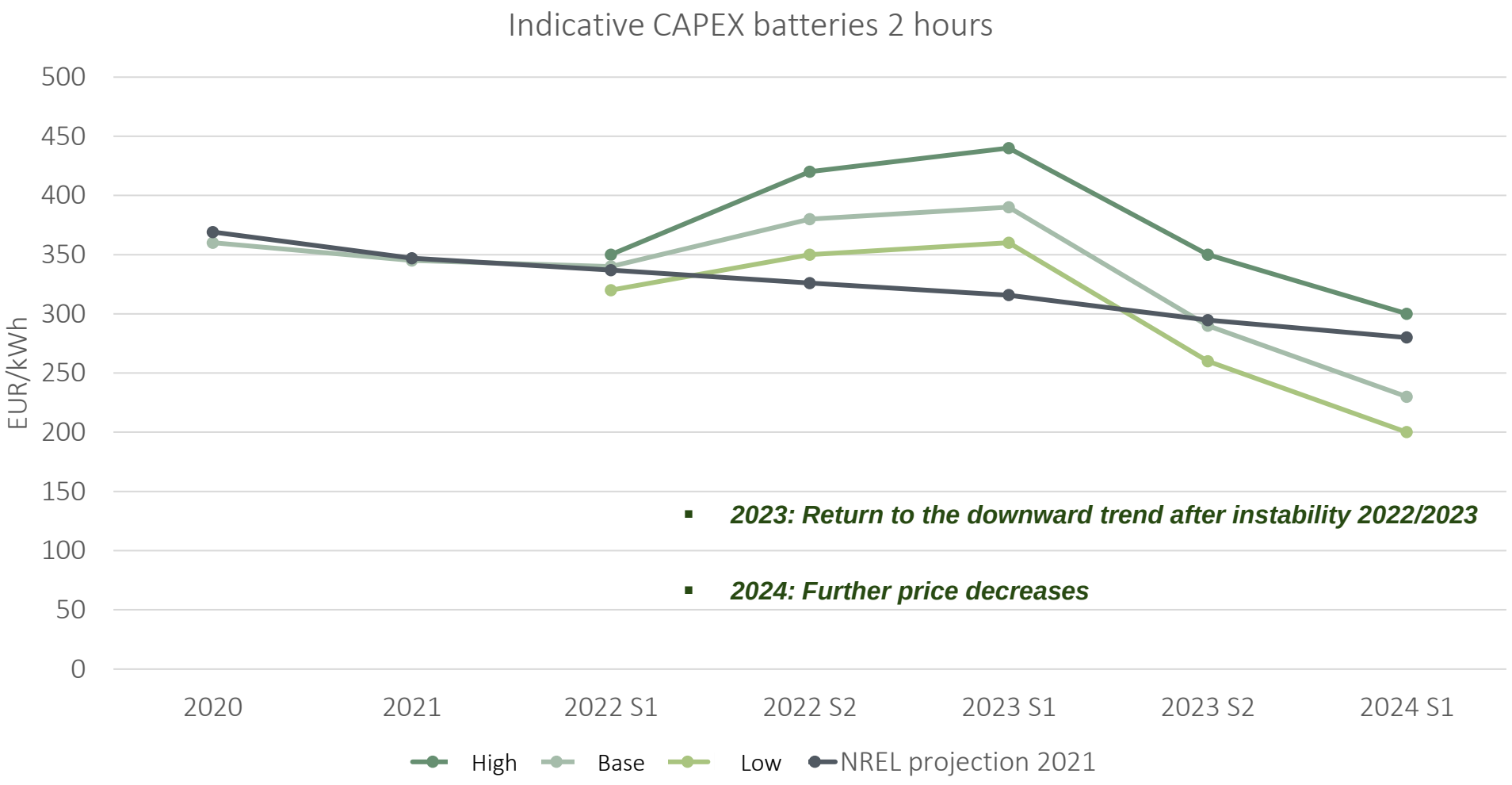
Identifying drivers of storage profitability in Spain

BESS business model - Main drivers

Business model driver / profitability	Key elements – Jun 2024 situation	Expectations	
Technology	• Technological improvement in useful life (20 years or >), degradation and efficiency	Manufacturers and integrators continue to announce improvements and integrate them into offers and warranties	
CAPEX and costs	• Significant decreases in CAPEX compared to the peaks at the end of 2022/2023.		
General regulatory framework	• In general terms: Legal certainty for development and operation. • Uncertainties in certain phases of processing and operation.	Review of operating procedures (OP 3.2) so as not to penalize hybridization with Energy Storage	
Regulatory framework: remuneration scheme	• Energy Storage income framework in Spain is very underdeveloped compared to European countries. • EU Market Reform (April 2024) proposes incentives for storage. • Critical to advance in Capacity Mechanism (Q2/Q3 2024)	Updates on the capacity mechanism in 2024. 2025: Specific remuneration for flexibility.	
Arbitrage Income	• Recurrence of zero prices / attractive spreads are beginning to be seen	PV penetration ambition (new PNIEC).	
Revenue: balancing services	• 2023 /2024 price increase in addition to market prices due to higher RES penetration.	PV penetration ambition (new PNIEC). Risk of cannibalization with development of Energy storage	

Identifying drivers of storage profitability in Spain

CAPEX decreases



- ***2023: Return to the downward trend after instability 2022/2023***
- ***2024: Further price decreases***

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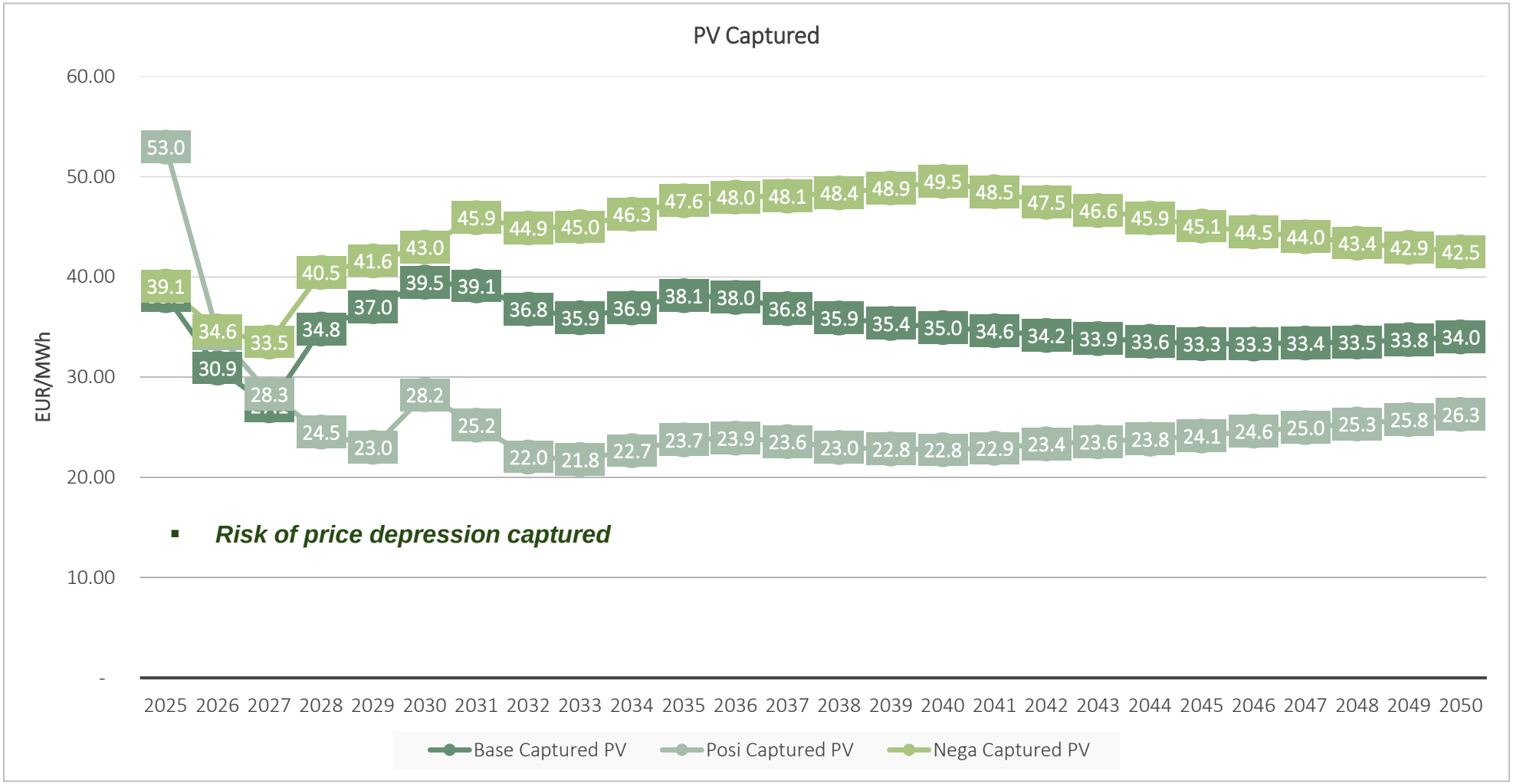
Identifying drivers of storage profitability in Spain

Impact of PV penetration on the electricity system



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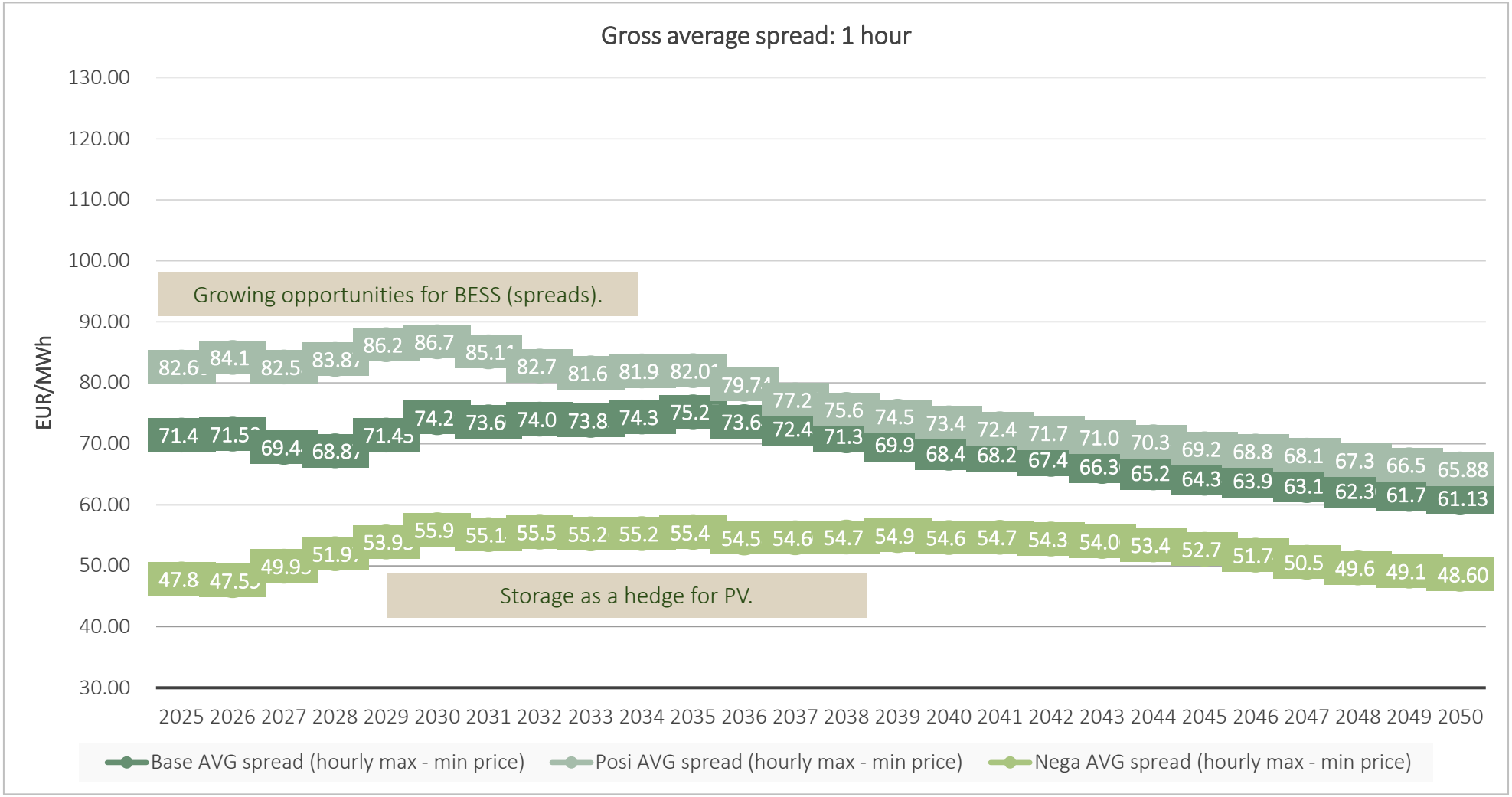
Identifying drivers of storage profitability in Spain

Spread evolution - growing opportunities but not enough: arbitrage in the Daily Market alone is not enough



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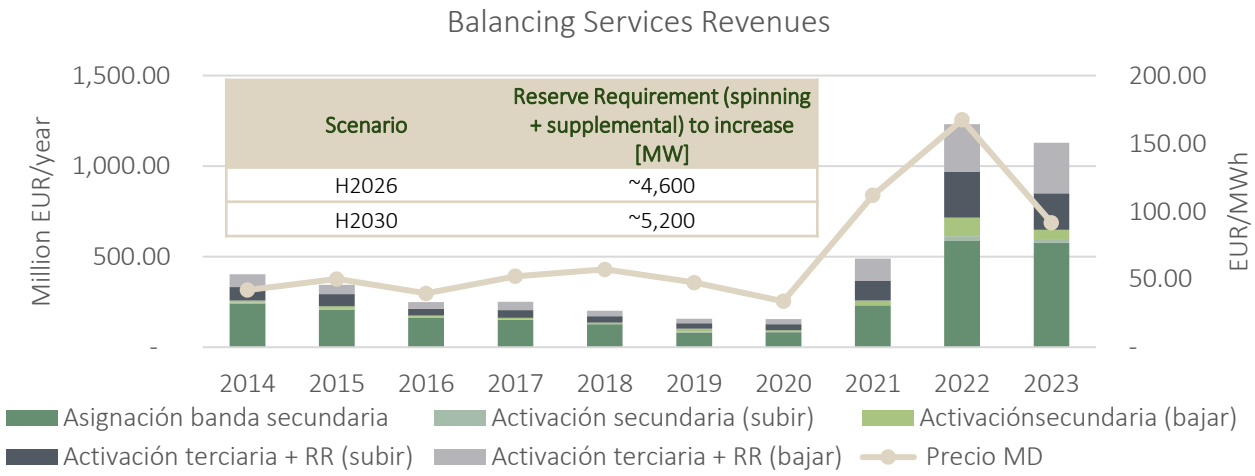
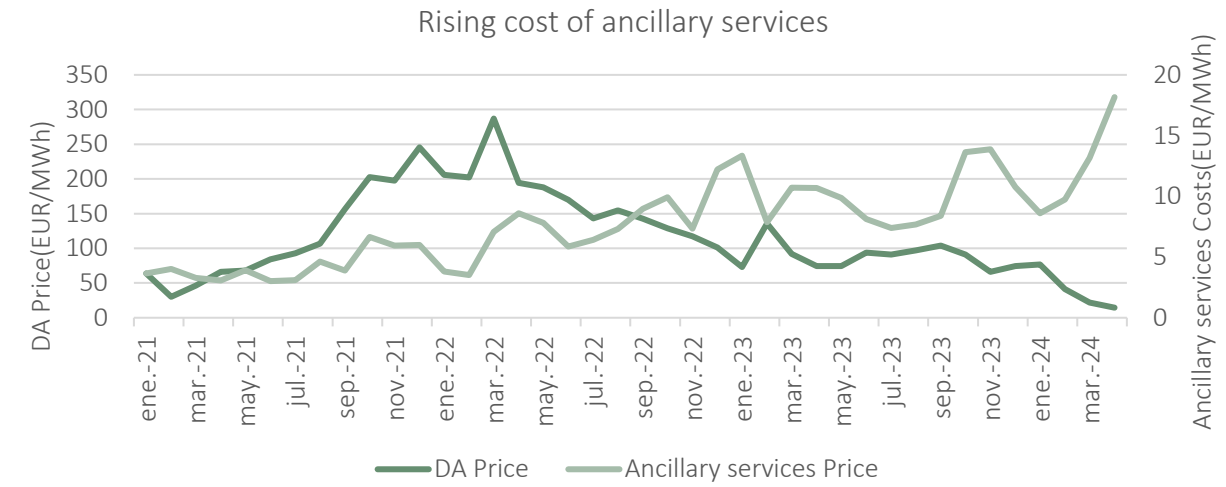
Identifying drivers of storage profitability in Spain

Balancing services revenue - Growing opportunities: ancillary services costs



Scenario	Reserve Requirement (spinning + supplemental) to increase [MW]
H2026	~4,600
H2030	~5,200



- **Declining prices in DA do not translate into lower prices in Ancillary Services**
- **Higher RES penetration = higher prices in Ancillary Services**
- **Opportunities for first BESS to connect. Risk of cannibalization due to limited volume**

- **Cost of ancillary services (balancing + technical constraints) due to increased renewable production.**

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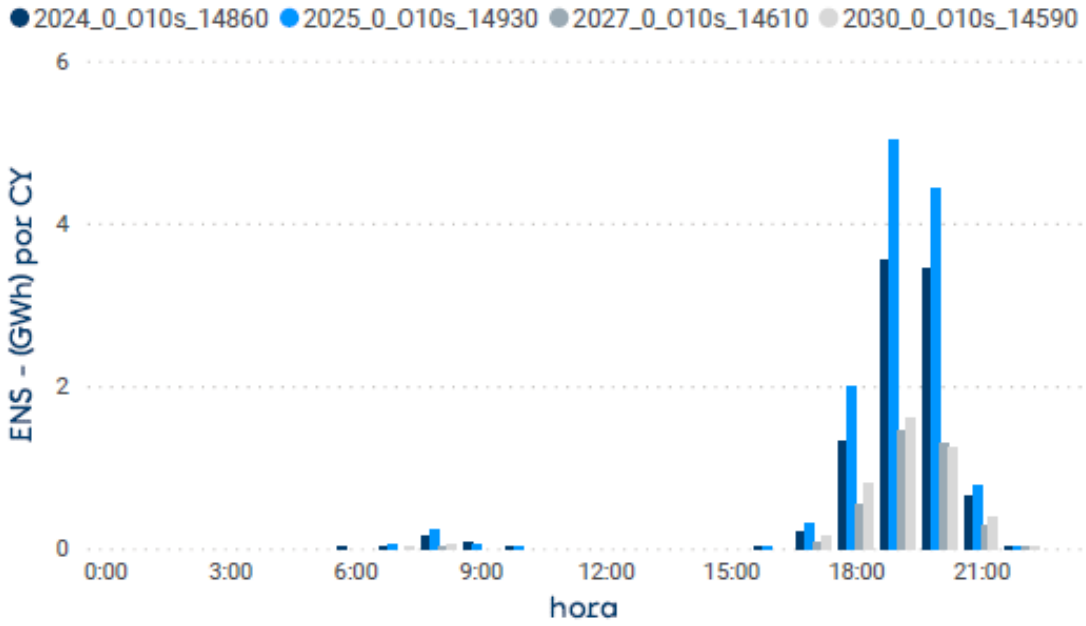
Identifying drivers of storage profitability in Spain

Capacity mechanism: Storage as a key instrument for hedging

Coverage indicators: daily distribution EENS



- Stress situations are concentrated in the evening peak and occasionally morning peak demand.
- Optimal batteries to resolve these situations: compatible with market signals.

- **~300 MEUR/year to be distributed among new capacity:**
- **5 GW BESS = 60 kEUR/MW/year**
- **Subject to competitive pressures: pay-as-bid auctions**

Pending regulatory developments:

1. Publication of new order
2. Outline Approval
3. Technical details and auctions Q3/Q4 2024?

Identifying drivers of storage profitability in Spain

New markets - Revenues: limited progress

Work needs to be done to complete the revenue framework to allow for the deployment of storage to enable the ambitious RES integration.

Specific auctions Economic Storage Regime

- Establish a specific remuneration for storable energy.
- There is regulatory support at EU level + proposed market reform.
- EU Market Reform April 2024: Where investment in non-fossil flexibility is insufficient to meet the national target [...] Member States may implement non-fossil flexibility support schemes consisting of payments for available non-fossil flexibility capacity.

Other market revenues

- FFR
- Voltage Control
- Local markets of flexibility

1) 250 EUR/kWh CAPEX 2 hours: 8% return on investment

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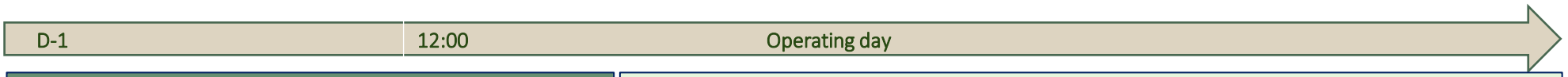
2. Revenue Stacking Framework: Market Revenue Expectations

Revenue Stacking Framework: Market Revenue Expectations

BESS Operating alternatives at a glance - Source of revenues



Operating decision: day ahead programming vs secondary band bidding are incompatible strategies due to activation and imbalances risks.

Operating decision: No discharges programmed and BESS on hold reserved to downward energy activation (mFRR, RR and intraday markets).

DA arbitrage bids
Max – Min spreads expectation + round trip efficiency losses.

DA: charges at minimum hourly prices and discharges at maximum prices
Guaranteed income: market liquidity and price visbility

Charges | Discharges

Feasible combined operation

Operating decision. aFRR band vs DA arbitrage.

Intraday and balancing energy markets (aFRR RR) arbitrage
Higher potential spreads than DA market. Bidding position (up/down) adjustable following state of charge (no imbalance risks). Limited volumes and activation risks. Challenging forecasting activation time, volumes and prices.

aFRR band allocation bids
Secondary reserve price expectations + regulation zone optimization.

State of Charge adjustment (intraday, RR, mFRR) offseting aFRR activation orders.

Availability payment. REE aFRR orders compliance at regulation zone level. Compliance level depends on state of charge.

Activation payment: aFRR prices closed to DA (cheapest mFRR offers).Unpredictable economic result (even negative) due to aFRR activation contrary to market prices.

BESS revenues optimization tools: Optimization tools in coordination with best-in-class EMS[1] provider comprising the technical operation Energy Management System (InMS) and market fronting optimization

Storage is a flexible asset with the ability to schedule and adjust its operations (charges / discharges) close to real time. This feature allows storage to participate in various markets and makes it more complex to define the optimal operating strategy. The optimization model defines every day the **optimal operation strategy** that maximizes the net income for storage considering the following operational alternatives:

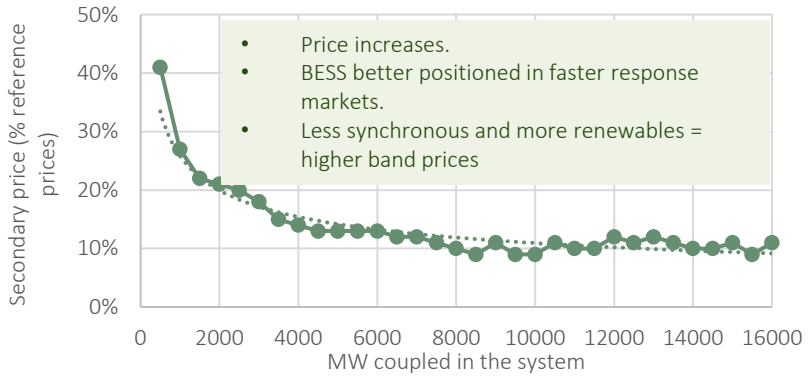
1. Arbitrage in the DA market complemented with potential in intraday and energy balance services (RR and tertiary)
2. Secondary band offer considering the remunerable capacity per band (within the regulation zone) and the economic balance of the activations.
3. Cycling the battery. Activations degrade the battery, reducing its useful capacity and generating an opportunity cost which is the income lost due to the degradation of the battery that can imply that the economic optimum is not using the battery for certain days.

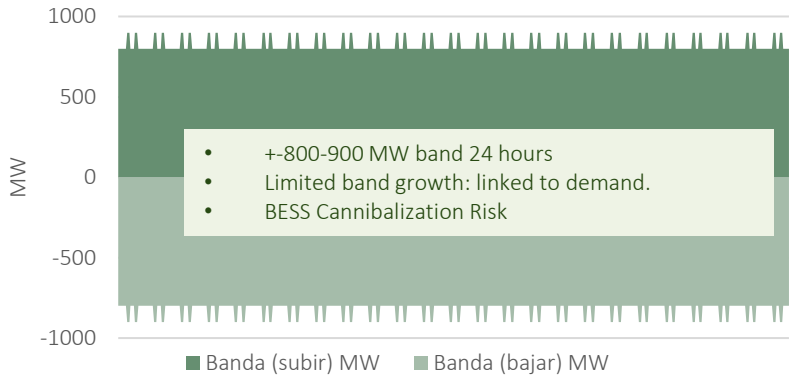
In addition, BESS shall comply with grid code and respond to REE frequency control requirements (additional to market operation) such as POD-P, POD-Q, inertia simulation, etc. These requirements are modelled based on technical parameters of the BESS and system frequency control needs based on real-time generation mix (synchronous generation and inertia estimation).
InMS hardware and software enables BESS physical operation to follow optimal market operation and to respond automatically to system needs / REE requirements.

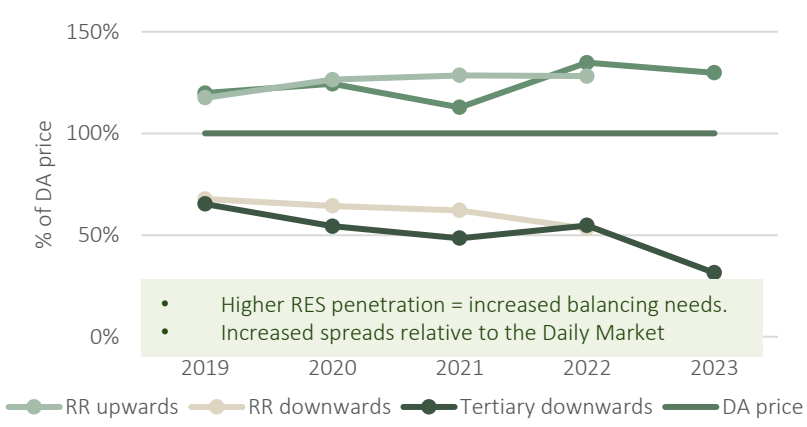
Revenue Stacking Framework: Market Revenue Expectations

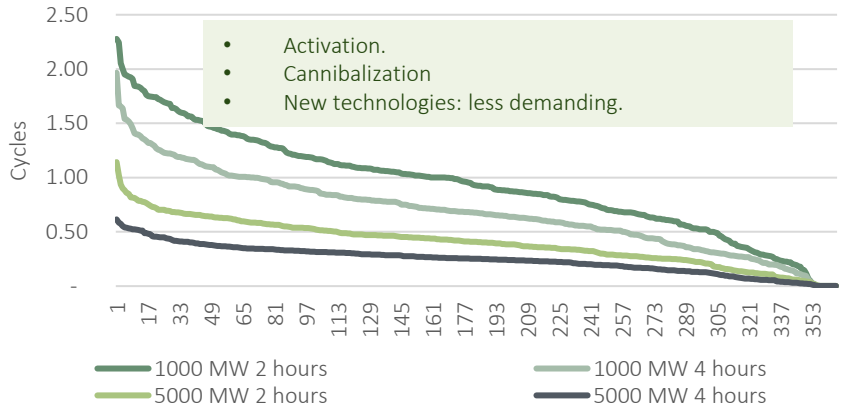
Ancillary Services: opportunities and risks

	Oportunidades	Riesgos
Secondary band	Secondary band price vs. activation DA cycles	Secondary band requirement 2024
Balancing energy: RR + tertiary	Balancing energy activation price	Equivalent potential cycles in pure arbitrage RR + Tertiary









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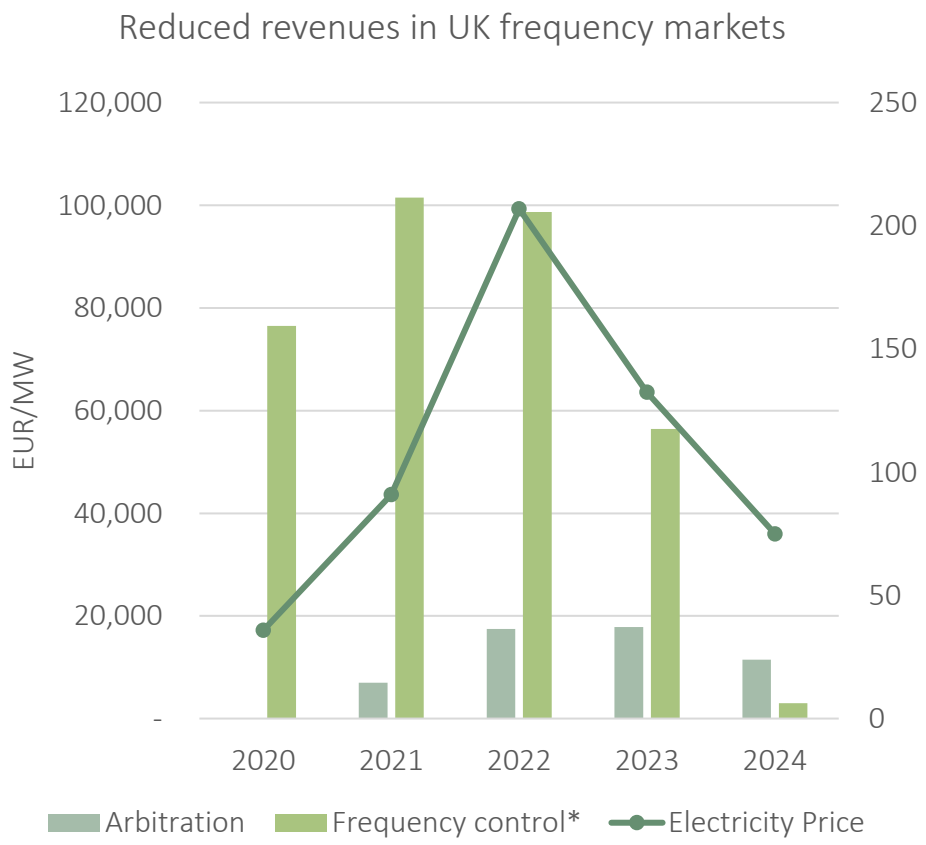
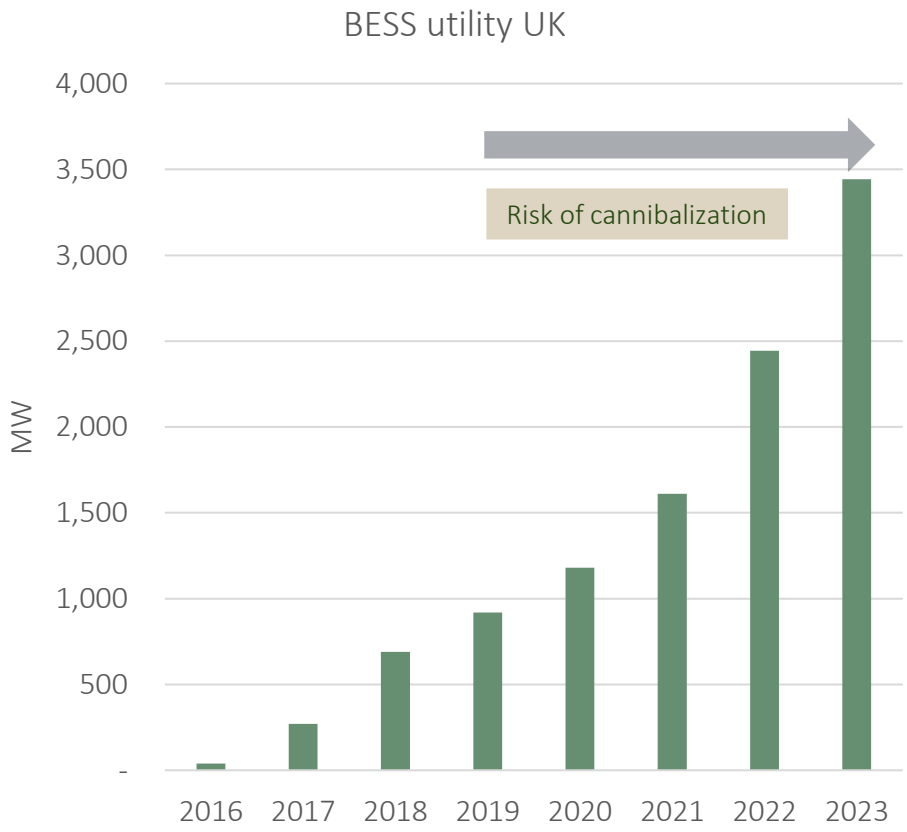
Revenue Stacking Framework: Market Revenue Expectations

Risk of cannibalisation of Ancillary Services in mature markets

In the UK, significant drops in potential revenues are being seen in frequency control markets: changes in services regulations + BESS competition

The cannibalisation of ancillary services in the UK can be seen from a BESS level (2021/2022)





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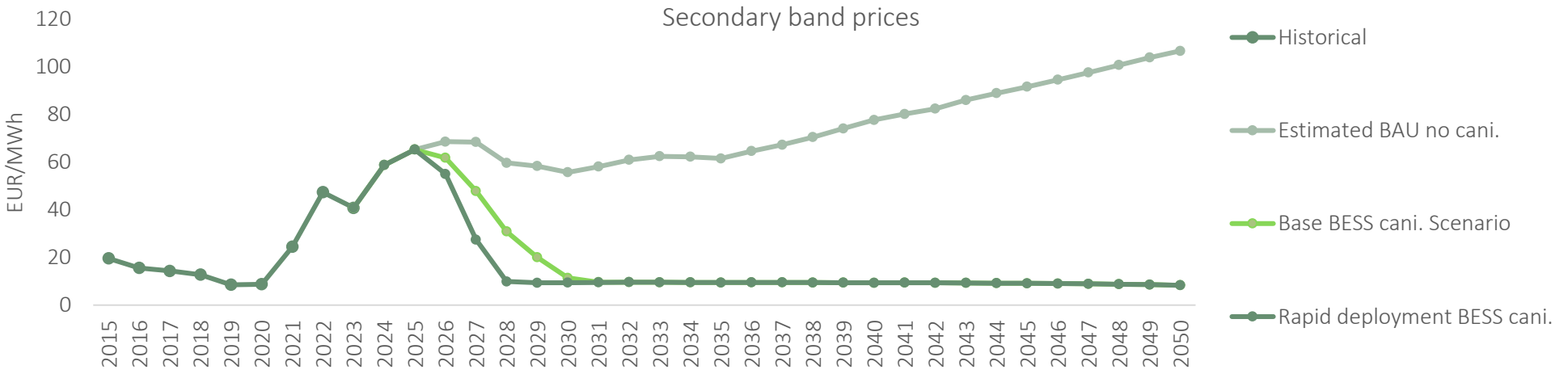
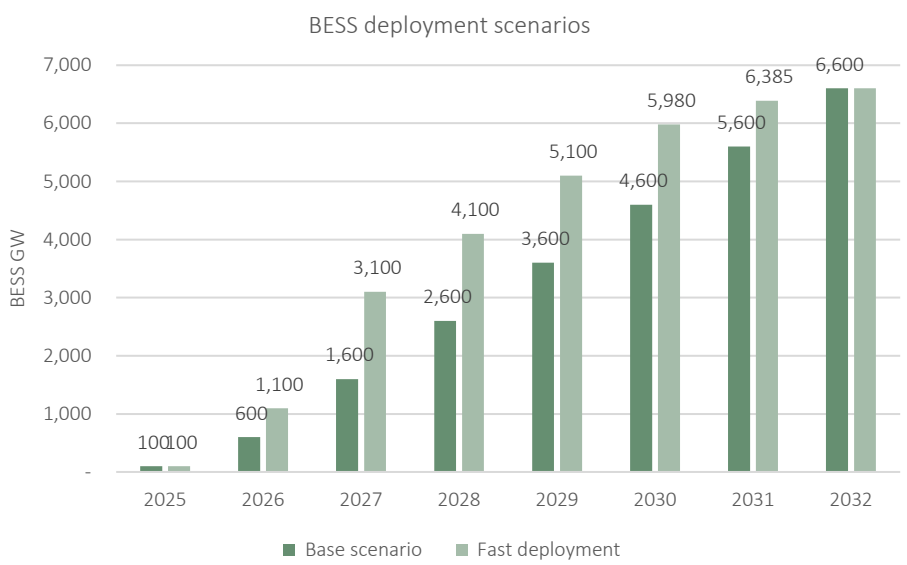
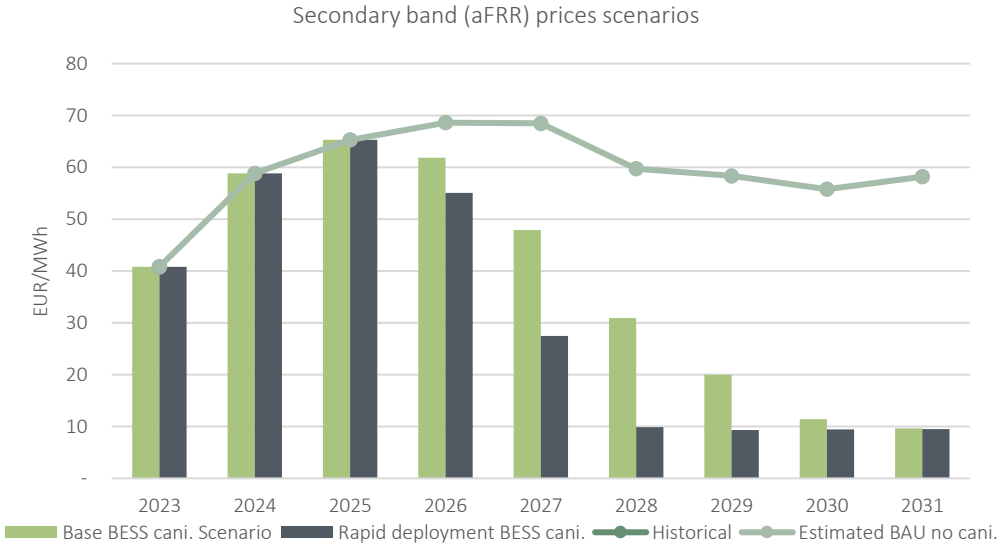
Revenue Stacking Framework: Market Revenue Expectations

Revenues from balancing services: opportunities in the secondary band







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3. BESS business case

BESS business case

Is investment in BESS profitable?

This question has no direct answer since the profitability of storage **will depend on the investment in storage and in turn the investment in storage will depend on the expectations of profitability**. The key question is:

How much storage can be developed financially viably under different revenue schemes?

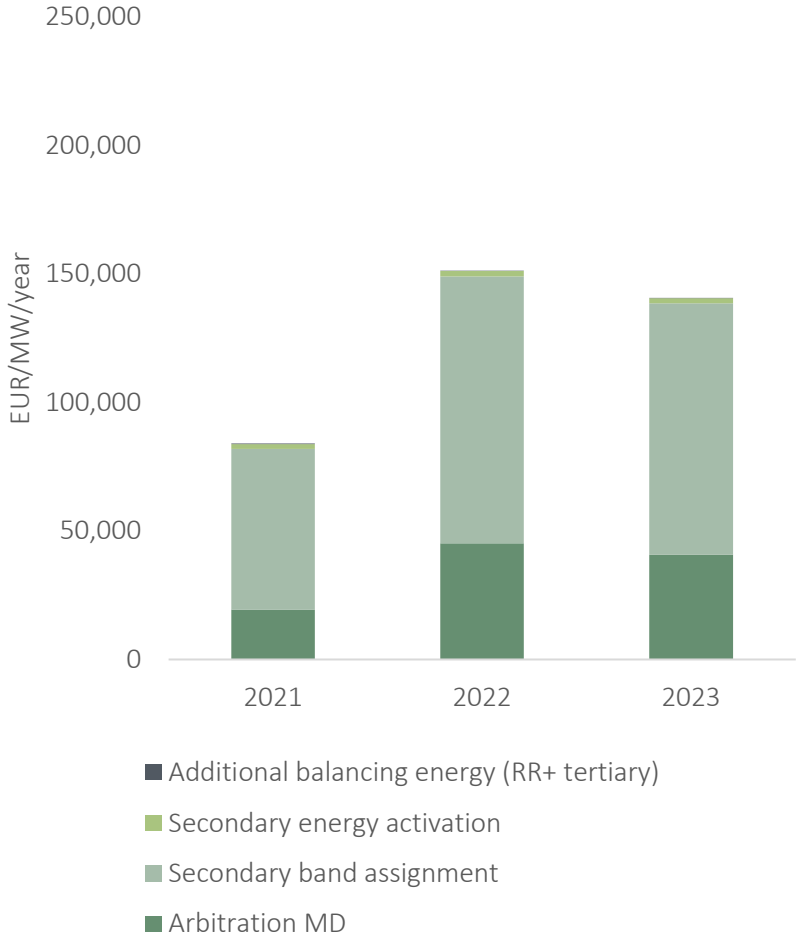
Agreement for the Reform of the European Electricity Market (April 2024)

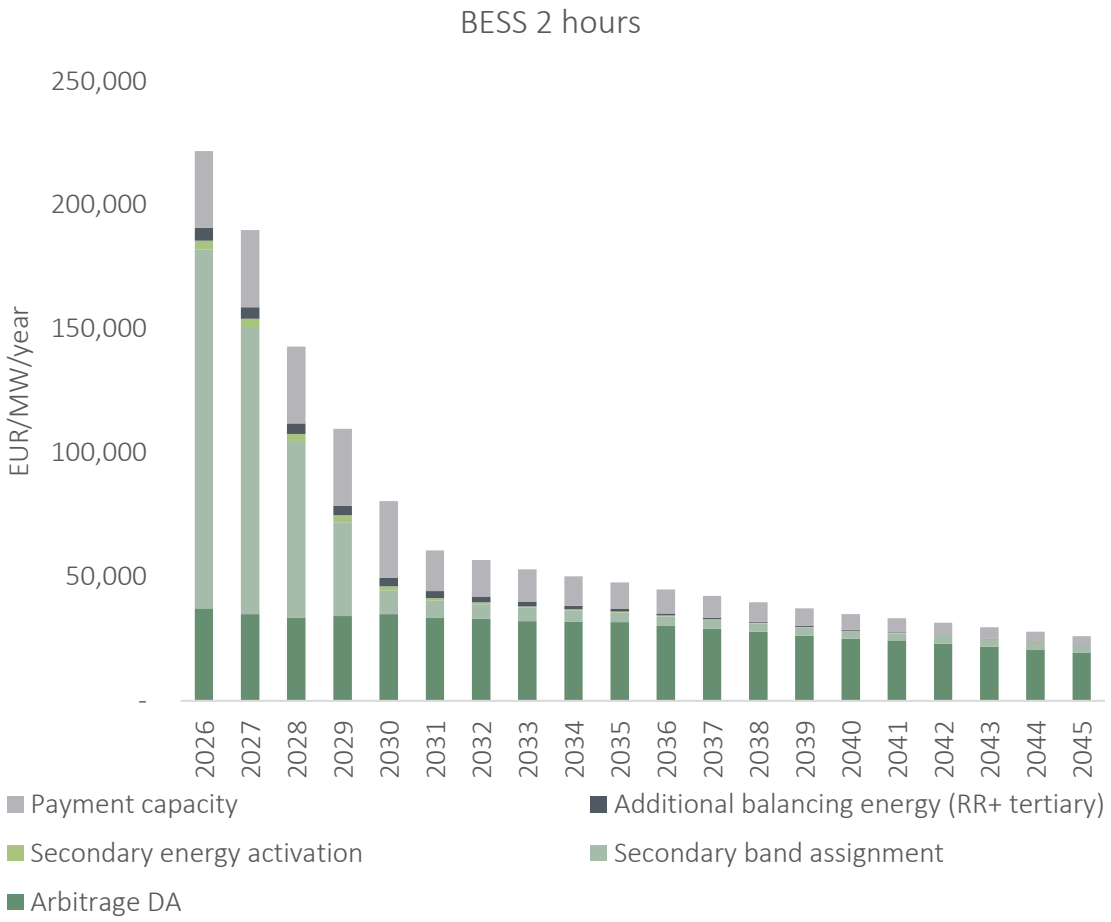
Where investment in non-fossil flexibility is insufficient to meet the national target [...] Member States may implement non-fossil flexibility support schemes consisting of payments for the available non-fossil flexibility capacity. Member States implementing a capacity facility shall consider making the necessary adaptations in the design of capacity mechanisms to promote the participation of non-fossil flexibilities, such as demand response and energy storage, without prejudice to the possibility for those Member States to use the non-fossil flexibility support schemes through the implementation of the referred to in this section.

BESS business case

Current market revenues + Payment for capacity

Assuming 1 GW of Batteries connected annually from 2026 onwards. 5 GW of storage is justified by security of supply (they would be entitled of receiving capacity payments)





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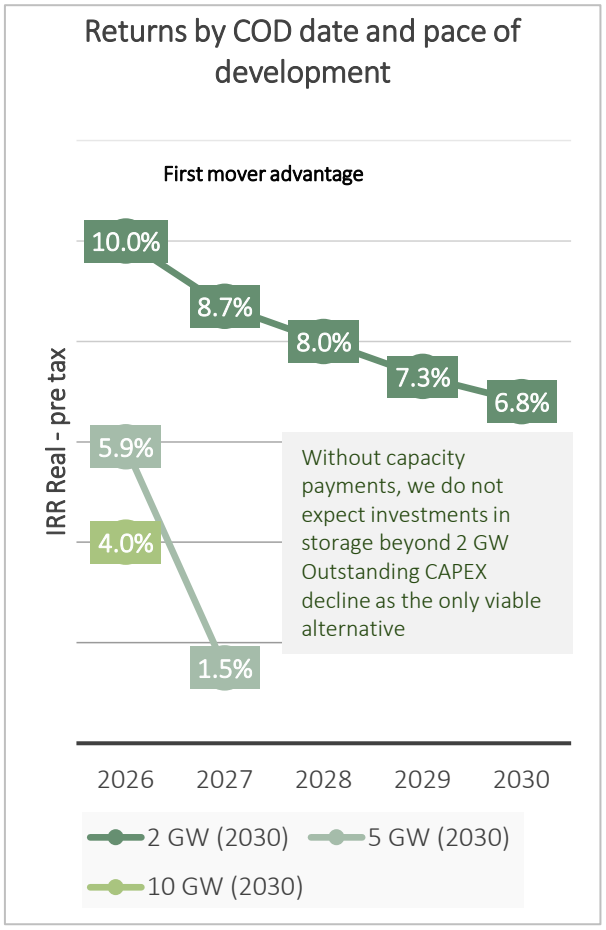
BESS business case

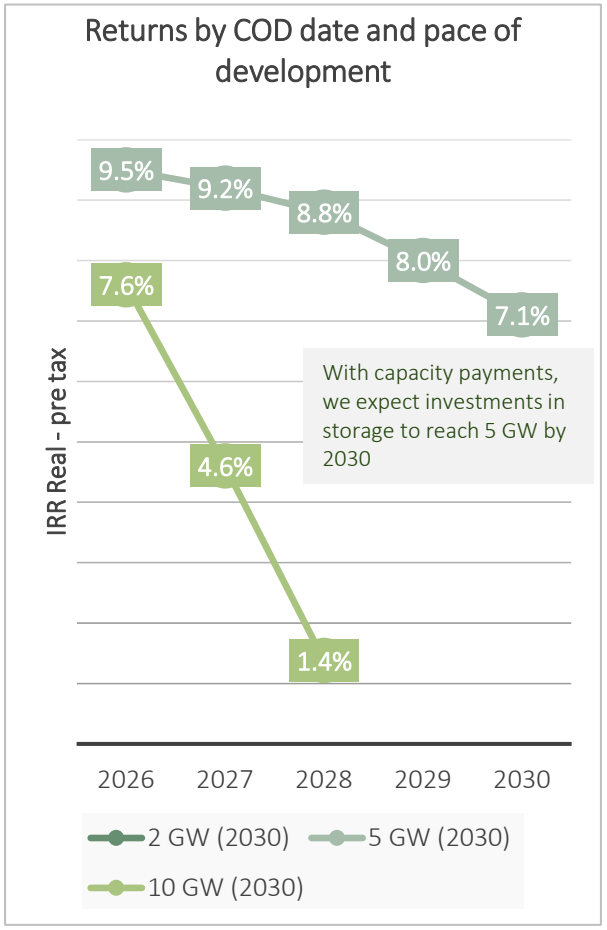
Current market revenues + Payment for capacity

No capacity payment + CAPEX base evolution

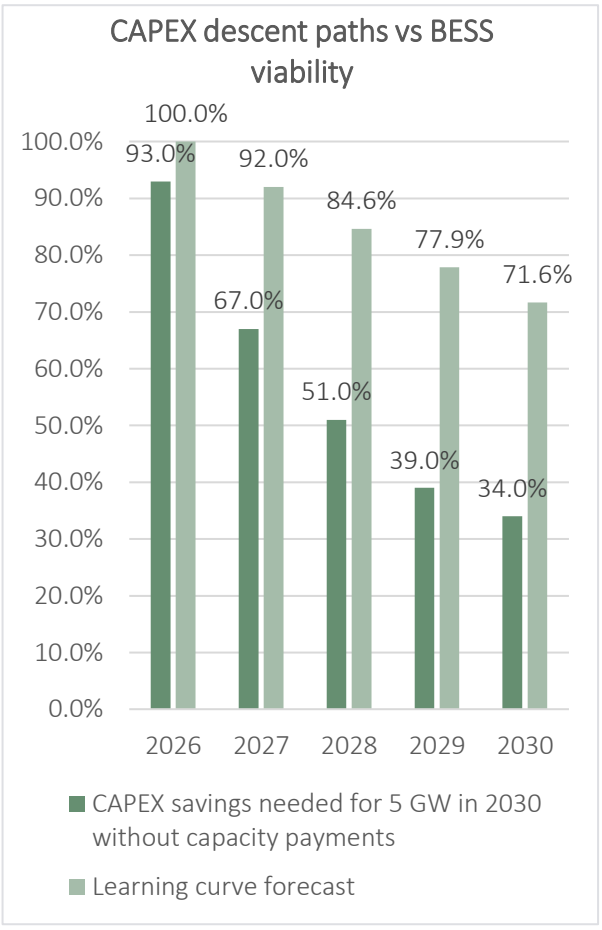


-8% projected annual CAPEX decrease

With capacity payment



CAPEX descent paths

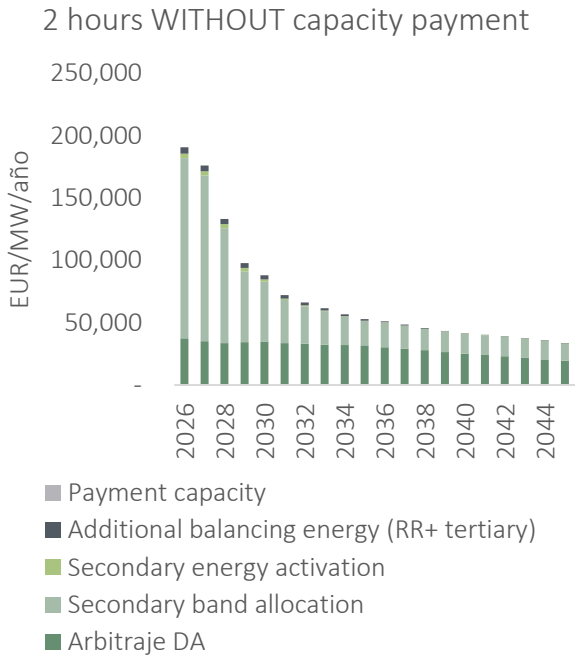


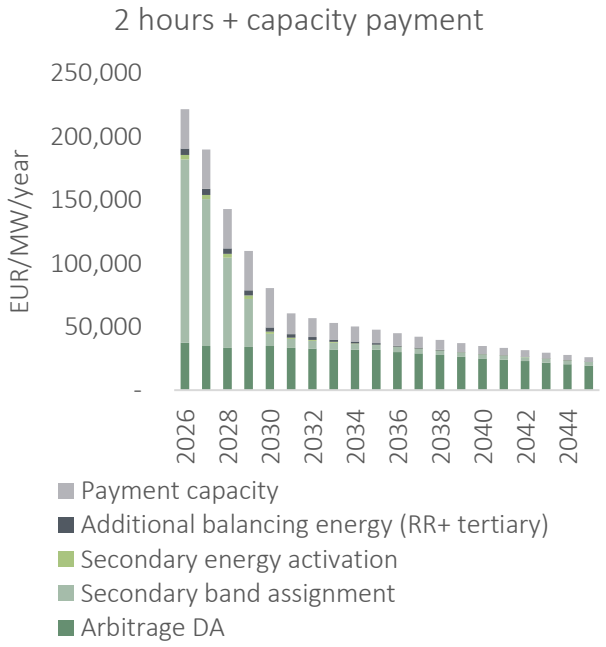
BESS business case

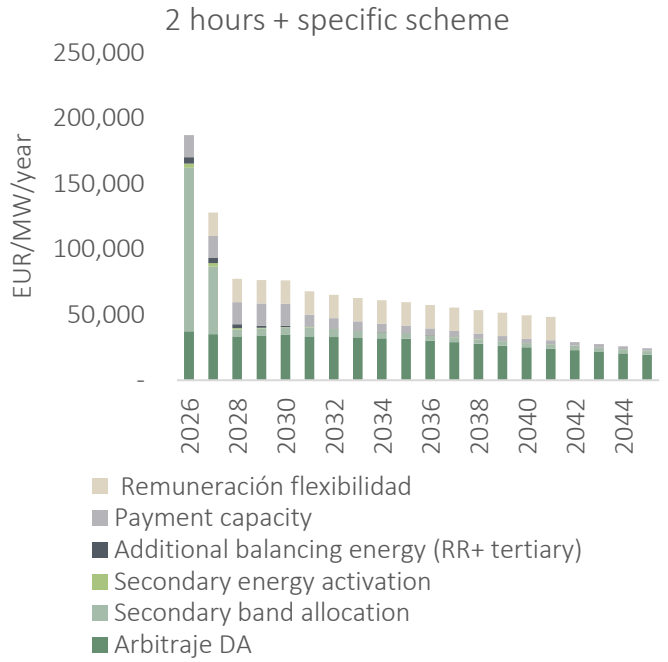
How much investment in storage will crystalize in the coming years?

Around 10 GW at different stages of development, the financing and construction of which will depend on the remuneration framework.

Current remuneration scheme	+ Capacity payments	With a specific remuneration scheme for flexibility
<2 GW 2030 (PERTE + merchant projects)	4 – 5 GW are justified by firmness needs (depending on combined cycle scenarios)	>5 GW require additional remuneration scheme
Returns >9% due to market risk and limited funding	Initial returns 9% to 6 - 7% due to financing possibilities	6-7% due to the diversity of financing options in the face of a regulated scheme







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