Long term outlook for power prices in Greece – levels, volatility and underlying market drivers

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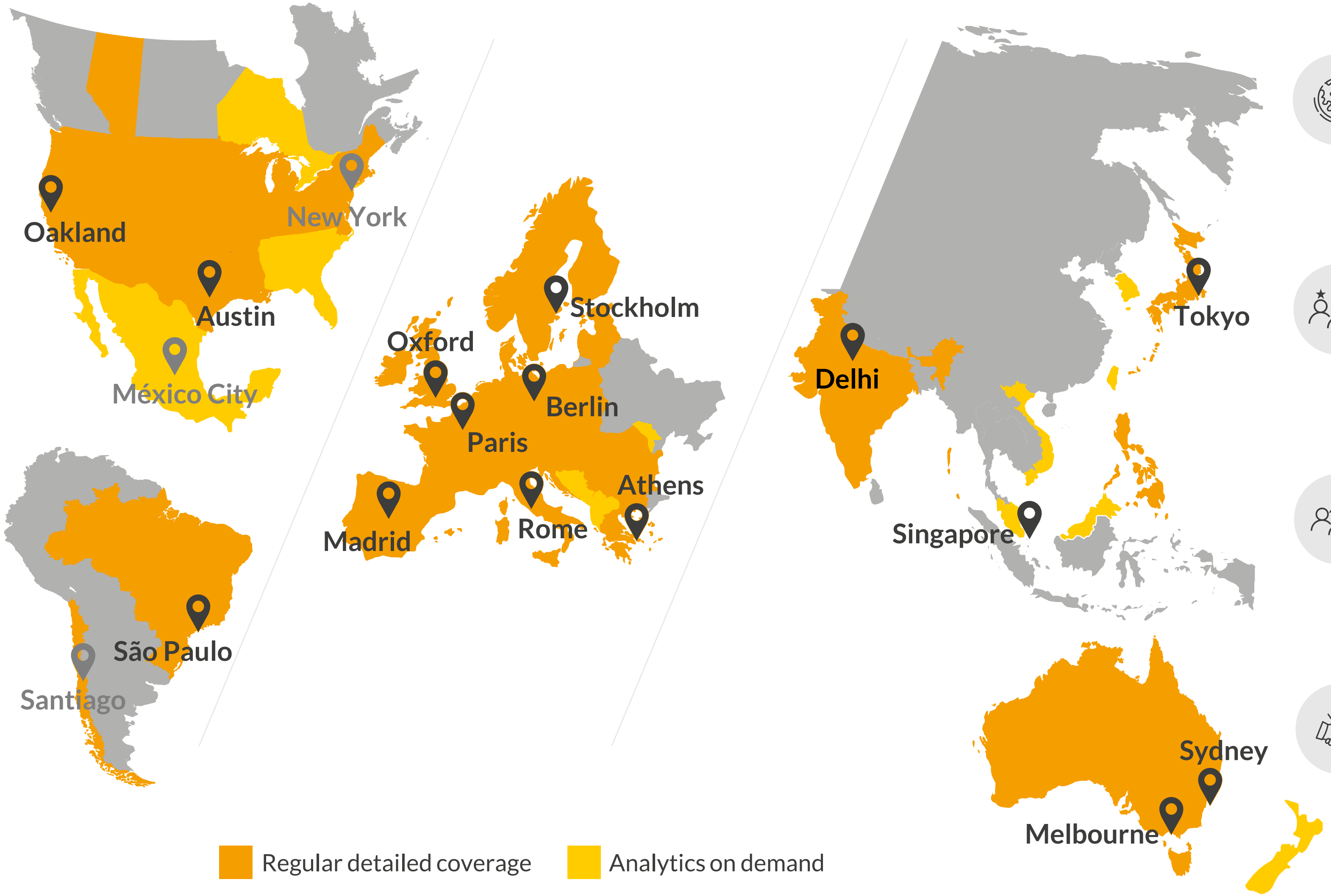

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Source: Aurora Energy Research

In 2024 electricity prices declined by 15% despite a 4.8% increase in demand, compared to 2023

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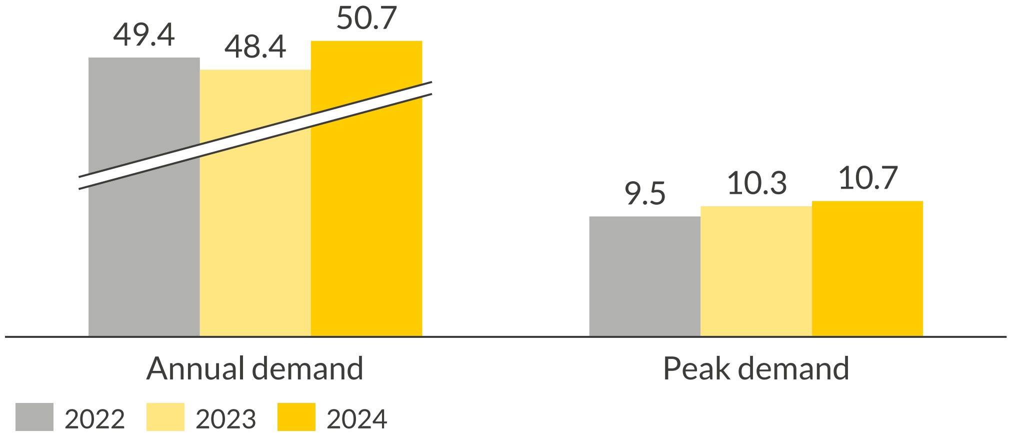
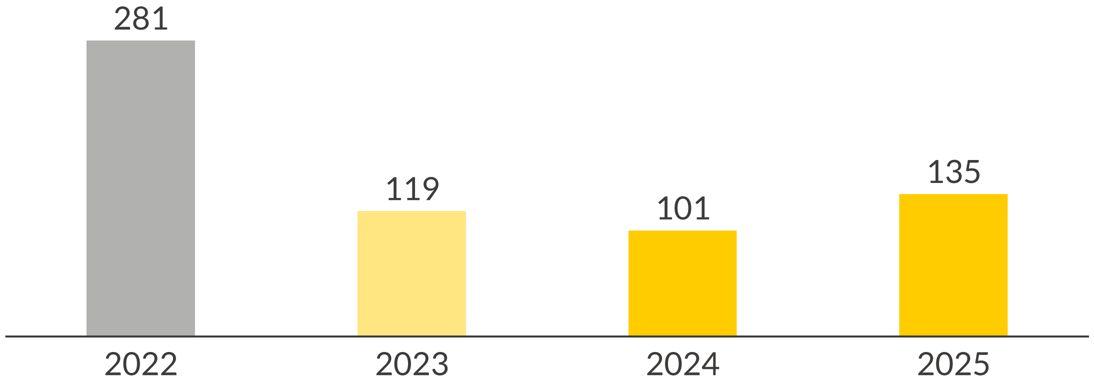
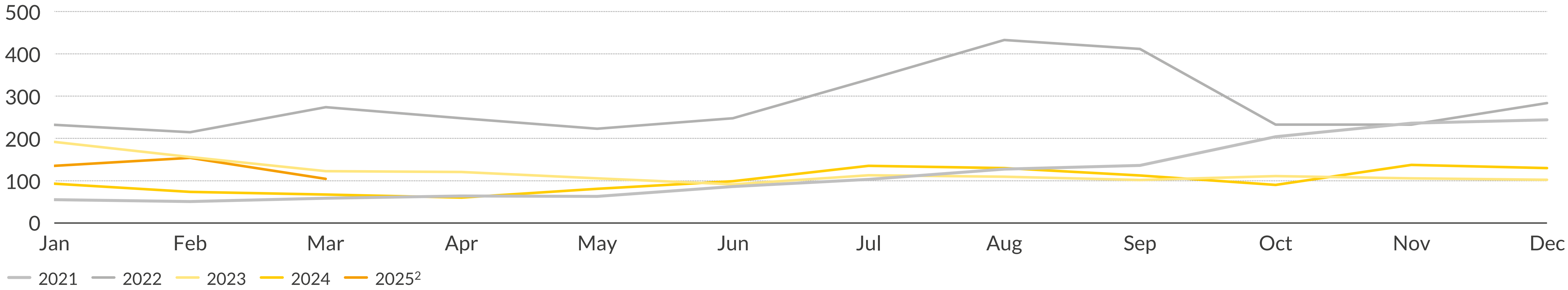
Net annual demand and peak demand
TWh/GW



Annual average day-ahead prices[1]
€/MWh



Monthly average day-ahead prices
€/MWh



1) Annual average day-ahead prices for 2025 refer to the January-February 2025. 2) Average price for March is until 18/03/2025

Sources: Aurora Energy Research, IPTO, ENTSOE

Gas prices rise over the forecast period due to increasing Asian demand and limited LNG export buildout after 2030; EU ETS prices climb due to stricter emissions targets

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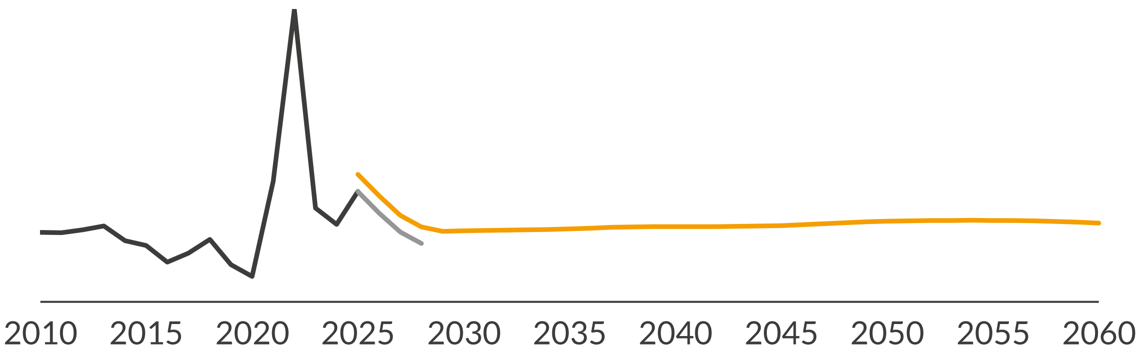
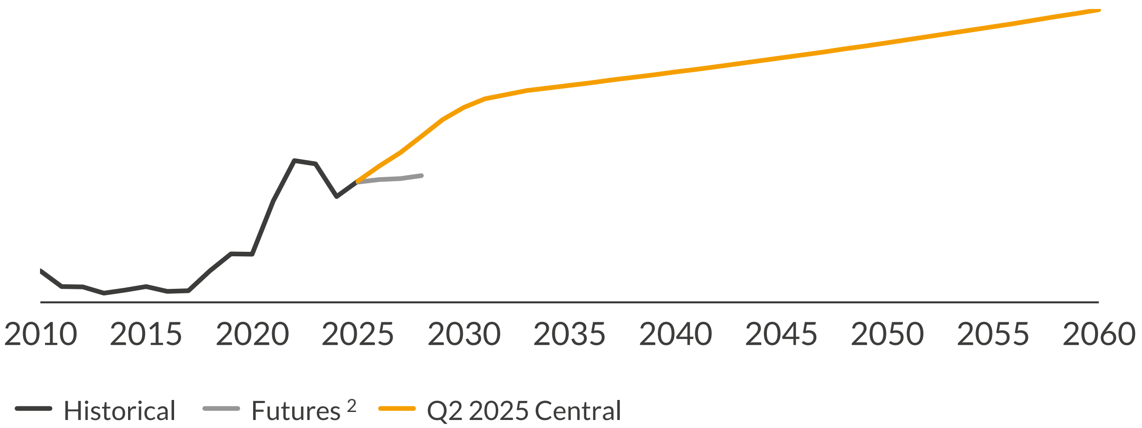
Gas prices
€/MWh (real 2024)[1]



Carbon prices
€/tCO_2 (real 2024)[1]



Key trends in commodity price forecast:

- **Short term (2025-2028)**
  - **Gas prices** average in the mid 40s €/MWh, higher than the previous forecast due to continued storage withdrawals resulting in a steeper backwardation. After 2025, new liquefaction capacity will increase the global offer of gas, driving prices well below current levels by 2028
  - **Carbon prices** average in the high 80s €/tCO_2 during this period
- **Mid to long term (2029-2060)**
  - **Gas prices** average in the mid 30s €/MWh. Gas prices gradually rise over the forecast, as European production declines and Asian demand surges, increasing competition for LNG
  - **Carbon prices** average about 150 €/tCO_2 in this period, and rise to over 180 €/tCO_2 by 2060, because anticipated abatement costs in the industry sector have increased while policy ambition is to be maintained

Role of commodity prices

Commodity prices are important drivers of wholesale prices and capacity buildout. In the short and mid-term, fossil fuel prices indicate the upper threshold for electricity prices, as price setting plants mainly run on gas.

1) For years 2025-2028, the prices shown consider current futures prices for the years in question, with declining weights. In 2025, forecast prices include historical prices up to Feb-25. 2) Futures on trading days between 03/02/2025 and 28/02/2025. For gas, THE historical and futures prices are shown.

Sources: Aurora Energy Research, EEX, CME

Capture prices mirror commodity price changes, and underpin the attractiveness of unsubsidised renewable entry

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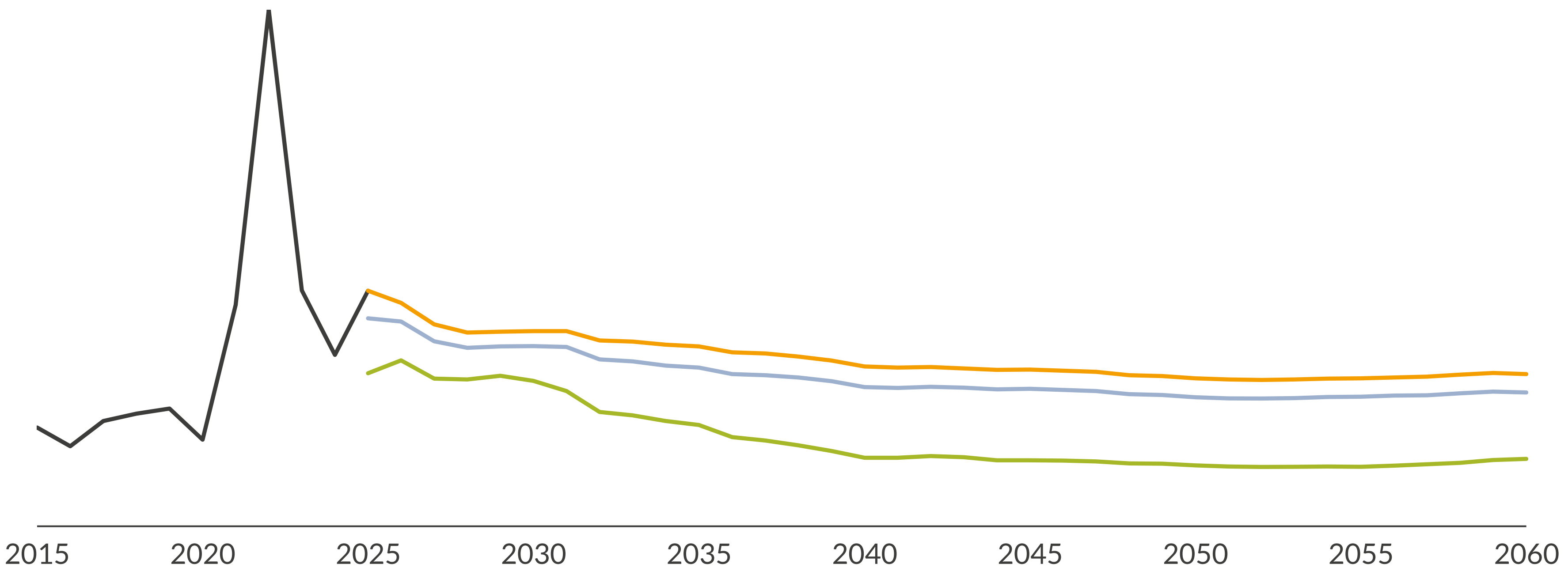
Baseload and renewables capture prices[1]
€/MWh (real 2024)



Average discount to baseload
10-year averages

Period	Onshore wind	Solar PV
2025-30	9%	27%
2031-40	12%	46%
2041-50	13%	58%
2051-60	12%	59%

Historical baseload
Onshore wind - Aurora Central (Q2 2025)
Baseload - Aurora Central (Q2 2025)
Solar PV - Aurora Central (Q2 25)

1) Generation weighted uncurtailed prices for wind and solar assets.

Source: Aurora Energy Research

- Baseload prices are expected to peak in 2025 due to higher demand and gas volatility, then drop as RES expand and gas markets stabilise
- Capture prices will decline after 2030, especially for solar, however when compared with LCOEs, they provide investable returns in the long run

Onshore wind

- From 2031 onwards, wind capture prices are projected to decline by an average of 1% annually, following the baseload trend

Solar

- From 2031 to 2060, solar capture prices are anticipated to be, on average, 54% lower than baseload prices, surpassing wind due to higher capacities and increased synchronous solar generation, which leads to greater price cannibalisation

Until the mid-2040s, intraday volatility rises with RES growth, but later declines as flexible demand and storage enhance market stability

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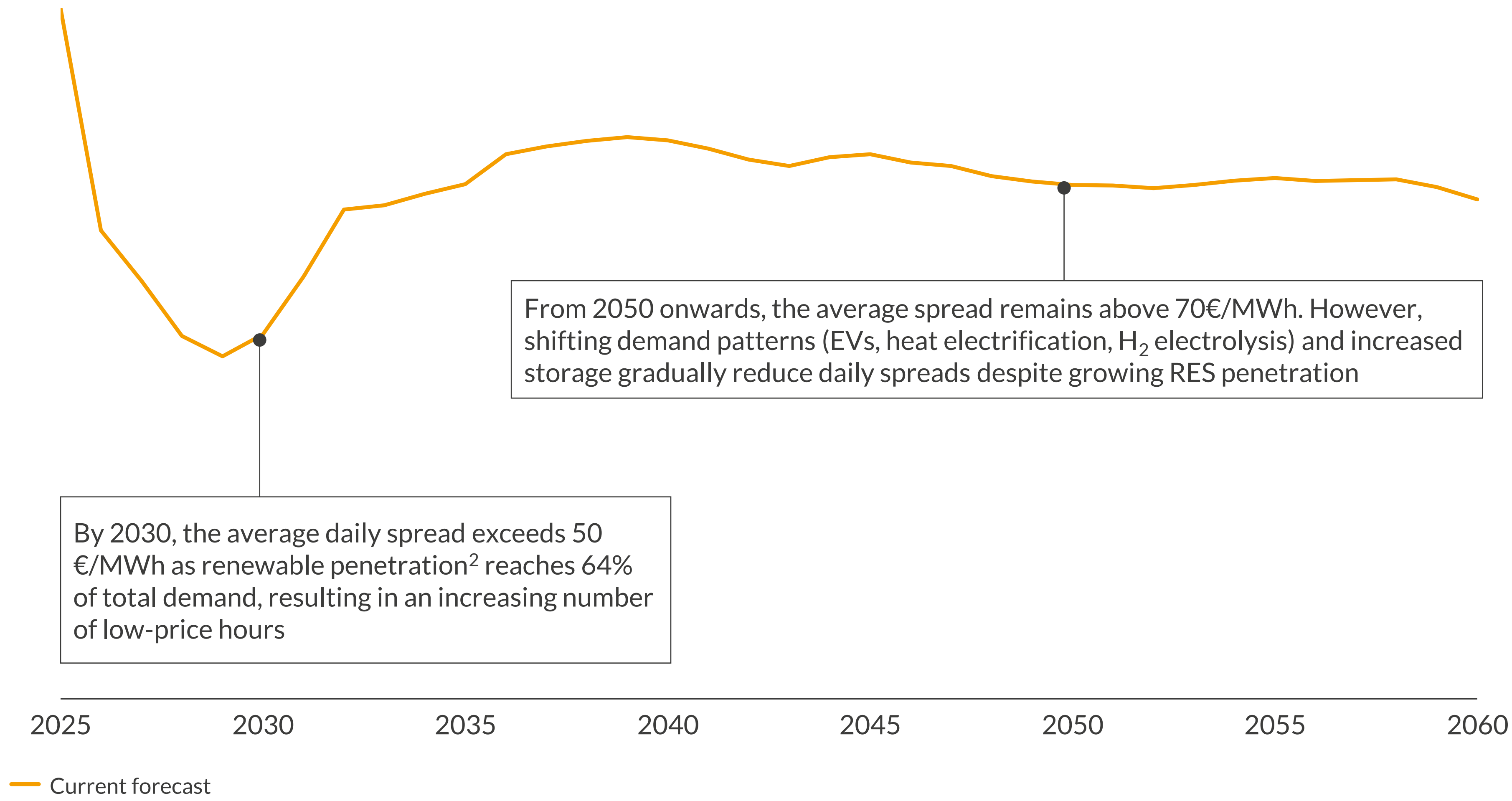
Average daily price spread[1]
€/MWh (real 2024)



- The average spread between the lowest and highest price during a day increases by 20% from 2026 to 2040
- This increase is mainly driven by high solar and wind output during low-demand periods lowers prices, while high demand and low renewables push prices up, with hydro and gas-fired plants setting prices amid higher gas and carbon costs
- After 2040, the average daily spread narrows as BESS, smart EVs, and H_2 electrolysers grow in capacity
- Recent Greek policy changes are also expected to boost BESS deployment in the short to mid-term, further influencing these dynamics

1) Average spread between the lowest and highest price during a day. 2) Includes Solar PV, wind (onshore and offshore), and hydro.

Source: Aurora Energy Research

Three types of solar and wind curtailement exist in Greece: economic self-curtailement, TSO imposed static and dynamic curtailment

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In Greece, three types of solar and wind curtailment take place:

A

Economic self-curtailment

Decided by the producer, at times when the wholesale price is lower than the plant's short-run marginal cost

TSO imposed curtailment

B

TSO static / horizontal curtailment

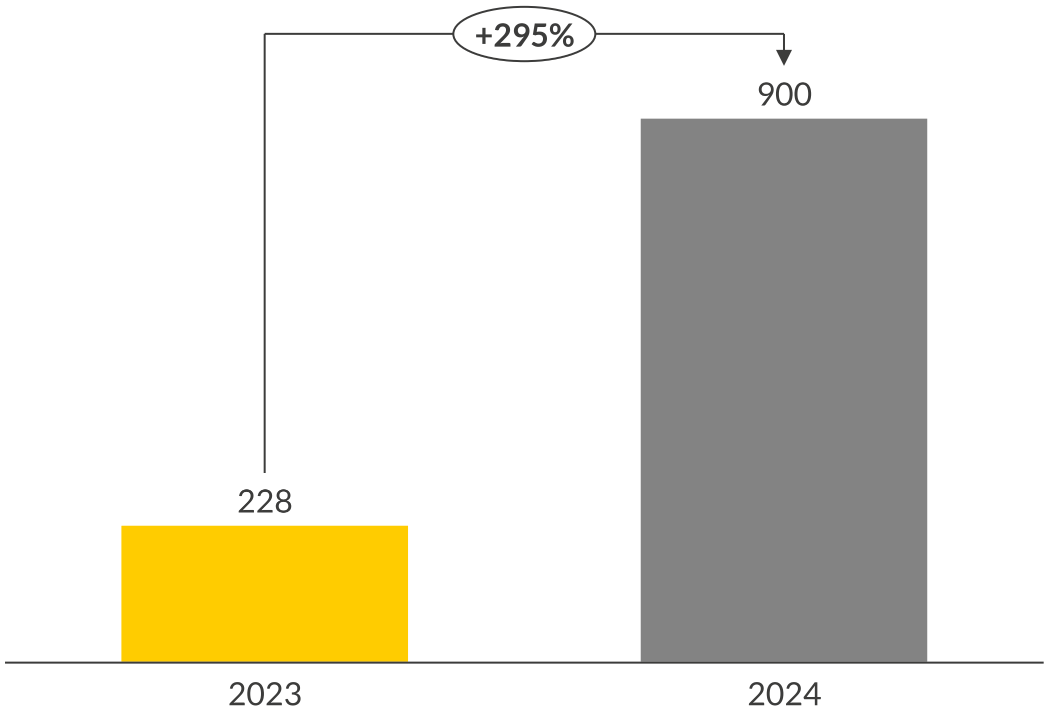
"Horizontal" RES curtailment only applicable to **newly build** plants and imposed by the TSO

C

TSO dynamic curtailment

Applied to all plants[1] and imposed by the TSO/DSO to manage local congestion events

Historical total RES curtailed volume in Greece[2]
GWh



- In 2024, RES curtailments in Greece were almost **4 times higher** compared to 2023, reaching **900 GWh**. This surge can be attributed to increased RES capacity, insufficient storage, and low demand periods. The Ministry of Environment and Energy is actively addressing this issue through regulatory refinements, future storage expansions, and grid upgrades to foster sustainable RES integration

1) From April 2024 (Law 5106/2024), the TSO may curtail any amount without compensating the producer. 2) Data from RAEEY's "Estimated Energy Surplus" tool which tracks RES surpluses in GRC using IPTO's ISP2 and ISP3 scenarios, with curtailed volume data from 18/01/2024 to 31/12/2024.
Sources: Aurora Energy Research, Law 4951/2022, Ministry of Environment and Energy, RAEEY, Media Sources

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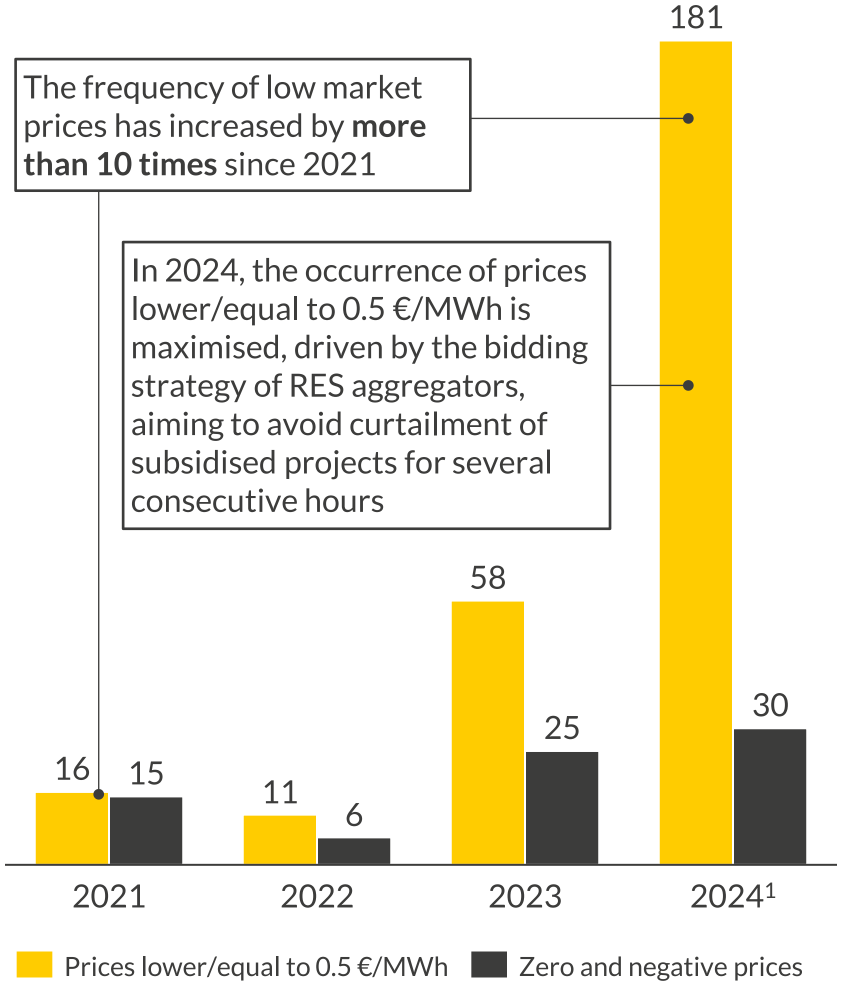
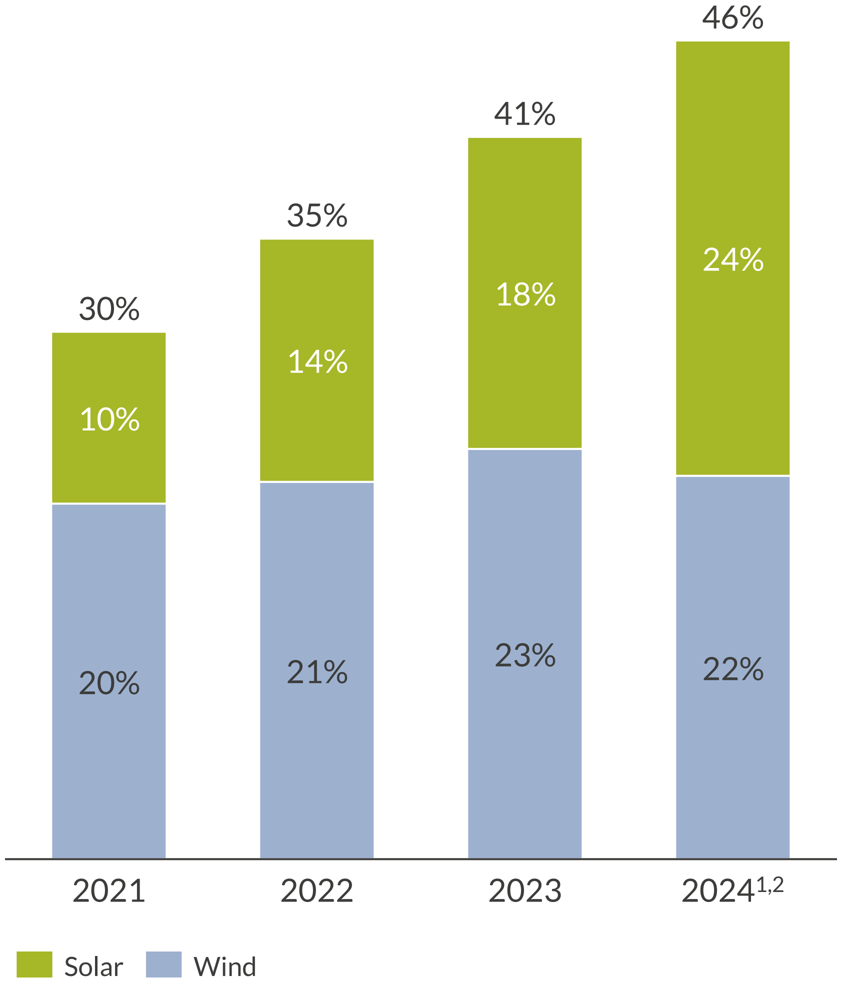
A Economic curtailment is driven by the occurrence of low price periods which rise with renewables' penetration in the system

Historical frequency of low day-ahead market prices in Greece Number of hours



Historical share of RES generation in the national generation mix %



Comments

- **Low market prices** (e.g. < 0.5 €/MWh) tend to appear with **increasingly higher frequency** since 2021, due to the significant growth of RES and/or the bidding strategy of RES aggregators
- In 2024, solar and wind generation accounts for **46%** of the national generation mix
- At the same time, according to the law **4414/2016**, subsidised RES, do not receive remuneration in case the day-ahead market price is **zero for 2 consecutive hours**
- In this respect, the occurrence of prices lower/equal to 0.5 €/MWh was maximised in 2024, driven by the bidding strategy of RES aggregators, which aim to avoid curtailment of subsidised projects for several consecutive hours

1) Data recorded until November 6th, 2024. 2) For 2024, data has been obtained from the ENTSO-e Transparency Platform, unlike previous years where Greece's energy mix has been sourced by DAPEEP's updated publications, up until 2023. Specifically, the data derives from the Actual Generation per Production section of the ENTSO-e platform.

Sources: Aurora Energy Research, DAPEEP, ENTSO-e

C The dynamic TSO curtailment is fundamentally driven by the topology and synchronisation of RES supply - power demand and the grid size

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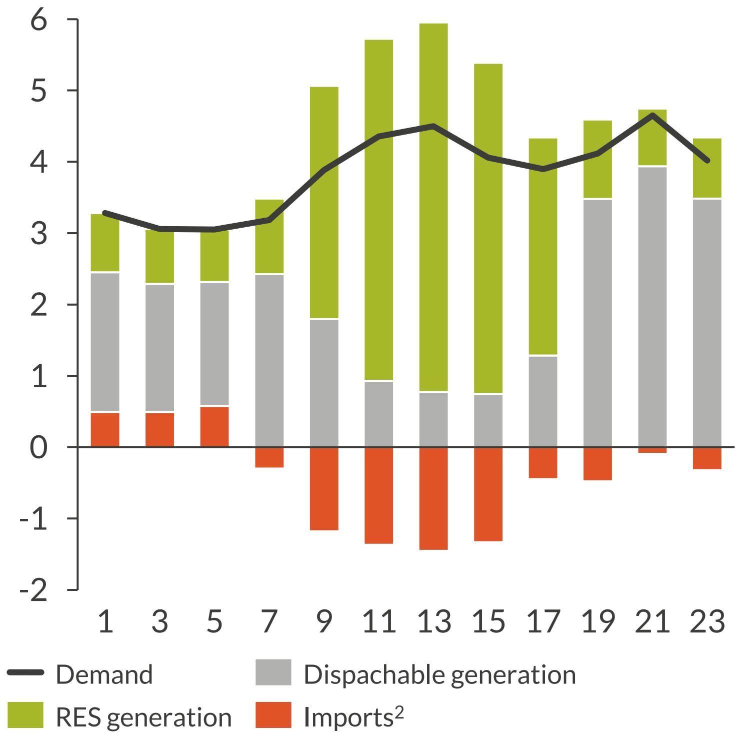
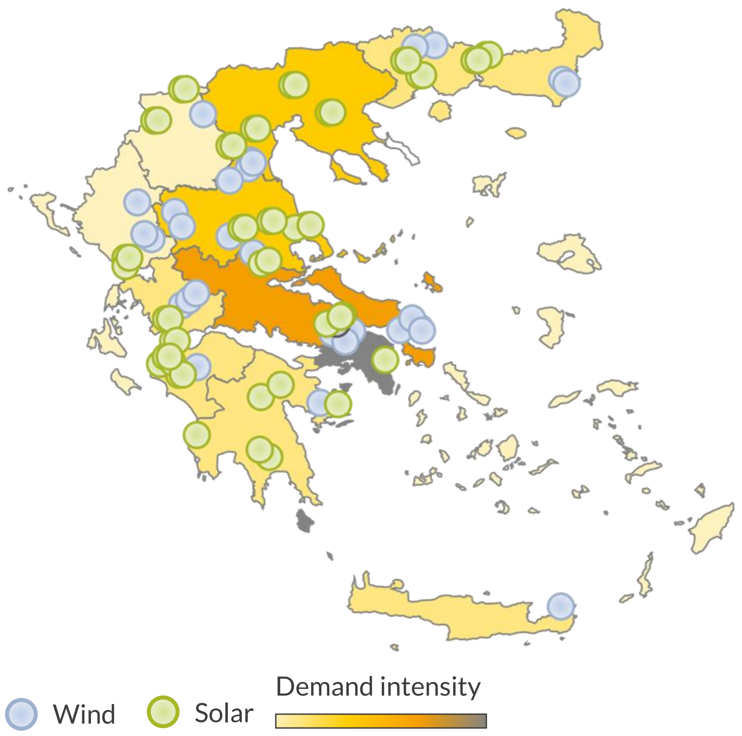
Hourly RES generation and power demand[1]
GWh



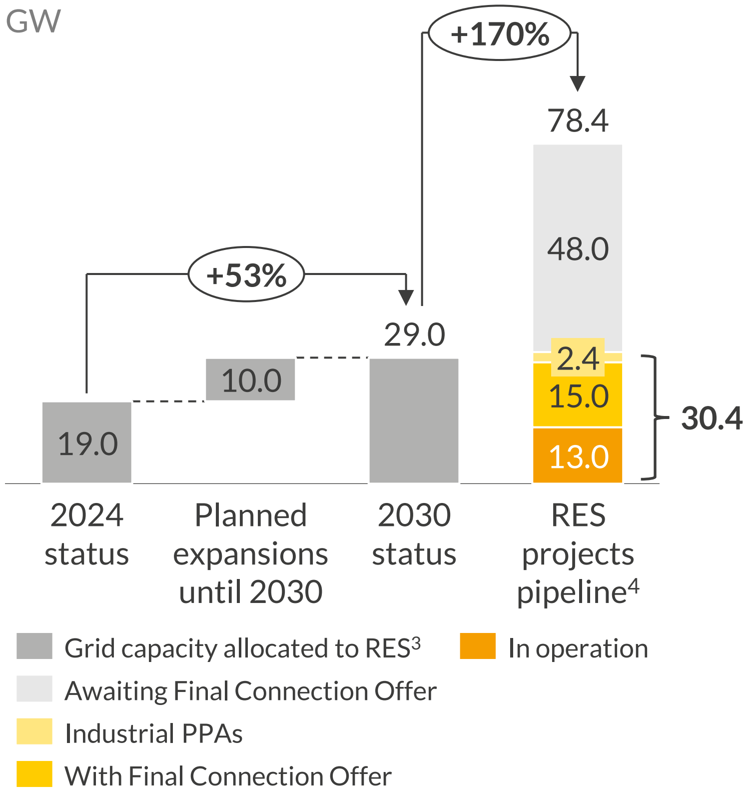
- The hourly RES generation does not follow the hourly demand profile in a synchronised manner, which can result in events of generation oversupply and deficit

Geographical distribution of RES capacity and total power demand[3]



- Power demand is distributed to regions with high population and enhanced industrial activity
- Power generation absorption from any demand center is dependent on the grid infrastructure's topology and size

Grid capacity and RES pipeline
GW



- By 2030, the **pipeline of operating and ready-to-build projects will exceed** the respective grid capacity of **29 GW** allocated to RES

1) RES generation and total power demand, recorded by the Regulatory Authority for Energy, on May 6th 2024. 2) From interconnected countries. 3) Power demand was computed based on the historical data and the population growth for each region. 3) As per September 2024. 4) Transmission and distribution.
Sources: Aurora Energy Research, RAE, IPTO, HEDNO, Earth Database

The roadmap for expanding BESS deployment focuses on auctions, grid access, business incentives, and fast-track licensing

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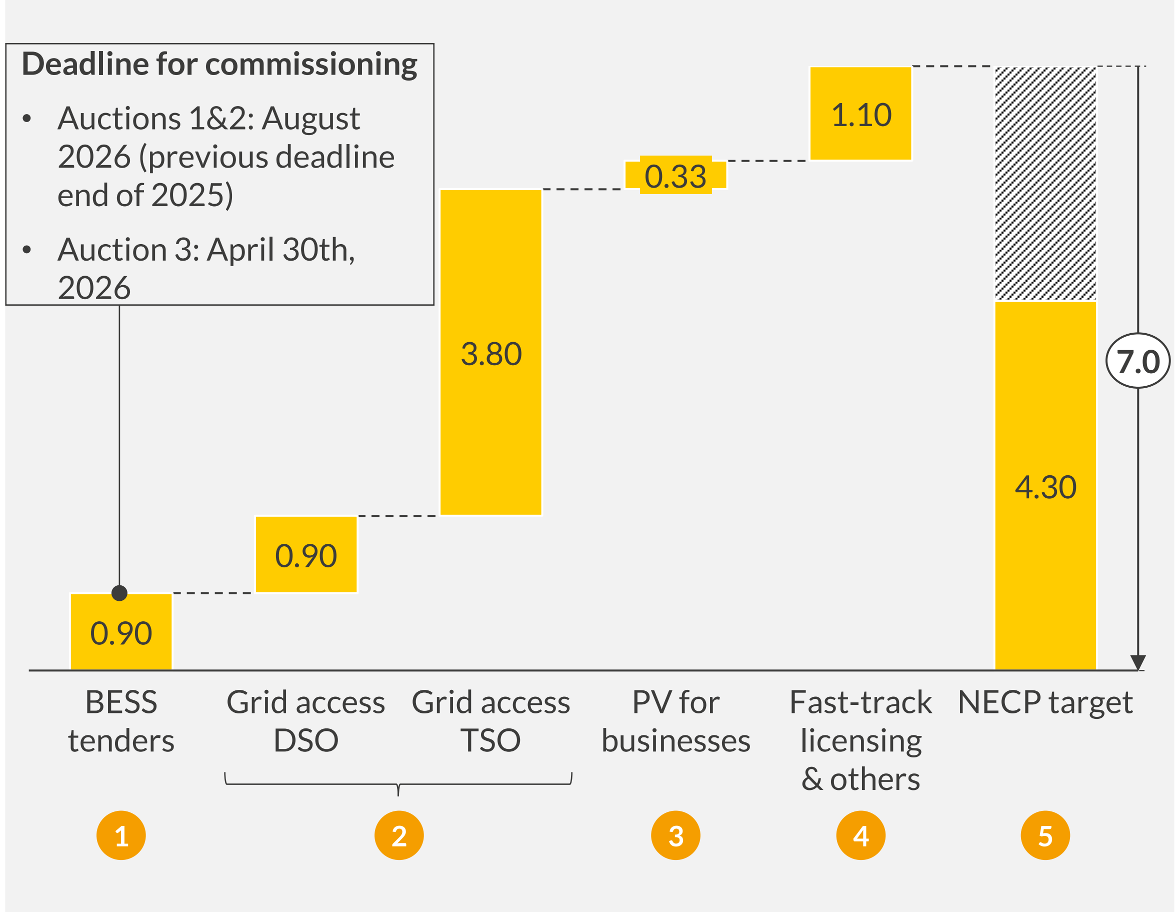
Potential breakdown of BESS capacity to achieve the 2030 NECP[1] target
GW



1. **Two tenders** completed **in 2024** awarded **700 MW of 2-hour standalone BESS**, with a 3rd set to allocate another **200 MW of 4-hour BESS** to be deployed in former lignite areas[2]
2. New regulations will enable **up to 4.7 GW of merchant BESS with easier licensing and priority grid access, without subsidies**[3]. The new law[5] **allocates** the capacity between the **TSO and DSO**, with **3.8 GW assigned to the TSO and 0.9 GW to the DSO**
3. Incentives will support the development of **at least 333 MW of BESS**, to be installed by commercial consumers **in co-location with solar PV systems**[4]
4. To meet the NECP 2030 target, **fast-track licensing** will prioritise access of **co-located** and **RES-integrated assets** to the grid, while also allowing Crete's **conventional fuel plants to convert their production licenses to BESS**. Additional support (e.g., Apollon program) and merchant BESS, will also be required
5. With the already concluded auctions and the announced grid connection licenses, the NECP target of 4.3 GW for 2030 has already been surpassed by 2.73 GW

1) Greek 2024 final NECP, published in January 2025. 2) Western Macedonia and Megalopolis. 3) Legal framework "Ρυθμίσεις για τον εκσυγχρονισμό της διαχείρισης αποβλήτων, τη βελτίωση του πλαισίου εξοικονόμησης ενέργειας, την ανάπτυξη των έργων ενέργειας και την αντιμετώπιση πολεοδομικών ζητημάτων". 4) "PV for businesses" program. 5) Law 1248/13.03.2025

Sources: Aurora Energy Research, Ministry of Environment and Energy, Greek 2024 final NECP, News

The range of merchant BESS IRR strongly depends on the asset's duration and entry year to the market; co-located projects are the most profitable

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Pre-taxed unlevered IRR of merchant standalone newly built BESS[1] %

COD[2]	BESS cycling pattern	IRR[3] 2h	IRR[3] 4h
2026	1 cycle/day		
2028	1 cycle/day		
	1.5 cycles/day		

- Entry in 2026 may lead to better IRR, driven by higher market prices
- RES-BESS co-located projects seem to be a highly attractive configuration for maximising profits
- It should be considered that even though co-located projects offer higher IRR potential, they are more expensive than standalone BESS, and riskier to finance solely through merchant trading

Pre-taxed unlevered IRR of newly built merchant RES-BESS co-located projects[1] %

COD[2]	BESS cycling pattern	IRR[3] 2h	Architecture[4]
2026	1 cycle/day		PV-BESS (DC / 11B)
			PV-BESS (DC / 11A)
2028	1 cycle/day		PV-BESS (DC / 11B)
			PV-BESS (AC / 11B)
			Wind-BESS (AC / 11B)
	1.5 cycles/day		PV-BESS (DC / 11B)

1) Based on Aurora's Central scenario. 2) Commercial operation date. 3) A repowering session is triggered, when the battery's health state reaches 63%. The asset's max. lifetime is reached when the battery's state of health drops to 63%, after the previously mentioned repowering event. 4) AC and DC co-located projects were simulated. For DC co-located projects, both 11A and 11B configurations were analyzed (Government gazette 4685/2020, article 10, paragraphs 11A and 11B).

Source: Aurora Energy Research

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