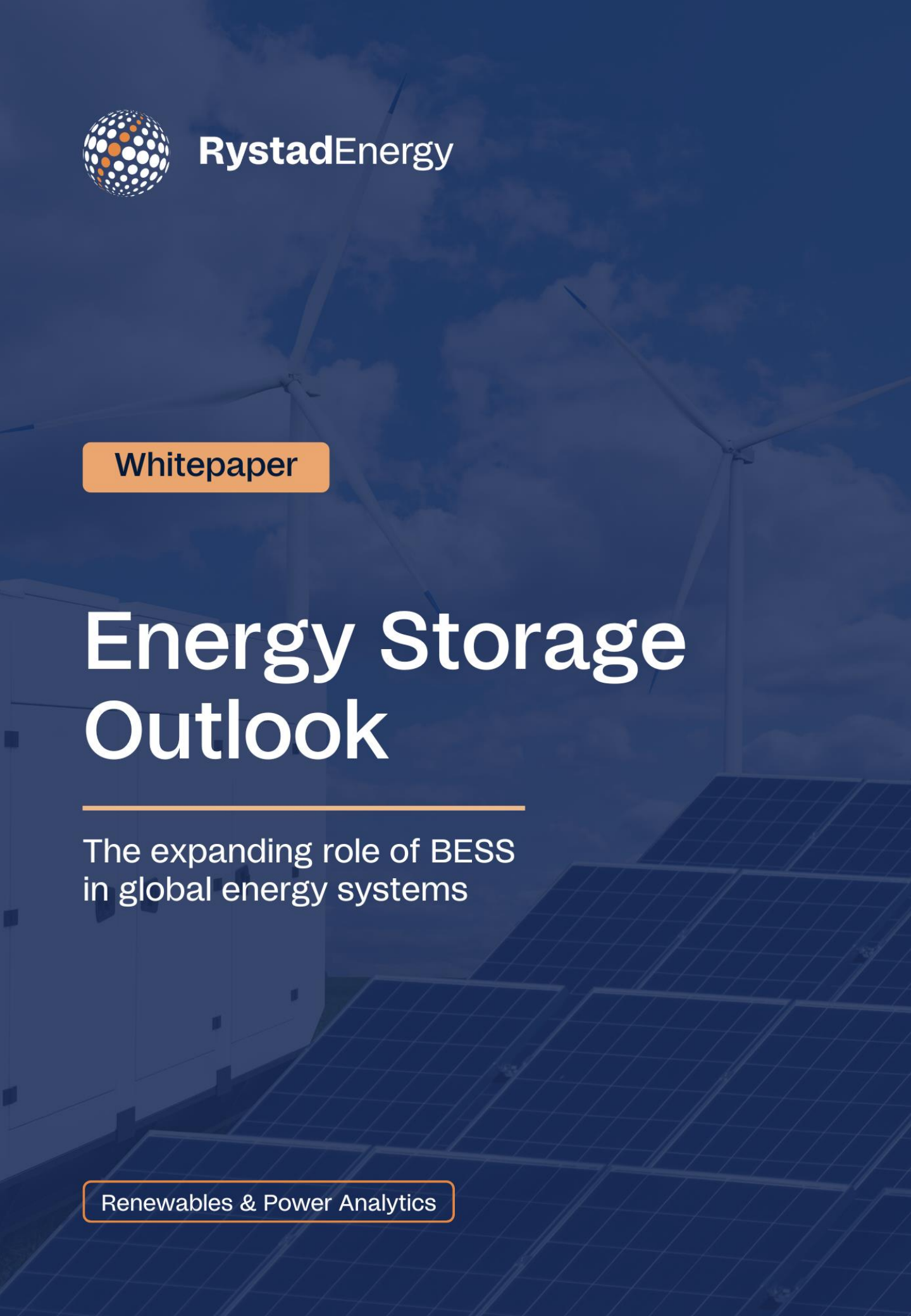


RystadEnergy

Whitepaper

Energy Storage Outlook

The expanding role of BESS in global energy systems

Renewables & Power Analytics

Battery energy storage systems enter 2026 with growing momentum

Last year marked a historic inflection point for battery energy storage systems (BESS). Global operational BESS capacity has surpassed 250 GW, overtaking pumped hydropower energy storage (PHES) for the first time. Annual additions exceeded 100 gigawatts (GW)/280 gigawatt-hours (GWh) in 2025 — nearly triple the volumes added in 2023 — reflecting a compound annual growth rate of over 100% between 2020 and 2025. This rapid expansion positions BESS among the fastest-growing energy technologies of the decade, driven by the urgent need for fast, flexible capacity to support power systems with rising renewable penetration.

Deployment momentum is expected to accelerate further in 2026. Global BESS additions are projected to exceed 130 GW/350 GWh, with established markets such as China, the US, the UK, Australia, and Germany continuing to lead. At the same time, emerging markets — including Italy, Saudi Arabia and the wider Middle East, Chile, and Eastern Europe — are becoming increasingly important to watch as policy frameworks, grid needs and project pipelines align.

Battery storage is no longer just enabling renewables — it is actively replacing gas generation. In 2025, battery generation in Victoria overtook gas-fired output for the first time, marking a major milestone for the Australian power system. Similar transitions are expected in New South Wales and Queensland in 2026. In California, batteries accounted for more than 20% of evening generation in April 2025 — a role previously dominated by gas plants as recently as 2020. These developments underscore the growing role of BESS as a core component of modern, clean, and flexible power systems.

Falling costs have been a key driver of deployment, though the pace of decline is set to moderate. In 2025, total turnkey BESS costs in China fell by around 15%, reaching levels as low as $150 per kilowatt-hour (kWh) and setting a global benchmark. Markets with strong exposure to Chinese suppliers benefited from this trend, accelerating installations worldwide. Looking ahead to 2026, however, the combination of export tax rebate reductions in China and recovering lithium prices signals a slowdown in cost deflation. Rebate changes could lift cell and container prices by around 6% per phase, while lithium price recovery may add a further 2–5% to system costs.

Battery storage is becoming economically viable across an expanding range of regions despite this price moderation. Continued technology improvements are extending system lifetimes beyond 20 years and more than 10,000 cycles. At a capital cost of around $200 per kWh, this translates into a levelized cost of storage of approximately $50 per MWh — or lower in favorable conditions. In regions with stable solar resources, co-located solar-plus-BESS projects are increasingly emerging as the most competitive source of new power generation.

Merchant revenue opportunities are drawing increased investor interest. In liberalized power markets, energy arbitrage and ancillary services revenues have proven sufficiently attractive to support standalone BESS investment. While emerging markets still offer largely untapped ancillary service opportunities, mature markets such as Australia, the UK, and California (CAISO) are seeing a shift in revenue composition, with energy shifting accounting for a rising share of total BESS revenues.

BESS picking up speed as solar slows

After several years of rapidly accelerating solar PV deployments, 2026 is expected to be the first year-over-year decline in annual additions since 2018. The main challenges in key markets currently revolve around reduced generation volumes due to curtailment and reduced capture prices of dispatched solar generation.

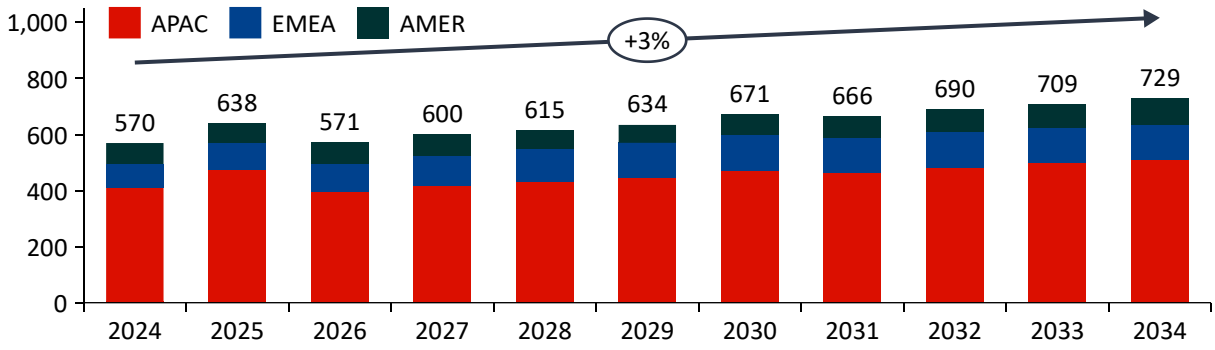
As a result, standalone solar PV projects are generally not considered financially viable in a lot of markets without additional measures such as hybridization with batteries, government-backed offtake schemes (including contracts-for-difference and feed-in premiums) or long-term corporate power purchase agreements.

The same difficult market conditions for solar PV are creating headwinds for BESS additions, which are now deemed a prerequisite for further solar build out in Australia, CAISO, and several markets across Europe.

This year is shaping up to be another record year for battery energy storage. Declining costs, continued technology milestones and growing policy support are accelerating deployment. As BESS increasingly provides the flexibility and resource adequacy needed to support renewable expansion, and as project pipelines continue to scale globally, battery storage is becoming economically viable across nearly all regions in 2026.

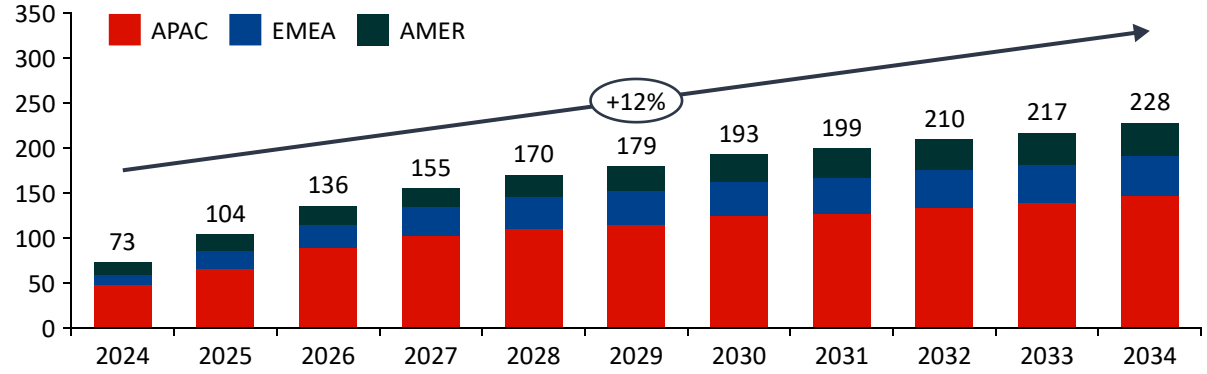
Global solar market gross addition outlook by region, 2024-2034

GW_{DC}



Global battery energy storage market gross addition outlook by region, 2024-2034

GW



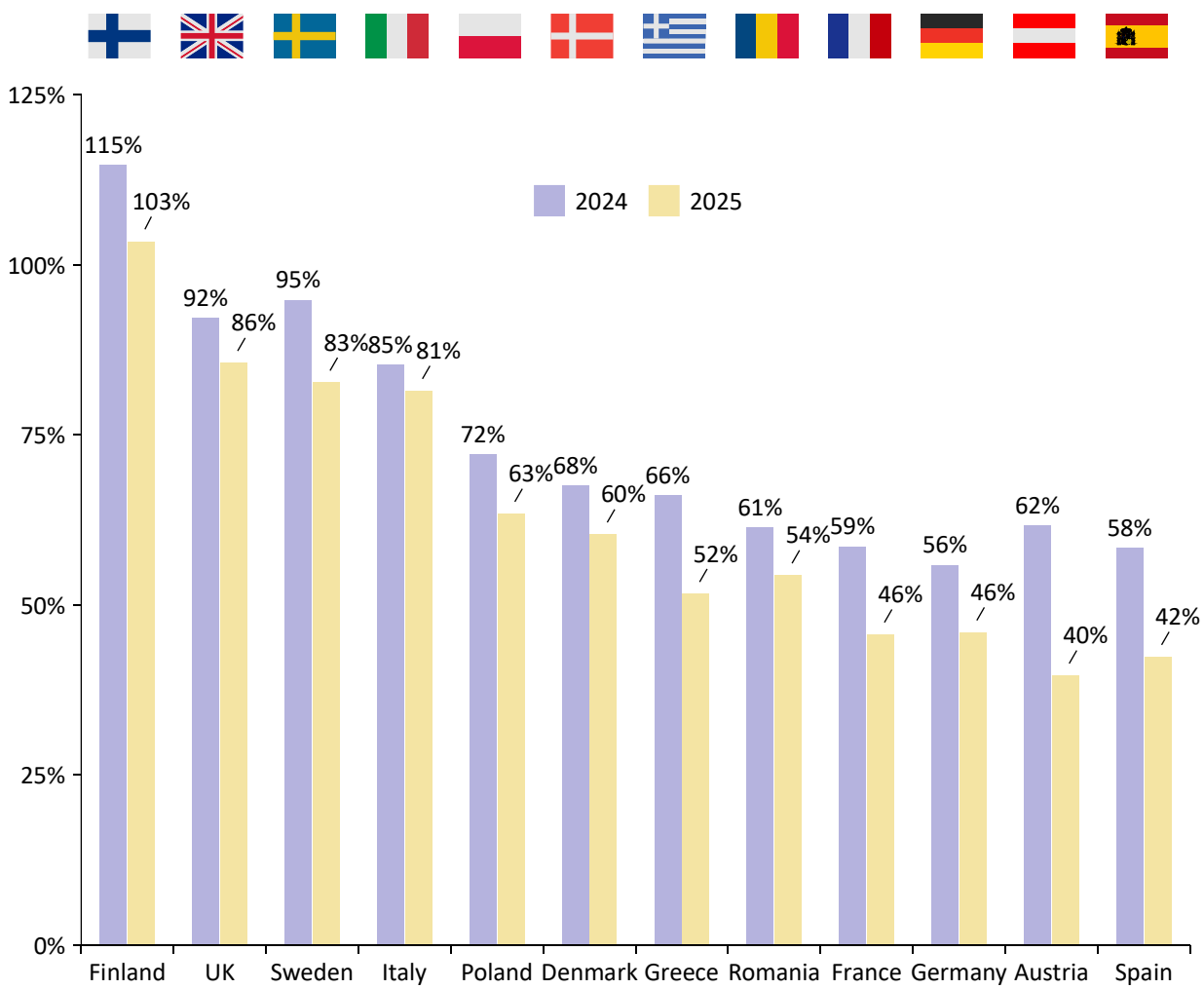
Source: Rystad Energy Solar Solution; Energy Storage Solution

European PV capture rates continued to decline in 2025

Average solar PV capture rates, the rate at which dispatched solar generation receives prices compared to the average market price, continued to decline in Europe in 2025. Averaged over the second and third quarters, when most solar generation occurs, solar projects in key markets like Spain, France, and Germany all received less than 40% of the market price for their power in 2025, down from around 60% during the same period in 2024. These markets are becoming increasingly difficult to enter with stand-alone solar PV without clear offtake agreements to secure revenue streams.

A few markets are however emerging as growth opportunities for solar PV, with Finland, the UK, and Italy all appearing resilient to cannibalization of solar PV capture rates as more capacity comes online.

Average solar PV capture rates in select European markets, 2Q-3Q 2024-2025
Percentage



Source: Rystad Energy Solar Solution; Europe Renewables & Power Solution

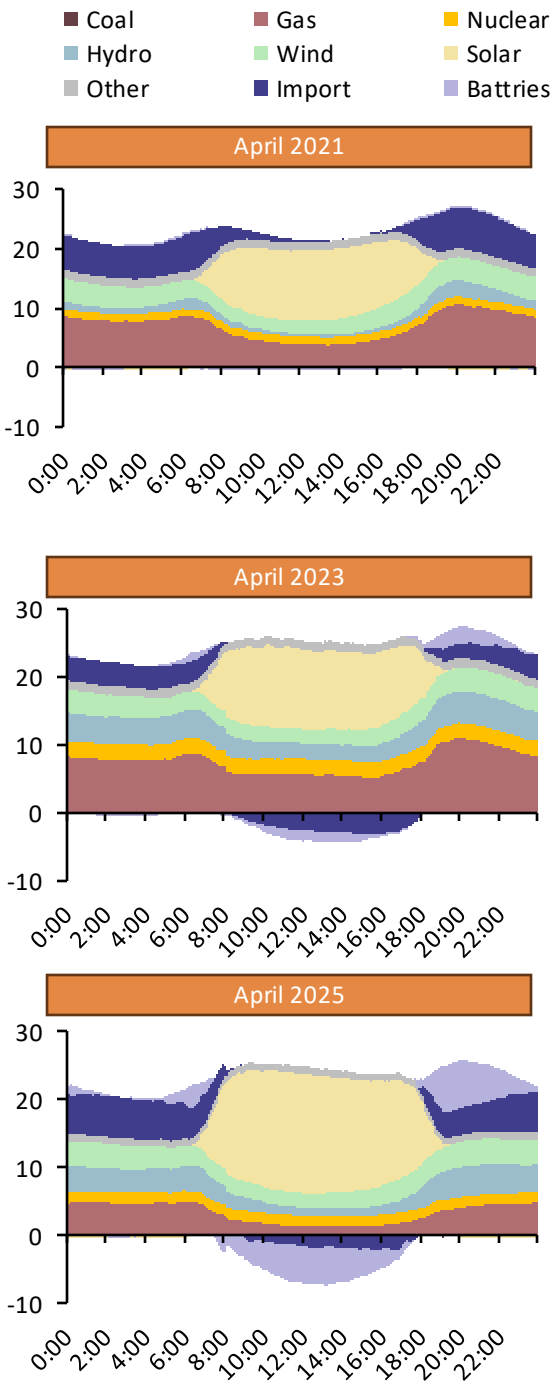
BESS extends California's renewable availability beyond daylight

California has been one of the earliest and most aggressive markets globally in integrating solar and other renewable resources into its generation mix. Large-scale solar PV deployments throughout the early 2020s fundamentally reshaped the CAISO supply stack, pushing renewable generation to dominate midday hours. However, this rapid solar buildout also amplified the system's reliance on gas-fired generation and imports from neighboring states to meet evening peak demand, a time when solar output declines sharply.

This dynamic began to shift materially from 2022 onward, as utility-scale BESS were deployed at scale and became operational across CAISO. Continued growth in solar capacity, combined with rising storage penetration, has altered both intraday power flows and the role of conventional generation. By 2023, CAISO increasingly transitioned into a net exporter during midday hours, reflecting structural solar oversupply rather than short-term variability. As battery installations reached multi-gigawatt scale, surplus midday solar generation has increasingly been absorbed by storage and redeployed during peak demand hours.

April as a sample month comparison over the years highlights this transformation. In April 2025 renewables (solar, wind, and hydropower) accounted for approximately 85% of total generation during afternoon hours, while batteries supplied around 24% of evening generation by shifting excess solar output from midday into peak periods. This shift has directly displaced gas-fired generation. On comparable days, evening gas output declined from roughly 10 GWh level in 2021 and 2023 to around 4 GWh by 2025. The data underscores a structural trend: battery storage is not only enabling higher solar penetration but is also eroding the traditional role of gas as the primary balancing and peaking resource in the CAISO grid.

Power generation in California by source
GWh



Source: Rystad Energy research and analysis, CAISO

Battery generation overtakes gas-fired power in Australia

Utility-scale batteries are no longer a complementary technology in Australia's power system — they are actively displacing gas generation across multiple states. Australia has emerged as one global proof point, alongside California, that large-scale battery energy storage can assume a central role in resource adequacy and peak supply in grids with high solar penetration.

Australia is one of the earliest and most advanced adopters of both renewable sources and battery energy storage. Across its three largest power markets, renewables and BESS now account for approximately 65%, 59%, and 70% of total capacity, respectively. While Australia already leads globally in rooftop solar and residential battery deployment, growth in utility-scale batteries has accelerated rapidly in recent years.

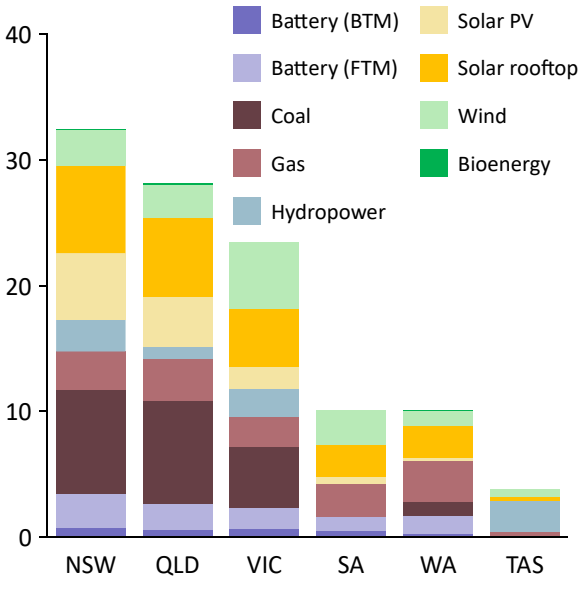
This shift reached a milestone in December 2025 in Victoria (VIC), where utility-scale battery generation surpassed combined gas generation from open-cycle (OC) and steam units for the first time. In New South Wales (NSW), battery output exceeded open-cycle gas generation, while in Queensland (QLD), utility-scale batteries also produced more electricity than open-cycle gas assets over the same period. These outcomes mark a structural change in the generation mix rather than a short-term operational anomaly.

Looking ahead, battery generation is expected to continue expanding across Australia, further eroding the traditional role of gas in providing peak capacity and system reliability. As utility-scale storage grows in parallel with solar capacity, batteries are increasingly fulfilling the flexibility and adequacy functions historically assigned to gas-fired generation.

This trend is not unique to Australia. Similar dynamics are likely to emerge in other regions where solar generation is relatively stable and predictable across seasons — including parts of the Middle East and Southern Europe. In these markets, solar paired with BESS is becoming cost-competitive for an expanding range of applications, while also freeing up gas for higher-value uses outside the power sector.

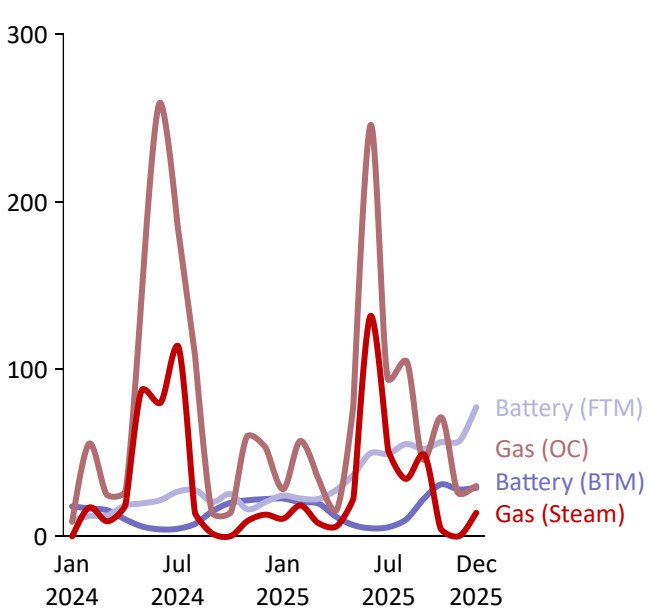
Power mix in Australia by state

GW



Gas and BESS generation in Victoria

GWh



Source: Rystad Energy Australia Renewables & Power Solution

The EU's deepening duck curve: A clear call for more BESS

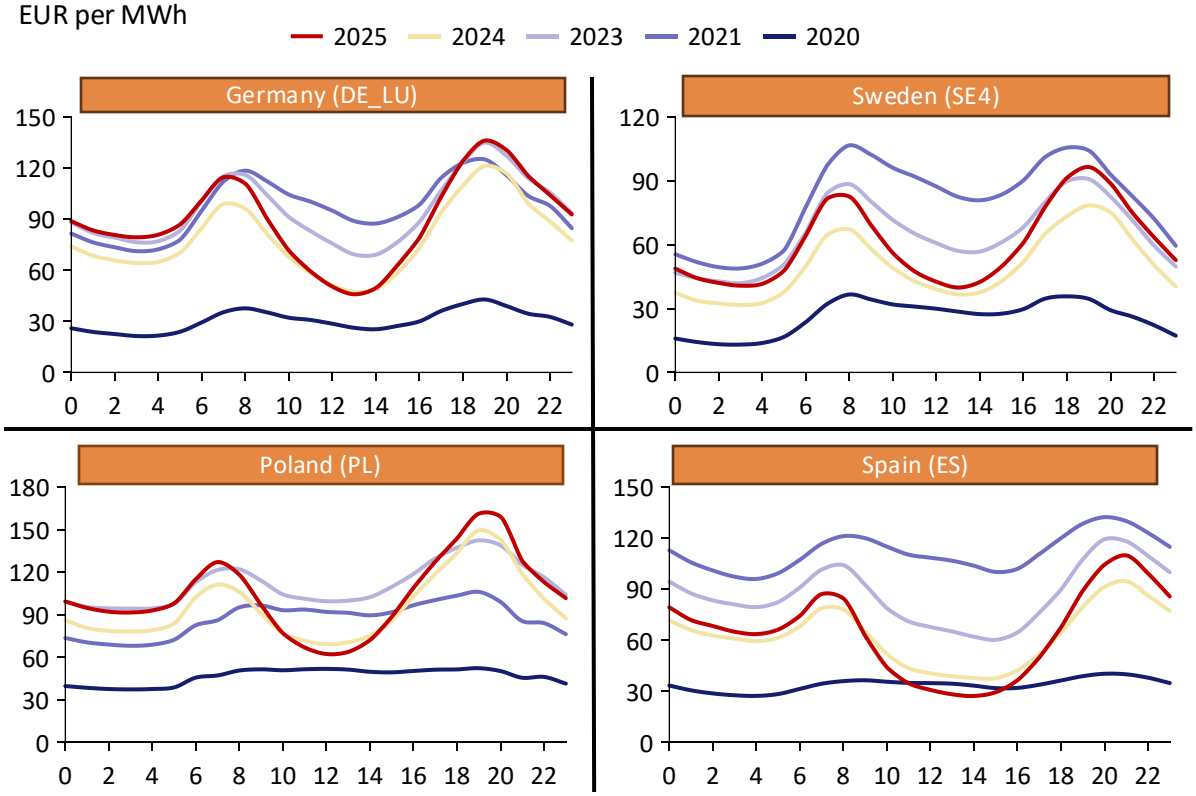
The "duck curve" is becoming increasingly pronounced across European power markets as solar generation expands. High midday solar output is pushing prices sharply lower, while declining solar generation and sustained demand in the evening are driving steep price increases. The deeper the midday trough and the higher the evening peak, the more pronounced the duck curve becomes.

Hourly spot price data from 2025 shows that intraday price swings have intensified across Europe, though the shape of the curve varies by market depending on generation mix, interconnection, and system flexibility. Germany recorded its deepest duck curve in five years, driven by limited flexibility and low midday solar capture rates, with coal and gas setting elevated evening prices. Poland shows a similar pattern, where rapid solar growth has depressed daytime prices while coal continues to drive higher prices at night. Spain presents a flatter, more extended profile, with lower prices sustained over several daytime hours and more moderate evening peaks. In Sweden, lower solar penetration and strong cross-border interconnections have helped limit intraday price volatility.

A deepening duck curve is not a system weakness but a signal of rising renewable penetration. Without sufficient flexibility, however, it increases price volatility, curtailment risk, and reliance on fossil fuels during peak periods. Battery energy storage offers a proven response. As seen in CAISO, batteries can absorb excess midday solar and discharge during evening peaks, smoothing intraday price swings. As Europe's duck curve deepens, the case for BESS strengthens — turning volatility into value while supporting a more resilient power system.

Yearly* average of hourly spot price in selected European power markets

EUR per MWh



2022 data has been excluded due to unusually high prices resulting from the energy crisis; however, the duck curve pattern is still observed in the markets.

Source: Rystad Energy Europe Renewables & Power solution

Chinese manufacturing continued to drive capex intensities down in 2025

Chinese solar PV module prices continued to decline over the course of 2025, helping to drive down solar PV project costs across most of the world. Chinese project costs remain significantly below that of most other regions, driven by inexpensive equipment and deployments happening at scale with record speed. Europe, the Middle East, and Africa are other regions that have benefited from declining Chinese equipment costs, cementing solar PV as the most competitive energy source for additions in these markets.

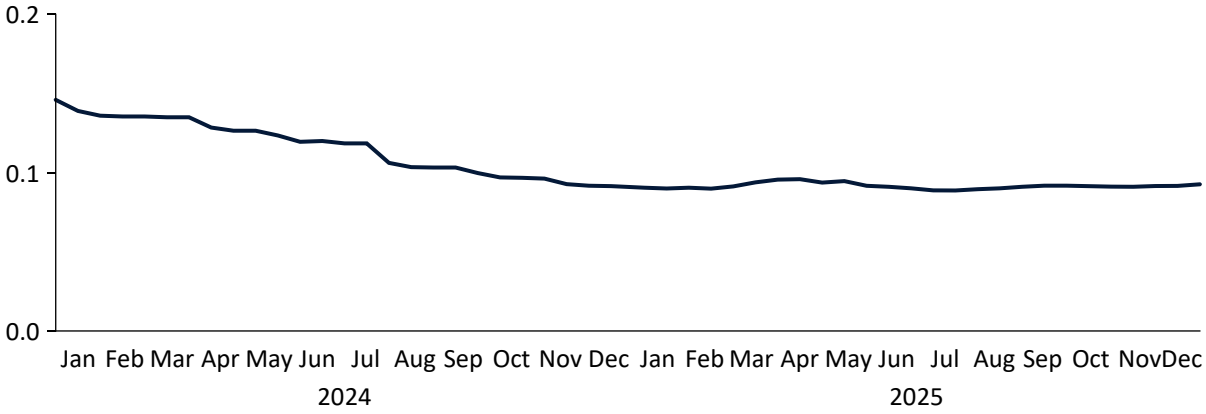
One market that has moved in the other direction is the US, which is essentially decoupled from Chinese equipment price trends.

The cost of utility scale solar PV varies across different markets, with ERCOT seeing the lowest costs in 2025. The high capital cost of solar PV projects in the US has so far been offset by tax credits.

The section 48 investment tax credit (ITC) is a 30% base credit with 10% additions allowing projects to offset up to 70% of capital costs if they meet all requirements. The credit has proven to be one of the most effective policy mechanisms for solar PV deployments in the country. Projects starting after 4 July this year will no longer be eligible for the ITC unless placed in service by 31 December 2027.

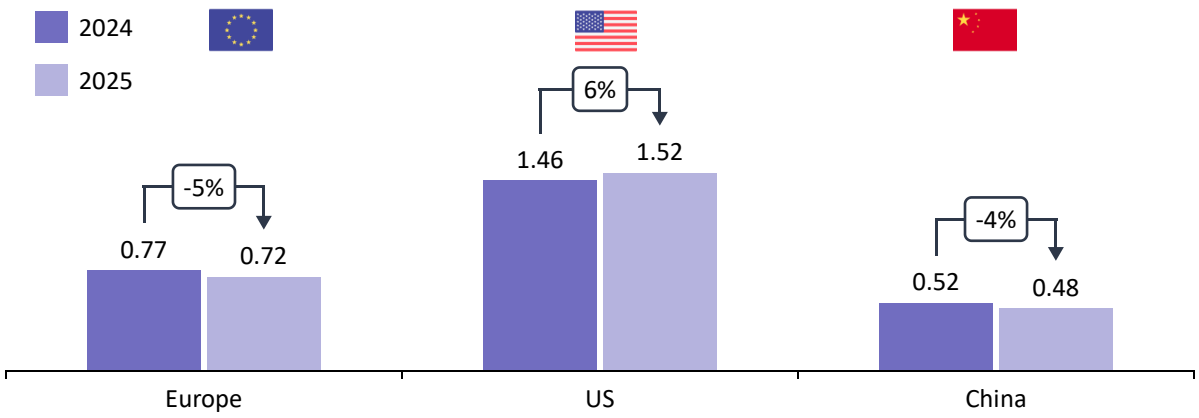
China's TOPCon module price trend 2024-2025

USD per watt-peak



Solar PV capex intensities in major markets, 2024-2025

USD per W_{AC}



Source: Rystad Energy Solar Solution

BESS costs continued downward trend in almost every market

Total turnkey costs for utility-scale BESS continued to decline in 2025 across most major markets, extending the downward trajectory observed in recent years. These reductions have been driven by incremental technology improvements, higher system energy density, manufacturing scale-up, and intensified competition across the supply chain. Looking beyond this global trend, however, regional costs increasingly diverge, shaped by differences in policy, trade exposure, local execution costs, and access to competitive equipment.

China remains the global cost benchmark. A highly competitive domestic market, combined with a mature and vertically integrated supply chain, has pushed utility-scale BESS costs to some of the lowest levels worldwide. In competitive tenders, turnkey installed costs for 4-hour lithium-ion systems in China have fallen to approximately $140–$160 per kWh in 2025.

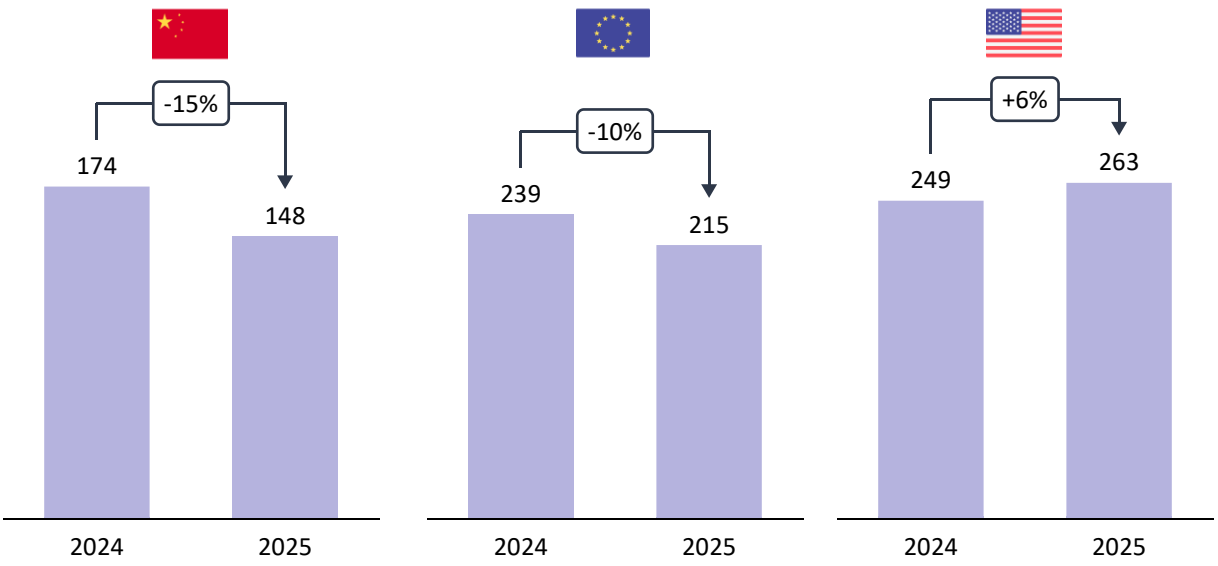
The influence of Chinese manufacturing extends well beyond its domestic market. Across much of the Asia-Pacific region, where Chinese suppliers dominate equipment sourcing, utility-scale BESS projects are frequently delivered at turnkey costs below $200 per kWh.

This highlights China's central role in shaping global storage economics and compressing costs in import-oriented markets.

Eastern Europe has also emerged as a competitive market for large-scale battery deployments. For example, a recently reported 400 MWh BESS project in Romania was delivered at an estimated turnkey cost of approximately €75 million, equivalent to roughly $170 per kWh. Across Europe more broadly, average installed costs for 4-hour utility-scale BESS projects declined materially in 2025 compared with 2024, reflecting continued global cost deflation. Average costs are estimated at around $215 per kWh in 2025, down from approximately $240 per kWh in 2024 — a reduction of roughly 10%.

In contrast, the US has moved in the opposite direction. New tariffs and trade-related policy measures introduced in 2025 have increased the cost of imported components and raised input costs for domestic manufacturing. These changes have translated into higher battery container pricing and elevated turnkey project capex. As a result, utility-scale BESS costs in the US now rank among the highest globally, typically exceeding $240–$260 per kWh.

Turnkey capital cost of a hybrid 4-hour utility-scale BESS in each market*
USD per kWh



* Battery cells (LFP) are imported from China
Source: Rystad Energy's Energy Storage Solution

Tax rebate changes and lithium recovery to impact prices in 2026

China remains the primary price-setter for global battery cell and BESS container costs, making visibility into Chinese cost trends and policy developments critical for understanding near-term price movements across all major storage markets. As China dominates lithium-iron-phosphate (LFP) cell supply and DC block manufacturing, even modest shifts in raw material pricing or policy affect global BESS economics.

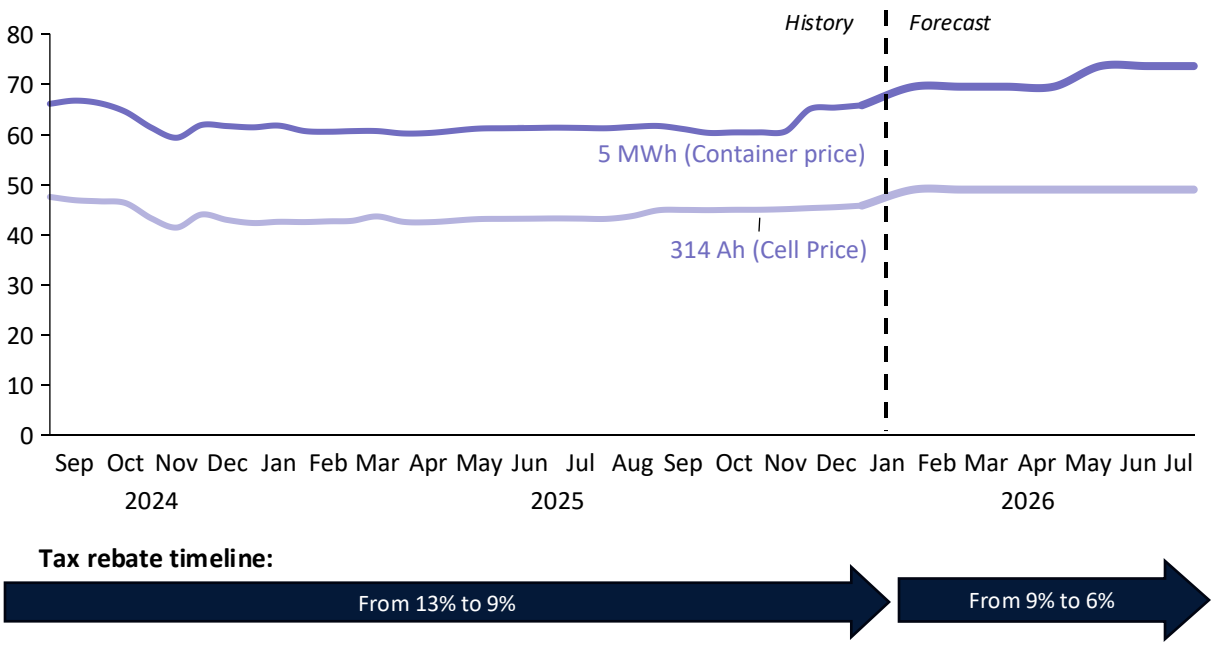
In the second half of 2025, lithium carbonate prices rebounded from the lows seen in 2024, driven by supply-side interventions such as mine output reductions, alongside stronger demand and short-term supply tightness. This recovery has started to lift LFP cell costs. At the same time, announced reductions in China's export tax rebate — from 13% to 9% by April 2026, and further to 6% through 2026 and complete removal in 2027 — introduce additional cost pressure and raise the question of how suppliers will respond.

Against this backdrop, a full pass-through of higher costs appears unlikely. The current market remains intensely competitive, and while profitability has improved, pricing power is unevenly distributed. Leading battery suppliers — particularly large, established OEMs — reported double-digit margins in 2025, giving them some room to absorb part of the rebate impact to defend market share. Smaller and more export-dependent players, by contrast, have far less flexibility.

The most probable outcome is therefore a partial cost pass-through. On balance, elimination of the rebate implies an increase in cell prices of roughly $4–7 per kWh, sufficient to lift average BESS container pricing in China toward around $75 per kWh, while keeping Chinese suppliers broadly competitive in global markets.

For projects outside China, these headline prices represent only a baseline. Shipping costs, trade tariffs, and import duties can materially alter delivered system costs, reinforcing the need for region-specific cost analysis when assessing procurement strategies and project economics.

Battery cell and DC block container price on spot market in China
USD per kWh



Source: Rystad Energy's Energy Storage Solution; Rystad Energy research and analysis

Solar + BESS: Increasingly competitive power source in EU

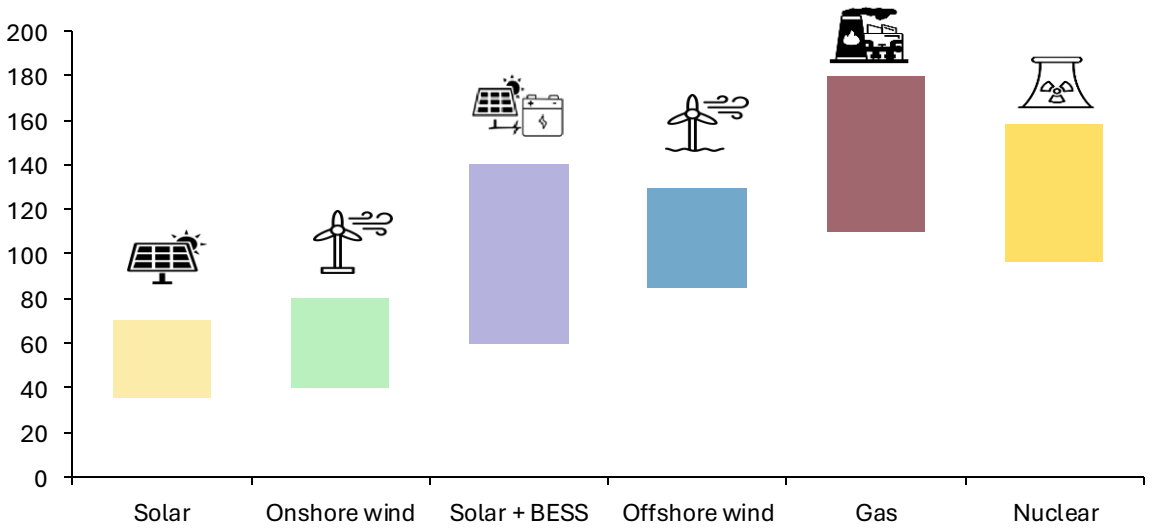
As demonstrated in Australia, utility-scale batteries are increasingly displacing gas-fired generation in the power mix. A key enabler of this shift is the continued decline in BESS project costs, which is improving the affordability of storage and making solar-plus-battery projects increasingly competitive on a levelized cost basis. Beyond cost, pairing solar with storage enhances flexibility and predictability — two attributes that are critical in high-renewables power systems.

In Europe, standalone solar PV remains the lowest-cost source of new electricity generation in many regions, with levelized cost of energy (LCOE) falling to as low as €38 per MWh for projects with strong solar resources. Onshore wind typically follows as the next most competitive option. Solar paired with battery storage ranks slightly higher on a pure LCOE basis but delivers materially greater system value by shifting generation to higher-price periods and reducing exposure to price cannibalization and curtailment. As a result, solar-plus-BESS offers a more reliable and dispatchable supply profile than standalone solar or wind.

When compared with conventional generation, particularly gas-fired power, solar-plus-BESS is increasingly emerging as the most competitive option for greenfield projects across large parts of Europe. While gas and nuclear generation often appear comparable in LCOE ranges — largely due to assumptions around fuel prices, carbon costs, and utilization — these technologies play fundamentally different roles in the system. Gas provides dispatchable capacity, but its economics are highly sensitive to fuel and carbon price volatility. Solar-plus-BESS, by contrast, offers fixed-cost generation with growing flexibility at declining capital costs.

That said, technology comparisons must be interpreted within a regional context. LCOE ranges reflect variation in solar capacity factors, labor and construction costs, carbon pricing, and operating assumptions. In regions with weaker solar resources or limited flexibility needs, gas may remain the more economic option for meeting baseload demand. However, in markets with strong solar profiles and increasing renewable penetration, solar-plus-BESS is rapidly becoming the lowest-cost pathway to both energy supply and system flexibility — reducing reliance on gas while supporting grid stability.

Comparison of LCOE values* to other relevant energy sources
EUR per MWh



*Intervals estimated based on European projects for solar, wind and gas with indicative value ranges for low/high cases. All LCOEs are given in EUR per MWh adjusted to 2025 real values
Source: Rystad Energy Power Macro Solution; Energy Storage Solution

BESS could help solve solar energy's cannibalization problem

One of the key challenges facing utility-scale solar PV in 2025 — and one that is expected to persist into 2026 — is the growing cannibalization effect. As solar penetration increases, periods of concentrated midday generation are increasingly depressing prices, eroding capture rates and weakening the financial performance of standalone solar projects. This dynamic is already slowing the pace of new solar capacity additions in several mature markets.

Co-locating solar PV with battery energy storage offers a clear pathway to mitigate this impact by shifting generation from low-price periods to higher-value hours and reducing curtailment. Our analysis of a standalone solar project in Germany operating throughout 2024 illustrates the effect.

Adding a 2-hour battery would have increased the solar capture rate from approximately 59% to 98%, while a 4-hour system lifts the capture rate further, to around 128%. However, higher capture rates do not automatically translate into proportionally higher returns.

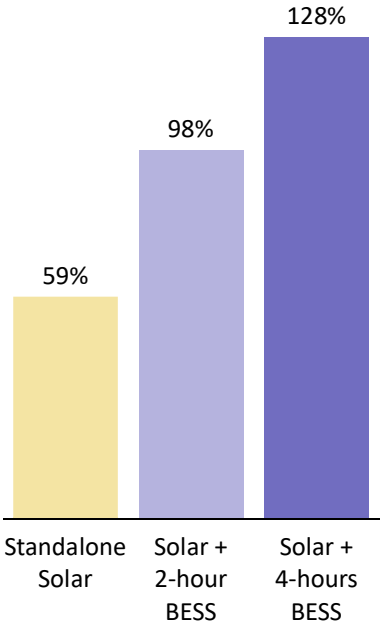
In scenarios where battery revenues are limited to energy shifting — without participation in ancillary services — the additional capital investment materially increases project costs.

In this case, the levelized cost of energy (LCOE) rises from roughly €60 per MWh for standalone solar to approximately €96 per MWh for 2-hour and €125 per MWh for 4-hour solar-plus-storage configurations.

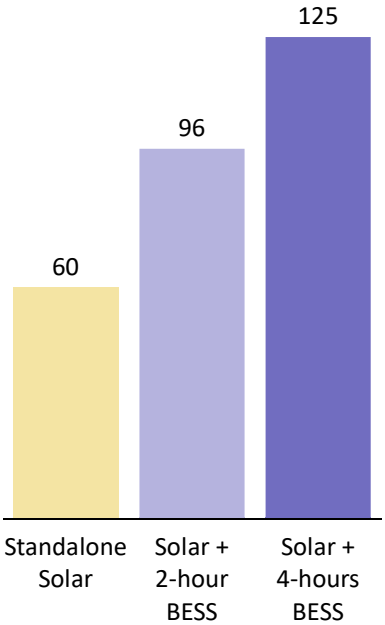
This cost-return dynamic helps explain why most battery additions in Europe to date have been standalone systems. These assets can be strategically located and achieve double-digit returns by stacking energy arbitrage with lucrative ancillary service revenues.

That said, from a solar operator's perspective, a hybrid approach remains compelling. Investing in a 2-hour co-located battery and enabling revenue stacking can offer the best of both worlds — mitigating solar cannibalization while unlocking additional value from ancillary services.

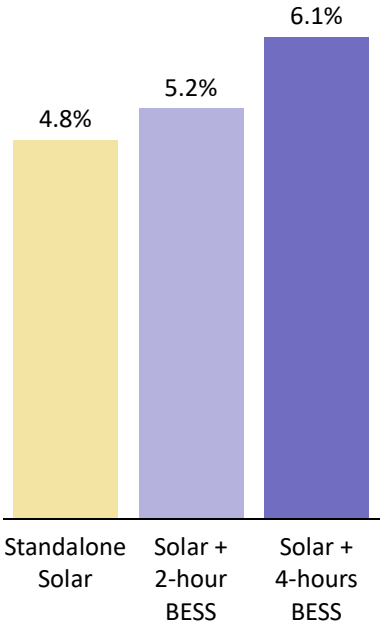
Hybrid system yearly capture rate
Percent



Hybrid system LCOE comparison
EUR per MWh



Hybrid system IRR comparison
Percent



Capture rate calculated as volume-weighted percent of yearly average spot prices the asset would receive if fully exposed to the spot market; assumes BESS only charges from the solar asset
Source: Rystad Energy Europe Renewables & Power solution, ENTSOe

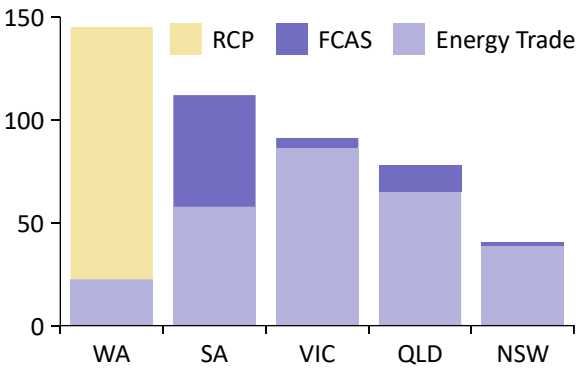
Energy revenue leads BESS earnings in Australia

By late 2025, energy trading had firmly established itself as the primary revenue driver for battery energy storage systems in Australia. During the fourth quarter of the year (1 September to 30 November), energy arbitrage accounted for close to 90% of total BESS revenues — a stark shift from the revenue mix observed in 2021, when batteries relied far more heavily on ancillary and capacity-style revenues.

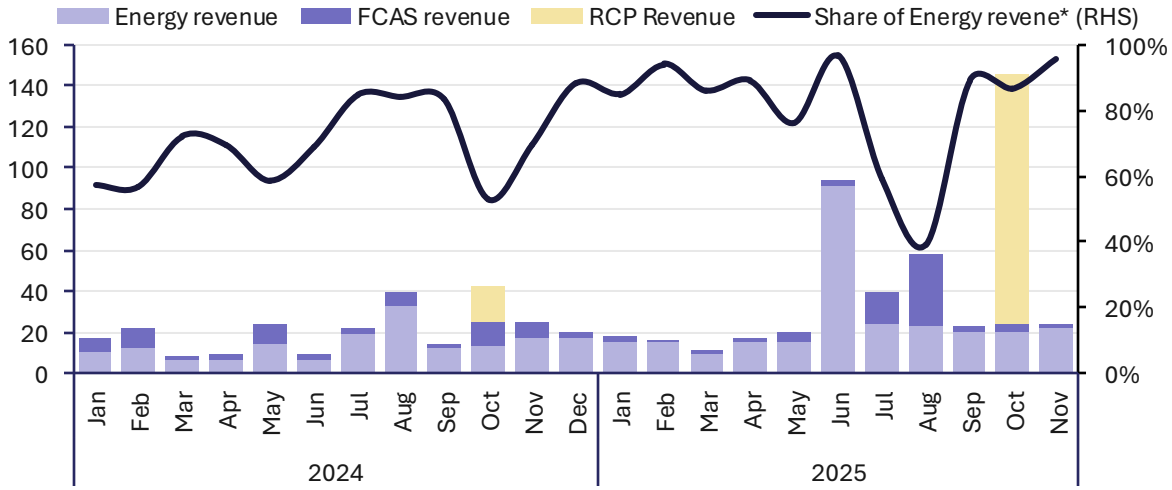
This transformation is most evident in the National Electricity Market (NEM), particularly in Victoria, Queensland, and New South Wales, where the majority of Australia's utility-scale batteries are deployed. These markets exhibit some of the highest levels of intraday price volatility globally, creating strong and recurring price signals for batteries to charge during low-priced periods and discharge into evening peaks. As a result, arbitrage has become the cornerstone of BESS revenue strategies across the NEM.

Western Australia presents a contrasting but equally instructive case. In 2025, battery capacity revenues in the Wholesale Electricity Market (WEM) increased significantly, supported by a near doubling of the Reserve Capacity Price and stronger capacity credit allocations. These changes reflect the growing recognition of batteries as highly reliable resources during peak demand, elevating capacity payments to a much more prominent share of total BESS revenues in the state.

Total BESS revenue in 2025**
AUD millions



BESS revenue by source in Australia's National Electricity Market
AUD millions



*Excluding the capacity payment revenues (RCP) **By end November 2025
Source: Rystad Energy's Energy Storage Solution; Renewables & Power Australia Regional Solution

Top 20 most volatile power markets in 2025

Intraday price volatility varied widely across global power markets in 2025, reflecting differences in generation mix, system flexibility, and exposure to supply-side disruptions. Based on 1-hour intraday spreads, the most volatile markets highlight where price signals are strongest and where energy arbitrage opportunities for utility-scale batteries are most pronounced.

Among the top-ranked markets, the Philippines stands out as the most volatile in 2025. This was driven in part by extreme price outcomes, including episodes of deeply negative prices reaching close to –€1,000 per MWh.

Australia features prominently across the ranking, with four of its power markets appearing among the top five most volatile globally.

In many cases, volatility was driven by persistently high power prices combined with system stress during evening peak hours. Unplanned coal outages tightened supply precisely when solar output declined, amplifying peak pricing and widening intraday spreads.

In Europe, Bulgaria, Romania, and Hungary emerge as one of the more volatile markets. As in several other European systems, volatility is increasingly shaped by the interaction between growing intermittent renewable generation and relatively inflexible baseload capacity. When solar or wind output drops sharply, limited short-term flexibility can result in rapid price escalation, even within a single day.

Average price volatility in 2025

Country	Bidding zone	Price volatility (1-hour intraday spreads) USD per MWh	Year-on-year change* Percentage
Philippines	Visayas	335	40.1 %
Australia	NSW	296	-29.5 %
Australia	SA	261	-31.9 %
Australia	QLD	190	-38.4 %
Australia	VIC	180	-12.9 %
Bulgaria	BG	159	-3.3 %
Romania	RO	158	-26 %
Hungary	HU	157	-7.57 %
Philippines	Mindanao	156	4.16 %
Greece	GR	154	-6.34 %
Lithuania	LT	151	-9.06 %
Latvia	LV	151	-11.8 %
Estonia	EE	150	-8.85 %
Croatia	HR	141	-10.3 %
Serbia	RS	137	-0.853 %
Slovakia	SK	137	-29.4 %
Slovenia	SL	137	-62.9 %
Poland	PL	136	-9.84 %
Philippines	Luzon	133	-66.1 %
Japan	Hokkaido	131	-9.8 %

*YOY is comparing the total potential income of the period from 1 January to 30 November in 2024 vs. 2025
Source: Rystad Energy's Energy Storage Solution

German power prices to face moderate decline over next decade

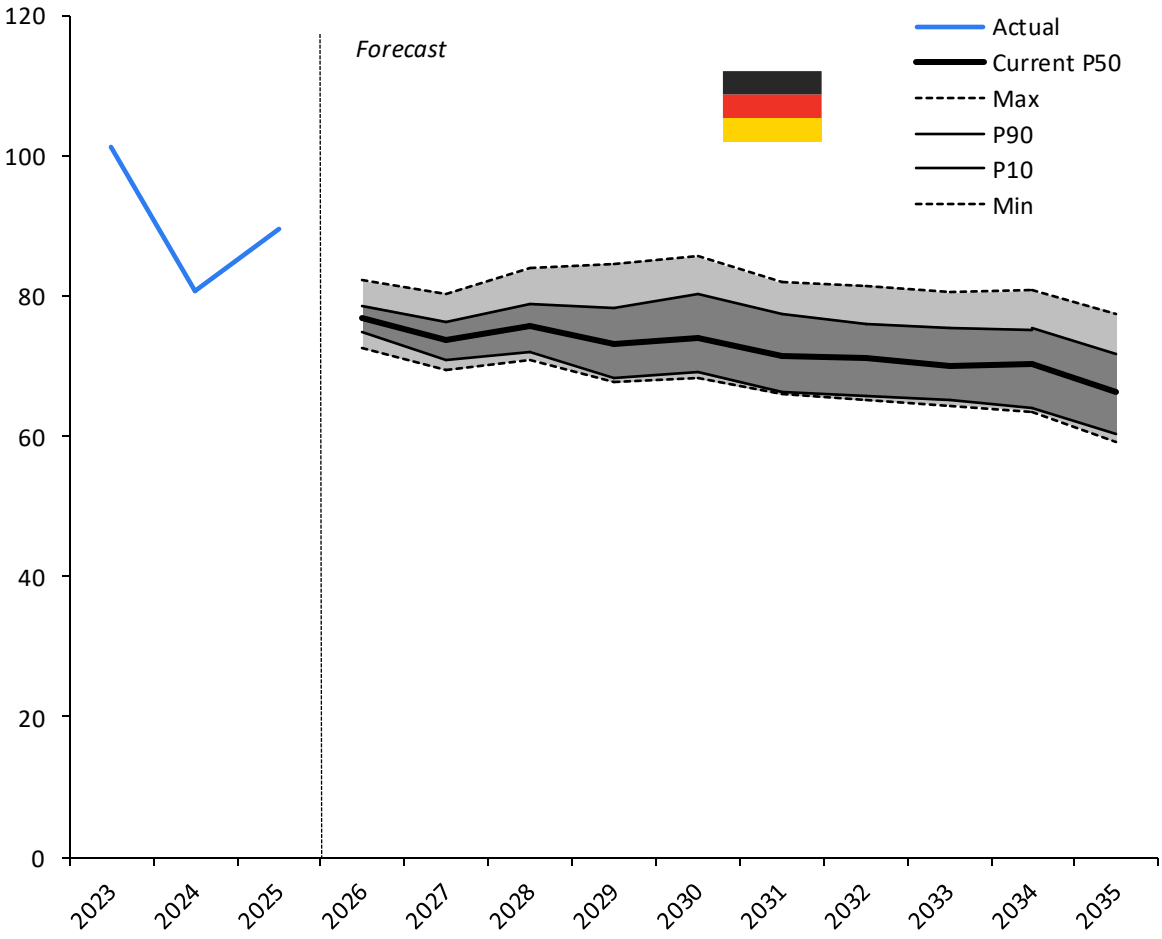
Rystad Energy recently published the first version of its Europe Power Price Forecast Report, detailing our forecast for price trends over the next decade. The forecast is built in an hour-by-hour track model, run across 30 weather scenarios, allowing for statistical analysis of the price data, as displayed in the chart below. The forecast includes 20 European bidding zones, from 2026 to 2050. Here we consider prices in Germany for the next decade, in yearly and monthly resolution.

Average German power prices increased in 2025 relative to 2024, but Rystad Energy expects prices to decline throughout the whole forecast period. We expect prices to already show a solid decline in 2026 relative to 2025, and that prices will move from the €80 per MWh range to the €65-70 range over the next decade.

The downward pressure on prices is caused mainly by a rapid increase in renewables in the power mix, combined with relatively stable fuel prices after 2030. Onshore wind, in particular, is expected to see very strong growth in Germany over the next year, after very high auction volumes over the last few years.

There is higher upside than downside risk around the p50 scenario, as extreme weather events are likely to cause more extreme price movement to the upside compared to the downside.

Yearly price forecast Germany*
Euros per MWh, real 2025



Source: Rystad Energy Power Solution; Volt Power Analytics

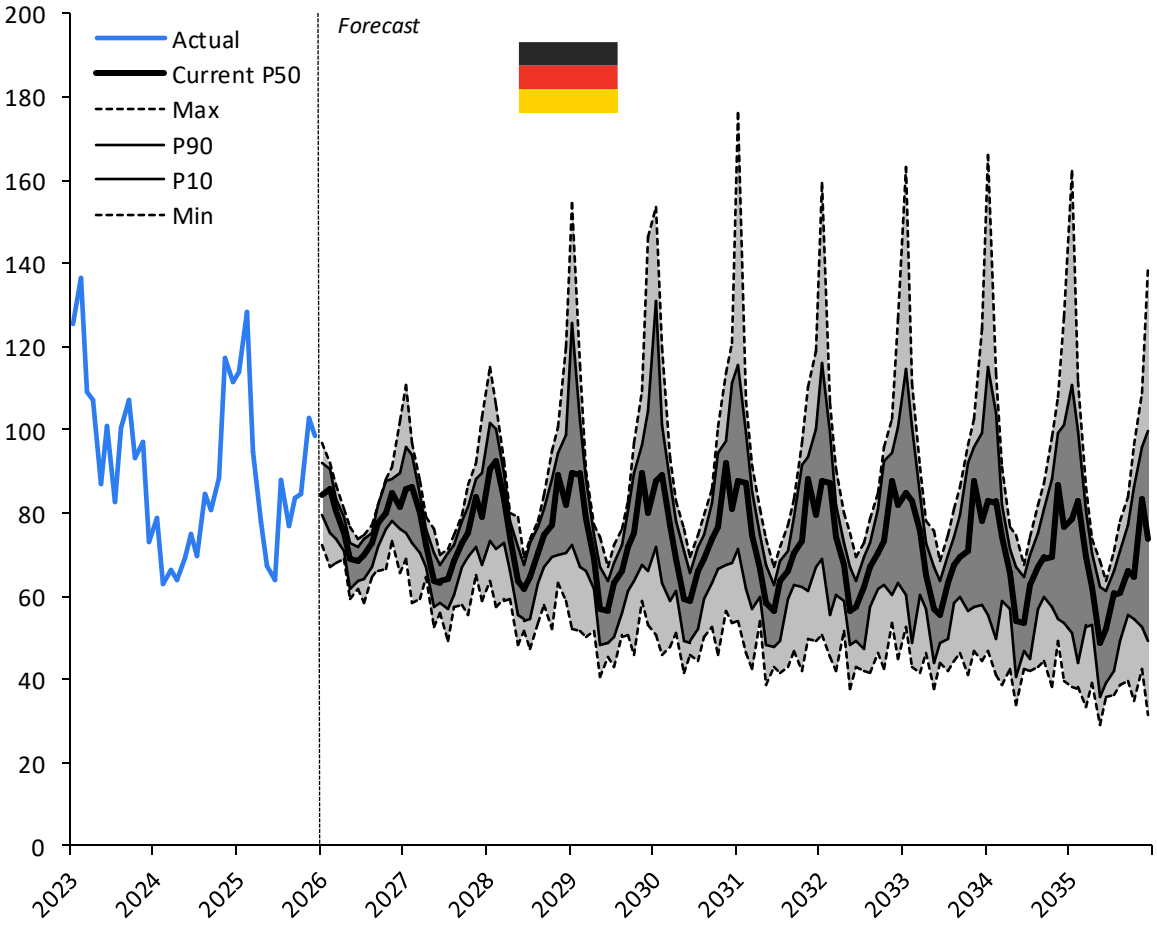
Price volatility to increase despite declining power prices

With the monthly resolution to the price forecast from the previous page, we can clearly see that the "high winter – low summer" price regime is expected to continue in our forecast. Even if average power prices are declining in the p50 scenario, the volatility is increasing, especially the upside risk during the winter.

In the Max scenario, corresponding to the weather scenario that generates the highest prices, prices reach above €160 per MWh each winter period after 2029, almost every single year. The downside risk in summer is limited to around €20-30 per MWh after 2030, a price level many other European countries have already reached in the summer. Many other European countries are expected to have prices much lower than €20-30 per MWh in the summer months, especially in the Min scenario, highlighting that Germany will continue to pay a premium for power compared to some peers.

In our base case forecast, Germany is set to have a relatively high fossil fuel reliance for longer than other European markets. Germany also has tighter coupling to Poland and other Central and Eastern European power markets, with exposure to fossil fuels, resulting in sustained higher prices for longer in Germany, compared to France and the Nordics and the UK.

Yearly price forecast Germany*
Euros per MWh, real 2025



Source: Rystad Energy Power Solution; Volt Power Analytics

Investment insights: BESS arbitrage opportunities and returns

One of the primary ways BESS can generate revenue is through energy arbitrage - charging the battery when electricity prices are low and discharging it during peak demand when prices are higher. In most liberalized power markets today price volatility has increased, presenting a compelling opportunity for BESS investment.

The key challenges, however, lie in the duration of this price volatility and the profitability of a pure arbitrage strategy for a BESS project. Our research indicates that an average arbitrage revenue of $70 per MWh per cycle, assuming one cycle per day over a 20-year project life, can yield an internal rate of return (IRR) of approximately 9%, given a capital expenditure of $200 per kWh.

For our analysis, we have assumed:

- Annual capacity degradation of 1%
- Annual operational expenses equal to 1% of capex
- Round-trip efficiency (RTE) of 95%
- System availability of 98%

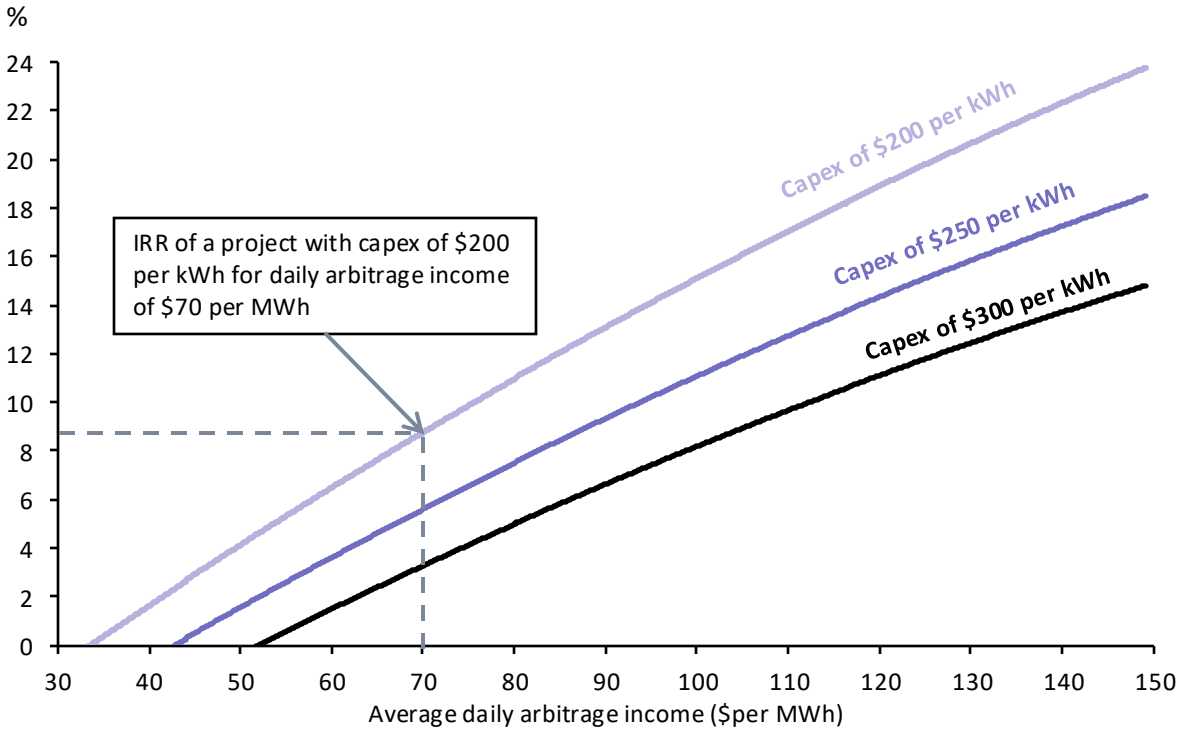
The chart below illustrates how variations in capex, arbitrage revenue, or operational cycles can influence project internal rates of return (IRR).

For example, markets in Europe and Australia have transitioned to higher granularity pricing, which our analysis suggests can increase arbitrage potential by up to 20% in some power markets such as Austria and Slovakia.

Applying this uplift to the baseline $70 per MWh revenue raises it to $84 per MWh and could increase IRR to about 11%.

This analysis underscores that while BESS arbitrage can be profitable under current market conditions, project economics are highly sensitive to market structure, price volatility, and capital costs, making careful modeling and risk assessment essential for investment decisions.

Project IRR* vs. average daily arbitrage income



*IRR is calculated for pure arbitrage revenue, with 98% system availability, 1% degradation per annum, 1% of capex for operation and maintenance cost per annum, round trip efficiency of 95%, and one cycle per day for 20 years of operation
Source: Rystad Energy's Energy Storage Solution; Rystad Energy research and analysis

Would you like to learn more?

At **Rystad Energy**, we offer an integrated data ecosystem that aligns with your workflows and projects. Our global project databases cover economics, production, costs, prices and the entire supply chain.

The key research and analysis in this whitepaper are based on insights from our **Energy Storage Solution**, which offers comprehensive coverage of the electrical energy storage landscape - from pumped hydropower to advanced battery energy storage systems - assessing demand across utility-scale, commercial and industrial, and residential markets, alongside supply dynamics and revenue opportunities. To discuss the findings, access deeper insights, or learn more about the Energy Storage Solution, scan the QR code below to request a short demo.

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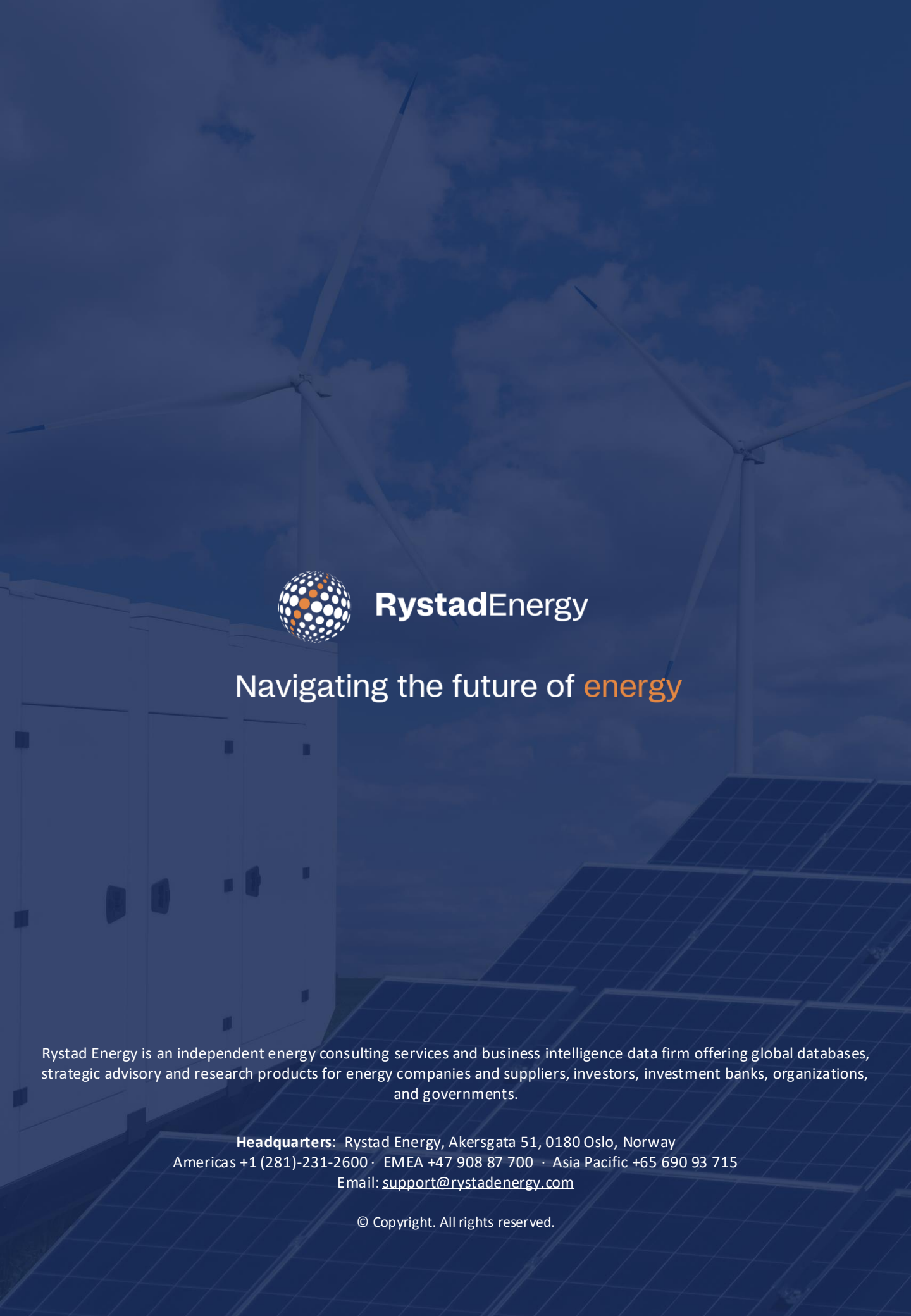

RystadEnergy

Navigating the future of energy

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