2025 Central and Southeast Europe Clean Energy Market Outlook

From coal to renewables, gas, and batteries

May 15, 2025

BloombergNEF

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€180/MWh

2024 average daily power price spread in Greece, Bulgaria, Romania, Hungary

18%

Solar and wind's share of generation in selected Central and Southeast European countries, 2023

50%

Coal's share of generation in selected Central and Southeast European countries, 2023

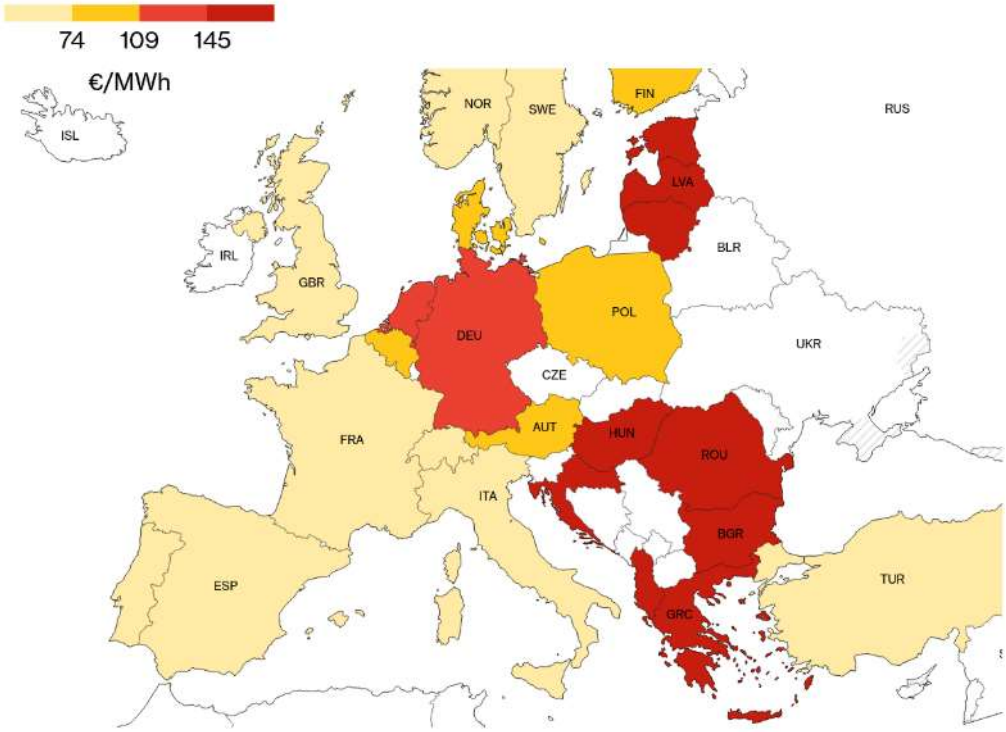
Rising carbon prices, falling technology costs and strong policy are due to drive a 125GW boost in solar and wind by 2035 in Central and Southeast Europe. Most countries are also expanding their gas power plant and battery fleets, targeting tight morning and evening power supply, and supporting a faster transition from coal. Prospects for new nuclear reactors are bleak and far in the future.

- Solar is booming in Poland, Romania, Czech Republic, Greece, Hungary and Bulgaria, with a cumulative installed capacity reaching 52GW in 2024, up 370% from 2020. BNEF expects the 2030 national targets for solar to be exceeded in all countries in this report.
- By contrast, BNEF expects the 2030 wind targets to be missed by 17% (equivalent to a 7.9GW gap) in the region, due to difficult permitting and lack of auction support. Only Romania is set to meet its 2030 onshore wind target, and only Poland is on track for its 2030 offshore wind target. Offshore wind turbines are unlikely to be installed in the Black Sea before 2035, because the bridges in Istanbul are too low to get offshore wind installation vessels through the one access channel to the body of water.
- The increase in solar generation is already causing low power prices during sunny hours in most countries, which dampens solar installation forecasts. At other times, power prices are very high, driven by the European energy crisis following Russia's invasion of Ukraine in 2022 and by rising carbon prices. As a result, daily power price volatility is increasing, making energy storage projects more viable, especially in Greece, Bulgaria, Romania and Hungary. In these markets, 2024 was an exceptional year, with average daily power price spreads of €180/MWh (although this was largely due to low hydro output in Romania, and may not persist). BNEF estimates that an average €119/MWh daily power price spread over the lifetime of a 2-hour battery project installed in 2025 is required to make it viable.
- Battery capacity is growing, largely driven by government subsidies rather than by merchant build. Most governments in the region seek to ensure that battery capacity is used to increase the stability and resilience of the energy system.
- Most countries have plans to phase out coal in favour of renewables, nuclear, and gas. Only Poland has a capacity market, under which some coal plants still receive payments despite European legislation to prevent this. This capacity market is also driving build of new gas plants and batteries. In other countries, build of new gas plants often relies on financial support from the government to compensate for the fact that new gas plants will run at low capacity factors due to cheaper renewables.
- New nuclear reactor projects have high price tags and, by Europe's track record over the last decade, are likely to be delayed. Plans ultimately depend on politics. BNEF expects just around 14GW of nuclear to be operational in 2050, compared to a planned pipeline of 23GW, from 9.3GW online in 2024 in the selected markets.
- Grid investment is lagging what is required to support renewables. This is manifested in Bulgaria and Hungary, where the grid connection queues are full. In addition to increasing

investment, grid operators could start exploring flexible connection agreements and cable pooling to temporarily ease queues.

- BNEF updates figures as new data is released. See the Capacity tool (link), Generation tool (link), Corporate PPA Tracker (link), and the Clean Energy Auctions Database (link).
- *Updated on May 19, 2025 to correct the installed capacity in Czech Republic, on Figure 33. On June 4, 2025, page 9 was corrected to show that Polish auctions offer remuneration under negative hour prices only when those occur for less than six consecutive hours.*

Figure 1: Average daily min-max power price spread for European countries in 2024



Source: BloombergNEF

Sector trends across the region

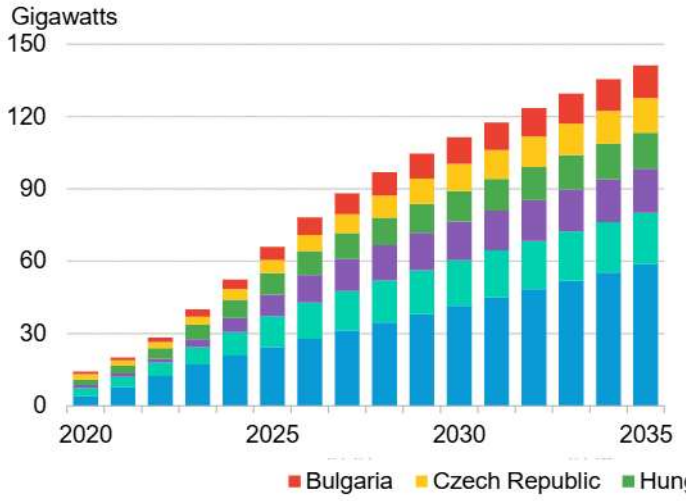
Clean energy

Solar capacity grows but is constrained by saturation and grid limitations

Several Central and East European countries went through a subsidized PV boom and bust cycle between 2009 and 2015, which cost governments significantly more than expected and killed political will for further incentives in the region for many years. However, solar costs have fallen dramatically, and when Russia invaded Ukraine in early 2022, gas and therefore electricity prices spiked. This has triggered a new round of solar market growth in most countries in the region. Subsidy schemes like grants or auctions for contracts for difference and rising corporate PPA activity also contributed to a rapid growth in renewable installations. Between 2020 and 2024, solar capacity almost quadrupled in the selected Eastern European markets analyzed in this report.

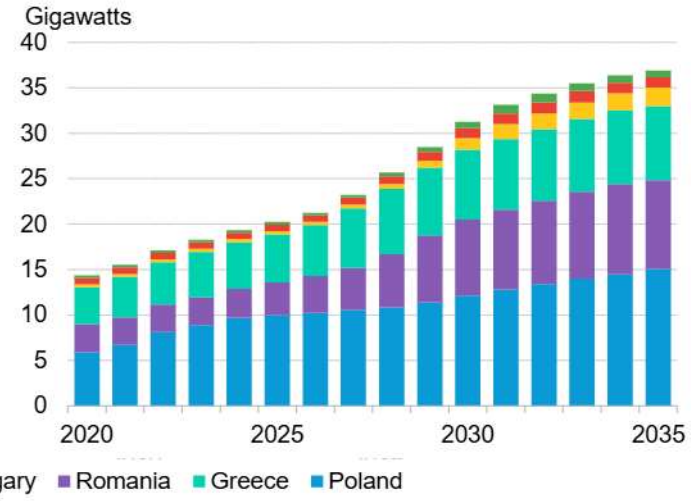
Going forward, BloombergNEF expects solar installations to keep increasing, but at a slower pace, almost tripling by 2035 compared to 2024. This is because some markets are approaching saturation or struggling with grid connection constraints.

Figure 2: Solar capacity by country in Central and Southeast Europe, historical and forecast



Source: BloombergNEF

Figure 3: Onshore wind capacity by country in Central and Southeast Europe, historical and forecast

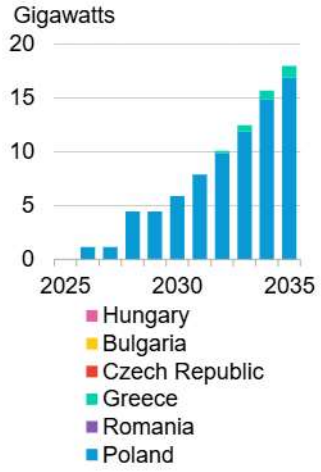


Source: BloombergNEF

Wind additions depend on permitting, auctions, and infrastructure

The rate of growth in wind installations is highly differentiated at country level. New auctions granting contracts for difference are helping to spur new onshore wind installations in Romania and Czech Republic. However, administrative bottlenecks and grid capacity constraints limit new onshore wind installations in some regions. Projects in Bulgaria, Hungary and Poland often encounter hurdles in securing building permits or in accessing the limited available grid connection capacity.

Figure 4: Offshore wind forecast, Central and Southeast Europe



Source: BloombergNEF

Among the analyzed markets, only Poland and Greece are expected to build offshore wind turbines installed by 2035. Poland has already allocated subsidies, and auctions are planned for Poland and Greece in 2025 and 2027 respectively. In Romania and Bulgaria, the only coast is onto the Black Sea, which only has one entry point for an offshore wind installation vessel to enter – through Istanbul. However, bridges in the city are too low for a vessel of that size to pass. Unless an offshore installation vessel is manufactured locally or dis- and re-assembled in Istanbul, no offshore wind installations will be possible. In addition, getting access to grid connections near the Black Sea is difficult, as a lot of renewable energy development is already underway near the shores.

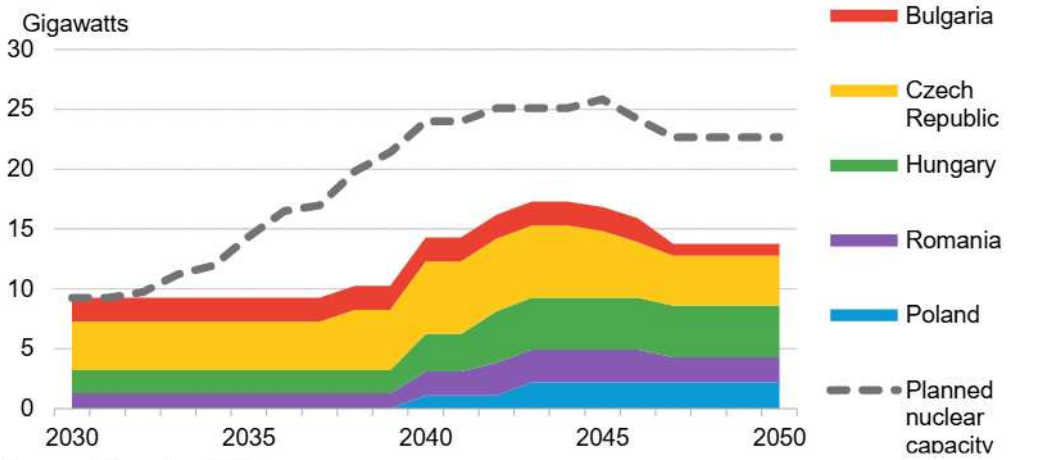
Nuclear ambitions are taking shape, but the elephant in the room is price

Except for Greece, all countries within the scope of this report have ambitions to build new nuclear capacity, either large scale reactors, small modular reactors (SMRs), or both. BNEF expects only a few of the new planned nuclear projects to materialize, at a delayed timeline compared to original government plans. The reason for this is Europe's track record of underestimating costs and incurring major delays for new reactors.

No large-scale nuclear project has yet reached the final investment decision in these regions. Czechia was on the brink of signing a deal with Korea Hydro and Nuclear Power (KHNP) for new large-scale reactors when EDF filed a complaint that is now under scrutiny by the government, which is delaying the deal. Romania is still at an early stage, undergoing engineering assessment. Hungary's plans hinge on Russian technology. Poland is in talks with US engineering firm Westinghouse and has committed some funding. Although Bulgaria has plans to expand nuclear, BNEF believes that the government's current capex estimates are unrealistic.

For now, BNEF excludes all SMR plans are not included in BNEF's base case due to technology risk which will result in difficulty accessing financing, probable high costs, and low commercial readiness. This could change.

Figure 5: Planned nuclear pipeline in selected Central and Southeast European countries, versus BNEF base case

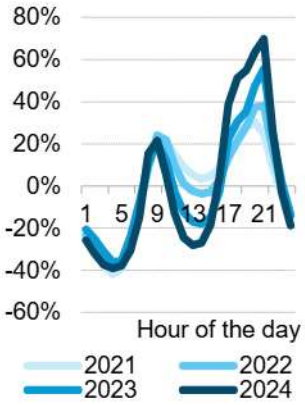


Source: BloombergNEF

Flexibility, grids and storage

Electricity oversupply is on the rise, and policy is stimulating battery storage additions

Figure 6: Hourly power price deviation from average in Romania



Source: BloombergNEF

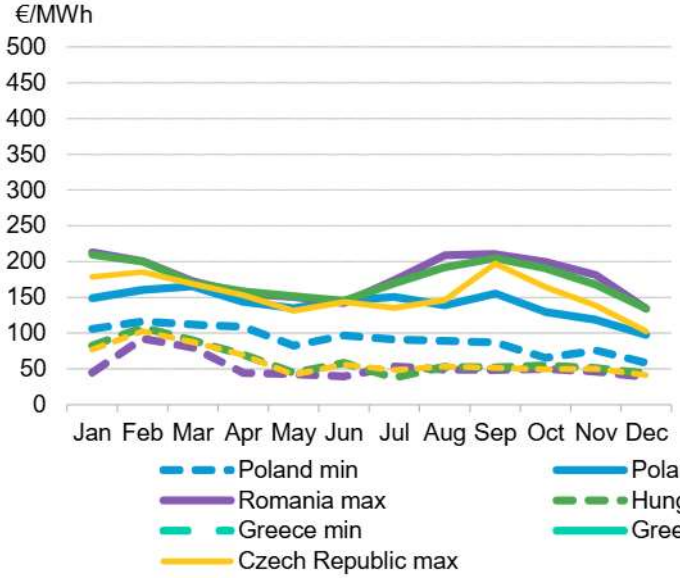
Some Central and Southeastern European power systems are already starting to experience oversupply at midday due to high levels of solar. In Greece, this is simply due to a huge amount of solar (approximately 26% of electricity supply in 2024) while Poland has much less solar but the grid runs mostly on inflexible coal. This leads to curtailment and causes the captured prices of solar to decrease, as seen by the low minimum daily prices at midday in Figure 6. Part of this can be mitigated by increasing flexibility through storage and the grid. Governments are rolling out schemes to incentivize storage build, taking advantage of European Commission support such as the Modernization Fund and the Recovery and Resilience post-pandemic funds.

Greece implemented storage contracts for difference (CfDs) in 2023, Hungary is following with a CfD scheme in 2025, Bulgaria recently rolled out standalone and co-located grant auctions, Romania is also handing out grants, and batteries are rapidly entering Poland's capacity market.

Daily power price volatility is already high, and likely to remain so in regions that are replacing coal with gas and solar. This could enable batteries to be built simply to arbitrage daily power price spreads, without subsidies. However, storage developers building for merchant revenue take on huge risk, as power price spreads can be cannibalized by new batteries coming online. That will be reflected in high financing costs. In 2024, Greece, Bulgaria, Hungary and Romania all saw power price spreads of around €180/MWh, and BNEF estimates that 2 hour-battery projects coming online in 2025 need a daily power price spread of around €119/MWh in Europe, over the lifetime of the battery. See *1H 2025 Energy Storage Market Outlook (web | terminal)*.

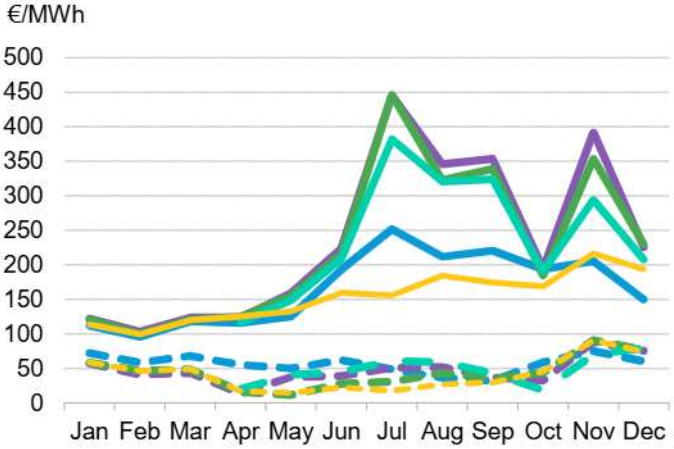
Among the selected markets, batteries only compete in the frequency reserve market in Czech Republic. The other countries' regulations have not evolved to include batteries yet, despite the technology's potential to reduce frequency management costs.

Figure 7: Minimum and maximum daily power price in selected regions, average by month, 2023



Source: BloombergNEF

Figure 8: Minimum and maximum daily power price in selected regions, average by month, 2024



Source: BloombergNEF, Enex

Grids demand more investment and some face large connection queues

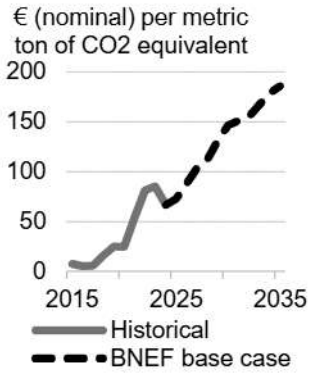
Grids are having to adapt to increasing variability in their power flows due to rising renewable energy supply. Coherently with this, some transmission system operators (TSOs) are increasing their planned investment in their grid plans. BNEF tracks increasing TSO investment in Poland, Romania and Hungary.

Grid connection queues are a visible bottleneck which is limiting renewable development, especially in Bulgaria and Hungary, where available grid capacity for new connections is largely exhausted. Expanding connection capacity requires investment in grid infrastructure. Beyond that, grid operators could draw lessons from other European stakeholders that are investigating or introducing flexible connection agreements and cable pooling, such as Germany, the Netherlands, and Poland. These types of contracts would enable renewables to connect earlier, under certain conditions, such as accepting some level of curtailment when the grid is congested.

According to TSO plans, high voltage direct current cables (HVDCs) are gaining traction: Poland is planning a HVDC to transport offshore wind energy from the north to the south demand pool, Greece is planning to connect Crete and Italy thorough HVDCs, and Romania is investigating the potential to connect nuclear- and wind-heavy regions in the east of the country to the west. These will enable the expansion of renewables and more efficient power flows.

Dispatchable power

Figure 9: ETS carbon price, historical and forecast



Source: BloombergNEF. Note: ETS is the European Union Emissions Trading Scheme. BNEF base case as of 1H 2025.

Coal generated 50% of all electricity produced in 2023 across Poland, Hungary, Czech Republic, Romania, Bulgaria and Greece, but its role in the generation mix is decreasing. Countries have committed to decarbonization and coal phase out targets, and increasing carbon prices are naturally pushing out coal, which cannot compete with cheaper renewable generation.

As the generation mix evolves more towards renewables, dispatchable power will be required to ensure that generation can ramp up in times of low renewables.

Of the markets in this report, Poland is the only country with an active capacity market, which provides yearly revenues to system-critical plants to ensure that they are available and can be called on to provide electricity when the system needs it. This is encouraging new gas plants and battery build, as well as enabling some coal plants to remain online despite low capacity factors.

Some governments are allocating public funds to support the buildout of gas power plants, encouraging private firms to invest despite the high risk of new plants running at low capacity factors because renewable energy is much cheaper when available. For example, Romania is supporting new gas through Modernization Funds, Czechia through contracts for difference for combined heat and power plants, and a subsidiary of MVM Group, Hungarian public-owned utility, is also investing in new gas plants.

Plans for sufficient dispatchable power remain uncertain in Bulgaria and Czech Republic, where energy systems may need to rely on imports to ensure there is enough controllable capacity when coal is phased out.

Figure 10: Cumulative installed power capacity in selected Central and Southeast European regions

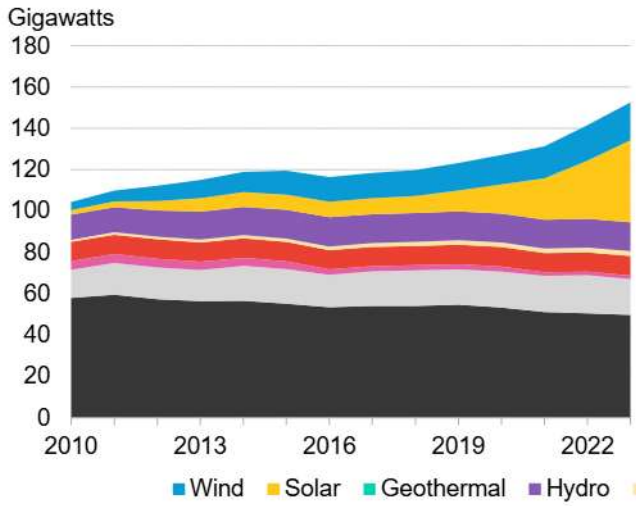
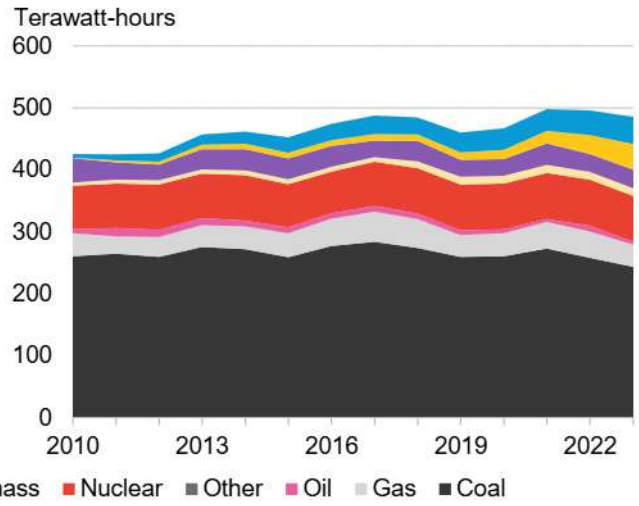


Figure 11: Annual electricity generation in selected Central and Southeast European regions



Source: BloombergNEF. Note: selected regions refer to Poland, Romania, Czech Republic, Hungary, Greece, Bulgaria.

Regional deep dives

Poland

Clean power

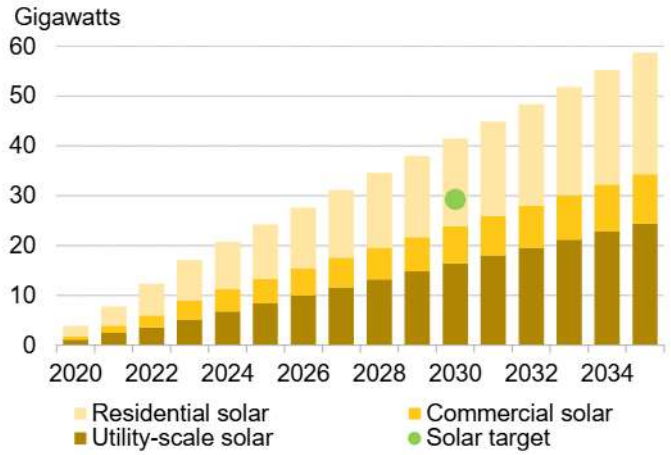
Solar booms, but onshore wind is limited by permits and offshore by auction uncertainty

Poland is making rapid progress in solar and offshore wind build and is on track to comfortably meet the capacity targets laid out in its national energy and climate plan. BNEF expects solar capacity to reach over 42GW in 2030, compared to a 29GW target in 2030, from almost 21GW of cumulative solar capacity at the end of 2024. Offshore wind build is also on track due to progress of projects in the Baltic Sea, which will amount to 5.9GW by 2030.

The outlook is less bright for onshore wind. With less than 1GW of new build in 2024, and similar levels in 2023, onshore wind remains limited by a strict permitting regime that sets 700 meters as a minimum distance between turbines and buildings. An even stricter rule called 10H, which only allowed wind turbines to be developed where the distance to nearby buildings exceeded ten times the height of the turbine, was relaxed in 2023. BNEF expects less than 13GW of onshore wind to be online by 2030, from 9.6GW in 2024. This is below the 15.8GW target.

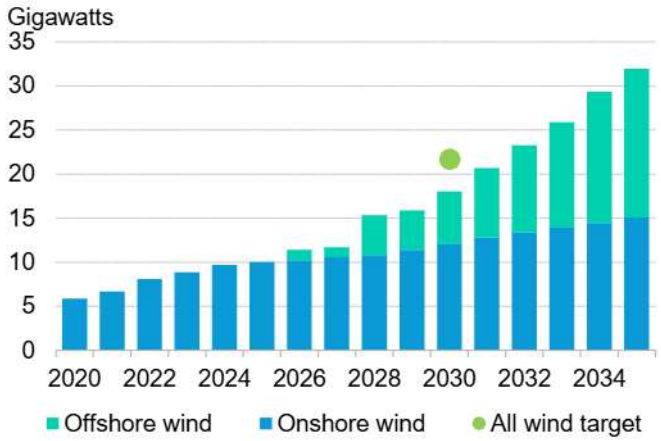
The Polish government is debating a further relaxation of the wind permitting rules, and in March 2024 the Polish Council of Ministers approved a draft to reduce the distance to 500 meters. To be enacted, this needs to be approved by the Polish Parliament and president.

Figure 12: Cumulative solar capacity, historical and forecast, Poland



Source: BloombergNEF

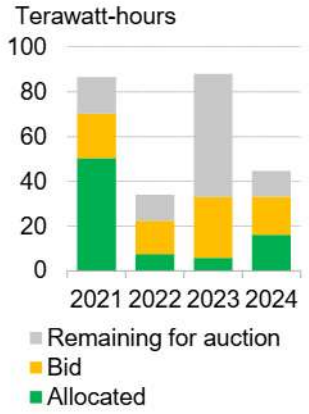
Figure 13: Cumulative wind capacity, historical and forecast, Poland



Source: BloombergNEF

Corporate power purchase agreements (PPAs) and auctions are both driving new commercial and utility-scale solar and wind. The PPA market is flourishing, hitting a record of over 1.2GW of signed agreements in 2023, followed by 0.8GW in 2024, and over 0.4GW in 2025 as of April. The combination of company sustainability commitments and high commercial electricity prices is driving demand for corporate PPAs, and competition to develop is high. BNEF's 2H 2024 price survey estimates a base case PPA price of €84/MWh for wind and €75/MWh for solar. For more, see: *European corporate PPA Price Survey 2H 2024: Right Margins (web | terminal).*

Figure 14: Subscription levels in Polish clean power auctions



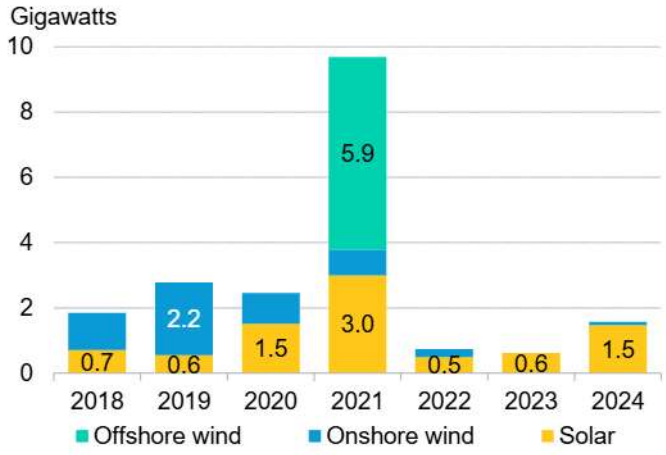
Source: BloombergNEF, URE

Auctions in Poland are also driving new-build capacity with varied success. The rounds award 15-year inflation-indexed two-way Contracts for Difference (CfDs) to deliver certain volumes of electricity (rather than MW of capacity, as is more usual) on a clean-power-agnostic basis. The government has awarded contracts to over 8.3GW of solar and 5.4GW of onshore wind projects via auctions between 2018 and 2024, but subscription levels have fluctuated (Figure 14). Subscription rates in 2024 recovered to around 74% of the available energy contracts in utility-scale auctions, and awarded subscription rates were 36% of available energy. That is up from a 38% bid subscription rate in 2023, which resulted in only 7% of the available energy contracts actually being awarded.

Polish auctions include a 'forcing competition' condition, where only the lowest-priced 80% of bid energy volumes are eligible to win. This forces developers to compete on price, even if auction rounds are undersubscribed. Despite low subscription levels and a relatively high reference price of PLN 324/MWh ($81.4/MWh) for 2024 onshore wind auctions, winning bids fell in a much lower range of PLN 149-175/MWh ($37-44/MWh). Similarly for solar, the reference price was PLN 389/MWh ($97.7/MWh), while bids fell between PLN 245-335/MWh ($61.5-84.2/MWh).

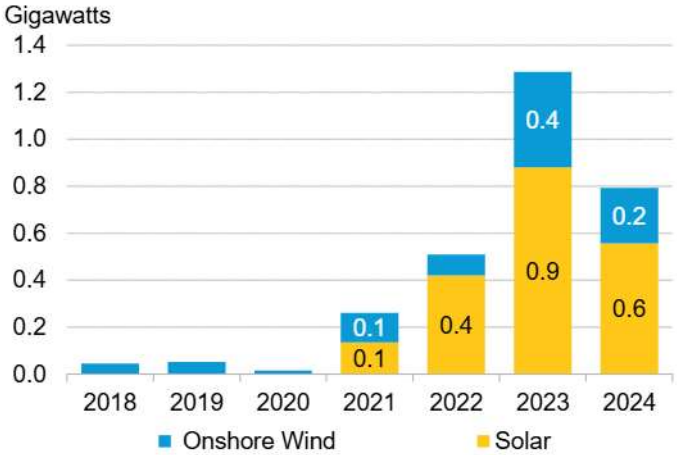
The forced competition condition, which leads to low bid prices, explains why some developers are opting to instead go for PPAs or even operate on a merchant basis. However, power price cannibalization in future will drive down merchant and corporate PPA prices and may make auctions more attractive. Auctions currently offer remuneration even in negative price hours, if those occur for less then six consecutive hours, which partially shields solar developers from low captured prices. As always, the government may change this in future if it becomes too generous to solar developers. New auctions are scheduled for July 2025, aiming to grant 76.9TWh of renewable energy.

Figure 15: Awarded volumes for wind and solar by government auction year, Poland



Source: BloombergNEF, URE. Note: Offshore wind CfDs were allocated on an ad hoc basis, without competitive auctions.

Figure 16: Corporate PPA volumes for wind and solar by signing year, Poland



Source: BloombergNEF

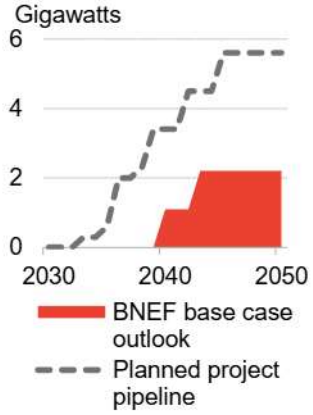
Offshore wind build is on course to deliver the 5.9GW by 2030 target set under the 2021 Wind Act. However, the sector awaits confirmation on further auctions to back another 12GW of new capacity. New auctions are planned for projects to be delivered after 2030, with the government proposing to hold auctions for 4GW in both 2025 and 2027, followed by 2GW in both 2029 and 2030. However, the auction has not been confirmed and as the offshore wind industry has called

for higher reference prices. Auctions are necessary for Poland to meet an 18GW by 2040 offshore wind target laid out in the national energy plan.

Residential solar installations are supported by subsidies under Poland's Moj Prad program, which gives grants for up to 50% of the purchase cost for rooftop installations. The program drove 3.2GW of rooftop solar deployment over 2019-2024 and also supported energy and heat storage installations. Its budget is disbursed in batches that so far have recurred at a roughly yearly frequency, drawing from European Funds for Infrastructure Climate Environment 2021-2027 program.

Nuclear development plans are overly optimistic

Figure 17: Planned nuclear pipeline versus BNEF base case outlook, Poland



Source: BloombergNEF

BNEF expects Poland to deploy its first nuclear unit in 2040, using technology from US firm Westinghouse, and to reach 2.2GW of nuclear installed by 2043 with the addition of a second Westinghouse unit. This is far short of the government's 2020 strategy, which initially targeted 6-9GW by 2043. The plan was delayed by three years, and BNEF still sees this revised timeline as ambitious, given the lack of project pipeline and Europe's typical decade-long delays, a lack of skilled personnel and the associated high costs. BNEF's base case does not assume small modular reactors come online, given slower progress on financing and high technology risk.

In February 2024, the government approved PLN 60 billion ($15 billion) to cover part of the financing for new nuclear generation. However, decisions on vendors for Polish nuclear have not yet been made. Any nuclear-related forecast hinges on politics and is subject to a high degree of uncertainty.

Flexibility, grids and storage

Growing levels of solar curtailment, in part due to inflexible coal

Poland's power system is having to rapidly adapt to growing variable wind and solar generation, while relying on 30GW of inflexible and old coal and lignite plants that are expensive to ramp down or up. Coal and lignite contributed 55% of total generation in 2024.

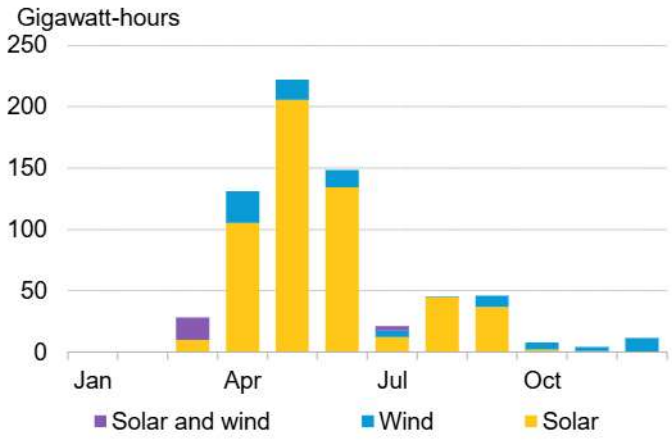
The combination of inflexible coal plants and an underdeveloped balancing market exacerbated the rapid increase in solar curtailment over 2023 and 2024. Curtailment peaked in May 2024 at 200GWh for solar, forcing up to 4.4GW of solar to shut down at midday, a fifth of the cumulative 21GW capacity installed by the end of 2024. While solar was being curtailed, coal was often still generating power, remaining online to serve the later evening demand peak.

A set of initiatives will help reduce the current expensive and carbon-intensive ~8GW of coal and lignite baseload. A balancing market reform implemented in June 2024 helps integrate curtailment within the market, rather than it being managed as a separate measure by the Polish TSO, PSE. The reform makes balancing services more transparent and competitive, and hence more efficient.

Increasing gas and battery capacity will help rebalance the market and reduce solar curtailment, because new ramp-up capabilities will force out coal.

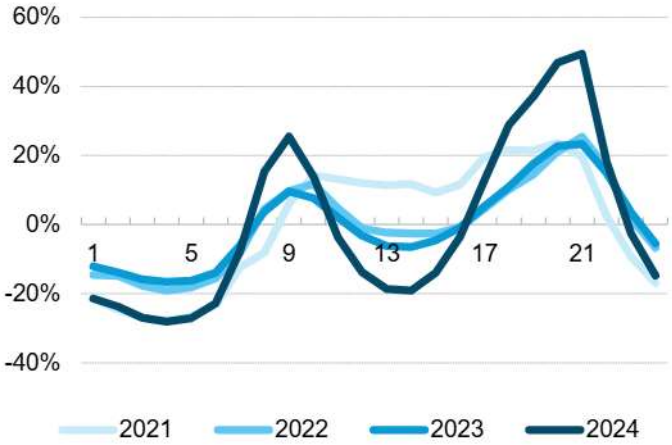
To further facilitate integration of renewables and overcome grid connection constraints, the Polish Renewable Energy Sources Act was amended in August 2023 to allow for cable pooling. This enables energy sources with complementary generation times to share the grid connection even if their aggregated capacity exceeds the grid connection capacity.

Figure 18: Monthly renewable energy curtailment in 2024, Poland



Source: BloombergNEF, PSE

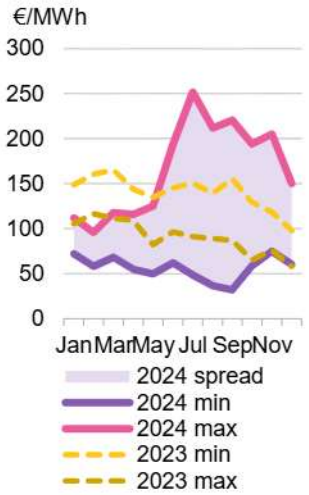
Figure 19: Hourly power price deviation from average in Poland



Source: BloombergNEF

Polish transmission system operator PSE, and Polish distribution system operators, are gearing up for more renewables by increasing investment in the network. A planned HVDC cable will cross Poland north to south to transfer future offshore wind generation to the demand pool in the South. PSE infers that the cable will come online by 2034 or earlier. For more, see: *ETIT 2025: Countries Annex (web | terminal)*.

Figure 20: Average daily power price spreads, Poland



Source: BloombergNEF, PSE

Opportunities for batteries from targeted subsidies and the capacity market

In an effort to integrate more renewables and help keep the system stable when coal is phased out, government policies are actively driving battery build through tailored schemes and subsidies for both residential and large-scale adoption.

Since 2022, the Moj Prad program provides subsidies covering up to 50% of the purchase cost for residential batteries, alongside supporting solar and heat pump installations. A PLN 4 billion scheme ($1 billion) is being deployed in 2025, aiming to support the installation of 5.4GWh of new large-scale electricity storage facilities in Poland through grants and loans. The call, open from April to the end of May 2025, provides grants covering up to 45% of total investment cost and loans for up to 100% of costs, for batteries systems of at least 2MW/4MWh in size. Lastly, the Polish capacity market is also offering a route-to-market strategy for batteries, and it will help bring online an estimated 4.5GW of batteries by 2030.

In the longer term, the growth in solar capacity together with new gas capacity could create new arbitrage opportunities for batteries potentially without subsidies and support schemes. The Polish power market is already seeing increasing price volatility, and Poland's minimum and maximum spread widened to an average of €110/MWh in 2024, compared to €50/MWh 2023, as seen in Figure 20. BNEF analysis shows that an average daily minimum-maximum power price spread of €119/MWh would be sufficient to make 2-hour battery storage projects coming online in 2025 attractive. For more, see *1H 2025 Energy Storage Market Outlook (web | terminal)*.

Still, daily power price spreads will grow as cheap solar floods power markets across Europe in sunny hours, and as gas replaces coal. This will benefit the investment case for storage.

Dispatchable mix outlook

New gas, wind and batteries to complement the coal phase down

Poland's energy mix is rapidly transitioning away from coal, despite the country's 2049 phase-out target. In 2024, coal generated 55% of electricity, down from 76% in 2022. Much of this is being replaced by solar and more flexible gas. In 2024, gas capacity increased by 40% with the entry of 1.5GW of new gas plants. The EU carbon price and gas prices also determine the relative economic attractiveness of gas and coal plants. Wind additions are also contributing to the displacement of coal, although growth in wind generation is less pronounced.

Figure 21: Cumulative installed power capacity, Poland

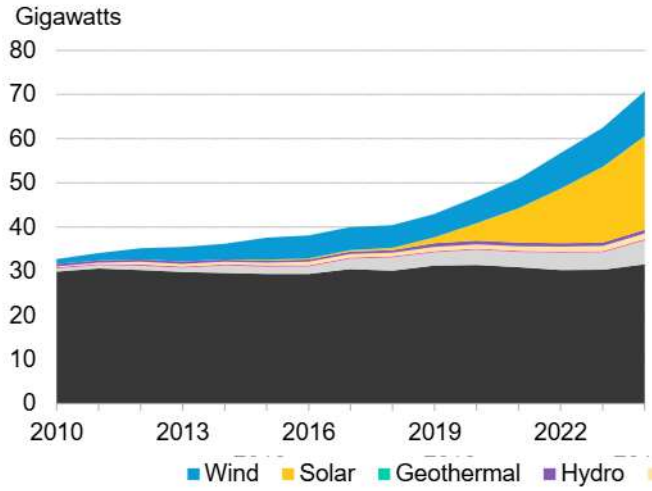
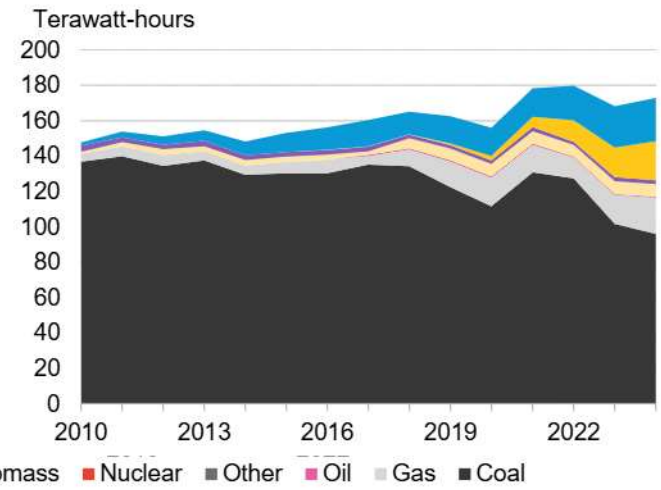


Figure 22: Annual electricity generation, Poland



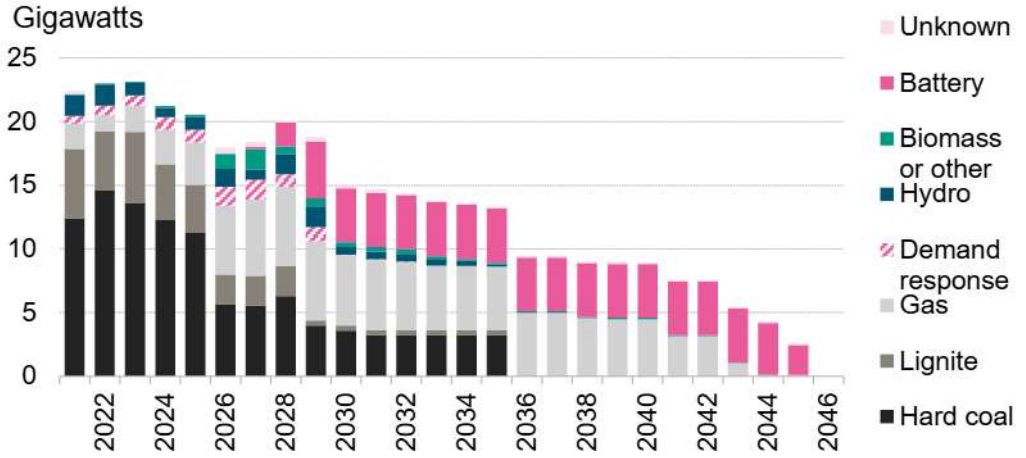
Source: BloombergNEF, ARE

The capacity market boosts new gas and battery build

Since its establishment in 2018, Poland's capacity market ensures that the country's power mix maintains appropriate levels of dispatchable capacity. The capacity market provides short and long-term contracts from 1 to 17 years, with those longer than one year linked to inflation. The rated aggregated dispatchable capacity for delivery in 2024 supported by this market amounted to 21GW (Figure 23).

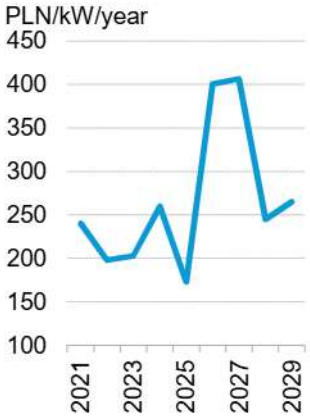
Coal and lignite capacity has also benefitted from the capacity market: auctions held in 2018 awarded 15-year contracts to 3.6GW of coal and lignite plants, which will be paid to stay online until 2035. Since the 2018 auction, no further long-term contracts were assigned to coal plants, but coal plants typically won the shorter 1-year contracts in the capacity market. EU regulation prohibits any power plant emitting over 550g/kWh and emitting more than 350kgCO2/year per installed kilowatt to participate in capacity markets from July 1, 2025, which would have stopped the Polish capacity markets from supporting coal. However, changes in Regulation (EU) 2024/1747 of June 13, 2024 led to a Polish Capacity Markets Amendment of February 2025, which extends this emission limit to apply to its capacity market until the end of 2028, to ensure Poland's security of supply. Furthermore, the amendment also adds new auctions 6 months ahead of delivery for 2026, 2027 and 2028. This makes it still technically possible for coal to be awarded support in the capacity market.

Figure 23: Polish capacity market support by technology class. Data as of auctions held in January 2025



Source: BloombergNEF

Figure 24: Settled price in Polish capacity auctions, by auction delivery year.



Source: BloombergNEF

As the EU pressures Poland to phase down its coal capacity, and its running costs increase together with carbon prices, other technologies are benefitting from the capacity market. These include demand side response (which is typically provided by pools of large commercial consumers or industrials), gas plants, and more recently batteries. Many of the new gas power plants in the construction pipeline in Poland either hold or are planning to get a capacity market contract. BNEF tracks an announced pipeline of 3GW worth of new gas capacity to come online between 2025 and 2027, but some of these projects have not reached a final investment decision yet – as this sometimes hinges on securing long-term capacity market contracts.

Battery storage entered Poland's capacity market for the first time in 2022 auctions. Since then, subsequent auctions have allowed batteries to secure a cumulative 4.2GW of rated battery capacity for delivery in 2029. Despite the lowering of storage derating factor from 95% to 61%, over 2.5GW of rated battery capacity was awarded in auctions held in 2024.

The low price of batteries compared with gas plants meant that the auctions held in 2025 for delivery in 2029 cleared at PLN 264.9/kW/year ($66.5/kW/year). This pushed most new gas plants out of the market. To address the government's worry that the contracted capacity will not be enough, the February 2025 Capacity Market Act amendment, which introduces further auctions to be held in May 2025, 2026, and 2027, could give gas another chance.

Romania

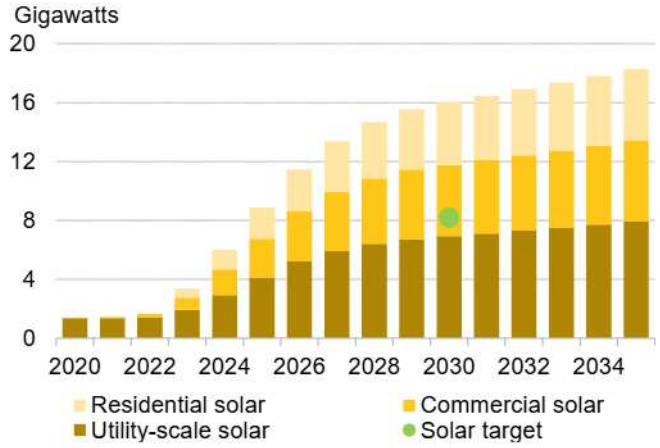
Clean power

Auctions unlock solar and onshore wind, but offshore falters

Romania's solar and wind market is growing rapidly, after years of minimal installations. Solar hit a record year in 2024, with an estimated additional 2.6GW deployed, up from 1.7GW in 2023 and just 0.2GW in 2022. No new wind capacity was added in 2024, but BNEF expects a revival after a new auction program awarded contracts for 1.1GW of new onshore wind in 2024, due to come online over 2027-2028.

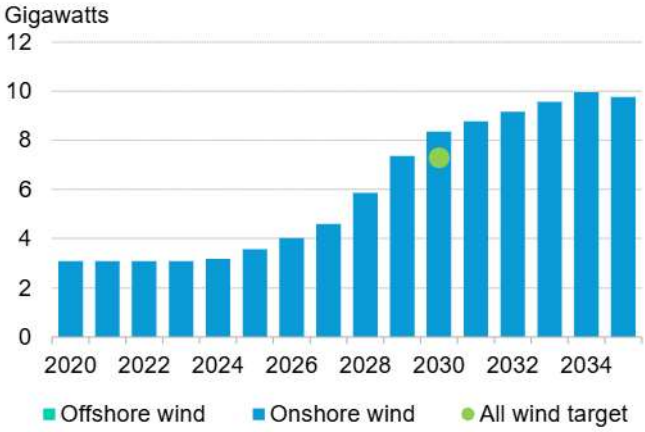
With this, BNEF expects Romania to build twice as much solar as its 2030 target for 8.2GW of solar and to comfortably meet the 7.3GW onshore wind target. These national goals were not revised up in the final National Energy and Climate Plan published in 2024, despite the market's growth.

Figure 25: Cumulative solar capacity, historical and forecast, Romania



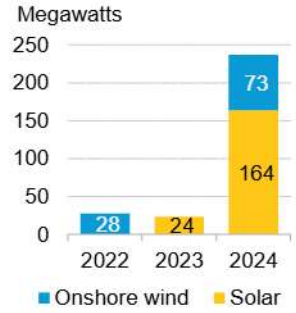
Source: BloombergNEF

Figure 26: Cumulative onshore wind capacity, historical and forecast, Romania



Source: BloombergNEF

Figure 27: Corporate PPAs in Romania, by signing year



Source: BloombergNEF

For residential and commercial solar, a combination of government support measures is driving up installations. This includes the 'Casa Verde Fotovoltaice' residential grants, net billing schemes for installations up to 400kW, and some grants under the Modernization Fund calls for self-consumption.

The rapid expansion of solar build in Romania has been enabled by the country's streamlined permitting regime. A 21/2023 amendment to Romania's construction law is helping to speed up project development timelines, by exempting renewable energy projects occupying less than 50 hectares of agricultural land (enough for about 30MW of PV) from the requirement to obtain a zonal urban plan.

Corporate PPA deals are increasing in popularity, with 237MW worth of solar corporate PPA deals signed in 2024. This trend is expected to continue and potentially accelerate as Romania plans to officially take part in the Association of Issuing Bodies[1] – enabling it to trade its guarantees of origin internationally. For now, cPPAs remain the main way that Romanian corporations can show their sustainability commitments. For more, see *Romania Sees Big Jump in Corporate Clean Energy Deals: BNEF (web | terminal), Romania Sets Date to Trade Clean Power Certificates Abroad (web | terminal).*

Romania's newly established auction program is set to significantly boost utility-scale solar installations, as well as onshore wind deployment, which has been stagnant since the early 2010s due to retroactive policy changes and lack of further government support. The program awards two-way contracts for difference (CfD) for fifteen years.

[1] Romania is not currently registered in the Association of Issuing Bodies, which limits its ability to trade Guarantees of Origin. The Romanian government is working on establishing a Guarantees of Origin market, and it has set a target to officially take part by 2026.

Table 1: Awarded capacity and average price for Romania's 2024 solar and wind auction

	Solar	Wind
Awarded capacity, GW	0.4	1.1
Average price, €/MWh	50.75	64.86
Ceiling price, €/MWh	78	82

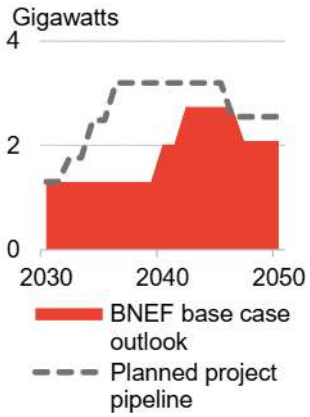
Source: BloombergNEF

The first auction round allocated contracts to over 1.5GW of renewable capacity in September 2024 and was oversubscribed by almost double the capacity. The winning bids include 1.1GW of new onshore wind and 432MW of utility-scale solar, due to come online between 2026 and 2028. The weighted average winning bid prices were €65/MWh ($70/MWh) for wind and €51/MWh ($55/MWh) for solar, well below the ceiling prices, as seen in Table 1.

Further auction rounds are expected to continue to support growth for utility-scale solar and onshore wind, at least until the total approved budget of €3 billion ($3.25 billion) runs out. A second round of auctions is expected to take place in the third quarter of 2025, with available capacity of 2GW for onshore wind and 1.5GW for solar. See *Global Clean Energy Auctions Update 1Q 2025 (web | terminal)*.

Romania's offshore wind sector faces uncertainty and BNEF expects no capacity deployments before 2035 without substantial policy changes. While the Romanian government passed a law in 2022 allowing offshore wind projects to be built from 2032 onwards, the only entry point for an installation vessel to reach the Black Sea is through Istanbul, where the bridges are too low for one to get in. Possible options to go around this include manufacturing the vessel locally or disassembling and then reassembling it at the bridge – but both these options would be costly and take time. See: *Bridges in Turkey Topple Offshore Wind Hopes in Romania (web | terminal)*. In addition, offshore wind developments could incur problems with grid connections: many renewable projects on the Black Sea's shoreline are already using up much of the grid capacity, according to conversations with developers. A proposed HVDC cable connecting Romania's east to its west could help address this, but even so, the low bridges remain a problem.

Figure 28: Romania's nuclear capacity, base case and planned pipeline



Source: BloombergNEF

Nuclear power extensions, but new reactors are unlikely to enter any time soon

Romania's government seeks to extend and expand nuclear power supply, partly to compensate for declining coal capacity. The country has 1.3GW of operational nuclear capacity across two units at its Cernavoda plant. Although these units were built in 1996 and 2007 respectively, in December 2024, the government signed a €1.9 billion engineering, procurement and construction (EPC) agreement for a 30-year lifetime extension to the older first unit. Upgrade work is scheduled to commence in 2026.

New-build reactors are at a very early stage. The government, via majority-state-owned operator Nuclearelectrica, wants to increase Cernavoda's capacity with two additional CANDU-6 units (units 3 and 4), of 720MW each. The scheduled operation for these units is for 2031 and 2032. BNEF expects delays of up to a decade, given the early stage of the project: Nuclearelectrica signed an engineering, procurement and construction management contract worth €3.2 billion at COP29, but a final investment decision will only happen after the first Limited Notice to Proceed phase, which could take years.

Romania is also investigating small nuclear reactors (SMRs), and it is hoping to bring online a 462MW pilot plant in Doicesti, with six modules from US developer NuScale. BNEF deems it unlikely that the project will materialize, as NuScale technology is still being licensed in the US, and it would be surprising if the first pilot plant that the company developed was located abroad. The first stage of the Doicesti Feed study was completed in late 2023, and the project's operation was initially scheduled for 2029.

Flexibility, grids and storage

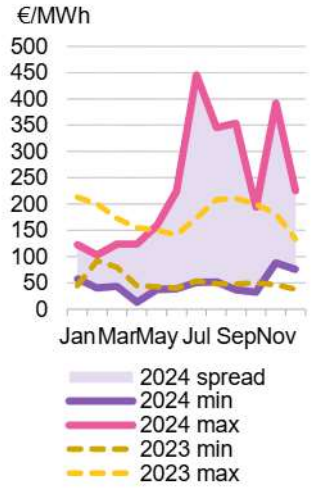
The battery storage pipeline is growing, thanks to subsidies and power price volatility

Romania's battery installations are picking up, with 137MW/269MWh of batteries online in 2024, up more than ten-fold from 2023 levels according to Romanian Photovoltaic Industry Association. Battery additions are expected to keep rising, spurred by government subsidies, regulatory changes, and a volatile power price environment.

In 2024, €65 million of funding from the EU's Recovery and Resilience Funds, a pandemic-era stimulus package, were allocated to a handful of battery projects, which are expected to add 1.3GWh of co-located batteries to the grid. Another €150 million ($158 million) is being rolled out through the EU's Modernization Fund, to finance new battery storage projects. The call is targeting 1GW but could contract as much as 3GW. Grants will cover a portion of the battery investment cost and will be distributed through a competitive tendering procedure (ranked by €/MWh). The call closed on February 17, 2025, and results are pending. Regulation is also encouraging battery development, and the recent reduction in grid fees for batteries (GEO 134/2024) further enhances battery economics.

Power price spreads were high enough to be above levels needed to economically build a 1-2-hour duration battery in Romania in 2024 – if the same spread was expected for all years of the battery lifetime. But such a high spread is unlikely to persist even in the short term. 2024 was anomalous because of unusually low hydropower generation which required importing more power and ramping up gas generation in a period of high European gas prices; power demand was also higher than usual in 2024, due to a hot summer and a colder period from October. 2024 daily spreads averaged €187/MWh, from €124/MWh in the previous year. The required daily power price spread to justify investment amounts to €119MWh for 2-hour battery projects coming online in Europe in 2025. See *1H 2025 Energy Storage Market Outlook (web | terminal)*.

Figure 29: Average daily minimum maximum power prices in Romania, in 2023 and 2024



Source: BloombergNEF

Grid investment is ramping up, to strengthen and modernize the grid

Investment is pouring into the Romanian transmission and distribution grid, to strengthen and expand the network for integrating more renewables and to better interconnect the Romanian power market. New rules for grid connections are also on the horizon.

Transelectrica, the Romanian Transmission System Operator (TSO), increased its 10-year investment plan amount to RON 9.5 billion ($1.9 billion) in its latest 2024-2033 plan, up 34% compared with the 2022-2031 one. Transelectrica will invest in retrofitting and modernizing the grid, integrating renewables and enabling more interconnection with neighboring countries. A proposal to build a 5GW HVDC cable by 2030 to better connect the eastern generating region to the western demand pool may get more traction if new offshore wind and nuclear expansion materialize.

In addition to transmission grid build, distribution grids also need modernization and expansion. In 2024, the government committed RON 3.5 billion ($0.76 billion) to distribution projects, of which RON 2.2 billion ($480 million) come from the Modernization Fund.

Due to the growing trend of speculative projects requesting grid connections, the Romanian Energy Regulatory Authority (ANRE) published an order in July 2024 requiring grid connection requests to provide a 5% connection tariff guarantee, from 2026. From 2026, grid connections will be allocated via tenders, instead of in the previous first-come-first-served order.

Dispatchable mix outlook

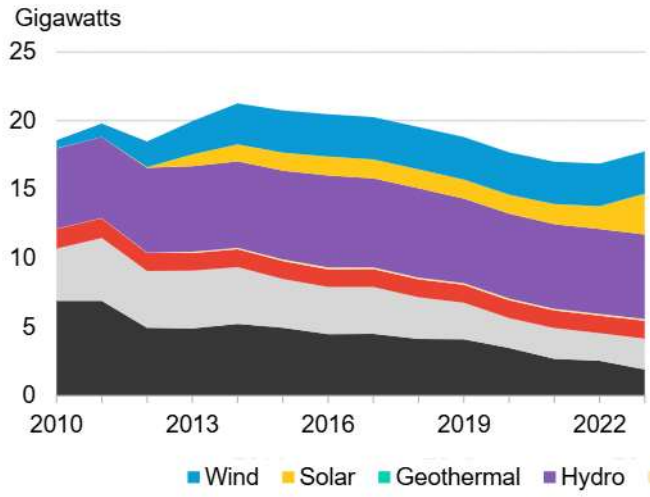
Romania replaces last coal with new gas power plants

Romania's dispatchable power heavily relies on hydropower and nuclear generation, which together provided over 50% of Romanian electricity in 2023. Gas and coal contributed to 15% and 14% of generation in 2023.

New gas plants are being built as Romania approaches its 2032 coal phase-out target. Some of the 2GW of coal capacity online in 2023 could be replaced by an announced new gas plant pipeline of ~4GW, coming online over 2024-2027. Because Romania has not established a competitive capacity market, the planned financing of these new gas plants typically relies on the Modernization Fund (i.e. Islanita, Turceni) and the National Recovery and Resilience plan Funds (Craiova II).

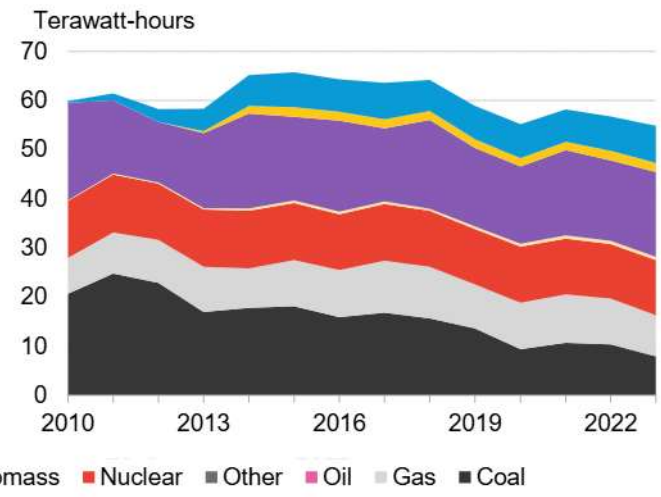
As Romania leans further into gas for power generation, it will have higher exposure to European gas price swings. However, the impact is expected to be cushioned by the country's strong domestic production – which met nearly all of its gas needs last year – and plans to further boost output through the development of the Neptun Deep offshore project in the Black Sea. For more, see *European Gas Market 2030 Outlook: Spotlight on LNG* (web | terminal).

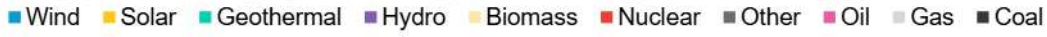
Figure 30: Cumulative installed power capacity, Romania



Source: BloombergNEF

Figure 31: Annual electricity generation, Romania





Source: BloombergNEF

Czech Republic

Clean power

Small-scale solar and auctioned wind farms grow

Solar and wind build will accelerate in the Czech Republic in the next few years, after stagnation for both technologies since 2013. EU funds are helping to finance renewable projects, especially for small-scale solar. Auctions are also improving prospects for new wind installations, but not for solar.

Figure 32: Cumulative solar capacity, historical and forecast, Czech Republic

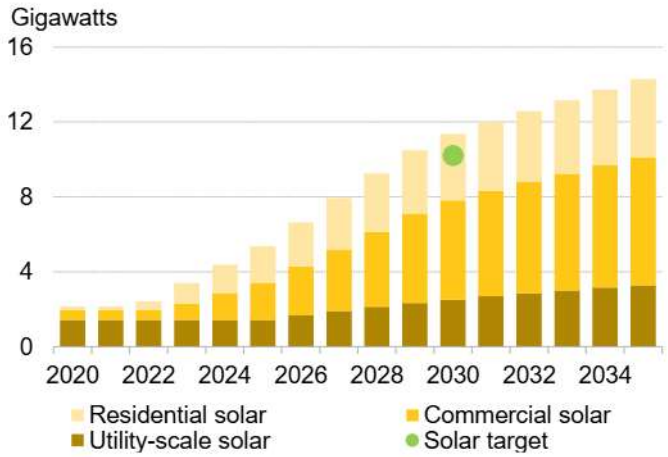
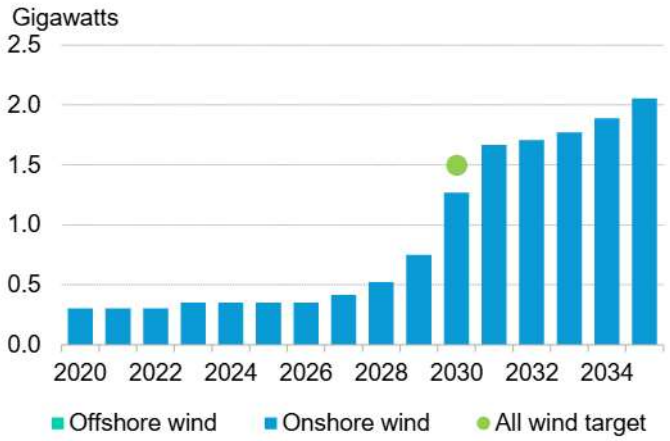


Figure 33: Cumulative wind capacity, historical and forecast, Czech Republic



Source: BloombergNEF. Note: 'Commercial solar' includes industrial installations, which can be larger than the 1MW typically used to define the threshold for 'utility-scale solar'.

Czech Republic is expected to meet its 10GW solar target by 2030, from just over 4GW of cumulative solar capacity in 2024, thanks to growth in small-scale installations. Commercial installations (which also include industrial ones) are set to grow fastest, driven by the cost benefits of self-consumption and subsidies, often supported by the Modernization Fund. A program called RES+ calls provided grants covering up to 75% of costs for commercial solar installations, and a separate scheme launched in 2024 is providing interest-free loans and grants covering up to 30% of solar installations and 50% for storage for enterprises. For residential consumers, the New Green Savings Program (NZU) is stimulating rooftop installations.

The corporate PPA market has not boomed yet, and expertise in these kinds of deals is still nascent in Czech Republic. But it is possible that developers will start targeting corporations in the future as routes to the market. The country's first cPPA deal was signed in 2024, for 30MW.

For now, the absence of solar CfD auctions in Czech Republic limits potential growth in the utility-scale solar segment. The government seems to be averse to auction schemes for solar power because it does not want to bear the risk of power price fluctuations, after feeling the weight of the solar feed-in tariffs on state budget since the 2010s boom.

However, the Czech government is rolling out contracts for difference auctions and simplifying permitting procedures to support the installation of new onshore wind capacity, in an effort to meet its 1.5GW national wind target in 2030. These measures are expected to support new onshore wind projects, but may not be enough for Czech Republic to meet the target.

The government is planning to hold new wind auction rounds offering 375MW of available capacity each year in 2025, 2026 and 2027. This is a substantial acceleration in available capacity compared to past auctions, which previously only offered two rounds a year, with 20-90MW of available capacity per round. The 2024 wind auction rounds were oversubscribed, and allocated 114MW of the total 179MW bid capacity, at an average winning bid price of CZK 3,152/MWh ($135.7/MWh). A possible reason for what seems like a high price is that bid prices are not indexed to inflation.

Table 2: Allocated wind capacity and average price in clean auctions, Czech Republic

	2023	2024
Bid capacity, MW	45	179
Allocated capacity, MW	45	113
Weighted average price, €/MWh	154	136

Source: BloombergNEF

Together with auctions, renewable acceleration areas, introduced in March 2025, will help drive near-term growth in renewable development. This legislation aims to simplify and speed up permitting for wind and solar, a key bottleneck for development.

Maintaining nuclear power remains a priority, but not without headwinds

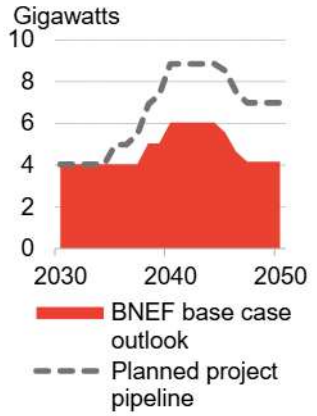
The Czech government is actively involved in maintaining and expanding the country's nuclear energy, which powers 40% of the country's electricity system through 4GW of operational capacity at the Dukovany and Temelin reactors. The country is exploring both new large-scale reactors and SMRs, but BNEF suspects that it cannot pursue both.

Majority-state-owned utility power company CEZ has invested in extending the lifetime of the ageing Dukovany plant by 10 years, allowing it to run until 2047. The company is also planning to invest in the addition of two new 1GW units (unit 5 and 6) in the Dukovany plant, by 2038 and 2040 respectively. In July 2024, Czech officials and CEZ picked Korea Hydro & Nuclear Power Co (KHNP) as supplier. KHNP's offer implied that the construction of the two new units could cost CZN 400 billion $18 billion. However, rival bidder EDF submitted a complaint to the Czech government, temporarily halting the purchase agreement on May 7, 2025. This occurred while KHNP and CEZ were in the process of negotiating the PPA terms, and after the Czech government announced a plan to purchase 80% of shares in the project.

The recent legal stall increases the risk that the project could be cancelled, as happened in the precedent case of Temelin. In 2014, CEZ proceeded far down the line to adding a new reactor at Temelin, only to cancel the project at the very end of the process. If the Dukovany project goes forward, the delays in signing the deal, together with other European lessons, could be a sign that the price tag might rise.

CEZ invested in UK-based subsidiary Rolls-Royce SMRs Ltd in October 2024, for a 20% stake. This move is in line with the government's plan to have 2.8GW of SMRs by 2040. SMRs could bring several advantages: the smaller scale of the units reduces the size of the investment risk, and if manufacturing is arranged locally, SMRs could boost employability and counteract the expected employment losses of the coal phase-out. For now, SMRs are not included in BNEF's base case due to its low commercial readiness.

Figure 34: Czech Republic's nuclear capacity, base case and planned pipeline



Source: BloombergNEF

Flexibility, grids and storage

Battery subsidies help renewables integration, but grid transparency remains an issue

Battery installations are growing, thanks to the Czech government's active subsidy support for both small- and large-scale installations. Subsidies are required to spur batteries installations, as BNEF analysis shows that the current power spreads do not support a viable business case for unsubsidized battery arbitrage projects.

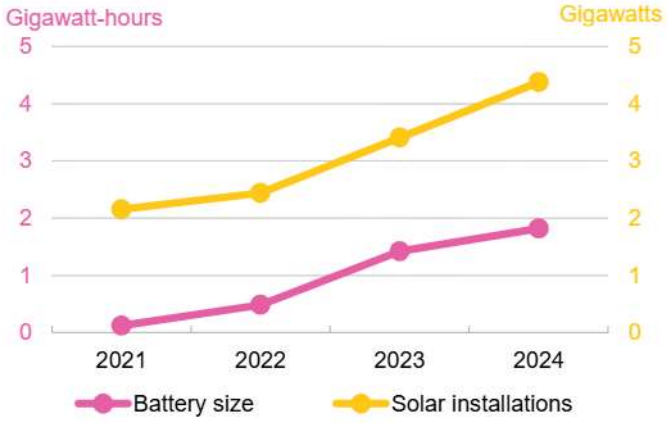
Ongoing subsidies covering up to 50% of the cost of batteries and solar systems for self-consumption are driving very high battery-solar attachment rates for the residential segment. Over 2022-2024, 80-90% of solar systems were installed with battery storage, with an average battery size of 12-14kWh. These contribute to the country's co-located battery storage capacity, which reached a cumulative 1.8GWh in 2024, up from 1.4GWh in 2023, according to the Czech Solar Association (Figure 35).

Czech Republic is expected to roll out another subsidy scheme in 2025, targeting 1.5GWh of new storage installations (across any electrical storage technology). This will be funded by a Modernization Fund budget of €279 million, approved by the European Commission in March

2025. Projects will compete in bids to receive direct grant subsidies and come online by 2028 or earlier. In the short term, this subsidy scheme is expected to be the main driver of large-scale storage additions, as merchant economics remain challenging. The country's daily 2024 and 2023 spreads averaged €108/MWh and €91/MWh, far from the required daily spread of €119/MWh estimated by BNEF for 2-hour batteries for projects coming online in 2025.

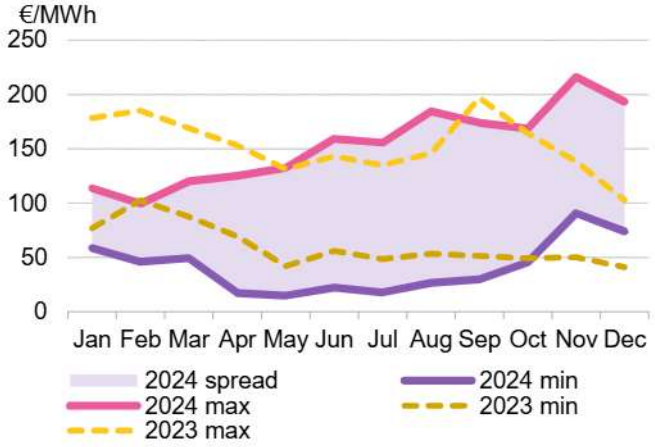
Of the markets covered in this report, Czech Republic is the only one where batteries can easily provide frequency regulation, after the country joined the EU Frequency Containment Reserve Market (FCR) in 2023. The frequency containment reserve prices for Czech Republic in 2024 were high, ranging between €10-65/MW/hour. This signals that there might be some opportunity for batteries to compete and provide grid frequency services. But the Czech demand for FCR is historically small, amounting to just 76MW in 2024, and could be easily saturated by new projects.

Figure 35: Solar and battery installed capacity, Czech Republic



Source: BloombergNEF, Czech Solar Association

Figure 36: Minimum and maximum daily spread averaged by month, 2023 and 2024, Czech Republic



Source: BloombergNEF

The Czech Republic's central location in Europe complicates the assessment of its grid's condition and the scale of necessary upgrades. Due to this strategic position, the country benefits from European funding—such as the EIB's CZK 3.6 billion ($155 million) loan aimed at enhancing transmission infrastructure from 2021 to 2025. Nonetheless, developers report lack of transparency in grid connection processes as a key barrier to expanding renewable energy.

Dispatchable mix outlook

Czech Republic targets a coal phase-out in 2033 through expanding renewable, nuclear and gas generation, and potentially increasing imports. In 2023, the 9GW of operating coal plants generated 41% of Czech electricity. The district heating[2] and industrial sectors also heavily rely on heat from coal co-generation.

CfDs help spur new gas plant additions, but this might not be enough to phase out coal

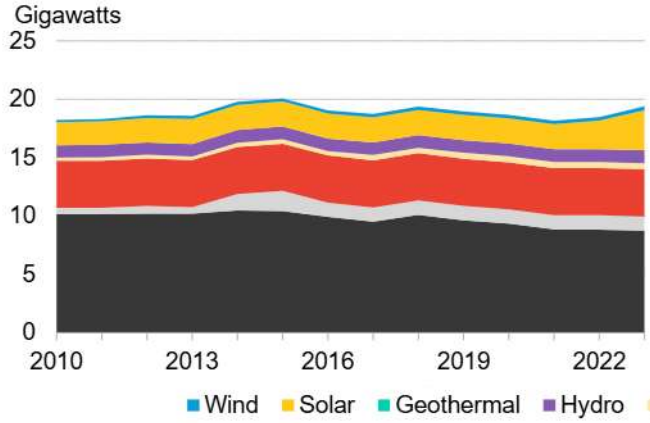
To support the establishment and consolidation of its firm capacity while phasing out coal, in 2024, the Czech government launched auctions providing a 15-year two-way CfD to new or

[2] According to the Ministry of Energy of Czech Republic, district heating provided around 50% of the country's heat consumption in 2021, and much of that is from coal. For more, see: *District Heat Networks: To Build or Not to Build (web | terminal)*, and *District Heating Project Valuation Model (DHVal 1.0) (web | terminal)*.

modernized biomass, biogas and natural gas combined-heat-and-power plants (CHPs) (with the condition that the latter ones can be converted to net-zero fuels by 2050). Two auction rounds took place in 2024, aiming to reach a total 3GW gas capacity by 2030, from 1.8GW online in 2023. The auctions were 18% oversubscribed and awarded contracts for 1.3GW. Most of the capacity was won by developers converting coal assets to new cogeneration plants powered by natural gas, helping the country transition away from coal.

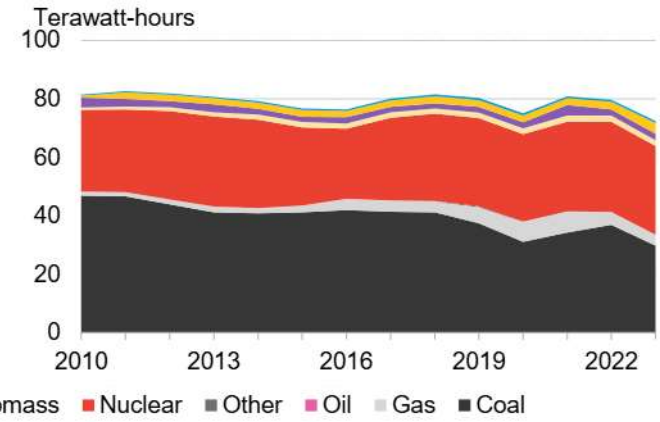
The winning bids weighted average price for auctions was CZK 4,171.6/MWh ($180/MWh). The compensation bonus increases with gas prices and carbon prices and decreases with power price increases, to avoid overcompensation. This feed-in-premium provides generators revenue certainty for the sale of the produced electricity but also caps potential upsides for moments of high electricity prices. The projects also rely on the sale of heat as an additional revenue stream.

Figure 37: Cumulative installed power capacity, Czech Republic



Source: BloombergNEF

Figure 38: Annual electricity generation, Czech Republic



Source: BloombergNEF

Context: Floating premiums awarded in the 2024 CHP auctions are a two-in-one solution to decarbonize the power and heat sector together, pushing out coal. Other countries like Germany and Slovakia also provide support to CHPs through bonuses and feed-in premiums.

Czech Republic is focusing its efforts to speed up permitting for new gas plants and renewables, also targeting power imports to enable coal's exit. For now, new additions of 1.3GW of gas will not be sufficient to replace the coal fleet by 2033 and more capacity is likely to be needed.

Imports could help fill the coal gap, and BNEF tracks at least 4.7GW of interconnection capacity between Czech Republic and its neighbours. However, imported volumes will depend on power price differentials. Historically, Czechia has been a power exporter, net exporting an average of 1.3GW of capacity and 15% of generation between May 2020 and May 2025. See *European Power Markets Monitor LiveSheet (web | terminal)*.

The government's extreme stress test scenarios show that it may need to intervene with public finances to support system-critical assets for security of supply. This could mean keeping coal assets in reserve, like Germany is doing. Alternatively, Czech Republic does not rule out setting up a capacity mechanism in the future, if the transmission operator CEPS deems it necessary. As in Poland, Czechia would have to comply with the EU regulations on emissions for capacity

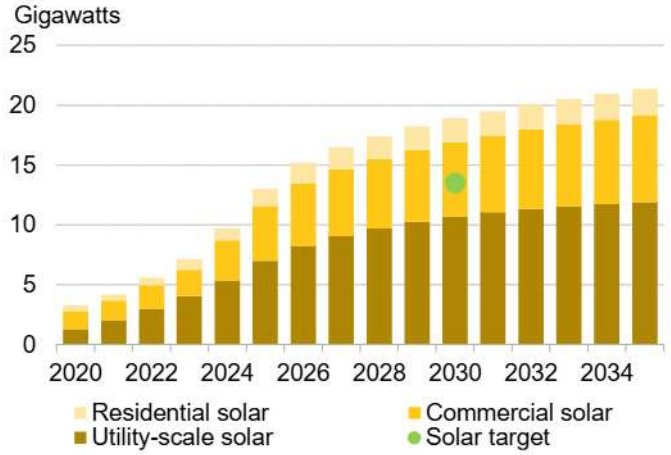
markets, which make coal ineligible for capacity market contracts from July 2025, unless exempted.

Greece

Clean power

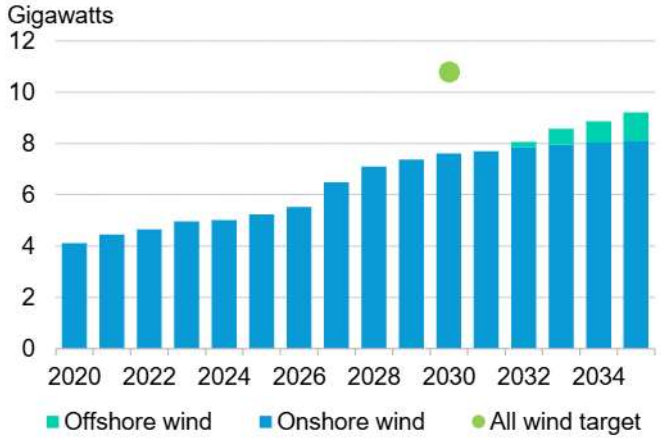
Greek solar installations are growing rapidly, and the country is projected to significantly exceed its 2030 solar target of 13.5GW. Growth is expected to shift towards smaller scale installations, as utility-scale solar approaches saturation. The wind sector has greater challenges, and the country is likely to miss the 8.9GW onshore and 1.9GW offshore wind targets, in part due to uncertainty in new large-scale auctions, which is dampening the forecast.

Figure 39: Cumulative solar capacity, historical and forecast, Greece



Source: BloombergNEF

Figure 40: Cumulative wind capacity, historical and forecast, Greece



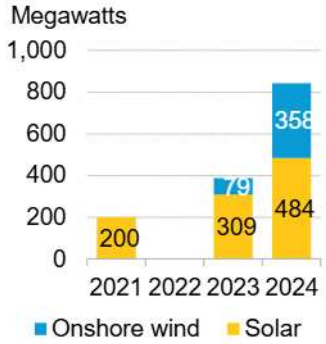
Source: BloombergNEF

Small-scale solar drives future additions, and auction uncertainty curbs wind growth

In 2024, 2.6GW of new solar capacity and around 50MW of onshore wind were installed. Corporate PPAs are a key driver for utility-scale solar and wind, but solar is somewhat limited by increasing levels of curtailment, and wind development is affected by uncertainty in future renewable auction rounds. Residential and commercial solar installations are expected to drive an increasingly larger share of new solar power.

The growth of commercial solar installations is supported by a net metering scheme that is in the process of transitioning towards net billing. Net metering, which also exempted residential users from value added tax on exported electricity, terminated on May 16, 2024, under the 5106/2024 law. This has been replaced by a net billing scheme, that was released in April 2025. In between the closing of net metering and the start of net billing, installations that applied to the net metering program before the May 2024 deadline were still driving additions. The net metering scheme supported around 400MW of the 1.3GW new-build small-scale solar segment in 2024. See *1Q 2025 Global PV Market Outlook (web | terminal)*.

Figure 41: Corporate PPAs by signing year, Greece



Source: BloombergNEF

Corporate PPAs are supporting large scale renewable projects, with 484MW solar and 358MW wind PPA deals signed in 2024, up from a combined 388MW the previous year. This additional capacity will come online over 2025-2027 and will mainly serve the technology and energy and metallurgy sectors (Amazon and Metlen Energy & Metals). Non-corporate utility solar PPAs are also a route to market. A 567MW solar project developed by PPC and RWE signed a 10-year offtake agreement with PPC's power trading branch.

The power market is already hitting constraints for solar development, with daytime prices low and curtailment levels increasing. We therefore expect the utility-scale market to stagnate. Solar developers might look for protection in renewable energy auctions, but the rounds expected for 2024 did not take place. This particularly limits routes to market for further wind development, which typically benefits the most from price guarantees.

Context: In a solar-saturated market, prioritizing schemes to increase flexibility could benefit the system more than awarding more auctioned CfD contracts for solar capacity. The same statement is not true for wind, which has different generation patterns. Auctions for new wind capacity could bring system benefits and reduce power sector emissions.

The Greek government plans to expand offshore wind, with a target of 1.9GW of capacity by 2030 and up to 4.9GW in 2032. Due to the early stage of project progress, uncertainty in auctions and long timelines for construction, BNEF only expects some small bottom-fixed projects to come online in 2032, and floating ones from 2034. Nascent and costly floating offshore wind is particularly important for Greece, as its coastline has deep waters, which limits suitable sites for bottom-fixed offshore wind. Developments for the sector will hinge on timely seabed lease tenders, after which contracts for difference auctions are scheduled to take place, probably sometime after 2027.

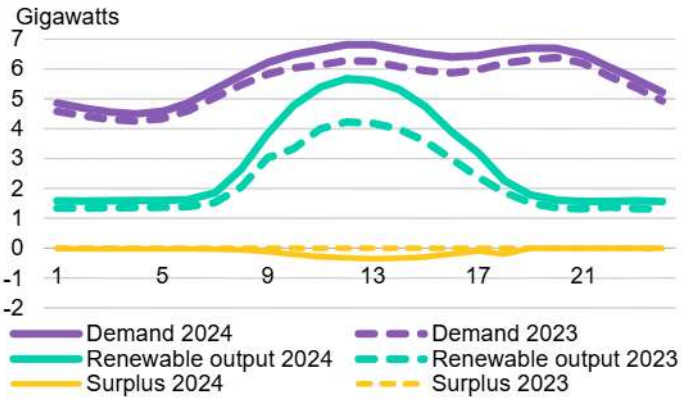
Flexibility, grids and storage

Midday curtailment is rising fast, and the grid is implementing contingency plans

Instances of energy surplus and renewable energy curtailment are becoming increasingly frequent in Greece, due to the rapid rise in solar (Figure 42). This will rise as solar penetration increases in Greece and in its neighboring countries. Renewables saw around 900GWh of curtailment in 2024, equivalent to 3.6% of renewable production, up from 228GWh in 2023 (1.2% of renewable generation). Energy surplus is particularly pronounced in the month of April, when the sun is high and the energy demand is low. In April 2024, surplus reached 11%.

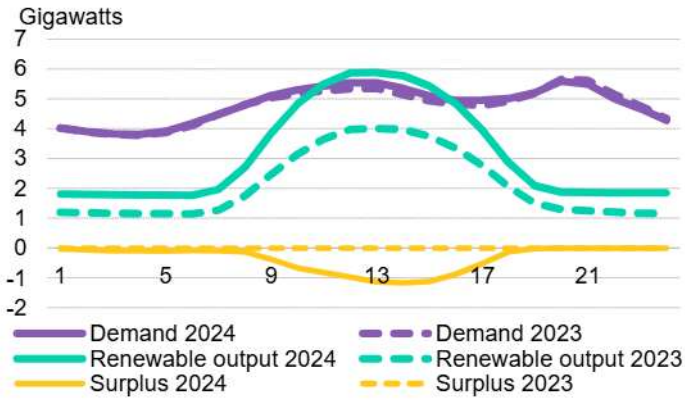
Greece is struggling to manage all this new and variable power generation. In May 2024, Law 5106/2024 mandated owners of renewable energy plants and combined heat and power exceeding 400kW to install remote monitoring and control equipment by December 13, 2024. This allows the grid to switch off plants in moments of oversupply.

Figure 42: Power demand, renewable output and power surplus averaged over the year, Greece 2023 and 2024



Source: BloombergNEF, RAAEY

Figure 43: Power demand, renewable output and power surplus averaged over April 2023 and April 2024, Greece

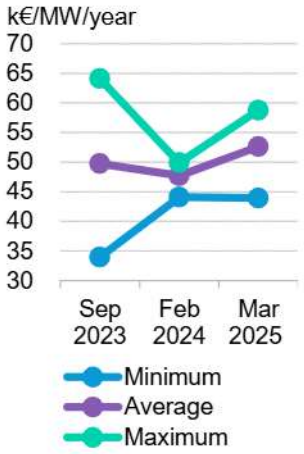


Source: BloombergNEF, RAAEY

Greece is also working on connecting its islands to the main grid and on increasing cross-border interconnection to better allocate the current power oversupply and to decarbonize. For example, the island of Crete was first connected to the mainland in 2021, and a second connection is set to come online in 2025, through a HVDC cable. A 1.4GW interconnector with Bulgaria was added in 2023, and it is possible that a new 500MW HVDC cable will increase the Italy-Greece interconnection by 2031.

Batteries are becoming more established, after learnings from storage auctions

Figure 44: Awarded bids in Greek battery auction rounds



Source: BloombergNEF

Greece is looking to batteries and energy storage as another way to manage growth in variable power. In June 2023, Greece became one of the first European countries to establish auctions for batteries, seeking 1GW of storage capacity across three auction rounds. After the completion of auctions, the government is hoping for projects to come online without further subsidy support.

As of April 2025, all three planned storage auctions have taken place, contracting almost 900MW of new battery storage capacity. The scheme offered a capital expenditure grant in €/MW and a 10-year operating subsidy in the form of two-way CfDs in €/MW/year. While the auctions kick-started the market by attracting otherwise hesitant developers, the reduced market risk coupled with the removed upside potential led to aggressive competition and very low prices. The weighted average CfD price across rounds was €49.6k/MW/year, but if batteries went merchant, they would have had revenues of €117.8k/MW in 2024. For more, see *Greek Energy Storage Auction Offers De-risked Returns (web | terminal)*, and *EU Battery Storage Projects Forgo Returns for Lower Risk (web | terminal)*.

The Greek government does not plan to hold further auctions, as it considers that energy storage is already economically viable without support schemes. Min-max power price spreads from April 2024 to April 2025 averaged €184/MWh, well above the €119/MWh threshold that BNEF estimates is required to make a 2-hour battery storage system economically viable in 2025. For more, see *1H 2025 Energy Storage Market Outlook (web | terminal)*.

The Greek government plans to auction grid connections to keen developers, seeking an additional 4.7GW of energy storage capacity. Regulations such as Ministerial Decision ΥΠΕΝ/ΓΔΕ/28255/1143 (Government Gazette 1248/B/13.03.2025) help prioritize grid connections for storage.

Context: By providing fixed annual revenues, the Greek storage auction's design did not provide incentives to run the battery optimally for the power system. For optimal policy design, a cap and floor subsidy scheme could provide better market incentives.

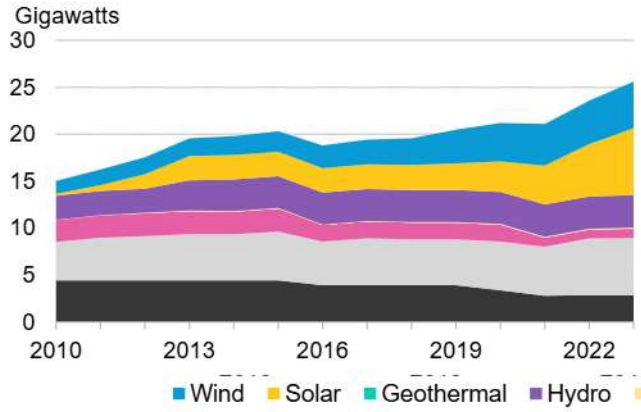
Some of the competitive bids and storage auctions came from developers that also own gas assets. These players may have been trying to protect their existing investment in the balancing market and even accept a small loss on the battery installation, while pushing away other battery-only developers.

The next wave of projects will be more competitive. Without storage subsidies in place, developers may build to benefit from structurally high spreads driven by high solar penetration and a tight power market increasingly dependent on peak pricing gas, as Greece and neighbors phase out coal and build new firm capacity.

Dispatchable mix outlook

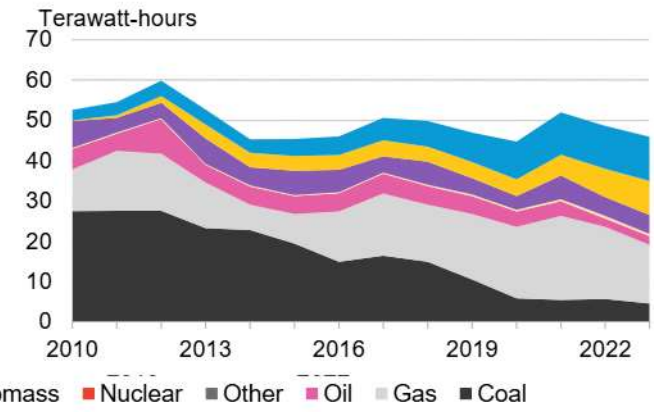
Greece's energy mix is increasingly shifting towards a system supported by natural gas and renewables, while coal is rapidly losing its share in the generation mix due to the rising cost of European emissions and as the country nears the 2028 coal phase-out target. As of March 2025, around 2GW of coal assets remain online, after 900MW of coal capacity retired in 2024.

Figure 45: Cumulative power capacity, Greece



Source: BloombergNEF

Figure 46: Annual electricity generation, Greece



Source: BloombergNEF

Some of this lost firm capacity will be replaced by gas. Two new gas plants, Alexandroupolis and Gek Terna Komotini, are scheduled to come online in 2025 and 2026, adding 1.7GW of capacity. Another ~3GW of new gas plant pipeline has been announced, but BNEF expects some of this to be abandoned, as more gas capacity may not be needed and projects have not reached a final investment decision. The recent rise in battery capacity may compete with gas plants and could also deter new gas plant construction.

Hungary

Clean energy

Hungary's solar installations are on track to meet the 12GW solar target by 2030. However, the 1.1GW by 2030 wind target may not be met, as a recent ease in permitting regulations for

onshore wind comes too late: grid connection pipelines are already swamped by the solar queue. Further nuclear reactor commissioning is strictly dependent on the timeline and outcome of the Russia-Ukraine war.

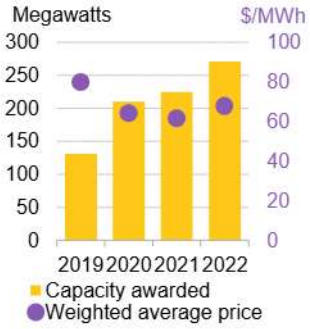
Solar's brief boom is set to taper off over hurdles to get grid connection permits

Hungary's solar capacity more than tripled between 2020 and 2024, reaching 7.5GW. Some projects were built to sell on the merchant power market at high prices during the energy crisis, and some relied on auction contracts for power. Several auction rounds ran between 2019-2022, providing 15-year two-way CfDs to over 800MW of solar, with winning bid prices between $62-80/MWh (Figure 47). Corporate PPAs have not been a driver of solar installations so far.

We expect the recent acceleration in solar development to end due to the absence of new auctions after 2022, and the lack of any newly granted connection permits over the past two years, as reported by Hungary's solar association.

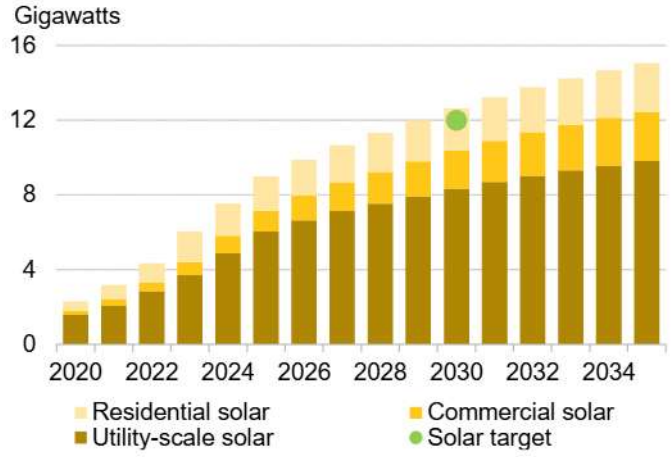
Residential solar is largely driven by subsidies, such as the Napenergia Plusz Program, which provides grants for residential solar and battery installations. Without grants, residential solar additions in Hungary would be small and stagnant, as the partially liberalized power market structure does not provide strong incentives to install rooftop solar. Residential electricity prices are regulated by the state and fixed at around €0.11/kWh, a subsidized rate maintained throughout the energy crisis. The government has no announced plans to change the market structure.

Figure 47: Awarded solar auction capacity and price, Hungary



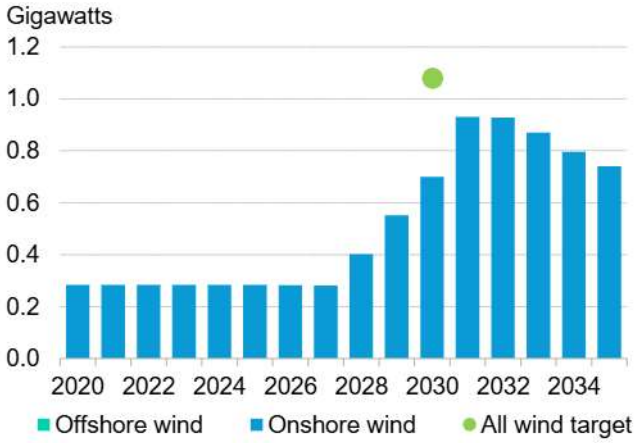
Source: BloombergNEF

Figure 48: Cumulative solar capacity, historical and forecast, Hungary



Source: BloombergNEF

Figure 49: Cumulative wind capacity, historical and forecast, Hungary



Source: BloombergNEF

Easing wind permitting but grid bottlenecks

BNEF expects Hungary to miss its 1GW onshore wind target by 2030, with most wind development likely to be postponed to later in the decade, due to late regulatory reforms and existing grid constraints.

Government Decree No. 660/2023 (XII.28), effective from January 1, 2024, reduces the minimum distance between wind turbines and residential buildings to 700 meters, from 12 kilometers previously. However, this change comes too late. The grid queue is already swamped with

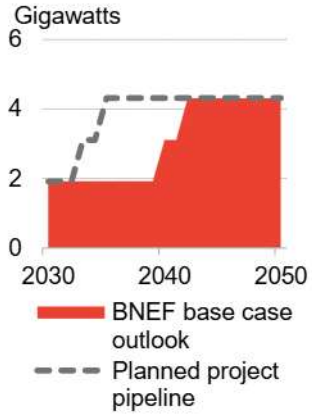
connection requests from solar projects, which may delay access to wind turbines in the near term.

The recent wind-stimulating reforms were partly driven by EU pressure to remove barriers to renewables development and to contribute to decarbonization targets. New wind installations had been banned in Hungary since 2016, when Government Decree No. 277/2016 (IX.15.) prohibited the installation of wind turbines within a 12-kilometer radius of residential areas, and subsequent regulations restricted the issuance of permits for wind development.

Nuclear development complicated by the Russia-Ukraine war

The Hungarian government aims to expand its nuclear reactor fleet by building two new 1.2GW units to the existing 2GW Paks nuclear plant, which in 2023 provided 45% of the country's electrical generation. However, the Russian war is complicating nuclear plans, now subject to political debates, financial stress and uncertainty.

Figure 50: Planned nuclear pipeline versus BNEF base case outlook, Hungary



Source: BloombergNEF

The existing Paks plant operates with Russian reactors, and the Hungarian government was planning to use the same technology for the new units, ensuring continuity and familiarity with the maintenance and operation of the reactors. Before the Ukraine-Russian conflict, the government was in talks for a deal where the Russians would finance 80% of the plant through a $10 billion loan, but a final investment decision was not reached due to a debate over the interest payment. Then the war started. The cost of the war may inhibit Russians from being able to commit the money to the new nuclear reactors, and this is aggravated by the EU's pressure on Hungary to not use Russian reactors.

Excavation work to extend the plant has already been completed, but stakeholders are still negotiating terms for financing. The first concrete was expected to be poured in early 2025, and BNEF estimates that this could mean that the reactors could come online from 2040, but delays could be substantial. The government's latest NECP expects the new reactors to be commissioned by 2035.

Flexibility, grids and storage

Hungary's grid is struggling to connect more renewable energy

In 2022, transmission system operator MAVIR announced that no further grid connection capacity was available for solar or wind. Since then, no new grid connection permits have been granted to renewables, according to an interview to the head of Hungarian Solar Association with PV Magazine in 2025.

To manage the backlog and limited capacity more efficiently, the government issued Decree No 54/2024, introducing an order of preference for evaluating grid connection applications, which prioritizes projects with earlier commissioning timelines and ones that have provided financial securities and binding declarations. The decree also mandates automatic rejection of projects to be connected after 2030.

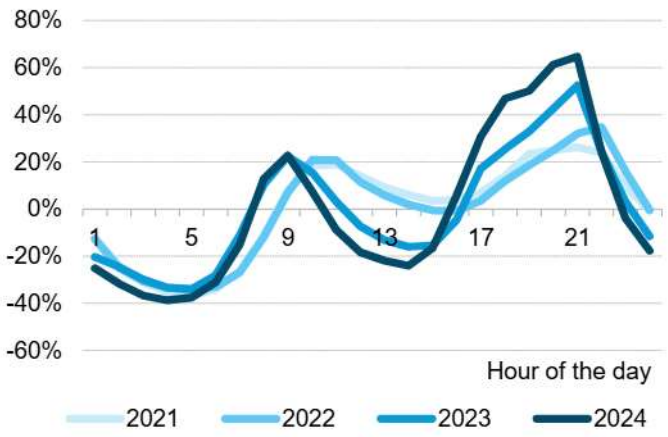
Investment in the grid is increasing. The 2022 network development plan approved by the regulator sees an investment of HUF 400 billion ($1.1 billion) across four years. This brings grid investment closer to that of European peers, accounting for the power system size.

Policy supports new storage capacity, as daily power price volatility increases

The Hungarian government is supporting storage capacity development through a series of subsidies, targeting 1GW of storage capacity by 2030. The daily power price is already volatile (Figure 51 and Figure 52).

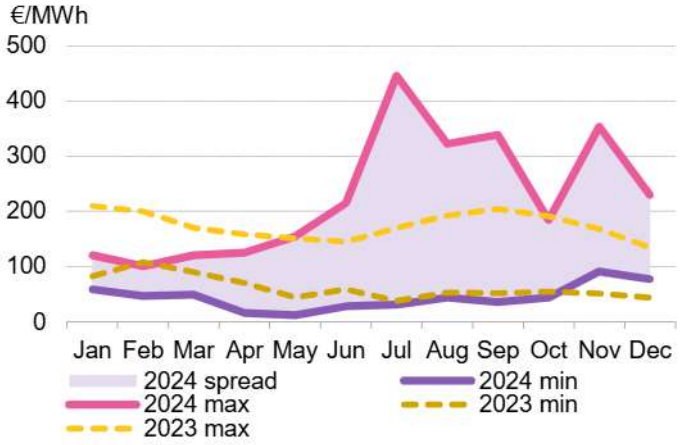
In June 2023, the European Commission approved a €1.1 billion support scheme for the development of at least 800MW/1600MWh new electricity storage facilities in Hungary. The scheme supports competitive bidding processes for grants and two-way CfDs covering the first 10 years of operation, and is funded by the Modernization Fund, the Recovery and Resilience Facility and a levy. Support must be granted by December 31, 2025, and projects must be operational within 36 months of contract signing, meaning the latest commissioning deadlines are in late 2028. An oversubscription rule mandating at least 50% of oversubscription to awarded capacity ensures that the auction is competitive and not over-generous.

Figure 51: Hourly power price deviation from average in Hungary



Source: BloombergNEF

Figure 52: Average daily power price spread, 2023-2024, Hungary



Source: BloombergNEF

The first CfD tender took place in January-February 2024, awarding 440MW of minimum two-hour-duration battery projects, with completion expected by April 2026. This tender allocated HUF 62 billion (€158 million). Additional tenders may be launched before the December 31, 2025 expiry of the European Commission-approved scheme, to fully allocate the available budget.

Hungary's daily power price volatility is growing and will rise further (Figure 51), creating opportunities for merchant storage, though eventually if the nuclear comes online the power price volatility will fall. As in other Southeastern European markets, the average daily power price spread amounted to €180/MWh in 2024. BNEF estimates that 2-hour battery projects coming online in 2025 need a daily spread of at least €119/MWh throughout their lifetime to be economically viable. For more, see *1H 2025 Energy Storage Market Outlook (web | terminal)*.

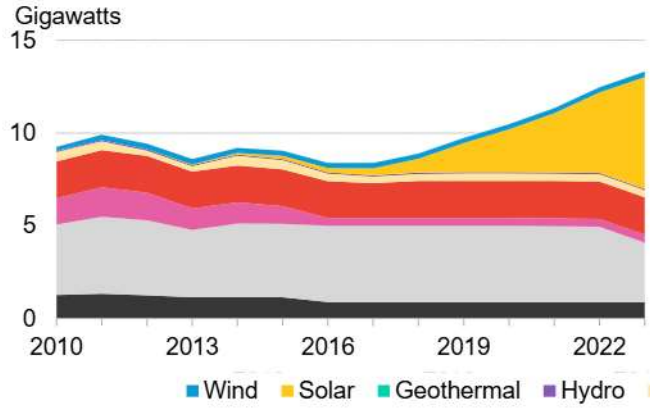
Dispatchable mix outlook

Hungary's gas capacity is expanding, in part to replace coal

Hungary delayed its 2025 coal phase out target, after the government stated that the 884MW lignite units at Matra plant will not be decommissioned until new gas replacement units come online at the same site over 2027-2029.

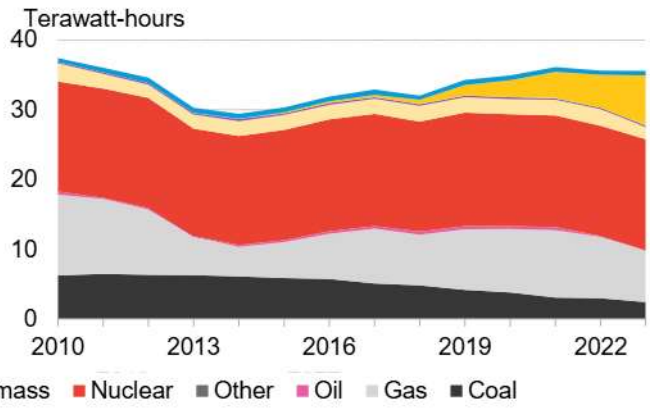
Hungarian state-owned utility MVM Group signed the development contract for the Matra gas replacement units in February 2025, after a tender procedure that selected Status KPRIA, Elsewedy Electric Egypt, and West Hungária Bau as the suppliers. According to the companies' public statements, the gas plant will have a capacity of 650MW and will be able to burn a 30% hydrogen blend. The potential implementation of carbon capture and storage was also mentioned in press releases.

Figure 53: Cumulative power capacity, Hungary



Source: BloombergNEF

Figure 54: Annual electricity generation, Hungary



Source: BloombergNEF

The development of another CCGT is also under evaluation to help manage intermittent renewable generation. The Tisza II project would take advantage of the grid connection of a previously retired gas plant and add up to two 500MW gas power units. Public conditional procurement was concluded by MVM Group in February 2024, and a final investment decision is expected after the finalization of a financing structure.

The increasing solar and gas capacity will eat into the market for less-flexible nuclear generation. Unless power demand increases, or Hungary wants to decrease its import dependency, additional nuclear units may not be required until the old nuclear units retire. Over May 2020-2025, 27% of Hungary's demand was met by net imports. See *European Power Markets Monitor LiveSheet (web | terminal)*.

Bulgaria

Clean power

BNEF expects Bulgaria to exceed its 2030 6.8GW solar target[3], driven by a rapid rise in large-scale projects. The 2.5GW wind target is unlikely to be reached. Further nuclear developments remain costly and highly uncertain.

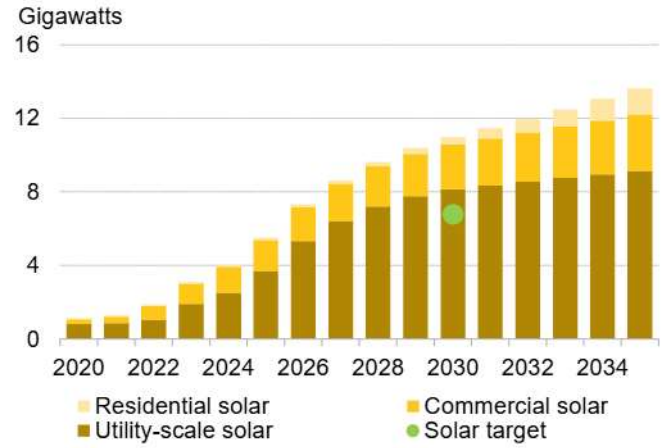
Utility-scale solar rises, but new projects are stuck in the grid queue

Cheap solar, high power prices and a positive permitting environment caused the capacity of solar in Bulgaria to more than triple in just three years, reaching 4.5GW in 2024 due to a combination of merchant and corporate PPA-linked utility-scale projects. Renewables and storage

[3] Bulgaria's National Energy and Climate Plan does not define a specific target, but instead a forecast for the energy mix by 2030. BNEF treats this as a target.

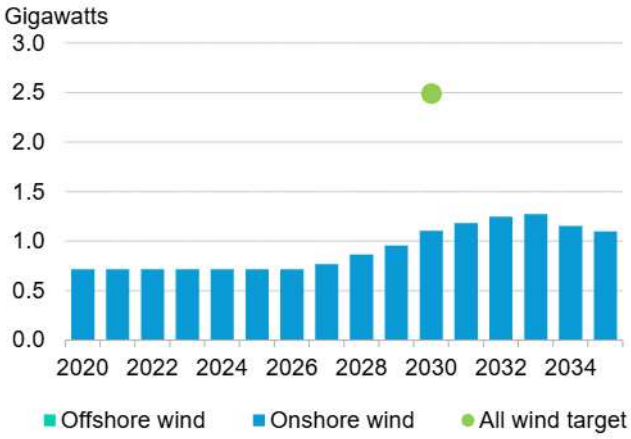
grant auctions tendered in 2024, and an activating solar corporate PPA market (Figure 57), will drive some build, while grid challenges and market saturation may slow growth (see flexibility section below).

Figure 55: Cumulative solar capacity, historical and forecast, Bulgaria



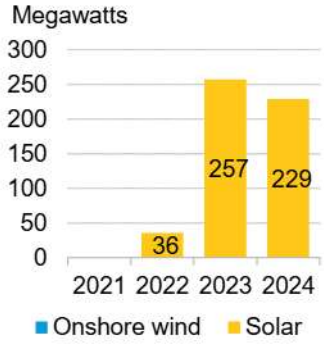
Source: BloombergNEF

Figure 56: Cumulative wind capacity, historical and forecast, Bulgaria



Source: BloombergNEF

Figure 57: Corporate PPAs by signing year, Bulgaria



Source: BloombergNEF

In 2024, the government rolled out a grant tender for the construction of co-located renewables and energy storage, with BGN 535 million (€269 million) from the country's Recovery and Resilience funds. The auction, which covered up to 50% of storage installation costs for co-located projects, awarded support for the development of 2.84GW of renewables, co-located with 1.18GW of storage capacity – much more than the expected 1.4GW of renewables and 0.35GW of storage. Projects are to be commissioned by March 2026. While the split between the awarded solar and wind capacity was not publicly disclosed, BNEF expects most to be solar.

The Bulgarian solar rooftop market is currently limited by the partially liberalized power market structure. Residential electricity prices are currently regulated by the state and fixed at around €0.12/kWh, a subsidized rate maintained through the energy crisis. The country's Recovery and Resilience Plan targets to liberalize the market by 2026, which, if and when implemented, may raise residential prices for power.

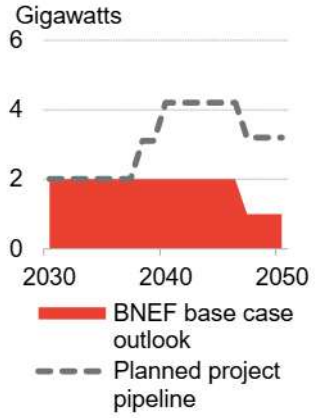
The 2030 2GW onshore wind target is likely to not be reached, due to administrative bottlenecks, such as complex permitting procedures and regulatory headwinds, and local resistance. No corporate PPA activity is known to BNEF. No progress is expected for Bulgaria's 0.5GW offshore 2030 target. As in Romania, offshore wind development is limited by the hurdles of getting an offshore installation vessel into the Black Sea under the low bridges of Istanbul.

New nuclear reactor costs are underestimated

Bulgaria is positioning new nuclear as a key pillar of its power sector decarbonization, but this looks far-fetched. According to the National Energy and Climate Plan, the country is aiming to add 2GW of nuclear capacity by 2040, on top of the 2GW currently in operation at the Kozloduy reactor site (Figure 58).

In 2023, Westinghouse AP1000 technology was selected to commission two new 1,100MW units (unit 7 and unit 8) at the Kozloduy plant. The government's cost estimate implies just €5.6 billion for the commissioning of the two nuclear units, according to the investment plan in the NECP.

Figure 58: Planned nuclear pipeline versus BNEF base case outlook, Bulgaria



Source: BloombergNEF

BNEF believes this to be a severe underestimate compared with other benchmarks. For example, $18 billion are under discussion for Korea Hydro & Nuclear Power company's proposed 2.1GW nuclear reactor in Czech Republic – roughly three times the Bulgarian government's planned investment, for a similar reactor size. For more, see *Nuclear 1H 2025 Market Outlook (web | terminal)*.

Flexibility, grids and storage

Plenty of solar already, grid struggling to process new connection requests

A rising trend of solar oversupply was noted by Angelin Tsachev, CEO of ESO, the Bulgarian transmission system operator, in an interview conducted by Economic BG in 2023 where he called for more storage and grid investment.

More investment in the grid would also help manage the grid's connection queue. In 2022, ESO noted that transmission grid connection requests were reaching the 24GW maximum capacity. As of May 2025, the map of freely available transmission grid connection shows widespread saturation, with 0MW of capacity available to connect in most substations. BNEF deems that ESO could also explore flexible connection agreements or cable pooling to integrate renewables while the grid gets upgraded.

To prevent speculative projects from joining and clogging the grid connection queue, a March 28, 2024 amendment to the Energy Act and the Energy from Renewable Sources Act from the Ordinance (number 6) requires storage systems to provide a financial guarantee for the grid connection application. On the other hand, the amendment simplifies renewable and storage producers by only requiring rights over project land, rather than detailed design plans.

Increasing interconnection would help to ease import-export bottlenecks and smooth out power price peaks and troughs caused by the scale up of intermittent renewables. After an increase in interconnection capacity between Bulgaria and Greece in 2023, ESO is assessing an additional 2GW of interconnection with Greece, Turkey and other neighbors.

Subsidies are laying the groundwork for battery development

Policy is driving Bulgaria's battery storage market through co-located renewable and storage auctions and standalone battery grants. Hybrid renewable and storage grant auctions will bring online 1.2GW of battery systems (see clean energy section above). A standalone battery scheme called RESTORE will support the commissioning of another 9.7GWh of storage. Both schemes have a deadline of installation by March 2026.

Both schemes were oversubscribed and had better success than the Bulgarian government originally expected. RESTORE will support 9.7GWh of battery storage capacity, compared to the intended 3GWh. The available budget of BGN 1.15 billion (€590 million) offered grants up to 50% of project costs for standalone batteries.

As in other Southeastern European markets, the average daily power price spread amounted to €180/MWh in 2024. BNEF estimates that 2-hour battery projects coming online in 2025 need a daily spread of at least €119/MWh throughout their lifetime to be economically viable. For more, see *1H 2025 Energy Storage Market Outlook (web | terminal)*.

Dispatchable mix outlook

Renewables reduce coal dependency, but new hydro and gas capacity is uncertain

Bulgaria aims to phase out coal by 2038, from a capacity of 4.5GW in 2024. Coal generation is already suffering from the entry of cheaper energy sources like solar, and dropped to 27% of the total in 2024, compared to 44% in 2021. Solar's share increased to 14% in 2024, from 3% in 2021. Adverse economics could mean that coal plants may close before 2038, unless support mechanisms such as a strategic reserve or a capacity mechanism are implemented. Bulgaria needs to comply with EU regulation or ask for exemptions in order to support coal through a capacity market mechanism.

Hydropower could provide additional capacity and system flexibility. Two new hydropower projects are under evaluation at the Dospat and Batak sites, which could each add 800MW of generation, with 750MW pumped capacity per plant. In June 2024, the European Investment Bank confirmed its support to assess the technical and economic viability for the project, which the government expects to be commissioned by 2032. BNEF deems that this timeline might be optimistic, given that pumped hydro projects can take 10 years or more, from securing environmental permits to project operations. See *Pumped Hydro: A Primer (web | terminal)*.

Figure 59: Cumulative power capacity, Bulgaria

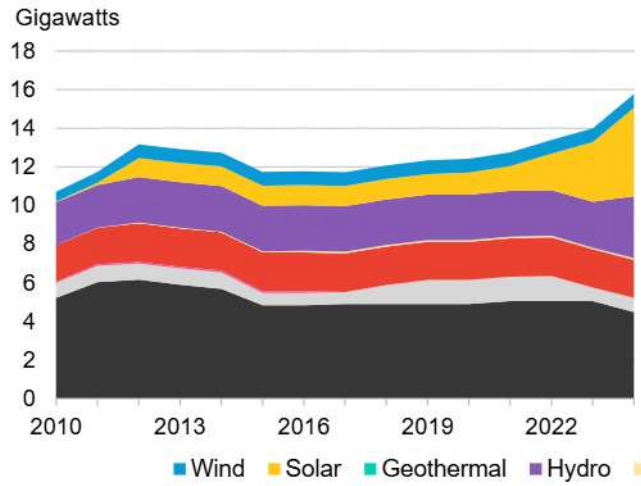
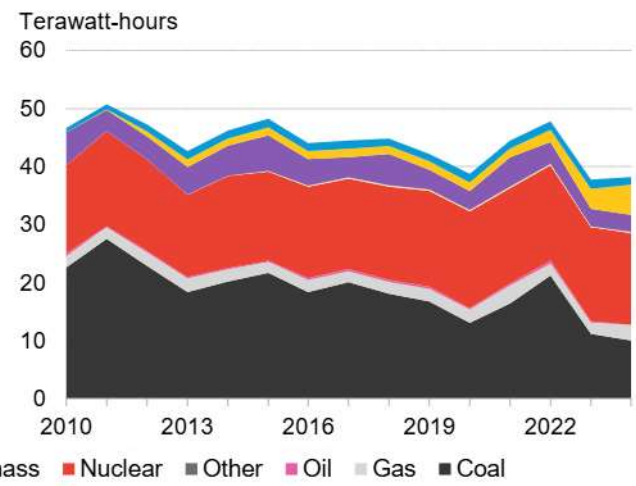


Figure 60: Annual electricity generation, Bulgaria



Source: BloombergNEF. Note: Generation decreased in 2023 and 2024 in part due to a reduction in exports.

While new gas plants may be required if the hydropower does not materialize to replace retiring coal, there are several complications. Developing new gas plants requires building new gas transmission capabilities. The recent high gas prices and the risk of stranded assets also weighs on investment decisions. This adverse situation is further exacerbated by the recent decrease in Russian flows, which challenges Bulgaria's ability to import and export large volumes of natural gas. On March 28, 2025, Energy Minister Zhecho Stankov said that Bulgaria will press ahead with a planned gas grid extension for adding capacity to transport gas to Ukraine, Moldova, Hungary and Slovakia from Greek LNG terminals. Bulgaria is also exploring domestic production of oil and gas in the Black Sea, granting new exploration rights to Shell in 2025.

Without government support or guarantees, or a clear view on gas transmission import and infrastructure, developers are unlikely to take the risk of building gas plants. Announced projects for the conversion of Varna and Bobov Dol, meant to come online in 2024/2025 have all stalled.

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