Poland Power Transition Outlook 2023

Three scenarios until 2040

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February 6, 2023

BloombergNEF

Executive summary

Poland's power sector faces significant economic- and policy-driven shifts that could see emissions fall 60-86% over 2021-2030. This report presents three BNEF scenarios for the development of Poland's power mix until 2040, using different energy policy and commodity price assumptions. All three scenarios see the role of coal changing from dominant to meager by 2030, while growing Polish electricity demand is supplied by cheaper wind and solar.

- Under all three scenarios, coal output collapses around 2030 and most units close by 2040. Some units remain online to ensure security of supply during winter peak demand, but once planned nuclear units are commissioned in the late 2030s, only one coal unit of less than 1GW remains in the system.
- Wind and solar generation grow rapidly in all scenarios, as they produce cheaper power than existing fossil fuel plants. The share of renewable generation reaches 59% by 2030 and 85% by 2040 in BNEF's Restricted Renewables Scenario (RRS), which reflects the end-2022 status of policy.
- Onshore wind build in Poland is restricted by minimum distance rules. In BNEF's Least-cost Power Scenario (LPS), where we remove these restrictions, onshore wind reaches a cumulative 33GW by 2030, driven by economics. In the LPS, the share of renewable generation reaches 78% by 2030, compared to 59% in the RRS. Slower wind build results in 36% higher cumulative power sector emissions in the RRS than the LPS over 2026-2036.
- As gas prices drop, gas plants join renewables in squeezing coal out of the generation mix over 2026-28. This happens even in the High Gas Price Scenario (HGS), where gas prices are held 50% higher than in the other two scenarios. The HGS burns 42% less gas than the RRS over 2031-40, relying more on renewables and batteries instead. Renewables can support self-sufficiency of energy supply, after coal becomes uncompetitive against gas.

59%

2030 share renewable generation under BNEF's Restricted Renewables Scenario

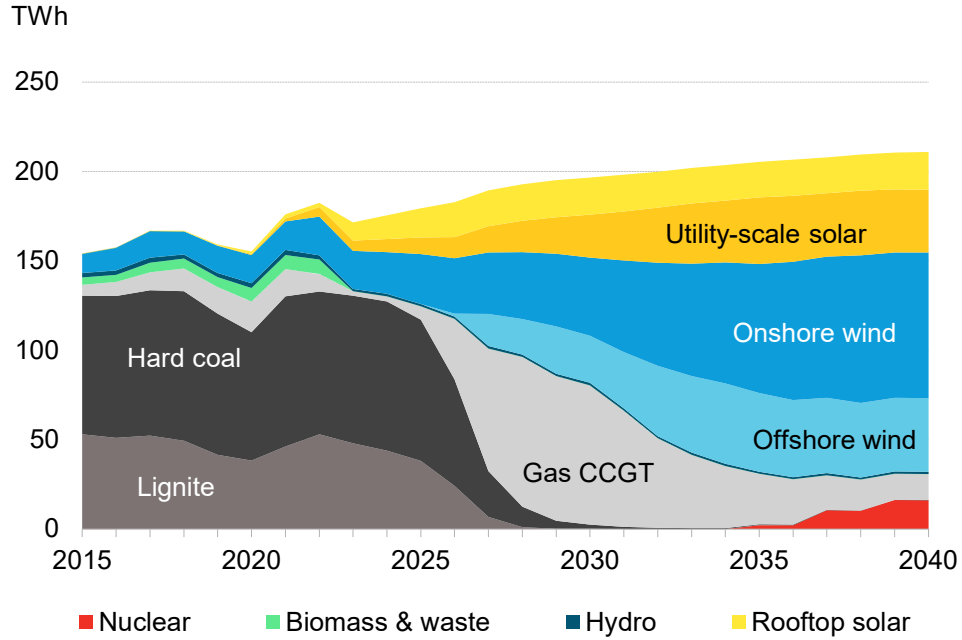
2030

The year coal generation falls below 1% of total under the Restricted Renewables Scenario

33GW

Onshore wind capacity online by 2030 under the Least-cost Power Scenario

Polish power generation until 2040, Restricted Renewables Scenario



Source: BloombergNEF. Note: CCGT is combined-cycle gas turbine

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Introduction

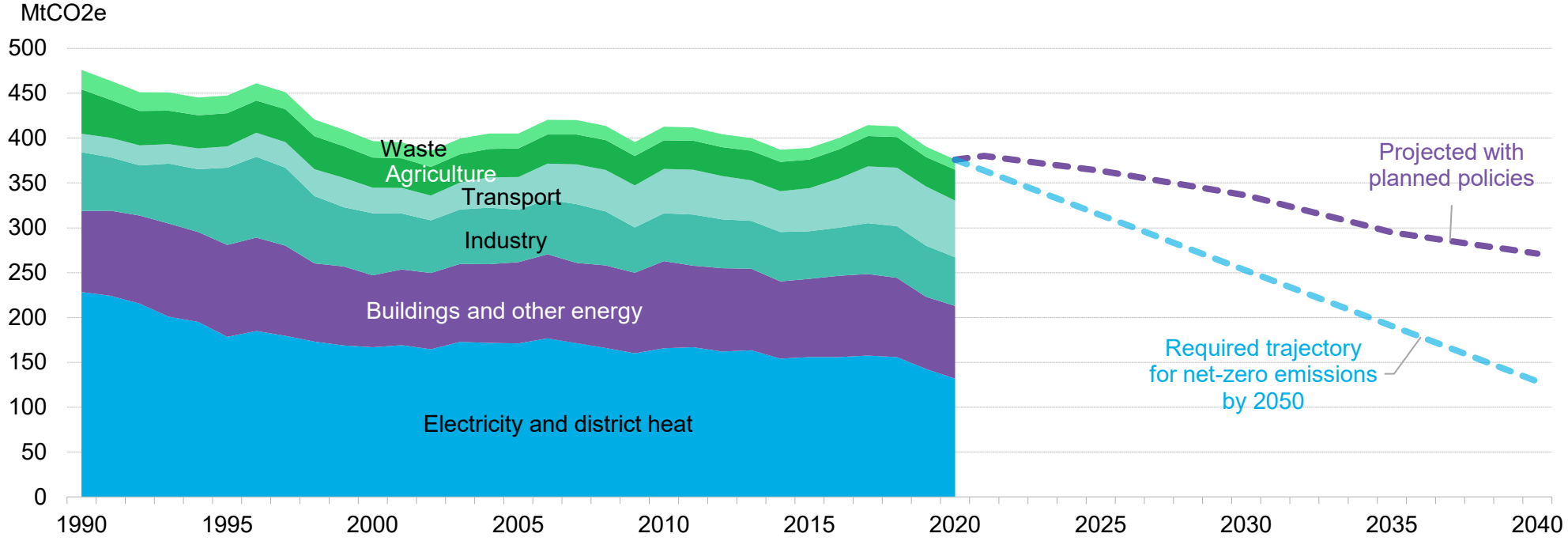
Context and overview of scenarios

Electricity generation represents over a third of Polish emissions

The power sector is a major contributor to Poland's greenhouse gas emissions, accounting for 35% in 2020 despite falling 42% since 1990. Economy-wide emissions averaged 402MtCO2e from 2000-2020 and remained largely stable despite Poland's economy more than tripling during this time. Poland has some measures in place to cut emissions, while supporting economic growth. The country submits annual emissions projections until 2040 to the European Environment Agency, under "existing" and "planned" policy scenarios. The latest outlook shows emissions dropping 28% by 2040 from 2020 levels under a "planned policies" scenario.

Poland lacks a national net-zero target, but if it adhered to the EU's net-zero by 2050 target, its 2040 emissions would need to fall to one-third of 2020 levels. This is twice as fast as the trajectory with planned policies by 2040.* Either case would see major changes for power generation, as this sector offers the most cost-effective technologies for emissions reductions; wind and solar power have already started replacing high-emitting coal power.

Poland historical and projected greenhouse gas emissions



*Source: UNFCCC, EEA, BloombergNEF. Note: Chart excludes land-use, land-use change and forestry emissions, but required trajectory for net-zero by 2050 accounts for effect of these negative emissions in Poland. *The EU net-zero emissions target is for the bloc as a whole. The net-zero trajectory outlined above assumes that Poland would reach net-zero by 2050 nationally, however Poland could emit above net-zero if this is offset by negative emissions by other EU member states.*

Scenario overview: Economics drive coal out of Poland's power mix

This report builds on the energy scenarios presented in BloombergNEF's *New Energy Outlook 2022* (web | terminal). The scenarios are modelled with BNEF's proprietary New Energy Forecast Model (NEFM), which optimizes for a least-cost capacity mix to meet hourly demand, accounting for both capital and operational costs of different generation technologies. See Appendix for more on the methodology.

For this report, BNEF has developed three additional power sector scenarios to 2040. These describe an economics-led transformation of Poland's power sector to 2040. Coal generation collapses as soon as 2030, but a few units remain online as back-up to meet growing heat-pump demand on cold days. Supply becomes dominated by variable wind and solar generation, supplemented by gas, nuclear and battery storage.

Least-cost Power Scenario

The Least-cost Power Scenario (LPS) depicts development of the power mix optimized for the lowest overall system cost. This scenario builds on BNEF's Economic Transition Scenario and accounts for legislated policies with clear implementation mechanisms, such as the capacity market and the EU Emissions Trading System.

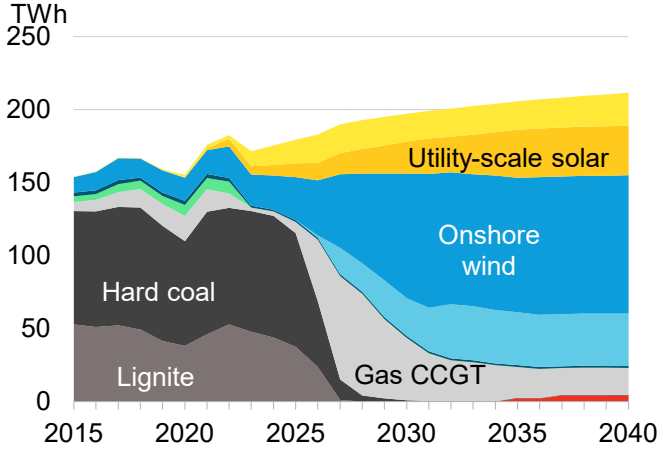
Restricted Renewables Scenario

The Restricted Renewables Scenario (RRS) includes a wider set of current and expected local energy policies. Most notably, the onshore wind fleet is limited to 17GW by 2030 and 2.2GW large-scale nuclear reactors come online in the 2030s in line with targets announced by the Polish government in July 2022.

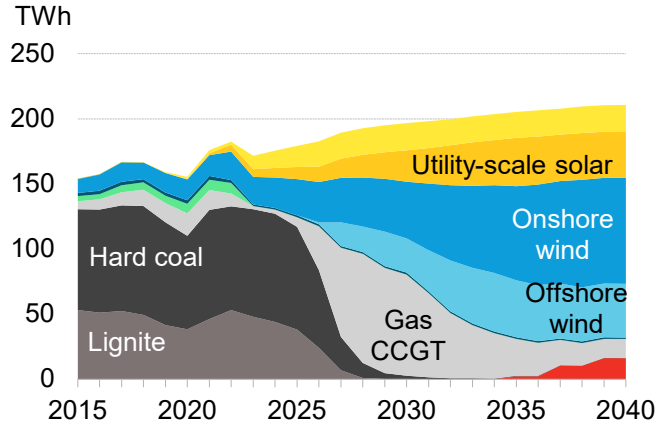
High Gas Price Scenario

The High Gas Price Scenario (HGS) builds on the RRS but assumes a prolonged energy crisis where gas prices stay above historic levels and LNG imports are limited. In the HGS gas prices are 50% higher than the RRS, and EU carbon prices are discounted by 20% until 2030, in a policy scenario allowing more coal burn.

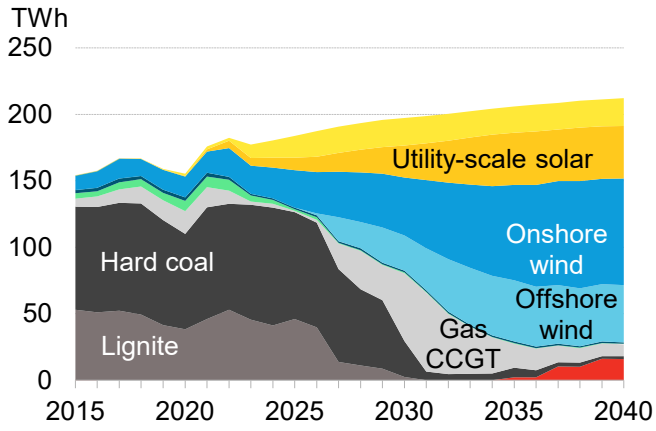
Electricity generation, LPS



Electricity generation, RRS



Electricity generation, HGS



Nuclear | Lignite | Hard coal | Gas CCGT | Gas OCGT | Biomass & waste | Hydro | Offshore wind | Onshore wind | Utility-scale solar | Rooftop solar

*Source: BloombergNEF. Note: The HGS assumes the same constraints for onshore wind and nuclear as the RRS. SMR is small modular reactor, CCGT is combined-cycle gas turbine, OCGT is open-cycle gas turbine. *LNG stands for liquified natural gas and requires terminals to be received in Poland.*

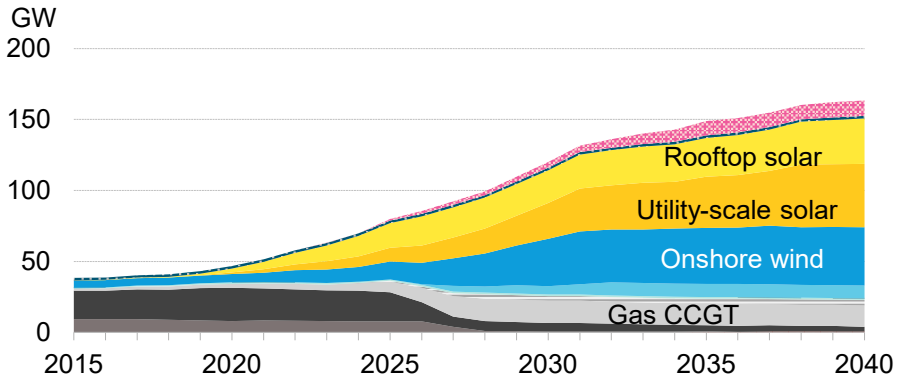
Results

Poland power system scenarios

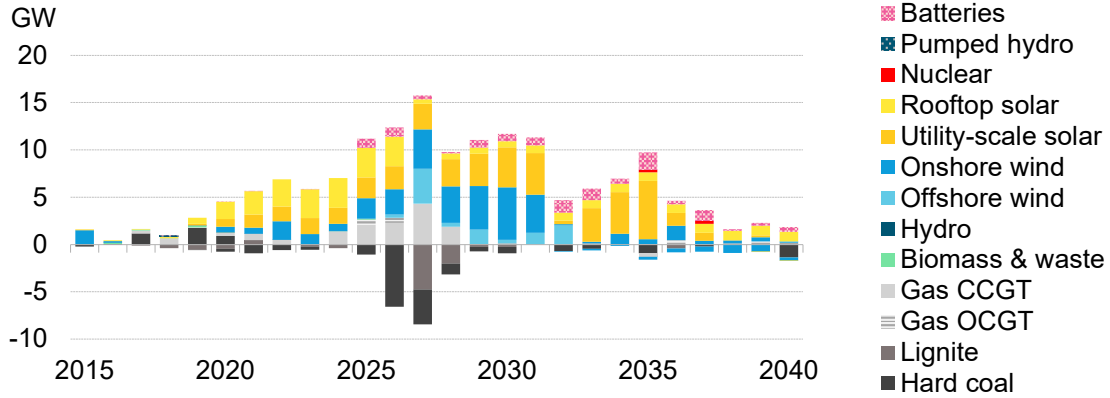
Least-cost Power Scenario: Onshore wind dominates, coal retreats

Under BNEF's LPS, Poland's coal-heavy power system has high generation costs, but shifts toward more cost-efficient technologies over time. By 2040, the power system is dominated by 37GW onshore wind and 83GW solar. This scenario sees annual PV additions of 2-4GW per year, of which roughly half is rooftop solar. Onshore wind additions pick up after 2027, with 3-4GW built each year until 2030. Offshore wind is built in line with the existing project pipeline of 10GW by 2033. A 21GW gas fleet and 10GW batteries provide back-up during occasional hours of low renewables generation. Some 3GW coal remains in 2040 to ensure system security during winter peak demand, but after 2030 it generates less than 0.4% of the time. Nuclear capacity of 0.6GW also supports peak demand after 2037. Zero-carbon sources, including nuclear and renewables, make up 78% and 91% of generation in 2030 and 2040.

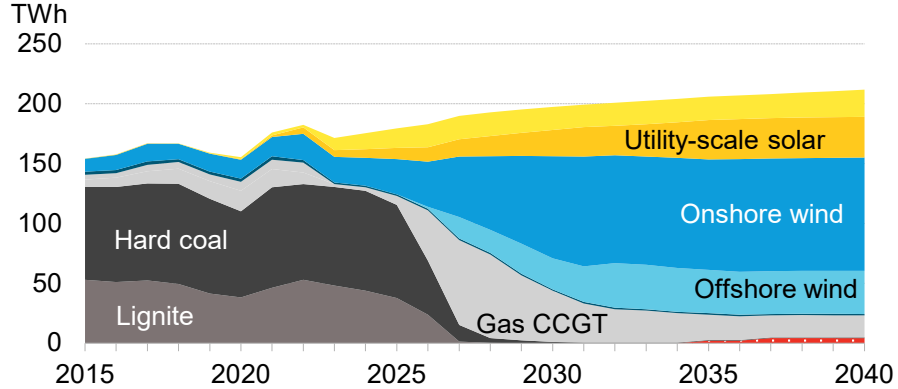
Installed capacity, LPS



Capacity additions and retirements, LPS

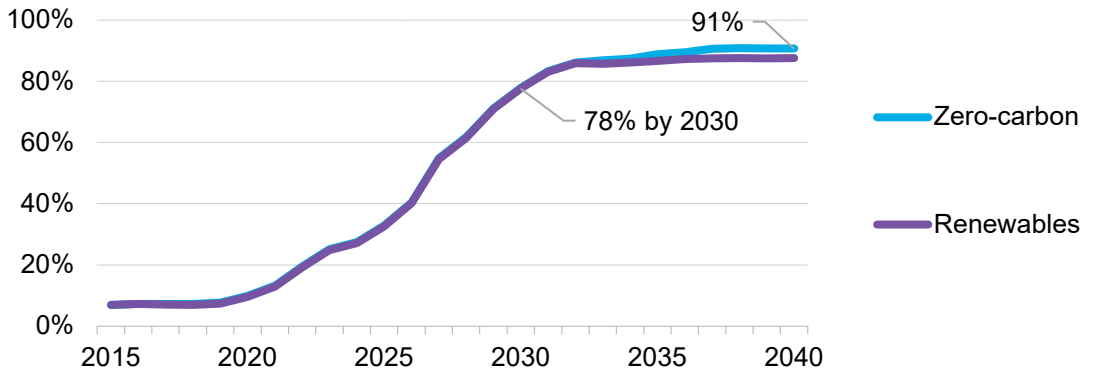


Electricity generation, LPS



Source: BloombergNEF. Note: Generation does not show use of energy storage. Graph shows actual generation until end of 2022.

Share of renewable and zero-carbon generation, LPS

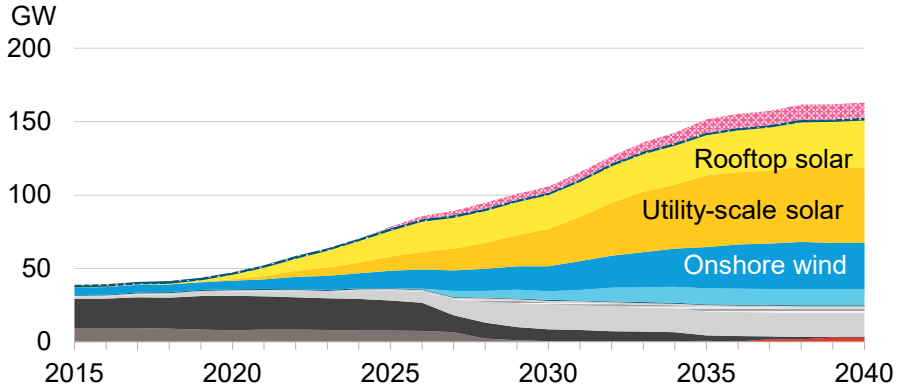


Source: BloombergNEF. Note: Renewables includes solar, wind, biomass and hydro power. Zero carbon includes renewables and nuclear.

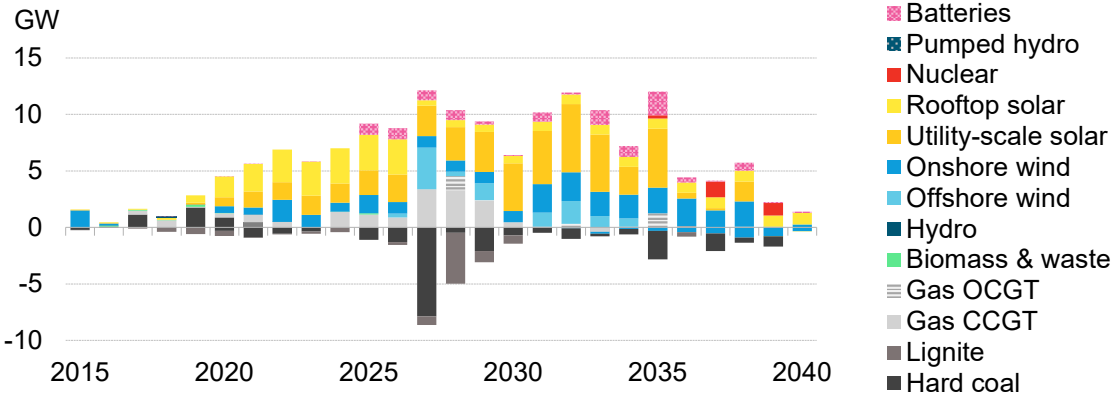
Restricted Renewables Scenario: Less wind but more natural gas

The RRS aligns more closely to current Polish energy policy, resulting in slower growth of onshore wind and the delivery of 3GW nuclear by 2040. Onshore wind totals 17GW by 2030 in the RRS, in line with the government's target announced in July 2022 and existing permitting restrictions. Instead, solar grows to 48GW by 2030. Coal retirements are slower than in the LPS, with 2GW more remaining online in 2028. But the rapid build out of a 20GW gas fleet and the nuclear additions over 2035-2039 mean that by 2040 there is enough firm capacity to meet winter peak demand with less than 1GW coal remaining. Coal provides only 1% of generation after 2030. Poland targets 6-9GW of nuclear by 2040, but BNEF expects delays in the commissioning schedule, as no nuclear project had secured financing as of December 2022, and delays are very common in the industry.

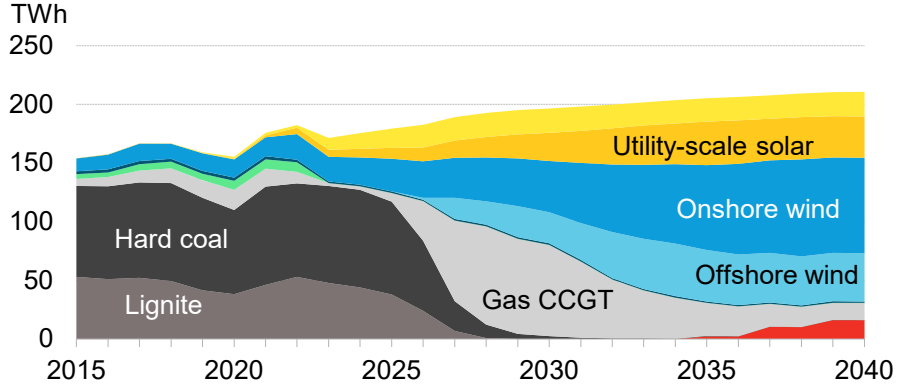
Installed capacity, RRS



Capacity additions and retirements, RRS

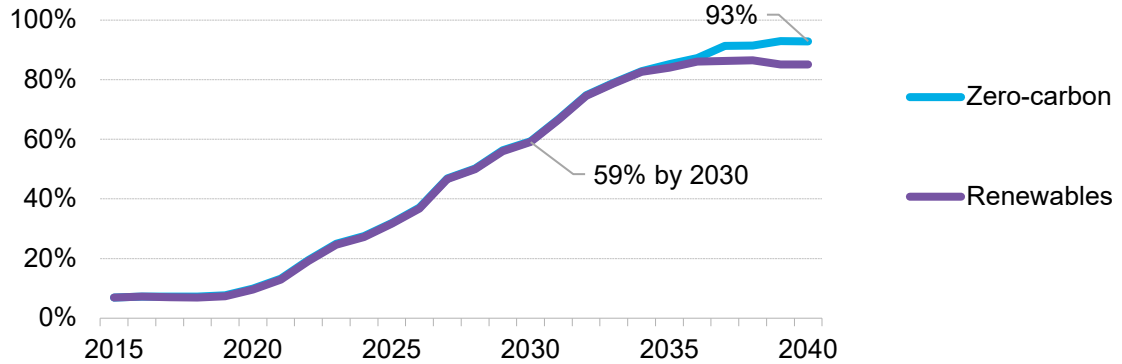


Electricity generation, RRS



Source: BloombergNEF

Share of renewable and zero-carbon generation, RRS

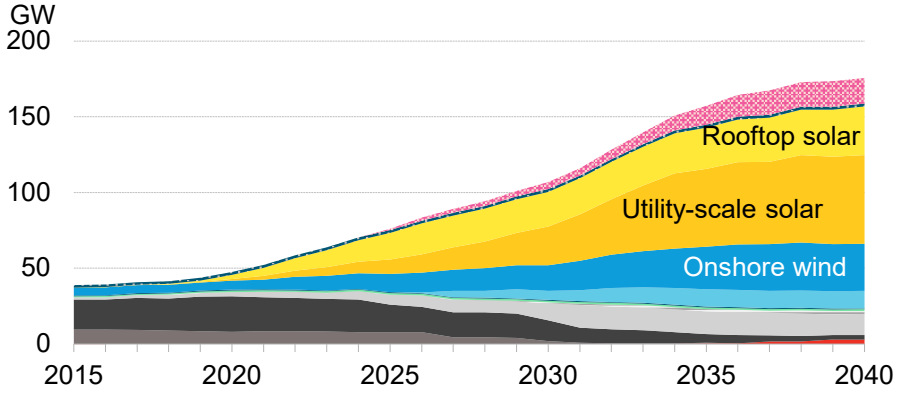


Source: BloombergNEF. Note: Renewables includes solar, wind, biomass and hydro power. Zero carbon includes renewables and nuclear.

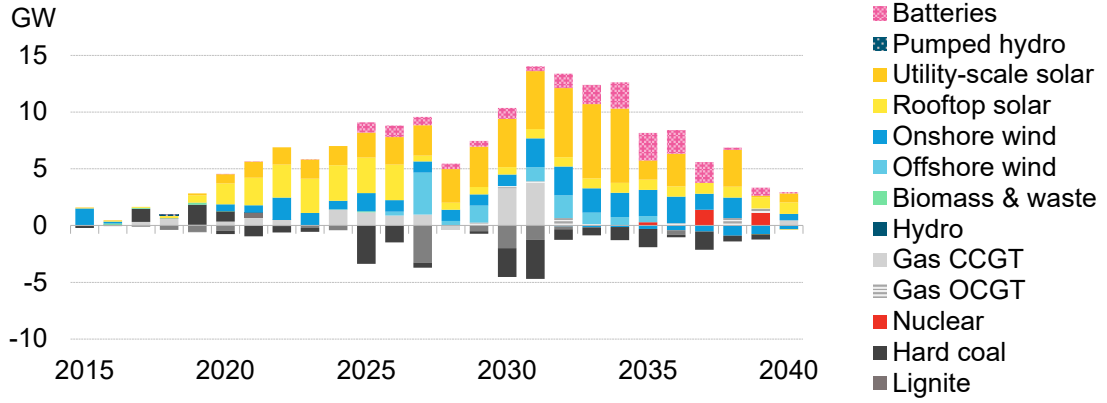
High Gas Price Scenario: Coal still generates 15% of power in 2030

The High Gas Price Scenario (HGS) is the same as the Restricted Renewables Scenario, but assumes a prolonged energy crisis with 50% higher gas prices and 20% lower carbon prices. In 2022, gas prices reached record levels and Poland stopped importing Russian gas after Russia's invasion of Ukraine. As energy prices rose, the Polish government pushed for the EU to reduce carbon pricing. Higher gas and lower carbon prices have a clear impact on thermal generation: coal still generates 15% of power over 2025-2030 in the HGS compared to 1% in the RRS. Renewable energy additions before 2030 remain largely the same as in the RRS. Over 2031-2040, retiring coal power plants are replaced by renewable energy and batteries. Lower gas generation, 3GW of new nuclear, and higher battery build enables 95% of generation to be zero-carbon by 2040.

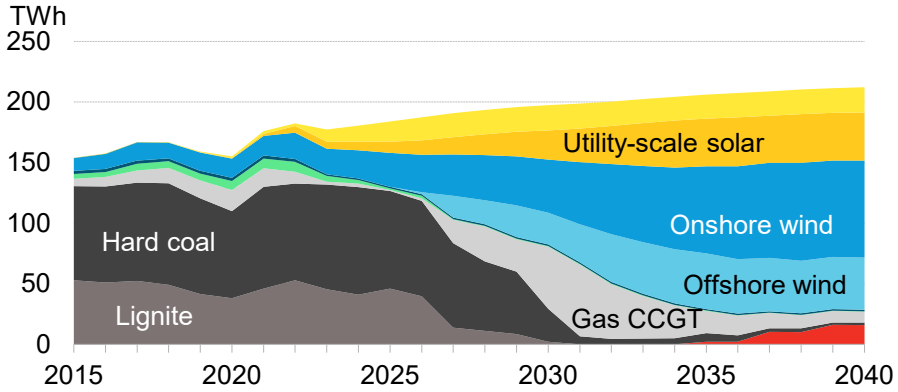
Capacity development until 2040, HGS



Capacity additions and retirements, HGS

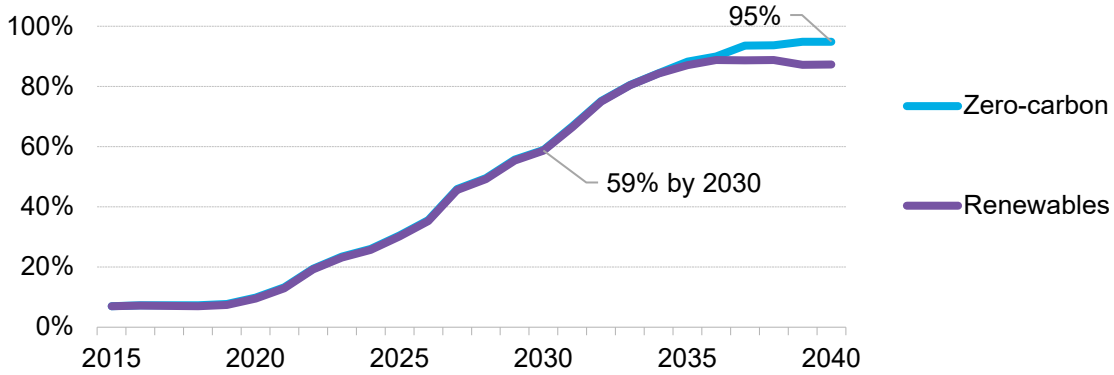


Generation mix until 2040, HGS



Source: BloombergNEF

Share of renewable and zero-carbon generation, HGS



Source: BloombergNEF. Note: Renewables includes solar, wind, biomass and hydro power. Zero carbon includes renewables and nuclear.

Scenario comparison

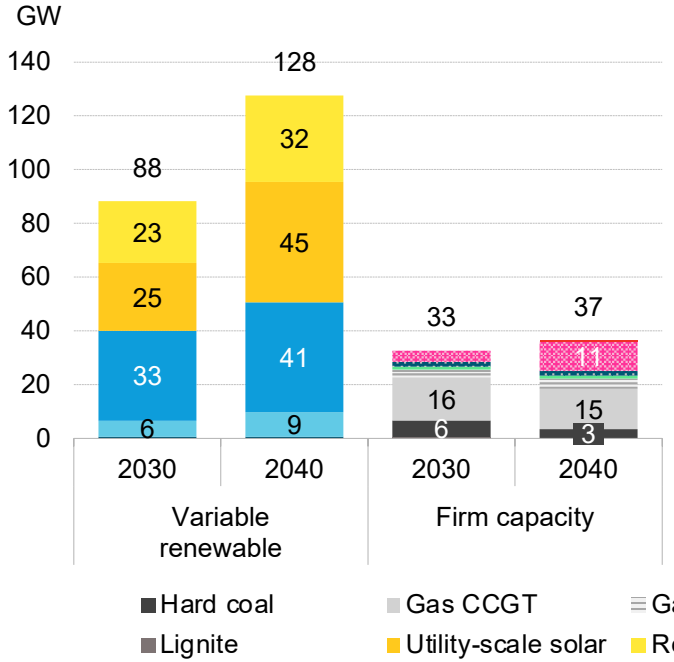
Differences in capacity, generation, emissions and cost

Solar becomes more important if onshore wind is restricted

The Least-cost Power Scenario (LPS) is dominated by cheap onshore wind, but solar plays a larger role in the Restricted Renewables (RRS) and High Gas Price Scenarios (HGS), where onshore wind build is restricted. The RRS builds 7GW solar and 2GW offshore wind more than the LPS. High gas prices and costly coal power in the HGS means that renewables become even more important, and this scenario builds 14GW more solar than the LPS. The key differences in firm capacity are in the pace of coal closure and the role of gas, batteries and nuclear. The HGS adds substantially more batteries than the other two scenarios, as they complement additional solar power that does not generate in the evenings. Nuclear and gas capacity together replace almost all coal capacity in the RRS, but the HGS retains a similar amount of coal (3GW) as the LPS in 2040 due to higher gas and lower carbon prices.

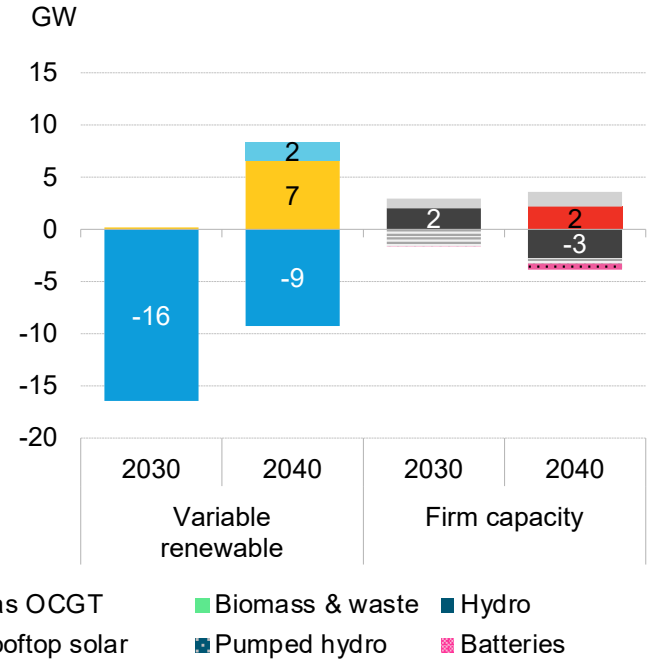
LPS 2030 and 2040 total renewable and firm capacity

Variable renewable energy, including wind and solar, make up the bulk of installed capacity by 2030. Firm capacity ensures peak demand is met.



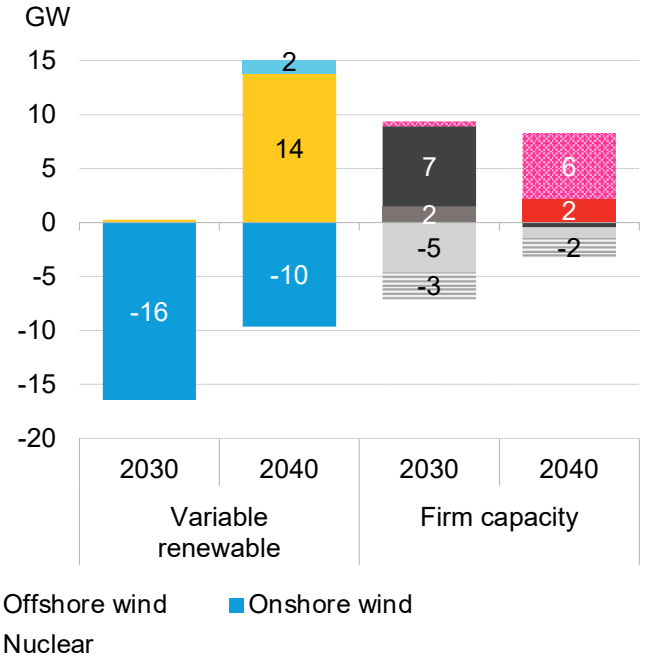
RRS versus LPS capacity in 2030 and 2040

The Restricted Renewables Scenario has 9GW less onshore wind than the Least-cost Power Scenario by 2040.



HGS versus LPS capacity in 2030 and 2040

In total, 9GW additional hard coal and lignite remain online in 2030 in the High Gas Price Scenario, compared to the Least-cost Power Scenario.



Hard coal | Gas CCGT | Gas OCGT | Biomass & waste | Hydro | Offshore wind | Onshore wind
Lignite | Utility-scale solar | Rooftop solar | Pumped hydro | Batteries | Nuclear

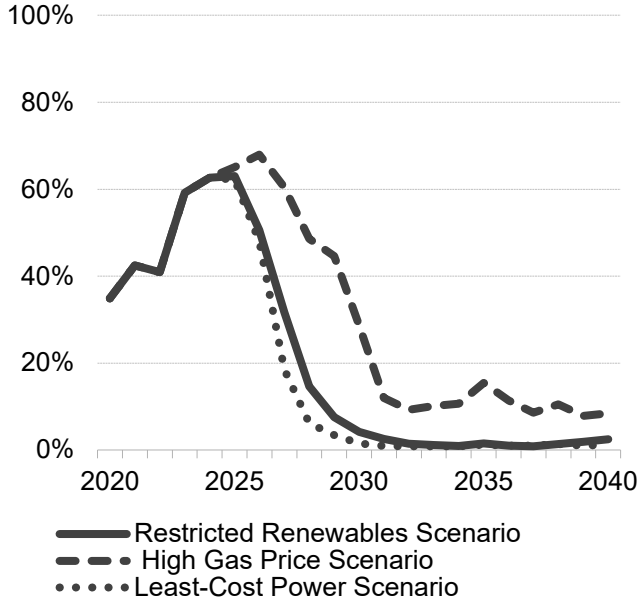
Source: BloombergNEF.

Thermal capacity factors collapse after 2030 across all scenarios

Lignite power plants and, to an extent, hard coal plants enjoy a period of high usage over 2021-26 due to high gas prices and the moderate pace of renewables growth. After 2026, lignite capacity factors start plummeting as carbon prices rise, new renewable energy capacity is added and gas prices recover towards pre-2020 levels. Hard coal plants face a similar fate. Natural gas capacity factors top 50% over 2026-2031, depending on the gas and carbon price assumptions. However, by 2035, nuclear, renewables and batteries generate enough to leave gas plants underutilized. By this time, different gas prices between the RRS and HGS result in virtually the same outlook for gas plants, because the system needs very little gas generation. This dynamic gives gas plants a short time to recoup investment costs through energy market revenues.

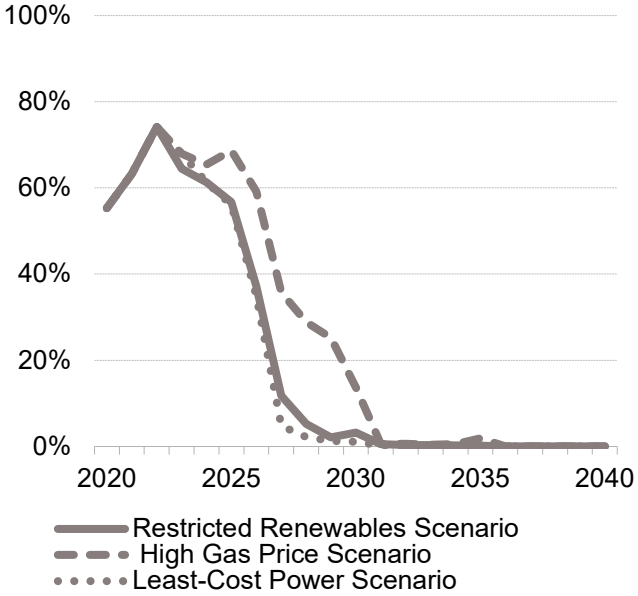
Hard coal capacity factors

Polish hard coal capacity factors averaged 42-45% over 2020-21, but could temporarily rise to 50% as older plants retire after 2025, if gas prices remain high. By 2030, capacity factors drop below 20% in both scenarios.



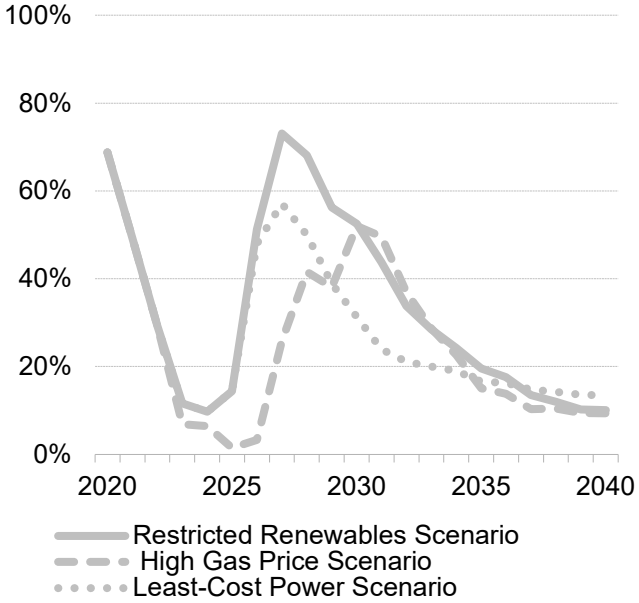
Lignite capacity factors

Lignite capacity factors averaged 54-66% over 2020-21, but quickly fall below 50% in 2026-27 as carbon prices start rising. By 2030, capacity factors drop below 20% in both scenarios.



Gas capacity factors

Poland saw coal-to-gas fuel switching in 2020, when gas plants ran at 70% capacity. A similar situation returns over 2026-2032, but capacity factors dip below 30% by 2033, as gas takes the role of back-up generator.

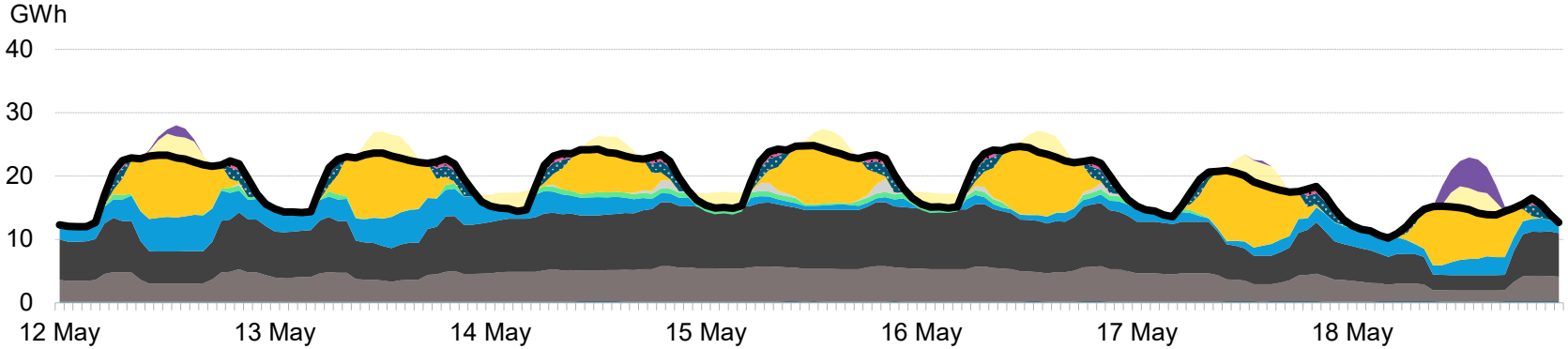


Source: BloombergNEF. Note: Historical data are actuals until October 2022.

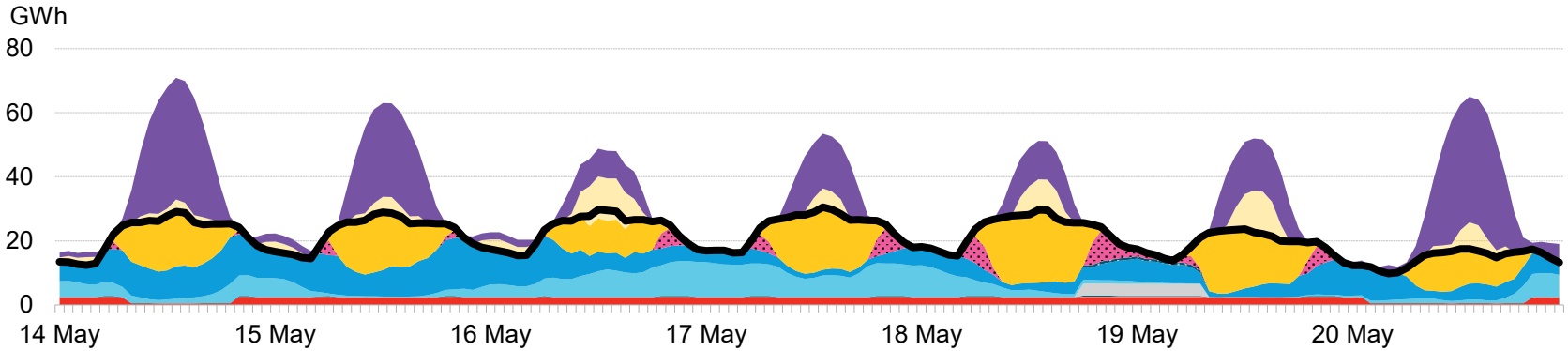
Curtailment grows with scale-up of renewables

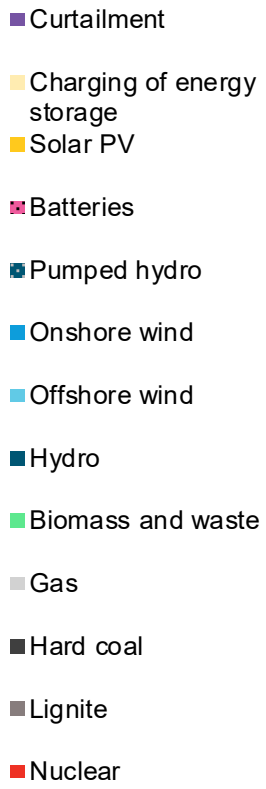
The hourly generation profile looks very different by 2040 compared to 2025 across all scenarios. In 2025, the high share of dispatchable plants allows generation to adjust to hourly demand. By 2040, the system is dominated by wind and solar in all three scenarios. In a higher-renewables system, both supply- and demand-side flexibility become important. For example, electric cars and large-scale batteries are charged in the middle of the day during low-price hours of high solar output. Despite some demand flexibility, some renewable energy is likely to be wasted, given an oversized fleet. Curtailment is not necessarily an issue, as both solar and wind are cheap on a megawatt-hour basis. In fact, the average cost of wind or solar energy remains below fossil fuel costs even when including the effect of curtailment. However, the power market and renewable energy support schemes have to adapt to account for it.

A projected week of generation in May 2025 under the Restricted Renewables Scenario



A projected week of generation in May 2040 under the Restricted Renewables Scenario



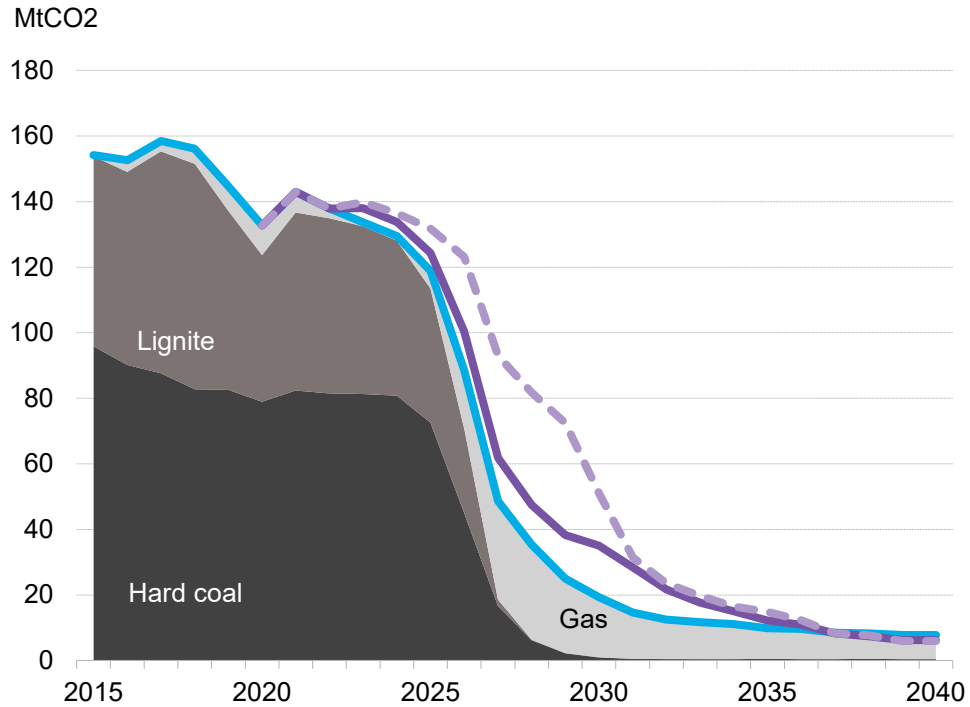


Source: BloombergNEF.

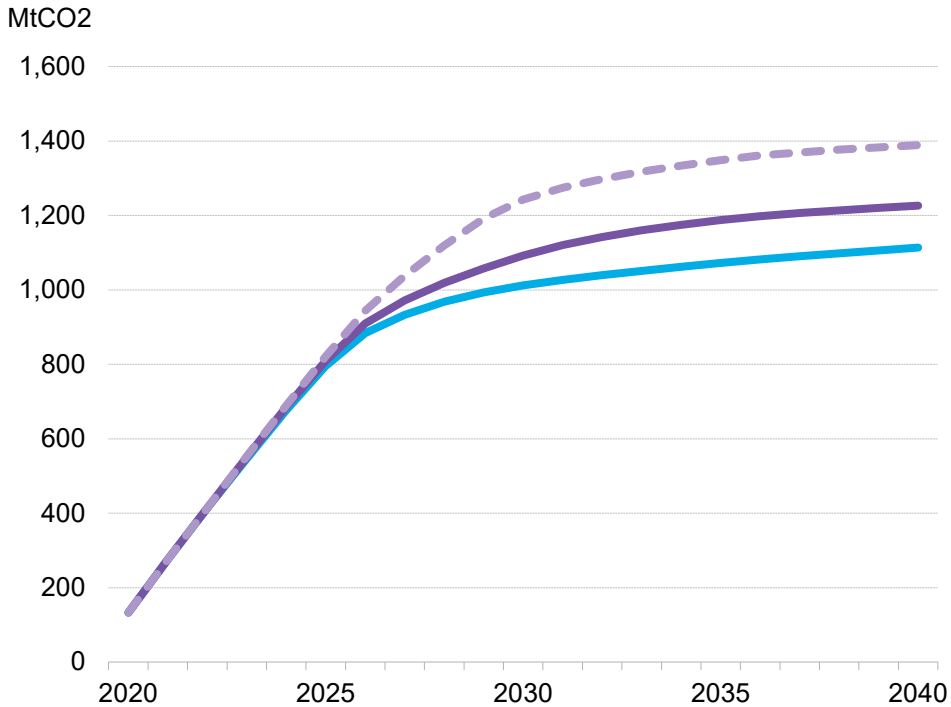
Delayed renewable build and high gas prices keep emissions high

Slower renewable energy build results in higher carbon emissions over the coming decade, with 45% higher emissions over 2025-2035 in the Restricted Renewables Scenario (RRS) than in the Least-cost Power Scenario (LPS). If Poland relies on more coal over the coming decade, as outlined in the High Gas Price Scenario (HGS), emissions are even higher, double than those of the LPS over the same period. By 2040, power system emissions drop by 95-97% across all three scenarios from 2021 levels, with the carbon intensity of Polish power dropping below 40 grams of CO2 per kilowatt-hour in 2040, from 750gCO2/kWh in 2021. Annual emissions in 2040 are slightly higher in the LPS due to less nuclear capacity. Higher emissions also translates into higher fuel and carbon costs. Although emissions eventually drop in all scenarios, cumulatively the HGS emits 25% more than the LPS over 2020-2030.

Annual power system CO2 emissions across scenarios



Cumulative power system CO2 emissions 2020-2040



Least-cost Power Scenario | Restricted Renewables Scenario | High Gas Price Scenario

Source: BloombergNEF

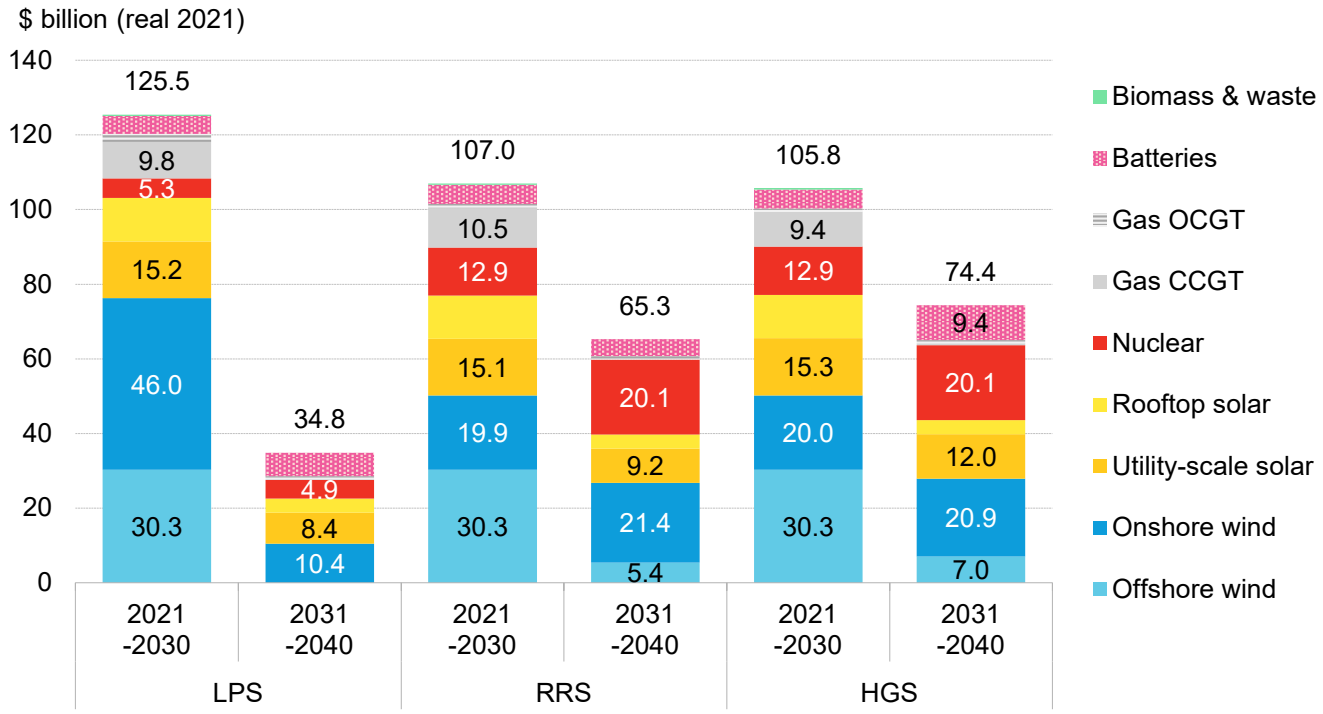
Source: BloombergNEF

Investment needs are 12% higher with renewables constraints and nuclear

Total investment over 2021-2040 ranges from $160 billion in the Least-Cost Power Scenario (LPS), to $180 billion in the High Gas Price Scenario (HGS), with the Restricted Renewables Scenario (RRS) sitting between the two at $172 billion. The early scale-up of renewables in the LPS sees a front-loading of investment opportunities prior to 2030, and a significant slow-down after that. Instead, the RRS and HGS see a more even distribution of investment before and after 2030, though these two scenarios are also weighted in favor of the 2021-2030 period. In the later years, these two scenarios see large investments in nuclear, which requires around $20 billion in funding. Overall, the HGS and RRS require more money than the LPS.

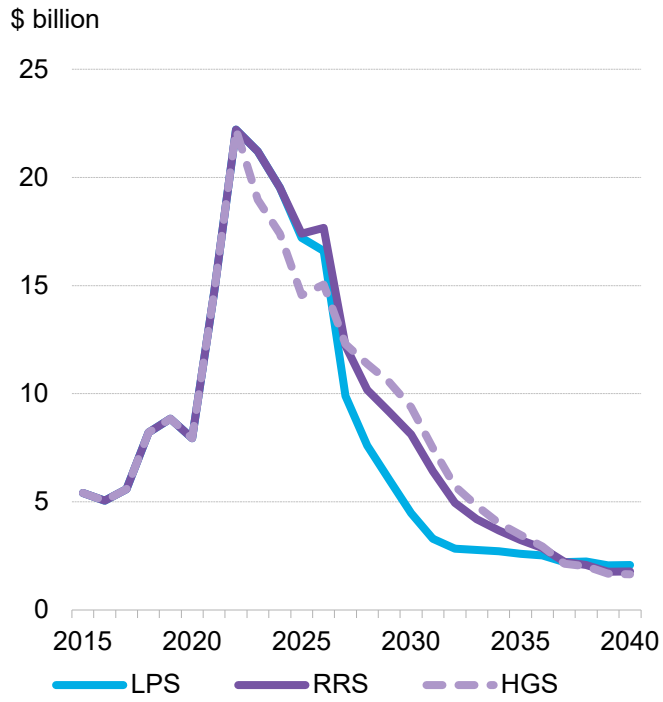
Delayed investment in clean technologies in the RRS and HGS translates into higher fuel and carbon costs for the system compared to the LPS. That is because the two former scenarios rely on fossil fuel generation for longer. The HGS benefits from the 20% discount on carbon prices until 2025, but it has on average 53% higher carbon and fuel costs than the LPS over 2026-2036.

Investment requirements per decade across scenarios



Source: BloombergNEF. Note: A fast build-out of renewables requires grid investment which is not included in this report, see Appendix for more on methodology.

Annual fuel and carbon costs for power generation by scenario



Source: BloombergNEF

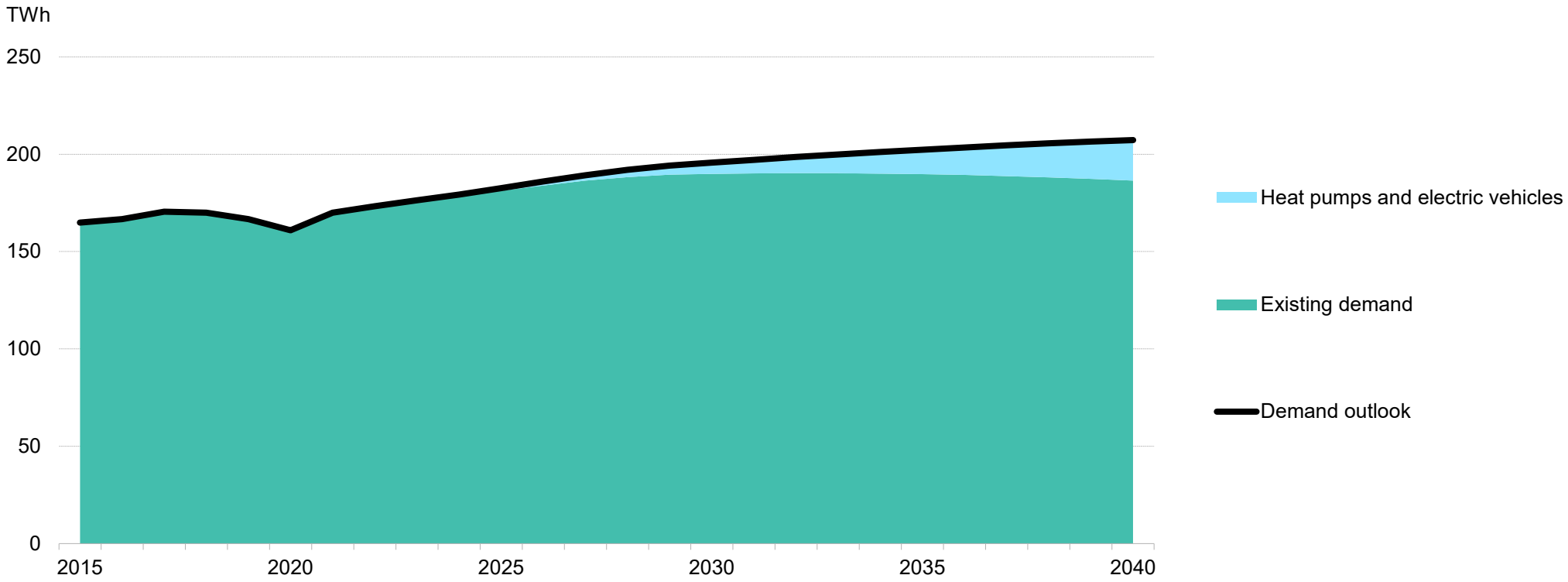
Drivers

Demand, commodity prices and fixed costs

Heat pumps and electric vehicles boost overall electricity demand

Polish electricity demand grows by 20% over 2022-2040 in all three scenarios. Much of this comes from the uptake of electric vehicles and heat pumps. Heat pumps make a more significant impact on peak demand than EVs due to the fact EVs can charge at night. Polish power demand typically peaks on the coldest days and this effect would become more pronounced as heat-pump usage grows. However, the availability of flexible demand including dynamic EV charging limit peak demand growth. As a result, while renewable energy provides the cheapest way to meet growing power demand, back-up capacity that generates only on a few, cold days per year is still needed to ensure system security. The demand growth presented in these scenarios does not include additional electrification of energy demand that might be needed to meet climate goals, including electrolyzers for hydrogen production.*

Power demand outlook

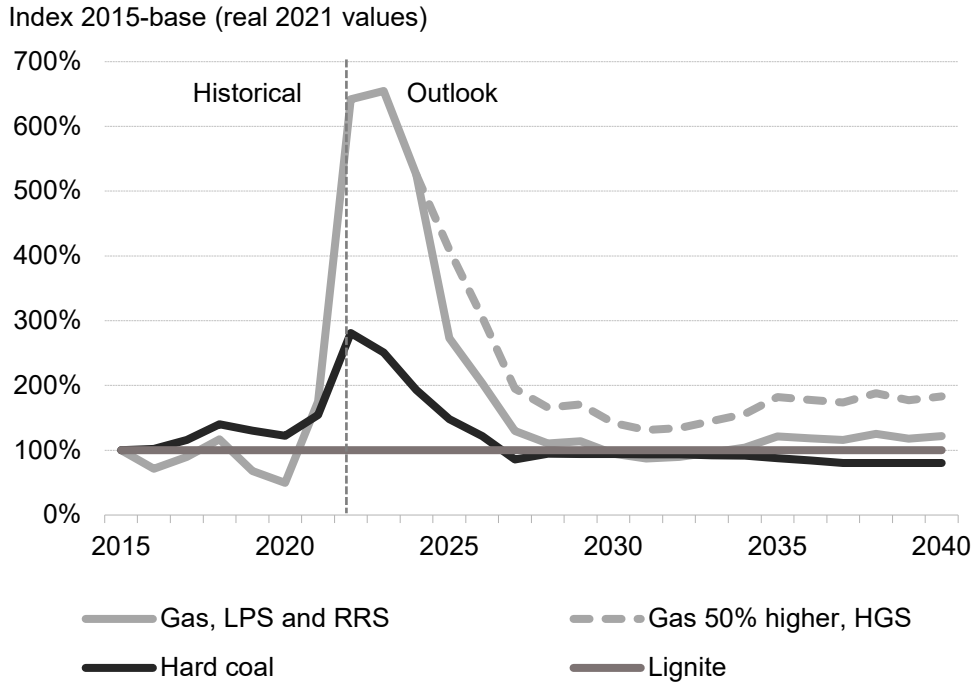


*Source: BloombergNEF. Note: *Effects on power demand from electrolysers for green hydrogen production is modelled in our New Energy Outlook 2022 (web | terminal) but is not used for these scenarios. BNEF's upcoming New Energy Outlook for Europe will include results for our Net-Zero Scenario for Poland.*

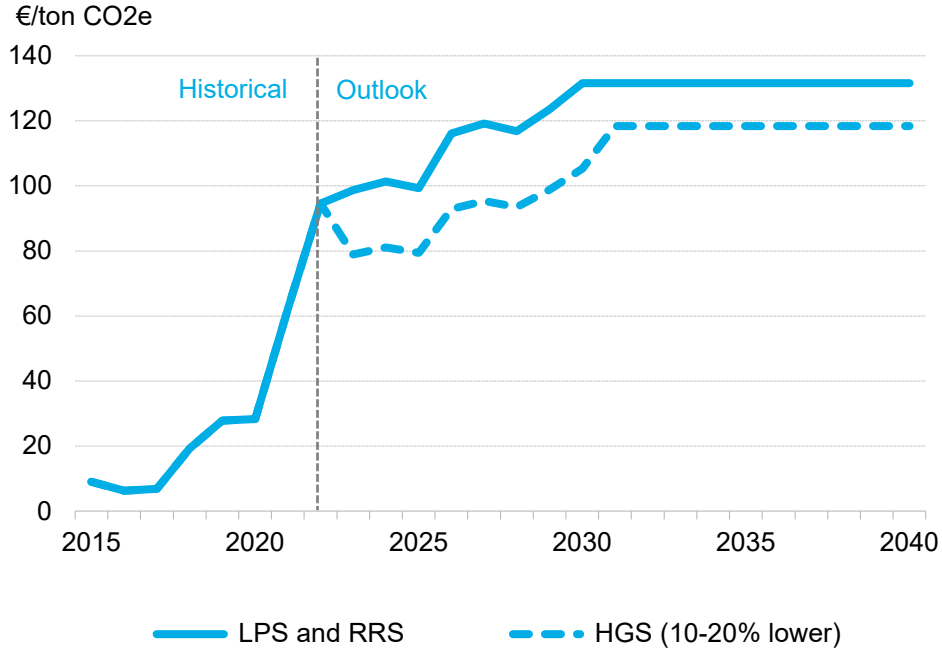
High commodity prices make all thermal generation expensive

Fuel and carbon prices play a significant role in determining dispatch of gas, hard coal and lignite power. Over 2021-22, global hard coal and gas prices soared, with gas prices on average 640% higher in 2022 than in 2015. European hard coal prices in 2022 were over 400% above 2015 levels. BNEF estimates coal prices to have risen only 280% over 2015-2022 in Poland due to a high share of domestically-mined hard coal under long-term contracts.* Lignite prices are kept flat in real 2021 terms in our outlook, but lignite plants are heavily exposed to carbon prices under the EU Emissions Trading System (EU ETS). BNEF estimates that carbon prices will double by 2030 compared to 2021 levels. BNEF only models EU ETS prices until 2030, in line with the end of Phase 4, and so we hold carbon prices flat in real terms after this date for the scenarios in this report. The Limited Gas Scenario assumes that EU policy allows more time for the transition due to the energy crisis and hence carbon prices are discounted by 20% until 2030, and by 10% over 2031-2040.

Gas and coal price development since 2015



Carbon price development since 2015

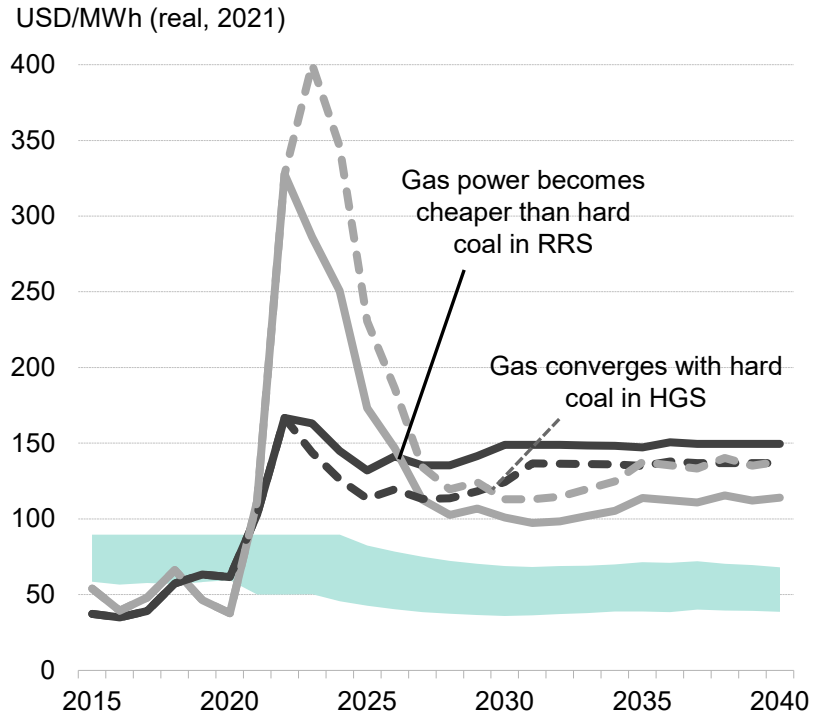


*Source: BloombergNEF. Note: Indexation based on real 2021-values. Dashed lines (of gas price: 50% higher and carbon price: 20% lower) are used for the High Gas Price Scenario. Carbon prices are based on BNEF's 1H 2022 EU ETS Market Outlook (web | terminal). *The Polish Steam Coal Market Index (PSCMI) for hard coal increased only 165% during this time, but as Poland has imported around 30% of thermal hard coal over the past 5 years, BNEF estimates the weighted average price increase to 280%.*

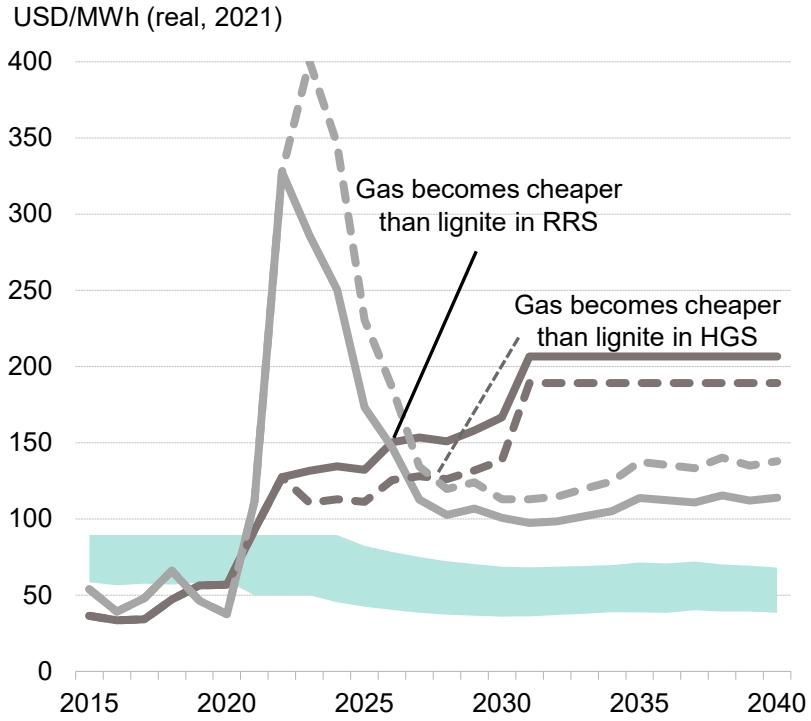
New-build renewables are already cheaper than existing coal and gas

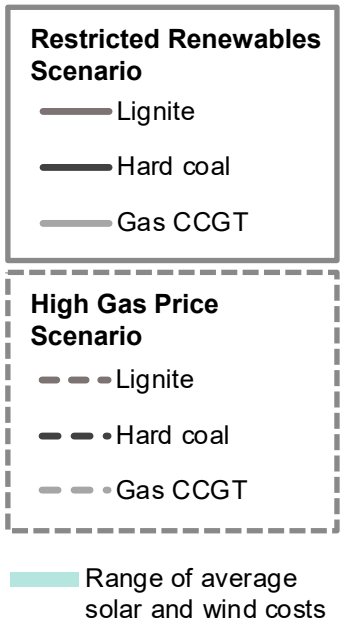
Since 2021, existing coal, lignite and gas plants are more expensive to run in Poland than building new solar, onshore wind, offshore wind and battery storage. Gas plant costs spike and remain above renewables and battery costs until 2040 across all scenarios. Gas becomes cheaper than hard coal in 2030 in the High Gas Price Scenario, some three years later than in the Restricted Renewables and Least-cost Power scenarios. Gas generation costs undercut lignite costs over 2026-2028 in all scenarios. The changes in fuel and carbon costs determine which fossil fuels will run at times of low-renewables generation: for example, in the High Gas Price Scenario, coal and lignite output is 62% higher over 2026-30 than in the Restricted Renewables Scenario. The Restricted Renewables Scenario closes coal units and build new gas units instead, since the latter becomes significantly cheaper to operate by 2026.

Short-term running costs of hard coal versus gas and levelized cost of new renewables



Short-term running costs of lignite versus gas and levelized cost of new renewables



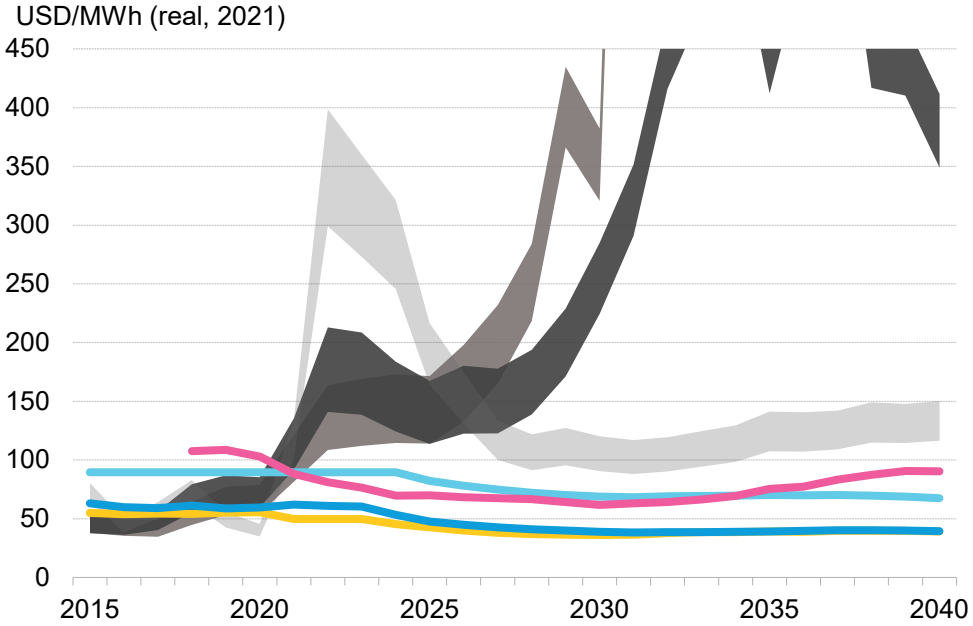


Source: BloombergNEF. Note: Renewables includes levelized cost of new-build solar, onshore and offshore wind. The short-term running costs includes fuel and carbon costs for lignite, hard coal and gas plants. It does not include the cost of building the plant. Solar and wind requires capital investments to be built, which is reflected in the average cost but these technologies have no running costs, and limited operational costs, once they are built.

Renewables and batteries 50% cheaper than coal by 2025

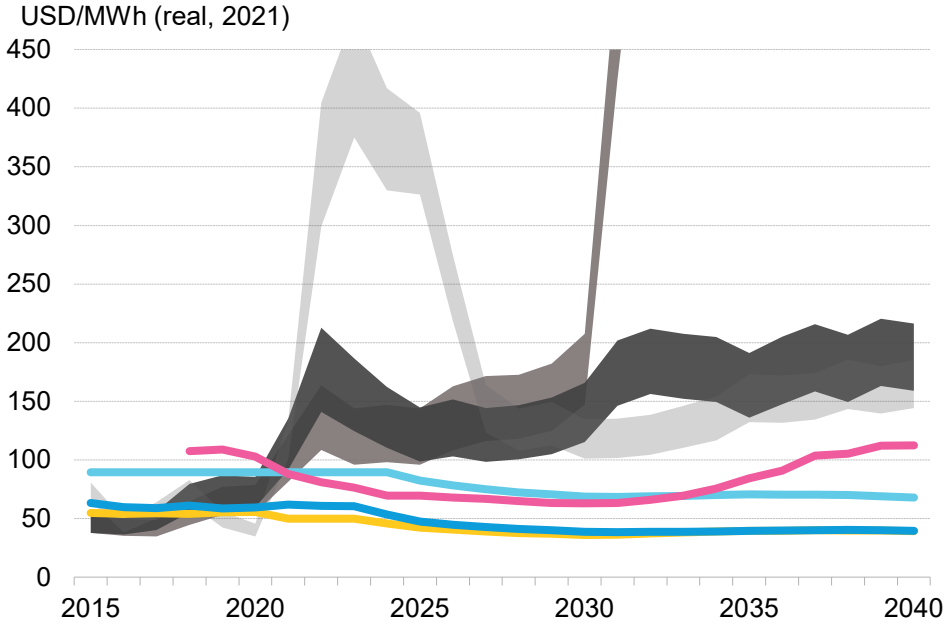
The cost of generation rise rapidly if a power plant has very low capacity factors, as it concentrates fixed costs over fewer hours of generation and reduces economies of scale. This happens to gas plants over 2022-2024, with the average cost of gas generation reaching around $400/MWh across all scenarios. Gas costs return to lower levels by 2026-27, when fuel prices drop and fixed costs are spread out on higher generation. In the Restricted Renewables Scenario, the cost of hard coal and lignite per megawatt-hour (MWh) soars by 2030 due to rapidly declining capacity factors. By contrast, hard coal continues generating in the 2030s in the High Gas Price Scenario, due to lower carbon prices and higher gas prices. Hence, the average cost of hard coal generation remains around $200/MWh until the last coal units retire in 2038. Despite changing cost dynamics for coal and gas, renewables and batteries remain significantly cheaper than hard coal, even in the High Gas Price Scenario.

Average costs of new renewables versus existing coal, lignite and gas, Restricted Renewables Scenario



Source: BloombergNEF. Note: average costs of coal and lignite dip in some years when capacity retirements leads to a better utilization of the remaining fleet.

Average costs of new renewables versus existing coal, lignite and gas, High Gas Price Scenario



Source: BloombergNEF. Note: Average battery costs are slightly higher in HGS due to larger battery fleet resulting in lower utilisation rates

Lignite | Hard coal | Gas CCGT | Solar PV | Onshore wind | Offshore wind | Utility-scale batteries

Carbon and fixed costs become increasingly important

The carbon price makes up more than 70% of the short-run marginal cost of a typical lignite plant in Poland in 2022, with fuel costs and variable operational costs making up the rest. Hard coal costs face a similar outlook, once fuel prices cool down after 2025. The running costs determine power plant margins in the short run, but does not account for fixed costs. As lignite and hard coal plants generate less, fuel and carbon costs comprise less of the total running cost, and instead the share of fixed costs grows. In the Restricted Renewables Scenario, the share of fixed costs reaches 92% for lignite and 81% for hard coal by 2037 when the last units are closed.

Hard coal plant cost structure, RRS

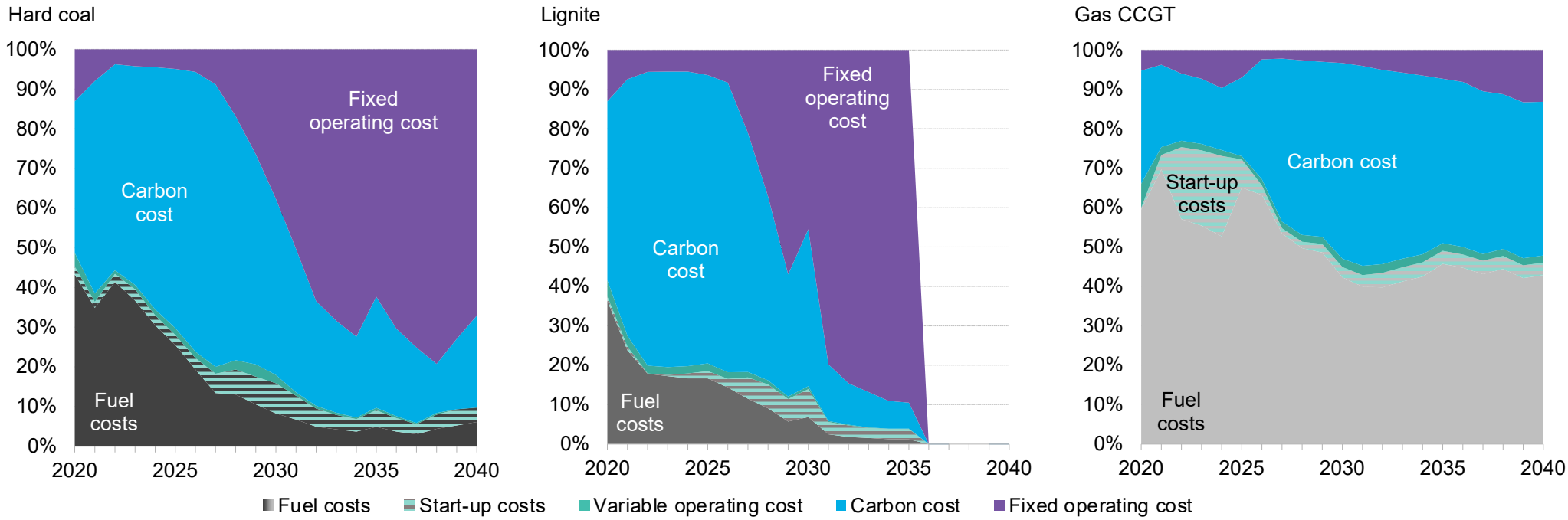
Fuel costs and carbon costs have fairly equal roles until 2024, when carbon prices rise. Once units not needed close in 2037, the share of fixed costs fall as the last coal unit has a higher capacity factor.

Lignite plant cost structure, RRS

Carbon costs make up over 70% of total costs for lignite plants until 2026, when generation dips. As lignite plants take on the role of reserve generators, fixed costs quickly come to dominate.

Gas plant cost structure, RRS

Gas plants are less carbon intensive than coal, leaving fuel as the most significant cost. These plants keep generating until 2040, so fixed costs remain less than 10% of total plant costs.



Source: BloombergNEF. Note: Start-up costs consist mainly of cost for fuel burned during start-up, before the power plant exports electricity to the grid.

State of the energy transition in Poland

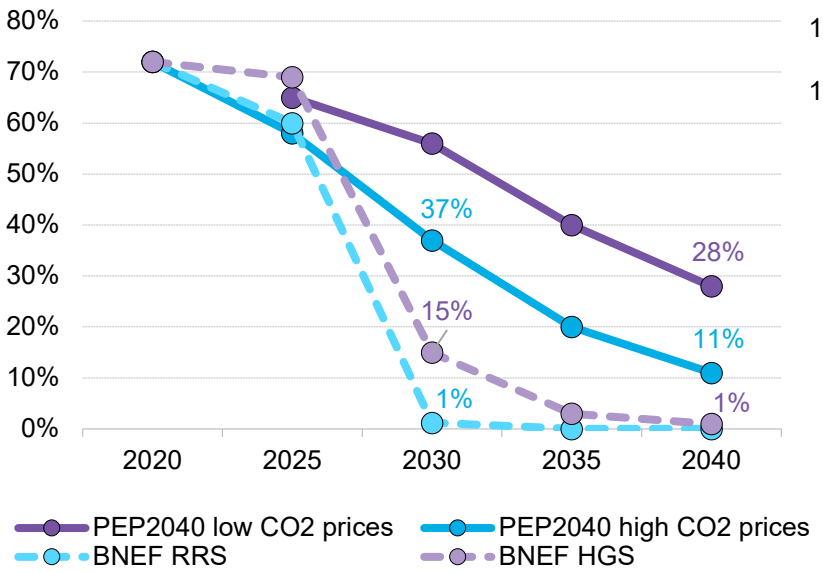
Policy and targets

Power sector: 2023 energy policy update could target 50GW of renewables by 2030

The Polish Ministry of Climate and Environment published its latest long-term energy strategy, the Polish Energy Policy until 2040 or "PEP2040", in April 2021. The plan is unambitious on solar and wind growth but recognizes that high carbon prices are likely to cause the share of coal generation to drop. In March 2022, the government agreed to update the PEP2040 in response to Russia's attack on Ukraine and the worsening energy crisis. The update is expected in summer 2023 and will place greater emphasis on energy security, energy efficiency and renewables. A preliminary statement reveals the new PEP2040 might aim for a 30-50GW of installed renewables capacity by 2030, up from the 20-26GW targeted in the 2021 version of the PEP2040, but well below the 71GW of wind and solar deployed by 2030 in BNEF's Restricted Renewables Scenario.

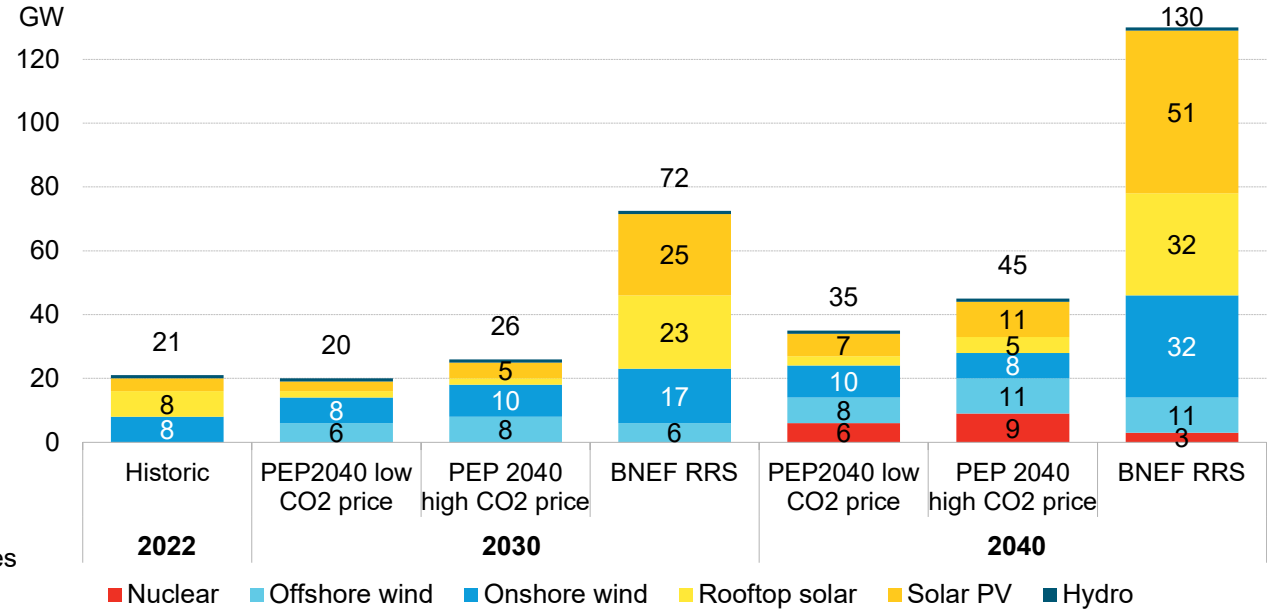
BNEF take: Poland still relies partially on imported hard coal. Replacing this with renewable energy would boost energy security while cutting reliance on increasingly expensive coal-fired power. BNEF expects coal to shift to a role of back-up generator by around 2030, well before the last coal units are scheduled to close. The role of gas remains under debate, but new gas plants are still incentivized by the capacity market. BNEF estimates that by 2030, gas and renewables capacity already operating or under development can generate enough to displace more than 75% of the 2021-level of hard coal and lignite power (107TWh). This results in the Restricted Renewables Scenario coal generation share of 12% in 2030, unlike the PEP2040 shares of 37-56%.

Coal and lignite share of generation, PEP2040 versus BNEF scenarios



Source: Polish Ministry of Climate and Environment, BloombergNEF

Zero-carbon generation capacity in PEP2040 (2021 version) scenarios versus BNEF Restricted Renewables Scenario



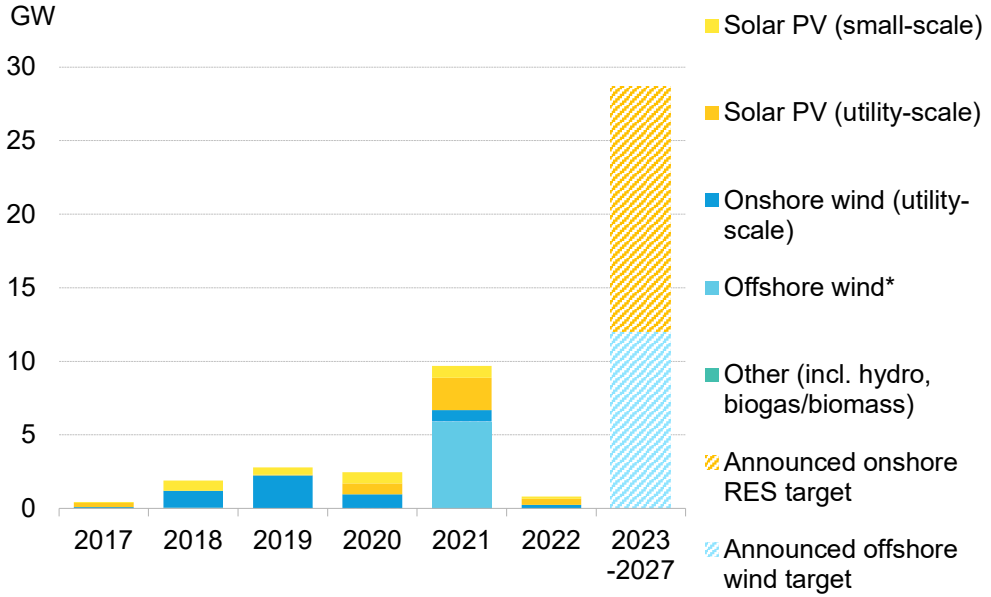
Source: Polish Ministry of Climate and Environment, BloombergNEF. Note: Excludes pumped hydro.

Power sector: Renewable energy auctions are effective, but onshore wind hurdles persist

Poland has allocated support to renewables through annual auctions over 2017-2022, awarding two-way contracts-for-difference (CfDs) to 6.8GW solar PV, 5.4GW onshore wind, as well as 76MW of small hydro, biomass and biogas. Separately, 5.9GW of offshore wind also received CfDs. The government aims to support 9GW solar, 3GW onshore wind and 5-12GW offshore wind in upcoming auctions until 2027. Most onshore wind projects awarded CfDs to date secured permits before 2016, when Poland's "10H rule" came into force, requiring wind turbines to be 10 times their height from residential homes. This excludes 98% of Polish land from wind development. The government proposed to relax the rule to 500 meters in July 2022, but Parliament is pushing for a 700m distance.

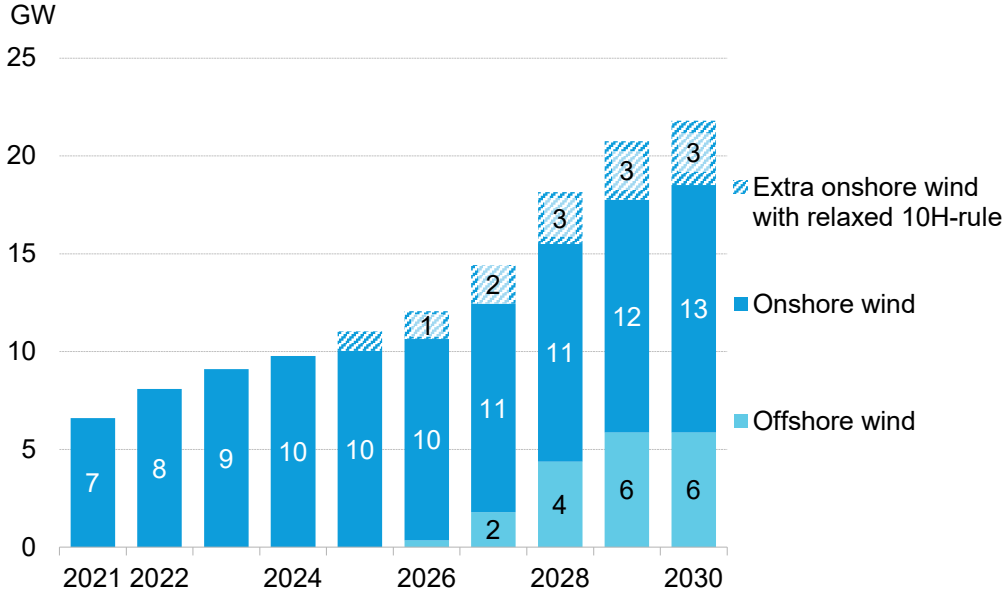
BNEF take: Auction participation dropped drastically in 2022 given limited availability of grid connection permits, onshore wind restrictions, as well as policy uncertainty and high power prices. The 2022 auctions procured only 8.5TWh of renewables generation for the 15-year contract period, compared to the 51TWh procured in 2021 auctions. BNEF lowered its 2030 forecast for onshore wind by 3GW due to Parliament's inaction on relaxing the 10H-rule. Solar can still benefit in auctions, but PV developers also face longer-term risks related to under-investment in the grid and difficulties securing grid connections. On the other hand, offshore wind is thriving and BNEF expects 4.4GW to be operating by 2028.

Historical and announced renewable energy auctions



*Source: BloombergNEF, Poland Energy Regulatory Office (URE). Note: *Offshore wind capacity was allocated with centrally-determined price in 2021. In January 2023, the government stated that offshore wind auctions capacity would grow from 5GW to 12GW.*

BNEF Poland wind forecast



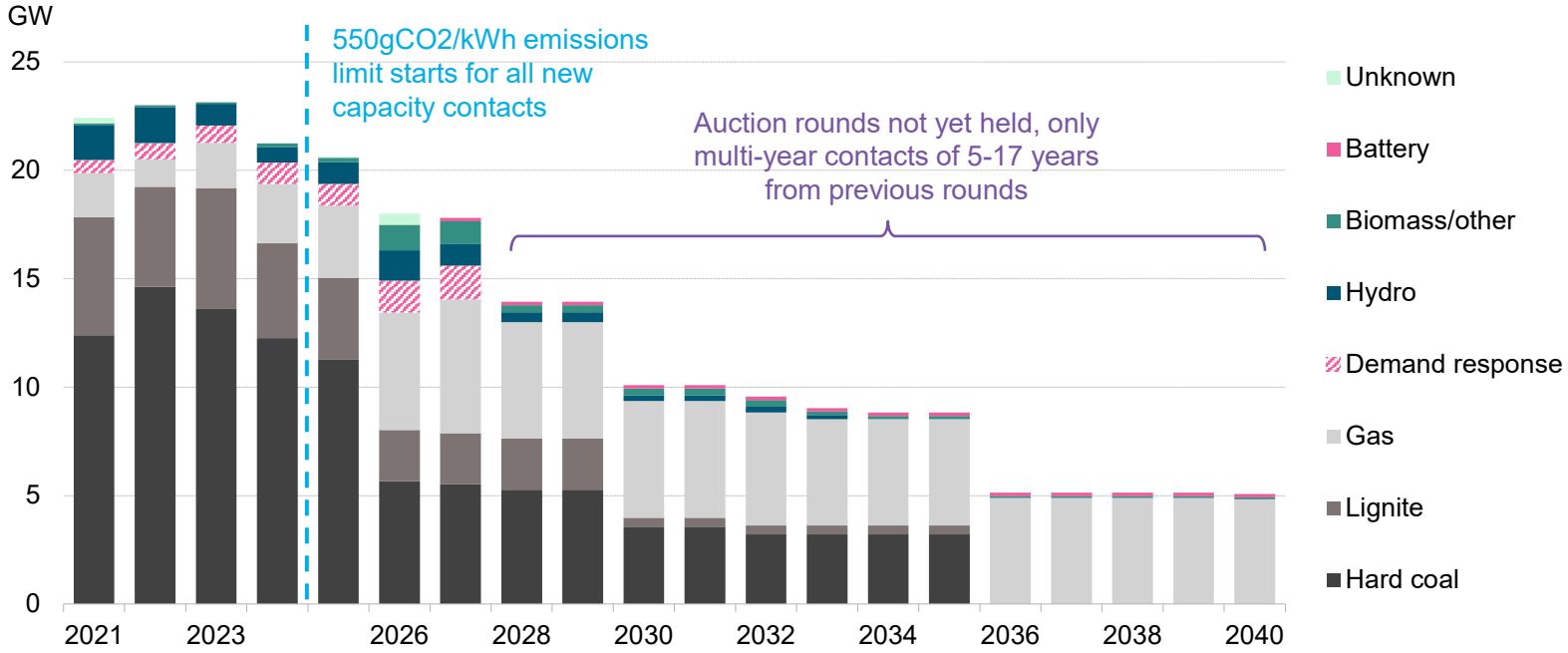
Source: BloombergNEF. Note: The extra onshore wind build assumes that the governments proposal for relaxed minimum distance of 500m is legislated in early 2023. A 700m minimum distance might allow 12-13GW by 2030.

Power sector: Capacity market supports gas, but batteries still struggle to compete

Poland's capacity market has held six rounds of auctions for contacts with delivery obligations over 2021-26. These rounds have awarded one-year contacts, as well as multi-year contacts of 15-17 years for new capacity and 5-7 years for refurbished capacity. Capacity contracts will support some 3.6GW of hard coal and lignite until the end of 2035. The capacity market supported around 19GW of coal in 2022, but less than 4GW will be supported after 2030. This is largely due to the EU-set operational emissions limit of 550CO2/kWh, which applies to all new capacity contracts starting in 2025 or later. In auction rounds with obligations from 2025 and 2026, most new long-term contracts were awarded to new gas power plants, with almost 4GW of contracted gas capacity until 2040. Capacity market payments have risen over the rounds, from €41,600 per MW/year for delivery in 2022 to €84,100 per MW/year for 2026 delivery. The December 2022 auction for delivery in 2027 supported battery capacity for the first time, of at least 157MW representing 3% of the total contracted 5.3GW.

BNEF take: Coal and gas plants have received around 90% of capacity contracts awarded so far. Despite high gas prices, gas power plants may still participate in future capacity auction rounds, given the latest capacity contract clearing prices result in 12-year payback periods for new CCGT gas plants even without power sales revenue. The 3GW of batteries that had pre-registered for the 2027-delivery auction could still try their luck in future rounds.

Estimated technology split of capacity contracted by Polish capacity market per year



€84,100 per MW/year
Price awarded in the capacity market round for delivery in 2026, or from 2026 for multi-year contacts.

€41,600 per MW/year
Price awarded in the capacity market round for delivery in 2022 (from 2022 for multi-year contacts).

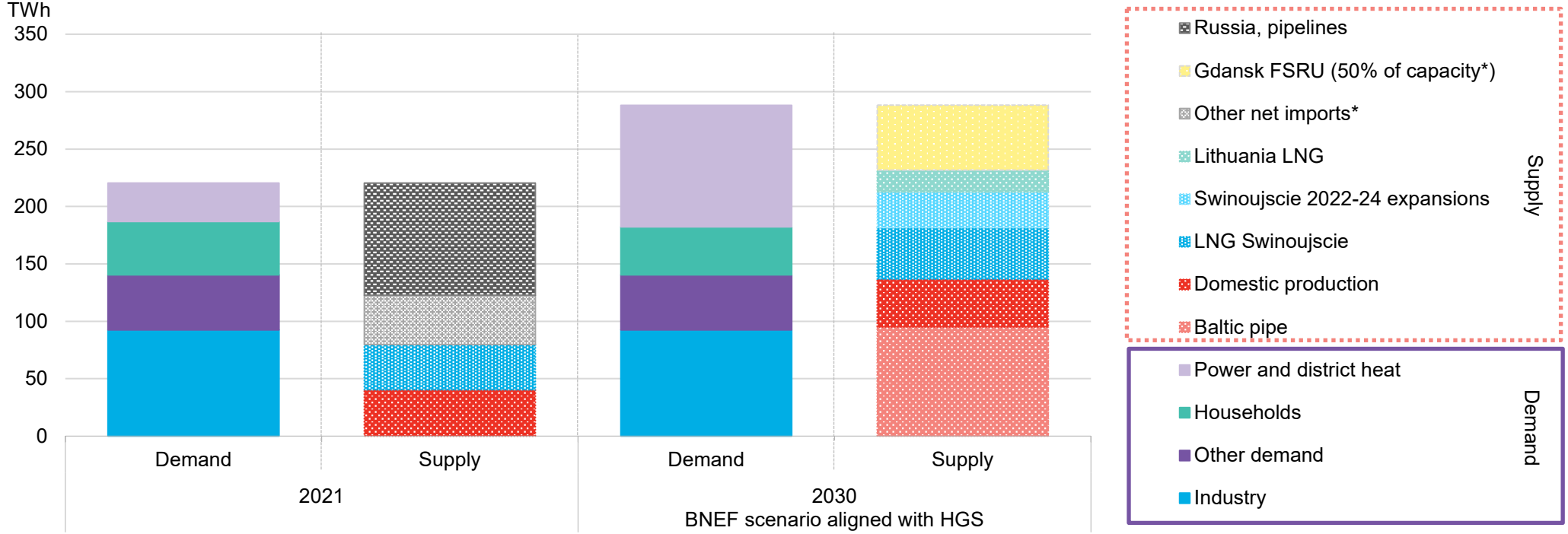
Source: BloombergNEF, URE Energy Regulatory Office, company filings. Note: URE does publish auction results per technology, only per company and size of contracted units. The technology of contracted units has been estimated by BNEF based on company announcements and installed capacity mix of winning power producers.

Power sector: Gas use for power could triple by 2030, enabled by LNG expansion

Polish natural gas imports underwent a rapid shift in 2022, when gas supplies from Russia were cut due to war in Ukraine. Instead, the Baltic Pipe from Norway started delivering gas to Poland. Expansion of the Swinoujscie liquefied natural gas (LNG) regasification terminal over 2022-24 further helps fill the gap. A new floating LNG storage and regasification unit (FSRU) is also planned to be built in Gdansk, with capacity of 12 billion cubic meters of gas per year. This would allow Poland to export to its neighbors. If half of the Gdansk FSRU terminal capacity serves the Polish market, total gas import infrastructure (pipelines and LNG-terminals) can accommodate a tripling in power sector gas use over 2021-2030.

BNEF take: Gas-to-power use is likely to grow significantly in Poland as the capacity market supports gas plants, with BNEF anticipating a tripling of demand by 2030. However, replacing domestically-mined coal with imported gas in the power sector could raise energy security concerns. Poland's plans to expand LNG terminals to diversify gas supply sources, are at odds with suggested changes to the PEP2040 that seeks to lower reliance on natural gas.

Polish gas supply and gas sources, historic and future scenario

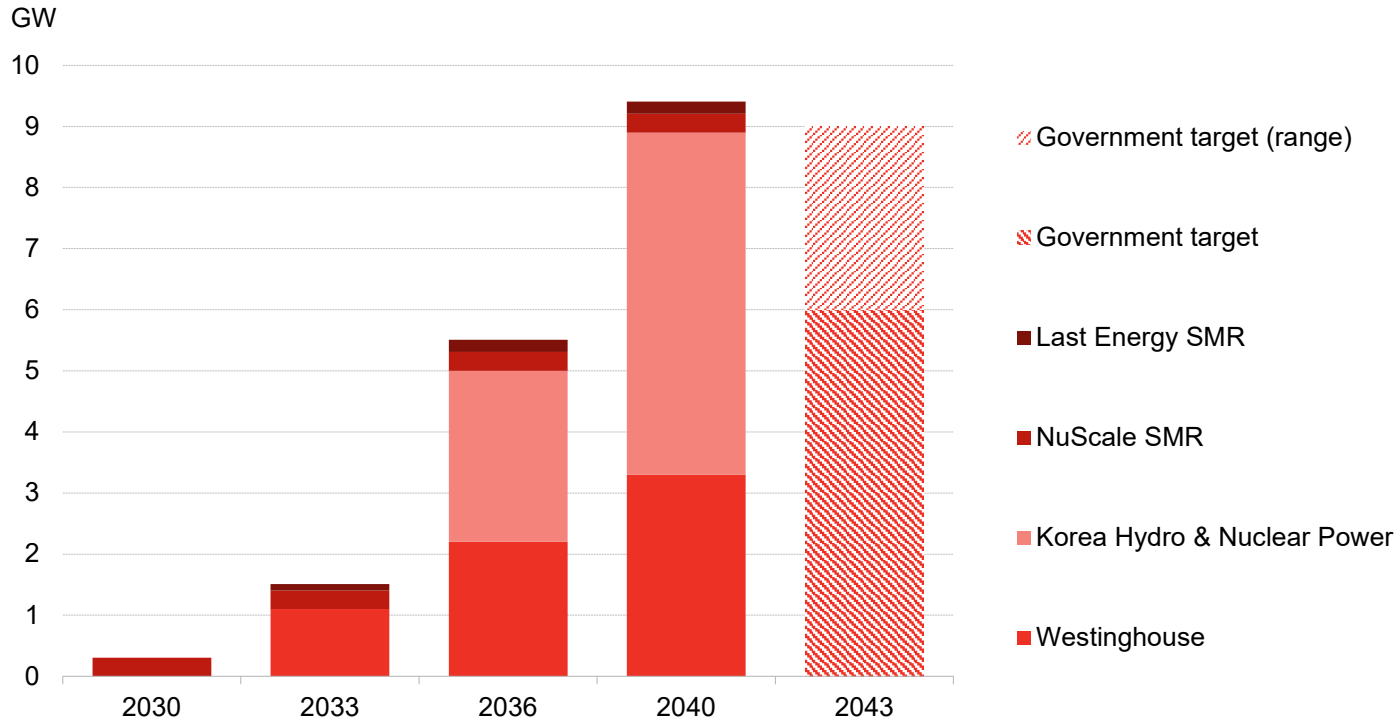


*Source: BloombergNEF, Eurostat. Note: *assumes the other 50% of Gdansk FSRU is dedicated to delivering gas to neighbouring countries. The increase in gas used in the power sector is aligned with the High Gas Price Scenario (HGS) presented earlier in this report.*

Power sector: Ambitious nuclear plans yet to be financed

Poland has lofty ambitions for future nuclear build, but the plans have yet to make any material progress. The latest version of the Polish nuclear program was adopted in October 2020 and aims for 6-9GW of nuclear capacity operating by 2043. The first version of this program was adopted in 2014, but the plan to build nuclear did not progress beyond a preliminary selection of sites. Earlier attempts to build nuclear power in Poland during the 1970s were scrapped after the 1986 Chernobyl accident. In October 2022, the Polish government announced a deal with US-based Westinghouse to build three 1.1GW reactors. Shortly after, utilities Polska Grupa Energetyczna and ZePak announced their plan to jointly build two other reactors,1.2GW each, supplied by Korea Hydro & Nuclear Power.

Cumulative capacity of announced nuclear power projects in Poland vs. government target



Source: BloombergNEF. Note: Data as of December 2022. SMR stands for small modular reactor. Year of commissioning is estimated for Last Energy SMR, while approximate commissioning timelines are announced for other reactors.

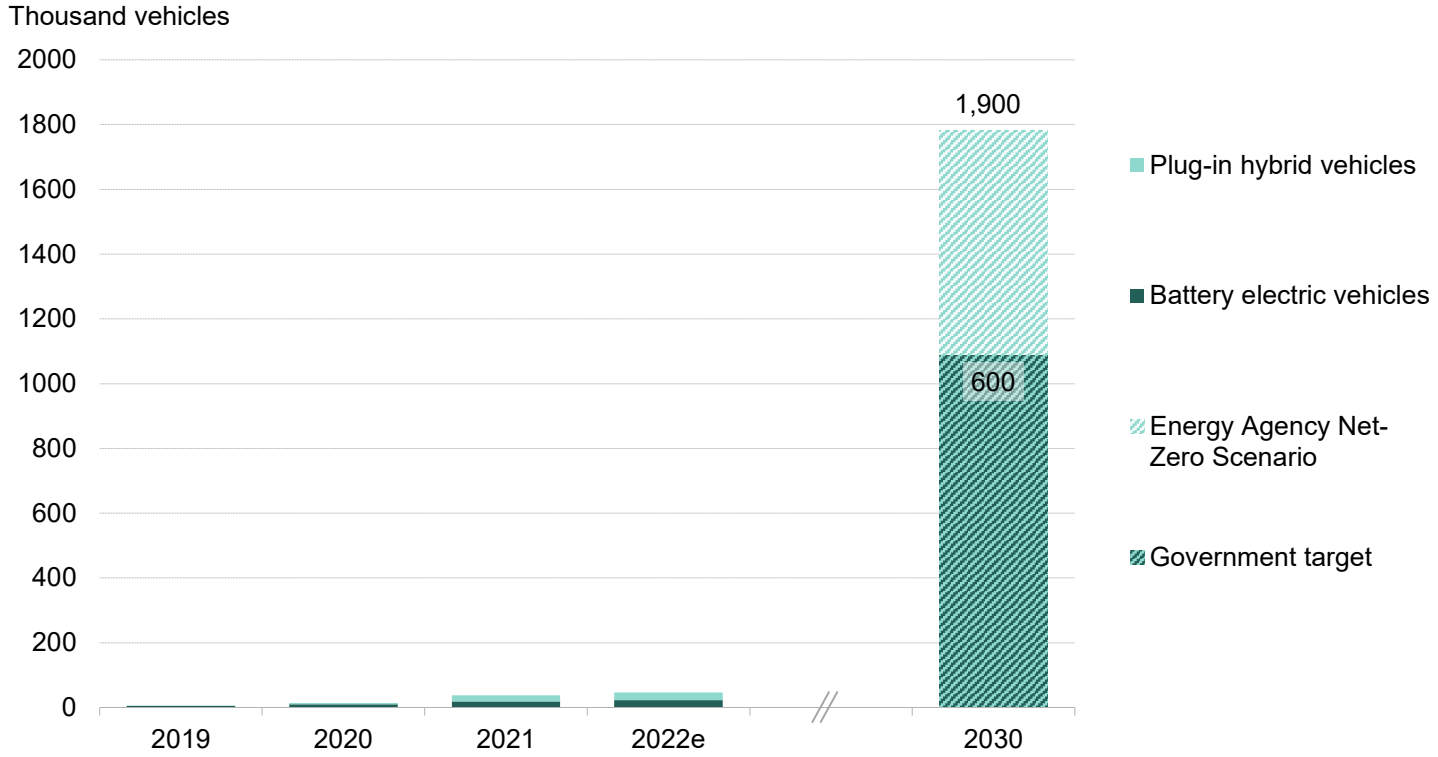
BNEF take: If all announced projects get built, Poland would have 9.4GW of nuclear by 2040. However, project completion and timely commissioning is far from certain. The Polish government and utilities have announced selection of reactor types and sites, but without agreed financing arrangements there is no guarantee these will be built. It is notoriously difficult to get private financing for nuclear power, and recent European projects have faced severe delays and budget overruns.

Nuclear could be built with a high share of public funding, but the political fragmentation of the Polish Parliament might make it difficult to agree on allocating a high share of the state budget for constructing these plants. Capital expenditure is likely to be $6-11 billion/GW (€5.7-10.4 billion/GW). The reliance on foreign technology and a partially foreign workforce could also create political complications.

Electrification: EV uptake slow and clean power needed for real impact

Uptake of electric vehicles (EVs) in Poland has been slow to date. BNEF estimates that the country's EV fleet reached 47,000 in 2022, including both battery electric vehicles and plug-in hybrids. While the Polish government seeks to have 600,000 EVs on the road by 2030, the current pace of adoption is too slow to meet this goal. While the EV fleet grew by an estimated 24% over 2021-22, EVs still make up just 0.2% of total passenger vehicles. The EV fleet grew by less than 10,000 in 2022, but an average of 70,000 new electric cars per year are needed to meet the target, and the government's 100-million-euro budget for EV subsidies over 2021-2023 of would only support 21,000 new electric cars.*

Poland's electric vehicle fleet, historical vs. government 2030 targets



BNEF take: Slow EV uptake so far is an obstacle for Poland to reach its 2030 target, but the country could still make it if uptake accelerates substantially closer to 2030. Given the current power mix, driving an EV actually offers limited emissions reduction compared to an internal combustion engine vehicle in Poland. However, EV uptake would support emissions reductions as the nation's power mix gets cleaner by 2030.

The government's 2030 EV target is unlikely to strain the power system, as 600,000 electric cars would increase current power demand by less than 1%, with annual charging needs of around 1.2TWh.** According to the Polish energy agency (ARE), Poland needs 1.9 million EVs by 2030 for emissions to be on a trajectory for net zero by 2050. That could bring annual demand for EV charging to 4TWh, requiring more clean generating capacity and smart charging.

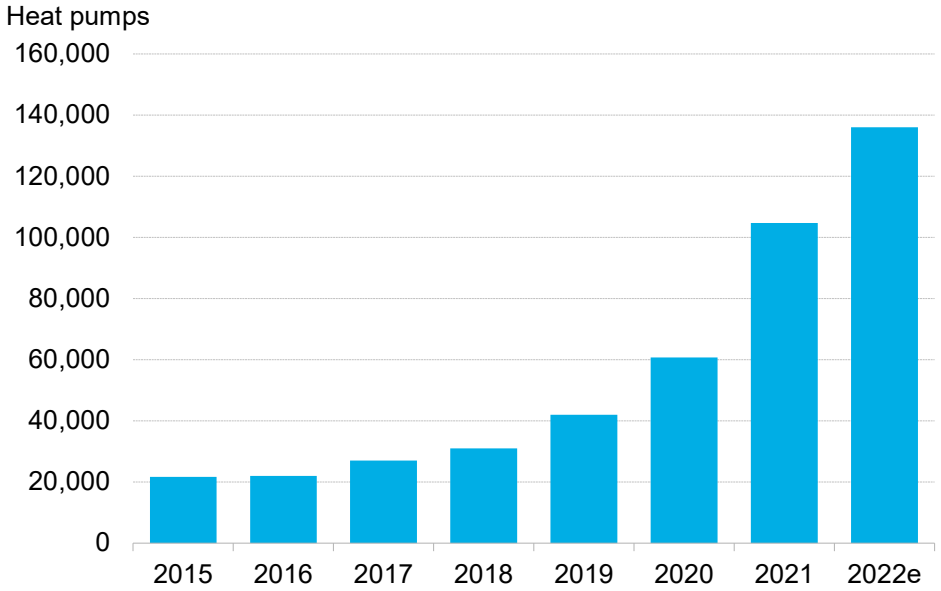
*Source: BloombergNEF, Statistics Poland, ARE (Energy Agency). Note: For more on EV uptake, see Electric Vehicle Outlook 2022 (web | terminal). *Assuming a typical subsidy of around 4,000 euros. **Assumes average driving of 10,000km per year consuming 2,000kWh of electricity per car.*

Electrification: Heat pump market takes flight, but many coal boilers remain

Poland was Europe's fastest growing heat-pump market in 2021, according to the European Heat Pump Association. Many families are switching their coal boilers for heat pumps, incentivized by the governments Clean Air Program. Poland imports most of the coal used for domestic heating, and high coal prices combined with a ban on Russian coal have significantly increased household heating costs. However, only 2% of the energy used for heating Polish homes came from heat pumps in 2020, while coal boilers produced more than a third of domestic heat. Another third of residential heat is provided by district heating,* and about 20% by gas boilers. Biofuels, electric radiators/boilers and oil, to a lesser extent, are also relatively common heating sources. The general public's reluctance to switch from coal to gas, historically supplied by Russia, has further tipped the scale in the favor of heat pumps.

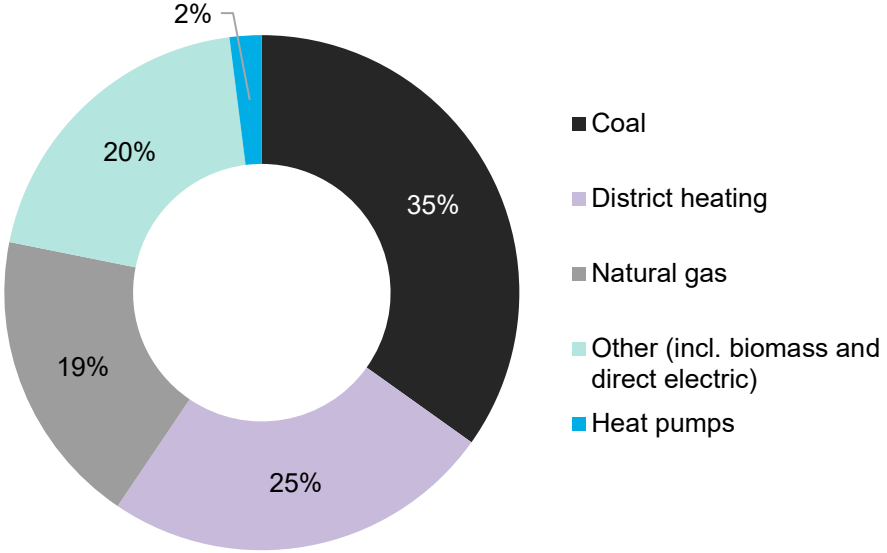
BNEF take: Heat pumps have significant potential to reduce Polish building-sector emissions and air pollution without adding significant electricity demand. The high efficiency of heat pumps mean that they can produce 2-4 times more heat than a standard electric radiator using the same amount of electricity. Some 4.5 million coal boilers remain in the country and present an opportunity for further growth of the Polish heat pump market.

Poland annual heat pump sales



Source: European Heat Pump Association (EHPA), Polish Organization for the Development of Heat Pump Technology PORT PC. Note: 2022 sales are estimated with PORT PC's forecast of 30% year-on-year growth. For more on heat pumps, see Abatement Potential of Household Energy Technologies (web | terminal).

Poland residential and water heating fuel source (2020)



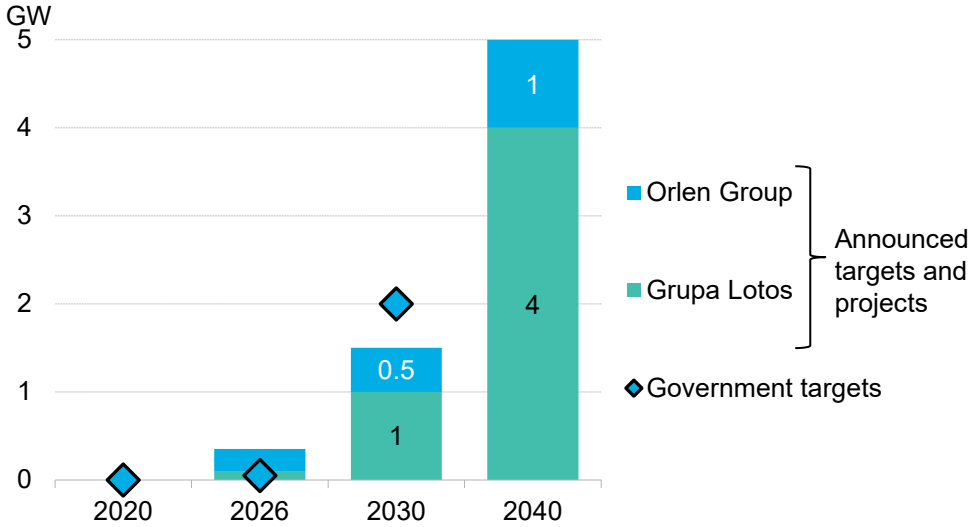
*Source: Eurostat. Note: *District heat (DH) pipes hot water to homes from central heat- or combined-heat-and-power plants. Some 70-75% of DH-plants use coal.*

Electrification: Hydrogen sector takes steps to turn green

Poland is one of Europe's largest producers of hydrogen, with annual output of 1.3 million tons. This hydrogen is currently 'gray', meaning that it is produced from natural gas and coal-derived gas with associated carbon emissions. The Polish Hydrogen Strategy aims for 2GW of electrolyzers installed by 2030. BNEF estimates that this capacity could produce 250,000 tons of green hydrogen in 2030, assuming the electrolyzers run on renewable energy at a 70% capacity factor. In addition, Polish state-owned companies have already announced their own goals for 4.3GW of electrolyzer capacity by 2040.* BNEF expects this could produce 540,000 tons of green hydrogen, equivalent of 41% of Poland's 2020 gray hydrogen production.

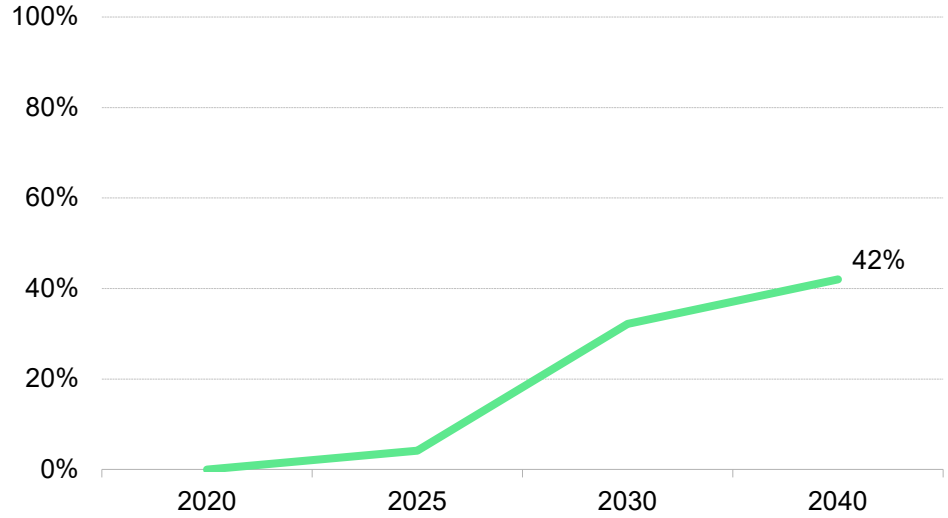
BNEF take: Poland's refineries and steel industry could make an economic case for green hydrogen use as early as 2030, especially if both coal and natural gas remains expensive. The country's plans for hydrogen in transport are less economic, however. Rising hydrogen demand means significantly more electrolyzers than the current project pipeline will be needed for green hydrogen to replace current gray production. EU rules for green hydrogen production require the electricity comes from renewables. This conflicts with the current make-up of the Polish power mix meaning electrolyzers would need to be powered by dedicated renewables to be considered 'green'. Renewables deployment in Poland must accelerate to accommodate both power decarbonization and green hydrogen production.

Polish government and company electrolyzer targets



*Source: BloombergNEF, Polish National Hydrogen Strategy (2021). Note: *Orlen Group is in the process of acquiring Grupa Lotos as of January 2023. The possible merger might result in changes in the company electrolyzer targets.*

Polish green hydrogen production targets as share of 2020 gray hydrogen production



Source: BloombergNEF, Polish National Hydrogen Strategy. Note: Assumes a 70% capacity factor of electrolyzers, as they must be powered by renewable energy for the hydrogen to be labeled green

Appendix

Methodology and context

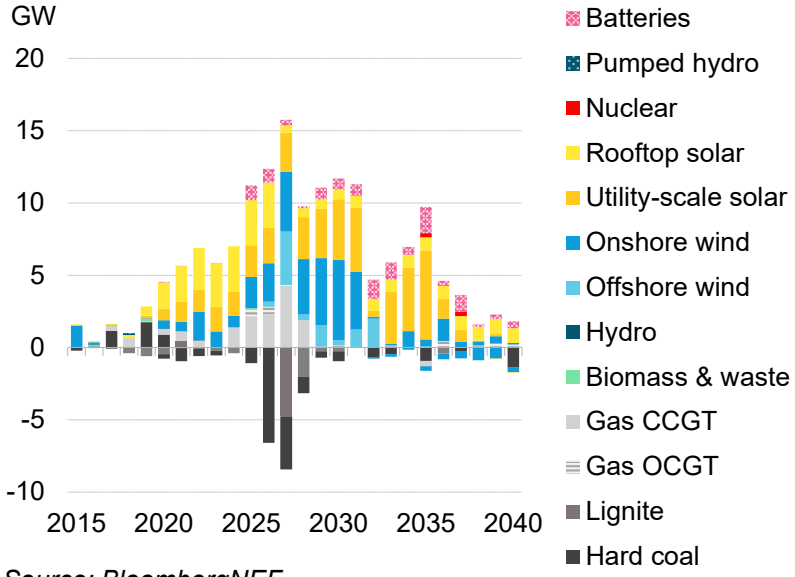
Methodology: Future energy scenario modeling at BloombergNEF

This research forms part of the library of energy transition scenarios at BloombergNEF, building on the analysis of our New Energy Outlook (NEO). NEO is BNEF's long-term scenario analysis on the future of the energy economy covering electricity, industry, buildings and transport and the key drivers shaping these sectors until 2050. As part of NEO, we use our in-house NEFM-2 power model to determine a least-cost system that can reliably meet electricity demand throughout the year. NEFM does not model import-export dynamics with neighbouring countries, but import capacity is modelled to help meet peak demand.

The core scenario used in BNEF research is our Economic Transition Scenario (ETS). This scenario employs a combination of near-term market analysis, least-cost modeling, and consumer uptake to describe the deployment and diffusion of commercially-available technologies, in the absence of new policy regimes, and uncover the underlying economic fundamentals of the energy transition. Scenarios are future-focused simulations combining a number of uncertain parameters into an internally consistent narrative. They are predominantly used for medium- to long-term investigative studies and may also include sensitivities to key variables. Scenarios differ from forecasts which are usually shorter-term predictions.

This outlook for Poland builds on results from our *New Energy Outlook 2022* (web | terminal) to explore additional policy and commodity market scenarios for the power market only.

Modelled capacity additions and retirements, Poland Least-cost Power Scenario



Source: BloombergNEF

Methodology and data inputs for Poland Power Transition Outlook

This outlook uses the Least-Cost Power Scenario (LPS) as a baseline. This scenario builds on the Economic Transition Scenario for Poland, but with additional assumptions on policy and capacity deployment. This includes updated gas and coal price forecasts; adjusted commissioning timelines for nuclear; updated near-term gas power pipeline based on Polish capacity contacts; a more granular split of thermal generation classes for gas; and updated assumptions on heat pump electricity demand.

The Restricted Renewables Scenario (RRS) and High Gas Price Scenario (HGS) are based on the LPS, but with additional assumptions to test different policy outcomes. The RRS restricts onshore wind build to 17GW by 2030, in line with government targets announced in July 2022. This target is not approved by Parliament as of January 2023, but previous Polish onshore wind targets for 2030 are out of date, as they have already been achieved.

The LGS is a sensitivity analysis reflecting the uncertainties in policy and gas prices, after Russia largely stopped gas deliveries to Europe. It assumes a 50% higher gas prices and 10-20% lower carbon price. The logic of cost-optimization and modeling approach remain the same in all scenarios.

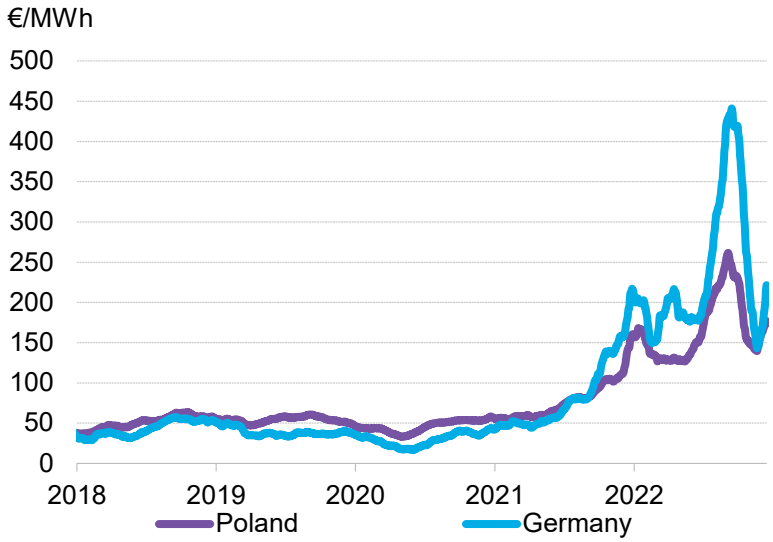
Methodology: Key limitations

The Poland Power Transition Outlook does not include a power price forecast for Poland and the precise dynamics of power plant profitability are therefore not analyzed. Our modeling optimizes for a least-cost system that meets peak demand at all times, which is different from a power price in day-to-day market operations. Power prices in Poland are set by a "pay-as-clear" system, where the marginal generator determines the power price for all generation at a given time. The least-cost optimization does not ensure that power plants get enough power market revenue to be profitable without any out-of-market support. Commodity prices, such as gas prices, vary on a daily basis, whereas BNEF models using annual average prices. This limits the accuracy in the short term, but the annual prices still help capture important dynamics in the medium and long term.

BNEF uses separate models to produce short-term power price outlooks. For example, BNEF's Germany Power Market Outlook (web | terminal) shows trends that are relevant also for Poland's future power prices. Our German power price analysis shows that margins for coal power plants relying on power market revenues will be too low to cover fixed operation and maintenance costs after 2027. Historically, German and Polish power prices show a high correlation with an R^2-value of 0.86 and the neighboring countries are likely to maintain correlated power prices in the future.

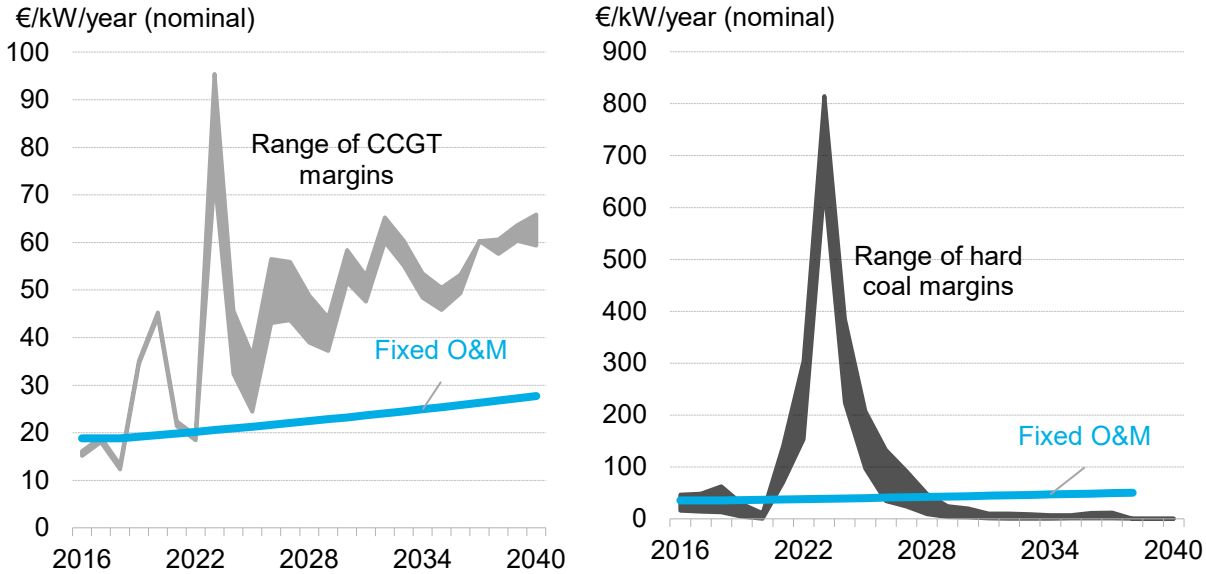
While the cost of grid expansion are not part of least-cost optimization, our scenarios include constraints on how "big" the grid can get. For more see NEO 2022 (web | terminal) and our forthcoming NEO grids report.

Poland and Germany average day-ahead baseload power price



Source: Bloomberg Terminal, EPEX spot, TGE. Note: shows baseload prices over an 50-day moving average.

Margins for hard coal and gas power plants in Germany



Source: BloombergNEF Germany Power Market Outlook 2022 (web | terminal).

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BloombergNEF (BNEF) is a strategic research provider covering global commodity markets and the disruptive technologies driving the transition to a low-carbon economy.

Our expert coverage assesses pathways for the power, transport, industry, buildings and agriculture sectors to adapt to the energy transition.

We help commodity trading, corporate strategy, finance and policy professionals navigate change and generate opportunities.

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