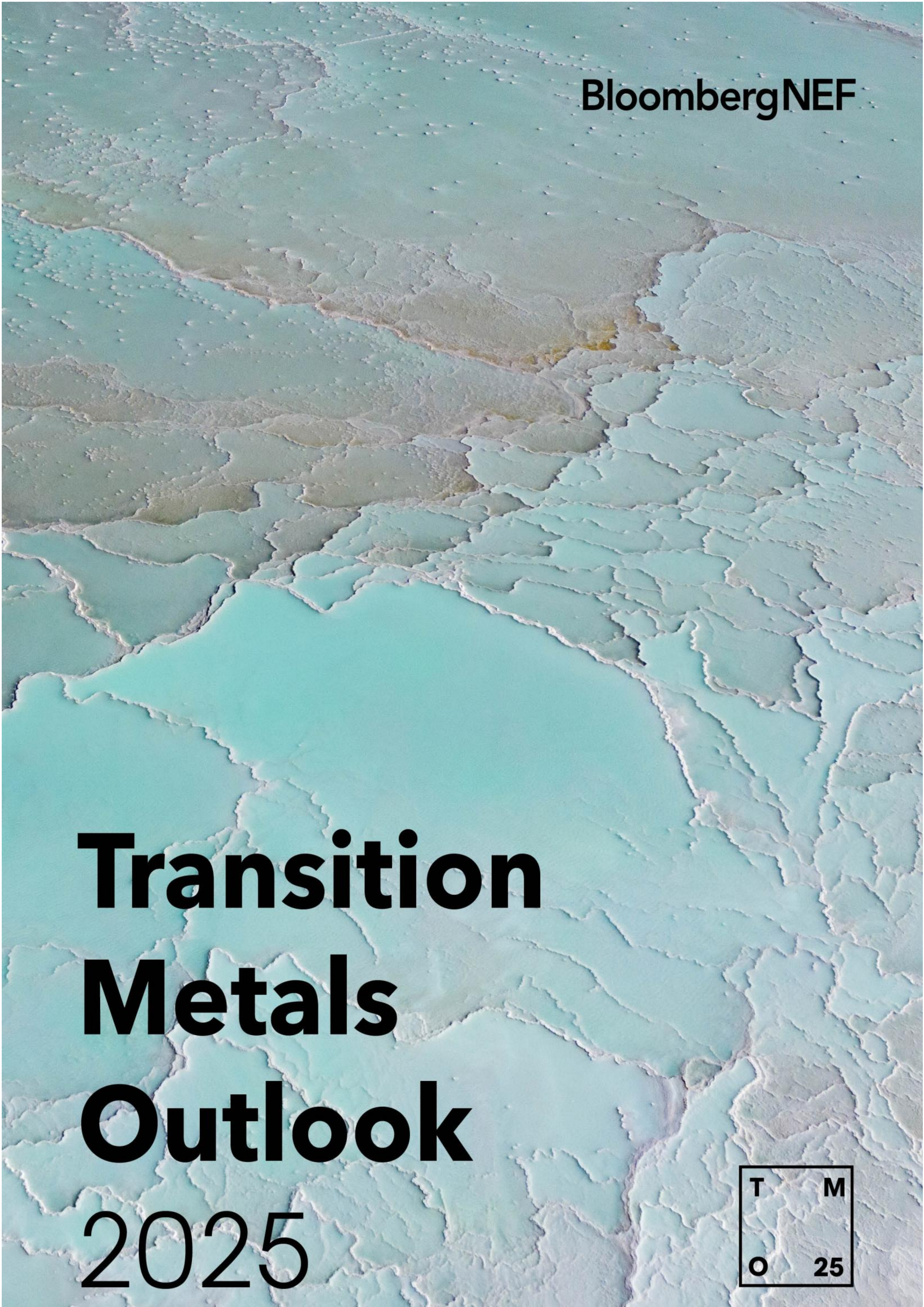

BloombergNEF

Transition Metals Outlook 2025

T M O 25

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Section 1. Executive summary

7 out of 10

Energy transition minerals expected to be in supply surplus between today and 2030

4 million metric tons

Copper deficit in 2030 under BNEF's ETS

597 million metric tons

The amount of new demand for metals and minerals this decade because of the energy transition

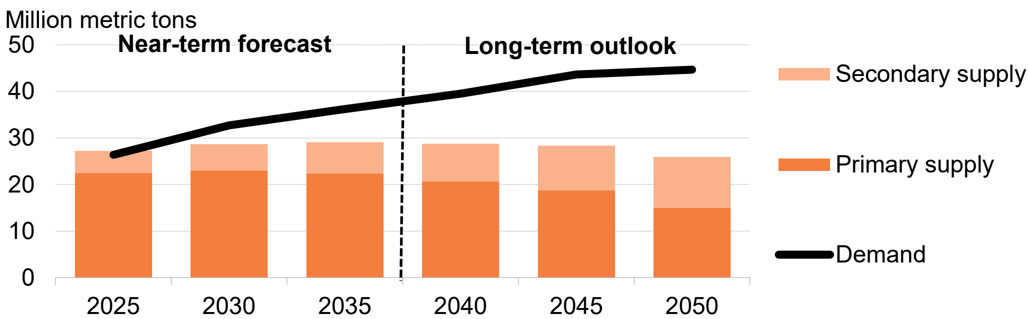
BloombergNEF's *Transition Metals Outlook 2025* assesses how shifting priorities in the energy sector will impact key metals markets over the next 25 years. It highlights sharply diverging demand trajectories, widening supply imbalances, rising geopolitical and policy risks, and the strategic repositioning of governments and global mining companies. For some key metals, energy transition momentum is pushing a rapid expansion in demand, leaving supply chains, investment levels and environmental policies struggling to keep up.

Demand for copper, aluminum, lithium, graphite and manganese is rising as electrification and clean-power buildout intensify. Copper faces the most acute long-term pressure, as a boom in copper-intensive data centers coincides with mine disruptions and slow permitting, which are holding back supply. Batteries remain the biggest driver of growth for lithium, cobalt and nickel demand, though chemistry shifts are changing their intensities. Supply remains uneven: lithium and cobalt are in near-term surplus, while graphite and copper are tightening. Steel and platinum group metals (PGMs) remain tied to legacy sectors, with limited upside from the energy transition.

For copper, all scenarios lead to a deficit

Copper sees a steep long-term increase in use. Energy transition demand triples by 2045, driven by electric vehicles, grid expansion and data centers. The commodity enters a structural deficit from 2026 onward. Mine disruptions in Chile, Indonesia and Peru amplify this tightness. A massive deficit – amounting to some 19 million metric tons by 2050 – looms if new mines and recycling facilities are not built over the next decade.

Figure 1: Global copper market balance



Source: BloombergNEF. Note: Supply is based on BNEF's announced asset-level supply analysis and benchmarking, and represents risk-adjusted capacity. Secondary supply includes collected scrap and battery recycling material availability. Demand is under BNEF's Economic Transition Scenario.

For aluminum, China leads production, but India is catching up

China is far and away the world leader in global aluminum supply, accounting for half of the metal produced today. As a result, supply risks in the sector are also concentrated in China. A government-imposed production cap on the metal – originally introduced to curb overcapacity and reduce carbon emissions – is close to being reached, and it now limits the industry's ability to respond to rising domestic and global demand. Raising the ceiling would ease supply pressures but could also resurface environmental concerns.

As production expands elsewhere, China's share of the global market falls to 37% by 2050 in BNEF's Economic Transition Scenario. At the same time, India is ramping up production capacity, and its total output more than doubles in the next 10 years under the ETS.

For graphite, a supply shortfall emerges after 2030

Demand for graphite is set to rise to 6.7 million tons in 2050 in the ETS, from 2.7 million tons in 2025. Graphite is the primary material for anodes – a key component of lithium-ion batteries – and much of its demand growth is driven by the expanding use of lithium-ion batteries across the electric vehicle and energy storage sectors. BNEF expects the graphite market to enter a technical deficit in 2032, as growth in secondary graphite production (graphite recovered from retired lithium-ion batteries) fails to keep pace with a slowdown in capacity additions in primary supply.

For lithium, supply keeps growing

Total lithium capacity from both primary and secondary sources could reach 4.4 million tons of lithium carbonate equivalent (LCE) by 2035, up from 1.5 million metric tons LCE in 2025. The lithium industry has matured over the last five years, following an extended period of depressed prices.

Capacity additions are expected to increase significantly due to three factors: maturity of some direct lithium-extraction projects, new sources of supply from South America and Africa, and retired batteries entering the secondary market. Mined capacity additions are set to grow threefold over the next decade, while secondary supply will grow faster after 2035, when retired batteries become more available for recycling. Lithium prices remain low after falling from a peak of $80,000 per ton in November 2022, although supply disruption, subsidy reduction and stationary storage growth have recently helped prices recover somewhat.

For manganese, upstream supply is stable, but downstream supply is concentrated

Global manganese use is – and will continue to be – dominated by steelmaking, which today accounts for 97% of the metal's use. BNEF expects the manganese market to align supply with demand through 2050. Unlike other energy-transition commodities, manganese ore faces no supply-related risks concerning reserves or production capacity, although regional policy and logistics constraints may influence short-term availability. Total supply is set to grow by roughly 1% a year between 2025 and 2050, as primary supply utilization rates can adjust to meet demand where logistics, energy and regulatory conditions permit.

China's steel production controls and dominance in battery-grade manganese sulfate production are likely to be the main factors impacting demand and trade flows. Logistical challenges in South Africa and a planned 2029 export ban in Gabon pose near-term supply risks, as both factors could curtail seaborne supply.

For cobalt, DRC export ban boosts price

Cobalt prices have been trending downward, largely due to a persistent supply surplus in the industry. In February, when prices had dropped 73% from their peak in April 2022, the Democratic Republic of Congo announced a four-month export ban aimed at stabilizing prices. The ban was later extended to September, when the DRC introduced an export quota policy for cobalt with a 96,600-ton annual cap for 2026 and 2027 – a 50% reduction from 2024 highs. Following these interventions, prices for cobalt metal and related products rebounded sharply, rising 128% from February to October, and the export cap is likely to continue supporting prices into the new year.

Countries are investing in supply chains, but China still dominates

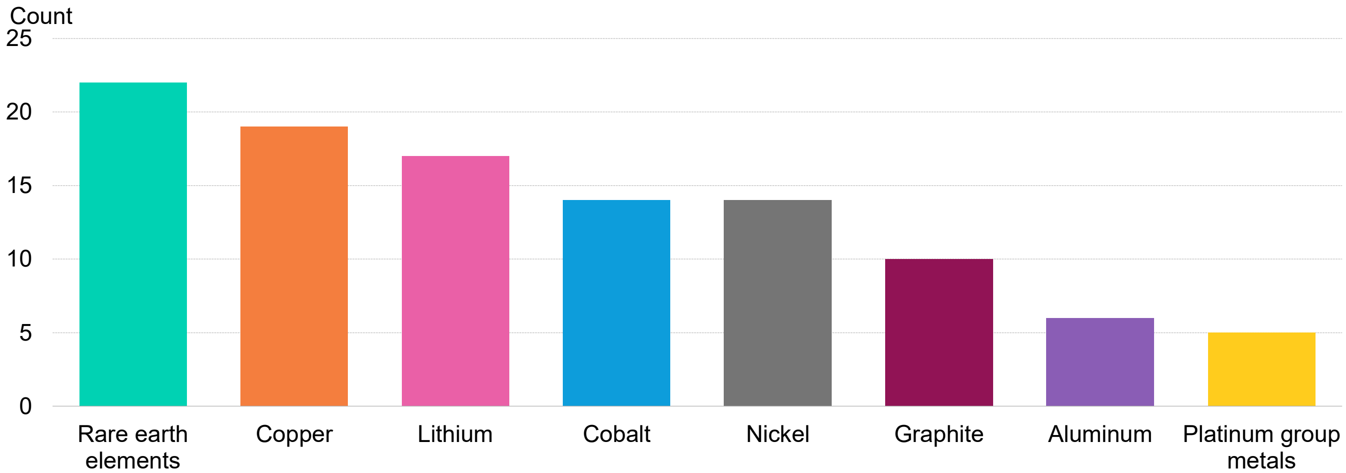
China dominates midstream capacity in aluminum, graphite, manganese, cobalt, nickel and rare earths – but relies heavily on imported ore for copper, PGMs and cobalt. Europe and the US have secured domestic supply for aluminum, steel, and to an extent copper, but remain deeply exposed across graphite, manganese, nickel and lithium. Japan and South Korea depend on diversified imports and recycling rather than meaningful primary supply. Southeast Asia sees Indonesia and the Philippines anchoring upstream production, especially nickel.

Across the rest of the world, upstream resources are abundant, but refining capacity remains highly concentrated, forcing ore flows back to China, Europe and the US for processing. Governments are responding with accelerated permitting, strategic stockpiling, recycling incentives and midstream buildout, but progress is uneven.

Rare earths get the most policy attention

Among the five countries assessed in detail in this report, rare earth minerals have attracted the most policy support through fiscal and financial incentives, followed by copper. The mining and refining of rare earth elements (REEs) is heavily concentrated in China, which has drawn significant attention from both the public and private sectors around the world. This intense focus is warranted, given REEs' crucial role in advanced technologies and the energy transition. Copper has similarly become a strategic priority for governments, due to surging demand and lagging upstream investment.

Figure 2: Count of policy incentives for critical metals in Australia, Brazil, Canada, Indonesia and South Africa, 2015-2025

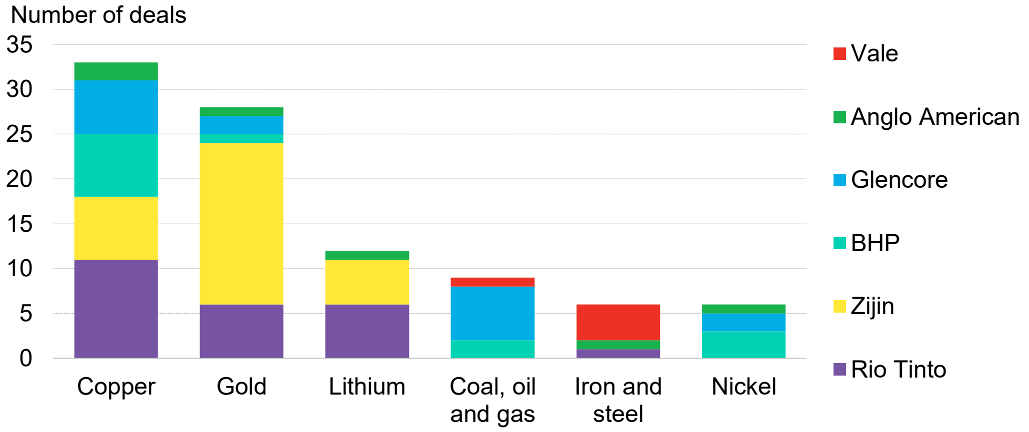


Source: BloombergNEF

Copper leads in corporate expansion

Increasing demand from both the energy transition and traditional sectors is prompting renewed investment activity in the metals industry. In the broadest terms, companies are developing new mines to meet growing demand for key metals and materials. This report assesses the capital investment activity of Anglo American, BHP, Glencore, Rio Tinto, Vale and Zijin amid shifting market conditions.

Figure 3: Acquisitions by commodity, 2020-25



Source: Bloomberg Terminal, company websites and news, BloombergNEF. Note: The period for the above deals is from Jan. 1, 2020, to Oct. 28, 2025. The deal count is based on the number of metal types involved rather than the absolute number of transactions. For assets producing multiple metals – for example, copper and gold – one transaction is counted once in each relevant metal category. In such cases, a single deal would be recorded as two metal entries in total. The dataset includes acquisitions of both companies engaged in producing or refining specific commodities and mining assets containing those commodities.

Decarbonization of metals is the next frontier

Renewable energy technologies play a central role in driving the global energy transition. Wind and solar capacity grow fivefold in the next 25 years in BNEF's Economic Transition Scenario, reaching almost 20 terawatts by 2050. These assets offset grid emissions once they are operational, but they carry an upfront carbon cost from the materials used in manufacturing of equipment and the construction of project infrastructure.

Steel, aluminum and copper are the main contributors to embodied emissions in solar and wind projects. Their production is tied to energy-intensive mining, smelting and refining processes. As grids decarbonize, avoided emissions gradually offset this embodied footprint.

Onshore and offshore wind reaches the breakeven point fastest, in under three months. This is thanks to high capacity factors and moderate material intensities. Utility-scale solar can pay back its metals emissions by operating for three months, while small-scale utility solar takes around 3.6 months. To decrease this carbon payback period, companies investing in the energy transition must prioritize both downstream investment (such as solar and wind) and upstream investment (such as mines and refineries). Ignoring upstream decarbonization leads to higher embedded emissions throughout the supply chain, prolonging the carbon payback of renewable energy technologies.

Figure 4: Carbon payback of wind projects, by technology

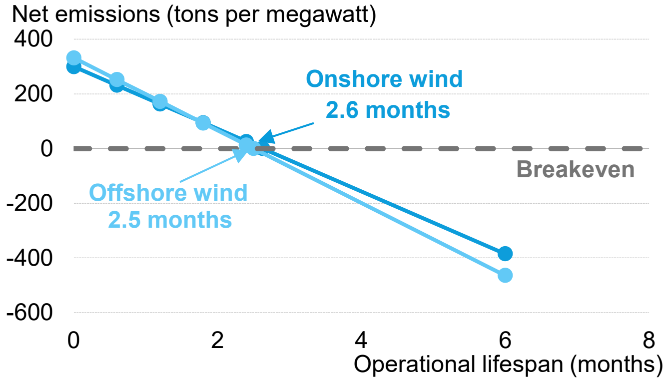
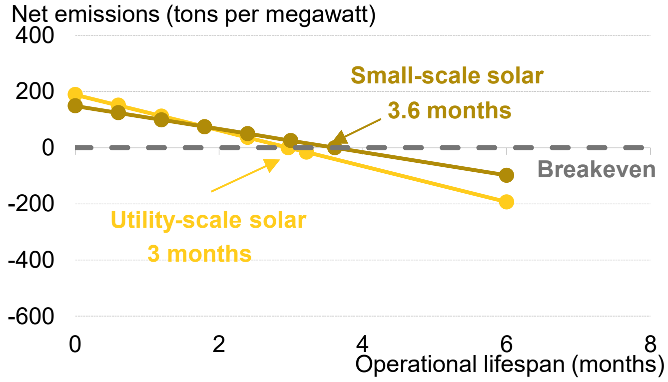


Figure 5: Carbon payback of solar projects, by technology



Source: BloombergNEF. Note: Operational lifespan reflects the technology's total lifetime. The chart shows only the early phase of a project's life, when payback occurs. Net emissions reflect the difference between a project's embodied emissions and the avoided emissions from replacing grid electricity generated from fossil fuels. The breakeven point, or carbon payback point, occurs when cumulative avoided emissions equal embodied emissions. Calculated using a global average grid emission intensity of 0.42 metric tons CO2 equivalent per megawatt-hour (tCO2e/MWh).

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