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A Fine Balance: The Energy Outlook for 2024



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Energy has witnessed four very volatile years since the start of the decade. Global markets are still striving to find a sustainable balance between supply and demand, while a decelerating macroeconomic framework and geopolitical events add headwinds to slowing demand growth. Meanwhile, policy developments in 2022 and 2023 related to the transition and associated critical minerals have yielded considerable near- and medium-term opportunities, but significant challenges are expected for market participants as interest rates remain elevated.

What is the outlook for energy in 2024? Will transition-focussed energy finally outpace traditional energy? Will new energies develop sufficiently to meet critical climate goals?

ENERGY RESEARCH PAPER

This research paper is part of a 12-month series published by the Al-Attiyah Foundation every year. Each in-depth research paper focuses on a current energy topic that is of interest to the Foundation's members and partners. The 12 technical papers are distributed to members, partners, and universities, as well as made available on the Foundation's website.



- Growth in global energy consumption will accelerate to 1.8% in 2024, up from 1.2% in 2023, supported by strong demand in Asia. Fossil fuels will continue to dominate, despite soaring demand for renewables and the pressure to reduce emissions.
- Global fossil fuel demand will reach record levels, although growth rates for oil and coal in particular will not be as high as in 2023. Relatively high commodity prices will continue to draw investment into oil and gas production.
- Momentum in renewable energy will continue, as in electric vehicles and hydrogen. The project pipeline will swell, although actual produced low-carbon hydrogen volumes ramp up from a very small starting point.
- Several wildcards for energy in 2024 remain, including reining in inflation and interest rates, China's economic slowdown, and the recovery of European power and gas demand.
- Geopolitical issues came to the forefront in 2022 and remained important in 2023; their direct impact on supply in 2023 was minor, but eastern Europe, East Asia and the Eastern Mediterranean/Red Sea, remain areas of significant threat to the global economy.
- A new wave of consolidation in renewable technology will foster a manufacturing base capable of operating more comfortably with thinner margins.
- This year might see a surplus in critical metals supply, but it may also be the last year of "low" prices as demand for batteries and potential instability in supplier countries increases.





- O&G companies will play a more consolidated role in the energy transition in 2024. By prudently allocating capital and effectively executing clean energy strategies, they can enable scaling of innovation in the industry, while maintaining profitability and shareholder value.
- O&G companies' disciplined, high-return capex strategy of yesteryears will more decisively transform into lean, ESG-focussed strategies that favour innovation, technological breakthroughs, and next generation solutions for decarbonising portfolios, and bolstering the scalability and commercial viability of low-carbon solutions.
- Industry consolidation will continue, particularly in the US shale sector, but with a growing prominence for non-Western companies outside North America.
- O&G companies could also play a role in critical minerals by securing a position in the supply chain to tackle perceived end-market risks, although this will vary from company to company.
- Fostering capabilities in critical minerals can present O&G companies with synergistic opportunities. To capitalise on them, companies need to develop mitigation strategies for high lead times, delays in permitting processes, and changing demand patterns.
- Long-term market strategies will have to be set with the backdrop of likely continuing geopolitical concerns, a softening economic landscape, the continuing use of sanctions on various countries and companies, and volatile commodity prices.



Growth in global energy consumption will accelerate to 1.8% in 2024, up from 1.2% in 2023ⁱ, supported by strong demand in Asia, where Chinese consumption is expected to increase by 3.2% – 4.4% in H1 2024 versus the same period in 2023ⁱⁱ, and in the Middle East, where the unprecedented heat waves experienced over the last two yearsⁱⁱⁱ are expected to continue, bolstering demand for air conditioning.

Energy demand in Europe will record its third year of decline as the region battles against high prices and limited gas supplies, although rationing gas supplies is unlikely due to an overall improved situation from 2022-23. In North America and Latin America, economic growth will be soft, resulting in marginal demand growth (Table 1).

Figure 1 Total Energy Demand, % Change year-on-year, by Region^{iv}

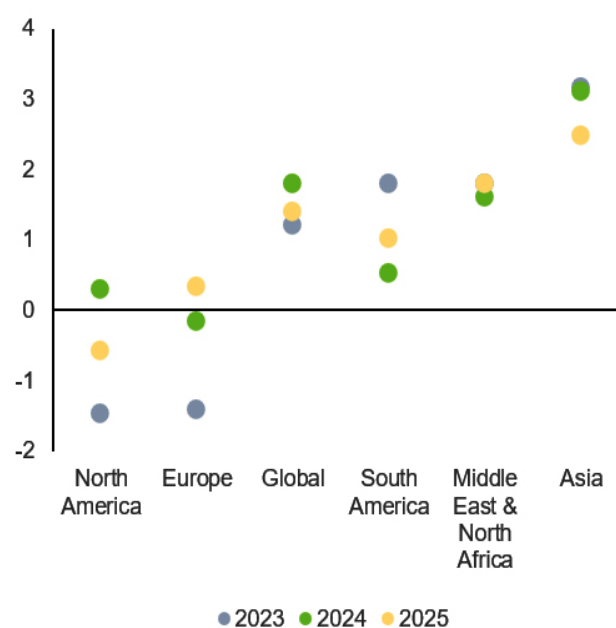


Table 1 Major factors impacting the change in energy demand in 2024, y-o-y, from 2023, in major regions of the world^v

Country / Region	Demand Change	Major Impacting Factors
China	3.2%	<ul style="list-style-type: none"> Strong petrochemicals appetite, first-half naphtha demand to grow by 11% Jet fuel demand growth fuelled by recovery in international air travel Some downside from higher EV penetration impacting diesel and gasoline demand Lower construction and manufacturing activity could reduce diesel consumption Power demand to remain strong, with growing share coming from clean energy
India	>3%	<ul style="list-style-type: none"> Higher industrial and manufacturing activity Unusually dry and hot summer spells (delayed monsoon rains) increasing power demand Increase in the use of pump sets for irrigation, increasing energy demand Power demand set to continue increasing by 8% on average y-o-y due to population growth and population shift towards urban centres
Other Asia	3.1%	<ul style="list-style-type: none"> Stronger services and manufacturing PMIs Steady air traffic recovery amid healthy driving activity Higher anticipated petrochemical industry operations Temperature declines in the winter season will increase energy demand (mainly in OECD Asia-Pacific, in line with seasonal patterns), plus expected return of nuclear power could support demand there
Europe	-0.2%	<ul style="list-style-type: none"> Minimal uptick in manufacturing activity, petrochemicals and industrial sectors largely expected to remain weak Electricity demand for gas expected to remain weak from 2023 levels, reflecting the continued fallout from the energy crisis following Russia's invasion of Ukraine Expectation of overseas subsidies such as the US Inflation Reduction Act (IRA) and Japan's Green Transformation Act "influencing production curtailment, plant closures, and pausing and diverting of investment"^{vi}
North America	0.3%	<ul style="list-style-type: none"> Higher private household consumption and GDP increase Further improvements in air travel will support jet fuel / kerosene demand Downside from prolonged downward trend in industrial output, expected to carry over to 2024 Road transportation fuels' demand expected to soften during the winter season, but light distillates' usage in other sectors could grow
South America	0.5%	<ul style="list-style-type: none"> Economic growth to remain relatively healthy Steady recovery in air travel Ongoing support from services and manufacturing sectors, and healthy power demand, with increasing share of clean energy to meet demand Petrochemical feedstock usage to increase as the sector expands Transportation sector to lead energy demand growth
Middle East and North Africa	1.6%	<ul style="list-style-type: none"> Current momentum of economic activity, especially in UAE, Saudi Arabia, Qatar, and Iraq is expected to be sustained into 2024 Strong international air traffic will likely continue Composite PMIs point to healthy economic and business activity, supported by GDP growth rates that are forecast to pass those of 2023 (although Egypt's growth rate is forecast to be lower than 2023's, and Israel's is expected to decline due to the war) Transportation activity is expected to remain healthy Major structural shift expected towards clean energy sources, particularly in the power sector to meet expected high demand, mainly in the UAE

07 FOSSIL FUELS WILL DOMINATE, BUT AT LOWER GROWTH RATES THAN YESTERYEARS

Fossil fuels will continue to dominate despite soaring demand for renewables and the pressure to reduce emissions.

Natural gas will be the most subdued amongst the fossil fuels, as soft economic indicators and some still ongoing expectations of a recession keep demand flattish in Europe and North America but offset by strong consumption from Asia and the Middle East, driven by higher demand from the power generation and industrial sectors. European gas demand has long passed its peak, and is unlikely to return to levels seen before Russia's invasion of Ukraine (Figure 2), with power demand forecast to be met by strong renewable generation growth (Table 2) in 2024.

Figure 2 European gas demand by end-use¹, Bcf/d^{vii}

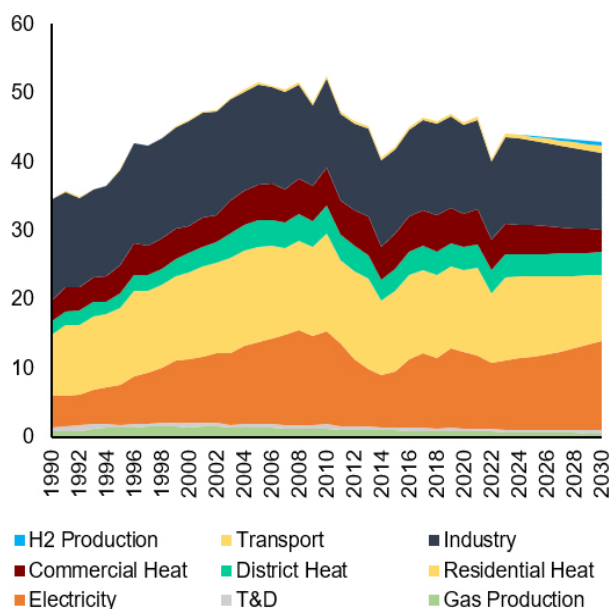


Table 2 European power demand in 2024 versus 2023 and capacity growth by generation source^{viii}

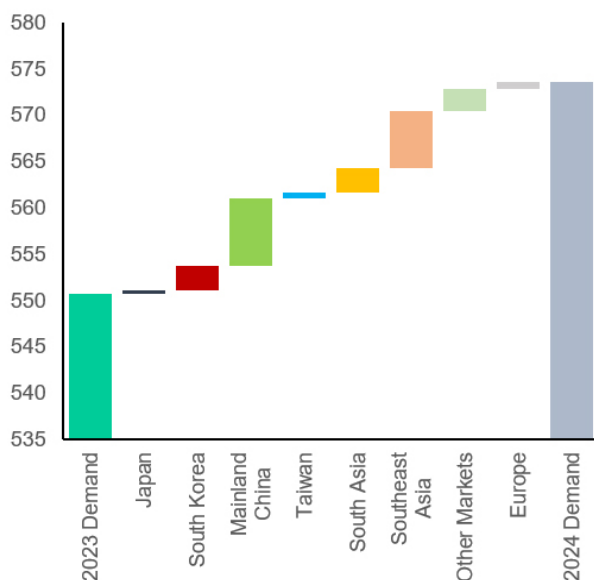
Source	Growth in Capacity vs 2023
Nuclear	+1 GW (to 56 GW)
Wind	+5 GW (to 52 GW)
Solar	+5 GW (to 28 GW)
Gas	-6 GW (to 36 GW)
Hydro	+1 GW (to 27 GW)
Coal / Lignite	0 GW (to 17 GW)
Total 2024 Power Demand	241 GW
Versus 2023 Power Demand	234 GW

In Asia, gas demand will be led by China, where the transport sector is likely to see the fastest growth amid more affordable LNG prices, improving the economics of natural gas-powered vehicles, although EVs will continue increasing. The competitiveness of gas-fired power plants will rise in India due to lower prices, increasing demand, whereas OECD Asia-Pacific will see demand rise mainly in the 2024-2025 winter period for heating, with demand in other seasons largely flattish, due to increased nuclear generation^{ix}.

Elsewhere, in other Asia, demand growth will be driven by falling production (such as in Thailand), buoyant economic activity (such as in Singapore, evidenced by recent new LNG contracts) and domestic shipments (such as from Indonesia's upcoming Tangguh Train 3). Bangladeshi demand is expected to increase in the form of higher spot LNG purchases due to softer prices, and Pakistan is expected to follow suit in the summer, after importing zero spot cargoes in summer 2023, due to high prices.

¹-Gas Production refers to gas own use in processing natural gas after production

Figure 3 Global LNG demand change, y-o-y from 2023 levels by region , BCM^x



North American gas usage in the power sector is forecast to shrink due to higher output from renewable energy, while improved energy efficiency standards and a gradual electrification of heating are set to shrink the role of gas in residential and commercial sectors. Overall gas demand should decline by 0.4% on 2023 levels^{xi}.

In the Middle East, an increased trend of decarbonisation, the growth of gas production, rapidly rising populations, and improving economic growth are expected to support the expansion of gas-intensive industries (including hydrogen), the displacement of oil usage with gas, and higher gas burn in the power sector (Figure 4).

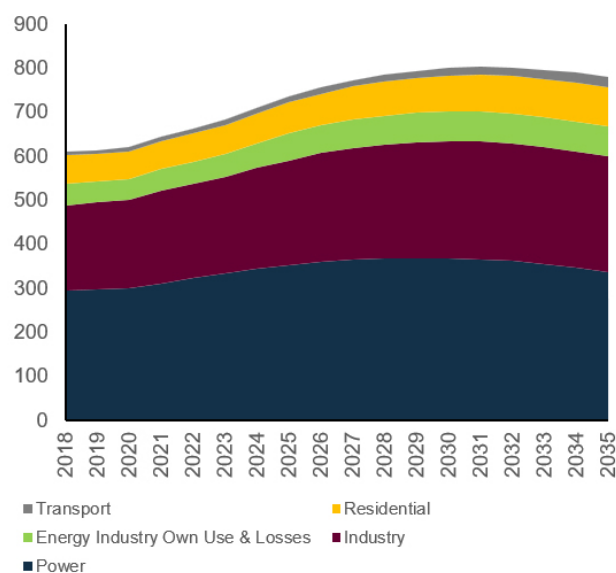
Oil demand will expand by 1.3% in 2024 from 2023 levels, mainly driven by Asia, Latin America, and the Middle East, where demand continues growing fast despite relatively high prices (even though current prices have weakened to a 6-month low, near US\$ 71/b^{xii}, given recent inflation, longer-term prices should average about US\$ 80/b), particularly from the road transportation and aviation sectors.

This growth is despite COP28's agreement to transition away from fossil fuels, signalling that the outlook for near-term oil use remains robust^{xiii}. This is, mainly in developing markets, which are expected to become the sites of increased petrochemical and manufacturing activity as the impact of higher interest rates and (in Europe) high energy costs cause businesses in mature markets to shift base.

North American demand growth will be tepid, expanding by only 0.3% over 2023 levels^{xiv}, and in Europe will witness a minor decline due to below-trend economic growth, efficiency improvements and a booming EV fleet, which will further reduce demand for oil-based road transportation fuels.



Figure 4 Middle East Gas Demand to 2035, BCM



Although 2024 was expected to be a year of negative oil demand growth in Europe, pushbacks on ambitious policy targets as the bloc places more priority on energy security and socio-economic development will avoid a significant drop in oil demand. For instance, the UK has postponed a ban on the sale of new petrol and diesel cars from 2030 to 2035.

In OECD markets, private household consumption will be the main driver of the limited oil demand growth, plus some improvements in air travel that should support jet fuel demand. Industrial output, however, will remain on a prolonged downward trend, and road transportation fuels' demand will soften due to the rise of EVs. Weaker manufacturing and petrochemical activity will continue to weigh on industrial fuels and petrochemical feedstock, while service PMIs are forecast to improve only in the Asia-Pacific markets.

Table 3 World oil demand by region in 2024 versus 2023, Mb/d^{xv}

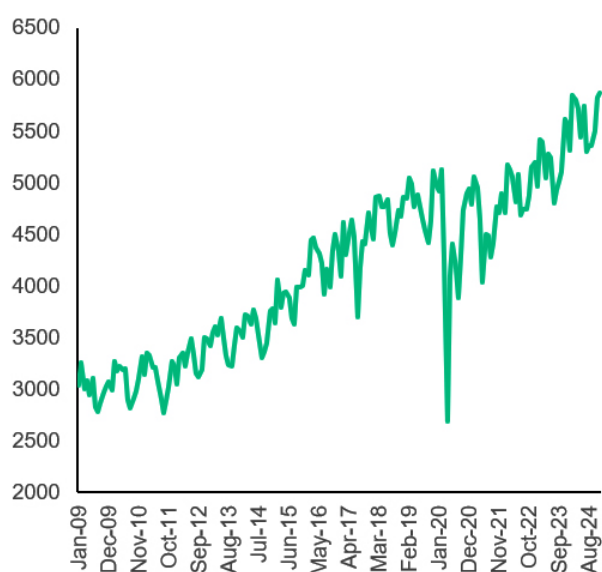
Region	2023	Q1 2024	Q2 2024	Q3 2024	Q4 2024	2024	% Change
North America	24.6	24.3	25.0	25.0	24.5	24.7	0.3%
Europe	13.3	13.0	13.4	13.4	13.1	13.2	-0.2%
Asia-Pacific	7.3	7.7	6.9	7.0	7.4	7.3	-0.9%
China	15.9	16.1	16.3	16.6	16.6	16.4	2.8%
India	5.3	5.5	5.5	5.4	5.6	5.5	2.8%
Other Asia	9.2	9.5	9.6	9.3	9.3	9.4	2.3%
Latin America	6.6	6.7	6.8	6.9	6.6	6.8	2.1%
Middle East	8.5	8.8	8.7	9.2	8.8	8.8	3.7%
Africa	4.5	4.6	4.3	4.3	4.9	4.5	1.3%
Russia	3.8	3.8	3.6	3.8	4.0	3.8	1.7%
Other Eurasia	1.2	1.3	1.2	1.1	1.3	1.2	-0.9%
Other Europe	0.8	0.8	0.8	0.8	0.8	0.8	-0.9%
Total	101.0	102.0	102.1	102.6	102.7	102.3	1.3%

Non-OECD markets will be the main drivers of forecast oil demand growth in 2024, with Asian markets leading the charge. In China, despite an expected easing in the momentum of GDP growth compared to 2023, oil demand is expected to expand by 2.8%^{xvi}, supported by sustained healthy services sector activity, a recovery in manufacturing, and petrochemical sector requirements (resulting in strong naphtha and LPG consumption).

Still, the rate of growth is lower than in 2023 (when demand grew by 7.8% over 2022 levels^{xvii}), as the impact of pent-up appetite for travel and consumption following a 3-year pandemic begins to fade, and demand for transport fuels becomes less significant as the EV fleet grows^{xviii}.

Favourable base effects and only a slight slowing in GDP growth will be the main drivers of increased oil consumption trends in India, who is expected to equal China in terms of year-on-year growth (also at 2.8%). Robust manufacturing, amid the Indian government's proposed increase in capital spending on construction should support demand growth, mainly for distillates. India also lags behind other regions in its transition from traditional gasoline and diesel-fuelled transport to EVs, which means demand for transportation fuels will remain buoyant, especially on the expectation of an influx of travellers during the festival seasons.

Figure 5 India's monthly oil demand to 2024, kb/d^{xix}

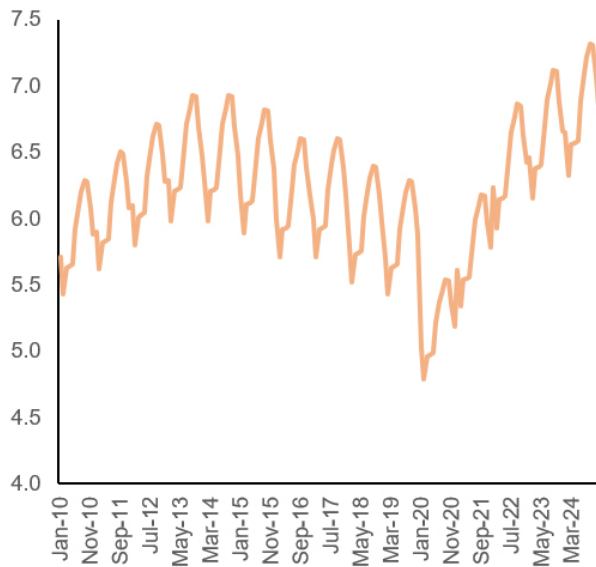


The other major region contributing to oil demand growth in 2024 will be the Middle East, where the current momentum of economic activity should carry forward well into H1 2024, with strong international air traffic supporting growth in the latter half of the year (with sporting tournaments, such as the AFC Asian Cup in Qatar encouraging air travel, although this might not be at the levels of COP28 in the UAE).

Composite PMIs in Saudi Arabia and the UAE will contribute to economic activity remaining buoyant, and transportation activity is expected to remain strong, supporting oil products' demand, despite planned policies for encouraging the uptake of EVs.

Africa should also contribute to demand growth, but considerable uncertainties around petrochemical activity (due to refiners' lower margins) and a patchy industrial sector that is yet to fully recover from the aftermath of the pandemic could impact actual growth levels. Latin American demand (Figure 6) will be supported by good economic indicators, a steady recovery in air travel, and ongoing support from the services and manufacturing sectors. Expectations for further subsidies and incentives for EVs (such as tax exemptions and duty-free imports of charging equipment and batteries) could begin denting road transportation fuels' demand, but meaningfully impact demand only from 2025 onwards.



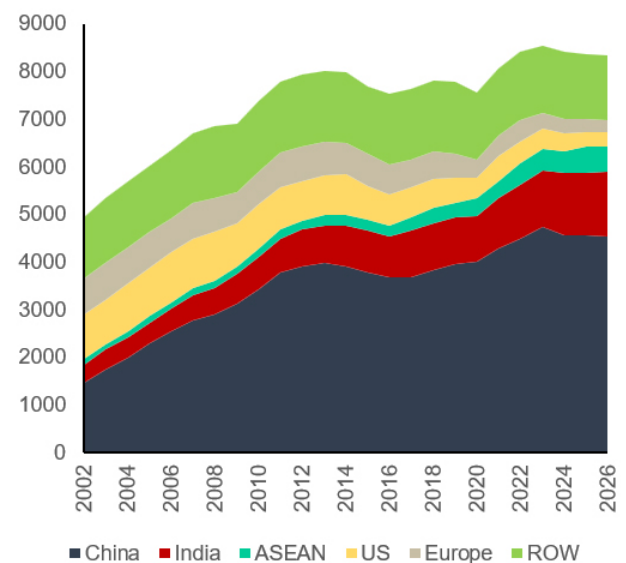
Figure 6 Latin America monthly oil demand to 2024, Mb/d^{xx}

After reaching an all-time high this year, coal demand will decline in 2024, led by sharp reductions in use in Europe and North America, softer but dedicated declines in China (somewhat offset by slight gains in India), and a phase-out of coal-fired power in the Asia-Pacific countries.

Chinese consumption will fall on the expectation of improved hydropower output, as well as the installation of half of the global renewable capacity expansion forecast for 2024. Major structural changes to its economy as it reaches the end of infrastructure-led, energy-intensive growth, and an increase in clean energy capacity will influence coal's stagnation to 2026, after which it is expected to enter a sustained decline.

India, Indonesia, and other emerging markets will continue to rely on coal to power strong economic growth, despite commitments to accelerate the deployment of renewables and other low-emissions technologies.

Still, consumption in these markets will grow only marginally, by ~2% in India, and a few million tonnes in Indonesia. Nuclear generation is set to see modest increases in India, whilst Indonesia is planning for nuclear power becoming a part of its energy mix by the 2030s^{xxi}, which should stagnate coal demand if not actively reduce it. However, the availability of hydropower in these countries is a key variable in the short term, since coal is used as a substitute when hydropower underperforms, especially in China and India, although the change in weather pattern from La Niña to El Niño should improve hydro availability in 2024.

Figure 7 Global coal consumption forecast to 2026, Mt^{xxii}

In Europe, lukewarm economic prospects, paired with the weakening of the factors that pushed coal-fired power generation in 2022 (namely, the Russian invasion of Ukraine) and lower gas prices will reverse the gas-to-coal switch witnessed in the last two years.

FOSSIL FUEL SUPPLY WILL INCREASE BUT IS INCREASINGLY ON THE EDGE OF ITS PEAK

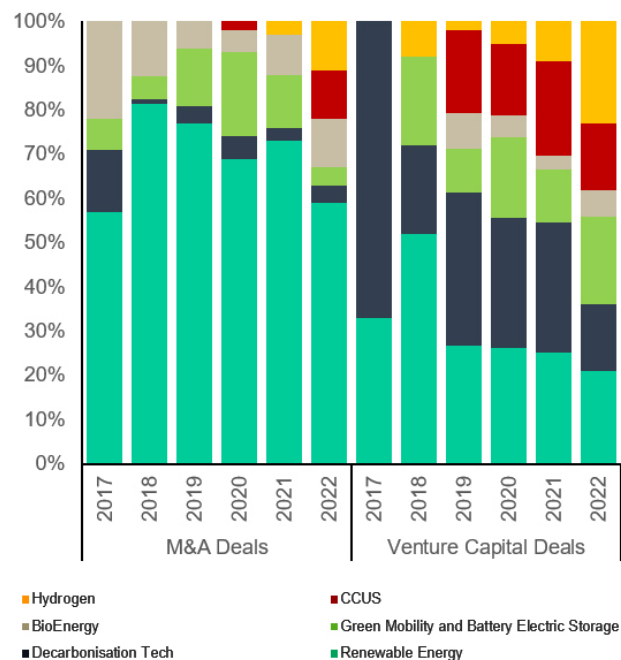
Despite calls by agencies like the IEA to end investment in new oil and gas fields^{xxiii}, the global upstream industry is projected to maintain its 2023 hydrocarbon investment level of US\$ 580 B (itself an increase of 11% from 2022 levels) and generate over US\$ 800 B in free cash flow^{xxiv}. Lower unit prices, efficiency gains, productivity gains, and evolving portfolio strategies will continue to increase the upstream industry's efficiency, meaning that the industry can do the same as before, but at much lower costs.

This continued financial strength will raise expectations of further progress in emissions' reduction in the upstream sector, augmented investments in low-carbon energies, and amplified returns for shareholders. These expectations are already being reflected in the upstream expansion plans of major producers across all world regions, many of whom have now committed to portfolios with a larger share of low-carbon initiatives (Figure 8).

The main reasons for this are to achieve their own net-zero goals and achieve synergies with existing oil and gas assets and operations. More importantly, aside from the legacy oil and gas producers of the West (mainly Europe, except Norway somewhat), most of the world's producers recognise their role as important suppliers of the world's energy needs in 2024 and beyond till peak demand hits, and the opportunity that presents to lead their reserves' development in a more sustainable, climate action-inclusive way.

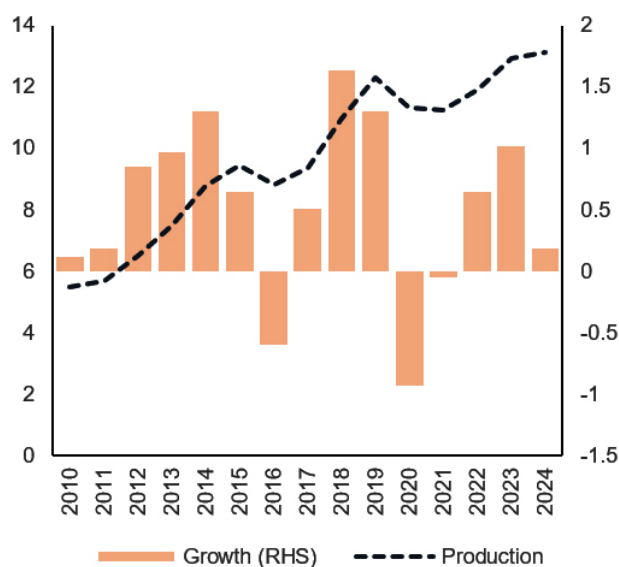
In 2024, non-OPEC producers will lead oil supply growth, forecast to increase by 1.4 Mb/d over 2023 levels, of which 0.6 Mb/d will come from the US (including 0.2 Mb/d of crude production increase^{xxvi}), reaching new record highs.

Figure 8 Breakdown of O&G players' low-carbon M&A and venture capital deals since 2017 by share %^{xxv}



Strong oil prices in 2022 and 2023 have returned investor appetite for more drilling activity, and project shareholders will continue watching how shale operators upgrade capital efficiency, which, through optimal completion designs, can be enhanced by about 20-25% in key shale basins^{xxvii}.

Figure 9 Forecast US Crude Oil Production and Growth, Mb/d^{xxviii}





Other contributors to supply growth will include Canada, Guyana, Brazil, Norway, and Kazakhstan. Offshore project ramp-ups will be the main sources of production increase in Guyana, Norway and the UK (where overall production will continue declining, albeit at a slower rate, due to ramp-ups at the ETAP and Clair sites, as well as at the Anasuria and Captain EOR start-up projects), while Kazakhstan will mainly see increases from its Tengiz oil field (through an expansion at the Tengizchevroil Future Growth Project), and some marginal growth from the Kashagan and Karachaganak fields, which are earmarked as key contributors to Kazakhstan's plans of expanding production capacity to 2.1 Mb/d^{xxix} from the current 1.8 Mb/d by 2027

Brazilian output is forecast to increase by a marginal 0.12 Mb/d over 2023 levels through production ramp-ups in the Buzios (Franco), Mero (Libra NW), Tupi (Lula), Peregrino and

Itapu (Florim) oilfields. Oil project start-ups are expected at the Atlanta, Pamp-Enchova Cluster and Vida sites.

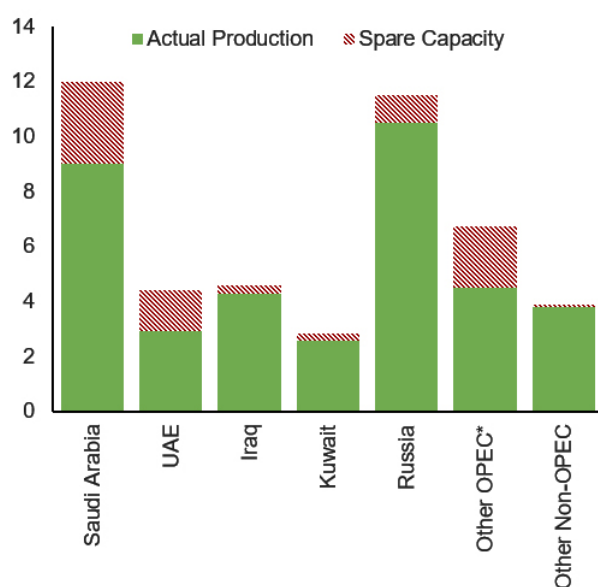
Russian production, meanwhile, is expected to hold steady in 2024, at about 10.5 Mb/d, as the country restrains supply by 0.5 Mb/d in line with its agreement with the OPEC+ cartel till end-2024^{xxx}. This is despite planned new developments coming online, including the 450 kb/d Irkinskoye West and 150 kb/d Yamburgskoye oil rims projects^{xxxi}.

Relaxed sanctions on Venezuela, and limited scrutiny of Iran production has increased prospects of higher production from both wildcards in 2024, although the results of the next US election could temper actual growth rates. Iranian production reached 3.3 Mb/d in November 2023, 0.5 Mb/d shy of what it was outputting before the 2018 sanctions, and 0.5 Mb/d higher than 2022 production levels^{xxxii}.

Oil markets should therefore be well-supplied. This should prompt OPEC+ producers to extend their cuts beyond the currently decided March 2024 deadline, and for voluntary over-compliers to beyond end-2024. Although markets are forecast to tighten during the second half of the year, OPEC+ would want to maintain the cuts to support prices, and avoid any rush to increase production, especially given that the US, Canada, Guyana, and Brazil are expected to hit new national output highs. If compliance is abruptly ended to maintain market share, prices could drop to as low as US\$ 50/b, whereas if cuts are maintained till at least end-2024, Brent prices could stabilise at around US\$ 80-90/b.

The opportunity cost of higher prices is faster growth in non-OPEC production (particularly in US shale oil and offshore basins that are breaking even below US\$ 70/b), but OPEC producers will want to maintain a disciplined approach.

Figure 10 OPEC+ Spare Capacity as of December, 2023^{xxxiv}



In the unlikely scenario of a long-term major supply disruption due to geopolitical events, while demand remains modestly robust, and OPEC spare capacity insufficient to offset

losses (made up mainly by Saudi Arabia and the UAE, at about 3.5 Mb/d^{xxxiii}), prices could escalate to over US\$ 100/b. This would provide impetus to producers like Iraq to rush the development of capacity from important state-led projects, and the UAE, to potentially bring forward its planned timeline to achieve 5 Mb/d of capacity from the already preponed 2027.

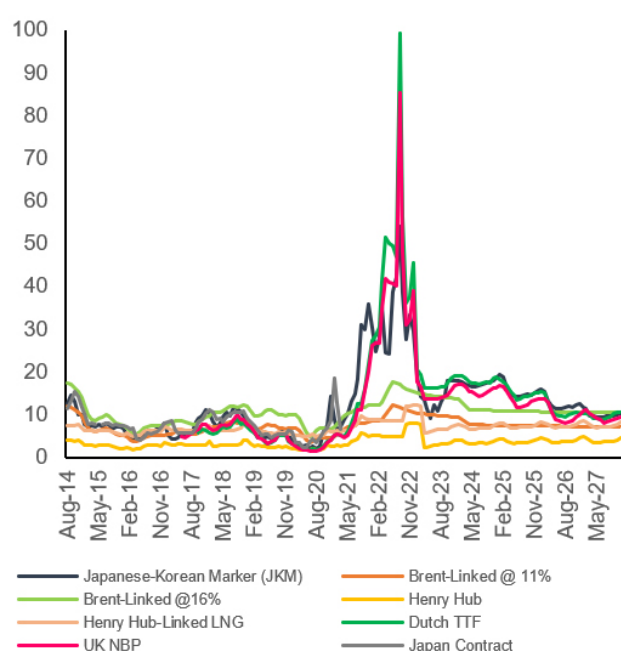
Natural gas production is expected to expand by 2.2% over 2023 levels in 2024^{xxxv}, with North America and the Middle East forecast to account for almost 80% of the net increase in global gas output during this period, while Russia's natural gas production is set to remain well below the record levels reached in 2021. Feed gas supply requirements *of LNG export projects will account for over 50% of the net increase in global gas output by end-2024 / early-2025, reflecting strong growth in LNG trade and an increasingly globalised gas market.

New gasification terminals coming online in early-2024 will drive global LNG production to 568 BCM in 2024, up from 550 BCM in 2023^{xxxvi}, and include the Greater Tortue Ahmeyim project between Senegal and Mauritania, the Congo floating LNG project, the Altamira plant in Mexico, and Train 3 of Indonesia's Tangguh LNG project. Other projects starting later next year include Phase-1 of the Plaquemines LNG in the US and Train 1 of Russia's Arctic LNG-2, though uncertainties over its supply linger because of sanctions^{xxxvii}.

Still, the market is expected to be short ~5 BCM against a global demand of 573 BCM (Figure 3) as most of 2024's supply has been sold out under term contracts. International LNG prices will remain around the same levels as in 2023, and much lower than the near

US\$ 100/MMBtu at times in 2022, averaging between US\$ 10/MMBtu during the summer to US\$ 20/MMBtu in the winter months, unless the world economy is unexpectedly strong, there is another surge in Chinese demand, or a significant LNG supply disruption. This will tend to drag down pipeline gas prices in Europe, particularly given the high levels of storage.

Figure 11 Global LNG Prices, US\$/MMBtu^{xxxviii}

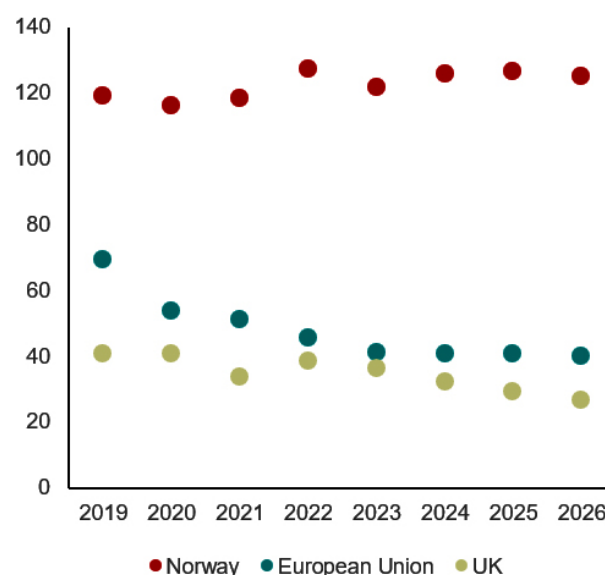


North American production growth shall slow from 4% in 2023 over 2022 levels to 1.8% in 2024^{xxxix}, reflective of declining domestic gas demand in the US and Canada. The bulk of incremental gas supply is set to feed North America's rapidly expanding LNG liquefaction fleet, with the region's LNG exports expected to increase by 50% (or 55 BCM) between 2023 and 2026^{xl}.

In Europe, natural gas production shall decline by 15 BCM/y as the increase in natural gas output in Eastern European markets such as Romania proves insufficient to offset the declines projected in Northwestern Europe.

Norwegian production will probably be roughly flat, but the Netherlands' giant Groningen field will be completely closed-in by October. In the UK, ageing gas fields in the North Sea, and technical problems with TotalEnergies' relatively new Greater Laggan Area west of the Shetland Islands, are expected to reduce the country's natural gas output by over 30% by 2026, compared with 2022, although the government's plan announced in July 2023 to grant >100 new licences for oil and gas production in the North Sea could provide some upside potential^{xli}. A couple of new fields started up in 2023 could provide further upside potential, including the BP-led offshore Seagull field^{xlii}, and a high-quality gas find by Dana Petroleum in Earn structure in the 42/27 block, west of Dana's Tolmount Southern North Sea gas development^{xliii}.

Figure 12 OECD Europe Gas Production Forecast, BCM^{xliv}



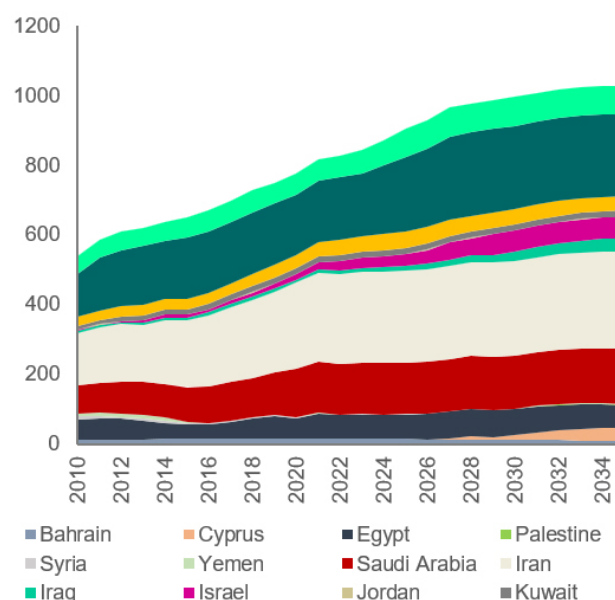
In the Middle East, gas production is expected to increase by 2% over 2023 levels^{xlv}. Growth is largely supported by the growing domestic demand in large countries like Saudi Arabia and Iran, as well as export projects in Qatar and the UAE.

The North Field East expansion in Qatar is set to increase the country's LNG export capacity by over 40%, requiring almost 50 BCM/y of additional feed gas supply by 2026-27^{xlvi}. In Iran, the bulk of incremental supply is set to be met by the rising output from the giant South Pars field. Phase-11 of the South Pars field started producing gas in August 2023, with initial output estimated at 4-5.5 BCM/y, and the potential to ramp up production to 20 BCM/y in the coming years^{xlvi}.

In Saudi Arabia, production will be supported by the ramp-up of the North Arabia field, the expansion of South Ghawar and the start-up of the unconventional Jafurah field, although this should take place around end-2026^{xlvi}. The initiation of the Hawiyah gas storage project will help the country balance between summer and winter consumption and even out seasonal oil burn. The UAE's production, meanwhile, will increase by 9% over 2023 levels^{xlvi} as additional output is unlocked from rising oil production (in the form of associated gas), as well as from prolific projects like the Shah Gas Development project that recently concluded a capacity expansion to 7.5 BCM/y, and strong offshore performance.

Coal supply shall increase in geographies with large resources but dwindle in others. Coal mining and consumption will dwindle in European producing markets such as Germany and Spain, as aggressive phase-out in the power sector is adopted and the contribution of renewables increases. US coal production is expected to fall 11% in 2024, having dropped 10% in 2023, and further geological issues in the West Elk mine in Colorado, and Lila Canyon and Skyline mines in Utah will continue to drag output downwards^{lii}.

Figure 13 Middle East Gas Production Forecast to 2035, BCM/y^{li}





However, in countries with a large domestic resource base, such as China, India, South Africa, Indonesia, and Australia, coal will remain integral to their energy production, albeit at lower levels than witnessed during the 2022–23 period. In Australia, thermal coal and lignite production will enter a sustained decline as new thermal coal projects face increasing headwinds in light of pressure from ESG standards, and from financing and insurance issues, as well as domestic demand being on a downward trajectory.

Indonesian production will decline due to the reduced demand for exports of its low calorific value coal to India and China, its main markets. India has been trying to lower its import dependency while China has hit an all-time high in its own coal production, which will continue reducing the need for imports. Indonesia's coal infrastructure also faces inefficiencies, such as in the Jambi province, where inadequate transport capabilities constrain output.

Indian output will rise on the back of a concerted effort to reduce imports, and infrastructure development to support domestic production. For example, the completion of the 1,337-kilometre Eastern Dedicated Freight Corridor can now carry coal from the east of India to northern regions in half the time it took before its completion. Russian production, meanwhile, will remain patchy, due to the European ban and volatile supply chains that have shifted its exports eastwards. Production should fall sharply in the central regions, whereas eastern production sites could continue to increase output for a while as the country strengthens ties with China. But as global seaborne import demand is likely to decline overall in 2024, this will have an impact on Russian exports, and consequently production.

Pakistan has been steadily boosting domestic coal production to counteract the effects of high inflation and energy import costs, with SECMC, Pakistan's largest coal miner, planning

to increase output by 50% by 2024, including the significant expansion of lignite production. Coal demand is also being supported by the start-up of the 1.3 GW Thar Block-I power plant (funded by the China-Pakistan Economic Corridor), in line with Pakistan's decided shift away from gas to coal in reaction to the high LNG prices suffered in 2022. The country is aiming to quadruple domestic coal-fired capacity to 10 GW, but financing for these projects remains uncertain, as China, the largest financier, has committed not to finance new coal plants abroad^{liii}. This should consequently impact production expansion plans.

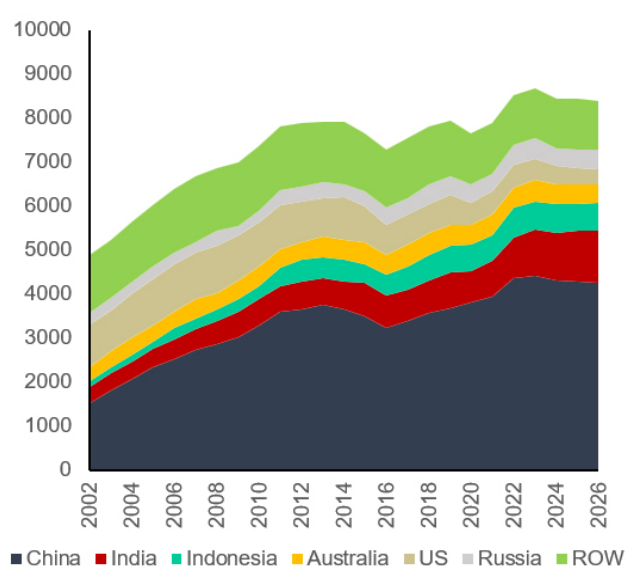
In Africa, coal mining projects dedicated to exports are likely to remain stagnant in 2024. For example, no project has advanced in Mozambique to an advanced stage, with three projects with a combined capacity of 40 Mt/y now considered shelved. Still, despite new projects stagnating, a strategically important terminal for Botswanan exports, the Matola Coal Terminal at Matupo Port, has plans to increase capacity from 7.3 Mt/y to 12 Mt/y, which could boost production. However, in addition to coal, iron oxide and magnetite are also processed at the site^{liv}.

Coal CCUS could support coal supply in some countries in the medium-term, such as the US, where the Biden administration has significantly increased tax credits for CO₂ storage underground, incentivising CCUS. However, most utilities so far have appeared to struggle with the costs and technological "complexities" of CCUS, projects of which can take several years to complete, so there should be no noticeable effects on production or demand in the immediate term.

Other large coal producing and consuming countries have shown little appetite for coal CCUS, with uptake in China (who has two of the world's only four coal-fired plants with CCUS, the other two being in North America, one in the

US, and one in Canada) moving slower than anticipated for a country with high ambitions for coal phase-out. In India, the national government has so far not announced any policy support for CCUS, although there is an emerging interest in the technology from power producers, which could potentially support supply continuity.

Figure 14 Coal Production Forecast by Country, Mt/y^{lv}



19 A NEW WAVE OF CONSOLIDATION IN CLEAN TECHNOLOGY WILL BOLSTER RENEWABLES

In 2024, consolidation in the renewable technology space is likely to foster a manufacturing base capable of operating more comfortably with thinner margins. The global renewable energy sector is already facing both rising capital costs and two-decade high financing rates as central banks worldwide embark on a historic money supply-tightening mission to tame persistent inflation. While this may challenge the economic viability of many clean technology projects, such as in the capital-intensive offshore wind space, smaller EPCs and developers are now increasingly more open to consolidating with larger players to limit losses and acquire cheaper capital backed by their partners' larger balance sheets or secured from legacy funds with lower hurdle rates.

Project pipelines should considerably ease in 2024 as more and more consolidation takes place. This should limit the impact of cost overruns (due to higher interest rates and interconnection costs) and provide price guarantees to developers against unforeseen factors. Moreover, the unwinding of two years of polysilicon supply constraints will continue to improve solar project costs and improve margins for developers, providing relief to companies who avoided buying an excess inventory of modules in 2022-23, fearing they would be undercut by cheaper newly manufactured ones in 2024.

High costs have also directly contributed to improving competitiveness across the renewable energy value chain: bifacial panels for solar modules have offset system price increases, and reduced energy losses during operation have improved the cost competitiveness of energy transmission and storage systems.

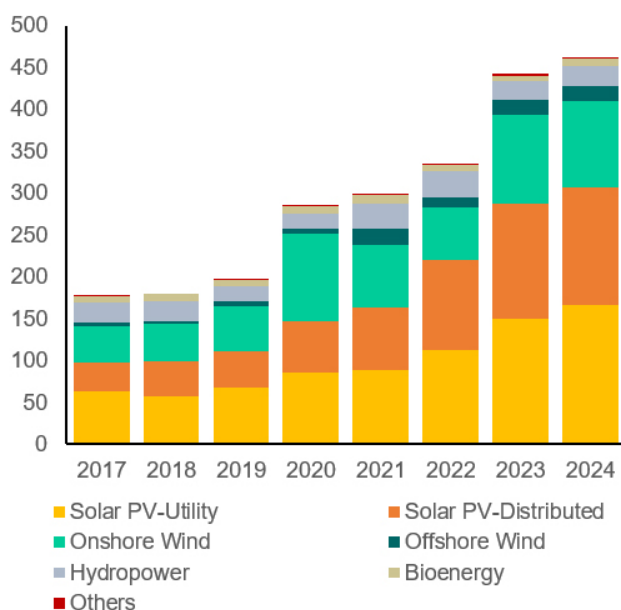
For example, Europe witnessed an increase of 50% in the rate of wind and solar roll-out across the bloc in 2023, compared to 2022 levels, despite rising energy and materials costs, due to technological breakthroughs supporting higher efficiency and higher per unit output.

Table 4 Recent consolidations (M&As) in the renewable technology space, 2023^{lvi}

Acquirer	Acquired	Sector	Region
Madison Energy Infrastructure	Pro-Tech Energy Solutions	Solar Energy	North America
CleanChoice Energy	Franklin Country Solar Project	Solar Energy	North America
EQT	Statera Energy, from InfraRed Capital Partners	Energy Storage	Europe
Ford	Auto Motive Power	Electric Vehicles	North America
Volvo	Proterra Battery	Battery Storage	Europe, NA
EverWind Fuels	Nova Scotia Wind Farms	Wind Energy	North America
PVcase	Anderson Optimisation	Solar Energy	Europe
Squadron Energy	CWP Renewables	Renewable Power	Asia-Pacific
REC	Avaada Energy	Renewable Energy	South Asia
JERA, NTT Anode Energy	Green Power Investment	Renewable Energy	Europe / Asia-Pacific

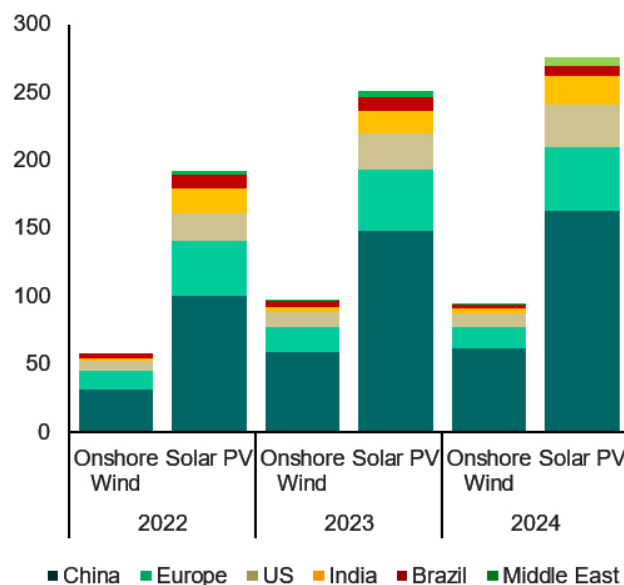
Despite the higher costs and persistent supply chain challenges, on a global level, the deployment of renewable energy will remain the most supported policy development across all countries, due to its importance for the transition. New renewable electricity installations are expected to break records in 2024, thanks to strong and continuous policy support, as well as high electricity prices, which will increase the economic attractiveness of distributed PV systems. Solar PV will account for 67% of 2024's entire renewable capacity additions (>462 GW), and could reach 310 GW, an increase of 7% over 2023 levels (Figure 15).

Figure 15 Net renewable electricity capacity additions by technology, GW^{lvii}



Greater distributed PV system uptake and a policy push for large-scale deployment will trigger higher annual additions in all major markets, including China, Europe, US, India, and to an extent, Latin America. In the Middle East, utility-scale solar PV projects will witness the biggest upside, due to historically fast pace of construction, permitting, and timely grid connection of the projects under development.

Figure 16 Net solar PV and onshore wind capacity additions to 2024 by major country / region, GW^{lviii}



Onshore wind additions, however, are expected to fall around 4% from 2023 levels^{lix}. While China's wind energy expansion is forecast to continue with the commissioning of large-scale onshore projects in mega-bases in the northeast, as well as provincial incentives that support offshore plants, additions in other major markets are expected to decline.



Developers in western markets are feeling the effects of turbine manufacturers' eroded margins, driven by cost inflation and an R&D race to produce larger turbines, combined with the increasing competition from Chinese suppliers. This has resulted in undersubscription in multiple auctions in northwestern Europe, aggravated by turbine placement restrictions in some countries like Poland. The new Polish government is likely to ease these limitations.

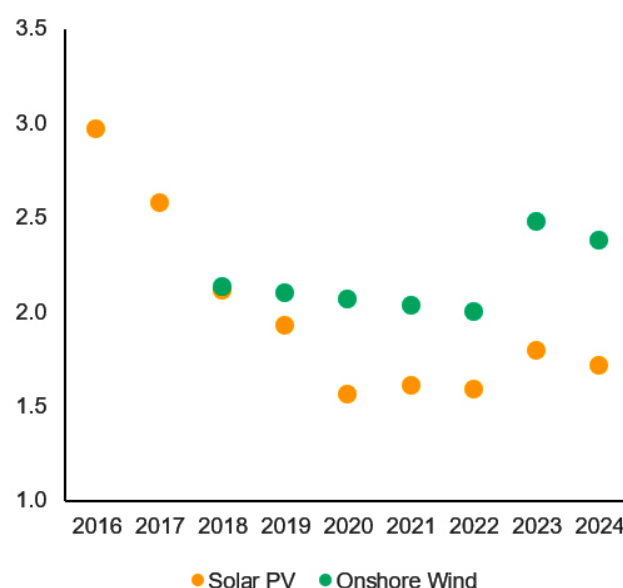
In the US, the pace of new capacity additions will be slower than in 2023, due to production tax credit rates being lower than under the previous federal policy. Impacts of long-term tax incentives for large-scale installations under the Inflation Reduction Act (IRA) shall become visible mainly beginning in 2025, meaning that projects will be eligible for incentives if construction begins before 2025, which would provide an alternative driver for new capacity additions in 2024. Permitting and grid connections remain serious challenges to US renewable additions, as do Jones Act limitations for offshore wind.

Electricity costs from new utility-scale solar PV and onshore wind projects are expected to decline in 2024, albeit not rapidly enough to fall below pre-CoVid-19 values in most markets outside China. Although commodity and freight prices have dropped from last year's peaks, they remain elevated. At the same time, developers' financing costs have increased due to the higher interest rates. As a result, global LCOEs for solar PV and onshore wind should remain 10–15% higher than 2020 levels in 2024^{ix}.

Improvements in renewable energy deployment will largely remain a matter of continuing economies of scale and incremental

improvements in manufacturing. For non-China manufacturers, direct financial incentives like India's Production Linked Incentive (PLI) can increase their competitiveness against Chinese ones and create more efficient supply chains for integrated facilities. In Europe, high industrial power prices make it expensive to manufacture onshore wind and solar PV equipment – without a manufacturing policy or domestic-content premiums, manufacturing renewable equipment there will remain less competitive than in India or the US.

Figure 17 Average LCOEs for utility-scale projects, US¢/kWh^{lxi}



Other improvements can come from the progress of floating wind turbines, giving access to higher wind speeds and deeper waters. In solar PV, greater module efficiency, including the use of bifacial panels which collect reflected light from the ground, is a continuing area of improvement. Perovskites, which offer higher theoretical efficiencies, can be used in tandem with conventional cells, although they have not been fully commercialised and there are still concerns over cost and degradation rates.

Floating solar can be deployed on lakes, reservoirs and irrigation canals to make use of scarce land as well as lowering evaporation.

Geothermal energy, meanwhile, might witness growing attention in 2024, as policymakers, especially in North America, step up investments into geothermal systems, through, for example, the IRA's 30% tax credit and a US\$ 200 M loan by the Canada Infrastructure Bank to Enbridge Sustain, which builds and operates residential clean energy systems, in 2023. Much of that funding will be directed at stoking the geothermal heat-pump market for residential use, although the development of large-scale, commercial geothermal power plants to provide baseload energy shall remain in its infancy (apart from hot spots in California)^{lxii}. Advanced and engineered geothermal systems employing similar horizontal drilling and hydraulic fracturing approaches to the US shale industry could access "hot dry rock", broadening applicability beyond areas with hot groundwater.

Indonesia, Turkey, and the Philippines could see further investment in geothermal energy unfold in 2024, with the US DFC recently approving a US\$ 126 M loan to PT Medco Cahaya Geothermal to finance the development of 31.4 MW of geothermal power generation capacity in Java. The UAE's Mubadala Energy has partnered with Pertamina and Chevron to explore geothermal opportunities, also in Indonesia^{lxiii}, and has developed a geothermal-powered district cooling system at Masdar City in Abu Dhabi. Geothermal's development has moved slowly despite its enormous potential and falling costs (which in some cases make it competitive with coal, nuclear, and certain solar applications), although some outlooks for energy suggest that 2024 could be the "breakthrough" year for the technology.

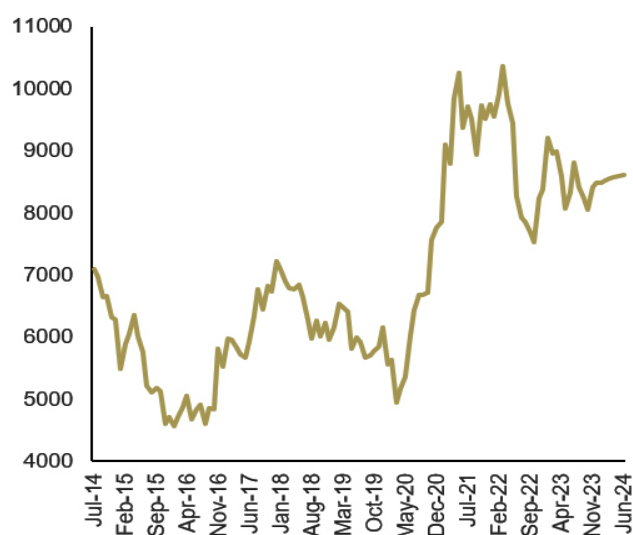


23 CRITICAL METALS WILL WITNESS SURPLUSES IN 2024, BUT PRICES MAY RISE LONGER-TERM

Tempered activity in key economic zones, mainly China, compared to 2023 levels, will cause critical metals' supply to run ahead of demand in 2024, squeezing margins for steel, copper, lithium, and cobalt, although 2024 might be the last year of "low" prices. Battery metals surged in 2022 on rapid growth in demand that year, but demand has since moderated due to a slower-than-expected global economy. A significant response on the supply side will continue to cool prices, which fell by as much as 50% in 2023, thanks to recent project startups, notably in Latin America for lithium, Indonesia and China for nickel, and the Democratic Republic of Congo for cobalt^{lxiv}.

Still, due to the continued large increases in demand for batteries, and potential instability in the DRC, current surpluses will begin to fade by end-2024, returning tightness to the market. Due to the long-lead nature of mining development, prices are expected to spike once again in 2025, with copper – the main metal for electrification – expected to see prices moving sharply higher over the medium-to-long term amid the emergence of significant deficits for both raw material and refined products.

Figure 18 Copper futures, US\$/t^{lxv}



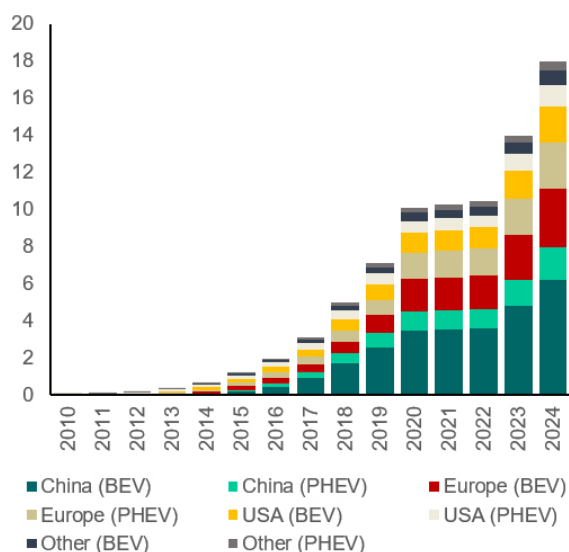
Moves by some western countries to decouple trade from China have added another layer of complexity to the outlook for metals in 2024, particularly from sectors of relevance to the energy transition, such as EVs, battery storage, and electrolyzers (for hydrogen). Mining capital expenditures should be challenged over the next year due to price weakness and lower-than-anticipated demand from other sectors (such as construction), and especially from government policies to ringfence domestic industries and utilise supplies of metals only of certain origin (such as non-China countries) for batteries, storage systems, and electrolyzers.

This is especially true for North America, Europe, and Australia, where recent policies supporting battery supply chain development have included measures to limit materials from China in favour of near- and friend-shoring. Europe has gone a step further in trying to access nickel supplies from non-Russia producers, which has been responsible for the steep volatility in nickel supplies in 2022. In the US, battery and EV manufacturers can qualify for incentives under the IRA only if utilised critical materials originate from the US or a free-trade-agreement country.

Such policy and supply chain developments could threaten the pipeline development of critical contributors to the energy transition, such as EVs, by making them more expensive and slowing their uptake (although current forecasts expect sales of EVs to increase by 28% in 2024 from 2023 levels^{lxvi}). Consumer subsidies have already been reduced in a number of geographies and are being replaced with producer mandates that exclude sourcing of materials and metals from China.

These new policies would be additional hurdles for the EU to meet its 2035 target to phase out internal combustion engine vehicles, with price increases left to the end-user to absorb.

Figure 19 Projected EV sales in 2023 and 2024, number of cars in millions^{lxvii}



Another major supply risk concern that should receive more attention in 2024 is the ethical sourcing of critical metals due to the risk for miners and the environment. Some improvements have been made, but investors are now proactively seeking "green" battery alternatives such as nickel and potassium-oxygen and lithium-oxygen batteries, sodium-ion and lithium-sulphur batteries, hydrogen fuel cells, thermal storage, and solid-state batteries. Several automakers have already pivoted or invested in less expensive battery technologies, such as Tesla and BYD. For example, Tesla recently shifted to the use of the lithium iron phosphate (LFP) battery, which has lower energy density but uses no nickel or cobalt and has become the de-facto battery chemistry in Chinese EV models^{lxviii}.

Sodium-ion is set to become the next big competitor to lithium-ion, being significantly lower-cost and environmentally friendly, but has some technical challenges that are yet to be solved. Manufacturing giants such as China's CATL and Sweden's Northvolt are pursuing the technology in a sign that it could soon be applied commercially^{lxix}. BYD is also actively looking to develop sodium-ion batteries for use in its EV models^{lxx}. Given its lower cost but lower energy density, sodium ion could be particularly competitive against lithium-ion for grid-scale storage.

There will also be increased emphasis on battery recycling and research into biodegradable batteries. For example, the University of Maryland is carrying out research into a partly biodegradable battery made of zinc and crab shells^{lxxi}.



HYDROGEN CAPACITY WILL INCREASE, ALTHOUGH PRODUCED VOLUMES WILL BE LOW

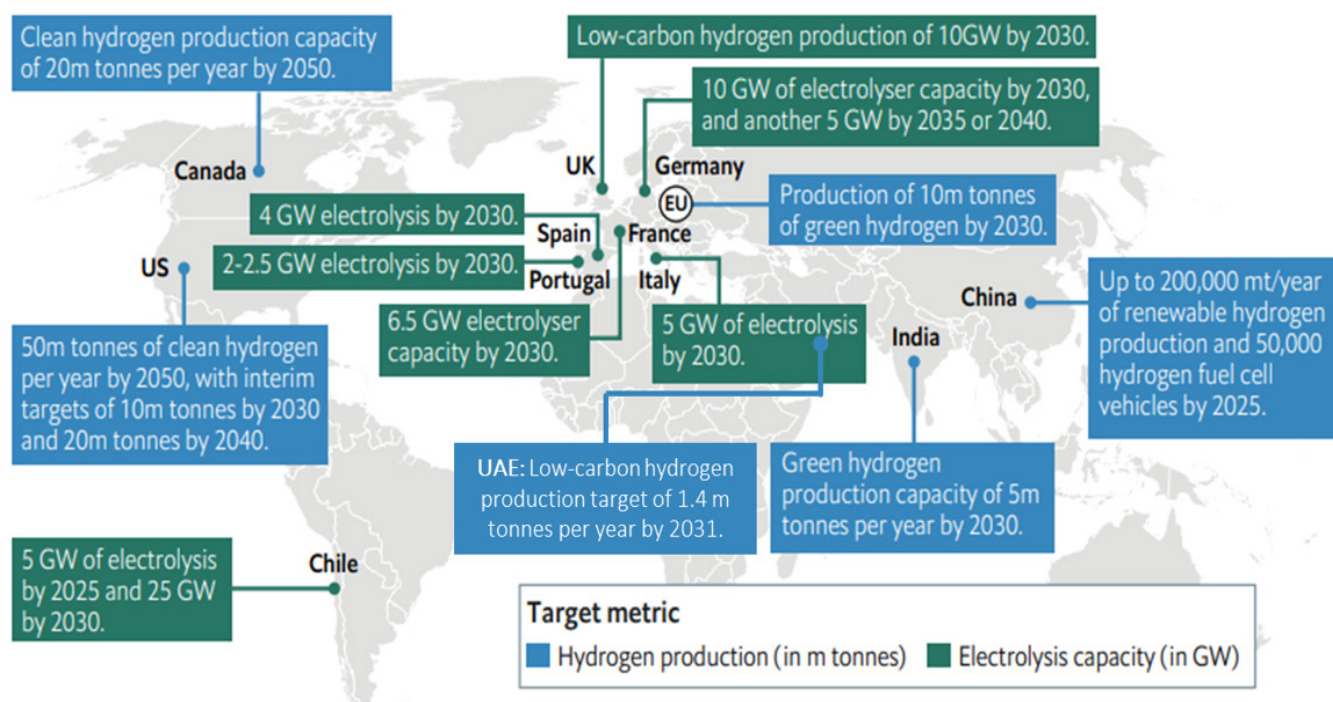
This year will be definitive for hydrogen. The US, UK, Netherlands, Germany, Denmark, Portugal, Australia, South Korea, and India have all announced supply-side subsidy schemes, while Middle East producers like the UAE are actively exploring incentive-based policy mechanisms to fast-track hydrogen production. Other producer countries such as the UK, Japan, South Korea, and other European countries like Norway have put low-carbon hydrogen production targets in national legislation^{lxxii}.

Bullish projections of future hydrogen demand have led to ~100 Mt of announced low-carbon hydrogen production capacity in various stages of the development pipeline. However, 2024 might witness cost increases across the value chain, with required capital expenditure estimates going up by 40-50%^{lxxiii}.

A recent example of this is the NEOM hydrogen megaproject in Saudi Arabia, which only achieved financial close in May 2023, after the project cost increased to US\$ 8.5 B from the original estimate of US\$ 5 B due to inflation and supply chain costs^{lxxiv}.

While some of this cost inflation may be transitory, electrolyser projects tend to be highly complex, bespoke, and are proving to be harder to construct than initially anticipated, particularly for captive use industries such as cement, glass, and aluminium. On the contrary, natural gas with CCUS-based hydrogen is much simpler to develop, due to the requirement of retrofitting a capture unit on the SMR process of grey hydrogen production in a number of industries, such as steel and fertilisers, but blue hydrogen has so far received lesser attention than electrolysis-based hydrogen as a long-term solution to fully decarbonise hard-to-abate sectors.

Figure 20 Hydrogen ambitions of major producing countries^{lxxv}



The hydrogen project pipeline is expected to grow further in 2024, with several new additions that will increase overall announced capacity, but the market is still lacking final investment decisions (FIDs) due to the absence of firm offtake agreements, the right permitting frameworks or regulations, and supply chain security. At a minimum, the market would require at least 12-15 large FIDs announced in 2024 to meaningfully jumpstart the hydrogen industry in a manner that aligns with critical net-zero climate goals, including interim goals of 2030 and 2035.

This will build momentum and likely yield strong results from planned European hydrogen auctions. If bids clock in significantly below ceiling prices, this will be evidence of the growing confidence in the market, and a tolerance on the part of developers to accept price and development risk. However, bids at or close to the ceiling will suggest the opposite, meaning that the hydrogen industry may grow more slowly than anticipated.

Developers will be wary of the still uncertain sentiment around costs for electrolyzers, as they are exposed to minerals and metals used in renewable energy, as well as requiring some other scarce materials (notably, platinum-group metals for most current proton exchange membrane electrolyzers). A rapid expansion of electrolysis capacity would mean higher mineral and metals prices, which in turn will raise the cost of both hydrogen and renewable energy generation, at least till sufficient and/or alternative materials for electrolyzers reach a technological readiness level that does not impact the quality and output of the produced hydrogen.

Furthermore, production of electrolysis-based hydrogen will compete with other sectors of the economy for scarce renewable energy output, which is a problem in major planned sites of green hydrogen production like Egypt, who already runs into power shortages, and is unlikely to divert critical renewable energy to power hydrogen production. This will require the installation of hydrogen-dedicated renewable capacity, which could run into issues of costs, land, and water availability, and permitting frameworks.



27 NUCLEAR POWER WILL TREAD WATER, DESPITE NEW REACTORS



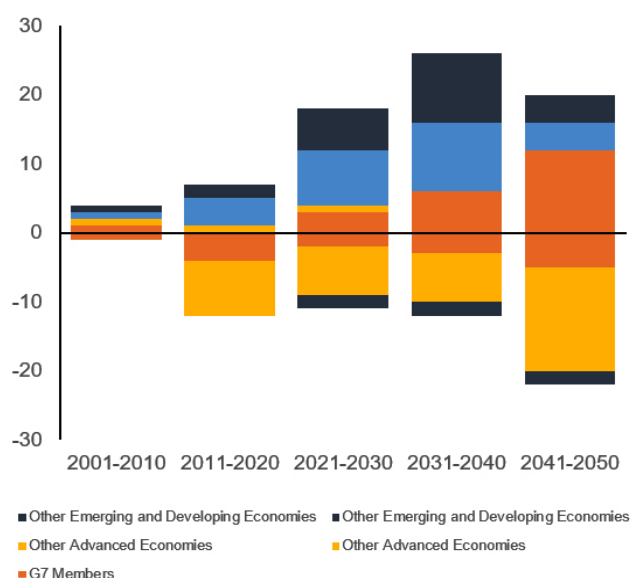
Q1 2024 will see a new 1.6 GW reactor come online at France's Flamanville Nuclear Plant, while in the US, the 1 GW Vogtle Unit-4 Reactor should soon start operating. In South Korea, a third reactor at the Saeul Facility should also start operations in 2024, while the construction of the Shin Hanul-3 and Shin Hanul-4 reactors will commence. By contrast, two early-1980s nuclear plants in the UK (Hartlepool and Heysham) are expected to go offline in 2026, having received a life extension from 2024.

Sweden, meanwhile, has approved a new bill that removes the country's limit on the number of nuclear reactors in operation, allowing more than 10 reactors to be in operation at the same time. These legislative amendments also allow nuclear reactors to be built on new sites (in locations other than the currently permitted areas in Forsmark, Ringhals and Oskarshamn in Southern Sweden) starting from 1 January 2024^{lxxvii}.

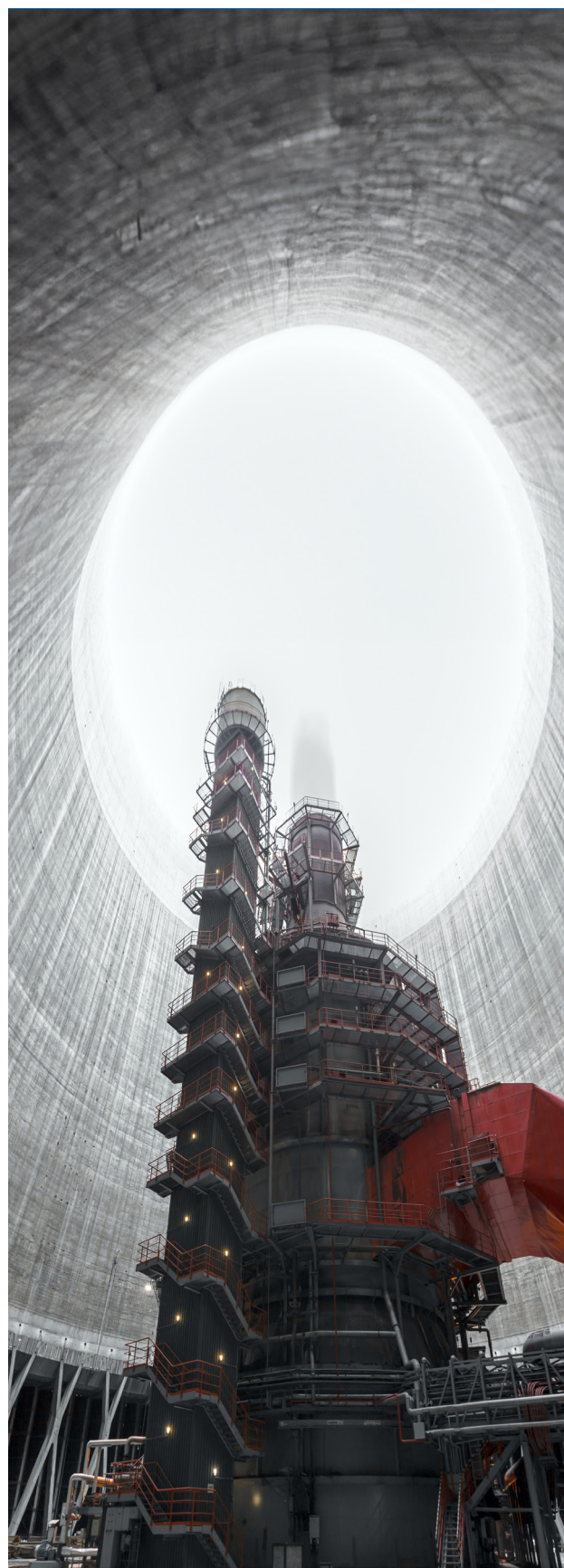
In China, the construction of 22 new nuclear reactors (with a total capacity of 24 GW) will double the share of nuclear energy in its energy mix, and further cement China's status as the world leader of nuclear power. Strong uranium prices, which reached a 15-year high of US\$ 85/lb in 2023^{lxxviii}, will also continue improving profit margins for miners, raising prospects for further mine restarts and new builds, which could support further nuclear growth.

Despite the new reactors and COP28's apparent endorsement of nuclear energy as an important part of the journey to net-zero, by announcing a Nuclear Energy Summit in 2024 to highlight the "renewed momentum" for nuclear power, nuclear energy is likely to continue treading water. The worldwide nuclear fleet is forecast to enter a decline, with a number of closures in US, Japan, and other parts of Europe – Germany has already closed its final three plants in 2023.

Figure 21 Forecast nuclear power capacity additions and retirements in selected countries and regions by decade to achieve net-zero, GW^{lxxix}



Moreover, nuclear power will continue to need cost reductions to hold its ground against renewables and gas power. Third-generation small modular reactors (SMRs) could receive a boost in 2024 on the sidelines of various events intending to showcase their technological progress, with a European Commission-led SMR Industrial Alliance to be launched in early 2024^{lxxx}. They could present a way forward towards lower-cost nuclear power, although considerable challenges remain.



This year promises to continue the 'working-out' of some of the themes of 2023, including an evolving energy transition landscape now increasingly challenged by surprise economic turnarounds; well-supplied oil and gas markets; robust progress on renewables and critical metals; new deployments in hydrogen and nuclear energy; and a more proactive move to divest from carbon fuels of all kinds – if the economics allow.

It also presents opportunities for oil and gas companies and countries. They can move more boldly on FIDs for new projects, particularly in LNG and hydrogen. They can acquire struggling competitors, especially in high-cost developments (such as sour developments).

More importantly, they can accelerate the retooling of their business models, by incorporating more ESG-focussed themes, next generation decarbonisation technologies, and carve a niche in segments of the transition value chain that are often overlooked, such as supply chain optimisation. They can also take more ambitious steps in new energies, learning the landscape as preparation for future transformational moves.



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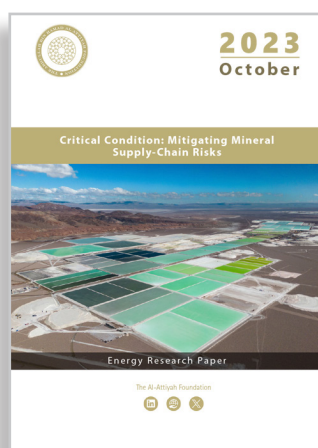
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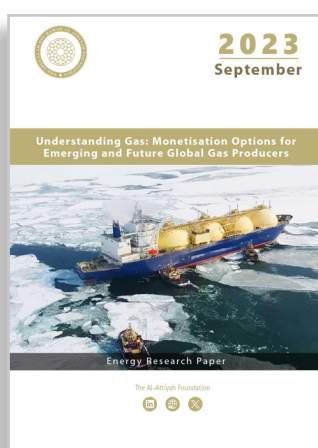
October – 2023

Critical Condition: Mitigating Mineral Supply-Chain Risks

New energy systems use a wide variety of critical minerals, including lithium, rare earths, cobalt and others. However, concerns are growing over the economic, political, and environmental risks to reliable supplies of such minerals. What are these risks? Which are real and which exaggerated? What are strategies to mitigate supply-chain risks in extraction and processing, for companies who use them as inputs, and for governments?



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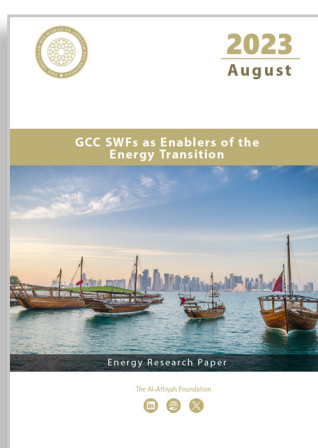
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Understanding Gas: Monetisation Options for Emerging and Future Global Gas Producers

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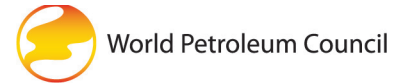
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