Testimony before the U.S.-China Economic and Security Review Commission

China's Domestic Energy Challenges and Its Growing Influence over International Energy Markets

Dr Michal Meidan, head of China energy research, Oxford Institute for Energy Studies

April 24, 2025

China's Energy Ecosystem and Growing Needs

China's energy demand increased four-fold between 2000 and 2024. Demand was met primarily by fossil fuels and most notably coal. Throughout the period, China's energy demand grew more rapidly than global averages, reflecting the country's industrialisation and economic development, with CO2 emissions rising strongly. Between 2000 and 2015, a combination of policy interventions and structural economic changes led to reductions in energy intensity (the amount of energy consumed per unit of GDP) but efficiency gains slowed after 2015, decelerating further in recent years[1].

Since 2019, however, China's energy system seems to be undergoing significant shifts. To be sure, energy consumption trends in China during and following the COVID-19 lockdowns, as in many other parts of the world, have been volatile. The initial lockdowns in 2020 were followed by a spike in economic activity and energy demand, which outpaced supplies and contributed to the power outages of 2021. Another bout of stringent lockdowns in 2022 depressed economic growth and energy use, followed by a boost in activity when they restrictions were eased. Travel resumption boosted gasoline and jet fuel demand while renewed industrial activity bolstered diesel use. At the same time, rapid electrification in the transport sector and a surge in new energy vehicle (NEV) sales has slowed gasoline demand growth, to the extent that gasoline consumption in China may have now peaked.

Meanwhile, electricity demand growth also outpaced GDP growth for five consecutive years between 2019 and 2024 due to a combination of strong industrial activity, electrification and bouts of extreme weather events. At the same time, China's renewable energy expansion accounts for almost half of global wind and solar capacity additions. Installed wind and solar capacity in early 2025 reached 1,456 GW, exceeding thermal coal and gas capacity.

These green-shoots are worth noting because they point to a number of potential structural changes: First, China's economy is electrifying rapidly. As a result, energy, and mainly electricity demand, is likely to continue growing. Second, in the transport sector, accelerated electrification and fuel switching could lead to steeper than expected declines in gasoline use. Diesel consumption could also plateau soon if it hasn't already. While China's oil demand may not fall until the early

[1] For more background, see Michal Meidan, written testimony for U.S.-China Economic and Security Review Commission, Hearing on China's Energy Plans and Practices, March 17, 2022, 11 and David Sandalow et. al., Guide to Chinese Climate Policy 2022, https://chineseclimatepolicy.oxfordenergy.org/

2030s due to growing chemicals consumption, the rapid electrification is changing dynamics, impacting the country's appetite for oil imports and its relations with its suppliers.

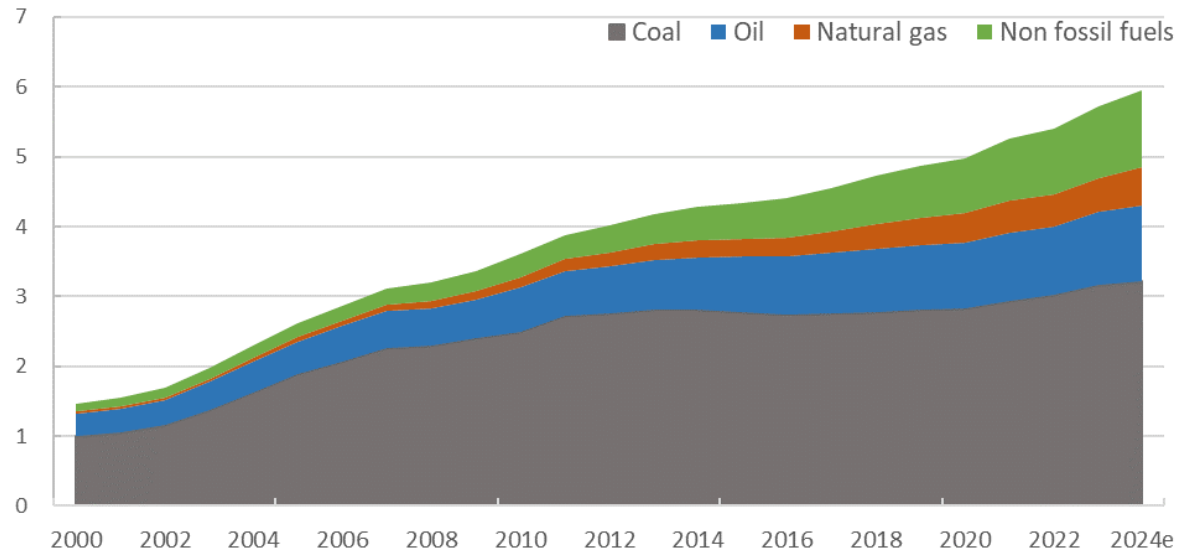
Third, rapid renewable deployment is set to continue even as connections to the grid face technical and institutional constraints. Renewable additions have already moderated China's CO2 emissions, and could lead to their stabilisation even though they have not yet led to a decline. Curtailment is an ongoing policy challenge and coal remains a pillar of China's energy system. This is complicating China's ability to meet its "dual carbon" goals, namely to peak emissions by 2030 and achieve carbon neutrality. But Beijing's support for renewables will continue even as climate policies take a back seat because the "new three industries" (solar photovoltaic, batteries and electric vehicles) are now significant drivers of China's economic growth, a key pillar of the country's industrial strategy and a source of exports and geo-economic leverage. Excess capacity in this industries is leading to lower prices which, in turn, could support accelerated deployment. In the context of a fraught trade and geopolitical environment, Beijing is prioritising resilience and flexibility in its energy system over economic efficiency and emission reductions. But the rapid build out of clean technologies could still lead to faster emissions reductions over time.

Going forward then, even as China's fossil fuel demand growth slows, it will remain a large importer of oil and gas, and will still be a critical market for producers. At the same time, its importance as a supplier of new energy supplies will also grow. This position will come with new strengths, but also new vulnerabilities.

1. China's new sources of energy demand

China's energy demand increased four-fold between 2000 and 2024 with coal and oil consumption growing three-fold. Non-fossil fuel and gas consumption surged, albeit from a much lower base than coal and oil (Figure 1).

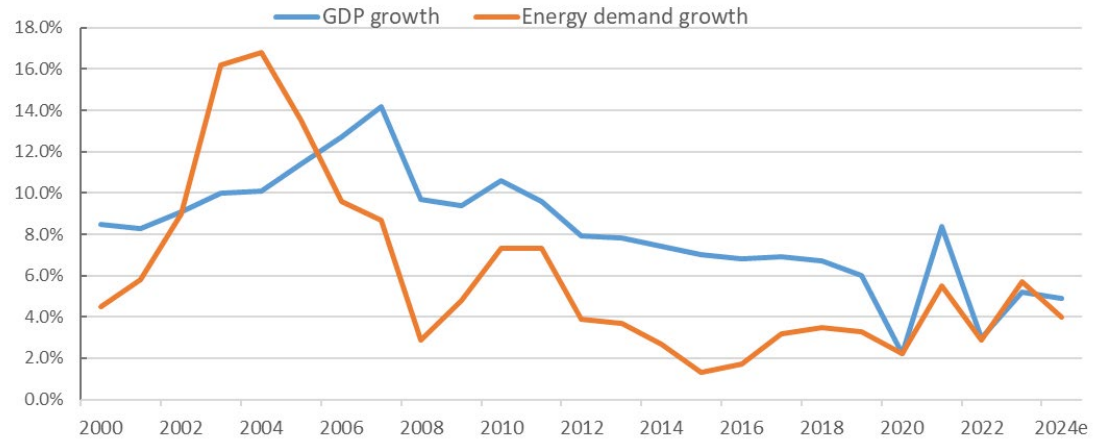
Figure 1: China primary energy consumption (btce)



Source: CNPC ETRI, OIES

A combination of policy interventions and structural economic changes in the early 2000s led to substantial reductions in energy intensity (the amount of energy consumed per unit of GDP). Efficiency gains slowed after 2015 but continued nonetheless (Figure 2).

Figure 2: China's GDP growth and energy demand growth, y/y change (%)



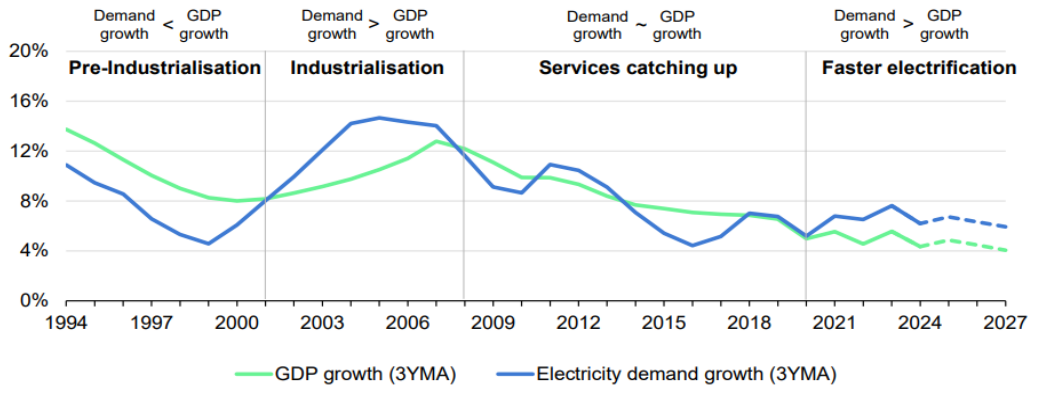
Source: CNPC ETRI, OIES

Since 2019, however, as mentioned above, China's energy use and supply structure has been undergoing significant changes. Given the economic shock of the pandemic and government efforts to boost growth, demand has been volatile, making underlying trends harder to discern but a number of potential trends are noteworthy.

1.1 Rapid electrification…

First, energy demand, and in particular electricity consumption is growing faster than GDP, reversing a decade-long trend of alignment between power consumption and GDP growth (Figure 3), highlighting the rapid electrification of China's economy.

Figure 3: Growth rates of electricity demand and GDP in China, 1994-2027



Note: 3YMA stands for 3-year moving average. GDP growth is based on the October 2024 edition of the IMF World Economic Outlook.

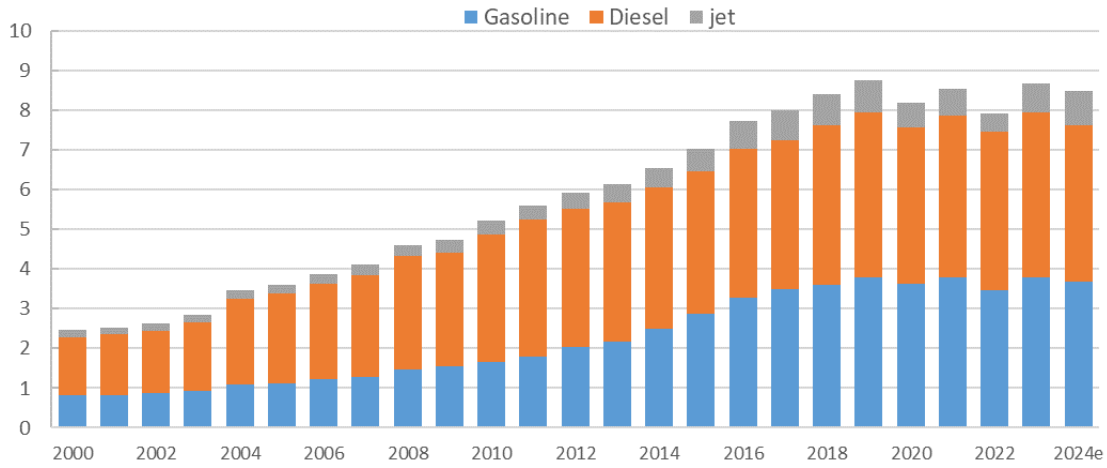
According to the IEA, the share of electricity in China's final consumption reached 28% in 2024, compared to 22% in the United State and 21% in the European Union[2]. Electric heating is replacing a number of fossil-fuel based heating in processes in the chemical industry and refining, while industrial heat pump uptake is on the rise. Electric vehicle (EV) charging demand[3] is also growing.

The country's industrial sector remains a key driver of electricity demand, consuming an estimated 60% of the country's power use, well above the 32% commonly seen in OECD countries. This is unlikely to change going forward given the country's focus on the production of new energy products such as solar PV modules, batteries and EVs which are electricity-intensive. The IEA further estimates that between 2022-2024, these new energy products made up nearly 35% of the increase in industrial electricity demand and 16% of the growth in total electricity use across China. When accounting for the electricity-intensive upstream processes associated with these products, such as the refining and processing of the related materials, power demand is likely higher[4]. In addition to strong industrial activity in new sectors, heatwaves and the resulting need for cooling have driven up electricity consumption in recent years, alongside the expansion of data centres and 5G. Finally, improved automation in manufacturing is also leading to higher electricity demand.

1.2 …means accelerated fuel switching in transport

Second, and related to this, oil product demand is set to peak sooner than previously anticipated, in large part due to the electrification of transport. China's oil majors estimate that gasoline and diesel demand have both peaked already (Figure 4).

Figure 4: China's gasoline, diesel and jet fuel demand (mb/d)



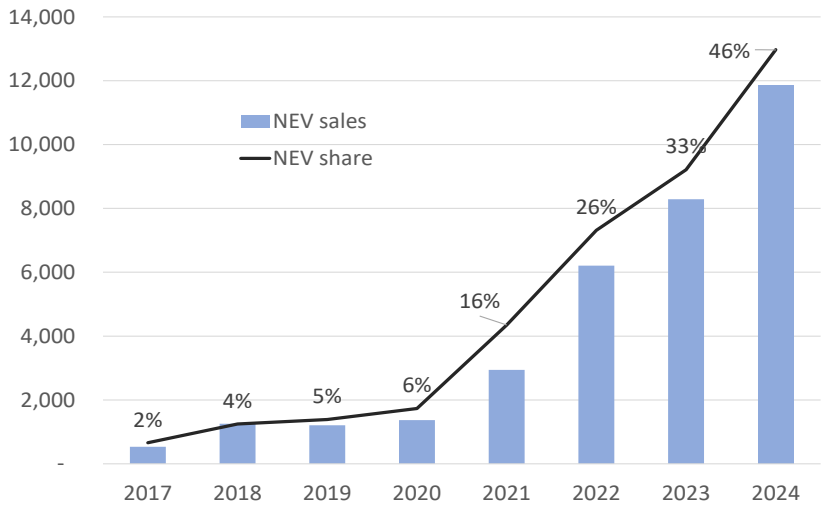
Source: CNPC ETRI, OIES

There are a number of uncertainties surrounding the timing of peak gasoline demand and perhaps more significantly the pace at which gasoline use could decline after the peak, especially in light of the rising share of plug-in hybrids in the NEV fleet (which consume both electricity and gasoline).

[2] IEA, "Electricity 2025: Analysis and forecast to 2027" February 2025, https://iea.blob.core.windows.net/assets/77522eb7-49c8-4611-851e-59bd5b93454c/Electricity2025.pdf
[3] IEA, "Electricity 2025: Analysis and forecast to 2027" February 2025, https://iea.blob.core.windows.net/assets/77522eb7-49c8-4611-851e-59bd5b93454c/Electricity2025.pdf
[4] IEA, "Electricity 2025: Analysis and forecast to 2027" February 2025, https://iea.blob.core.windows.net/assets/77522eb7-49c8-4611-851e-59bd5b93454c/Electricity2025.pdf

Nonetheless, rising NEV penetration rates suggest a structural shift is already underway. NEV sales which stagnated at around 5% from 2018 to 2020, rose rapidly from 2020 to 2024 (See Figure 5). Given the government's support for the sector alongside the cut-throat competition within China, NEVs are cheaper than many ICE vehicle models sold in China[5] suggesting that the boom is far from over.

Figure 5: China NEV annual sales and share of total vehicle sales, 2017-2024 (thousands)



Source: Anders Hove, data from China Association of Automobile Manufacturers, OIES

Diesel demand is also set to slow. Diesel is consumed in a variety of sectors in China, including transport, agriculture and industries making the outlook more complex. To date, the weakness in diesel demand has been linked to the real estate slowdown, limited infrastructure projects due to rising local government debt and broader macro-economic shifts away from construction toward less diesel-intensive activities such as semi-conductors, AI and others. Even the "new three" as discussed above are more electricity-intensive than diesel-intensive. But government policies to support economic growth could reverse some of these weaknesses.

At the same time, diesel use in transport is falling due to government policies such as generous trade-in subsidies to replace diesel trucks with lower-emission fuel trucks, and stricter fuel consumption standards for heavy-duty vehicles. In this sector, the pace of the shift away from diesel toward LNG and electric trucks will depend on the availability and cost of the alternatives. In 2024, for instance, diesel trucks accounted for 57% of China's heavy truck sales[6], down from 70% in 2023, and trucks powered by natural gas made up 29% of total sales. Battery electric trucks reached a 13% sales share and were the third most popular powertrain technology. For medium trucks[7], diesel remained the dominant powertrain accounting for 81% of total sales, but battery electric trucks reached a 14% market share, making it the second most popular powertrain[8]. As the cost of

[5] David Fickling, "In China, It's Already Cheaper to Buy EVs Than Gasoline Cars", 8 August 2023, Bloomberg, https://www.bloomberg.com/opinion/articles/2023-08-08/chinese-evs-are-now-cheaper-than-gasoline-cars
[6] Defined as trucks with a gross vehicle weight above 12 tonnes.
[7] Trucks or vans with a gross vehicle weight between 3.5 and 12 tonnes.
[8] Shiyue Mao and Felipe Rodríguez, "Zero-emission medium- and heavy-duty vehicle market in China, 2024", 25 March 2025, ICCT, https://theicct.org/publication/ze-mhdv-market-china-2024-mar25/

batteries continues to decline and battery swapping technologies evolve, electrification in the heavy duty segment is also likely to accelerate, although it remains unclear how rapidly.

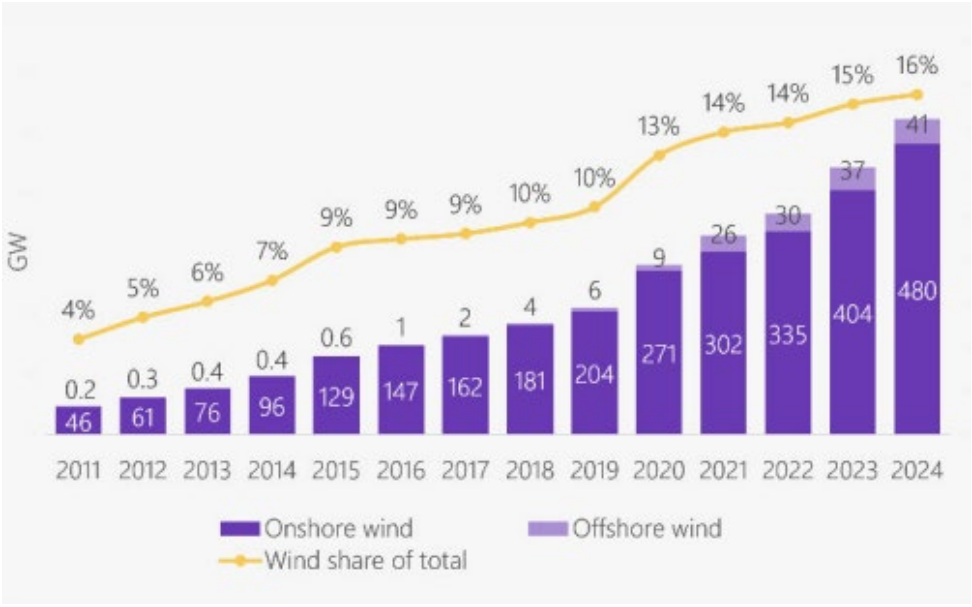
Even though demand for jet fuel continues to rise, the combustion uses of petroleum fuel in China have already likely plateaued and that the potential for future growth may be very limited. Chinese oil demand continues to increase, with growth dominated by petrochemical feedstocks: Oil demand for petrochemicals in China rose by almost 5% in 2024 as new plants came online, a trend that is expected to continue in the next few years. Combined, these trends suggest that China's oil demand and imports will slow[9] but China is still likely to remain a key importer of crude and an important customer for global oil suppliers[10]. The country's large refining system will need to adapt to this change faster than expected, likely accelerating a shift toward petrochemicals. Nonetheless, Beijing remains concerned about the price implications of volatility in the Middle East (that it attributes to US policy actions) and the impact of sanctions on Iranian, Russian and Venezuelan oil[11].

2. Changes to China's fuel mix: keeping both the old and the new

A third notable development over the past five years has been the acceleration of renewable energy deployment. In 2024, China added 356 GW of new capacity including 276 GW solar and 80 GW of wind. In 2025, the National Energy Administration (NEA) set a conservative target of over 200 GW of new renewable capacity additions[12] for the year. The aim is for total installed renewable capacity to exceed 1,610 GW, meaning that non-fossil energy sources will account for around 20% of total energy consumption, a target set out in the 14th Five Year Plan. Meanwhile, the China Electricity Council forecast is more ambitious, estimating that China will add around 119 GW of wind and 213–255 GW of solar capacity in 2025, an estimate shared by the China Photovoltaic Industry Association (CPIA). The Chinese Wind Energy Association (CWEA) also expects wind power to maintain a growth rate of about 100-120 GW/year from 2025 to 2026. From 2027 to 2030, the construction of wind power and solar PV is expected to accelerate, with newly added wind power reaching as much as 150 GW/year and newly added solar PV of 260-280 GW/year. In an aggressive scenario, solar PV could reach 300-340 GW/year.

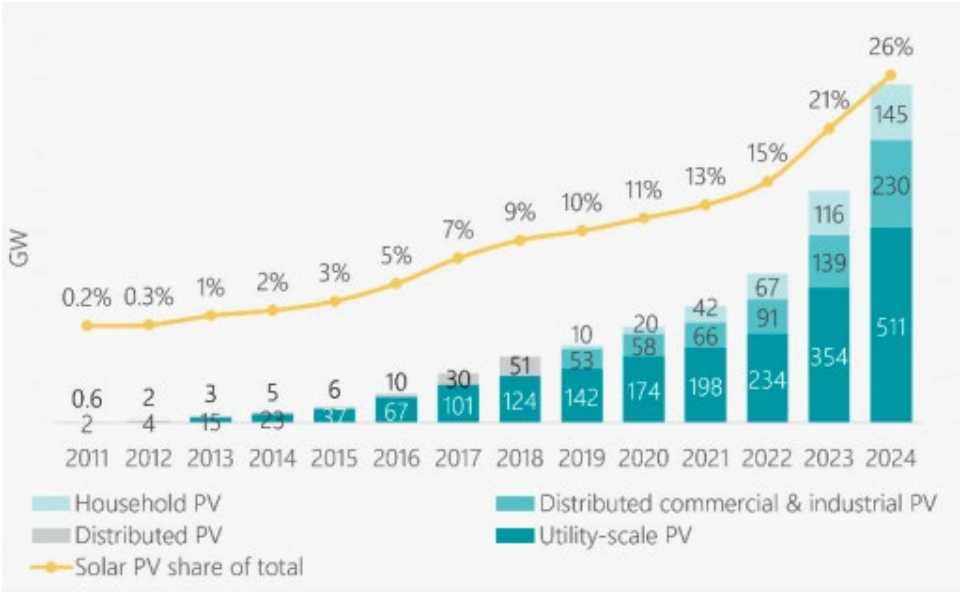
Figure 6: Total installed wind capacity (GW) and share of total (%)

[9] Ciarán Healy, Rebecca McKimm, Ivo Walinga, "Oil demand for fuels in China has reached a plateau", IEA, 11 March 2025, https://www.iea.org/commentaries/oil-demand-for-fuels-in-china-has-reached-a-plateau
[10] Michal Meidan, "The outlook for China's fossil fuel consumption under the energy transition and its geopolitical implications", OIES Paper C8, June 2023, https://www.oxfordenergy.org/wpcms/wp-content/uploads/2023/06/CE8-The-outlook-for-Chinas-fossil-fuel-consumption.pdf
[11] Zhong Feiteng, "Geopolitical risk and China's energy security", World Energy Development Report, 2019;
[12] NEA, Policy interpretation of the "Guiding Opinions on Energy Work in 2025", 27 February 2025, https://www.nea.gov.cn/20250227/105a07a9be2c4727b7fe12c11c7b84cf/c.html



Source: NEA

Figure 7: Total installed solar capacity (GW) and share of total (%)



Source: NEA

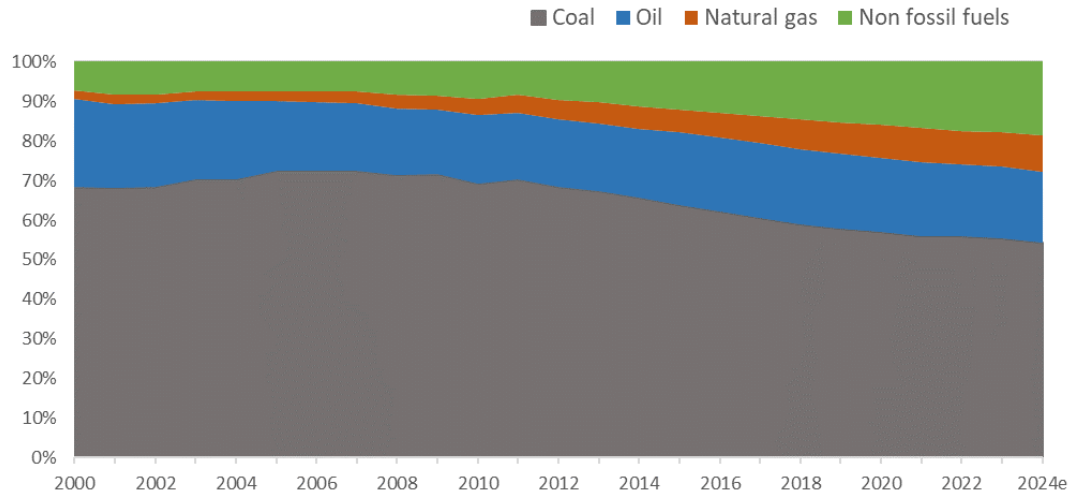
2.1 Renewables rising

By the end of 2024, China's installed wind and solar capacity had exceeded installed coal power generation and at 1406 GW was well in advance of China's nationally determined contribution (NDC) which consisted of reaching 1200 GW of installed wind and solar capacity by 2030[13]. As such, non-fossil fuels at the end of 2024 accounted for 18.5% of the energy mix, exceeding the share of oil for the first time (Figure 8). What is more, renewables accounted for 86% of incremental electricity consumption.

[13] Summary of China's energy and power sector statistics in 2024, China Energy Policy newsletter, https://www.cet.energy/category/data/

Despite this, the strong increase in energy demand combined with the government's concerns about energy security and reliability, as well as limited progress in power market reforms have all meant that coal continues to play an outsized role in China's energy system. In 2024, it accounted for 54% of primary energy consumption and roughly 60% of power generation.

Figure 8: China primary energy consumption by fuel (%)



Source: CNPC ETRI, OIES

The rapid additions of renewable generation, at times exceeding the grid's ability to absorb new capacity, has led to curtailment, i.e. a deliberate reduction or shutdown of capacity. In April 2024, the Chinese government raises the allowed curtailment limit from 5% to 10%, indicating that policymakers want to add renewable capacity, even if transmission capacity and technology can't keep pace. In 2024, official wind curtailment rates reached 4.1% and solar PV curtailment was reported at 3.2%, rising from 2023 levels, but the national pictures masks a strong variation in regional trends. In 2024, for instance, curtailment rates hovered around 10% in a a number of provinces and regions in northern and north-western China including Inner Mongolia, Xinjiang, Hebei and Shanxi, where most of the country's utility-scale solar and wind power bases are located[14].

2.2 Barriers to renewable integration

Renewable integration, like in many other parts of the world, face a number of challenges. Given the large renewable bases in in northern and north-western China, ultra-high voltage (UHV) transmission lines are needed to deliver the power to the demand centres in central, southern and east China. China's 14th Five-Year Plan includes plans to add UHV transmission lines, but they are likely insufficient[15] and take a longer time to build than renewable capacity additions. In the East China region, where distributed solar is widespread, the regional grid and power distribution network are

[14] "China's new energy grid connection and consumption", 2024年全国新能源并网消纳情况 , https://finance.sina.com.cn/roll/2025-02-08/doc-ineiufta9005634.shtml

[15] Aiqun Yu et. al, "China continues to lead the world in wind and solar, with twice as much capacity under construction as the rest of the world combined", Global Energy Monitor, July 2024, https://globalenergymonitor.org/report/china-continues-to-lead-the-world-in-wind-and-solar-with-twice-as-much-capacity-under-construction-as-the-rest-of-the-world-combined/

ill-equipped to deal with the distributed solar boom, leading to temporary suspensions of distributed solar applications[16] .

China also has limited storage: at the end of 2024, China had an estimated 74 GW of "new type energy storage" which refers to flexible storage solutions critical for integrating high shares of renewable energy into the power grid (excluding traditional pumped hydro storage), a twenty-fold increase compared to 2021. Despite the large increase, this represented an average 2.3 hours of storage time with over half of the projects located in Northern and North-western China, far from the key consumer centres[17]. But the technical and physical constraints are overshadowed by institutional barriers.

China's policy makers view coal power as an important source of flexibility to mitigate the intermittency of renewables. Since 2022, the National Energy Agency (NEA) has mandated that new coal power plants should focus on supporting peak load and regulating renewable energy. In practice, and especially after the power outages of 2021, few coal power projects were actually aimed at facilitating solar and wind integration. Instead, they are aimed at ensuring local energy supply, driving economic development, meeting heating demands, or supporting industrial parks. Still, China approved 66.7 gigawatts (GW) of new coal-fired power capacity in 2024[18]. That same year, 94.5 GW of new coal power projects started construction and 3.3 GW of suspended projects resumed construction, the highest level since 2015.

China's power market design prioritises coal through long term power purchase agreements (PPAs). Since 2020, long-term PPAs have required coal power plants to secure contracts covering at least 80% of their projected annual output, effectively guaranteeing baseline utilisation rates. Electricity buyers must then fulfil their coal power obligations, even when cleaner and cheaper energy options like solar and wind are available. Most of the new coal-fired plants also secure these purchase agreements before coming online.

The simultaneous expansion of coal and clean energy has created regional oversupplies of coal power, leading to lower prices[19]. While lower prices could discourage new renewable investments, they also provide low input costs for industry. With greater concern for economic growth as well as energy and industrial resilience than economic efficiency or emission reductions, the government is intent on keeping coal plants in the mix to secure supplies. In 2023, in light of the financial losses in the coal sector and in a bid to enable coal to remain in the mix to back up renewables, the government also introduced a capacity payment mechanism which offers a guaranteed annual payment for coal plants per megawatt of available capacity, regardless of how many hours a generation unit operates. The aim of the plan is to ensure coal plants are available when needed to back up intermittent renewables. In reality, however, the criteria for inclusion under the plan for

[16] https://www.china5e.com/news/news-1161773-1.html
[17] Summary of China's energy and power sector statistics in 2024, China Energy Policy newsletter, https://www.cet.energy/category/data/
[18] Qin Qi, Christine Shearer, "When coal won't step aside: The challenge of scaling clean energy in China", CREA, 13 February 2025, https://energyandcleanair.org/wp/wp-content/uploads/2025/02/CREA_GEM_China_Coal-power_H2-2024_FINAL.pdf
[19] Qin Qi, Christine Shearer, "When coal won't step aside: The challenge of scaling clean energy in China", CREA, 13 February 2025, https://energyandcleanair.org/wp/wp-content/uploads/2025/02/CREA_GEM_China_Coal-power_H2-2024_FINAL.pdf

coal plants is loose while alternatives like batteries and flexible demand do not qualify, further risking the build out of excess coal power.[20]

But even as Beijing keeps allowing more coal to be added to the mix, it is also looking to move to a less emissions-intensive power generation system with solar and wind power at its core, eventually displacing coal as the main power source. In 2024, the NDRC issued a decarbonisation plan for coal power, focusing on co-firing with biomass or green ammonia and deploying carbon capture, utilisation and storage (CCUS)[21]. Provincial governments and central state-owned enterprises were tasked with proposing retrofits to lower coal power emission intensity to gas power levels. There are still open questions, however, about the scale of retrofits and implementation[22]. Meanwhile, in early 2025, the government introduced a new pricing regime for renewables[23], which will take effect in early June. The new regime is akin to a market-oriented contract-for-difference pricing system for domestic wind and solar power and will include a strike price, set by provincial governments based on their local targets for renewable additions and production. The price will have to be set below the coal benchmark tariff, but the initial price range is likely to be narrow, striking a balance between a desire to drive down prices but keeping them high enough to ensure the viability of wind and solar. For renewable generators, the change is a mixed bag: they will no longer have the guarantee of offtake and revenue, but will benefit from minimum prices, albeit subject to local policy maker decisions.

Finally, in April 2025, the National Development and Reform Commission (NDRC) and National Energy Administration (NEA) reportedly jointly issued guidelines mandating continued coal plant construction through 2027 in regions with renewable penetration exceeding 35% in order to provide peaking capacity during periods of low wind and solar output; maintain frequency stability in grids with high variable renewable shares and serve as emergency reserves during extreme weather events[24].

China's plans to reduce carbon emissions from coal power and the insistence on coal as a baseload power source indicate that coal power will continue to play a significant role in the near-term energy landscape, complicating Beijing's dual carbon targets in 2030 and 2060. Even though storage combined with renewables could provide a more cost effective and flexible alternative to coal power for balancing the grid, coal power remains shielded from competition. To be sure, the Chinese government is looking to establish a low emissions power generation system, but there still seems to be limited appetite for dramatic reforms that would greatly increase the role of market mechanisms in resource allocation or shift the incentives of local officials decisively away from coal[25].

---

[20] Qin Qi, Christine Shearer, "When coal won't step aside: The challenge of scaling clean energy in China", CREA, 13 February 2025, https://energyandcleanair.org/wp/wp-content/uploads/2025/02/CREA_GEM_China_Coal-power_H2-2024_FINAL.pdf

[21] https://www.ndrc.gov.cn/xwdt/tzgg/202407/P020240715559357737744.pdf

[22] Qin Qi, Christine Shearer, "When coal won't step aside: The challenge of scaling clean energy in China", CREA, 13 February 2025, https://energyandcleanair.org/wp/wp-content/uploads/2025/02/CREA_GEM_China_Coal-power_H2-2024_FINAL.pdf

[23] NDRC, "Notice on deepening market-oriented reforms of new energy grid-connected electricity prices and promote the high-quality development of new energy", 9 February 2025, https://www.ndrc.gov.cn/xwdt/tzgg/202502/t20250209_1396067_ext.html

[24] "China to keep building coal plants through 2027, state planner says", Reuters, 14 April 2025

[25] Anders Hove, "New moves in China's power market reform chess game", OIES Energy Insight no 139, November 2023, https://www.oxfordenergy.org/wpcms/wp-content/uploads/2023/11/Insight-139-New-moves-in-Chinas-power-market-reform-chess-game-1.pdf

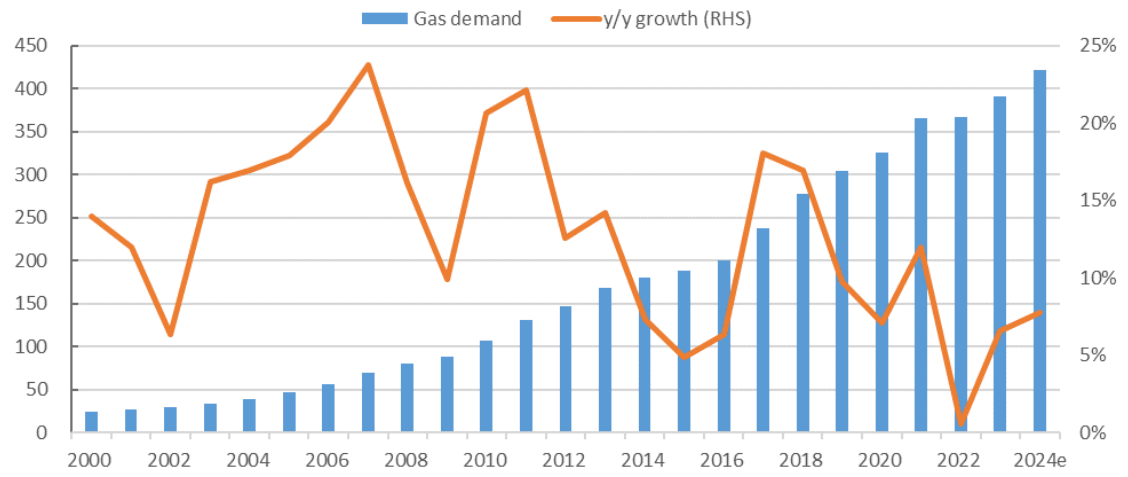
And in the current global environment, the government remains focused on ensuring ample supplies (and even oversupplies), perhaps also in order to keep industrial power prices low. Even prior to the COVID-19 pandemic, as the first US-China trade war began, the Chinese leadership began to focus on industrial and technological leadership as well as energy security. The two trends may now already be converging in Beijing's focus on coal, and its lead in clean-tech industries.

2.3 Natural gas can support the transition, but it is not a priority

These changes in China's energy structure raise questions about the outlook for natural gas. China's gas demand has increased by an annual average of 9% between 2014 and 2024, with consumption more than doubling from 180 bcm in 2014 to 422 bcm in 2024 (Figure 9). This strong growth was driven by a combination of favourable policies and competitively priced resources (both domestic and imported). But just as the availability of supplies, favourable policy and competitive prices have enabled gas consumption, they have also, at times hindered it: When overly ambitious fuel switching policies led to supply shortages and price spikes in 2017-2018, appetite for gas waned. Weak economic activity in 2022 combined with global market volatility and concerns about import dependence, led to a slowdown in gas consumption.

Even though China's gas use has grown substantially over the past two decades, it still accounts for under 10% of the country's primary energy mix, and annual growth rates have varied considerably (Figure 9), depending on both prices and policies.

Figure 9: China's gas demand (bcm) and y/y change (%)

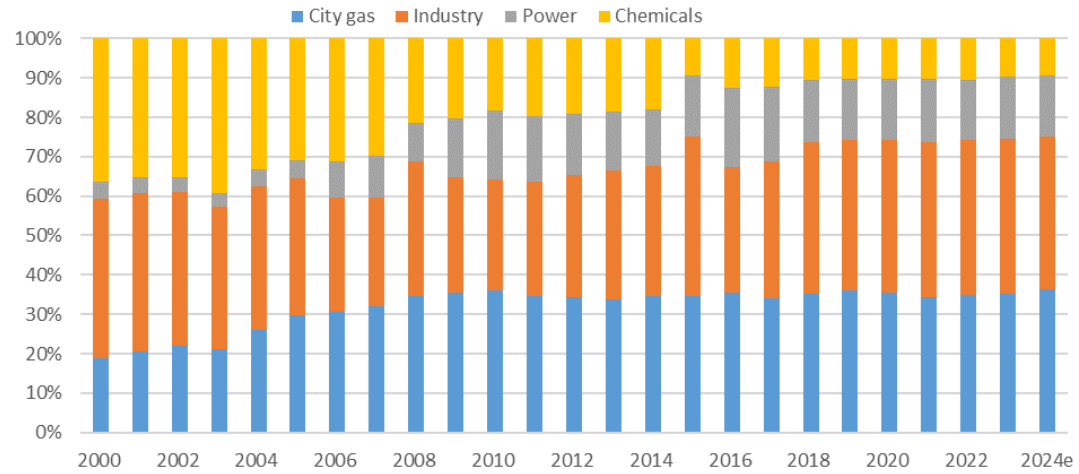


Source: CNPC ETRI, OIES

Estimates of the country's future demand vary widely with divergences as to whether industry or power will be the main drivers of demand growth. Sinopec, China's second largest oil and gas company, estimated that between 2020 and 2040, industrial demand will account for 180-200 bcm of new gas demand while the share of power in this growth will be more muted. CNPC, China's largest oil and gas company, reckons that gas demand will reach around 520 bcm in 2030 and peak at 606 bcm in 2040 but that power will soak up almost 170 bcm of that increment through 2040[26].

[26] Michal Meidan, "Gas in China: It's the policy, stupid!", Oxford Energy Forum, https://www.oxfordenergy.org/wpcms/wp-content/uploads/2024/09/OEF-141.pdf

Figure 10: China gas demand by sector

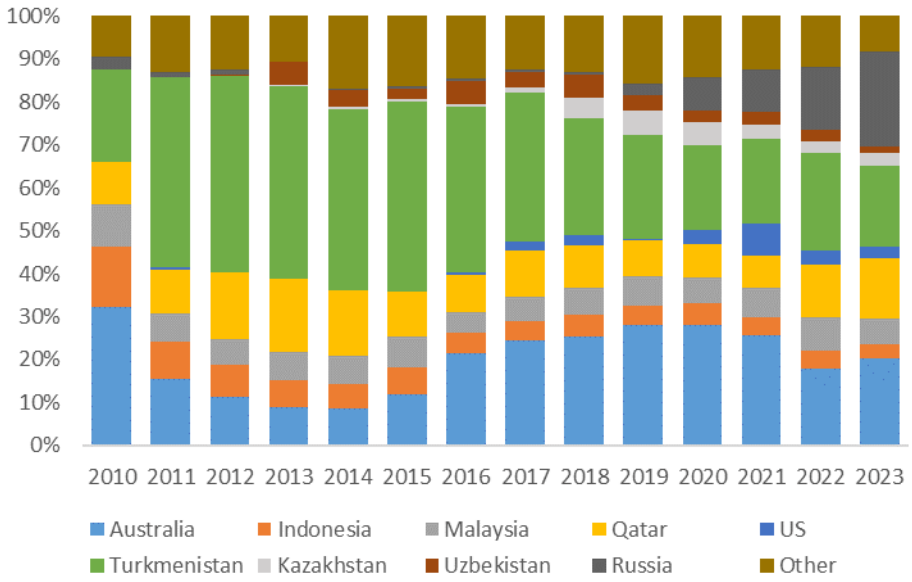


Source: CNPC ETRI, OIES

Gas is viewed as a partner fuel in the country's energy transition and is central in a number of industries as well as in the power systems of a number of provinces[27], as such, gas consumption will continue to grow but its growth trajectory could be volatile given that it is constrained by the availability of both coal and renewables and by price volatility.

To date, China's domestic supplies account for just under 60% of demand, with LNG and pipeline flows filling the gap. While demand is expected to rise, production growth is unlikely to keep up, increasing China's dependence on imports. Over the last decade, China has diversified its import sources but remains reliant on a handful of countries for its imports.

Figure 11: Gas imports (pipeline and LNG) by country



[27] Yan Qin, "Natural gas in China's power sector: Challenges and the road ahead", OIES Energy Insight 80, December 2020, https://www.oxfordenergy.org/publications/natural-gas-in-chinas-power-sector-challenges-and-the-road-ahead/

The fraught geopolitical environment combined with high tariffs on imports of US LNG could lead Beijing to prioritise other supply sources given that future supplies are expected to come overwhelmingly from the US, Qatar and potentially Russia. This means that without a clear mandate to switch from coal to gas, the cost competitiveness of coal and renewables—both of which in Beijing's eyes offer greater supply security—could limit the growth potential for gas.

3. New energy paradigms?

China's energy system, as discussed above, is in flux. Discerning structural shifts from cyclical change is complicated by the extreme market volatility since the COVID-19 pandemic and the aftermath of the Russian invasion of Ukraine. But a number of trends need to be monitored carefully as they may herald deeper changes to China's energy system. Moreover, these changes need to considered in the context of intensifying US-China competition: Already back in 2018-2019, Beijing began reinforcing coal as part of its energy security, prioritising domestic production of all energy sources (and critical minerals), building out storage of oil and gas, while also doubling down on its ability to produce and deploy the energy industries of the future.

3.1 New energy (in)securities

China's sense of energy insecurity has not disappeared, but policies now focus on balancing fossil fuel stability with renewable expansion, emphasizing domestic production capacity, diversifying import channels, including a focus on the Belt and Road countries, and diversifying domestic energy sources[28]. Given the growing importance of the power sector, energy security policies now also include efforts to enhance the physical aspects of grid modernisation (infrastructure build out, technology innovation, digitisation) as well regulatory and market tools to improve efficiency. Infrastructure flexibility and resilience are all parts of the energy security equation.

Critically, though, as electrification is accelerating, deploying renewable energy is an additional source of energy security given China's centrality in new energy supply chains. Not only are clean tech costs falling, but these industries are now significant drivers of China's economic growth[29], a key pillar of the country's industrial strategy and a source of exports and geo-economic leverage.

China produces enough lithium-ion batteries, solar panels and electric vehicles to meet most or more than the world's demand. Chinese lithium-ion battery production in 2023 was roughly equivalent to global demand, at around 950 GWh[30] while China's solar PV manufacturing capacity is estimated at about 1,200 GW as of early 2025, or double global market demand.

But China's lead extends beyond manufacturing. Chinese companies have a deep footprint in the extraction and mining of ores both in China and abroad, they have developed expertise and leadership in the processing of many minerals and materials and are leading producers of components and end goods such as batteries, electric vehicles, solar panels and wind turbines. While estimates of China's market concentration vary depending on data and methodologies, all point to

---

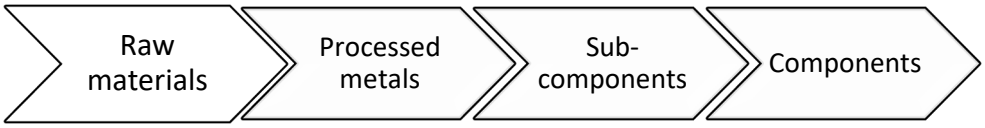
[28] Lin Boqiang "China can deal with local energy security issues from these aspects", Yicai, 28 February 2023, https://www.yicai.com/news/101688159.html; Wang Yongzhong, "Trump's energy plans, impact and response", World Energy Studies, July 2, 2018, http://www.iwep.org.cn/xscg/xscg_sp/201807/W020180703586326878428.pdf

[29] Lauri Myllyvirta, Qi Qin, and Chengcheng Qiu, "Analysis: Clean energy contributed a record 10% of China's GDP in 2024", CREA, 19 February 2025, https://energyandcleanair.org/analysis-clean-energy-contributed-a-record-10-of-chinas-gdp-in-2024/

[30] Colin McKerracher, "China Already Makes as Many Batteries as the Entire World Wants", BloombergNEF, 19 April 2024, https://about.bnef.com/blog/china-already-makes-as-many-batteries-as-the-entire-world-wants/

extremely high levels of dominance especially in the processing of minerals and materials, but to reliance on imports for raw materials and ores. Flows of cobalt, nickel, lithium and manganese, among others, come from a host of countries in Africa, Latin America and South East Asia.

Figure 12: China's involvement in the supply chain for Li-ion batteries in 2022

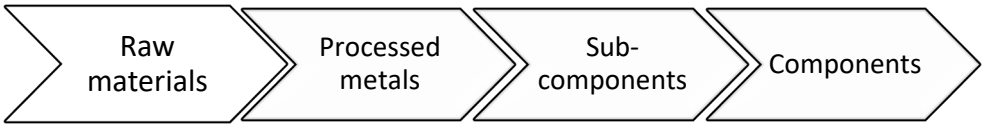


Raw materials	Processed metals	Sub-components	Components
Natural graphite	High-purity graphite	Anode	Lithium-ion cells
Synthetic graphite			
Niobium ores	Niobium		
Titanium ores	Titanium		
Cobalt ores	Cobalt	Cathode	
Nickel ores	Nickel		
Manganese ores	Manganese		
Niobium ores	Niobium		
Lithium ores	Lithium		
Phosphates			
Lithium ores	Lithium	Electrolyte	
Copper ores	Copper		Casing & parts
Bauxite	Aluminium		

Legend:
80-100% concentration
60-80% concentration
40%-60% concentration
20%-40% concentration
0%-20% concentration

Note: The table is a schematic, simplified, representation of supply chains depicting China's share of production
Source: Philip Andrews-Speed, OIES[31]

Figure 13: China's involvement in the supply chain for solar PV in 2022



Raw materials	Processed metals	Sub-components	Components
Sand	Polycrystalline silicon	Silicon cells & wafers	Silicon modules
Boron ores	Borates		
	Germanium		
Silver ores	Silver		
Zinc ores	Zinc		
	Tellurium	Cd-Te cells	
	Cadmium		
Copper ores	Copper	CIGS cells	
	Indium		
	Gallium		
	Selenium		
Titanium ores	Titanium	Perovskite cells	

Legend:
80-100% concentration
60-80% concentration
40%-60% concentration
20%-40% concentration
0%-20% concentration

[31] Based on USGS 2025, Mineral Commodity Summary; GWEC 2024. Global Wind Report 2024; IEA 2024. Clean Energy Technology Manufacturing; IEA Global critical mineral outlook; US DOE 2022 Rare earth permanent magnets. Supply chain deep dive assessment; Sivaram et al 2024. Winning the battery race. Sivaram Gordon - Battery Race-2024.pdf; China to hold over 80% of global solar manufacturing capacity from 2023-26 | Wood Mackenzie

<table>
<tr><td>Zinc ores</td><td>Zinc</td><td rowspan="4"></td><td rowspan="4"></td></tr>
<tr><td>Bauxite</td><td>Aluminium</td></tr>
<tr><td>Zirconium ores</td><td>Zirconium</td></tr>
<tr><td>Tin ores</td><td>Tin</td></tr>
<tr><td>Bauxite</td><td>Aluminium</td><td></td><td rowspan="4">Frame</td></tr>
<tr><td>Nickel ores</td><td rowspan="3">Steel</td><td rowspan="3"></td></tr>
<tr><td>Molybdenum ores</td></tr>
<tr><td>Iron ores</td></tr>
<tr><td>Lead ores</td><td>Lead</td><td></td><td rowspan="2">Installation</td></tr>
<tr><td>Copper ores</td><td>Copper</td><td></td></tr>
</table>

Note: The table is a schematic, simplified, representation of supply chains depicting China's share of production
Source: Philip Andrews-Speed, OIES[32]

China's industrial prowess, which has been supported by government policies and subsidies, has enabled a significant scale up in clean tech manufacturing. This has led to cost reductions and a leading role for Chinese companies globally. In 2023, the average price of a Chinese battery electric vehicle into the EU was 16 percent lower than other imported battery electric vehicles.[33] Similarly, manufacturing solar panels in the EU is estimated to be 70–105 per cent more expensive than in China.[34]

While the cost reductions offered by Chinese clean-tech are significant, so are the policy challenges posed by Chinese competition. Central and local government backing has been an important part of Chinese corporate success, but there is also considerable innovation in China in a cut-throat competitive corporate environment. What is more, the creation of industrial parks and manufacturing hubs has allowed Chinese firms to scale up and innovate rapidly,[35] and this suggests that in certain areas, they will remain leaders. The raft of supportive policies that both central and local governments have issued and fine-tuned over the years has spanned innovation and production of clean tech (often with strong localization policies and forced technology transfers), support for deployment, and demand, as well as infrastructure development.

Trade defence measures alone will not offset these factors. Excluding Chinese companies and know-how from Western markets may reduce some of the above-mentioned risks, but it does not

[32] Based on USGS 2025, Mineral Commodity Summary; GWEC 2024. Global Wind Report 2024; IEA 2024. Clean Energy Technology Manufacturing; IEA Global critical mineral outlook; US DOE 2022 Rare earth permanent magnets. Supply chain deep dive assessment; Sivaram et al 2024. Winning the battery race. Sivaram Gordon - Battery Race-2024.pdf; China to hold over 80% of global solar manufacturing capacity from 2023-26 | Wood Mackenzie

[33] 'The EU's drive on China: What EV tariffs mean for Europe', https://www.cer.eu/insights/eus-drive-china-what-ev-tariffs-mean-europe#:~:text=In%202023%2C%20the%20average%20Chinese,30%2C200)%20(Chart%202).

[34] 'China dominates EU solar photovoltaic (PV) market: 98% of solar panels come from China', 21 October 2024, https://www.evwind.es/2024/10/21/china-dominates-eu-solar-photovoltaic-pv-market-98-of-solar-panels-come-from-china/101922#:~:text=According%20to%20Eurostat%20data%2C%20a,panels%20from%20China%20in%202023.

[35] Hove, Anders (2024, July), 'Clean energy innovation in China: fact and fiction, and implications for the future', OIES Paper CE14, https://www.oxfordenergy.org/wpcms/wp-content/uploads/2024/07/CE14-Clean-energy-innovation-in-China-Final.pdf.

guarantee that Western countries will be able to develop their own supply chains[36] and insulate themselves from China's perceived predatory industrial policies or economic statecraft. Consistent and comprehensive industrial policies that support the creation of the relevant ecosystems alongside certainty around the demand for these technologies, will be required in order to foster growth and innovation.

What is more, tariffs and duties will lead to constant supply chain readjustments that will, in part, support geographic diversification, but will also incur additional costs for companies operating in this space. New supply chain reconfigurations could also end up cutting off Western companies from Chinese suppliers. Even though, over time, fragmentation could spur new innovation and new market responses, it will be a lengthy and costly process.

Over the coming years and decades, Chinese companies will remain active globally. And Western policymakers should not underestimate the dynamic corporate space in China which spans the extractive industries, processing, and manufacturing. Chinese companies operating in this space have different ESG strategies and standards. Some, because of international pressure or Chinese government mandates, are looking to set better common ESG reporting frameworks.[37]

More importantly perhaps, it is important to ascertain when and where dependence on China is a vulnerability, where it is a threat, and where the risks outweigh the benefits. Even though at the outset Beijing did not have a strategy to dominate these supply chains, the end result is still that China today has a powerful economic and geostrategic tool that it can wield. Moreover, Beijing increasingly resorts to it as part of its toolbox. But using export controls is not without cost to the Chinese economy and to Chinese companies. At the same time, China still relies on imports of minerals, materials, and ores that it then processes; it views this reliance as a vulnerability.[38] Finally, the Chinese economy is growing increasingly reliant on exports of clean tech. Dominance, therefore does not mean independence.

Conclusions

Even though China's energy system remains heavily dependent on fossil fuels, the combination of geopolitical competition with the US—which is leading Beijing to focus on industrial development

---

[36] The EU Parliament 'calls on the Commission and the Member States, in coordination with industry stakeholders to implement the decision to gradually reduce the dependence on China by diversifying the sources of critical raw minerals and rare earth elements, establishing strategic partnerships with reliable third countries with a view to ensuring a secure and reliable supply of critical raw materials; urges the EU to assist Member States in developing projects that will aim for greater independence from Chinese production'— https://www.europarl.europa.eu/doceo/document/TA-9-2024-0028_EN.html.

[37] Deberdt, Raphael, DiCarlo, Jessica, and Park, Hyeyoon (2024), 'Standardizing "green" extractivism: Chinese & Western environmental, social, and governance instruments in the critical mineral sector', *The Extractive Industries and Society*, 19, https://doi.org/10.1016/j.exis.2024.101516; DiCarlo, Jessica (2024), 'Can the race for decarbonization be "green"?: critical minerals, China's responsible mining initiatives, and the role of non-state actors', 2023-2024 Wilson China Fellowship, https://www.wilsoncenter.org/sites/default/files/media/uploads/documents/2024-WCF_DiCarlo.pdf

[38] Yu, Shiwei et. al. (2021), 'An evaluation of the supply risk for China's strategic metallic mineral resources', *Resources Policy,* 70, https://www.sciencedirect.com/science/article/abs/pii/S0301420720309223?via%3Dihub; Chen, Weiqiang (2022, November), 'Challenges and security strategies of China's critical metals supply for carbon neutrality pledge', *Bulletin of Chinese Academy of Sciences*, 37(11).

and energy security—and dramatic cost declines in clean technologies are altering the country's energy dynamics.

Electrification is accelerating rapidly and is set to continue rising, suggesting a faster than expected decline in oil use. Renewable deployment is surging and while coal power remains the dominant strategy for grid flexibility and dealing with the intermittency of renewable, progress in storage technologies cannot be ruled out. The role of gas is an open question: if supplies are available and cost-competitive, its market share will grow but its role in China's energy mix could remain constrained by the availability of coal and renewables.

China's policy makers are more preoccupied with building a flexible and resilient energy system that can provide low-cost electricity to fuel industrial development than they are with economic efficiencies or emission reductions. Perceptions of a weakening global commitment to emissions reductions are reducing the pressure on Beijing to build out a low-carbon economy. But China's policy makers are still working toward a low-carbon economy because of the advantages it will offer over time. Beijing is looking to build a robust and flexible, low-carbon system that will be competitive globally on both cost, and over time, on a lower emissions footprint.

Rapid electrification of transport and declining oil demand could lead to redundancies in the petrochemical sector while excess supplies of clean-tech are weighing on Chinese companies' margins, prompting them to look overseas for export markets. New trade frictions are emerging. Meanwhile, old dependencies on oil and gas suppliers are being supplemented with reliance on providers of minerals, metals and ores as well as export markets for intermediate goods and finished products. Even though China's energy structure is changing, leading to reduced reliance on imported oil and gas, new sources of external and domestic insecurity are emerging.