



BHP

BHP's Economic and Commodity Outlook

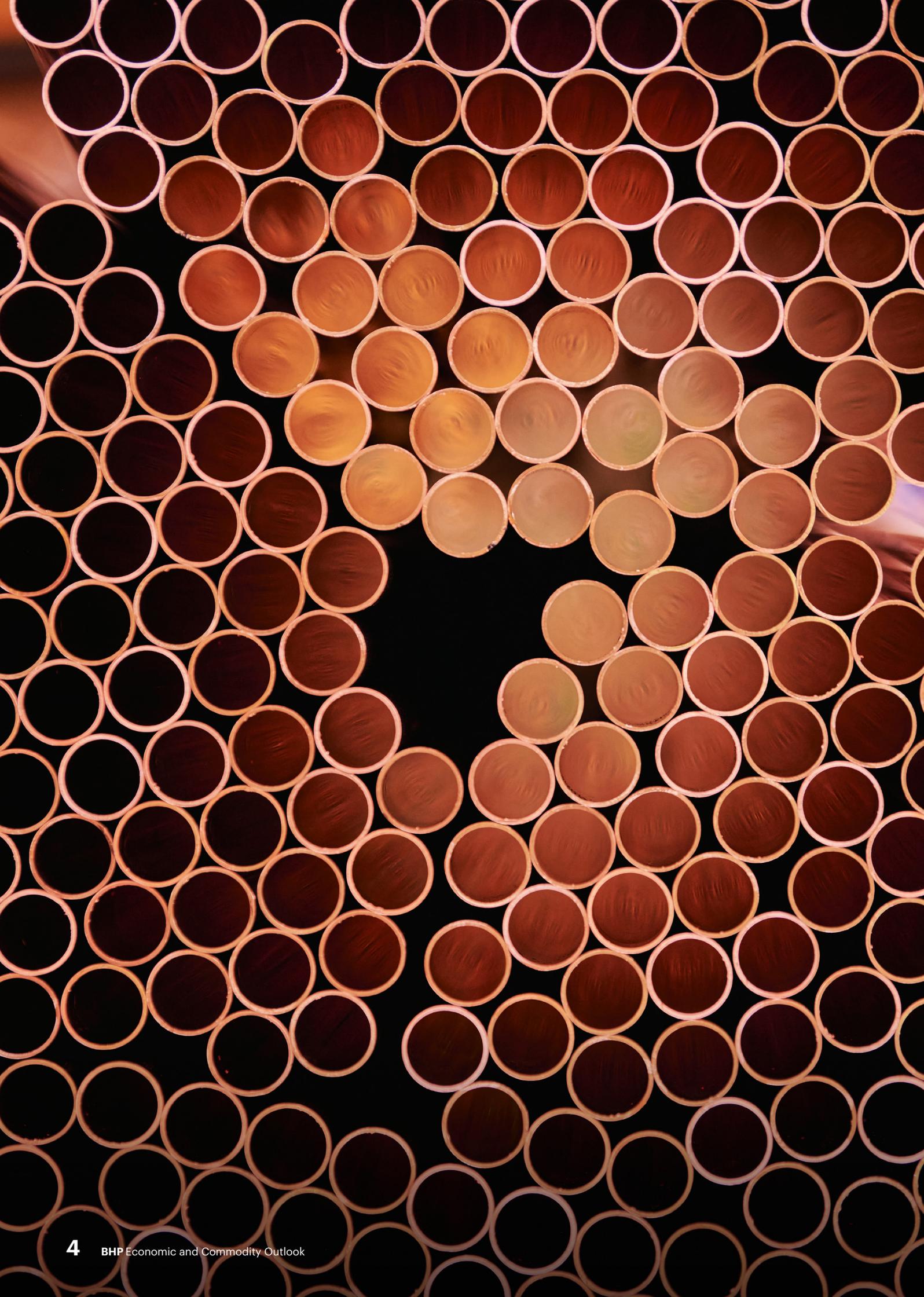
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Twelve months ago, at the time of our half year results for financial year 2023, we introduced the “three Rs”– framework to synthesize the outlook for CY2023: *reality* (of slower growth in the developed world), *relief* (that the inflationary wave appeared to have crested); and *re-opening* (the China dynamic).

Complementing that, we positioned China and India as a source of stability for commodity demand in the face of the widely anticipated developed world slowdown. An ebb and flow between these forces was expected to continue throughout the year. Our basic framing against this multi-faceted backdrop was that we expected that price formation would, on average, improve across calendar 2023 versus the second half of calendar 2022, when pessimism on Chinese growth prospects was at its height, the US Fed was at its most hawkish and the energy price shock was at its peak. But at the same time, we gauged that the constellation of prices observed at the time (January–February 2023) overstated how tight physical commodity markets were likely to be over the full year, especially in non-ferrous metals where roughly half of global demand emanated from outside China. We also argued that should there be phases within the year where prices do trade to the downside, these dips were more likely to be shallow rather than deep, noting that industry-wide cost inflation has raised real-time price support well above pre-pandemic levels in many of the commodities in which we operate, and value chain inventories in general were low across multiple industries.

In August 2023, at the time of our full year results for financial year 2023, we extended and updated that framework,

with the biggest deviation being the fact we moved to a conditional forward view of the Chinese economy, acknowledging ineffective policy transmission in real estate and an overhang of weak confidence had held the system back in the first half of calendar 2023, despite a promising start. The expectation of slower growth in the West feeding into soft demand for commodities, and demand and supply forces both contributing to a continued unwinding of the general inflationary wave, needed no adjustment. Indian demand was strong, as expected. China also held up its end of the “stability bargain” where commodity demand was concerned, though this presented a paradox in the eyes of generalist observers due to the underwhelming nature of the broader data flow, and outright disappointment from housing.

Against that backdrop for demand and inflation, which sat alongside the usual uncertainty on the supply side of commodity markets, we judged that commodity price dynamics were expected to be highly complex once again in the second half of calendar 2023. Non-ferrous prices did under-perform, as expected, but steel-making raw materials did better than anticipated, especially in the final months of the period. The reasons for this, and what that performance might mean for calendar 2024, will be a major theme of the commentary across this article.

On the specific commodity clusters, energy, food, and fertiliser markets spent much of the last twelve months unwinding the stunning peaks that emerged in calendar 2022. The main exception among energy commodities was uranium, which passed \$100 per lb in the first weeks of calendar 2024, trading over 5 times the low point reached in its post-Fukushima *decennium horribilis*. Across calendar 2023, the steel-making value chain saw gains in the March quarter, downward pressures in the middle quarters, and then an “unlooked for” rally in the final quarter of the year. Within the general theme of under-performance under the shadow of weak OECD demand, non-ferrous metals diverged over the last six months, with nickel under relatively constant downward pressure as the supply glut deepened and spread to Class-I in disruptive fashion, while copper range-traded through most of the period—outperforming nickel but lagging behind the gains made by the steel-making complex. Copper though ended calendar 2023 on the front foot, with the inflation-interest rate nexus having tilted in a pro-growth, pro-risk direction, and supply challenges coming to the fore once again. At the time of writing, the most pronounced shift in copper has been in a spectacular decline in treatment charges in the concentrate market, with base refined prices and premia continued to trade in a defined range.

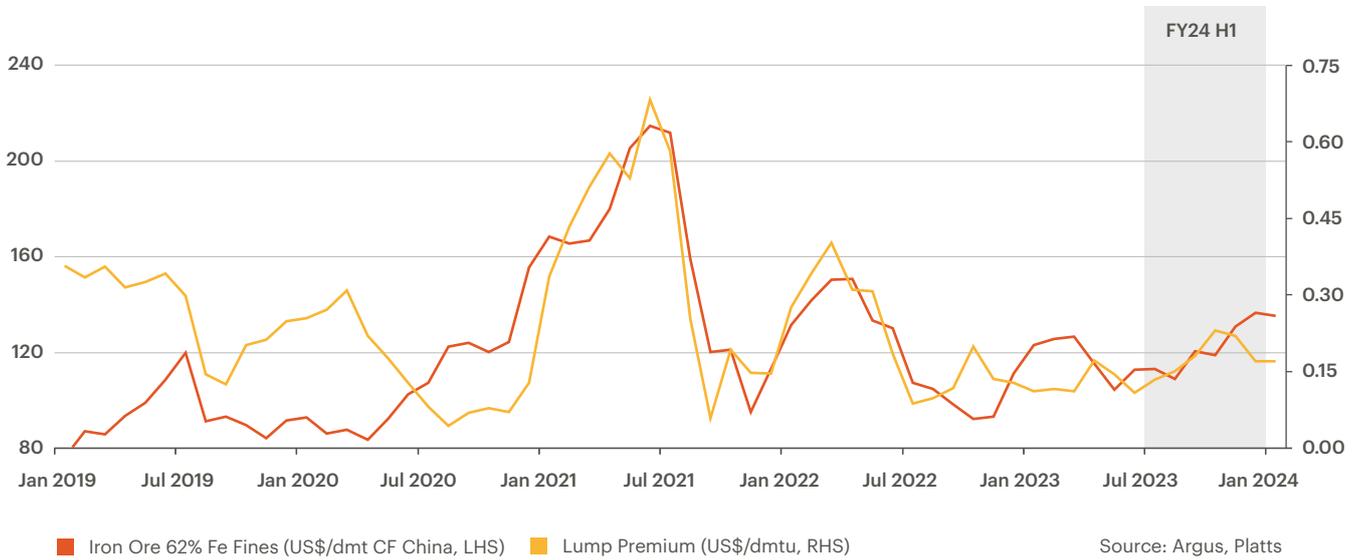
H1 FY24	Iron ore 62% Fe CFR \$/t	Met coal PLV FOB \$/t	Copper LME cash \$/t	Nickel LME cash \$/t	Potash FOB Van. \$/t
Average	121	299	8,258	18,808	309
Low–High	103 – 142	222 – 324	7,813 – 8,721	15,885 – 22,355	297 – 327
YoY ¹	+20%	+13%	+5%	-20%	-55%
HoH ²	+3%	+2%	-5%	-22%	-31%

Note:

1. Average prices in H1 FY24 (Jul–Dec 2023) vs. H1 FY23 (July–Dec 2022)
2. Average prices in H1 FY24 (Jul–Dec 2023) vs. H2 FY23 (Jan–Jun 2023)

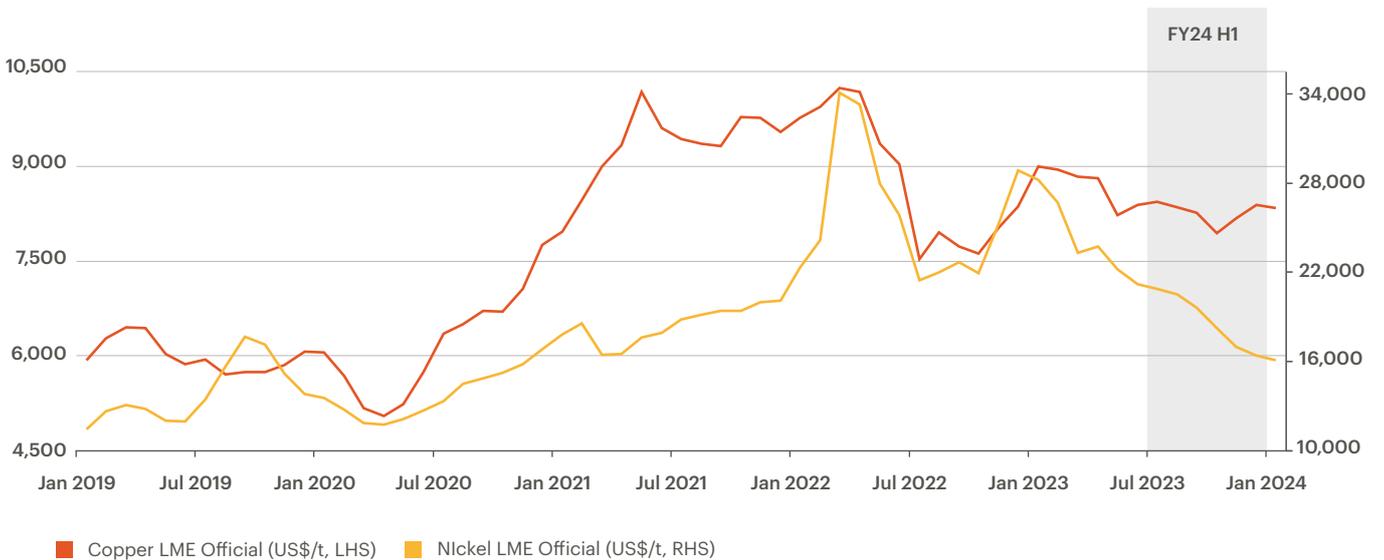
Iron ore prices

(monthly spot average)



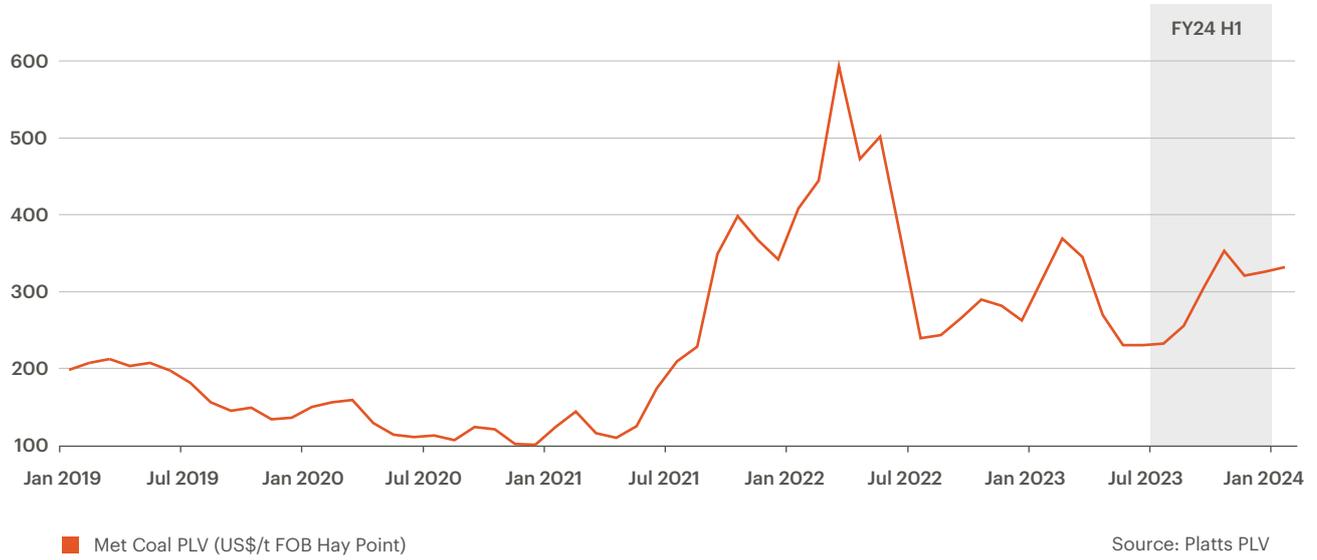
Copper and nickel prices

(monthly spot average)



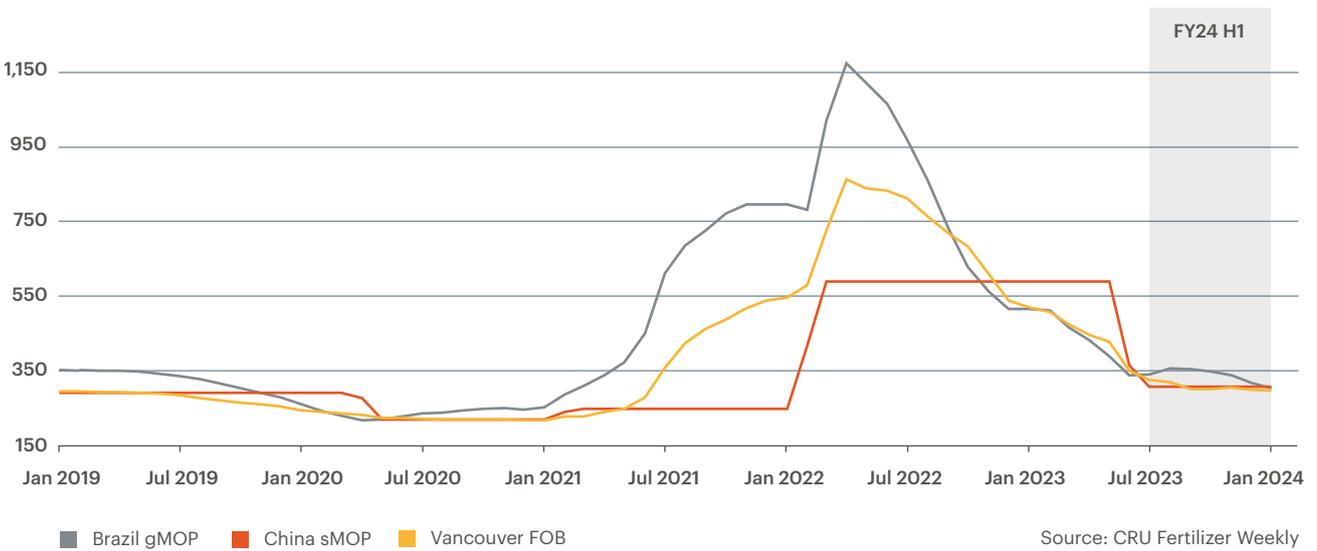
Metallurgical coal prices

(monthly spot average)



Potash prices

(monthly spot average)



With the 2024 calendar year upon us, we have updated our expectations for short-term supply-demand balances (where a surplus means rising inventories and a deficit means inventories running down). We now see refined copper in deficit and a very tight situation in copper concentrate (solid Chinese end-use demand, a reduced drag from the West, the abrupt closure of Cobre Panama and other operational shortfalls, new Chinese smelting capacity coming online), which is considerably better than expected six months ago, when a moderate refined surplus seemed likely. We foresee another material surplus in total nickel units, although with the scale narrowing from the very large excess supply of calendar 2023 (a reduced demand drag in the developed world, an end to destocking in the battery value chain, some announced curtailments and less rapid growth from Sino-Indonesian facilities). We anticipate another year of a broadly balanced iron ore market on average across the 2024 calendar year, although there are multiple uncertainties feeding into that assessment, including the perennial question of the intra-year disposition of Chinese regulators towards their domestic steel industry: a point on which it is disingenuous to hold a high conviction position. The metallurgical coal market tightened somewhat late in calendar 2023, although nothing like the situation in calendar 2022, when a series of pricing records were set. Improving supply as per industry-wide guidance and somewhat firmer demand beyond India and China are expected to produce a broadly balanced outcome for all metallurgical coals in calendar 2024, although the supply of higher quality metallurgical coals looks to be moderately tighter than the aggregate position across all product specifications.

Looking beyond the immediate picture to the medium term, we continue to see the need for additional supply, both new and replacement, to be induced across many of the sectors in which we operate.

After a multi-year period of adjustment in which demand rebalances and supply recalibrates to the unique circumstances created by COVID-19, the Ukraine conflict, and the global inflationary shock, we anticipate that geologically higher-cost production will be required to enter the supply stack in our preferred growth commodities as the decade proceeds.

The projected secular steepening of some industry cost curves that we monitor, which may be amplified as resource nationalism, supply chain diversification and localisation, carbon pricing and other forms of so-called “greenflation” become more influential themes in both demand and supply centres, can reasonably be expected to reward disciplined and more sustainable owner-operators with higher-quality assets featuring embedded, capital-efficient optionality.

We confidently state that the basic elements of our positive long-term view remain in place.

Population growth, urbanisation, the infrastructure of decarbonisation and rising living standards are expected to drive demand for steel, non-ferrous metals, and fertilisers for decades to come.

Over the course of the 2020s we expect: global population to expand by 0.8 billion to 8.5 billion; urban population to also expand by 0.8 billion to 5.2 billion; nominal world GDP to expand by \$78 trillion to \$165 trillion; and the capital spending component of GDP to expand by \$15 trillion to \$38 trillion.¹ Each of these fundamental indicators of resource demand are expected to increase by more in absolute terms than they did across the 2010s.

By 2050, we project that: global population will be approaching 10 billion; urban population will be approaching 7 billion; and the nominal world economy will have expanded to around \$400 trillion, with one-fifth of that—i.e., around \$80 trillion—being capex.

In line with our purpose, we firmly believe that our industry needs to grow in order to best support efforts to build a better, Paris-aligned world.²

And it is not just us.

What is common across the 100 or so Paris-aligned pathways we have studied is that they simply cannot occur without an enormous uplift in the supply of critical minerals such as copper and nickel.

Our research also indicates that crude steel demand is likely to be a net beneficiary of deep decarbonisation, albeit not to the same degree as nickel and copper. And some of the more extreme scenarios we have studied, such as the International Energy Agency’s technologically optimistic *Net Zero Emissions* scenario³, would be even more favourable for our future-facing non-ferrous metals than what is implied by our own work to date: albeit with different assumptions and potential impacts elsewhere in the commodity landscape.

Against that backdrop, we are confident we have the right assets in the right commodities in the right jurisdictions, with attractive optionality, with demand diversified by end-use sector and geography, allied to the right social value proposition.

Even so, we remain alert to opportunities to expand our suite of options in attractive commodities that will perform well in the world we face today, and will remain resilient to, or prosper in, the world we expect to face tomorrow.

1 Data comparisons are between 2019 and 2030 and reflect our central case forecasts, which incorporate aspects of the potential physical impacts of climate change for regions around the world and responses to them for these global indicators, the projected climate-related “green” investment boom, estimates of global inflation and the likely impact of expected climate policies. GDP is in nominal US dollars, on a base of \$87 trillion in 2019, with changes being the absolute difference between the 2019 actual and the 2030 projection. Capital spending is estimated based on the expected share of gross capital formation (GCF) applied to this measure of GDP. In PPP terms, the 2019 GDP base is around \$135 trillion.

2 Paris-aligned means a societal pathway aligned to the aims of the Paris Agreement. The central objective of the Paris Agreement is its long-term temperature goal to hold global average temperature increase to well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels.

3 Available from <https://www.iea.org/topics/net-zero-emissions>



China

China's economy has been buffeted by multiple headwinds across calendar 2022 and 2023. From a GDP perspective, China's growth slowed to just +3.0% in calendar 2022, 0.4 percentage points lower than the world growth rate. That was the first time in more than 40 years that China's economy had expanded at a slower rate than the global weighted average. Conditions improved in calendar 2023, with real GDP expanding by 5.2%, but that was an underwhelming follow-up to the disastrous year before.



Such weak economic growth across two years (relative to China's potential rate) saw producer price deflation setting in. The combination of soft real and weak nominal growth weighed on profits, household income, debtors, and private sector confidence. The two-year growth rate for nominal GDP (9.7%) was the lowest on record in the reform era—marginally worse than the first year of the pandemic (10.3%).

So, while the annual real GDP target of “around 5%” announced at the Two Sessions in March 2023 was achieved, this target was always a low bar. The reality is that a decisive reflation that moved both growth and profitability onto a more comfortable plane, and sparked a wider uplift in confidence, required a more formidable and effective combination of push and pull from the fiscal, monetary, and political authorities. The hope is that this emerges over calendar 2024, and the overhang of low confidence that characterised the first year of the post zero-COVID era progressively recedes. The reality is that while this might occur, it also might be that confidence does not turn for a considerable time yet, presenting two plausible book-ends for the outlook. Until we see greater coherence between policy word and deed, and evidence of effective transmission into commercial decision making, our outlook will remain conditional.

That train of logic positions our CY2024 forecast for real GDP at 4½% to 5%—between these two stylised positions and a little below the actual from the prior year. That is in line with the early indications from provincial authorities' targets that the national goal will be announced as “around 5%.” The risks around the midpoint of the range are balanced. According to the Bloomberg Consensus, mean real GDP expectations for calendar 2024 were steady at 5% for most of the first half of calendar 2023, before dropping to 4.5% in the difficult July–August period, which with hindsight looks like it was the trough in terms of monthly momentum. The Consensus is sitting at 4.6% as of the end of January 2024, with the range being from 4.0% to 5.2%. The major international banks in the Bloomberg Consensus are clustered in the 4.6% to 4.8% region.

The early bottom-up, high frequency and macro lead-lag portents for calendar 2024 are mixed. Credit supply is reasonable in aggregate, but that was also true in early calendar 2023 as well. In fact, calendar 2023 opened with a bang on the credit front, which was a key element of the March quarter “head fake” (along with the bounce in housing price and sales indicators). It was the targeting of that credit, and the composition of the growth, that left much to be desired. This also raises the practical point that after a year when base effects generally produced flattering YoY outcomes in Chinese economic data, the March quarter of 2024 will see that flip to a more onerous base of comparison.

Consumer confidence surveys show a bottoming out in sentiment, but there is no sign of a genuine recovery yet, either in the surveys or in the household savings rate, which remains extraordinarily high. We estimate that excess household savings in China now amount to around 17% of GDP, or \$2.6 trillion, which is a phenomenal figure. Discretionary spending appears to have improved in the recent holiday period, with restaurant orders, cinema box office, car sales, domestic tourism anecdotes, household credit growth and internal migration indicators all showing signs of promise. Time will tell on this front.

Business confidence remains soft overall, weighed down by the housing value-chain, excess capacity, low profitability, the sagging equity market, and the challenging environment for traditional exporters. However, the destocking dynamic that characterised much of calendar 2023 could well be easing. The policy stance though is a clear positive, with the People's Bank and other financial authorities stepping up support for both housing and the equity market, and the passive fiscal drag of calendar 2023 expected to reverse. The rare intra-year increase in the central government's fiscal deficit target (from 3.0% to 3.8%) announced late in calendar 2023 is an important scene setter in that regard.

At the time of our full year results for financial 2023, the outcomes of the July 2023 Politburo meeting were front of mind for China watchers.

We drew out five major themes from the communique, ranging from the cathartic (openly acknowledging the problem), to the specific (optimising the 16 measures package for real estate, stimulating consumption), to the general (the promise to deliver a “basket of measures” on local government finances, and an olive branch being extended to Big Tech).

Progress on these themes in the time since has not been linear, although there has been a steady drumbeat of announcements, especially in real estate. The fact that President Xi used his New Year message to deliver some emphatic words to businesses and families is a sign that the senior leadership grasps the gravity of the situation, but also that the transmission of policies remains imperfect.

That tallies with our assessment of six months ago that the key judgement call was to gauge how effectively the various policies already in place would transmit. We argued that:

IF they transmitted based on pre-pandemic lead-lag relationships, then the economy would stabilise soon and then firm progressively in the remaining months of the 2023 calendar year and open CY24 with solid momentum.

BUT IF the transmission mechanism remained impaired, perhaps due to an overhang of weak confidence, the recovery would inevitably take longer, and near-term growth outcomes would disappoint, as they did in the June quarter.

We positioned our working base case somewhere in the middle of these two plausible hypotheticals, updating our calendar 2023 outlook. The resulting GDP forecast of +5–5½% (a three-quarter point downgrade from the outset of the year) neatly captured the 5.2% actual.

This cautious, conditional framing guides our thinking again in calendar 2024.

Switching to the critical real estate sector, this is how the major “commodity” housing data (i.e. commercially available for sale as a “commodity”) stood at the end of calendar 2023, after roughly a year of the “16 measures” being in place. The volume of commodity housing starts—the key indicator for contemporaneous steel use in real estate—declined by –20.4% YoY. That is a third consecutive annual contraction, bringing the total drawdown from the peak to around –60%. Sales volumes of commodity housing declined –8.5% (weighed down by pre-sales at –14%: while new homes in completed projects sales [i.e., where completion risk is rendered moot] rose +18%). The total drawdown from the peak for sales is around –40%. Completions—the key indicator for contemporaneous copper use in real estate—rose +17% YoY. Floor space under-construction was tracking at –7.2% and developer financing was –13.6%.

The dichotomy between pre-sales and new homes in completed projects implies that a loss of buyer confidence in *private developers and their ability to deliver projects* remains a non-trivial element in real estate turnover dynamics: interest in real estate as an asset class is relatively undiminished when the delivery of the project is de-risked.

The head of the Ministry of Housing and Urban Development (MOHURD) added some ballast to that assessment by inferring that the combined volume of new and second-hand housing sales grew in calendar 2023. Second-hand transaction volumes in the top-30 cities, most of which saw purchasing restrictions loosened to some extent in the year, surpassed new homes volumes for the first time. Using the broader top-70 city sample, new home prices declined over the year (–1% from calendar 2022, –4% YoY in December 2023), consonant with other indicators.

Another way of illustrating the trust deficit is the fact that the historical share of sales and land acquisitions between private and SOE developers has flipped, from 70:30 to 80:20 prior to the current phase, to 30:70 to 20:80 today.

It is important to remember that the monthly “commodity” housing data documented above is only one component of total construction in China. “Commodity housing” is the available-for-sale commercial segment where private developers have historically thrived. The remaining “non-commodity” segment is in fact larger in terms of total floor space⁴, (noting that it includes non-residential as well as non-market residential activity), but unfortunately the data is not available in a suitably timely way to make precise judgements around potential turning points of the cycle. Our estimates indicate that non-commodity construction underway expanded a modest +2.4% in calendar 2023, down from +7.3% in the first half. Non-commodity starts contracted at a rate of –2.9% in calendar 2023, similar to the result of six months ago. Notably, in line with robust manufacturing fixed investment (see below), factory floor space completions and warehouse completions have remained solid, but offices and retail floorspace have both remained weak. Strong manufacturing completions will also raise China’s near-term export capacity: not good news for those competing directly with Chinese firms in industries where economies of scale rule.

In the public housing space, the “Three Major Projects” program launched in the second half of calendar 2023 will generate headlines in the coming year. The program encompasses (1) urban village renovation, (2) economic housing—pegged to be higher in calendar 2024 than the 3.6 million units target of calendar 2023, and (3) a pillar called “emergency facilities,” on which we will refrain from comment until we understand exactly what this will entail. An intriguing aspect of the economic housing pillar is that the target is not just about building. It also seeks to transfer housing inventory from the private developers to the public balance sheet, through monetary-fiscal financing. This seems a sensible strategy to us, as it acknowledges the challenges of the moment.

Back in the previous downcycle in the mid-2010s, we framed the housing de-capacity problem as one where housing assets needed to be transferred from developer balance sheets to the household balance sheet, with a consequent rundown of developer liabilities and a run-up in household liabilities to finance the transfer. At the time, mortgage debt was low and there were significant constraints on out-of-town investor purchases that were put in place as a counter-cyclical measure during the upswing. A more lenient approach to investors and mortgage availability was the obvious solution. This time around, a re-run of that successful transfer strategy is constrained by the substantial breach of trust between developers and consumers on housing delivery, and uncertainty over house prices. It makes sense for the public sector to attempt to break the circuit by intermediating as the initial purchaser and begin what seems likely to be an arduous recovery process. Finally, note that for the economic housing that is built under the auspices of this pillar will have a lower average per capita footprint than commercial dwellings.

⁴ The relative size of the two segments moves considerably over the course of cycles. The non-commodity segment was 72% of starts and 79% of completions in calendar 2022. However, such was the scale of the starts ramp-up in the multi-year upswing that led up to the pandemic, that developers still account for 58% of the stock of floor space underway.

On the urban village renovation pillar, the stock opportunity here is roughly equivalent to half of the annual flow in real estate investment. Spread over the best part of a decade, the question here is how the activity will be distributed in a temporal sense, and whether it can be front-loaded effectively given the damage done to the supply side of the construction sector during the “Three Red Lines”⁵ era.

In the weeks leading up to this article being finalised, a number of new policies were put in place on both the demand and supply side of the housing value chain. On the demand side, Guangzhou, a Tier-1 city, scrapped housing purchase restrictions outright. That removes all restrictions on non-residents buying. Note that Hangzhou (Tier-2) was the first city to remove all restrictions, and the impact has been positive for sales turnover. Market expectations were immediately set on other key cities following suit: and Shanghai (for non-residents), Suzhou (outright), Beijing and Shenzhen (both partial) have since lifted restrictions.

On the supply side, there have been two changes of real note. 1) The PBoC gave the official nod for banks to lend to developers to meet outstanding debt repayments to suitably collateralised applicants. 2) MOHURD and the National Financial Regulatory Authority (NFRA—the reasonably new mega-regulator) initiated a so-called “urban real estate financing coordinating system”, which included (critically) KPIs for local officials. Progress will be assessed on a weekly/monthly basis. On the rhetorical front, a NFRA spokesperson indicated that the “Real estate industry is very important to the economy and citizens and the financial industry has every responsibility to support it.” The basic takeaway is that there will be fewer and fewer acceptable excuses for bank executives whose institutions are not extending credit to the supply side of the property sector. Notably, the major banks have begun reporting the number of real estate development projects they are supporting, and household loans grew strongly in January 2024. Local governments are also on notice

via their KPIs. With many cities still retaining some purchase restrictions, the incentive to follow Guangzhou and its fast-followers will be very tempting under this new framing. That is an example of the “synergistic” policies that the leadership has been referring to.

To close out this section, there are some final observations on housing supply in a level sense, as opposed to rates of change, which are useful for gauging the big picture. The estimated unsold universal housing stock (the broadest measure) has fallen to 2.24 billion square metres, almost a decade-low⁶. By way of comparison, the all-time high for this measure was north of 2.9 billion square metres during the associated heavy industrial recession of 2014–16, and the low point after the multi-year resolution of that overhang (when housing destocking was a macroeconomic priority rolled under the supply side reform banner) was a little above 2.4 billion square metres. Nevertheless, the inventory-to-sales ratio (so-called “stock turnover”) has lifted to around 30 months, which is the highest since the tail end of the previous housing downcycle. These apparently paradoxical observations are squared by the extraordinary weakness of sales in the last two years.

For medium and long-term analysis, it is important to consider the separation between apparent demand for housing at a point in time, as measured by sales, and underlying demand, as proxied by demographic and economic geography variables relative to the dwelling stock. The urban population has increased from 767 million in 2014 to 921 million in 2022, and the average household size has declined from 3.1 persons in 2010 to 2.62 persons in 2020.⁷ And urban population is still rising steadily on a forward-looking basis, with around 15 percentage points of population share to go before urbanisation peaks. The sustained period of weak starts over the last three years will ensure that aggregate supply will continue to tighten relative to underlying demand for some time yet. A tight housing supply situation is likely to emerge in Tier 1 and Tier 2 cities a few years down

the line as sales respond to easier monetary policy as well as the more liberal purchasing conditions now in place after years of restrictive rules that supported the “housing is for living, not for speculating” mantra. In the upper tiers, this is a question of when, not if. Third-tier cities and below though will inevitably take a much longer time, and that is where public interventions, as discussed above, would be most effectively concentrated.

There is no more important consideration for the sentiment level of Chinese consumers than real estate prices, with more than 90% home ownership and around 70% of wealth held in this asset class.⁸

The poor returns produced by other major asset classes in recent times, such as domestic equities, wealth management products and corporate bonds (the latter two influenced in part by private developer default risk) highlights the ongoing centrality of housing as the primary vehicle for the deployment of China’s enormous pool of personal savings.

Moving on to non-housing end-use sectors now, and fixed investment in infrastructure was a bright spot across calendar 2023, as expected, with +8.2% YoY growth. That was a solid follow-up to +11.5% growth in the previous year. While the overall growth in this broad segment was not a surprise, the composition of infrastructure investment rotated over the year.

5 We have discussed the 3 Red Lines macroprudential criteria for property developers many times on this platform. Those interested in a refresher and a historical comparison to the previous housing downturn can revisit the August 2022 vintage of this Prospects series, available from <https://www.bhp.com/news/prospects/2022/08/bhps-economic-and-commodity-outlook#chineseeconomicgrowth>

6 It is not an all-time low, partly because the commodity housing market did not exist until the late 1990s, and therefore the inventory figures were exceedingly small in absolute terms in the 2000s.

7 Household size is from the decadal Census. Sample surveys are conducted more frequently but the data is of substantially lower quality than the Census.

8 Estimates from the China Household Wealth Survey Report: The proportion of real estate remains high China Economic Network National Economic Portal (ce.cn)

Water conservancy and related areas (e.g. sewerage⁹, residential water supply, irrigation, flood prevention, environment river restoration), which was a major source of support for growth earlier in the infrastructure upswing with double digit growth in calendar 2022, slowed to +3% YoY at the halfway point of calendar 2023, and was back to approximately flat for the full year. This segment, which accounts for roughly two-fifths of total infrastructure spending, is heavily reliant on local government financing as well as cross-departmental coordination. With local government bond issuance lagging year-ago levels in the first half of calendar 2023, and general revenues under considerable pressure, the slowdown in this segment was not unexpected but was certainly unwelcome. With bond issuance doing better in the later part of calendar 2023, we will watch closely for signs that water projects are getting a reasonable share of those new funds. Power infrastructure though has accelerated notably, with impressive growth of +23% YoY over the year. This was led by renewables capacity additions in the “power source” category (+30.1%), as discussed in more depth in the copper chapter, while the conventional grid (+5.4%) also had a better-than-average year. Transport had lagged the other two segments in calendar 2022, but it accelerated to +11% YoY over the first half of 2023, with momentum retained across the second half. That has helped offset the slowdown in water conservancy. Rail has been a particularly strong sub-sector.

Investment in manufacturing capacity was also solid again at 6.5% YoY, after a 9.1% outcome in calendar 2022. The uptrend was not quite as broad-based across sub-sectors as in calendar 2022, with major pockets of strength including non-ferrous smelting (about 3% of the total: a sector BHP is directly exposed to through our copper concentrate sales), machinery and equipment (about a fifth), and automotive manufacturing (5% share). The outlier on the downside remains ferrous smelting, reflecting tight regulatory scrutiny of steel sector capacity. Reflecting both the slowdown in traditional export sales and the crunch in foreign direct investment (FDI) inflows in light industry (around a quarter of the total) had an underwhelming year after registering double-digit growth in calendar 2022.

For auto production, it has been a positive but turbulent year, with annual averages hiding how sentiment swung within the period, and the difficulty experienced by various segments of the value chain. Total units (production) grew +11.6% in calendar 2023, with commercial vehicles bouncing back from a weak 2022 (+27% following -32%), passenger vehicles up +9.6% YoY, and new energy vehicles (NEVs) up +35.8% YoY (following 160% and 97% in 2021 and 2022 respectively). Those figures obscure the fact that the NEV segment opened the year with a glut of vehicles that could only be moved with a price war and a jump in exports (on which more below). The impact of this aggressive de-stocking was a core feature of the year across the value spectrum, with the auto original equipment manufacturers (OEMs) arguably better off than their suppliers. Specialty battery producers experienced a very challenging bout of excess supply and forced destocking, which contributed to the sharp declines in battery metal (and derived chemicals) pricing (notwithstanding sector-specific issues in the upstream, which will be discussed in the nickel chapter).

Elsewhere in the domestic end-use story, the diverse machinery category expanded 5.7% in calendar 2023, an improvement from the halfway point. Surveying the major components, agricultural machinery edged higher, while metal-cutting machines recorded a solid 6.4% YoY expansion after considerable two-way volatility across the prior two years. Domestic demand for construction machinery remains weak, but exports have proven to be resilient. The boom in power machinery continued, with a 28.5% YoY outcome in calendar 2023 coming on top of +34 percentage points of growth in the prior two years. This broad mix favours copper over steel, especially in a phase where wind investment is lagging behind solar installations. Total consumer and electronics goods output expanded +4.9% YoY in calendar 2023. Household goods were strong, with air-conditioners, refrigerators and washing machines all enjoying double digit growth. Civilian shipping was strong at +11.8% YoY, with a considerable order backlog that promises a multi-year run of high utilisation of Chinese shipyards, with container

vessels and car transport vessels dominating the order flow.

Total merchandise exports increased by around +30% in value in calendar 2021, and against expectations they managed to expand a solid +7% in calendar 2022 despite that high base and ongoing tariff protection in the US. The inevitable correction from these heights played out in calendar 2023, with exports declining -4.6%. Weakness in the processing trade, and in domestic consumption, as well as China’s rising competitiveness in higher value-added sectors like autos and capital goods, all contributed to imports declining -5.5%.

The transition from lockdown consumption dominated by goods and gadgets in 2020 and 2021 to a more “experiential” 2022 and 2023 (highlighted by so-called “revenge travel”), the end of the work-from-home technology hardware boom, and the global semiconductor industry’s three-year journey from critical shortage to aggregate glut, are all readily deducible from the Chinese trade data. However, on the final point, a new upswing in the semiconductor cycle appears to be in its early stages: something that can also be seen in the South Korean and Taiwanese statistics. China’s semiconductor exports were growing at +7.9% YoY as of December 2023.¹⁰

China’s own “revenge travel” catharsis feels as if it has been somewhat slow getting started, but we note that the data suggests that international Chinese tourism spending has returned to about 80% of 2019 levels as of Sep-2023, and the services trade deficit has returned to around -1.5% of GDP, from an average of -2% to -2.5% in the late 2010s, and a low of -0.3% of GDP in the darkest days of the zero-COVID era.

Balancing the trend in traditional goods export sectors, which have been cyclically soft, secular strength in workhorse decarbonisation technologies continues to be evident.

9 China has a target to increase the share of rural sewage that is treated from 28% in 2020 to 40% in 2025. That is also an interesting datapoint for those wondering if China is saturated with infrastructure. Developed countries treat about three-quarters of their sewage, on average.

10 As the line goes, the supply chain issue constraining autos in China is no longer chips, but ships, with a shortage of car transport vessels limiting China’s ability to increase its auto exports even more.

The authorities have dubbed NEVs, lithium-ion batteries and solar panels as the “three new” items. The “three new” collectively grew +30% YoY in calendar 2023. In 2023, China’s exports of NEVs rose +53%, keeping pace with the remarkable 57% upswing in ICE auto unit exports¹¹, with the total reaching 5.2 million (up from 3.3 million in 2022). That put China in the #1 position globally, above traditional automotive powerhouses Germany and Japan. The NEV hit 1.7 million units up from 1.1 million units in calendar 2022¹². On the power generation side, exports of solar panels increased +39%, but consistent with the weakness across the wind-power value chain globally, turbine exports fell back heavily (-43%). For more on Chinese and global energy transition spending, see the dedicated chapter.

Moving to the longer-term, our view remains that China’s economic growth rate will moderate as the working age population falls (noting estimates from both the UN and China’s Statistician indicate that the *total* population has already peaked) and the capital stock matures.

China’s broad production structure is expected to continue to rebalance from industry to services and its expenditure drivers are likely to shift from investment and exports towards consumption, with late-stage urbanisation a complementary element in this shift. China’s strategic decision to invest heavily and consistently in low carbon technology production, complemented by high rates of adoption internally, imply it will remain an opportunity rich market for future-facing commodities for many decades to come. New Premier Li Qiang has stressed that the economy’s basic fundamentals remain sound, which in his word’s should allow for “strategic composure.” Translation: there is no need to panic about longer term prospects due to the recent deceleration.

¹¹ An unsustainable spike in exports to Russia was a contributor to this stunning outcome for ICE vehicles.

¹² These figures are exports produced in the country. Japanese auto sales produced by affiliates abroad dwarfs their direct export numbers. Of the approximate 24 million sales of Japanese auto makers in 2022, 70% were foreign affiliates, 17% were domestic and 13% were traditional exports. So, while China may be the largest exporter now, but it is still far from being the larger seller of cars in foreign markets.



We broadly agree with that, noting that the 14th 5YP projected a +4.7% compound annual growth rate (CAGR) for real GDP out to 2035. Our view is that the inferred GDP per capita level implied by this growth assumption is a plausible objective (including the impacts of the latest demographic projections referenced above), but that the growth arc will not resemble a steady CAGR.

In our opinion it is very unlikely that China will still be achieving annual growth rates as high as +4.7% in the middle of the 2030s. In fact, anything in the 4s would be a considerable stretch. Our mid case point estimates for growth in 2035 and 2050 are (rounded) +3½% and +1½% respectively. But such is the underlying scale of the economy—in 2035 China will be roughly the same size as the US, India, Europe, and Japan put together today—+3½% growth in that year would be equivalent to \$1¼ trillion of incremental new activity (PPP terms). That is roughly double the annual incremental change that China produced in the high-speed growth era of the mid-to-late 2000s. \$1¼ trillion of incremental new activity is also big enough to produce the equivalent of a new G20 member annually, being larger than the entire economies (in 2019) of Canada, Saudi Arabia, Australia, Thailand, Egypt, and Spain, just to name a few.

Knowledge of that arithmetic is part of the reason why we are not perturbed that percentage rates of growth are bound to slow down. China is expected to remain the largest incremental volume contributor to global industrial value-added and fixed investment activity through the 2020s and many decades beyond: not just GDP.



We estimate that China's incremental volume contribution to the world economy in the year 2050 will be roughly the same as what it averaged in the 2010s, despite the sub-2% growth rate that we anticipate.

Demographics of course will be a more important factor by 2050, where we estimate a direct 1.6ppt drag on the world economy from population pressures in that year (prior to any adjustments to working hours or productivity assumptions), with China the major factor on the negative side. India, by the by, is adding 0.3ppt on the positive side.

As of 2022, China was about one-third as wealthy as the United States per capita, ranking 66th in the world. It also has the world's 25th or 17th most "complex" economy (depending upon which organisational measure you prefer¹³) and the world's 29th most competitive economy, according to the World Economic Forum. The World Intellectual Property Organisation ranks China #11 in its Global Innovation Index. The World Bank ranks China #20 for the quality of its logistics infrastructure. China has also joined the top ranks of countries in terms of both the quantity and quality of scientific publications, it has emerged as an artificial intelligence "superpower," it has more industrial robots than any other country and it is home to around one-third of the world's 500 most powerful supercomputers. China also spends more on experimental R&D than any other country, it now produces almost as many science and engineering PhD graduates as the United States, while a subset of Chinese fifteen-year-olds have achieved the highest scores in the world in the OECD's standardised reading, maths, and science "PISA" tests.

The outlying rank in the above rendering is the first one: 66th. That does not trivialise the challenges the economy presently faces, including the complexity of the geopolitical environment, issues of inequality and governance, and the urgent need for fiscal reform: a task that has been on the to-do list for more than a decade. Our basic contention is that there is more signal than noise in the catalogue of wide-ranging measures of current and prospective capability outlined above. Based on their combined weight we assess that China's most likely long-run pathway (noting there is considerable uncertainty in any long-term projection and our planning range

is wide) is to ultimately achieve a relative average living standard similar to those economies currently sitting on the fringes of the high-income bracket. In quantitative terms that means something between one-half and three-fifths of US GDP per capita levels, with perhaps two-thirds at the upper end of the range. China's policymakers certainly have a long list of issues confronting them in the near- and long-term, but the nation also has considerable strengths that are unique for a middle-income economy: meaning China's chance of achieving "borderline" high-income status is sound—but not overwhelming.

Finally, we note that while long-term forecasts on the horizons we are considering here are not abundant, a small number of credible scholars and organisations have attempted to predict China's absolute and relative GDP per capita level at mid-century, or at the nation's carbon neutrality target year of 2060.

These projections range from 46% to 77% of US living standards, with a mean of 58%.¹⁴ Our planning range fits neatly within these parameters. That gives us confidence that our long-term planning range is built on robust foundations.

¹³ The Observatory of Economic Complexity (with MIT roots) and Harvard's Atlas of Economic Complexity are the two competing sources.

¹⁴ This range should be treated with modest caution, given different weighting systems, different years of publication and the fact that a bullish or bearish disposition towards US growth may bias the relative level assessed for China. We feel though that the information is broadly indicative of the best thinking on this incredibly important topic.



Steel and pig iron

Global steel production reportedly edged up just 0.1% to 1.89 Bt in calendar 2023, according to worldsteel and the official agencies that they rely on for national level data.

On the face of it, that is a weak follow-up to the -4% decline of calendar 2022.¹⁵ While that assessment suits the performance of the steel industry in the developed regions, it does not fit well in the populous emerging markets, led by China and India. These two giants were a collective “source of stability” for global commodity demand in calendar 2023, as anticipated, with the steel-making value chain at the centre of that. The disconnect for the developing world comes from the different conclusions that might be drawn from official and alternative measures of production. An alternative measure of Chinese production derived from physical indicators of feedstock consumption and survey data on capacity utilisation would add around 30 Mt to the official figures, raising the world steel growth rate to around +1½%. This theme is relevant for pig iron as well.

What we can say with certainty is that China recorded a 5th consecutive year of crude steel production above 1 billion tonnes, on the back of solid demand in non-housing end-use sectors and a material jump in net exports to a seven-year high. India produced another strong year, with crude steel production of 140 Mt, up around +12% YoY and +40% since the beginning of the decade. Ex-China and India (a new sub-aggregate you will begin to see more regularly from us) production declined -1.8% YoY in calendar 2023, which is a weak follow-up after a -8% outcome in calendar 2022. Production of crude steel by this group is now -6% from calendar year 2019, with pig iron down even more, at -11%. Speaking of pig iron, the precise global figure for calendar 2023 of 1.31 Bt, +0.6% YoY. Adjusted for the extremely high rates of blast furnace (BF) utilisation observed in China throughout the year, there is a case to be made that it could actually be 3-4% YoY.

China’s BF utilisation rate averaged a robust 88% in the first half of calendar 2023, and 90% exactly in the second half, hitting 89.1% for the full year. That is just 0.7 percentage points below the all-time record. That compares to 84% across calendar 2022 and the peak within the year was a spectacular 93.1%.

BFs have been able to run at such elevated rates for three main reasons. The first has been the weakness of electric-arc furnace (EAF) production for most of the year. EAFs were constrained by a lack of competitiveness, weak demand for commodity construction steels, scrap feedstock availability and a loss of profitability. Apparent demand for long steel declined by -9% YoY in calendar 2023, and -14% YoY in the second half alone, reflecting for the most part weak housing starts, as described in the Chinese economy chapter. The second was the availability of global export markets as a safety valve for supply in excess of domestic requirements, with the run-rate for exports increasing by around 30 Mtpa in the first half of calendar 2023 versus the full year 2022. The third was the relatively resilient performance of flat steels, where apparent demand has increased by +2% YoY, and +3.2% YoY in the second half alone. This growth was the result of a respectable performance by manufacturing end-use sectors (of which more below). Blast Furnace-Basic Oxygen Furnaces (BF-BOFs) with the optionality to change their product mix took advantage in calendar 2023.

Realised margins for Chinese steelmakers were poor throughout calendar 2023. In the first three quarters of calendar 2023, EAFs continued to endure consistent losses, while BF operators were just above break-even on average, with the most sophisticated operators with higher exposure to less-commoditised products, and/or manufacturing end-use, doing a little better (with inland BFs producing construction steels joining EAFs in making losses). EAF margins turned positive in the December quarter, as scrap-economics improved for the first time in a while.

We estimate that BF-BOF spot margins averaged around +\$7/t in calendar 2022, but they fell to -\$6/t in calendar 2023. A curiosity in this period of weak profitability is that the intra-year inventory cycle for finished steel has returned to pre-pandemic norms in calendar 2023. Earlier in the pandemic, BF-BOF steelmakers were forced to consume working capital by building stocks through lockdown periods, having to trust that demand would be

there on the other side. That produced abnormally large stock builds, sometimes out of the regular seasonal pattern. It does feel odd that a successful return to a leaner finished inventory strategy has occurred without an improvement in profit.

The end-use demand picture for Chinese steel in calendar 2023 was a combination of pronounced weakness in housing starts, strength in infrastructure, mixed outcomes for machinery (construction machinery weak, power machinery strong, machine tools in the middle), solid outcomes for transport (autos and shipbuilding) and consumer goods (e.g., washing machines), and weaker metal goods (e.g., shipping containers). There was no major shift in composition across the two halves of the calendar year. Key sectoral trends are discussed in detail in the Chinese economy chapter. From a steel point of view, the most important forward-looking considerations remain:

1. the pace, scale, and composition of the housing construction recovery,
2. the steel intensity of the same (e.g. a housing start is more important than a project completion, and a commercial dwelling has more floor space than standard public housing and contains more steel than a rural dwelling),
3. the response of machinery demand to the anticipated mix of activity in associated sectors, and
4. whether the tentative signs of stabilising external demand for steel-containing goods builds further momentum. Note that the infrastructure upswing still feels well entrenched and is a solid foundation on which to build the remainder of the forecast.

We estimate that net exports of steel-contained finished goods (such as wind turbines or earth-moving machinery) account for around 12% of Chinese apparent steel demand, on average. That is a lower degree of external exposure than, say, Japan or Germany, where the number is about one-fifth. An additional 4-8% of Chinese production has been exported directly in the last three years, with the top of that range being in play in calendar 2023.¹⁶ The direct trade surplus in steel has fluctuated widely since the

15 Data on steel and pig iron in this chapter are from WorldSteel and official agencies, unless specified otherwise. Some growth rates have been rounded and historical figures have been revised since our previous version of this report.

16 Note that the net exports increased to around 12% of production in 2015 and 2016, circa 100 Mtpa, on a much smaller production base than today. That spike in exports was a sign of stress, not strength.

pandemic began, both seasonally and year-to-year. In calendar 2022, net exports were +54 Mt, up from a +41 Mt outcome in the prior year, and +17 Mt in calendar 2020, a period when China was a net importer in some months. Calendar 2023 saw a large step up to +87 Mt, with multiple months above +90 Mt, with a peak of +98 Mtpa. That level of exports is a source of unease in the global industry. Add that to the desire of the Chinese authorities to keep production at a reasonable level, and a lower net export run-rate in calendar 2024 seems more likely than maintaining a pace of +80-90 Mtpa. Counter to that, the incentive to export from a price perspective has actually increased with rallies in other major regions. Our starting point is thus for a decline in exports, but to a level

midway between the 2022 and 2023 outcomes, not a decline all the way back to the +40-60 Mt range.

Moving away from the historical, our preliminary take on total Chinese crude steel production in calendar 2024 (incorporating the net export logic outlined above) is that the current five-year streak (2019-2023) of outcomes in the 1.0 to 1.1 Bt plateau range is likely to extend to six. We anticipate that underlying production as derived from feedstock consumption and surveyed utilisation rates will fall around the middle of that range. The official statistics may reflect something similar, or they may indicate a broadly flat outcome from the 1.019 Bt reported for calendar 2022.

The key caveat on the outlook for Chinese steel, as it has been for some years now, is the annual status of mandated production cuts. Each and every year, the breadth, timing, and severity of any prospective cuts are uncertain.



In calendar 2023, with Chinese steel production hitting an extremely robust 1080 Mtpa in the first half of calendar 2023 (the all-time high for a full year is 1065 Mtpa in 2020), and with the half closing with a 1109 Mtpa pace in June, market chatter on cuts built up steam in the September quarter. At the time of our annual results for financial year 2023, we reported that some regions and cities were rumoured to have issued verbal guidelines to local mills, that one smaller province had officially announced a cap, and rumours of a nationwide edict were also swirling. And then ... nothing concrete was announced. As the year wore on with no announcement, and no real let up in BF utilisation, the steel-making value chain progressively realised that a top-down impost was becoming increasingly unlikely due to the impossibility of slowing production sharply enough to meet a zero-growth objective. That pushed the speculative money from short to long, and also encouraged the steel mills themselves to restock, as they had been running a very lean raw material inventory position, partly due to uncertainty on the mandate. So, calendar 2023 ended up as a “Godot never came” year. No one knows what calendar 2024 will bring on this front. We will revisit this issue again in the iron ore chapter.



Turning to the long-term, we firmly believe that, by mid-century, China will increase its accumulated stock of steel in use, which is around 9 tonnes per capita, by between 1½ and 1¾ times on its way to an urbanisation rate of around 80% and living standards similar to those of nations currently on the fringe of the high-income bracket.

China’s current stock is still well below the current US level of around 12 tonnes per capita. Germany, South Korea, and Japan, which all share important points of commonality with China in terms of development strategy, industry structure, economic geography, and demography, have even higher stocks than the US.

The exact trajectory of annual production run-rates that will achieve this near doubling of the stock is uncertain. Our base case remains that Chinese steel production is in a plateau phase, with the literal peak likely to be the cyclical high achieved in this period (with 1.065 Bt in 2020 being the “clubhouse leader” in golfing terms). Identifying the literal peak year and level precisely is merely a tactical question from today’s vantage point. Strategically, the plateau can be usefully thought of as a range from 1.0 to 1.1 Btpa, with cyclical and policy driven year-to-year fluctuations contained within those general boundaries.

Increasing scrap availability is a powerful lever at the Chinese steel industry’s disposal as it seeks to contribute to the national objective of carbon neutrality by 2060. We estimate that the growing stock described above will create a flow of potential end-of-life scrap sufficient to enable a doubling of China’s current scrap-to-steel ratio of around 22% by mid-century. The official target of a scrap-to-steel ratio of 30% by 2025 is thus directionally sound, notwithstanding the fact it is more aggressive than our internal estimates. Uncertainty regarding the future availability of imported scrap makes China’s official targets a little more challenging, while the anticipated rebound of domestic supply from the constrained availability of the pandemic era has been underwhelming to date.

Beyond the considerable passive abatement opportunities available to it, of which scrap availability is the largest, the decarbonisation choices of Chinese steel mills will be determined by the age of their integrated steel making facilities, the policy framework they are presented with, developments in the external environment impacting upon Chinese competitiveness, and the rate at which transitional and alternative steel making technologies develop.

We have noted considerable interest in the novel (for the iron-steel complex) electric-smelter furnace (ESF) from our global customers, including those in China. This interest is being turned into initial action as steel producers in Europe, South Korea, and Australia have now included this technology in their 2030 plans and/or longer-term decarbonisation pathway options. Subject to successful pilots, such as the potential for our collaboration with Rio Tinto and BlueScope Steel [announced in February 2024](#), we expect these initial projects will catalyse industry growth.

Some of the advantages of the ESF versus the more established EAF, which is designed for scrap, are its greater flexibility in accommodating medium and lower grade ores through the Direct Reduced Iron (DRI) route, and its ability to be physically incorporated into an existing integrated facility to feed a basic oxygen furnace. You can read more about the ESF from our technical experts [here](#).

Iron ore

In the first half of financial year 2024 iron ore prices (62%, CFR, Argus) averaged \$121/dmt, with the price ranging between \$103/dmt and \$142/dmt. Prices were +3% versus the second half of financial 2023, and +20% YoY. The average lump premium was \$0.18/dmtu in the second half of financial year 2023, +5 cents from the prior half.

Iron ore Fe 62% CFR (US\$/t)

FY19	FY20	FY21	FY22	FY23	H1 FY24
80	93	154	138	109	121
5-Year Period High: 236 (FY21); Period Low: 62 (FY19)					+20% YoY

Rarely has the performance of a major commodity price confounded so many. Neither the resilience of the iron ore price across the full 2023 calendar year, when it did not fall below \$100/t on an average basis in any month, or the steep price appreciation towards \$140/t late in the year, accorded with the general narrative on the Chinese economy that dominated media commentary and investor discourse.

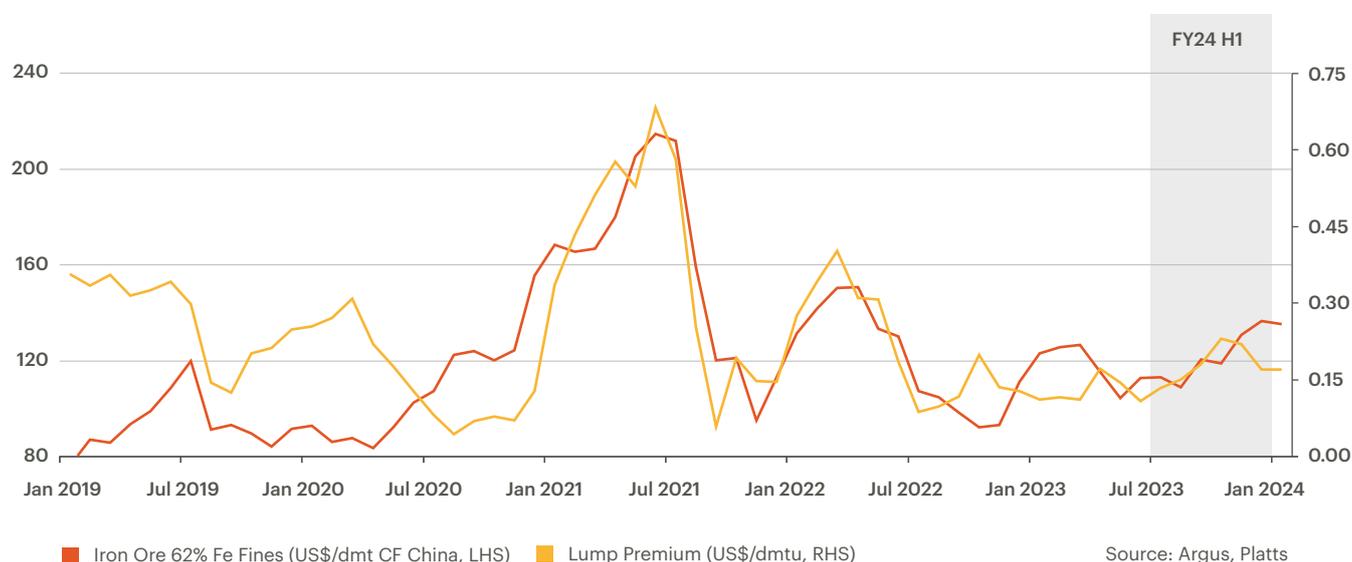
The second half performance was the “unlooked-for rally” *par excellence*—and in its initial phases, we were surprised too. The simple caricature of the Chinese economic situation—that the housing downturn superseded everything else—was grounded in the reality of real estate distress, but it also glossed over a n enormous amount of pertinent information for the commodity markets.

What careful observers of the economy and the steelmaking value chain saw in calendar 2023 were:

- strength in a broad range of non-housing activities that are collectively very important for steel demand
- the fact that over the course of this multi-year downturn commercial housing had shrunk appreciably in terms of its total share of steel end-use, and therefore even with profound weakness in property, it was becoming a less influential swing factor in the overall balance
- a near-record overall run-rate for crude steel (measured in various ways) was sustained for most of the year, and BF mills gained share within that, allowing for extremely high utilisation rates
- these high utilisation rates led to consistently strong port outflows of iron ore
- these outflows, and limited incremental supply from low-cost seaborne exporters, contributed to a steady trend decline in iron ore port stocks from 142 Mt in late February 2023 down to a new record low of 108 Mt after the Golden Week mill restocking in early October. After the usual seasonal lift in the final few months, the overall change in port stocks for the full calendar year was -12 Mt YoY, despite a record year for imports and +10 Mt YoY from Chinese domestic production
- the record year for imports was made possible by a +57 Mt increase in higher-cost and swing supply, which thickens the cost support membrane even further (see below).

Iron ore prices

(monthly spot average)



All of the above (acknowledging the at times fractured chronology in the storytelling) built up to a level of considerable nervousness that steel production had been doing a little too well, and that draconian top-down cuts from the Centre would be required intra-year to:

- a. respect the zero-growth mandate, which mills were apparently front-running,
- b. help restore profitability, as margins were poor throughout the year, and
- c. help contain the surge in net exports that was building up a head of steam around mid-year, and was becoming yet another source of international trade tension for the authorities to manage.

A decisive intervention from the authorities had the potential to create a sudden stop in raw material demand à la the September quarter of 2021, when iron ore prices halved in a matter of weeks. This issue hung over the market like a black cloud through the September quarter of 2023. However, the highly credible threat ultimately didn't come to pass, the industry specific fundamentals were sound, and China's policymakers had lifted macro sentiment a little with pro-growth rhetoric and the announcement of a range of policies which, if effectively implemented, would improve conditions in steel end-use sectors. The speculative flip from short-to-long in the investor community gave the price some momentum, and the physical fundamentals justified a price with a decent premium above cost support. And, of course, the mills themselves, once they realised that a central mandate was unlikely, could restock with more freedom—and many had quite a bit of ground to make up quickly, having let their coverage days run down to historically unprecedented levels.

For all the excitement over the rally late in the year, market behaviour when the price was under downward pressure in the June quarter of 2023 is equally worthy of comment.

Once again, price dynamics underscored the utility of real-time estimates of cost support as a vehicle for understanding short-term developments in the iron ore market. Our estimate of this important metric remains \$80–100/t CFR. In the second half of calendar 2022, there was a stern test of the bottom end of this range, with prices ultimately bottoming at \$79/t. In the first half of calendar 2023, with generally firmer fundamentals than in the prior half, the top end of that range proved to be an effective guide to where price dips would bottom out. We observed marginal seaborne supply coming under pressure when prices approached \$100/t, with any dips below that threshold unable to persist for any meaningful length of time. That framing held up well through the second half of calendar 2023 also.

The reliability of this range during this phase in the history of the iron ore industry is partly due to the fact there are three differentiated envelopes of supply contributing to a relatively dense shield of cost support in this region: higher-cost juniors in traditional basins, the shoulder of the Chinese domestic mine cost curve and lower-grade Indian exports. Why is this the case? As we argued at the Western Australia Iron Ore (WAIO) site visit in October 2022, there have been a series of unexpected developments in the industry since late 2018 that have produced a fundamental balance that is more dependent on swing supply than was thought possible from the perspective of the pre-Brumadinho world.¹⁷

It is useful to remember that just five years ago, in the midst of the US-China trade war, expectations for the iron ore industry were subdued.

In terms of our own views, we agreed with much of the stylised consensus position at this time, with the key exception of demand, where we have been consistently more positive than most since the mid-2010s—reflecting in large part our long-held (and accurate) views on the timing and level of China's steel production plateau.

Half a decade ago, the consensus outlook for iron ore was that demand would be modest, low-cost seaborne supply from the major basins would increase, higher-cost supply would be progressively squeezed out, the cost curve would flatten, and prices would soften. In reality the opposite has happened on every score.

Using Wood Mackenzie's forecasts published in the September quarter of 2018 for the state of the industry in 2023 as a proxy for market consensus, we note that actual contestable demand in 2023 was +187 Mt higher than expected five years ago. Major seaborne producers collectively exported –30 Mt less than was expected. And rather than being squeezed out, higher-cost producers increased total production by an enormous +188 Mt—essentially enough to constitute a new “major.” Those figures also imply an inventory draw over the period, whereas the original expectation was that inventory would build over this period, and quite substantially so.¹⁸

Comparing actuals for calendar 2021 and 2023 now, the major seaborne producers have collectively increased supply by only +12 Mt over the two years, while contestable demand has increased by +45 Mt, essentially quadrupling that. Ergo, there has been an increase in the aggregate call on higher-cost supply (net of the work being done by destocking), and hence we return to the original observation that the wedges of supply that currently underpin the \$80–100/t cost support range feel like they are firmly in place while the current constellation of demand and low-cost supply fundamentals persists.

¹⁷ The tragic Brumadinho tailings dam collapse occurred in the south-eastern Brazilian state of Minas Gerais in January 2019. With hindsight, it has been revealed as a key inflection point for the iron ore market.

¹⁸ The comparisons are made with the 2018 Q3 forecast. We first presented analysis along these lines in late calendar 2022, with the end point being 2021 actuals. This analysis is updated for two extra years of activity, but the story remains strikingly similar. The 2023 levels from which the changes in the text are derived are as follows: contestable demand 1860 Mt (actual) versus 1696 Mt (forecast). Low-cost major supply was 1315 Mt (actual) versus 1349 Mt (forecast) and the rest (including Chinese domestic, junior producers and swing exporters) was 559 Mt (actual) versus 392 Mt (forecast). The forecast change in industry-wide stocks was +45 Mt. The actual change in stocks (inferred) has been –14 Mt.

Here it is important to note that the supply–demand fundamentals of this era define *who* is likely to be a marginal source of tonnes, but not precisely what those tonnes will cost on a 62% CFR equivalent basis. Mining input costs, exchange rates, freight rates and product differentials can fluctuate markedly in a short space of time for reasons that may not be directly related to the industry mass balance *per se*. We have explained the dynamics of this feedback loop on multiple occasions, with an emphasis on two of the more sensitive and volatile factors: freight rates and product differentials. With product differentials and freight lacking volatility (by their own standards) across calendar year 2023, cost support estimates were steady. But it was not so long ago that real–time cost support was estimated to be in the \$120–130/t range, with buoyant steel margins, elevated freight rates and large discounts for lower–grade producers combining to lift the incentive price for swing producers to keep shipping. In that regard, 58% Fe iron ore discounts have been known to trade as wide as ~40% of the 62% base price. With products even lower than 58% on the Fe spectrum actively traded, and the current 58% discount being close to 10% in the current weak margin environment for steelmakers, it is easy to see how quickly the incentive price

might steepen under propitious operating conditions for Chinese steel mills.

Looking out a few years we consider the entry of new, higher–grade supply from the Simandou project in Guinea to be a near certainty, with first tonnes likely to come no later than the final third of the decade. Additional tonnes are likely to come out of the major basins as well, including the plans and studies that BHP has outlined. We also note the ambitions of the Chinese domestic iron ore industry to increase production materially, while the scrap–to–steel in China is also assumed to be heading consistently higher—*notwithstanding* the struggles that the scrap industry (and their EAF customers) has endured in the zero–COVID era and its immediate aftermath. China’s domestic mining ambitions, as enshrined in the “Cornerstone Plan” have been trimmed somewhat from the original scoping, but the direction of travel is clear. These developments will go a considerable way towards finally getting back to the future that seemed assured before the poly–shocks that have characterised this industry since 2018 turned the consensus narrative upside down.

In the medium to longer–term, as described in our steel decarbonisation Prospects articles (episodes 2, 3 & 7 in

our *Pathways to Decarbonisation* series) we see higher–quality iron ore fines and direct charge materials such as lump as important abatement sources for the BF steel making route during the optimisation phase of our three–stage [Steel Decarbonisation Framework](#). In China of course, the BF–BOF route represents roughly 90% of steel–making capacity, with the average integrated facility being around 13 years old. BHP’s South Flank project, which achieved first production in May 2021, is expected to maintain WAIO’s average iron ore grade of at least c. 61% (excluding Yandi), in addition to increasing the share of lump in our total output from around one–quarter to around one–third.

Our analysis indicates that the long run price will likely be determined by the all–in 62% equivalent cost base of the least competitive seaborne exporters (higher operating cost and/or lower value–in–use) in either Australia or Brazil. That assessment is robust to the prospective entry of new supply from West Africa, and China prioritising the accelerated development of its domestic resources. This implies that it will be even more important to create competitive advantage and to grow value through driving exceptional operational performance.



Newman, Western Australia

Metallurgical coal

Metallurgical coal price¹⁹ volatility remained a feature of the industry over the last six months, but relative to the dramatic circumstances that emerged as the Ukraine conflict got underway, the magnitude of price changes was modest.

¹⁹ The abbreviations used in the metallurgical coal section are as follows—PLV: Premium Low-Volatile, MV64: Mid-Volatile 64, PCI: Pulverised Coal Injection, SSCC: Semi-soft Coking Coal, as published by Platts. Unless specified otherwise, figures are rounded to the nearest dollar and are quoted in free-on-board (FOB) terms. The terms “coking” and “metallurgical” coal are used interchangeably throughout the text. Note that the PLV index is used as a benchmark for “premium hard coking coals” (PHCCs), which also comprise PMVs (premium mid vol, generally traded at a discount to the PLV index), as well as PLVs.



Met Coal PLV FOB (US\$/t)

FY19	FY20	FY21	FY22	FY23	H1 FY24
205	144	122	380	279	299
5-Year Period High: 671 (FY22); Period Low: 97 (FY21)					+13% YoY

In the first half of financial 2024, the PLV index ranged from a low of \$222/t FOB Australia to a high of around \$367/t, averaging \$299/t. The average was +2% on the prior half, but +13% YoY. The range for PLV was \$146/t wide in the most recent half, versus \$168/t in the prior period. Non-premium Mid-Vol (MV64) has ranged from \$191/t to \$282/t; PCI has ranged from \$155/t to \$208/t; and SSCC has ranged from \$141/t to \$191/t. Following completion of the divestment of the Blackwater and Daunia mines, around 90% of our tonnes will reference the PLV FOB index, approximately, up from around three-quarters pre-divestment.²⁰ And that is materially higher again than it was prior to the divestment of our stake in BMC during the second half of financial year 2022.

The differential between the PLV and MV64 indexes widened to 21% in the first half of financial 2024, up from 11% in the second half of financial 2023, and 9% in the half prior to that. The recent five-year average is 12%.

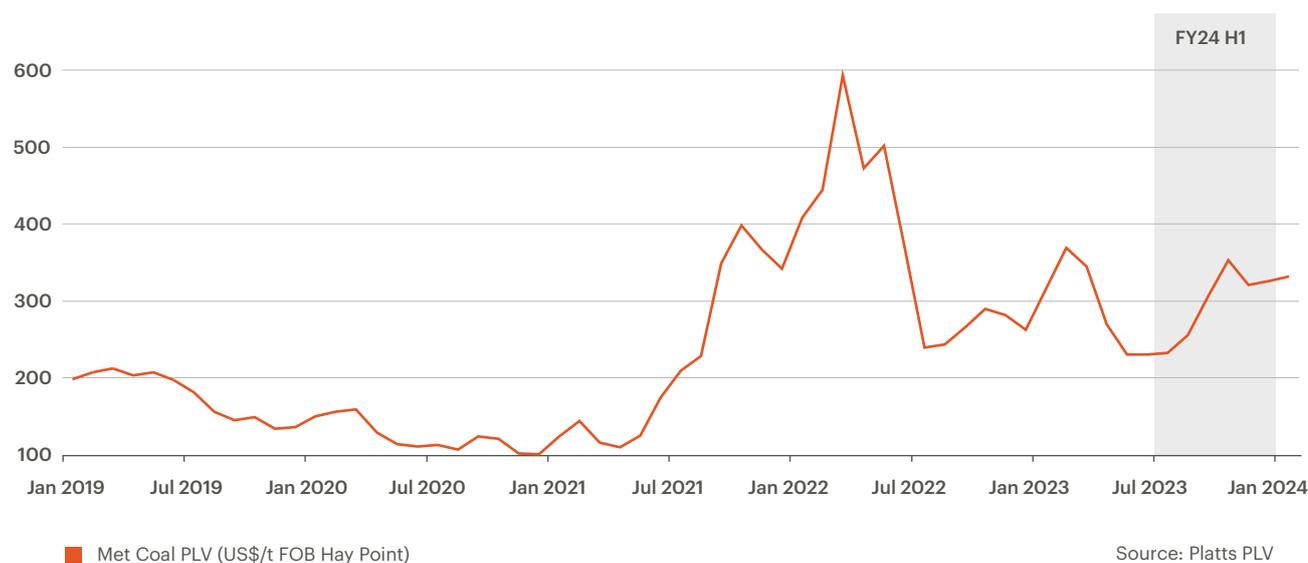
The metallurgical coal industry has experienced both hunger and plenty in the 2020s, with periods of loss-making for some producers in calendar 2020 and the first half of 2021 having given way to fly-up and then scarcity pricing in calendar 2022. While conditions were calmer in calendar 2023, prices remained elevated by historical standards.

A few reporting cycles ago we coined the phrase “multi-region, multi-causal” supply headwinds to capture the industry’s operational struggles in the 2020s, with a focus on the intersection of pandemic-era shortages and bottlenecks, three consecutive La Nina weather patterns as well as the string of idiosyncratic issues that beset individual assets across all major export nodes. We dropped that phrase six months ago with an El Nino weather pattern in prospect, but with hindsight this was a premature decision.

Metallurgical coal mines around the world have again struggled to meet guidance in the second half of calendar 2023, a general trend that goes back at least half a decade. The average shortfall versus guidance mid-points among major seaborne exporters in the last five years is about -8½% (a figure that changes modestly to -6¼% when the sample stretches back ten years).

Metallurgical coal prices

(monthly spot average)



²⁰ See footnote 30 for terminology. Note that around two-thirds of our product was in the PHCC technical quality bracket pre-divestment, but three-quarters referenced the PLV index in our contracts. The slide in the results presentation is presented on the former basis, where 86% of production will meet the specifications of PHCC post-divestment.



Goonyella Riverside, Queensland

The “so what” here is that unlike in non-ferrous metals, where the major consultants that help anchor analytical thinking in the finance industry systematically apply blanket disruption factors for the copper and nickel industries in their mass balance forecasts, this is not generally done in bulk commodities—but doing so would have produced a more accurate view of short and medium-term metallurgical coal supply and thus pricing over the last decade if it had been included. With Wood Mackenzie having now incorporated a disruption factor into its met coal methodology, it will be interesting to see if this also impacts upon other industry analysts, both the commodity boutiques and those in the financial sector. Given the scale of the historical shortfalls are material for the mass balance, a staggered diffusion of this methodological change across the analyst community could create an apples-versus-oranges split in the Consensus survey sample.

Moving on to the supply side fundamentals, overall seaborne supply was around 301 Mt in calendar 2022, still -19 Mt behind calendar 2019. That lifted to 310 Mt in calendar 2023, almost closing the gap to pre-pandemic levels. Adding changes in Mongolian

landborne exports to the seaborne mix, total supply was -19 Mt versus 2019 a year ago, but after a record year for Mongolia in calendar 2023, supply was +18 Mt versus 2019. The sum of Chinese imports and ROW seaborne imports also surpassed pre-pandemic levels in calendar 2023.

Looking at the performance of the major regions, both in 2023 and versus 2019, it becomes clear that operational challenges have been multi-regional and enduring. Australian shipments to the seaborne trade saw another decline in calendar 2023, this time to 150 Mt, -30 Mt from the calendar 2019 level. North American exporters saw almost flat YoY tonnages in 2022, and +6 Mt in calendar 2023. Mongolia was logistics constrained through the COVID-19 era, with its 2021 nadir being a meagre 14 Mt of exports. After a solid improvement off that low base in calendar 2022, it accelerated to 54 Mtpa in calendar 2023: +20 Mt versus 2019.

In China, run-of-mine hard coking coal capacity has been allowed to lift from the 2019 trough, the level of which was dictated by supply-side reform mandates. Notably, it appears that the recent increases have raised capacity above 2015 levels: +3% on the most recent estimates. The capacity

increases (and some local regulatory forbearance that has increased effective capacity) put hard coking coal production in the first half calendar 2023 on track for a solid increase. However, safety inspections in the December quarter saw overall production dip slightly into negative territory (-1% YoY for the full calendar year). Production is now around +4% higher than 2019 levels (+14 Mt). The PLV proportion of that though has been relatively flat between 25 Mt and 28 Mt.

Mongolian and Russian sellers who have no or few other major competitive outlets than to sell to China (Mongolia due to geographic reality, Russia due to sanctions/self-sanctioning by alternative buyers) have significantly increased their exports into China. 57 Mt of China's 74 Mt total imports in calendar 2022 (77%) came from these two sources, and 92 Mt of 115 Mt (80%) in calendar 2023. That compares to 33 Mt of 81 Mt in calendar 2020 (41%). Those volumes are likely to be sticky (and attractively priced for profit-challenged Chinese steel mills) and Mongolia could well grow further as logistics improve. This uplift in neighbouring supply is clearly limiting China's call on the seaborne trade.

On the seaborne demand side of the metallurgical coal industry, it was another difficult year for European pig iron, continuing the theme going back to the late 2010s. European pig iron production is -19% in the 2020s so far, with back-to-back declines in calendar 2022 and 2023. In developed Asia, Japanese pig iron contracted -1.7% in calendar 2023, with construction end-use of steel falling and manufacturing end-use relatively flat. In South Korea it was a different story, with growth of 5.1%. We expect some improvement in crude steel production across Europe and Japan in calendar 2024, but pig iron producers may see less of the pick-up than EAF mills. India though had a strong year, with pig iron production expanding by +7.3% YoY. That translated into +4.5% YoY growth in imports (coking coal and PCI), with some of that gap explained by an increase in imports of coke from Southeast Asia.

A year ago, we put forward a framework for thinking about what a resumption of the China-Australia trade might look like. After tabling our view that “As of today, a swift normalisation to pre-ban norms is much less likely than a tentative reset in calendar 2023,” we argued that “While in the medium-term trade flows are likely to converge on the intersection of logistical efficiency and optimised customer blending preferences, it is unclear exactly what the path to the medium-term will look like.” With Chinese imports from Australia hitting a meagre 2.8 Mt in calendar 2023 and competing tonnes from Mongolia and Russia having ramped up considerably, the bridge from the short to the medium term is no more certain than it was a year ago. Against that backdrop, coupled with the reality that India is even more firmly embedded as the largest and fastest growing import region, the likelihood of the seaborne trade eventually clearing in India has certainly increased. Whether that likelihood is now above 50% remains a point of debate.

Longer term, we argue that a policy focus on safety, environmental considerations, and financial sustainability in Chinese coal mining, in addition to the intent to embark upon a decarbonisation path for steel making, should highlight the competitive value of using higher-quality Australian coals in China’s world class fleet of coastal integrated mills. China’s steel industry is still in the optimisation phase of its

decarbonisation journey, in which higher-quality raw materials make a clear difference to the energy and greenhouse gas (GHG) emissions intensity of the BF-BOF route, which accounts for around 90% of Chinese and around 70% of global crude steel production.

In coming years, most committed and prospective new metallurgical coal supply is expected to be mid quality or lower, while industry intelligence implies that some mature assets that have historically produced higher-quality coals are drifting down the quality spectrum as they age.

Additionally, the regulatory environment has become less conducive to long-life capital investment in the world’s premier PHCC basin—Queensland, Australia. The relative supply equation underscores that a potentially durable scarcity premium for true PLV coals is a reasonable starting point for considering medium terms trends in the industry.

The advantages of coking coals at the higher end of the quality spectrum with respect to GHG emissions intensity are an additional factor supporting this overarching industry theme: an advantage that could become increasingly apparent if carbon pricing becomes more pervasive.

The flip side of the burgeoning advantages of PHCC, as derived from the fundamentals discussed above, is that the non-PHCC pool of the industry could face structural value-in-use headwinds in the coming decades.

On the topic of technological disruption, our analysis suggests that blast furnace iron making, which depends on coke made from metallurgical coal, is unlikely to be displaced at scale by emergent technologies for decades. The argument hinges partly on the sheer size of the existing stock of long-lived BF-BOF capacity (70% of global capacity today, average fleet age²¹ of just 13 years in China—the major

producer—and around 18 years in India—the key growth vector for metallurgical coal trade). It also highlights the lack of cost competitiveness and technological readiness (or both) that is expected to inhibit a wide adoption of potentially promising alternative iron and steel making routes, or high-cost abatement levers such as hydrogen iron making and carbon capture, use and storage (CCUS), for a couple of decades at least in the developing world. Notwithstanding the sweet spot in profitability in calendar 2021 under record pricing in many regions, steelmaking is typically a low margin industry where every cent on the cost line counts. Calendar 2023 was a reminder of that fact.

We certainly acknowledge that

- a. PCI could be partially displaced in the BF at some point by a lower carbon fuel, and
- b. the well-established electric arc furnace (EAF) technology, charged with scrap and without any need for metallurgical coal, is likely to be a stern competitor for the BF at scale to the extent that local scrap availability allows. In a decarbonising world, EAFs with reliable scrap supply running on renewable power should be very competitive. We assess that the emerging technologies that are expected to feature in a low carbon end-state for the industry, such as green hydrogen enabled DRI-EAF and DRI-ESF (see discussion in the steel chapter), are some decades away from being deployed at scale. Accordingly, we expect that the industry will need to be a purchaser of carbon credits (as required to meet regulatory or voluntary commitments) for a considerable period even as it positions itself to pursue long run carbon neutrality.

Information on our eight Scope 3 MOUs with China’s *China Baowu*, *HBIS* and *Zenith*, Japan’s *JFE Steel*, South Korea’s *POSCO* and *Hyundai Steel*, India’s *Tata Steel* and European multinational *ArcelorMittal* are available elsewhere on our website.

21 These approximations are based on a sample of mills, not a census. Note a BF is typically relined every 20 years or so.

Copper



Copper prices ranged from \$7,813/t to \$8,721/t (\$3.54/lb to \$3.96/lb) over the first half of financial year 2024, averaging \$8,258 /t (\$3.75/lb).²² The average was around -5% lower than in the prior half but +5% versus the first half of financial year 2023.

²² LME Cash Settlement basis. Daily closes and intra-day lows and highs may differ slightly.

Copper LME Cash (US\$/t)

FY19	FY20	FY21	FY22	FY23	H1 FY24
6,151	5,673	7,944	9,645	8,280	8,258
5-Year Period High: 10,730 (FY22); Period Low: 4,618 (FY20)					+5% YoY

Treatment Charge Fastmarkets (TC—US\$/dmt)

FY19	FY20	FY21	FY22	FY23	H1 FY24
76.1	54.9	38.4	62.4	78.7	81.4
5-Year Period High: 89.2 (FY24); Period Low: 21.9 (FY22, '24*)					+4% YoY

*FY24 low occurred in January-2024, after the close of the H1 FY24 reporting period.

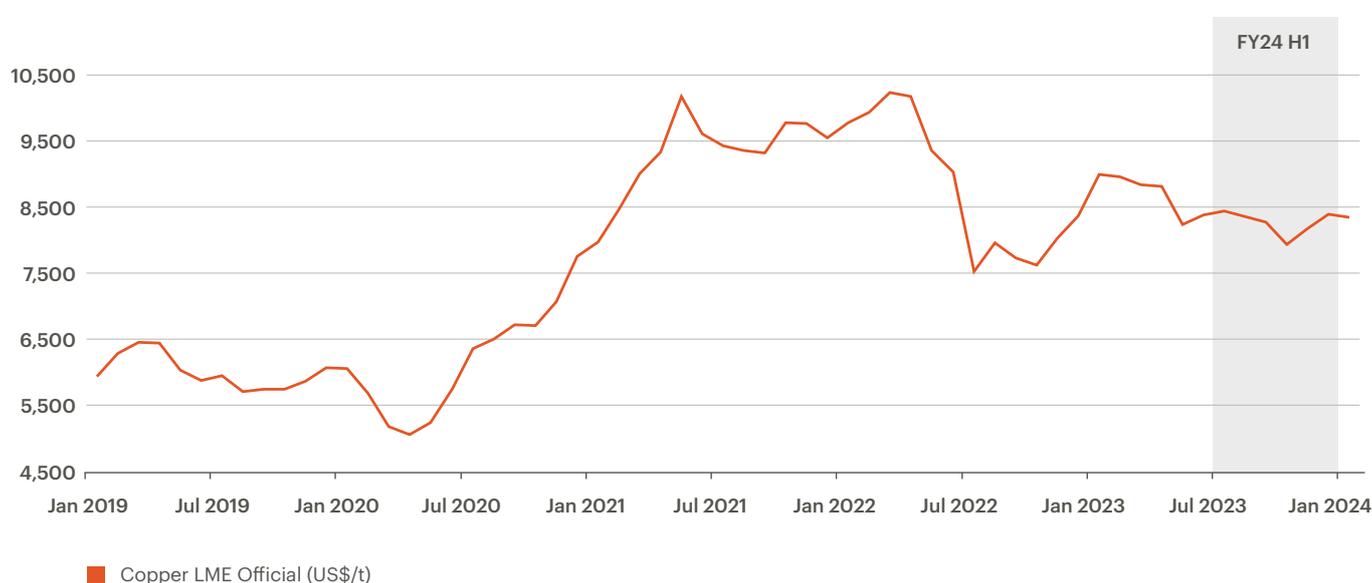
Copper prices were narrowly range-bound for the last half-year, with the highs and lows of the 2021–2022 calendar years untested in the period. That was not for a lack of potential price drivers, with a string of pertinent macro and industry specific news flow. What the relative lack of volatility in copper prices reflected was actually the offsetting nature of the “three Rs” framework: where the prospect of inflation–interest rate relief and the reality of soft commodity demand in the developed world perpetually jockeyed for attention, while the China dynamic oscillated between solid physical copper demand signals, a series of pro-growth policy announcements and the grind of disappointing signals from the real estate sector reflecting less than fully effective transmission of those policies. The balance of this information did not produce an unambiguous

directional view that would justify a breakout from the range in one direction or the other—noting that low inventories and underwhelming operational performance were defences against the downside in any case. The fact that Chinese and developed world physical demand signals were pointing in opposite directions, partly due to the perceived disconnect between the macro rhetoric on China and the reality of robust copper demand, added to the air of indecision. Even late in calendar 2023, the combination of a material downward adjustment in the supply landscape (which in our view flips the expected calendar 2024 refined mass balance to a deficit) and a turn in global macro sentiment led by a prospective turn in the US monetary policy stance, were insufficient to establish a new high for the year.

It is the nature of the copper industry that the base price narrative for any given period can sometimes be told without direct reference to industry-specific fundamentals. That is not the case for spot treatment and refining charges (TCRCs) for copper concentrates [four-fifths of primary production], where physical fundamentals are undiluted in price formation. After drifting upwards through much of calendar 2023, with a modest surplus of concentrate having emerged, the combination of the court-ordered cessation of mining at Cobre Panama (an operation guiding to production of around 370–400 ktpa prior to the closure), and a major downgrade to medium-term production guidance by a top 10 producer in early December, allied to the known factor of a steep and imminent increase in new smelting capacity in China, saw spot

Copper prices

(monthly spot average)





Olympic Dam, South Australia

TCRCs plunge towards record lows (lows being to the benefit of the miner, not the smelter). Whether or not the base refined price and cathode premia follow this signal in the first half of calendar 2024 by breaking out of the current range to the topside remains to be seen.



Industry participants have been challenged to distinguish between signal and noise amidst the negative sentiment directed towards the general Chinese economy, declining YoY imports of unwrought copper and less predictable CIF premia in Shanghai, and the reality that the most copper-intensive parts of the industrial system were doing extremely well, with end-use increasing around +6½% YoY in calendar 2023, even as inflows relating to financing demand cratered²³ and net exports of semis continued.

It is the physical segment that interests us the most of course, and so it is Chinese end-use that we tend to focus on. Six months ago, we recounted the broad-based uplift in demand across sectors observed in the first half of calendar 2023. That put an end to the dichotomy of calendar 2022, whereby between end-uses facing the traditional economy and end-uses leveraged to the energy transition were on different trajectories. In calendar 2023 energy transition demand remained strong, and the majority of the traditional sectors moved into the plus column. The standouts have been construction (where the “housing delivery” mantra has seen copper-intensive completions jump +17% YoY, in stark contrast to the still very weak starts situation that has weighed on steel profitability, if not production), air-conditioners (+13.5% YoY, while white goods also saw double digit growth), NEVs (which rebounded quickly after a short de-stocking cycle in early calendar 2023) and power infrastructure (a combination of decarbonisation technology and conventional grid and generation outlays). Within the broad power infrastructure category, investment in the grid (around 18% of total end-use) was +5.4% YoY (outstripping the State Grid annual budget of +4%), and power source investment was up around +30% YoY.

Wind and solar together saw 293 gigawatts installed in calendar 2023 (three-quarters from solar, one-quarter from wind), with solar surpassing hydro as China’s second largest power source by capacity within the year.

Tracking China’s renewables build-out requires a constant search for new superlatives and jaw dropping comparisons.

At the time of our full year results in August 2023, we noted that the 101 gigawatts installed in the first six months of calendar 2023 was roughly equal to the total hydro capacity that the United States has built up over the last century or so. A suitable analogue for the 293 gigawatts? **The total installed wind and solar capacity of the US at the beginning of the year.** In other words, the flow of new wind and solar capacity in China was equivalent to the stock in the second largest energy consumer, whose energy use per capita is more than double China’s, who has been building wind farms for about half-a-century, who pioneered concessional feed-in-tariffs for solar power in the Carter Presidency, and who also just brought in landmark legislation (the IRA) to speed its own energy transition. Incredible.

23 A decade ago, stocks in Chinese bonded warehouses reached 1 Mt. At the end of January-2024, there was less than 10 kt.

For more on the energy transition activities in China and around the world, please see the dedicated chapter.

In the ROW, refined demand struggled in calendar 2022 and weakened further in calendar 2023. The major OECD regions (about 30% of global demand—defined here as Europe, North America and developed Asia) registered a second consecutive annual contraction in calendar 2023, which offset strength in India (+11.4% YoY, but only 3% of global refined demand) and resilience in the remainder of the developing world (+0.7% YoY, 14% of total). The total ex-China outcome was -1.5%. Total refined copper demand in calendar 2023 then rose by around 2½%, or ~600 kt.

With Chinese demand up strongly, and the ROW moving backwards, the latter's share of world refined demand is expected fall -2 percentage points from the calendar 2022 level, to around 44%.

Total refined copper demand in calendar 2023 then rose by around 2½%, or ~600 kt.

On the supply side of the industry, with operational disruptions relative to guidance tracking towards -6% for the full calendar year in our estimation, the modest surplus we projected at the outset of calendar 2023 is now likely to be a small deficit. We hedged our bets on the surplus call at the halfway point of the year, reflecting both demand outperformance in China and negative signposts on supply. But we hedged for a potential balance, not for a deficit. Total mine supply looks likely to increase just +1% YoY in calendar 2023, (around +220 kt), and secondary supply of copper into refined production is on track for something a little more than that (around +250 kt), a turnaround from the weak -190 kt outcome of calendar 2022. As discussed above, with Cobre Panama offline from the outset of calendar 2024, and some lower guidance elsewhere in the system, supply is unlikely to keep pace with projected demand in the coming twelve months unless disruption factors plunge well below average (i.e. operational performance versus guidance snaps back to where it was in the late 2010s). And that judgement holds despite the expectation that the African Copperbelt will see another year of strong growth and various other regions are anticipating a bounce back.

Turning to the outlook, a long-awaited cluster of projects (including in Peru, Chile, central Africa, and Mongolia) have either recently come online or are expected to do so by the end of 2024. While there have been a range of problems encountered delivering and ramping-up projects through the pandemic, when the dust settles, we expect mine supply will have lifted by around +8½% from calendar 2021 levels by the end of calendar 2024, which compares to an estimate of +12% just six months ago. So rather than easily covering the +7% increase in global refined demand expected over the same period (China -11%, ROW ~2¼%—and noting that 2021 was a deficit year, so supply was already behind the game in the base period), the theoretical call on scrap in the refined space is now going to go up in calendar 2024, not down. However, the much-anticipated bounce in scrap collection (and thus availability) post zero-COVID has been underwhelming to date, with calendar 2023 barely regaining the ground lost in calendar 2022. Global secondary supply into refined copper (3.65 Mt in a 25.3 Mt refined industry in calendar 2023)²⁴ is now expected to be +6¼% higher in calendar 2024 than in 2021. Like our mine supply assumptions, that is materially lower than our prior base case.

The supply side challenges described above have altered our thinking on what the middle third of the 2020s will look like for copper, with profound implications for the final third.

Previously, we envisaged the middle third of the 2020s as an opportunity for the industry to build a modest inventory buffer on the back of a run of small surpluses. The projected accumulation of stocks over this period was certainly not enough to absorb the major deficits we thought were likely to occur in the final third of the decade, but they were better than nothing and could at least mitigate price volatility for a time. Now, with both calendar 2023 and calendar 2024 presenting as deficits, whither the buffer? The answer is that it is no longer there, even with a modest surplus projected for calendar 2025. The durable inducement pricing regime previously expected to emerge in the final third of the 2020s could well come forward under these circumstances, with the pronounced deficits we envisage in the copper industry's medium-term future looming.

These expected deficits are a joint function of historical under-investment in new primary supply and geological headwinds at existing operations intersecting with the “take-off” of demand from copper-intensive energy transition spending that we expect will be a key feature of global industry dynamics as the final third of the 2020s arrives—if not earlier.

Our confidence in medium term deficits is underpinned by both the demand and supply side, but if forced to elevate one over the other, supply headwinds would be the #1 motive force. Simply put, the supply response to supportive demand and price signals in the 2020s to date has been underwhelming, despite copper's future-facing halo effect. And time is running very, very short to turn that story around.

It is quite apparent that there is a very substantial disconnect between what needs to be done at the macro level to support both rising traditional demand and the exponential lift in metal needs implied by the energy transition, and what is occurring at a micro level.

We have previously highlighted that according to data from S&P Global Market Intelligence, if we distinguish between sustaining and development capital among specialised copper miners, spending was apportioned 70:30 in calendar 2022 (sustaining being the larger figure). The average share going back to 1991 is a more balanced 59:41. These ratios tell a story of sustaining capex cannibalising the budget at a corporate level, which is an intuitive outcome in an industry with an ageing asset base in the major regions. It also begs the question: how affordable is a major growth push for the sector at large?

²⁴ Note that scrap is also used directly by copper semi producers, and these copper units are outside the refined balance. The total scrap share of copper semis in calendar 2023 is estimated to be just short of 31% (-19 percentage point from direct use in semis production, -12 percentage points from use in refined production).



In terms of hard numbers, we have previously divulged that in a plausible upside case for demand, the world would require approximately 10 Mt of supply by 2030 (7 Mt to meet growth and 3 Mt to offset projected decline at existing operations).

We estimate that the cumulative industry wide growth capex bill out to 2030 to bring 10 Mt of copper production online could reach one-quarter of a trillion dollars. Updated analysis, including both volume assumptions and cost estimates, indicates that this could well be an under-estimate. How much new capacity was formally sanctioned in calendar 2023? 340 kt.

How big is the cumulative capex bill as a financing objective? It is very large relative to the copper value chain and the financial resource of individual companies. But looking at it another way, it is small versus the investment currently being directed towards upstream fossil fuel production (oil, gas, and coal) which is currently around \$650 billion annually (or \$6½ trillion in a decade). It is remarkable to consider that the redirection of just a small percentage of the funds currently servicing the traditional energy system could turn the copper industry's capital mountain into a molehill. Food for thought.

A primary focus on financing though presumes that the projects are ready and waiting and funding is the bottleneck. The reality is more complex. The industry's collective set of development options is modest by comparison with prior decades, with the well-known lack of discoveries, the depth and complexity of what has been found, and the lengthening catalogue of above ground risks and regulatory hurdles that confront project developers all add to the challenges of bringing additional copper to end-users in a timely fashion. Technological

progress can help at the margin to improve the productivity of existing operations, including innovative leaching, where BHP has several studies underway at our Chilean operations. But the binding geological realities feel like the stronger force for this decade at least.

In closing for this chapter, we reiterate our view that the price setting marginal tonne a decade hence will come from either a lower grade brownfield expansion in a mature jurisdiction, or a higher grade greenfield in a higher risk and/or emerging jurisdiction. None of these sources of metal are likely to come cheaply, easily—or, unfortunately, promptly. A decade though is a long time, and between now and then, with the conditions we anticipate in the final third of the 2020s, it is entirely possible that at times the cost curve will cease to be binding on price. An alternative pricing regime which we refer to as “fly-up,” whereby prices disconnect from the cost curve due to systematic excess of demand over supply amidst critically low inventory levels, is a scenario that we feel the eco-system should start preparing for today.



Olympic Dam, South Australia

Nickel

London Metal Exchange (LME) **nickel prices** ranged from \$15,885/t to \$22,355/t over the first half of financial year 2024, averaging \$18,808/t. The average is -22% versus the prior half, -20% from the corresponding half of FY23, and -46% YoY on an end-of-period basis.



Nickel LME Cash (US\$/t)

FY19	FY20	FY21	FY22	FY23	H1 FY24
12,353	14,009	16,241	23,406	23,924	18,808
5-Year Period High: 45,795 (FY22); Period Low: 10,440 (FY19)					-20% YoY

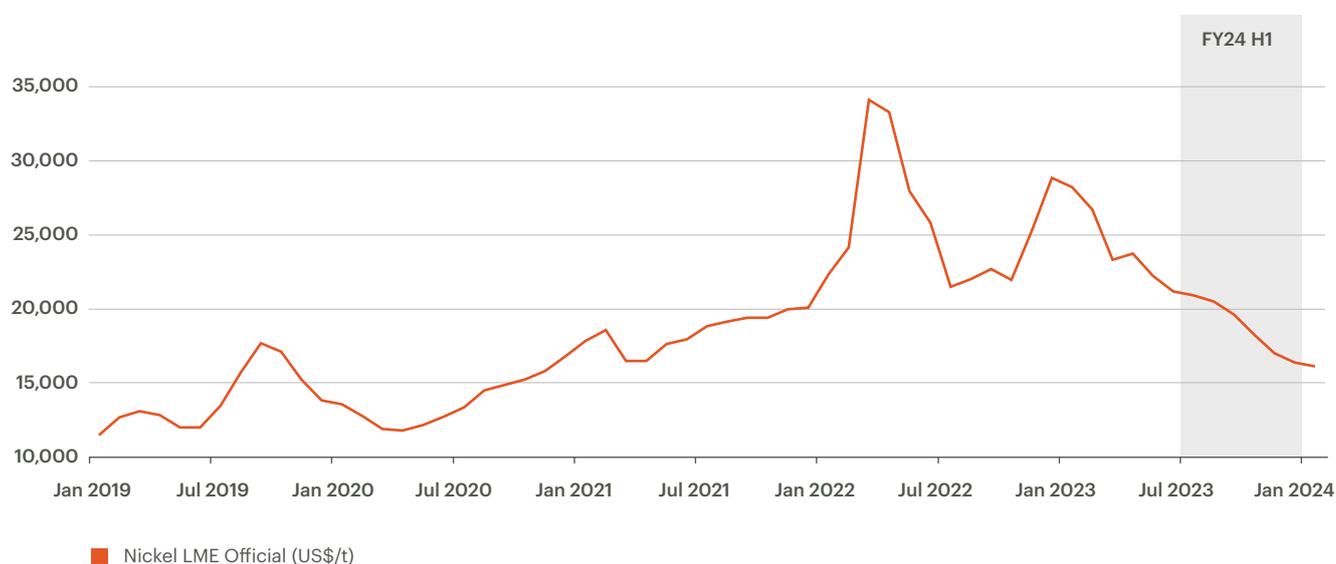
How did such a large movement in price occur in such a short time period, with so little apparent warning? A survey of twenty private-sector forecasters published in January 2024²⁵ was predicting the nickel price would average a little over \$19000/t in calendar 2024 with the price path remaining relatively stable above their mean long run real price estimate for the entire period from 2024 to 2027. The Australian Commonwealth Government's decision to classify nickel as a "critical mineral" on February 16, 2024²⁶, something it chose not to do in an updated list published December 16, 2023²⁷, speaks to the speed of the deterioration in industry conditions.

Like most cliff events, while it felt abrupt, the series of developments that led up to it were widely known and commented on, such as excessive Class-II and intermediates supply growth from Indonesia, extreme discounts to LME pricing for non-Class-I nickel products in the physical trade in Asia, and the LME's impaired price discovery mechanism painting it into a corner on exchange liquidity. What was lacking prior to the last half year was that there was no bridge to bring the mostly distinct Class-I and "other" supply buckets together, thereby triggering the potentially negative price dynamics.

When a potential bridge appeared via the conversion of a portion of the glut of Indonesian-origin nickel products into nickel cathode, enabled by the LME's fast-track decision to allow this product to move onto its system, that turned the hypothetical into a reality. That brought the Class-II and intermediates surplus directly into line of sight of the broadly balanced Class-I trade, just as destocking in the battery value chain and weakness in OECD demand for stainless steel made the industry especially vulnerable to such a shift. A very sharp correction in prices ensued.

Nickel prices

(monthly spot average)



25 Consensus survey distributed to UBS clients monthly. The January 2024 edition cited in the text captured forecasts current as of end November 2023.

26 <https://www.minister.industry.gov.au/ministers/king/media-releases/nickel-placed-critical-minerals-list>

27 <https://www.industry.gov.au/publications/australias-critical-minerals-list-and-strategic-materials-list>

While the supply glut was still contained mainly in the Class-II segment of the industry, operating conditions for integrated sulphide businesses, globally, remained solid. However, since the LME began to take delivery of Sino-Indonesian nickel cathode to its warehouses, thus catalysing price convergence between product classes, loss-making has become widespread.

If the LME nickel price is set to \$16000/t, close to the spot price in mid-February, as much as one-half of global production could be loss-making on a cash plus sustaining capex basis.²⁸ Producers adopting more sustainable practices could be disadvantaged in this environment, with their efforts not yet recognised with a commercial premia that could help buffer profitability when the base price declines to cyclical lows.

At a very high level, that is how we got here. Due to the deterioration in the short-term and medium-term outlook for nickel, we have lowered our nickel price assumptions. In addition, capital costs for Western Australia Nickel have increased due to inflation. BHP has undertaken a carrying value assessment of Western Australia Nickel having regard to these factors and will recognise an impairment as at 31 December 2023.

The following tells the story of that deterioration in more detail.

The refined nickel balance flipped from a large deficit in calendar 2021 to an aggregate surplus of material size across calendar 2022, and as highlighted in this article series six months ago, the glut increased in the first half of calendar 2023. Notwithstanding the substantial

unwinding of calendar 2022 fly-up pricing levels that had occurred at that point, and the collapse in payables for nickel products in China, the Class-I sub-balance was still on a relatively even keel at this stage, keeping exchange stocks at very low levels (-44% YoY). However, the directional risk for LME prices was skewing lower at that point, with a multi-year run of aggregate nickel unit surpluses likely and “bridges” between the Class-I, Class-II and higher-nickel intermediate “islands” being actively developed in the Sino-Indonesian industrial complex (50–60kt of Sino-Indonesian cathode was already online at mid-year). With the stainless steel demand backdrop in the developed world weakening as expected, and aggressive destocking in the battery value chain almost neutralising still strong electric vehicle (EV) sales globally (producing a much weaker outcome for nickel in batteries than our expectations), the LME nickel price slumped in the second half of calendar 2023. A series of curtailments were publicly announced, beginning in December 2023. Low inventories were an important element of the industry story prior to the arrival of Sino-Indonesian cathode into LME warehouses, but this narrative quickly evaporated. Visible inventories ended December 2023 up +26% YoY.

While short-term inventory swings and the negative impact on durable goods demand of anti-inflationary policies in the West have played a part in the recent price movement, the key strategic dynamic here has been on the supply side of the industry. There have been four consecutive years of rampant growth in Class-II production from 2020–2023 (with net growth in Chinese and Indonesian nickel-pig-iron [NPI] up around 1.6 times versus 2019, with the Indonesian standalone component up 3.6 times). This has been accompanied by stunning growth in intermediates from a standing start in Indonesia: NPI-to-matte production (~75% nickel contained) increased from 3 kt in calendar 2021 to an estimated 180 kt in 2023; while mixed-hydroxide precipitate (MHP: 30–45% nickel contained) rose from 16 kt in 2021 to an estimated 154 kt in 2023.²⁹ In calendar

2023, this vertical uplift in supply across the product spectrum intersected with a weak year for stainless steel in the ex-China world (stainless still provides 65% of total first-use), and a global demand speedbump in the battery space (of which more below), leaving a considerable glut of nickel units smeared across all product classes.

Taking a step back to consider the underlying fundamental drivers of the supply impulse, we note that Wood Mackenzie’s long term Indonesian nickel production forecast has been increased by more than +200% between late-2019 and late-2023. Wood Mackenzie utilises a methodological framework for project assessment based on the kind of hurdle rates of return that a listed Western producer would be familiar with. Consequently, they have been continually surprised when Indonesian projects kept coming forward. These projects were also being delivered at significantly lower costs (and ramping up to nameplate more smoothly) than was thought likely just a few short years ago. Clearly capital has been committed in the Sino-Indonesian nickel complex based on very different return parameters to those that underpin shareholder expectations of capital allocation processes in the West, and/or more optimistic input assumptions are being used in this particular ecosystem, and/or non-commercial imperatives such as security of supply for strategic downstream industries are carrying the day. Whatever combination of the above you favour, the reality is that this avalanche of operating and committed supply has left the overall industry highly vulnerable to any sort of demand disappointment, such as we saw in calendar 2023.

From here, we assess that demand needs to track close to the upper end of the plausible range to justify this breakneck expansion and to restore profitability across the supply curve within the decade’s middle third. If demand instead tracks the middle of the plausible range, we estimate that the market may not re-balance before the late-2020s. In this case, prior to that, a multi-year run of surpluses is in prospect.

28 Based on the 2024 Wood Mackenzie cash plus sustaining nickel cost curve as of January 2024. Note that under considerable financial pressure operators can take urgent actions on their cost base that make it very difficult to estimate true cost in real-time. It also assumes that all producers face spot prices, whereas some producers may have taken hedge positions. Therefore, the analysis presented here should be taken as a rough approximation of industry conditions at a specific point in time, not as a precise estimate with an extended period of validity. The loss-making share could go higher with even small downward movements in price, or lower if, for example, sustaining capex was temporarily suspended at a number of operations. Management actions such as the latter would not be visible to the rest of the industry for some time. The cash plus sustaining cost curve is quite flat either side of the current intersection with spot prices.

29 Historical data is compiled from a composite of sources (Wood Mackenzie, SMM and CRU), with some BHP estimates.

These conditions, brought about by excessive investment, have created financial stress across the global industry. As already mentioned, several producers having publicly announced curtailments in response, including multiple operations in Western Australia. These announcements are included in the supply-demand scenarios described in broad brush strokes above. The negative price shock has occurred at a time when Australia's international competitiveness is at a low ebb in commodity sectors where the geological endowment does not provide an absolute advantage: a group that includes nickel. High general labour costs, ageing mines and processing facilities, a considerable regulatory burden, skill shortages, and economy-wide productivity outcomes that are historically poor, are increasing the distance between the general Australian cost base and business environment and that of some key competitors in the critical minerals sphere. Decisive action is needed to reinstate the durable competitiveness of the industry. Otherwise, Australia and those nations looking to Australia to boost the supply of more sustainably produced future-facing commodities like nickel, may be further disadvantaged. We will return to the theme of sustainability, and ways to remunerate its tangible value, below.

Switching now to the demand side of the equation, generalist observers have been surprised by the apparent paradox of strong global EV sales (around 40% YoY) in calendar 2023 and the profound slump in the price of key battery metals, such as nickel and lithium. The nickel price declines have been hugely painful, but they pale when compared to the Chinese spot lithium carbonate price slumping -85% from its peak. A vicious bout of mid- and downstream destocking has amplified the weakness in the upstream.



For nickel specifically, we estimate that destocking—the process whereby demand is met by carry-over stock from prior production periods, contributed to approximately 100 kt of ‘demand loss’ across calendar 2023.

Global nickel battery installation is estimated to have grown by +28% YoY in calendar 2023 (China +14% YoY even with more LFP (lithium-iron-phosphate) batteries and plug-in hybrids gaining ground in colder regions), but global nickel cathode output (in gross tonnage) barely gained ground over the year. We expect end-user (battery cathode-active-materials—CAM) stocks to have declined further in January to February 2024, including some additional ‘passive destocking’ due to the Red Sea logistical disruptions.

The good news is that inventory swings are not perpetual, and at some stage in calendar 2024 we are likely to see a flip towards restocking, and the gale force drag of calendar 2023 will turn to a tailwind (of uncertain force). Alongside the supply-side developments discussed above and a modestly firmer industrial economy across the OECD, these factors feed our expectation that the nickel industry's currently bloated surplus (equivalent to 13% of total demand in calendar 2023) could reduce in size in calendar 2024 and 2025.

The bad news is that smaller does not mean small in absolute terms. We estimate that the average surplus across 2022–2025 will easily exceed 200 kt. As a rough guide, 250 kt is equivalent to about 8% of calendar 2023 demand. Difficult operating conditions are expected to endure for years to come.

As discussed above, the mechanism that transmitted the Class-II and intermediate glut into the Class-I sub-segment was the conversion of over-supplied non-Class-I products into cathode, and the delivery of these cathodes to LME warehouses. This brought previously invisible nickel units into the harsh glare of the investor community. Huayou was the first Sino-Indonesian operator to apply for brand listing under the LME's new “fast track” approvals process. They have since been followed by GEM and CNGR, with China likely to become a net exporter of nickel cathode in the near future.

Diversifying sources of deliverable metal to the LME exchange by fast tracking Sino-Indonesian nickel cathode was an attempted solution to the institution's liquidity problem, arguably without due consideration for unintended consequences.

Not only did these expedited approvals contribute to the rapid drop in the LME price as Class-I pricing converged with the over-supplied Class-II and intermediates spaces, the pain of which is being felt across the established Class-I producer universe, this new Class-I product begs some important questions for the nickel industry. The first are the potential consequences of the fact that the new Class-I supply is going to come in the form of cathodes. Cathodes are traditionally used in stainless steel and are not particularly suited to the rapidly growing lithium-ion battery sector. If Sino-Indonesian cathodes do not prove to be fully fungible with other Class-I products from the perspective of the battery value chain, then there is potential for a material bifurcation within the LME Class-I products space. Bifurcation driven by questionable fungibility in real demand, for which we have a recent analogy with respect to Russian Class-I nickel products, and the hoped-for durable uplift in liquidity, may not go together.

The second question is that fast track approvals of new products where the majority of feedstock will come from Indonesia, where an increasingly well-known range of ESG concerns currently exist³⁰, asks important questions about how fit-for-purpose the policy on Responsible Sourcing of LME-Listed Brands is. The LME's current policy towards responsible sourcing is narrowly defined, limiting its scope to certain risks both at the point of production which is typically the refinery (health & safety and environmental management system standards focussed) and to due diligence with the upstream metals supply chain (human rights, conflict and financial crimes focussed). Critical ESG risks such as biodiversity, Indigenous rights, tailings, GHG emissions profile

³⁰ Beyond the mining ecosystem, these concerns have been noted in the NGO community, for example <https://cri.org/indonesia-huge-nickel-project-driving-climate-rights-environmental-harms/>

and environmental due diligence are not in scope. Standards elsewhere in the ecosystem (for example the relevant OECD Guidelines, Copper Mark, and EU battery regulations) have leapfrogged the LME's approach, encompassing broader definitions that are more demanding of companies and more reflective of global sustainability best practice.

To modernise the LME policy and address existing shortcomings we recommend the following:

- a. Define a single *Conflict Affected and High-Risk Area* (CAHRA) listing that is made publicly available, kept up-to-date and adopted consistently by all LME Brands.
- b. Expand the scope of upstream due diligence requirements to cover environmental risks in line with the OECD's Handbook on Environmental Due Diligence in Mineral Supply Chains, and include recycled materials.
- c. Ensure all upstream production, including all mining and processing that act as third-party feed in the production of any LME Brand, are independently assured against a recognised ESG performance standard (e.g. ICMM's Mining Principles, Towards Sustainable Mining [TSM], Copper Mark) with a clearly defined minimum performance threshold by standard.

Such reforms would likely bring more comfort to downstream metal customers that position themselves as ESG industry leaders to speak to the higher standards of sustainability of their supply chain with more conviction. Presumably they are aware of these fundamental points of difference between traditional sources of LME deliverable Class-I nickel, and cathodes converted from Indonesia origin material. Nickel users in the midstream and downstream are a sophisticated group. Yet they are also pragmatists who want their feedstocks to be as cost effective as possible as they seek to compete in low-margin processing or manufacturing industries. With the influx of Indonesian origin nickel flowing directly and indirectly into western EVs over the last few years, including trade in intermediate products over the last twelve months, it is obvious that pragmatism is winning out.

We argue that adopting the reforms proposed above would help the LME (and/or other competing organisations) grasp the opportunity created by the actual and potential flurry of new sources of nickel, to increase the transparency for both buyers of metal and ultimate consumers of nickel-containing products as to the heterogeneous GHG emissions intensities and other relevant ESG characteristics that are deemed valuable by discerning purchasers but are currently outside the LME Policy on Responsible Sourcing of LME-listed Brands. Simultaneously, exchanges can explore options to develop nickel market infrastructure that can explicitly incorporate such characteristics as premia and discounts to the base price (i.e. placing tangible value on relative GHG emissions intensity and independent assurance against credible responsible mining and processing standards which incorporate broader ESG risks such as biodiversity, human rights and tailings). We also note in this regard that entrepreneurial interest in alternative nickel pricing solutions has been growing, such as Global Commodities Holdings' spot trading platform for the physical delivery of Class-I nickel, and Abaxx's development efforts towards a nickel sulphate price. BHP is monitoring all these developments, and we are engaging constructively with the broader ecosystem to try to help build a more transparent, efficient, and robustly independent pricing mechanism for this critical mineral—in its many traded forms.

Yet the responsibility for getting this right should not rest solely with private exchanges and leading producers. There are other important players in the ecosystem, not the least of whom are policymakers in the world's major ex-China manufacturing centres. Arguably the two most influential pieces of legislation in the climate arena are the US' Inflation Reduction Act (IRA) and Europe's carbon border adjustment mechanism (CBAM). Neither make it any easier for more sustainable nickel producers to procure a premium for their efforts. The scope of the CBAM is not yet broad enough to encompass trade in nickel products prior to what we call "first-use", and therefore a nickel-matte product from Indonesia is theoretically treated in the same fashion as a product from Canada or Australia. The IRA differentiates between where nickel is produced, but not how it is

produced. The IRA also treats all battery metals as a basket of value-added, rather than as standalone commodities, which is overly complex for the private sector. It also makes it more difficult to overlay sustainability criteria in addition to point of origin.

Why is this too complex? Principally because a change in relative prices can swing a procurement strategy that was eligible for subsidy in the prior year to be ineligible in the coming year. Note the dramatic collapse in lithium prices referenced above. If a downstream firm was relying on the value of lithium from Western Australia remaining broadly steady to achieve the threshold, for example, they would be unlikely to be able to reconstruct their supply chain in time to remain eligible for subsidies. That seems to defeat the intent of the policy, which is to increase the US' security of supply of critical minerals in this strategic emerging sector and hasten the penetration of "clean" energy technology (as labelled and defined by the US government) downstream.

If the framework was instead based on individual metals, with volume-based sourcing thresholds calibrated to the realities of the individual industries, it would simplify the policy, remove the price-linkage flaw, and make it more targeted and effective. It would also make it easier to overlay a sustainability incentive into the policy design, in a similar way to how the 45V "clean" hydrogen tax credits work. The 45V credits range from \$0.6 per kg to \$3 per kg of hydrogen, depending upon the lifecycle GHG emissions associated with each route.³¹ With the carbon emissions intensity of nickel production from integrated nickel sulphides typically being 4–8 times lower than laterite ore-based processing in Indonesia, the nickel industry is a perfect candidate for a similar policy. The combination of a threshold for eligibility (say 20 tonnes of carbon emissions per tonne of nickel), with an escalating tax credit for nickel produced underneath that threshold, would be an elegant design. A framework along these lines (hopefully cascaded across key manufacturing centres) would serve as a solid foundation for the private sector ecosystem of price reporting and assessment agencies, standards and certification schemes (which could streamline standards to improve transparency and comparability of ESG performance and incorporate GHG

³¹ See this link for the official policy on "clean" hydrogen. [U.S. Department of the Treasury, IRS Release Guidance on Hydrogen Production Credit to Drive American Innovation and Strengthen Energy Security](#) | U.S. Department of the Treasury

emissions intensity), traditional and emerging exchanges, and leading firms at all steps in the value chain to drive the development of an industry based around the reliable supply of more sustainable battery materials.

More broadly, a set of clear, predictable, and common set of regulations—finalised with a greater sense of urgency—are critical to delivering progress more effectively on ESG performance and transparency across battery supply chains and ensuring a level playing field. Getting this right today will go a long way towards reinstating confidence in the nickel industry's status as an attractive business in developed jurisdictions.

Turning to the longer-term fundamentals, we believe that nickel will be a substantial beneficiary of the global electrification megatrend and that nickel sulphides will be particularly attractive—while acknowledging the fact that the overall industry is presently enduring a difficult phase that is expected to extend for many years and sulphide operators are obviously not immune to that.

Our longer-term conviction regarding sulphides is based on their relatively lower cost of production of battery-suitable class-1 nickel than for laterites in a balanced market, as well as the favourable position of integrated sulphide operations on the GHG emissions intensity curve. We acknowledge that turning that reality into a durable competitive and commercial advantage under mid-cycle operating conditions will take many years and require a whole of ecosystem effort. No company or nation can do it alone.

While that effort has already begun, as an upstream producer competing in an increasingly unfavourable situation, it is prudent to carefully consider all our options from an operational and capital perspective. You can read more [here](#).

Looking beyond the 2020s, there are five key questions for the nickel market in the longer run:³²

- How fast will electric vehicles (EVs) penetrate the auto fleet?
- What mix of battery chemistries will power those vehicles?
- What will be the “steady state” marginal cost of converting the abundant global endowment of laterite ores to nickel products suitable for use in battery manufacturing once the current frenetic rate of expansion dissipates?
- How will the cost curve evolve in the face of ever-increasing consumer and regulatory demands for transparency with respect to the sustainability performance of upstream activity, including a transition to pervasive carbon pricing?
- How will the trade flow of nickel units be influenced by policy and geopolitics?

We have pre-empted the third, fourth and fifth points with the discussions on Indonesian supply and the desirable evolution of policy frameworks above. Our views on the first two questions are both well-known and uncontroversial: EVs are taking off, and ternary nickel-rich chemistries (mostly NCM nickel-cobalt-magnesium but also NCA nickel-cobalt-aluminium) are expected to be the leading technology that powers them. Leading of course does not mean that this technology will monopolise all applications, and we have previously reported that we revised the long-run share of nickel-rich batteries lower in recent analyses. LFP (lithium-iron-phosphate) has made considerable inroads in recent times, particularly in China, where affordability concerns are paramount among EV buyers and range anxiety is somewhat less pronounced than in the West.

Equally, when LFP is not being used, the proportion of nickel-rich chemistries have been rising at the expensive of low and mid nickel chemistries (defined as 622 and below), even in China. NCM and NCA combined added 3-4 percentage points of share in China in the December quarter of 2023, with fast charging capability reportedly a driver of that.

In Europe, nickel-rich chemistries have increased their share from 17% in calendar 2021 to 32% in calendar 2023, while 622 and 532 formulations have lost a combined 11 percentage points of share over the same time period (from 74% to 63%). Our view is that LFP will continue to play an important role at the low-and-medium end of the cost and performance spectrum, especially in the developing world. Other chemistries (for example those that thrift on cobalt and/or accommodate more manganese) are also likely to find their niche as EV penetration broadens to all vehicle categories. Sodium-ion batteries are expected to play a long-term role in stationary storage, with possible application in some segments of the two-wheeler space, three-wheelers, and no-frills passenger vehicles, where they will compete with LFP.

Some of the longer-term market share that we had previously allocated to “unspecified future technologies” has now been captured by incumbent chemistry families, partly due to projectable signposts on cathode pairings with solid-state electrolytes. We have also seen an increasing focus on the anode as a battery performance lever. We've chosen to bring forward the likely timing of the commercialisation of solid-state batteries, the first generation of which (featuring semi-solid electrolytes, sometimes referred to as “condensed matter”) seem likely to be paired with high nickel cathodes within just a few years. Beyond that, indications are that solid-state batteries, which are expected to represent a leap in safety and performance, can be deployed with a range of anode and cathode technologies and can thus serve as a default electrolyte platform.

³² We focus on key uncertainties in the main text, but the future path of conventional non-battery demand is also worthy of note. Nickel *first-use* is dominated by the stainless steel sector. It comprised more than two-thirds of primary demand in the 2010s but has been losing ground to batteries at the rate of a few percentage points each year in the 2020s. Non-stainless, non-battery demand has been more stable in its share of around one-fifth. Nickel *end-use* is diverse, with broad sectoral exposure to construction, consumer durables and electronics, engineering, metal goods and transport, in addition to finished batteries.

Potash

The last twelve months have been characterised by a downtrend in prompt potash prices as the industry continued the process of unwinding the extremely high prices associated with the scarcity regime that emerged in the first half of calendar year 2022. Across the two halves of calendar 2023, price movements were larger in the first half than the second, with some regions range trading over the last six months.



Potash FOB Vancouver (US\$/t) CRU

FY19	FY20	FY21	FY22	FY23	H1 FY24
283	251	229	596	567	309
5-Year Period High: 867 (FY22); Period Low: 216 (FY19)					-55% YoY

Looking at price developments by region, according to assessments in CRU's *Fertilizer Week*, the price of gMOP³³ into Brazil opened the second half of calendar year 2023 at \$335/t CFR and closed at \$315/t. gMOP into the United States (at NOLA), which initially led the global rally in 2021 before ceding that place to Brazil, opened the second half of calendar year 2023 at \$414/t FOB Barge, and closed at \$356/t. Spot prices for sMOP in South-East Asia opened the second half of calendar year 2023 at \$318/t CFR, and by year end were sitting at \$320/t.

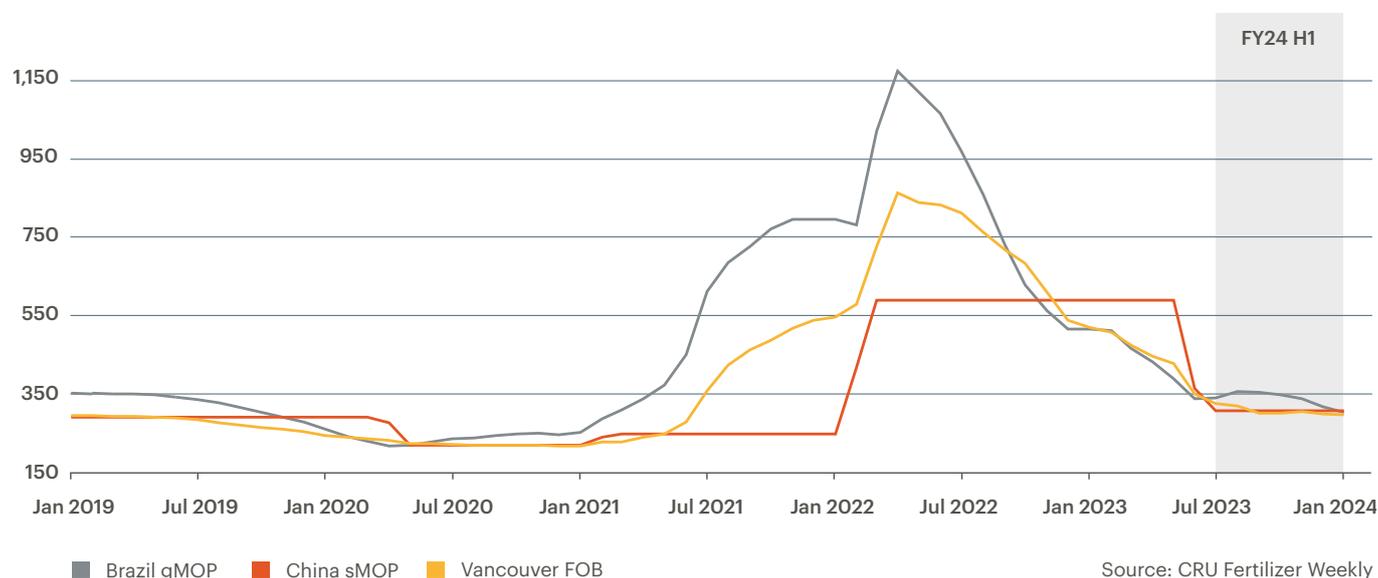
India re-negotiated its annual contract down to \$319/t CFR in August-2023 from \$422/t CFR in April-2023, following China's settlement in June-2023 at \$307/t CFR.

There is a sense that the market is broadly balanced as calendar 2024 opens. The fact that major regional MOP-crop intersections (e.g., Brazilian soybeans, American corn and wheat, Southeast Asian palm oil) were back closer to balance versus the long run affordability trend was a calming factor for the industry in the second half of calendar 2023, after the volatility and strife of the prior year.

Balanced though does not mean that the market is in any sense "at rest." The industry remains in the midst of a significant disequilibrium phase as it adjusts to the major shocks of recent years.

Potash prices

(monthly spot average)



³³ Fertiliser-grade MOP is commonly sold in powder ("standard") or compacted "granular" forms, abbreviated as sMOP and gMOP respectively. gMOP typically sells at a premium. Major demand centres for sMOP include China and India, while gMOP is prevalent in the Americas. Pricing data sourced from *Fertilizer Week* and public filings. The FOB prices in *Fertilizer Week* are freight netbacks only. Realised prices will differ from these estimates to the extent that other contract terms, such as negotiated discounts, deviate from zero.

Realised prices for producers tend to reflect developments in prompt pricing assessments with a lag that is partly dependent on the perpetual dance between prompt and fixed price contract markets. Approximate realised prices for Canadian producers (FOB Vancouver equivalent as reported by CRU) as of January 2024, were around \$296/t. The peak for the fly-up period was \$867/t, achieved in the months immediately following the opening of the Russia-Ukraine conflict.

Overall shipments increased by +7½ Mt to 66½ Mt in calendar 2023 (+12% YoY, our estimate), which was roughly +1 Mt higher than our full year projection at the halfway point. Production rebounded a lesser +7% YoY, from 62½ Mt to 66¾ Mt.³⁴

The demand figures represent a decent recovery from the stunning -12 Mt, -17% YoY collapse of calendar 2022, bringing the market back to 93% of its pre-shock volume. Four of the five major contestable importing regions (China, US, Brazil, India) saw double digit YoY growth in percentage terms in calendar 2023, with Southeast Asia being the lone exception to that trend. That said, on a multi-year basis, India, and not Southeast Asia, has been the laggard. Comparing calendar 2023 imports with the calendar 2020 level, the top-ranked growth markets are Brazil (19% above) and China (11% above). Arithmetically, with those two major consumers pursuing precautionary and/or strategic stocking strategies (albeit the approaches are of a very different nature), and with the producer side of the market still supply-constrained, there was no room for any other major importing region to have grown over the same time period. Accordingly, the US and Southeast Asia have not yet fully recovered to pre-shock levels (90% and 87% respectively), while India and Europe (again, for different reasons) have been mired at 59% and 65% respectively. The rest of the world (collectively, these tonnes are the third biggest bloc worldwide after China and Brazil) is sitting at 82%—flat on a year ago.

Moving to the exporters now, the major YoY changes came from Belarus and Laos. Having fallen to just 43% of calendar 2020 production levels in calendar 2022, Belarus made considerable progress in circumventing logistics constraints in calendar 2023, shipping an extra +4.2 Mt to reach 9.4 Mt (73% of 2020 levels). That +4.2 Mt was equal to the total lift in global shipments, with a 1 Mt jump in Laotian exports and slightly higher Russian flows fully offset by declines in China, Canada, and the Middle East. Canada's run-rate in calendar 2023 was down mildly (-1%) after a flat year in calendar 2022. Voluntary mine curtailments in late calendar year 2022 that extended into the following period, and logistics issues due to work stoppages at its western ports, were both headwinds for shipments.

The approval of stage two of BHP's Jansen potash project, announced on October 31, 2023, advances our strategy to increase our exposure to future-facing commodities. Longer-term, we feel potash offers very attractive fundamentals. Demand for potash stands to benefit from the intersection of global megatrends: rising population, changing diets and the need for the "sustainable intensification of agriculture". Developments in the geopolitical landscape since we approved stage one of the project have the potential to bring the balance point of the market forward from prior estimates.

The compelling demand picture, rising geopolitical uncertainty and the maturity of the existing asset base collectively provide an attractive, accelerated entry opportunity in a lower-risk supply jurisdiction such as Saskatchewan, Canada.

The phrase "sustainable intensification of agriculture" includes both the need to improve yields on existing land under cultivation in the face of depleted native soil fertility, but to also begin factoring in the long run land-use implications of large-scale first-generation biofuel production, lower availability of crop residues as an alternate supply of potassium to chemical fertilizer³⁵ under large-scale 2nd generation biofuel production (e.g. "sustainable" aviation fuel), giga-industrial scale renewables and nature-based solutions to climate change. To be clear though, we consider that the impact of deep decarbonisation on potash demand is best characterised as attractive upside on top of an already compelling demand case: not a case in itself.

Something else that attracts us to conventional potash mining and processing is its generally favourable upstream environmental footprint among the major fertiliser nutrients, and beyond the mine gate potash does not generate some of the negative environmental impacts associated with excessive application of nitrogen and, to a lesser extent, phosphorus. The major issues here are leaching into and polluting waterways and the release of GHGs in the application process. Excess nitrogen and phosphorus flows to the biosphere and oceans have been identified as critical "planetary boundary" parameters.³⁶

34 All trade data in this section are from S&P Global.

35 The potassium uptake of crops comes from (a) native K in the soil, (b) crop residues, (c) manures, and (d) chemical fertiliser. These shares vary widely by region, but the global averages are 30% from the soil, 20% from manures, 20% from crop residues and 30% from fertiliser. We anticipate that the fertiliser share will rise over time as soil fertility depletes.

36 For more on the Global Boundaries framework, see W. Steffen et al., Science 347, 1259855 (2015).

Inputs and inflation trends

Eighteen months ago, our core message on the inflation front was that we were sensing emerging differentiation between manufacturing and logistics, on the one hand, and labour and energy on the other. The first two categories were moving into the “past the worst” camp. Labour and energy, especially power, remained pressing issues where it was unclear if conditions might yet deteriorate further. Europe’s energy crisis and Australia’s east coast power crisis were cases in point.

Twelve months ago, it was becoming clear that our instincts on manufacturing and logistics had served us well. If you slow the industrial sector of the developed world down to the point where it is balanced on the precipice of a possible recession, you can take a lot of pressure off physical supply chains and the cost of durable goods and logistics services.

Operational labour markets justified the concerns we expressed, with worker availability tight and wage pressure coming through. But importantly, we gauged that risks with respect to energy costs had become balanced at that stage, rather than skewed to the upside,

thus leaving labour markets as the single most pressing forward looking inflationary concern for calendar 2023.

And we repeated the standard disclaimer on realised costs versus prompt prices:



The lag effect of inflationary pressures is expected to remain a challenge in the 2024 financial year.

In the time since, those predictions have begun to manifest in significantly lower rates of general inflation and as well as industry-specific exposures. Even so, the lag effect is very real and will be with us for some time yet.

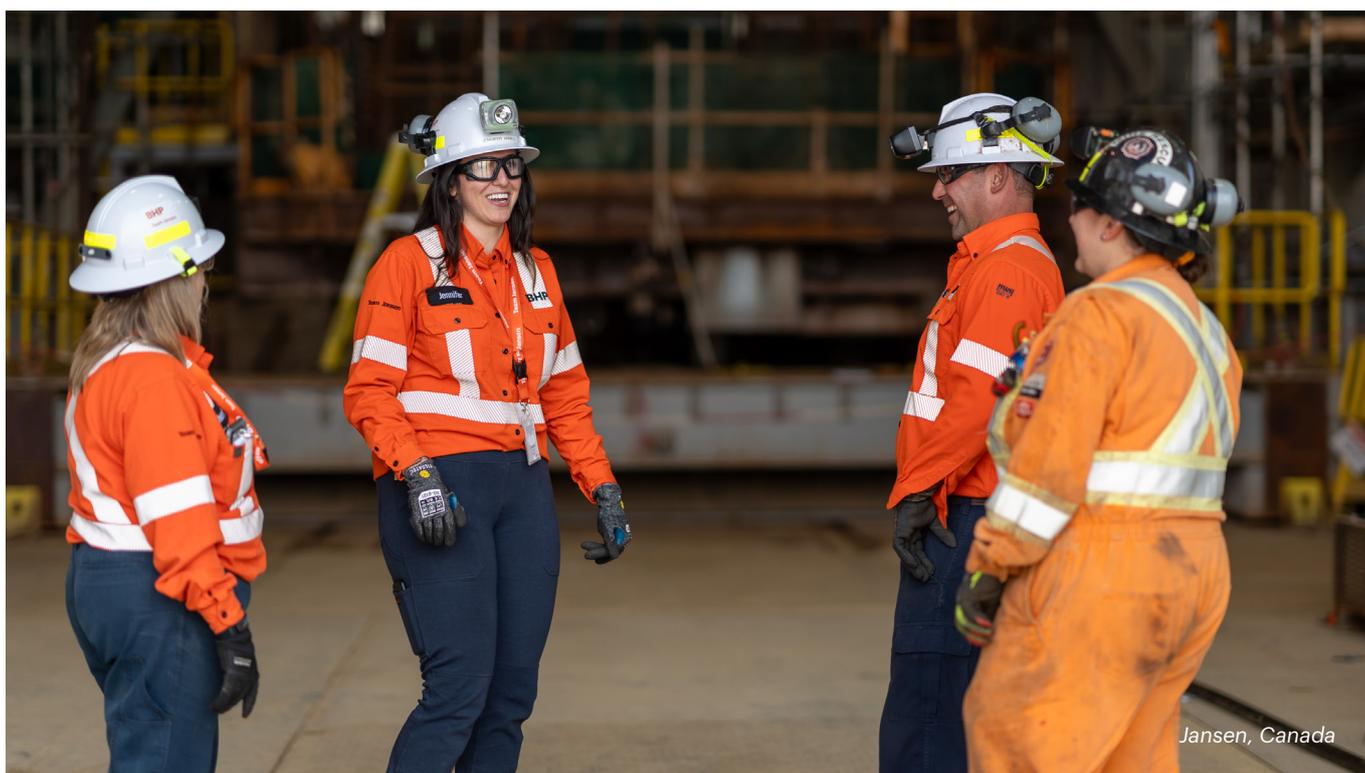
Maritime bulk freight

The key C5 WA–China route averaged \$9.5/t in the first half of financial year 2024 up 22% half-on-half and +6% YoY. In the medium term, we anticipate that rates may rise, with very modest growth

in the fleet after a period of weak orders intersecting with an expected lift in bulk volumes. The orderbook for Capesize vessels stands at 5% of the fleet, versus 10-11% for vessels in smaller subclasses. We also note that shipbuilding capacity is stretched across the board due to the surge in container ship orders in response to the pandemic crunch, in addition to a backlog of tankers, LNG/LPG vessels and car carriers.

Regulatory shifts are also likely to influence industry evolution in coming years, with the International Maritime Organization’s newly minted “close to 2050” net zero ambition, and the shorter-term targets that lead up to that milestone, requiring decisive action across the maritime ecosystem if they are to be achieved.

Last year, BHP participated in two joint industry initiatives to propel the decarbonisation agenda forward: the Australia–East Asia Iron Ore Green Corridor consortium, led by the Global Maritime Forum; and the ammonia bunkering safety study conducted by DNV under the leadership of one of our strategic partners, The Global Centre for Maritime Decarbonisation



Jansen, Canada



in Singapore³⁷. The first study concluded that ammonia-fuelled vessels could be in operation out of Western Australia from 2028. That finding is subject to technology, safety and regulatory considerations. The second study identified parameters that need to be addressed for safe bunkering of ammonia, which of course have resonance with the outcomes of the first study.

Wages

Wages in Australia and Chile are on different trajectories. Chilean nominal mining wage inflation (as measured in local currency terms by the national statistics agency) has decelerated sharply over the last twelve months, coming down from a peak around 18% YoY to the mid-single digits in the most recent reading, which is close to the longer-term average. The primary force in the deceleration has been the steep decrease in CPI, as hard indexation flows through to wage

movements with a predictable lag. Softer labour demand has also contributed, with the Chilean unemployment rate up by around three-quarters of a percentage point over the last twelve months.

Australian nominal wage inflation is still rising, as the large, administered wage increases covering the financial year 2024 and the rolling renegotiation of expiring enterprise agreements (EAs) flow through the system. Public sector catch-up is an important element in the latest wave of EA inflation. While the Australian labour market remains reasonably tight in absolute terms, it is not as tight as it was earlier in the cycle, with the lead indicators of SEEK and ANZ job ads down by -17% and -15% YoY respectively in December 2023, the coincident indicator of hours-worked declining YoY and the lagging indicator of the unemployment rate now edging up. While a range of skills relevant to mining remain in critically short supply, the relative availability of general workers has improved a little in recent times,

partly due to the rapid migration influx. The ABS' national wage price index (and its mining component) continues to underestimate the growth in labour costs, although at a fourteen year high around 4% YoY in the latest quarter, some of the gap has closed. The true cost of labour though for Australian business, measured on a unit cost rather than a rate basis, is increasingly onerous, with economy-wide productivity performance having been alarmingly weak. Australia's international competitiveness is suffering from this trend, and arresting this decline is arguably the most urgent task facing all levels of government across Australia. The commonsense response to a productivity problem is to double-down on productivity enhancing policies. Re-regulating aspects of the labour market without reference to the potentially deleterious effects on already weak productivity is the opposite of the commonsense prescription.

37 <https://www.gcformd.org/ammoniabunkeringreportdownload>

Ammonium nitrate

Benchmark indices for ammonium nitrate (AN)—a proxy for explosives costs we estimate as a weighted average of inputs (which varies by region), was quite stable across our key operational regions in the first half of the financial year 2023. Our index increased +1% in Western Australia, fell -1% in Chile, and was flat in eastern Australia. Volatility in feedstock costs (ammonia and its feedstock, natural gas) in the prior half lowered the calendar 2023 outcome for Western Australia -23%, with Chile -30%. Eastern Australia was down just -4%.

Earth-moving tyre

Earth-moving tyre raw material costs (weighted) declined by -0.4% in the second half of financial 2023 versus the prior half. Natural rubber has the highest weight in our index, and it has stabilised over the last six months. There were modest increases in petroleum derived inputs, and modest falls half-on-half in steel.

Sulphuric acid

Sulphuric acid prices for Chilean end-users, sourced from Argus, have been volatile within a downtrend trend overall. After falling in both halves of financial 2023, hitting pre-pandemic norms late in the period, they rose again, modestly, in the first half of financial 2024. North Asian FOB prices have been volatile, with negative prices in July 2023 before jumping up to around \$40/t just a few months later. They have since receded to around \$10/t. CFR Chile pricing ranged from \$90/t to \$151/t over the first half of financial year 2024, averaging \$127/t, a +12% move half-on-half. The end-of-period price is close to the top of the range. The acid market is changing as the massive build out of Indonesia HPAL nickel projects has created a major new demand node in the trade structure, while China's large build-out of copper smelting capacity promises to uplift Asian by-product supply a material way.

Power prices

Power prices were crisis-prone across multiple regions for much of calendar 2022, but a sense of (relative) calm descended in the second half of calendar 2023. With prices having receded to more normal levels, we see the forward-looking risks for power prices in our main operational jurisdictions as balanced, with the volatility skew to the downside in Chile if hydro generation continues to improve, and to the upside in Australia—which is our default position given the obvious fragilities in the system.

Chilean spot power prices

Chilean spot power prices in the Northern grid (SING) fell -52% in the second half of calendar 2023 to an average of US\$51/MWh, versus \$104/MWh in the prior half. In Chile, the principal regulatory response to the breakdown of the energy trilemma in calendar 2022 was to mobilise and extend coal power utilisation. Stronger hydro generation has made it feasible to go back to Plan A, with all coal plants that were extended at the time of crisis now being decommissioned.

Australian NEM spot power prices

Australian NEM spot power prices were in a welcome low volatility period in the second half of calendar 2023, with prices down to \$56/MWh on average, close to the pre-shock average in calendar 2021. That was -41% from the first half and -64% YoY. For the full calendar year, prices averaged \$75/MWh, down from \$165/MWh in calendar 2022. Power prices have also been assisted by improved renewable generation, lower fossil feedstock prices and mild weather (in the main). This combination managed to keep the price range in the second half of calendar 2023 much narrower than seen in recent times, despite disappointing coal availability. That said, we see periodic bouts of high volatility as an inherent characteristic of the NEM—with a major spike in evening power prices in Queensland in late January being another reminder of the tenuous nature of calm periods like Spring 2023. We consider the difficulties of calibrating the exit of coal capacity with increasing penetration of intermittent renewables, and managing the complexity for

incumbent generators that rising output of rooftop solar brings, all of which is backed by an (as yet) immature storage infrastructure and an under-invested transmission network (noting the NSW-SA interconnector project has been delayed by several years), points towards the amplification of the in-built volatility feature for the remainder of this decade. For more on the Australian power landscape in the context of the energy transition, see the dedicated chapter here.

Diesel prices

Diesel prices have unwound a reasonable portion of the extraordinary gains registered in the wake of the start of the Ukraine conflict, but they remain high after modest gains half-on-half. Average Singapore diesel (into Minerals Australia) increased +11% half-on-half from \$101/bbl to \$112/bbl, while average US Gulf Coast seaborne (into Minerals Americas) increased +10% half-on-half from \$103/bbl to \$113/bbl. Refinery spreads have receded from their record highs, but they still remain elevated relative to history. USGC peaked at \$80/bbl in the first half of financial 2023 and averaged \$33/bbl in the first half of financial 2024. Singapore's peak was \$57/bbl, with an average of \$37/bbl). As for crude markets, we see balanced risks in calendar 2024, with escalation in the Middle East a wild card.

Mining equipment

The rate of increase in the US producer price index (PPI) for **mining machinery and equipment manufacturing** moderated further in the second half of calendar year 2023. The index is now running at +10.9% on a 12-month smoothed basis, and +9.5% YoY for the month of December 2023, with the former down around -2.2 percentage points over the last six months. While these figures remain high, and we are somewhat skeptical about the index' relative stickiness given the time series dynamics of adjacent sectors and comparable indicators, at least they are an improvement from the rate of increase we were facing at times in financial year 2023, with outcomes that were the highest since 1976. The **construction machinery PPI** was at +9.4% YoY on a 12mma basis and was running at +7.7% YoY in Dec-2023. The YoY rate peaked in August 2022 at +13.8%.

BHP's Energy Transition Trends



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This chapter is the part of **BHP's economic and commodity outlook for the first half of the 2024 Financial Year. To read the full report click [here](#).**

We have touched on elements of the energy transition in the commodity chapters, but it is worth also reflecting on how the low GHG emissions technology transition is progressing in aggregate. Many of the commodities in our portfolio are positively leveraged to the energy transition mega-trend, with copper, nickel, steel and potash all beneficiaries of elements of the decarbonisation of power, electrification of transport and growing land intensification associated with most of the Paris-aligned scenarios we have reviewed.

So how is the transition progressing? Bloomberg NEF (BNEF), an energy think tank, reports that global energy transition investment reached \$1.77 trillion in calendar 2023, a +17% increase over calendar 2022 in nominal terms. That compares to an average +24% CAGR from 2020–23.³⁸ While China dominated last year's figures, growth in calendar 2023 was broader-based. The EU-27 and the UK collectively contributed to one-third of the annual increase, the US to over one-fifth, with China around two-fifths, down from 90% in calendar 2022.

Solar continues to lead energy transition spending in the power sector globally, at \$393 billion, with China accounting for roughly half of that. The renewables installations in China in calendar 2023 were truly monumental: the country installed 293 GW of wind and solar in calendar 2023, with solar now the second largest power source by capacity. In just 12 months, China installed the equivalent amount of wind and solar that the United States had installed in its entire history until the beginning of last year.

Despite the large growth in physical wind and solar capacity on the ground, BNEF reported that renewables investment (measured at the global level) was weighed down by wind, and particularly wind investment in China, which declined -35% year-on-year. Capacity additions typically lag investment, so while China's National Energy Administration and the International Energy Agency both reported a large uptick in new wind projects installed in calendar 2023, we could potentially see a slowdown in wind turbines coming online at a global level this year. Ex-China, the wind value-chain has been struggling for a little while now, with weak offshore auctions results, sharply rising manufacturing costs, project over-runs, asset write-downs and job losses at bellwether companies.³⁹

A notable exception to the OECD growth story mentioned above was Australia, which saw tepid growth of +2%, versus the OECD average of +28%. Despite having a target of 82% renewables by 2030, only six utility-scale wind and solar projects reached FID in the first three quarters of calendar 2023—the lowest since 2015. "Clean" power investments (according to the BNEF definition) for the full year were down -35%. In speaking with our renewables suppliers (BHP sources renewable power for a proportion of our power needs at almost all of our operated assets [globally](#)), they cite numerous reasons for the slowdown, including higher financing and supply chain costs, as well as grid constraints—not dissimilar to the headwinds that would be facing the rest of the OECD. Policy uncertainty and approval delays add to the list. Another major challenge has been integration of the growing number of households with rooftop solar. Distributed solar in the National Electricity Market (or NEM, which serves the states of Queensland, New South Wales, Victoria, South Australia and Tasmania) accounted for 11% of power generation in calendar 2023 (+2 percentage points from calendar 2022); in South Australia, it reached as high as 22%.⁴⁰ Meanwhile, investment in energy storage and grid interconnections in Australia, while growing, has been inadequate to temper the wide swings in day and night-time grid demand and supply caused by rooftop solar.⁴¹

³⁸ Bloomberg NEF changed its methodology in this year's update to include a wider range of technologies (grids, "clean" shipping, "clean" industry), but using last year's methodology, growth was even higher at +20% YoY. The expanded coverage to grids now brings the Bloomberg numbers closer to the IEA's methodology, which estimated "clean" energy investment would reach US\$1.74 trillion in CY23.

³⁹ Siemens (the leading offshore turbine manufacturer), Vestas (the leading turbine maker on a combined basis) and Orsted (global project developer and generator), three European giants operating in various segments of the wind industry, all reported financial results in February 2024. The general theme was that the sector's profitability is being challenged on many fronts.

⁴⁰ In contrast, distributed solar generation accounts for around 3% of the EU-27's power generation mix.

⁴¹ For example, in Queensland the phenomenon known as the "Russ Christ Effect" is often at play in the summer months. During daylight hours strong rooftop solar offsets higher demand during hot and humid days, but by late afternoon, storm clouds from the rising humidity can dim solar penetration, while household air conditioning demand remains at relatively high levels. This leads to a sharp increase in operational grid demand, requiring expensive gas generators (or even diesel) to rapidly be brought into the system.

These dynamics have contributed to extreme volatility in wholesale power prices over 24-hour periods, with daytime prices often negative, but shooting into the triple digits per megawatt-hour in the evening hours. Enhancing energy storage and grid interconnectors could help smooth the peaks and troughs, but progress has been patchy to date (see: the multiple year delay to the South Australia-New South Wales interconnector since the project was announced).

We are hopeful that the expansion of the Government's Capacity Investment Scheme, which aims to bring an additional 23 GW of renewables and 9 GW of low GHG emissions dispatchable capacity in Australia, will bolster investor confidence in this space.

Access to low GHG emissions firm power supply and grid infrastructure are an essential enabler for the mining sector to meet its decarbonisation targets in Australia, as well as to ensure the competitiveness of Australia's mining sector writ large. Further policy support to ensure zero emission power supply is ready to replace retiring thermal capacity, such as providing clarity around the Renewable Guarantee of Origin scheme, reforming permitting (with the goal of reducing approval timelines without lowering standards) and enhancing coordination and consistency between federal and state governments, will be essential.

Moving back to the global story, electric vehicle penetration continued to climb, reaching 16% of worldwide auto sales and growing around 40% year-on-year in calendar 2023. For the first time, electrified transport also grew to be the largest segment of "clean" energy investment in BNEF's methodology, overtaking all forms of renewable energy. China was the overwhelming stand-out in terms of vehicle output: nearly 1 in 3 light duty vehicles sold in China in calendar 2023 were non-internal combustion engine (ICE) vehicles—more than double the amount of EVs sold in all of Europe, and more than all the vehicles (ICE and non-ICE) sold in developed Asia. Increasingly affordable Chinese EVs, and a proliferation of new models and features to lure consumers, not only underpinned a rise in domestic demand but have also enabled a surge in exports. This has accelerated growth in markets that allow unfettered access

to Chinese EVs. For instance, Israel and Thailand both recently passed the 10% penetration mark, a critical first infection point for S-curve take-off.

In the US and Europe, EV sales penetration continued to rise, but at a slower rate. Both saw penetration lift around 3 percentage points in calendar 2023, to around 9% and 23% respectively. A number of factors are turning retail buyers more cautious, from higher interest rates (coupled with higher EV financing rates) to OEMs announcing a roll-back in some model releases—particularly in the affordable segments. In the US, hybrids have gained market share after some battery electric models lost access to tax credits amid stricter eligibility criteria. This trend could deepen in the coming months following stricter 'foreign entity of concern' guidelines, which may render some more EV models ineligible for federal credits. Fleet operators such as hire car companies have also become somewhat wary of EVs due to less-than-expected residual values on the second-hand market.



We view the recent EV slowdown in the US and EU as a “bump in the road.” In time, improved cost economics coming out of China should translate to learning and improvements in all markets—as has been the case in a variety of energy transition technologies over the last decade. We still expect a sticker price cross-over point in most major markets between ICE and EVs in the second half of the 2020s, particularly as manufacturing scales and new technologies, such as solid-state batteries, permeate the mass market. Nevertheless, protectionist policies in the politically sensitive auto sector remain a key risk to the outlook in the near term.

Investment in harder-to-abate decarbonisation technologies is accelerating but is still only ~4% of the investment flowing into the power and transport sectors. According to BNEF, hydrogen and CCUS investments have each grown to above \$10 billion for the first time, while investments in the “clean industry” category, which includes low-GHG emissions steelmaking and ammonia, as well as recycling facilities and bioplastics, grew to \$49 billion. We have yet to see the true impact of the US IRA come through in the data for the hard-to-abate sectors, but an increase can be expected in the coming years as businesses wrap their heads around the complex legislation—noting of course the clear policy risk at play as we head into a US Presidential election year.

In just 12 months, China installed the equivalent amount of wind and solar that the United States had installed in its entire history until the beginning of last year.





On the international policy front, two major pledges were signed at COP28 in Dubai: one to triple global renewables capacity by 2030 (signed by 129 countries, representing roughly half of global power demand) and one to triple global nuclear capacity by 2050 (22 signatories, ~30% of global power demand, but 70% of nuclear capacity).

For the first time ever in a COP agreement, nuclear was also called out as a solution to combat climate change. If achieved, the pledges would drive renewables capacity to 11 terawatts by 2030 and nuclear to 1100 gigawatts by 2050—both above the plausible upside case in our planning range. An important nuance to the pledges is that they do not require each individual signatory to triple capacity domestically, but rather to support a global goal. Notably absent from the list of signatories were China and India, which we expect will be responsible for 40–60% of capacity growth in renewables and nuclear over the coming decades. Without their contribution, the ‘global’ targets may be difficult to meet.

Meeting the two targets or even getting close to them (noting that on average, the external 1.5-degree scenarios we have studied only get to 6.2 terawatts of wind and solar by 2030, and 939 gigawatts of nuclear by 2050) will require an even steeper uplift in primary mineral and metal supply than currently expected. A typical onshore wind turbine is 3 ½ times more steel-intensive and 1½ to 2 times more copper-intensive than a gas-fired power plant; moving that turbine offshore requires 5.3 times more steel than the gas plant, and over 5 times as much copper.

These multiples quickly add up, and demand from “energy transition” sectors (i.e. renewables, EVs) represent a growing share of metals and minerals demand over time. BHP’s 1.5-degree scenario⁴² envisages cumulative primary copper demand over the next 30 years to be around double the amount consumed in the previous 30. Whereas today, the ratio of traditional sources of copper demand (construction, consumer durables, capital goods, etc) to energy transition end-use demand is roughly 93:7, by 2035, that ratio shifts to 80:20. Steel demand, too, sees upside growth from the power sector that more than offsets declines driven by the phase down in fossil fuels.

On the nuclear pledge, the uranium spot market certainly took notice. Nuclear’s standing in the COP process, coupled with a series of supply announcements—with the latest being Kazatomprom’s downgrade of its calendar 2024 production outlook—sent the uranium price above \$100/lb for the first time since 2007. These latest developments have augmented the upside coming from the geostrategic risks that have engulfed nuclear fuel supply chain since Russia’s invasion of Ukraine: Russia accounts for half of global enrichment capacity, and one-quarter of Kazakh mined supply is Russian-owned (Kazakh supply represents around 40% of the global total). If the US Senate joins the House in banning the imports of enriched Russian uranium later this year, it could send the spot price even higher.



Back in 2021, we celebrated the crossing of the \$500 billion mark for annual investment focused on the energy transition, but we noted that there was still much more to do. We’re now well past \$1 trillion, and yet the message remains the same.

Progress across all aspects of the energy transition is accumulating, but the world is still not on track to keep global average temperatures from increasing by more than 1.5-degrees above pre-industrial levels at the end of the century. Current pledges, in our view, fall short of this objective whilst the populous emerging markets target carbon neutrality at a point beyond 2050. Both Bloomberg and the International Energy Agency (IEA) agree that current investment in the energy transition is only slightly above one-third of where it needs to be this decade in their respective Paris-aligned scenarios. The story is nuanced, of course, with some categories roughly tracking to where they’d need to be in a 1.5-degree scenario—this is particularly true for technologies that have reached the point of being commercially competitive (e.g. new solar, Chinese EVs). However, major changes in behaviour and policy are clearly still required for the rest of the energy system. For our part, BHP will continue to focus on the more sustainable production of resources that are essential to meet the world’s climate ambitions.

⁴² This scenario requires steep global annual GHG emission reduction, sustained for decades, to stay within a 1.5°C carbon budget. 1.5°C is above pre-industrial levels. For more information about the assumptions, outputs, and limitations of our 1.5°C scenario refer to the BHP Climate Change Report 2020, available at bhp.com/climate.

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