BHP's economic and commodity outlook[1]

Financial Year 2023

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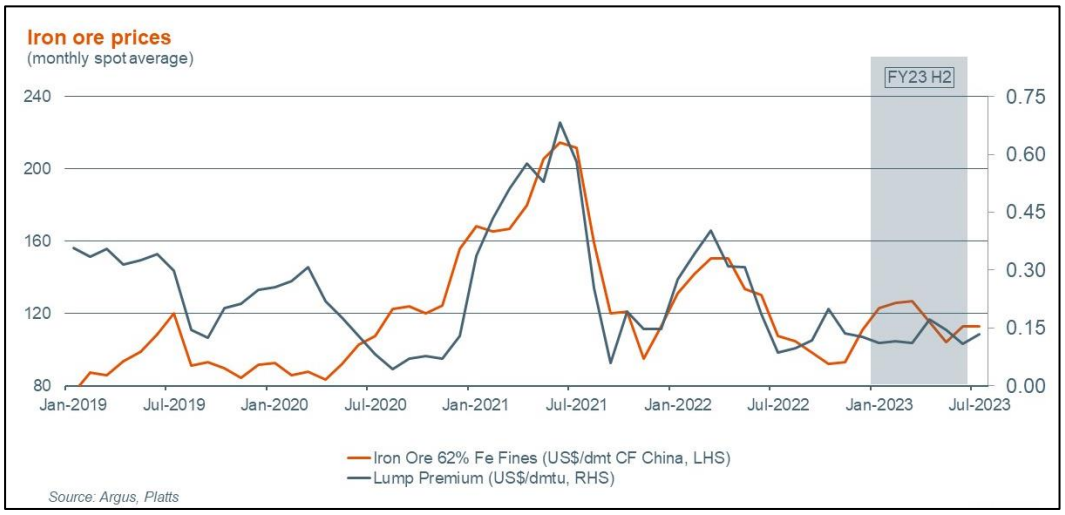
Six months ago, at the time of our half year results for the 2023 financial year, we observed that while the range of uncertainty around the growth and general inflation outlook was narrower than it had been in some time, commodity price dynamics were expected to be highly complex once again. We argued that price volatility would be generated within the year by an arm wrestle between three major forces that were summarised by the following "R"–words: *reality* (of slower growth in the developed world), *relief* (that the inflationary wave appeared to have crested); and *re–opening* (the China dynamic).

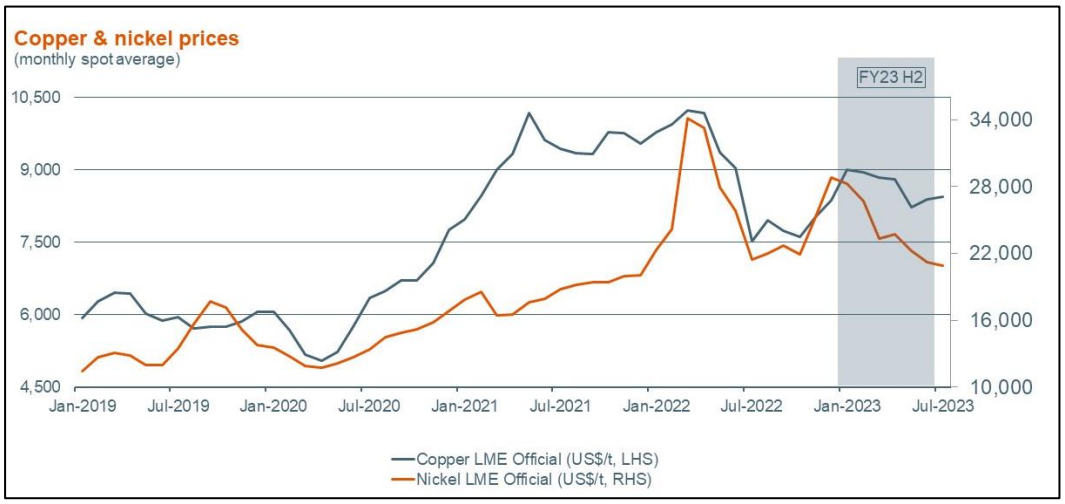
An ebb and flow between these forces was expected to continue throughout the half year. Our basic framing against this multi–faceted backdrop was that we expected that price formation would, on average, improve across calendar 2023 versus the second half of calendar 2022, when pessimism on Chinese growth 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 of our half–year results for the 2023 financial year over–stated 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.

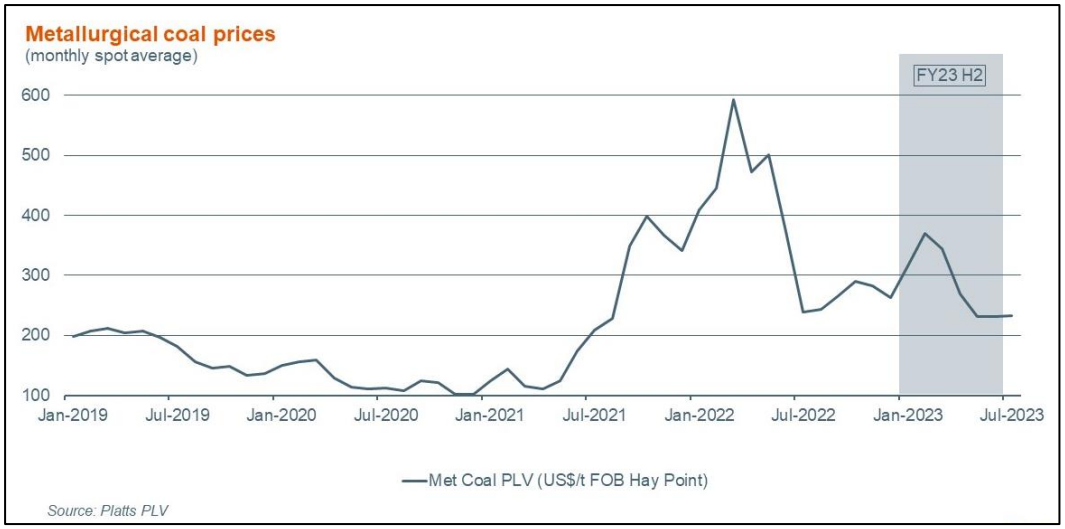
[1] "Data and events referenced in this report are current as of **August 14, 2023**. All references to financial years are June–end, as per BHP reporting standards. For example, "financial year 2023" is the period ending 30 June 2023. All references to dollars or "$" are US dollars unless otherwise stated. The data is compiled from a wide range of publicly available and subscription sources, including national statistical agencies, Bloomberg, Wood Mackenzie, CRU, IEA, ILO, IMF, Argus, CREIS, Fertecon, FastMarkets, SMM, Parker Bay, MySteel, Platts, LME, COMEX, SHFE, ICE, DCE, SGX, and S&P Global, among others."

That framework has held up well. Reality has never been far away, with the materials–intensive segments of the developed world's economies clearly slowing down, and financial fragility and policy uncertainty periodically rearing their heads. The global headline inflationary pulse has also clearly peaked, and while that is a relief in and of itself, interest rate relief in the absolute sense is still likely some way off. China started calendar 2023 well with a strong re–opening in the March quarter, but the June quarter was underwhelming, with weakness in housing weighing on both local government finances and private sector confidence levels, thereby offsetting the generally solid outcomes seen elsewhere in the system. And commodity prices were certainly volatile, with the trend of divergence between commodity clusters continuing, but dips have been relatively shallow, reflecting elevated cost support, a moderate operational performance in general, and the aforementioned low stocks.

On the specific commodity clusters, energy, food, and fertiliser markets spent most of the last six months unwinding the stunning peaks that emerged in calendar 2022. The steel–making value chain saw gains in the March quarter, but these have since dissipated, with prices experiencing two–way oscillation within a relatively narrow range in the June quarter and the month of July. Non–ferrous metals have been influenced by swings in risk appetite in the West (bank failures in the US and Europe, the debt ceiling standoff, the inflation–interest rate nexus), industry specific factors such as low exchange stocks, and the inconstant fundamental demand and policy signals coming out of China.







With the 2023 calendar year half over, we have updated our expectations for short-term supply-demand balances (where a surplus means rising inventories and a deficit means inventories will run down). We now see a small surplus or a balanced copper market (better Chinese end–use demand and operational shortfalls), which is a shade better than expected at the outset of the year. We foresee a somewhat larger surplus in total nickel units (lower than expected demand and very rapid growth from Sino–Indonesian facilities). We anticipate a broadly balanced iron ore market on average across the 2023 calendar year, although there are multiple uncertainties feeding into that assessment, most notably the breadth, severity and timing of mandatory steel cuts in China, a point on which it is disingenuous to hold a high conviction position. Should we see an abrupt slowdown in production, port stocks in China would certainty increase through the period when production is curtailed. The metallurgical coal market is obviously not as tight as it was in calendar 2022, when a series of pricing records were set, and has evolved broadly as expected in the aggregate under conditions of improving supply.

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[2] 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 $83 trillion to $171 trillion and the capital spending component of GDP to expand by $16 trillion to $39 trillion.[3] 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; 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.[4] As indicated by the scenario analysis in our Climate Change Report 2020 (available at bhp.com/climate), if the world takes the actions required to limit global warming to 1.5 degrees, we expect it to be advantageous for our portfolio as a whole.[5]

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 nickel and copper.

[2] The UN released new long–term population projections on World Population Day (July 11, 2022). At a global level, these are essentially unchanged from the prior vintage out to 2050. There are, however, important regional differences and there are considerable changes in the second half of the century. We will review these changes and their implications in a future blog.
[3] 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 "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.
[4] 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.
[5] We note, of course, that there is an almost infinite array of technical, behavioural and policy assumptions that can achieve this end in combination, and our 1.5–degree scenario is just one of the many. Each unique pathway produces a unique call on commodity demand and presents a unique incentive matrix vis–a–vis supply. This highlights the need to avoid treating any single pathway as the sole source of "truth". That is too heavy a burden for any one scenario to carry. As the common knowledge base of publicly available Paris–aligned scenarios continues to grow, we will continue to learn from this invaluable collective resource to improve the work that helps to inform our strategic deliberations. The statement in the text is explicitly based on the commodity demand and price impacts of our 1.5–degree scenario, a technical pathway modelled in consultation with Vivid Economics which requires steep global annual emissions reduction, sustained for decades, to stay within a 1.5°C carbon budget. Demand figures derived from the pathway, together with its assumptions and limitations, are described in our Climate Change Report 2022, available at bhp.com/climate.

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 scenario[6], 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.

China

China's economy was buffeted by multiple headwinds in calendar 2022. From a GDP perspective, China's growth slowed to just +3.0% in that year, 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. Such weak economic growth relative to China's potential rate saw producer price deflation setting in, with consumer prices also very subdued. China's outlier status regarding price pressures, in a world enveloped by inflationary risk, provided Chinese policymakers considerable freedom to stimulate the economy without worrying about managing a parallel cost–of–living crisis.

With the U–turn on zero–COVID executed in December–2022, international relations stabilised and policy support for housing in place, expectations for what China could achieve under its re–opening were high.

The annual GDP target of "around 5%" announced at the Two Sessions in March was seen by many as unduly conservative – and was accordingly interpreted as a low hurdle that the new leadership team would be able to clear at a canter.

The early portents were good. Credit supply opened calendar 2023 very strongly, new house price gains broadened to almost all the country's top 70 cities, and mobility and discretionary consumption indicators showed that urban residents were returning to a lifestyle more conducive to spending on services. Steel production for was the highest on record for that month, at 1.122 Btpa. The Politburo's April communique on the state of the economy confidently described the March quarter as "better than expected", and the range of private sector forecasts were revised upwards. According to the Bloomberg Consensus, mean real GDP expectations for calendar 2023 bottomed in the final week of calendar 2022 at +4.8%, and they peaked in mid–May at +5.7%. The low end of the range bottomed at 2.2% in October 2022: but it had doubled to +4.4% by May. And then … the early year momentum slowly bled out as the June quarter progressed.

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[6] Available from https://www.iea.org/topics/net-zero-emissions

Initially, our sense was that the June quarter was a soft spot naturally attributable to the pull forward of activity associated with the sugar rush of the first few months of re–opening, and the fact that officials and the financial system consciously took their feet off the accelerator after the Politburo's confident April assessment. We also noted that the April communique was tinged with some hawkish commentary on local government finances ("strictly control the growth of implicit debt") and a repetition of the well–worn phrase on "housing is for living, not for speculating", which provided an undertone of caution that officials should not lose sight of the structural impact of their decision making. However, after the monthly data round for May, we adjudged that this was more than just a minor soft spot – it was reflective of an overhang of weak confidence that had been shrouded by the re–opening euphoria – and therefore a renewed policy push was going to be required. And the focal points for the reinvigorated stimulus effort would need to reinstall confidence in private developers via the more effective implementation of the "16 measures"[7] (of which more below) and put local government finances on a firmer footing (where something new on the structural front is likely required, in addition to the obvious cyclical desire to get land sales moving again). The synergistic aspects of stabilising housing and reducing risks in local government finance are impossible to refute.

As the need for additional policy support became increasingly apparent as the June quarter advanced, expectations centred on the late–July Politburo meeting to deliver a shift in tone towards more decisive support for growth. So: what did the Politburo say?

The Politburo communique confirmed that the leadership understand the need for new counter–cyclical policy measures, as well as the need for more effective implementation of the measures already put in place.

There were five major themes:

Openly acknowledging there is a problem: in stark contrast to the confidence of the April report where growth was described as "better–than–expected" with "supply and demand pressures eased", in July, "the economy is currently facing new difficulties and challenges, which mainly arise from insufficient domestic demand, difficulties in the operation of some enterprises, risks and hidden dangers in key areas, as well as a grim and complex external environment." The need to stabilise employment and mobilise monetary policy were highlighted. Firmer language on the "grim" external sector is also noteworthy.

Real estate: The stock phrase of recent years that "housing is for living, not for speculating" was removed, with a vow to "optimise policies" in the face of "the significant shift in housing supply & demand balance". "Optimise policies" indicates a refocus on implementing existing frameworks, most notably the "16 Measures" package that was announced in late CY22 has not been as successful as hoped, especially where it comes to the funding of private developers.

[7] Six of the sixteen measures focus on the financing real estate development. They are (1) Stabilise real estate development loan growth. (2) Support reasonable demand for individual housing loans. (3) Stabilise credit support of construction companies. (4) Support the extension of existing real estate development loans and trust products. (5) Stabilise bond financing. (6) Stabilise trust products financing. Two were related directly to the delivery of stalled projects, one citing development banks and the other for the general finance industry. Two related to the resolution of distressed developers, covering M&A and the role of asset management companies (AMCs). Two related to consumer protection for those struggling to service loans. Two related to relaxing the strict enforcement of banks' macroprudential ratios vis–à–vis the sector. The final two related to M&A within the sector and the promotion of REITs in the rental segment.

Local government (LG): In April, the Politburo was borderline hawkish on LG finances. In July, we were promised a "set of measures to lower the risks of LG debt". This is a dramatic, but much needed about–face. It is unclear exactly what the authorities will come up with here, but anything that mobilises the Central balance sheet at scale would be deeply beneficial. Kickstarting the weak land sales market (about 2½% of GDP in revenue for LGs pre-pandemic, this is now down to about 1½%) – which is directly related to the funding issues of private developers – would be synergistic. The announcement on August 11 that provincial governments will be allocated up to 1 trillion yuan in refinancing bonds to bring the debt of LG financing vehicles onto the formal balance sheet left financial markets unimpressed. That is understandable with around 66 trillion yuan (32% of GDP) of LG debt sitting on-balance sheet, and an additional 40 trillion yuan (53% of GDP) in financing vehicles (LGFVs).[8]

Government and the private sector: The Politburo extended an olive branch to China's Big Tech platform companies and committed to greater dialogue with the business sector.

Stimulating consumption: The aim now is to "proactively expand domestic demand … To lift consumptions for automobile, electronics, household durables and tourism." In April, only services and tourism were called out for assistance. The NDRC has already announced some policies to assist these areas in the weeks leading up to the session and has also followed up with additional guidance to spark housing.

The key judgment call now is to gauge how effectively these various policies will transmit.

IF they transmit based on pre–pandemic lead–lag relationships, the economy should stabilise soon and then firm progressively in the remaining months of the 2023 calendar year and open CY24 with solid momentum. That would be similar to the view we held six months ago, but obviously delayed.

BUT IF the transmission mechanism remains 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. That would be at odds with our views from six months ago and would almost certainly be negative for commodity prices.

Our working base case is somewhere in the middle of these two plausible hypotheticals. We revised our GDP, steel, and copper forecasts after the release of May monthly data based on what we had seen in the year to date, and a view of the likely implications of the July Politburo meeting. Our updated GDP forecast is +5–5½% for CY23 versus +5¾–6¼% at the time of our half year results for the 2023 financial year. Our CY23 steel forecast range has come down and copper expectations have gone up: noting that the segments of the economy that are doing well despite the real estate drag are (in the main) copper intensive activities. Please go to the steel and copper chapters for more details.

It is useful to consider how we got to this point as we dynamically recalibrate the outlook. Going back in time twelve months, China's housing market was the obvious wild card for the outlook over the next year–and–a–half (i.e., a period ending roughly six months from now). Our diagnosis at the time was that "what ails Chinese housing is not a demand problem – it is a supply–side problem. More specifically, the resolution of the current issue lies within the nexus of developer balance sheets, macro–prudential controls on the same, and risk–averse financiers".

[8] These are 2023 estimates by the IMF. See page 44 of the report available from: https://www.imf.org/en/Publications/CR/Issues/2023/02/02/Peoples-Republic-of-China-2022-Article-IV-Consultation-Press-Release-Staff-Report-and-529067

Given that diagnosis, the month of November 2022 felt like a watershed for housing policy. The precise turning point was the joint PBOC and CBIRC (now the National Financial Regulatory Administration: NFRA) “16–measures” policy package of November 23rd. At the time of our half–year results for the 2023 financial year, we wrote the following with regards to the “16 measures”. “The immediate impact of this reinjection of liquidity will be to accelerate the completion of projects that were stalled, consistent with the concept of ensuring “housing delivery” – the phrase that entered the policy lexicon at the time of the widespread mortgage boycott protests of the September quarter. A rebound in new project starts, and their lead indicators – land transactions and off–the–plan sales – will take somewhat longer.”

The reality is that the policy simply did not transmit effectively where it was most needed: and the measure there is not a data point. It is the obvious lack of trust in private developers that has persisted in buyer and financier behaviour.

While the demand side measures have brought about some modest (but fragile) improvements in sales and prices, and “housing delivery” has performed relatively well as evidenced by commodity housing completions expanding +19% YoY in the first half of calendar 2023, major new funds have not flowed to private developers through any external channel. That has kept them out of the land market and has held the volume of starts down at levels not seen since the late–2000s.

Reflecting this reality, on July 10, 2023, roughly a fortnight before the Politburo was due to meet, the PBoC and NFRA took the unusual step of declaring that the “16 measures” would be “valid for a long time”. They also firmly indicated that financial institutions should focus on the “implementation” of these policies. In the Politburo communique, this came through in the phrase “optimise policies”. The duration of regulatory forbearance being granted to banks in terms of their macroprudential guidelines may have been a point of uncertainty that was holding credit back. New People’s Bank Governor Pan met with financiers and developers in early August to deliver these messages in person.

This is how the major “commodity” housing data (i.e. commercially available for sale as a “commodity”) stood at the end of the first half of calendar 2023, after roughly half 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 –24.3% YoY, pointing to a third consecutive annual contraction in calendar 2023. Sales volumes of commodity housing declined –5.3% (weighed down by pre–sales at –8.6%: while new homes in completed projects sales [i.e., where completion risk is rendered moot] rose +10.3%). As mentioned above, completions – the key indicator for contemporaneous copper use in real estate – rose +19.0% YoY. Floor space under–construction was tracking at –6.6% and developer financing was –9.8%.

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 has been a non–trivial element in real estate turnover dynamics in calendar 2022 and the first half of 2023: interest in real estate as an asset class is relatively undiminished. Tremors in the bond, trust products and equity spheres in the month of August-2023 have arguably set things back further in terms of trust, raising the bar for what effective policy looks like.

Another way of illustrating this is the fact that the historical share of sales and land acquisitions between private and SOE developers has flipped over the last twelve months, from 70:30 or 80:20, to 30:70 or 20:80. Reversing home buyers’ distrust of private developers could have high multiplier effects, especially in the context of (a) the pool of excess savings that has accumulated over the pandemic, and (b) the insipid uplift in the household credit impulse observed since the conclusion of zero–COVID.

It is important to remember that the monthly "commodity" housing data documented above is only one component of total construction. The "non–commodity" segment is in fact larger in terms of total floor space[9], (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 +7.3% in the first half of calendar 2023. Non–commodity starts grew at a rate of +8.4% in calendar 2022, but they have contracted –3.2% in the first half of calendar 2023. Notably, in line with robust manufacturing fixed investment (see below), factory floor space completions and warehouse completions have remained solid.

The Ministry of Housing and Urban Development (MOHURD) has also announced 3.6 million units of social housing will be built in calendar 2023, up from 2.4 million in 2022. The 3.6 million would be equivalent to one–fifth of all housing starts by floor area (noting that social housing has a lower average per capita footprint than commercial dwellings). These less visible but collectively important vectors of materials demand are providing a partial offset to the steep decline in the commodity housing segment.

Some final observations on housing supply in a level sense, as opposed to rates of change. The estimated unsold universal housing stock (the broadest measure) has fallen below 2.3 billion square metres, to almost a decade–low[10]. 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 de–stocking was a macroeconomic priority rolled under the supply side reform banner) was a little above 2.4 billion square metres. 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.[11]

The sustained period of weak starts over the last two–and–a–half years will ensure that aggregate supply will continue to tighten relative to underlying demand for some time yet. A genuine shortage of housing is likely to emerge in Tier 1 and Tier 2 cities in coming years. It is a question of when, not if. That may help explain why housing prices have not fallen more heavily despite the challenges the industry has endured. That should also provide some confidence that starts can bottom out relatively soon.

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.[12]

Moving on to non–housing end–use sectors now, and fixed investment in infrastructure was a bright spot in the first half of calendar 2023, as expected, with +10.1% YoY growth. While the overall growth in this broad segment was not a surprise, the composition of infrastructure investment did rotate over the last six months.

[9] 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.
[10] 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.
[11] Household size is from the decadal Census. Sample surveys are conducted more frequently but the data is of substantially lower quality than the Census.
[12] 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. sewerage[13], residential water supply, irrigation, flood prevention, environment river restoration) slowed to +3% YoY in calendar 2023 to date, having underpinned the overall pick–up a year ago, with +10.3% growth in calendar 2022. 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 so far in calendar 2023, the slowdown in this segment is an expected, but unwelcome, development. Power infrastructure though has accelerated notably, with robust +27% YoY growth over the last six months. This was led by renewables capacity additions, as discussed in more depth in the copper chapter. Transport had lagged the other two segments in calendar 2022, but an acceleration to +11% YoY over the first half of 2023 has helped offset the slowdown in water conservancy. The major categories of road (+3.1%) and rail (+20.5%) were mixed, while a +29.7% jump in residual transport categories (e.g., sea and river ports, airports) was an impressive follow–up to a +32.5% outcome in calendar 2022.

Investment in manufacturing capacity was also strong. The uptrend was not quite as broad–based across sub–sectors as in calendar 2022, although non–ferrous smelting (about 3% of the total), machinery and equipment (about a fifth), and automotive manufacturing (5% share) all enjoyed double–digit growth. The outlier on the downside remains ferrous smelting, reflecting tight regulatory scrutiny of steel sector capacity. Perhaps reflecting the slowdown in traditional exports, light industry (around a quarter of the total) slowed to +0.8% YoY after registering double–digit growth in calendar 2022.

For auto production, it has been a positive but turbulent year so far. Total units (production) are up +9.3% in the first half of calendar 2023, with commercial vehicles bouncing back from a weak 2022, passenger vehicles up +8.1% YoY, with new energy vehicles (NEVs) up +42.4% YoY. 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. The impact of this aggressive but temporary de–stocking could be seen in sharp declines in lithium pricing and steep discounts of Chinese nickel sulphate to LME nickel metal prices.

Elsewhere in the domestic end–use story, the diverse machinery category edged up +1.5% YoY in the first half of calendar 2023. Surveying the major components, transport and agricultural machinery are on a recovery trajectory. Domestic demand for construction machinery remains weak, but exports have proven to be resilient. Machine tools are a drag. Power machinery is the major bright spot, as it was six months ago. This mix of course favours copper over steel. Total consumer and electronics goods output expanded +2.5% YoY in the first half of calendar 2023. White goods were strong at +16.8% YoY, reflecting firmer domestic demand, while semiconductors and other electronics fell heavily (–14.4% YoY), as exports came under pressure.

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 has played out in calendar 2023 to date, with exports falling into negative YoY territory in the month of June 2023, although on a quarterly basis they remained slightly positive. Imports, on the other hand, fell in nominal YoY terms in both the March and June quarters.

[13] China has a target to increase the share of rural sewerage 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 (no pun intended). Developed countries treat about three-quarters of their sewerage, on average.

The transition from lockdown consumption dominated by goods and gadgets in 2020 and 2021 to an "experiential" 2022 (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. China's own "revenge travel" catharsis is just getting started, with its neighbours to the north and south preparing for a spectacular influx this year and next. Group tours to a number of popular destination countries including the US, Japan, Australia and South Korea were reinstated in mid-August 2023. The data suggests that international Chinese tourism spending has returned to about 70% of 2019 levels as of mid–2023. Note that there were more than 150 million outward international passenger movements from China in 2019.

Balancing the above slowdown in traditional goods export sectors, secular strength in workhorse decarbonisation technologies continues to be evident.

The authorities have dubbed NEVs, lithium–ion batteries and solar panels as the "three new" items. The "three new" collectively grew +62% YoY in the first half of calendar 2023. In 2022, China's exports of NEVs rose +120%, which was one–quarter of the impressive 54% growth in total Chinese auto unit exports, which reached 3.11 million. That put China in the #2 position globally, between traditional automotive powerhouses Germany and Japan. In 2023, auto exports have already reached 2.14 million units at the half–way mark for the year, which represents 76% YoY growth. That implies that China is likely to be recognised as the #1 exporter when the full year figures are known. The NEV component is tracking at 534 thousand units, or +160% YoY.[14] On the power generation side, exports of solar panels increased +47%. Note that Bloomberg NEF, a think–tank, estimates that China's investment in "energy transition technology" rose +70% in 2022, contributing roughly half of total spending globally. And with European spending slowing down, no acceleration in the US, and the UK and Japan going backwards, 90% of the growth in the global figure came back to China as well. Under a different definition, the IEA estimates that one–third of global investment in what it labels "clean energy"[15] occurred in China: still #1, but not quite as striking. Either way it is very helpful to have the world's largest domestic market for green technology when pursuing cost competitiveness in the global arena.[16]

Moving to the longer–term, our view remains that China's economic growth rate will moderate as the working age population falls (noting new estimates from 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.

[14] 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.
[15] Definitions can be found here: https://www.iea.org/reports/tracking-clean-energy-progress-2023
[16] Interestingly, China's wind turbine exports are –6.5% YoY in the first half of calendar 2023 – another sign that this critical value chain is going through a difficult period globally. Other signposts include job losses among major western OEMs, asset write–downs, and a string of offshore wind project cancellations.

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 2025, 2030, 2035 and 2050 are (rounded) 5%, 4¾%, 3½% and 1¾% 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 $1¾ 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. $1¾ 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. Beyond 2050, the story is expected to be even more dramatic … but to read it, you will have to wait for a dedicated blog.

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 prefer[17]) 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

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

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 chances for achieving "borderline" high–income status are 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%.[18] **Our planning range of 56% to 65% fits neatly without these parameters. That gives us confidence that our long–term planning range is built on robust foundations.**

[18] 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 fell to 1.88 Bt in calendar 2022, –4% from the record 1.96 billion tonnes produced in calendar 2021.[19] China's production declined –2% YoY, with the full year finishing at 1.018 Bt (after revision), which compared to 1.035 Bt in 2021 and the (record) 2020 figure of 1.065 Bt. Ex–China production declined –6% YoY to 866 Mt, with India (+6%, 125 Mt) the positive outlier. In pig iron, the global figure for calendar 2022 of 1.30 Bt was down by –4% on calendar 2021's 1.35 Bt, with a –1% outcome in China (864 Mt) allied to an ex–China contraction of –9%.

In the first half of calendar 2023, world crude steel production slipped a further –1% YoY, with China and India serving as a collective "source of stability" with +1% YoY (1080 Mtpa run–rate) and +7% (137 Mtpa run–rate) growth respectively, while the rest of the world contracted –5%. The most pronounced weakness was in Europe (–12% YoY), while South Korea was relatively resilient (–0.5% YoY), with the FSU, Japan and North America registering outcomes roughly mid–way between those book–ends. Pig iron though was able to lift mildly at the global level (+1% YoY), led once again by China's +3% and India's +7%.

For China, our updated crude steel estimate for calendar 2023 and our preliminary take on calendar 2024 indicate that the current four–year streak of outcomes in the 1.0 to 1.1 Bt plateau range running from 2019 through 2022 are likely to extend to five and then six.

The key caveat on the intra-year outlook for Chinese steel, as it has been for some years now coming into our full–year results season, is the looming spectre of mandated production cuts.

Non–environmental production cuts[20] (or their credible threat), typically backloaded to the second half of a calendar year, have become a major influence on industry dynamics. In the weeks leading up to the publication of our full–year financial results, some regions and cities were rumoured to have issued verbal guidelines to local mills, one smaller province has officially announced a cap, and rumours of a nationwide edict are also swirling. Market chatter is centring upon a general requirement to keep production at prior year levels. We are monitoring this closely, given the obvious impacts on the overall value chain if mills had to pull back abruptly late in the year after their sprint in the first half, as they did in calendar 2021. And it would also appear that some mills are choosing to run flat–out in anticipation that they may not be able to operate in unconstrained fashion later in the year.

At this stage though, the breadth, timing and severity of any prospective cuts are uncertain.

Note that Chinese steel production reached a robust 1080 Mtpa in the first half of calendar 2023 (the all–time high for a full year is 1065 Mtpa in 2020), with the half closing with a 1109 Mtpa pace in June. It is obvious from that starting point that we were already assuming a lower run–rate in the second half to get back to around +2% YoY growth. Pig iron surpassed a 900 Mtpa run–rate in the first half, and is on track for the second or third highest output in history, behind 2020's 908 Mt. Our assumptions include a materially lower path for direct exports in the remainder of the year: exports have been very high around 85 Mtpa in half one. To hit +2% YoY (our crude steel forecast based on end–use needs with middle of the road policy intervention), the second half run–rate for calendar

[19] 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.
[20] This distinction is made to avoid confusion with seasonal restrictions on heavy industrial activity based principally on air–quality concerns, which have a much longer history, particularly in Beijing and surrounding areas.

2023 would need to be about 996 Mtpa. To be flat versus calendar 2022, which was 1018 Mt, the run–rate would have to fall to 956 Mtpa in half two.

We would categorise the latter scenario as a severe impost on the sector if it were to eventuate, noting blast furnace (BF) utilisation would need to be about 20 percentage points lower than at the intra–year peak to meet the objective. China's BF utilisation rate averaged a robust 88% in the first half of calendar 2023, versus around 84% across calendar 2022 and in the previous corresponding period. The peak so far this year was around 92%.

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, who have been 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 –12% YoY in calendar 2022, and –3.5% YoY in the first half of calendar 2023, reflecting for the most part weak housing starts, as documented 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 +0.8% YoY. This growth was the result of a respectable performance by manufacturing end–use sectors (of which more below).

Against this backdrop, realised margins for Chinese steelmakers were poor for most of calendar 2022, with loss–making widespread.[21] In the first half 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. We note that while rebar and wire sales have consistently tracked the lower extremity of the demand range of recent years, with hot–rolled coil (HRC) only marginally better, cold–rolled coil (CRC) and plate have been either in the middle or upper part of the historical range.

We estimate that BF-BOF spot margins averaged around +$7/t in calendar 2022, and +$2/t in the first half of calendar 2023. A major difference between those two years has been that the intra–year inventory cycle for finished steel was back closer to pre–pandemic norms in calendar 2023. A similarity between the two periods has been elevated utilisation rates for integrated BF–BOF[22] facilities, which historically has tended to correlate with good margins. That relationship though has broken down through the pandemic era, with calendar 2023 an extension of that. Previously, excessive inventory seemed to be the proximate driver of that disconnect. With inventory under control in calendar 2023 to date (trader stocks are –5% YoY and mill stocks are –8% YoY as of early August), that theory is being challenged. See the discussion in the iron ore chapter for an explanation of how product differentials for lower-grade products impact upon cost support in that industry.

Taking a step back, we note that margins averaged $70/t from 2017–2021. Those who have followed our views for some time may recall that we argued that around two–thirds of the initial supply-side reform (SSR) boost to margins (which peaked at $105/t in 2018) would be durable, and one–third would be transitory. The realised margins for 2017–2021 have validated that estimate.

The end–use demand picture for Chinese steel in the first half of 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). Key sectoral trends are discussed in detail in the Chinese

[21] The latest information on steelmaking processes have led to a revision of historical estimates of margin levels. All figures are presented on this updated basis. Margins reported in previous vintages of this outlook are thus not like–for–like.
[22] A BF–BOF operation is an integrated process with "hot metal" (molten pig iron) produced in the BF then transferred to the blast oxygen furnace (BOF) for conversion into steel.

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), (3) the response of machinery demand to the anticipated mix of activity in associated sectors, and (4) the tussle between slowing external demand for steel–containing goods and the needs of the domestic economy. Note that the infrastructure upswing still feels well entrenched and is a solid foundation on which to build the remainder of the forecast. The caveat is that the rotation within this category towards power and transport, in parallel with a softening of water conservation outlays, is a trend to watch. We note that severe rains and flooding in northern China are highlighting that a multi–year upswing in the water segment may be somewhat overdue. This was a constant refrain during the second term of the Xi administration, but local governments never provided anything much more than a lukewarm response until last year, and that initial boost looks to have hit the doldrums. This segment of infrastructure spending could be a major beneficiary of any decisive efforts to restructure or consolidate local government debt.

We estimate that net exports of steel–contained finished goods account for slightly more than 10% 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.[23] The direct trade surplus in steel has fluctuated widely since the 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. There was an unexpected jump in the first half of calendar 2023, with sizeable surpluses in excess of +80 Mtpa recorded in multiple months, with a peak of 98 Mtpa in May. 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 substantially lower net export run–rate in the second half of calendar 2023 seems far more likely than not.

Turning to the long–term, we firmly believe that, by mid–century, China will increase its accumulated stock of steel in use, which is approaching 9 tonnes per capita, by between 1½ and 1¾ times on its way to an urbanisation rate of around 80% and living standards around three-fifths of those in the United States.

China's current stock is 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.

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.

[23] Note that 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.

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 by a few percentage points. 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.

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. 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 pathways. Subject to successful pilots, 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 DRI route, and its ability to be physically incorporated into an existing integrated facility to feed a basic oxygen furnace (BOF). You can read more about the ESF from our technical experts here, including plans for a pilot plant to optimise and de-risk the technology designed to enable these advantages to be realised at full scale.

Steel production outside China (hereafter ROW) weakened appreciably across calendar 2022, with the energy crisis in Europe and the Russia–Ukraine conflict both having a major negative impact. ROW utilisation (all mills, not just BF-BOF) closed the year at a weak 62% after a series of cuts across Europe and Northeast Asia (noting that the normal pre–pandemic range was 70–75%). There was a restart infused recovery to around 70% utilisation in the early months of calendar 2023, but no additional follow–through in the aggregate: utilisation fell back slightly to 69% in June. That was not enough to return the major regions to YoY expansion in the first half of calendar 2023: with the notable exception of the world's #2 producer, India.

India's crude steel sector has recovered strongly from the pandemic, with output in 2023 now expected to be +35% from the 2020 low point. India is expected to lead global growth again in calendar 2023 (in percentage terms). In terms of new tonnes, it will contribute roughly half of the growth produced by China, on an approximate 3.8–to–1 ratio of percentage growth rates.

Together, China and India are expected to provide around 60% of the incremental tonnes in the 2023 calendar year. That broad expectation was one of the reasons why we stylised these populous giants as a "source of stability" for commodity demand twelve months ago.

Indian mills are producing into a well–entrenched capex upswing in this pre–election year, with public sector capex at its highest level as a share of GDP since the mid–2010s, and gross investment to GDP on track to exceed the average of Prime Minister Modi's first term in office. And while the looming general election and the associated fiscal impulse are impossible to ignore as inspirers of confidence, an equally important and more durable fact is that corporate and financial sector balance sheets are much improved from the late 2010s. With the lifting of the credit crunch that defined the pre–pandemic years, there is a considerable backlog of private sector capex to be worked through

now that balance sheets are better placed to sustain it. You can read our views on Indian infrastructure needs here.

Back to the ex–India portion of ROW, and we note that output cuts in the second half of calendar 2022 established a trough for calendar 2023 first half run–rates, but the staggered reopening seen in calendar 2023 to date, including some "throttling" of production in the weak demand and narrowing margin environment, has been insufficient to see a return to YoY growth at this stage. Demand headwinds combined with a series of accidents and disasters (Turkey's earthquake, fires in major furnaces in France and Spain), in addition to sanctions on Russia and the impact of the Russia-Ukraine conflict itself, to produce a very weak –12% YoY outcome for the pan–European aggregate. While flattering base effects (and an improving automobile sector) are likely to see high single–digit or low double–digit growth across major ROW regions in the second half of calendar 2023, presuming they can hold onto utilisations rates at least in the high 60s, full year growth will be underwhelming – and Europe is expected to decline overall. Ex–Europe, that view is consistent with recent guidance from major Japanese mills, who have signalled low single–digit growth in their current fiscal years (April to March) despite declining production in the year–to–date. Demand from automakers is expected to be strong. By the end of calendar 2024, we still expect North America to be running back above calendar 2021 levels behind their tariff wall, while Europe and North–east Asia, with their greater external exposure and underwhelming domestic growth prospects are anticipated to fall short of reclaiming that benchmark.

The price path associated with the above operational performance traced a flattish, upside down U-shape across the first half of calendar 2023. According to Platts, benchmark prices in India (ex–tax), Europe, and the US opened calendar 2023 at US$683/t, US$737/t, and US$794/t respectively: modestly above the November/December 2022 price trough that instigated a number of voluntary curtailments. As the energy crisis in Europe faded, and utilisation picked up, prices lifted to an intra–half high in early April of around $739/t, $938/t, and $1295/t respectively. Another phase of downward pressure on prices then ensued, partly due to underwhelming demand and partly due to very competitively priced Chinese steel exports. In late July, Indian prices were back below $700/t, Europe was sitting around $725/t and the US was back to $920/t. Operating margins are unappealing but still estimated to be positive at these price levels.

Iron ore

In the second half of financial year 2023 iron ore prices (62%, CFR, Argus), averaged US$118/dmt, with the price ranging between US$97/dmt and US$133/dmt. Half–on–half average prices were +17% versus the first half of financial 2023. The average lump premium was US$0.13/dmtu in the second half of financial year 2023, on par with the first half.

Supporting the improved price performance half–on–half, Chinese port stocks ended the 2023 financial year at 127 Mt, down by around 4 Mt over the last six months. Higher port arrivals were more than offset by robust iron ore demand, which was a function of exceedingly high operating rates for China's BF fleet (see steel and pig iron chapter). Port outflow averaged more than 3 Mtpd in the second half of the 2023 financial year, versus 2.92 Mtpd in the prior half and 2.97 Mtpd in the second half of the 2022 financial year. Despite that, steel mills' iron ore coverage days fell sharply over the half, from ~27 days in calendar 2022 to a mere 17 days in June 2023. There has been a secular decline in the level of inventories that mills choose to hold directly in the era of active port stock trading which opened around the time of the SSR, but the leanness of the current holding is historically unprecedented: even in prior episodes where steel cuts were looming. Turning points in intra–year stocking mini–cycles tend to be correlated with price direction, so this is more than an academic observation.

At the time of our half–year financial results six months ago, the iron ore price was sitting on the crest of a wave. Having bottomed at $79/t in late October 2022, it had traded as high as $133/t in early calendar 2023. That latter price was partly a function of re–opening euphoria, undiluted by the realities of both a still challenging global outlook and the ongoing difficulties of private property developers in China, as proxied by weak rebar sales. Prices soon receded from that level and settled into a range trade with the floor in the vicinity of $100/t. The average price for the period, circa $118/t, and the solid uplift half–on–half, felt like a good approximation of the physical fundamentals. One thing that the price action in financial year 2023 reinforced for us is that real–time estimates of cost support are a powerful instrument for understanding short–term developments in the iron ore market. In the first half of financial 2023, there was a stern test of the bottom end of our current range of $80–100/t, with prices ultimately bottoming at $79/t. In the second half, 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.

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 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.[24]

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.

The consensus in 2018 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.

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.

Using Wood Mackenzie's forecasts published in the September quarter of 2018 for the state of the industry in 2021 as a proxy for market consensus, we note that actual contestable demand was +125 Mt higher than expected in 2021. Major seaborne producers collectively exported –79 Mt less that year than was expected three years' earlier. And rather than being squeezed out, higher–cost producers increased total production by an enormous +183 Mt – essentially enough to constitute another "major".

Fast forward to calendar 2023, and the major seaborne producers have collectively increased supply by only +25 Mt over the calendar 2021 level, while contestable demand has been relatively flat. Chinese domestic production has been relatively stable too. Ergo, there has been little change in the aggregate call on higher–cost supply, 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 fundamentals persists.

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. 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 explained the dynamics of this feedback loop six months ago, with an emphasis on two of the more sensitive factors: freight rates and product differentials. With product differentials and freight lacking volatility (by their own standards) in the second half of financial 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 this on the Fe spectrum actively traded, and the current 58%

[24] 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.

discount being less than 10%, it is easy to see how quickly the incentive price might steeple 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 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 blogs (episodes 2, 3 & 7 in our Pathways to Decarbonisation series) we see higher quality iron ore fines and direct charge materials such as lump are 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 12 years old. BHP's South Flank project, which achieved first production in May 2021, will raise the average iron ore grade of our overall portfolio by around 1 percentage point, in addition to increasing the share of lump in our total output from around one–quarter to around one–third.

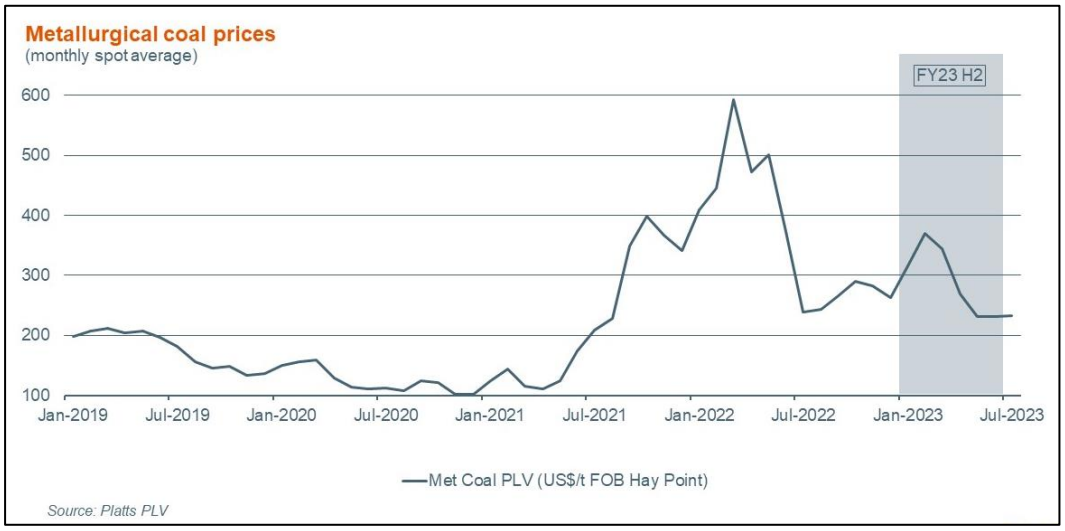
Our analysis indicates that the long run price will likely be determined by the all–in 62% equivalent cost base of the least competitive seaborne exporters (higher operating cost and/or lower value–in–use) in either Australia or Brazil. That assessment is robust to the prospective entry of new supply 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.

Metallurgical coal

Metallurgical coal price[25] 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 2023 financial year has felt almost tranquil. In the second half of financial 2023, the PLV index ranged from a low of $222/t FOB Australia to a high of around $390/t, averaging $294/t. The average was +11% on the prior half, but –37% YoY. The range for PLV was $168/t wide in the most recent half, versus $133/t in the prior period. For the full financial year 2023, PLV averaged $279/t, –29% YoY from the record high of $390/t in financial 2022.

Non–premium Mid–Vol (MV64) has ranged from $198/t to $350/t; PCI has ranged from $187/t to $344/t; and SSCC has ranged from $164/t to $289/t. Three–quarters of our tonnes reference the PLV FOB index, approximately. That is materially higher 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 averaged 11% in the second half of financial 2023, versus 9% in the prior half. The recent five–year average is 12%.

The metallurgical coal industry has experienced both hunger and plenty in the pandemic era, 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.



Beyond the abrupt volte–faces on the demand side associated with lockdown and re–opening economics around the globe, the industry has also dealt with the presumptive clearing market [China] not accepting products from the major exporter [Australia] for more than a year, a supply side shock in lower–end coals in the wake of the Ukraine conflict, massive arbitrage opportunities between the FOB and China CFR sectors of the trade, three consecutive La Nina phases that hampered production on Australia's east coast, and a generalised energy system crisis that pulled already scarce metallurgical

[25] 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.

coals into power generation. After all of that, the last six months felt relatively uneventful, even with the key uncertainty of China's trade re–opening to absorb, an easing of the "multi–region, multi–causal" supply headwinds we have been repeatedly referencing, and a tilt towards El Nino looming on the horizon.

Six months ago, we put forward a framework for thinking about what a resumption of the China–Australia trade might look like: noting that at the time of writing we did not have any firm indications one way or the other on the re–opening of borders. 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." These are the main considerations we then put forward for assessing how the bilateral trade and broader industry might evolve, with updates for material developments over the last six months.

1) Already strong producer/end–user relationships for Australian FOB became even stronger as trade flows rebalanced swiftly when access to customers in China was lost. Long–term contract volumes committed to the FOB trade will be honoured, and the long–term contract share of total FOB trade has increased. Equally, with the return of some bilateral trade between Australia and China, that bodes well for liquidity in the spot market and for robust price formation driven by physical fundamentals. *Updated comment: exactly as foreshadowed in terms of where the transactions have been concentrated, although the import arbitrage window has rarely been open for Chinese traders, which has limited demand for seaborne cargoes. Imports from Australia have been meagre, at just 2 Mtpa in the first six months of calendar 2023.*
2) Mongolian and Russian sellers who have no other major competitive outlet 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, vs 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 could grow as the end of zero–COVID eases logistical constraints at Mongolia truck border crossings. *Updated comment: Mongolian truck flow has increased to a four–year high above 1000 per day, and Russian imports continue to grow: both factors are limiting China's call on the seaborne market. In fact, Chinese coke exports have increased, a clear sign that domestic coal supply is ample.*
3) Also in China, domestic capacity additions have reduced import requirements, with the discipline of the SSR period having been set aside somewhat under the record prices seen in calendar 2022. (More details below). *Updated comment: domestic capacity is now 9% higher than before SSR, although the regulatory forbearance on the safety front that emerged during the energy crunch has been tested by incidents in calendar 2023.*
4) While loss–making prevails, it reduces the incentive for the median Chinese steel mill to compete aggressively to divert higher-quality Australian supply from the FOB trade. Chinese BF–BOF steel margins are still negative early in calendar 2023, so the productivity and GHG emissions intensity benefits of premium coals are not as sought after by steel mills at this exact juncture as we expect they would/will be under regular operating conditions (although there will be exceptions to this general observation among the largest, most sophisticated coastal mills). As we argue below, we expect the time will come when traditional value–in–use dynamics reassert under more normal margin conditions, but it does not feel like this is imminent. *Updated comment: steelmaking margins did not improve over the half and therefore this dynamic is pushed out. If steelmaking cuts are initiated in the second half of calendar 2023, and margins improve quickly, that will be an interesting test of this proposition.*
5) India has moved into the #1 seaborne import position and its appetite is growing rapidly, versus steadier demand in the other major import regions. That is a relevant consideration for where the seaborne trade might clear in the medium–term. *Updated comment: India is distinguishing itself*

positively in a number of commodity markets at present and met coal is certainly one of them, with growth of +6.8% YoY (coking coal and PCI).

6) The key hypothetical argument in favour of a swifter re–rebalancing would be a major wedge between Chinese and ROW pig iron production growth developing, as we saw in 2020. That though seems unlikely while the Indian economy (the largest seaborne importer of met coal, at ~70 Mt) is looking firm, but the potential for Europe (~45 Mt) and North–east Asia (~96 Mt) to be weaker than expected is certainly still there. *Updated comment: India has performed well on all fronts while Europe has been the weakest major pig iron region. A swift re–balancing has obviously not occurred.*

Moving on to the supply side fundamentals, overall seaborne supply was around 295Mt in calendar 2022, flat YoY and –17 Mt behind calendar 2019 levels. Adding changes in Mongolian landborne exports to the mix, total supply was –25Mt versus 2019, a –7% decline. Calendar 2023 to date is tracking towards a significantly improved outcome, with total seaborne supply expected to pick up 4-5% to a level within touching distance of calendar 2019 levels. China's imports from Mongolia are also expected to rise markedly YoY, establishing an approximate 40 Mtpa pace that is in excess of the rates achieved in the late 2010s. The sum of Chinese imports and the ROW seaborne trade is expected to be just a few tonnes short of pre–pandemic levels at the end of the 2023 calendar year.

The source of China's imports though has changed abruptly not once, but twice since the pandemic began. The dramatic trade rebalancing in calendar 2021 necessitated by the sudden–stop of Australian coal inflows saw North American producers and Russia stepping up, with Mongolia unable to do so at the time. In calendar 2022, Russia stepped up further, Mongolia started to pick up, and North America was squeezed lower. In calendar 2023, those trends have been accentuated, with Russia plus Mongolia increasing by +40 Mt over two years, and the North Americans falling –9 Mt on the same basis.

Looking at the performance of the major regions, both in 2023 to date and versus 2019, it becomes clear that while operational challenges have been multi–regional and enduring, the headwinds have begun to ease somewhat in the last six months. Australian shipments to the seaborne trade were –4.2% to 160 Mt in calendar 2022, –20 Mt from the calendar 2019 level. After a weak March quarter, production has rebounded, and if that trend persists in the second half, it is feasible that shipments could close roughly half the gap to 2019 levels. North American exporters saw almost flat YoY tonnages in 2022, with modest growth anticipated for calendar 2023. Neither is expected to reclaim their pre–pandemic baseline this year or next. Mongolia has been 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 is now on track to export 40 Mtpa to China in calendar 2023: +6 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 materially above 2015 levels: +9% on the most recent estimates. The capacity increases (and some local regulatory forbearance that has increased effective capacity) have enabled hard coking coal production in calendar 2023 to date to rise +2.7% YoY. Production is now around +11% higher than 2019 levels (+18 Mt). The PLV proportion of that though has been relatively flat between 25 Mt and 28 Mt.

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. As we argued here, 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 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 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 PLV 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 will be increasingly apparent if carbon pricing becomes more pervasive.

The flip side of the burgeoning advantages of PLV, as derived from the fundamentals discussed above, is that the non–PLV pool of the industry could face headwinds for an extended period in the disrupted post COVID–19 world.

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 age[26] of just 12 years in China – the major producer – and around 18 years in India – the key growth vector). 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 and storage, 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.

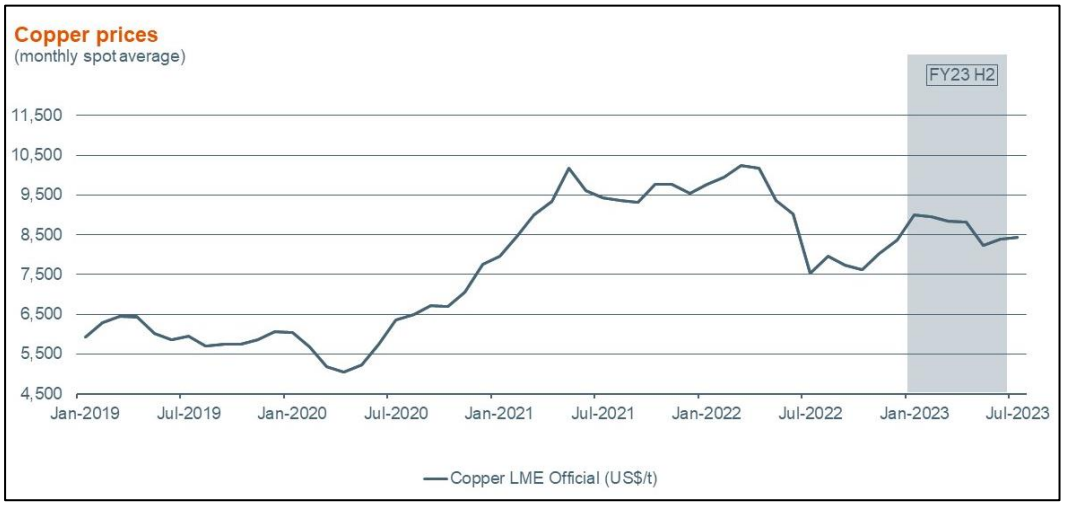
We certainly acknowledge that (a) PCI could be partially displaced in the BF at some point by a lower carbon fuel, and (b) the well–established electric arc furnace (EAF) technology, charged with scrap and without any need for metallurgical coal, is likely to be a stern competitor for the BF at scale 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, 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 seven Scope 3 MOUs with China's China Baowu, HBIS and Zenith, Japan's JFE Steel, South Korea's POSCO, India's Tata Steel and European multinational ArcelorMittal are available elsewhere on our website.

[26] 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 $7,910/t to $9,436/t ($3.59/lb to $4.28/lb) over the second half of the 2023 financial year, averaging $8,703 /t ($3.95/lb).[27] The average was around +11% higher than in the prior half but –11% versus the equivalent half of financial year 2022.



Zooming in on the price path in the second half of financial 2023, the period opened with copper riding a major macro updraft. The impetus for this was China's triple volte–face on zero–COVID, international relations and real estate: and copper did not miss out on the re–opening trade. However, the reality of hawkish central banks, weakening OECD manufacturing activity, and financial instability (Credit Suisse failure, regional bank runs in the United States) soon poured cold water on the exuberance that was extant as we went to press in February 2023. China's inability to build on its fast start to the year also increasingly took its toll on investor sentiment towards industrial metals. As the half concluded, the industry was turning its attention towards the need for stimulus in China, the potentially imminent conclusion to the US Fed tightening cycle as inflation indicators eased, and the increasing likelihood of a soft landing for the US, with resilient growth printing in parallel with the promising progress on disinflation.

It is the nature of the copper industry that the base price narrative for any given period can often be told without direct reference to industry–specific fundamentals. As the preceding paragraph illustrates, that was the case again in the first half of calendar 2023. It so happens that on this occasion, the fundamental picture was somewhat ambiguous, so trading macro fluctuations was perhaps the path of least resistance. At a high level, part of the complexity came from the fact that while the industry has moved into a small surplus situation in the first half of calendar year 2023, as proxied by steadily rising treatment and refining charges (TCRCs) for concentrates [four–fifths of primary production], this has not been well reflected in visible cathode stocks, which have been stuck at very low levels. Operational performance has also remained patchy, with another year of at least 5% disruption versus initial guidance likely. If there is modest slippage from producer expectations in the second half of the year, overall units could yet be in balance.

[27] LME Cash Settlement basis. Daily closes and intra–day lows and highs may differ slightly.

China has also been something of an enigma in calendar 2023 to date. Industry participants have been challenged to distinguish between the negative sentiment directed towards the general Chinese economy in the June quarter, declining YoY imports and unattractive CIF premia in Shanghai, and the reality that the most copper–intensive parts of the system were doing extremely well (end–use is likely to increase around +6% YoY in calendar 2023 while refined production registered double–digit growth in half one), even as inflows relating to financing demand cratered[28] 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. At the time of our half–year results for financial 2023, we recounted the mixed performance across sectors in calendar 2022, where a dichotomy between end–uses facing the traditional economy and end–uses leveraged to the energy transition was a major theme. In calendar 2023 to date, energy transition demand has remained strong, but this time the majority of the traditional sectors are also in the plus column. The standouts have been construction (where the "housing delivery" mantra has seen copper–intensive completions jump +19% YoY, in stark contrast to the still very weak starts situation), air–conditioners (+17% YoY), NEVs (rebounding quickly after a short de–stocking cycle) 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 +7.8% YoY (outstripping the State Grid budget of +4%), and power source investment was +54% YoY, with solar installation up +154% YoY.

Wind and solar together saw 101.4 gigawatts installed in the first half of calendar 2023, with solar having now surpassed hydro as China's second largest power source by capacity. As an aside, while making comparisons with hydropower, 101 gigawatts is roughly equal to the total hydro capacity that the United States has built up over the last century or so. China has just installed the same nameplate capacity in renewables in half a year.

We have already referenced that under the Bloomberg NEF definition, China saw a +70% uplift in energy transition investment across calendar 2022. Another large number is on the way for calendar 2023. This broad–based performance seems likely to ensure copper out–performs steel for a third consecutive year.

In the ROW, refined demand struggled in calendar 2022 and has weakened further in calendar 2023. The major OECD regions (about 30% of global demand) are all on track for annual contractions in calendar 2023, which easily offsets strength in India (+8% YoY, but only 3% of demand) and resilience in the remainder of the developing world (+1.5% YoY, 14% of total). With Chinese demand up strongly, the ROW share of world refined demand is expected fall –2 percentage points by the end of calendar 2023, to around 44%.

On the supply side of the industry, the copper concentrate balance has loosened a little, with the average spot TCRC in the first half of calendar 2023 ($79/dmt & US 7.9¢/lb, according to FastMarkets) rising to the highest level since 2019 (noting higher rates favour the smelter and lower rates favour the miner). The spot TC closed the 2023 financial year in the high $80s. More favourable TCRCs are underpinning smelter profitability, with acid by–product revenues having come off sharply over the last twelve months. Notably, China's acid exports fell –55% YoY in the first half of calendar 2023: an unflattering commentary on the state of global heavy industry. Within that though, Indonesia has supplanted Chile as the #1 destination for these shipments, with the rapid ramp–up of HPAL (high pressure acid leaching) nickel facilities leading to a fourfold lift in acid imports in just one year.

[28] A decade ago, stocks in Chinese bonded warehouses reached 1 Mt. Today, there is less than 100 kt.

As of July–2023 (i.e., with the benefit of some June quarter operational reviews), Wood Mackenzie had so far identified disruptions equivalent to 1.7% of initial production expectations in calendar 2023. That compares to an average run–rate of 1.9-2.2% in 2019-2022 (excluding the outlier observation from the peak of the Great Lockdown in 2020). Our reading (with a slight advantage of having seen most Q2 operational reviews) is that rather than looking at a better than average operational performance, which a literal reading of the Wood Mackenzie figure would imply, 2023 is likely to see a slightly higher than average level of disruptions. Our point estimate is 5½%. Note that 5% is the long run average for this metric: and that is our default assumption at the outset of any year. However, as we indicated in this report six months ago, a normal year for disruptions in percentage terms in calendar 2023 would be far worse than average in terms of expected copper units from the perspective of two years ago. That is because several major copper producers lowered their guidance for calendar 2023 during 2022 or very early in 2023 – and on our estimates these downward revisions were worth ~3.1 percentage points of pre–disruption primary production (~3.4% post disruption) versus what was guided for 2023 at the outset of 2022. Therefore, a "normal" 5% in calendar 2023 versus year-opening guidance would be the operational equivalent of 8–8½% if guidance had not been pre-emptively lowered. From our current vantage point, that may be precisely where we are headed. That is a major reason why we are hedging our mid-case call on the calendar 2023 mass balance. Weak operational performance clearly has the potential to erode the modest ex ante surplus we derived at the outset of the year.

Turning to the outlook, a long–awaited cluster of projects (including in Peru, Chile, central Africa, and Mongolia) have either recently come on-line or are expected to do so within the 2023–2024 window. 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 +12% from calendar 2021 levels by the end of calendar 2024, roughly double the +7% increase in global refined demand expected over the same period. Rising primary supply is also expected to coincide with an increase in the availability of copper scrap. The scrap uptrend is supported by the increasing size of the end–of–life pool in China, accommodative prices, and fewer physical constraints from social distancing. However, the much–anticipated bounce in collection post zero–COVID has been underwhelming to date, partly due to what small scrap collectors feel is an onerous VAT burden in China.[29] Global secondary supply into refined copper (3.5 Mt in a 24.8 Mt refined industry in calendar 2022) is expected to be +7½% higher in calendar 2024 than in 2021. That is –1½ percentage points versus what we expected six months ago.

The industry needs to digest the entry of this supply over the next two years, at a time when demand in the developed world is expected to be at a low ebb: which puts a major onus on China. Instinctively, at a high level this feels like the supply–demand balance is more likely to be in surplus than not under these conditions. Bottom–up, we reach the same conclusion: but not by too much.

Once this phase of the decade is transited, a durable inducement pricing regime is expected to emerge in the final third of the 2020s. Holistically speaking, a decent build–up of inventories in this decade's middle third would provide a healthy buffer in advance of the pronounced deficits we envisage in the copper industry's medium–term future.

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.

[29] A MOF ruling in 2022 specified that Chinese scrap firms are required to pay 3% of their general revenue in VAT, a concessional rate from the general scheme of 13% of added value. Reportedly, many firms were not paying any VAT, and their business models are coming under strain as local authorities are no longer willing to look the other way with fiscal stress high.

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. In calendar 2024? 77:23. These ratios tell a story of sustaining capex cannibalising the budget at a corporate level, which beg the question: how affordable is a major growth push for the sector at large?

In terms of hard numbers, we have previously divulged that in a plausible upside case for demand, the cumulative industry wide growth capex bill out to 2030 (which will be here before we know it) 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.

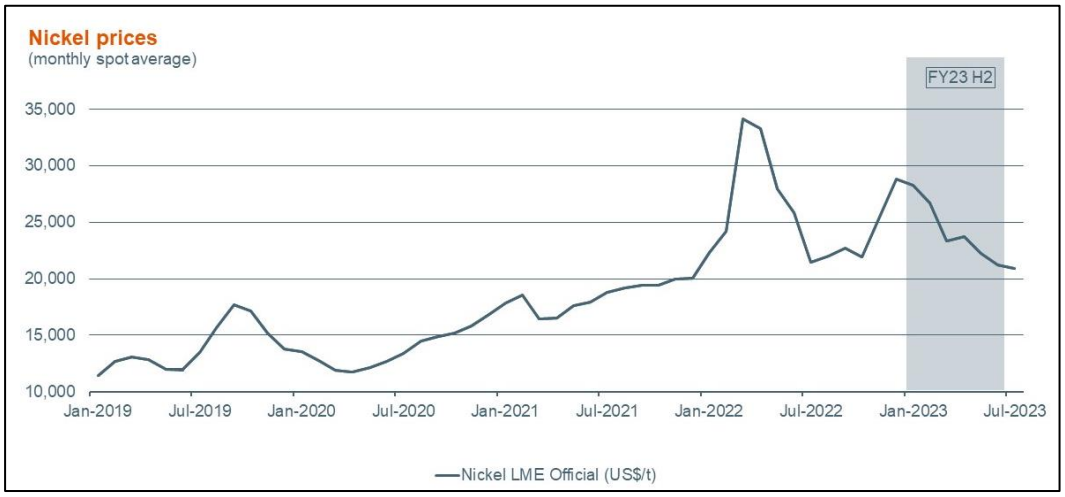
How big is that as a financing objective? It is large relative to the copper value chain and the financial resources of individual companies. But looking at it another way, it is small versus the investment currently being directed towards upstream fossil fuel production (oil, gas, and coal) which is currently around $650 billion annually. It is remarkable to consider that the re–direction 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 presumes that the projects are ready and waiting. The reality is that 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, 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.

Nickel

LME nickel prices ranged from $19,745/t to $31,200/t over the second half of financial year 2023, averaging $24,205/t. The average is +2% versus the prior half. The general trend has been downwards, with the half opening at its highs and closing at its lows. There was certainly volatility in between, but none of the periodic upswings in price felt overly convincing.



We estimate that the refined nickel balance was in a large deficit in calendar 2021, with a steep associated rundown in visible stocks. This flipped to an aggregate surplus of material size in calendar 2022. At the midpoint of calendar 2023, we estimate that we are in the middle of a three–year run of surpluses that are likely to average out well over 200 kt. The point at which this manifests itself fully in LME pricing has not been reached yet, notwithstanding the substantial unwinding of calendar 2022 fly–up pricing levels that has occurred over the last six months. The Class–I sub–balance has remained tight, keeping exchange stocks at very low levels. Visible stocks are down by –44% YoY.

The excess has been contained, to date, within the significantly larger Class–II product set, and the rapidly growing intermediates space, where the surplus has burgeoned. The excess of nickel units outside of Class–I has been most evident in the Asian theatre for some time, and payables versus LME equivalents have plunged accordingly.[30] We consider that there have been three major dynamics at play here. The first is that demand for stainless steel (70% of nickel first–use in calendar 2021, but only 65% in calendar 2022) has slowed. Second, there have been three consecutive years of double–digit growth in Class–II production from 2020–2022 (with net growth in Chinese and Indonesian nickel–pig–iron [NPI] up around 1.6 times versus 2019), which will be followed up by something in the high–single digits in calendar 2023 (with the net China–Indonesian NPI uplift moving to around 1.8 times 2019 levels). The third has been stunning growth in intermediates from Indonesia: NPI–to–matte production (~75% nickel contained) increased from 2 kt in calendar 2021 to 124 kt in 2022, and is on track for something in the mid 130 kt area in calendar 2023; while mixed–hydroxide precipitate (MHP: 30–45% nickel contained) rose from 16 kt in 2021 to 113 kt in 2022, with calendar 2023 projected in the mid 140 kt area.[31]

The surge in intermediates supply is the direct result of upstream innovation to meet the needs of the rapidly expanding battery value chain. But breakneck growth and profitability are not always the same thing. The move to bring more supply into the battery value chain has, to date, not been a particularly profitable exercise, with insufficient capacity on the Chinese Mainland to process discontinuous

[30] While this is most evident in Asia, Class-II ferro-nickel producers have also faced considerable discounts outside Asia.
[31] Historical data is compiled from a composite of sources (Wood Mackenzie, SMM and CRU), with some BHP estimates.

growth of an essentially new product. It has also seen a collapse in the economics of the metal dissolution route to nickel sulphate in China. Separately, NPI margins have also come under considerable pressure, but the existing glut of intermediates make the NPI–to–matte escape route unrewarding to pursue. The elegant solution to these circular problems (from the perspective of a Class-II producer, something we are obviously speculating on) was, of course, to find a way to economically convert some of the glut of intermediates into refined metal suitable for delivery to the major exchanges: thereby easing the opposing pressures in each product class, accessing the considerable arbitrage presently on offer, and enjoying the optionality of exchange deliverability. Accordingly, we have seen 50–60kt of new Class–I capacity come online in China as of June 2023, with double that expected to be operational across China and Indonesia by December 2023. Chinese industrial giant Huayou Cobalt has been approved for deliverable status on both the SHFE and the LME, with others expected to follow.

Huayou was the first company to apply for brand listing under the LME's new "fast track" approvals process. Diversifying sources of deliverable metal to the LME exchange is a sensible in-principle step in the reform of this institution, as is the return of Asian trading hours and their consideration of making nickel powder LME deliverable. However, this new Class-I capacity 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 cathodes do not prove to be fully fungible from the perspective of the battery value chain, then there is potential for a material bifurcation within the Class-I products space. The second question is that as the majority of feedstock behind the new product flow will come from Indonesia, where a well-known range of ESG and responsible sourcing challenges currently exist, how might that impact upon the attitudes of metal consumers that are not indifferent to these fundamental points?

While the LME will no doubt enforce its policy on "Responsible Sourcing of LME Brands" to any material applying to be listed, will it be sufficient to address the aforementioned challenges if/as this new subset of Class-I material becomes a growing share of LME inventories and/or turnover? The veracity of this price as a representative benchmark for the lithium-ion battery value chain may come into question. The battery value chain is a sophisticated and demanding group of consumers that require high ESG standards and supply chain transparency as well as nickel feedstocks that are cost-effective to convert to nickel sulphate.

We argue that the LME and other organisations could look to grasp the opportunity created by the potential flurry of new listings, to either increase the transparency for buyers of metal as to the heterogeneous GHG emissions intensity and other relevant ESG characteristics that are deemed valuable by discerning purchasers, or explore options to develop nickel pricing that can explicitly incorporate such characteristics as premia and discounts to the base price (e.g. GHG intensity, adherence to agreed mining and refining standards, such as tailings management). We also note in this regard that entrepreneurial interest in alternative nickel pricing solutions has emerged, such as GCH's 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 build a more transparent, efficient and robustly independent pricing mechanism for this critical mineral – in its many traded forms.

Turning to the longer term, we believe that nickel will be a substantial beneficiary of the global electrification mega–trend and that nickel sulphides will be particularly attractive. This is due to their relatively lower cost of production of battery–suitable class–1 nickel than for laterites, as well as the favourable position of integrated sulphide operations on the GHG emissions intensity curve.

There are five key questions for the nickel market in the longer run.[32] The first is how fast will electric vehicles (EVs) penetrate the auto fleet? The second is what mix of battery chemistries will power those vehicles? The third is 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? The fourth question is related to the third: 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 the transition to pervasive carbon pricing? The fifth is how will the trade flow of nickel units be influenced by policy and geopolitics?

Our views on the first two questions are both well–known and uncontroversial: EVs are taking off, and ternary nickel–rich chemistries 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. 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.

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. Sodium–ion batteries have also been garnering additional interest. They could 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.

On the third and fourth questions, the frenetic pace of capacity additions in Indonesia offers multiple data points. We have observed that capital–intensity estimates from Sino–invested projects in Indonesia are consistently lower than those with Western sponsors, or consultant estimates of likely capital intensity. Evidence to date implies that the reality is sitting somewhere between the developer–advertised cost and the more sober views of the analytical community. Notably, ramp–ups have also

[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 year in the 2020s. Non–stainless, non–battery demand has been more stable in its share 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.

been far smoother than the bumpy ride experienced by the first generation of HPAL projects attempted globally in the early 2010s, where official nameplate capacity proved chimerical in some instances. We have also observed that some projects that are adopting gas–fired power from the outset, rather than the typical coal, are inevitably coming in at a higher capex cost. On the operational side, an increasing recognition among nickel customers and the wider investor community of the broad environmental impact of Indonesian operations (for example land–use change, biodiversity, and tailings management)[33], in addition to the highly carbon emissions intensive nature of the local (frequently captive) electricity supply, should – rightly – add to the cost base of supply from this region in due course. We range the quantum of this cost uplift in our long run scenario analysis. Western media scrutiny of ESG issues in Indonesia has arguably intensified over the last six months, amidst heightened interest in the provenance of critical mineral and decarbonisation technology in general.

The question of how carbon pricing at home (i.e., direct mine costs embedded in a traditional supply stack) and at the border (i.e., delivered cost to a user in a region enforcing a carbon border adjustment mechanism – a CBAM) will influence medium– and long–term competitiveness remains wide open. While market forces will have much to say about this matter, policy and politics will also matter a great deal. Which leads into the fifth point well.

Calendar 2022 may well be memorialised by future historians of the energy transition as the year that the US passed the Inflation Reduction Act (IRA).

The over–arching design of the IRA neatly encapsulates the intersecting themes of the decarbonisation imperative, the desire for energy security, supply chain resilience, economic nationalism, and great power rivalry.

The practical import of the legislation for nickel and other battery raw materials is that there are significant inducements for automotive OEMs to dramatically reconstitute the geographic make–up of their critical mineral supply chains in favour of domestic activity. Or failing that, partnering with FTA aligned nations, those given equivalent status under a formal exemption (e.g. Japan and the UK) or perhaps those brought in under other banners such as the Indo–Pacific Economic Framework (IPEF). The IPEF captures a number of countries of interest in the EV and broader technology supply chain, including Australia, Japan, India, Singapore, Malaysia, South Korea, the Philippines, Vietnam and, of course, Indonesia. The IPEF reported that a landmark supply–chain agreement was close to being finalised in May–2023, after a session suitably hosted by the city of Detroit, with a sector specific Supply Chain Council and a Supply China Crisis Network among the outcomes. Whether IPEF becomes a quasi–FTA from the perspective of the IRA remains speculative. Roughly a year after President Biden signed the IRA into law, there also remains ambiguity around the interpretation of the "Foreign Entity of Concern" provision, and by extension, whether Indonesian nickel produced or part–owned by Chinese companies will eventually find its way into the US as a qualifying material for IRA subsidies.

Europe's Critical Raw Materials Act was launched in March 2023, establishing targets for the EU's contribution to its own consumption at the extraction (10%) and processing (40%) stages for the materials on its list, adding a recycling objective (15% of consumption – noting that the earlier waste management framework directly limits the export of scrap to the developing world) and a supplier concentration ceiling (no more than 65% from any single third country). A voluntary central buying entity remains part of the framework – which is not something that has historically produced efficient outcomes for either producers or consumers. Japan's refreshed strategy includes a provision where the venerable JOGMEC (styled as "Japan's organisation for energy and metals security", whose roots go back to the 1960s) will extend its activities to financial support for metals processing investment,

[33] An interesting study from the IFC provides estimates of the land–use GHG emissions impacts on copper and nickel mining. See https://commdev.org/publications/ifc–net–zero–roadmap/

with smelting specifically called out. That could well create a match for resource–rich, processing–poor jurisdictions with ambitions to move further downstream.

Australia's Critical Minerals Strategy has also been refreshed. As a major exporter of a diversified basket of commodities, some of which are leveraged principally to traditional fundamentals, and some of which will furnish the essential building blocks of the energy transition, Australia's starting point and perspective is very different to that of the northern hemisphere manufacturing powerhouses. Our consistent advice on this matter has been that Australia can productively focus on creating the most internationally competitive business environment possible, and much can follow on from that. That requires an emphasis on economy-wide productivity enhancing policies, including getting the balance right in industrial relations, having a competitive and predictable taxation and regulatory system, pursuing a world-class energy and logistics infrastructure base, tackling our current skill shortages and pre-empting what the next wave of skills demand will look like, and systematically seeking to attract the best individual talent and most innovative companies that the world has to offer. For mining specifically, speeding up approval processes would be a major contribution to collective efforts to mobilise the metals and materials that the world needs for both traditional purposes and to decarbonise.

In terms of Australia's critical minerals list itself, which is currently under review, copper, nickel and uranium are, in our opinion, natural additions due to their integral role in the energy transition and their inclusion in the lists of many other producing and consuming regions, including the nation that is arguably most like Australia in this context - Canada.

World Bank analysis[34] of ten low-carbon energy technologies that are expected to drive the broader growth in critical minerals demand, shows that copper is essential to all ten technologies and nickel to nine of them. Uranium is central to the production of zero-carbon nuclear electricity, and nuclear power features quite prominently in the majority of 1.5 degree scenario analyses we have studied. It would also be likely to satisfy any geostrategic screening criterion that is applied.

[34] Climate-Smart Mining: Minerals for Climate Action (worldbank.org)

Potash

The last six months have been characterised by a steady downtrend in prompt potash prices, as the industry continued the process of progressively unwinding the extremely high prices associated with the scarcity regime that emerged in the first half of calendar year 2022.

Looking at price developments by region, according to assessments in CRU's Fertilizer Week, the price of gMOP[35] into Brazil opened the first half of calendar year 2023 at $515/t CFR and closed at $328/t. gMOP into the United States (at NOLA), which initially led the global rally in 2021 before ceding that place to Brazil, opened the first half of calendar year 2023 at $499/t FOB Barge, and closed at $413/t. Spot prices for sMOP in South–East Asia opened the first half of calendar year 2023 at $530/t CFR, but by end were sitting at $318/t. India settled an annual contract price at $422/t CFR in April–2023, and China followed in June–2023 with a $307/t CFR settlement. India has been rumoured to have re–negotiated at $319/t CFR in the wake of this. With annual contract uncertainty passed, disruptions to Canadian west coast logistics, much improved affordability conditions and seasonal turns in the demand cycle in key importing regions have contributed to prices stabilising early in financial year 2024.

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. We estimate that approximate realised prices for Canadian producers (FOB Vancouver equivalent) as of early July 2023, were close to $300/t. The peak for the fly–up period was around $780/t, achieved in the months immediately following the opening of the Russia–Ukraine conflict.

The old saying that "the best cure for high prices is high prices" is very pertinent in potash.

Contrary to metals and other bulk commodities, the cure can come quickly from the demand side, even as a supply disruption unfurls. In metals, once demand jumps out materially in front of supply, it

[35] 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.

can be a multi–year to decade–long process for new supply to bring a disrupted market back to balance (depending upon the level of conviction in the deficit and the type of development options the industry is facing ex ante). In potash, the adjustment can come almost immediately: not via new supply, but via a buyers' strike (aka potash holidays) as farmers reason that they can skip a season and get roughly the nutrients they need from "mining" the soil and recycling crop residues and manures. This is exactly the bet that many farmers took in the second half of calendar 2022 once it became clear that the rally in crop prices was roughly half the scale of the rally in fertilisers, including MOP (the major bulk product within the potassium universe). Demand simply hit an air pocket. Import volumes in key prompt price regions like Brazil, the US and SE Asia declined sharply. Accordingly, non–FSU suppliers began to introduce soft curtailments in the December quarter of 2022 and started to soft–pedal on newly–minted medium–term growth objectives (of which more below). So, an industry that was expected to be supply constrained for most of calendar year 2022 closed the period constrained by demand as well: albeit major regional MOP–crop intersections (e.g., Brazilian soybeans, American corn and wheat, South–east Asian palm oil) were back closer to balance versus the long run affordability trend.

Overall shipments declined –17% YoY in calendar 2022 to 59 Mt, a stunning drop from 71 Mt in calendar 2021. With the exception of China, all of the major importing regions saw YoY declines. Production came down a lesser –12% YoY, from 72 Mt to 63.4 Mt.[36]

In Brazil, the most reliable growth destination in recent years, recorded an import volume decline of –13% YoY in the first half of calendar 2023. Twelve months ago, we flagged that the strength of Brazilian imports in the aftermath of the Ukraine conflict had a non–commercial feel to it, especially in the context of declining affordability. Our exact words were "It seems likely that some of the growth in Brazilian imports in the last two quarters was purely precautionary as a hedge against a sudden stop in the availability of FSU product." When the sudden stop never came (for Russian product at least), the Brazilian value chain found itself awash with inventories, with storage at full capacity. Demand accordingly dried up, and in the thin liquidity prices began an inexorable descent. Mostly as a result of the MOP price drop, soybean affordability was back close to long–run average by the end of calendar 2022: and at the time of writing, it has moved to a position of outright favourability. Flows have accordingly improved, with a string of 12 Mtpa (plus) monthly run–rates from March to July 2023. Unflattering comparisons are holding YoY growth down for now (–13% YoY Ytd in calendar year 2023). These base effects will turn sharply later in the calendar year.

The US took the opposite approach to their Brazilian competitors. Rather than stocking up in the wake of the invasion, they backed right off and never really returned in scale, with calendar 2022 net imports being around –25% YoY versus –8% in Brazil. Given that starting point, despite an insipid annualised pace, shipments are up +4% YoY Ytd. We note that Canada's share in US shipments has increased notably from pre–2022 norms. In 2019 for example, 18% of US net imports came from the FSU, split 50/50 between Russia and Belarus, with Canada supplying 78%. In calendar 2023, Belarus has dropped to zero, Russia has fallen to 8% and Canada is sitting at 89%, with that share rising as high as 94% in individual months over the last year. US corn and wheat MOP affordability is now better than average, and farmers who took the risk on a "potash holiday" last year for economic reasons should now be back in the market.

Imports into China (+28% YoY Ytd in the first half calendar 2023) and India (–19% YoY Ytd) moved in completely different directions. The FSU's struggles have been China's gain. An influx of landborne imports from the FSU have put China in the luxurious position of being quite selective in how it engages with the seaborne trade. The FSU share in Chinese imports has increased by +15 percentage points to around 60%. In addition to its preferential access to FSU volumes, China has also benefited from its investment in neighbouring Laos, where production is ramping up quite quickly.

[36] All trade data in this section are from S&P Global.

For India, the weak –19% YoY Ytd outcome for calendar 2023 is partly a function of supply availability: since May–2022, only two months have seen any supply at all from an FSU source entering India, and traditional partner Belarus has not shipped anything to India in that period. A substantial cut in the MOP subsidy for the 2023 Kharif planting season[37] was an additional drag. South–east Asian imports have also declined heavily (–38% YoY Ytd). In contrast to India though, FSU flows to this region have been increasing, with Canada losing share over the last six months. Belarusian shipments have been registered as non–zero in five individual months since July–2022: indicating that South–east Asia was a third, minor outlet for Belarusian product, after China and Brazil.

Moving to the exporters now, and it is clear that Belarus has mitigated its main logistics constraints more rapidly than expected. After its production more than halved in calendar 2022 (from 13.1 Mt to 6.3 Mt, 4.9 Mt of which was exported), it is back in the 7–8 Mt export range in the first half of calendar 2023. Russia did not fall anywhere near as far as Belarus did, as it never lost access to its infrastructure, but nor is it ramping up back to pre–Ukraine conflict levels: indeed, production in calendar 2023 is expected to be lower than last year. Some of that will be due to the fact Russia is sacrificing some port and rail capacity to accommodate its Belarusian ally (at the sovereign, not company level). Canada's run–rate in calendar 2023 to date is down –5%, with voluntary mine curtailments from late in calendar year 2022 setting things up for a decline YoY.

Getting away from temporary adjustments in trade flows and logistical issues, how will the new geopolitics of the FSU impact upon the potash industry in the longer run? The most honest answer is that it remains too early to tell. The secondary answer is that at a minimum it is reasonable to expect a delay of some years from the original timetable for new mines in the FSU.

The careful pre–Ukraine calculus that helped motivate our Jansen stage 1 decision was partly based on a ~5 Mt FSU project pipeline in the 2020s. There are obvious risks pertaining to both the timing and ultimate delivery of those projects given the new state of affairs. We also note that Nutrien reported an "indefinite pause" on its mid–2020s expansion plans at its Q2 earnings call. Pushing the other way there is more Laotian product moving into China than was previously expected.

We consider that a material delay or non–arrival of a portion of these FSU growth tonnes is likely to create either an earlier balance point for the market, or a potential reshuffling of the theoretical inducement queue, with non–FSU latent capacity released, non–FSU projects coming forward and FSU projects moving backward. Or as is most likely, we observe some combination of these options whereby some of the space vacated by the FSU is captured elsewhere, but perhaps not to the point where it prevents the balance point being achieved sooner than previously expected. Nutrien's "indefinite pause" helps to ascribe updated likelihoods to the various combinations.

It is important to note that none of these options would change the real long–term price we have in mind – but it could alter the time by which it emerges as a durable trend. There are many, many possible permutations here, and against this backdrop it is strategically prudent for us to accelerate studies of our own capital–efficient organic options beyond Jansen Stage 1, as we have stated in other fora.

Beyond the balance point, with the market very likely to continue expanding in the following decades, our views on the most likely operating environment for the industry in the 2030s and beyond – an

[37] The Kharif is one of India's two main cropping seasons, the other being Winter (Rabi). Kharif tends to coincide with the monsoon, with crops (staples being rice and corn) sewn alongside the early rains and harvested at monsoon end. Wheat and barley are staple Rabi crops.

extension of what we have dubbed the “4th wave” of the potash industry – is a durable inducement pricing regime. You can read more about this framework here and here.

Longer–term, we see potash as a future facing commodity with attractive fundamentals. Demand for potash stands to benefit from the intersection of global mega–trends: rising population, changing diets and the need for the sustainable intensification of agriculture.

That latter point 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 fertilizer[38] under large–scale 2G 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.[39]

Inputs and inflation trends

Twelve 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.

Six 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 recession, you can take a lot of pressure off physical supply chains and the price of durables 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, 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.”*

Over the last six months, those predictions have begun to manifest in general measures of inflation and as well as industry-specific exposures.

[38] 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 coil, 20% from manures, 20% from crop residues and 30% from fertilizer. We anticipate that the fertiliser share will rise over time as soil fertility depletes.
[39] For more on the Global Boundaries framework, see W. Steffen et al., *Science* 347, 1259855 (2015).

Turning to the **maritime bulk freight** market, the key C5 WA–China route averaged $7.8/t in the second half of financial year 2023 down –12% from the $9.0/t outcome from the prior half. For the full financial year, C5 was –33%. C3 (Brazil–China) was –28%. Capesize congestion was down –16% YoY as of early August, and Panamax congestion was –14% YoY. We have noted a more pronounced correlation between spot freight rates and general macro sentiment than in the past, with China's real estate challenges weighing on freight sufficiently to offset traditional seasonal forces at time. 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 9–10% for vessels in smaller sub–classes.

Regulatory shifts are also likely to influence industry evolution in coming years, with the IMO's newly minted "close to 2050" net zero pledge, and the shorter–term targets that lead up to that milestone, requiring decisive action across the maritime ecosystem if they are to be achieved.

BHP recently participated in two initiatives with considerable potential to propel the decarbonisation agenda forward. The first was the Australia–East Asia Iron Ore Green Corridor consortium, led by the Global Maritime Forum. The second was the ammonia bunkering safety study conducted by DNV under the leadership of one of our strategic partners, The Global Centre for Maritime Decarbonisation in Singapore.

Benchmark indices for **ammonium nitrate** (AN) – a proxy for explosives costs we estimate as a weighted average of inputs – declined –21% in the second half of the 2023 financial year in Western Australia, –28% in Chile, and –6% in eastern Australia. Volatility in feedstock costs (ammonia and its feedstock, natural gas) produced sizeable falls as the extreme spikes seen in the early months of the Russia–Ukraine conflict unwound.

Earth–moving tyre raw material costs (weighted) declined by –0.9% in the second half of financial 2023 versus the prior half. Natural rubber has the highest weight in our index, and it stabilised over the last six months having declined by –25% in the prior half. There were modest declines in petroleum derived inputs, and modest uplifts half–on–half in steel.

Sulphuric acid prices for Chilean end–users, sourced from Argus, fell sharply in the first half of financial 2023, and they fell again in the second half. North Asian FOB prices have collapsed on weaker demand from the phosphate and industrial sectors. Lower sulphur feedstock costs and lower freights rates have also contributed to the decline. CFR Chile pricing ranged from $98/t to $139/t over the second half of the 2023 financial year, averaging $113/t, a –32% move half–on–half. The end–of–period price was also the low.

Power prices were crisis–prone across multiple regions for much of calendar 2022, as developed nations faced up to their sternest energy security test in generations. With the northern hemisphere winter of 2022–23 now navigated, an (uneasy) calm has descended. We see the forward–looking risks for power prices in our main operational jurisdictions as balanced.

Chilean spot power prices in the Northern grid (SING) rose +6% in the second half of financial 2023 to an average of US$104/MWh. In Chile, the principal regulatory response to the breakdown of the energy trilemma was to mobilise and extend coal power utilisation. Prices increased by a modest +14% over the full financial year 2023. Note that Chile has a power capacity market that remunerates emergency peaking capacity whether it is mobilised or not.

Australian NEM spot power prices were engulfed by crisis in the June quarter of 2022. In the second half of financial year 2022, prices increased 219% on average across the NEM. They then fell just –12% from that elevated level in the first half of financial 2023, but they came down a further –38% in the second. The Federal Government intervened directly in the market in December–2022 by

way of capping feedstock prices (gas @ $A12/GJ, coal @ $A125/t). Gas prices had already begun to recede before the ban was imposed. Power prices have also been assisted by improved renewable generation. We see periodic bouts of high volatility as an inherent characteristic of the NEM – with a major spike in power prices in South Australia a week prior to this report being published being a case in point. We consider that the difficulties of calibrating the exit of coal capacity with increasing penetration of intermittent renewables backed by an (as yet) immature storage infrastructure and an under-invested transmission network seem more likely to amplify than dampen that feature for the remainder of this decade.

Diesel prices have unwound a reasonable portion of the extraordinary gains registered in the wake of the start of the Ukraine conflict, with both lower crude oil prices and an easing of refinery spreads contributing to that outcome. Average Singapore diesel (into Minerals Australia) declined –24% half–on–half to $101/bbl, while average US Gulf Coast seaborne (into Minerals Americas) declined –25% half–on–half to $103/bbl. Even so, prices were slightly higher on average across financial year 2023 than in the prior financial year ($116/bbl versus $112/bbl). Refinery spreads are no longer at record highs (USGC peaked at $80/bbl in the first half of financial 2023, averaging $49/bbl. Singapore's peak was $57/bbl, and an average of $37/bbl) but they are, elevated relative to history. Singapore closed financial year 2023 at $18/bbl versus the 2017–2019 average of $13/bbl. As for crude markets, it was a less volatile half–year after the drama of calendar 2022, with macro sentiment and supply discipline by OPEC being major influences on price direction. Financial instability in the US and Europe in March–2023 drove Brent prices markedly lower, precipitating a surprise out–of–session supply cut by OPEC on April 2. The resulting price gains were short–lived, but additional "voluntary" cuts in July seem to have had a more durable impact, given they have coincided with stronger seasonal demand.

The rate of increase in the US producer price index (PPI) for **mining machinery and equipment manufacturing** moderated further in the second half of financial year 2023. The index is now running at +12.8% on a 12–month smoothed basis, +10.6% YoY for the month of July 2023, with the latter down around –3 percentage points over the last six months. While these figures remain high, and we are somewhat sceptical 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 +11.1% on a 12mma basis and was running at +10.2% YoY in July–2023. The YoY rate peaked in August 2022 at +13.8%.

Important Notice:

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