



**COBALT
INSTITUTE**

enabling technology, advancing society

Cobalt Market Report 2023



May 2024

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Benchmark Mineral Intelligence was commissioned by The Cobalt Institute to prepare the 2023 Cobalt Market Report ahead of the Cobalt Congress in New York in May 2024. The report summarises the key trends in the cobalt market across demand, supply, prices, sustainability and policy, as well as a spotlight on the position of the US market.

The report was prepared using Benchmark's market-leading reporting and analysis on the lithium-ion battery supply chain and broader energy transition, particularly from the quarterly Cobalt Forecast, Recycling, ESG and Policy Reports and bi-weekly Cobalt Price Assessments.



1 | FOREWORD

RESILIENT COBALT MARKET IS KEY TO ACHIEVING COBALT'S GREEN ENERGY POTENTIAL

As we look back on a year of change, both for our industry and for the world, three things become clear.

The first is that the market continues to grow, change, and challenge. Businesses must be more resilient than ever to navigate the uncertainties that continue to characterise the cobalt market. Yet despite disruptions and fluctuations, the industry has demonstrated remarkable adaptability and endurance, as we see in new supply capacities coming onstream and growing demand from key sectors: EVs, portable electronics, and super alloys.

Second, changes in the geopolitical landscape will continue to reshape the global market, influencing supply chains, trade dynamics, and investment flows. It is only last year that we decided to include a geopolitical section in our market report – we would not have imagined the outside role this section would play to better understand such legislative initiatives as the USA's Inflation Reduction Act or the EU's Critical Raw Materials Act.

Third, the world is now ready to acknowledge the critical role of our industry for security and economic prosperity. Cobalt is now rightly seen as a linchpin in the transition to a low-carbon economy. As demand for cobalt is expected to more than double on 2023 levels by 2030, stakeholders around the world are striving to secure a sustainable critical minerals supply.

In the midst of this change, Cobalt Institute remains committed to ensuring cobalt's central role in the modern world. And as always, we are grateful to our members for helping to shape everything we do.

*Dinah McLeod,
Director General, Cobalt Institute*



2 | EXECUTIVE SUMMARY:

OUTLOOK REMAINS POSITIVE DESPITE SUSTAINED MARKET WEAKNESS

Battery applications account for 73% of cobalt demand and are the dominant driver of market growth. Electric vehicles (EVs) alone accounted for 96% of 2023 demand growth despite perceived weakness in the sector. EV sales growth is strong but slowing, rising by 33% in 2023, but it is important to note that the industry is building from a very low base and that previous growth rates are not sustainable. **The outlook for EVs remains positive and cobalt has a key role in this critical part of the global energy transition.**

Cobalt remains an important component in a number of the dominant cathode chemistries used in lithium-ion batteries for EVs, portable electronics and nascent demand from energy storage systems (ESS). Cobalt has faced pressure from raw material substitution but maintains a key part in the stability and performance of several major chemistries and is integral to the strategies of many of the major cathode active material (CAM), cell and EV producers outside of China. Cobalt is used in nickel-cobalt-manganese (NCM), lithium cobalt oxide (LCO) and nickel cobalt aluminium oxide (NCA) chemistries – mid nickel NCM overtook LCO as the primary driver of cobalt battery demand in 2023. Despite strength in cobalt-free lithium iron phosphate (LFP), cobalt-containing chemistries still accounted for 55% of total battery demand in 2023 with this share expected to remain steady in the medium to long term, providing support to growing cobalt demand.

24% of cobalt demand remains supported by non-battery applications with super alloys, primarily for aerospace applications, accounting for 9% of this share. **The aerospace sector continued a faster-than-expected post-Covid recovery in 2023, supporting demand for cobalt's largest non-battery application.** Global military spending hit a new record in 2023 which further supports cobalt use in niche defence and aerospace applications. Another notable contributor to cobalt's use in 2023 – equivalent to 4% of annual demand – was purchasing by China's State Reserve Bureau (SRB), the first time strategic reserves have been added to since September 2020.

CMOC dominated supply side dynamics in 2023, as the Kisanfu mine started operations and quickly ramped up, exceeding market expectations. Kisanfu alone added 32.5 kt of supply. CMOC, at Kisanfu and also Tenke Fungurume, increased total output by 35 kt to become the largest global producer, surpassing Glencore for the first time. The DRC maintained a 76% market share and supported 78% of annual supply growth.

Indonesia – now the second largest producer by some margin – supported 24% of annual supply growth as output increased 86% y/y. The pipeline of high pressure acid leach (HPAL) operations producing nickel and cobalt continues to build at pace as Indonesia looks to capture greater market share in the battery supply chain. By 2030, global supply will become more diversified with Indonesia to account for 16% of cobalt supply, up from 7% in 2023; the DRC's share will fall to 67%. Over this period, the DRC will support 48% of total supply growth, with 37% from Indonesia.

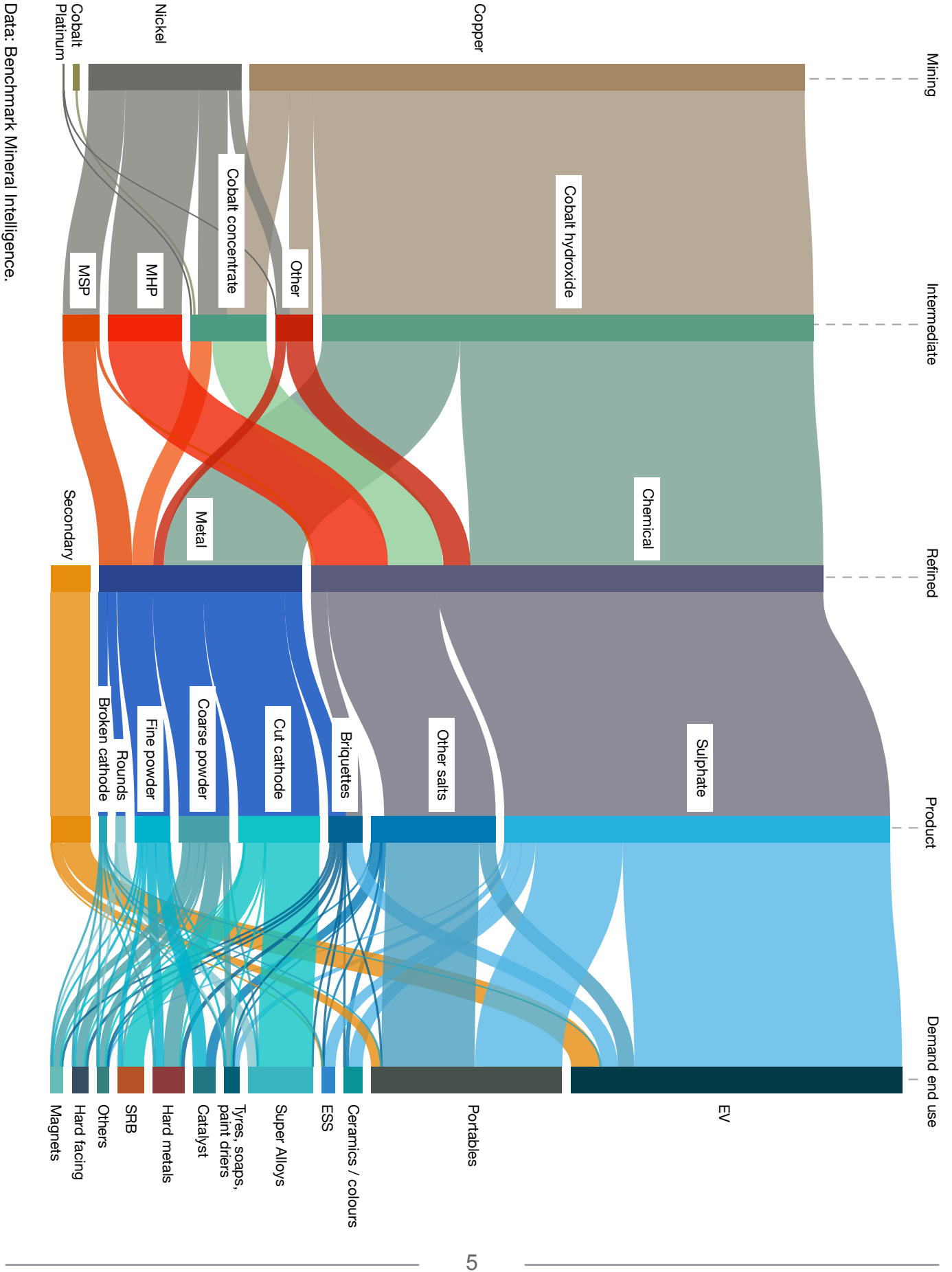


Cobalt prices continued to decline throughout 2023 following the weakening market conditions in the second half of 2022. Global supply rose by 17% y/y in 2023 whilst demand growth (+10% y/y) maintained similar annual growth rates to 2022. Despite robust demand growth, significant de-stocking of raw materials in the battery supply chain weighed on market sentiment. With supply outpacing demand, the market surplus widened in 2023 to 14.2 kt, equivalent to 7% of the overall market.

The current low point of the cycle is expected to persist in the short term, weighing on prices, although the medium to long term outlook for cobalt remains positive. By 2030, the cobalt market is set to double in size with 95% of growth supported by battery applications – global battery cell demand is forecast to almost quadruple. Cobalt’s key role in a number of the major existing battery chemistries will underpin market performance over this period. Demand is forecast to outpace supply and the market will shift into a deficit in the mid to late 2020s, providing support to cobalt prices.



2023 Cobalt Supply Chain



3 | DEMAND: TOTAL MARKET CONTINUES TO SEE STRONG ANNUAL GROWTH SUPPORTED BY COBALT'S KEY ROLE IN BATTERY APPLICATIONS

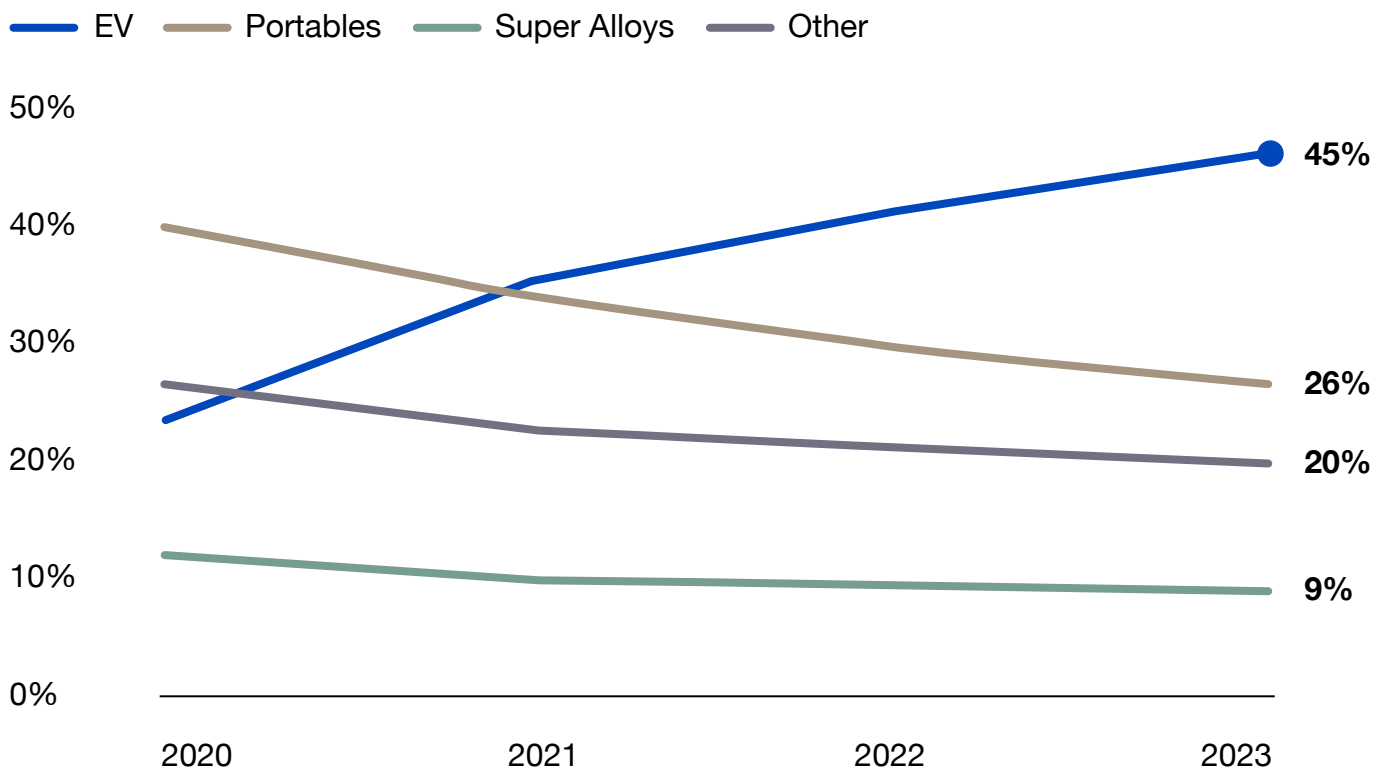
3.1 COBALT DEMAND DRIVERS

Cobalt demand reached close to 200 kt for the first time in 2023, with the overall market size more than doubling since 2016. Demand grew 10% y/y at a similar rate to 2022 (9%).

Battery demand now accounts for around three quarters (73%) of the cobalt market, up from 71% in 2022. Battery demand grew by 13% y/y, with non-battery applications growing by 2% y/y. Cobalt demand from batteries accounted for 93% of total demand growth in 2023.

Electric vehicles (EVs) alone are now supporting 45% of the market – 90 kt of cobalt demand. Demand from the sector rose 23% y/y, down marginally from 27% y/y growth in 2022. The second largest sector, portable electronics, primarily using LCO cathode chemistries, accounted for 26% of demand despite absolute demand falling 2.4% y/y to just below 52 kt.

Figure 1: Share of total cobalt demand by sector, %



Data: Benchmark Mineral Intelligence – Cobalt Forecast.



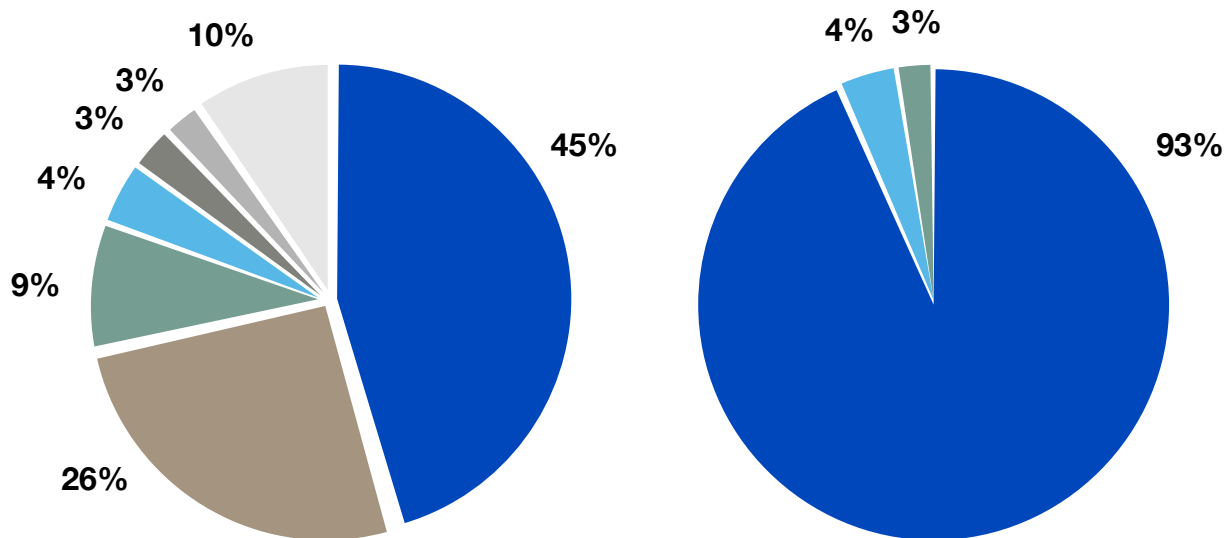
Figure 2: 2023 cobalt demand by end use and share of demand growth, %

Share of 2023 demand

- EV
- Portables
- Super Alloys
- Hard metals
- Catalysts
- Ceramics / Colours
- Others

Share of 2023 demand growth

- Batteries (EV, portables & ESS)
- Super Alloys
- Others



Data: Benchmark Mineral Intelligence – Cobalt Forecast.

In 2023, the global battery market entered the terawatt era whereby global production surpassed 1 TWh for the first time. Despite economic headwinds, the battery market is continuing to gather pace and remains critical for the future of the cobalt market. The following sections describe the key end use markets, starting with EVs.

3.2 EV MARKET MAINTAINS STRONG GROWTH DESPITE SLOWDOWN

The passenger segment accounted for 87% of EV demand in 2023 and is the largest demand driver over the forecast period. Global passenger EV (BEV and PHEV) sales rose to 13.8 million units in 2023, up 33% y/y – a fall from 58% y/y growth in 2022. Of this, China (7.9 million), EU (3.5 million) and the US (1.4 million) accounted for 93% of sales. EVs accounted for 16% of total global vehicle sales in 2023, up from 14% in 2022.

Annual growth rates are slowing for the EV sector, but it is worth noting that the industry is growing from what was an almost negligible base (pre-2020) and that previous growth rates of >50-100% y/y were not sustainable. Current macro-economic conditions in Western markets,

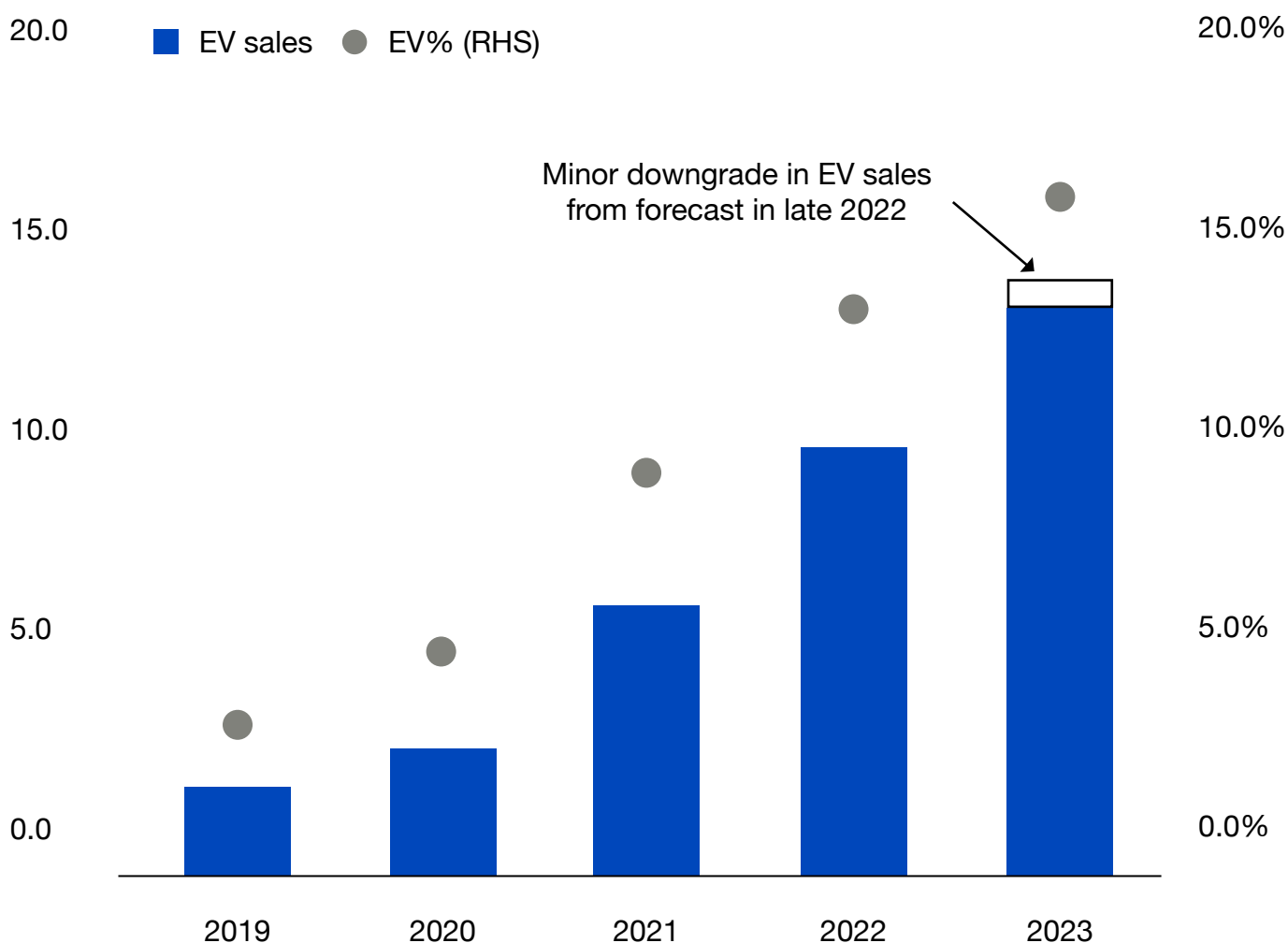


primarily high inflation and interest rates, are having an impact on car sales. This is particularly the case for EVs as they are yet to reach price parity with internal combustion engines (ICEs).

The figure below shows that the 2023 EV forecast was only downgraded marginally through the year, supporting the view that market conditions are not as bearish as some commentators have indicated. Healthy double-digit annual growth for the lithium-ion battery markets is forecast over the next 15 years, based on strong long term fundamentals.

Various sources have also recently commented on the downturn in EV sales and conflated this with price reductions for some EV models. However, these two factors aren't inextricably linked. EV price cuts from 2022 to 2023 have been a move by some OEMs to capture market share.

Figure 3: Global EV sales, million units (LHS) and EV penetration, % (RHS)

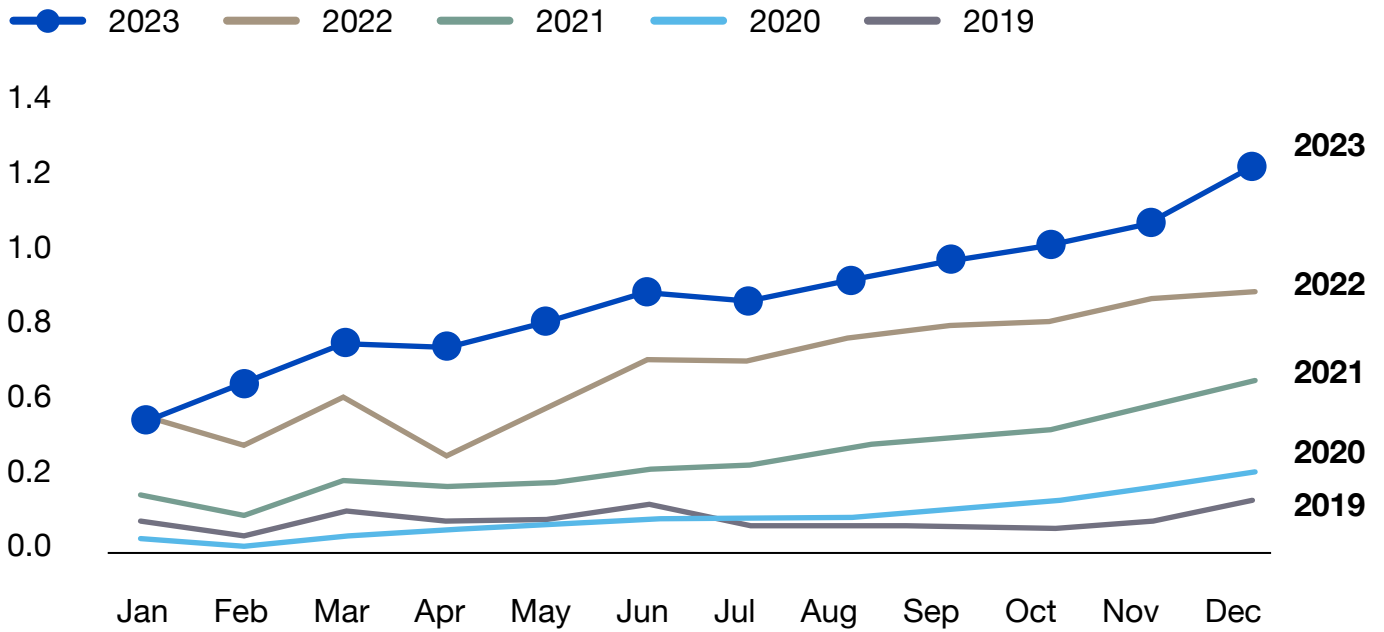


Data: Benchmark Mineral Intelligence – Battery Forecast.

Europe and the US saw a boost to annual sales growth rates in 2023, despite the market negativity – rising from 16% to 17% y/y for Europe and 46% to 51% y/y for the US. The slowdown in EV sales was most noticeable in China, with the annual growth rate falling from 94% to 34%. However, sales in China reached record highs for every month in 2023, except January, demonstrating that EV fundamentals still remain robust despite the slowdown in growth.



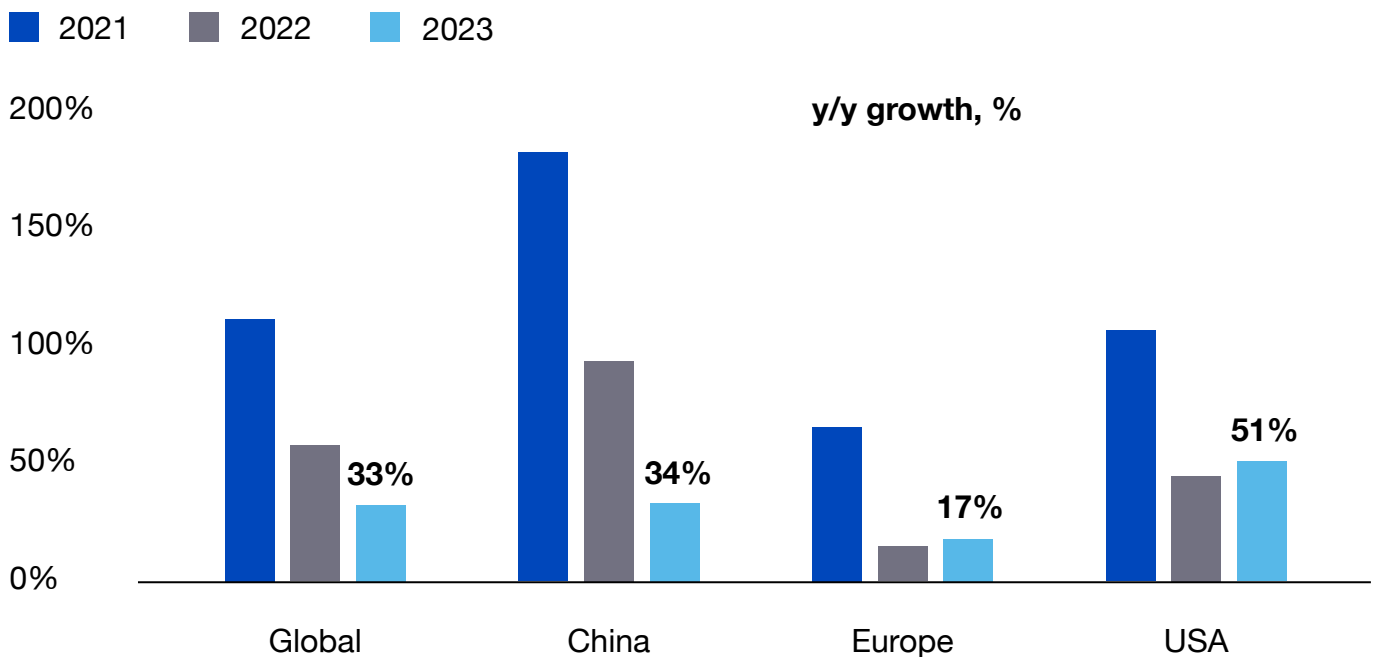
Figure 4: Monthly NEV sales in China, million units



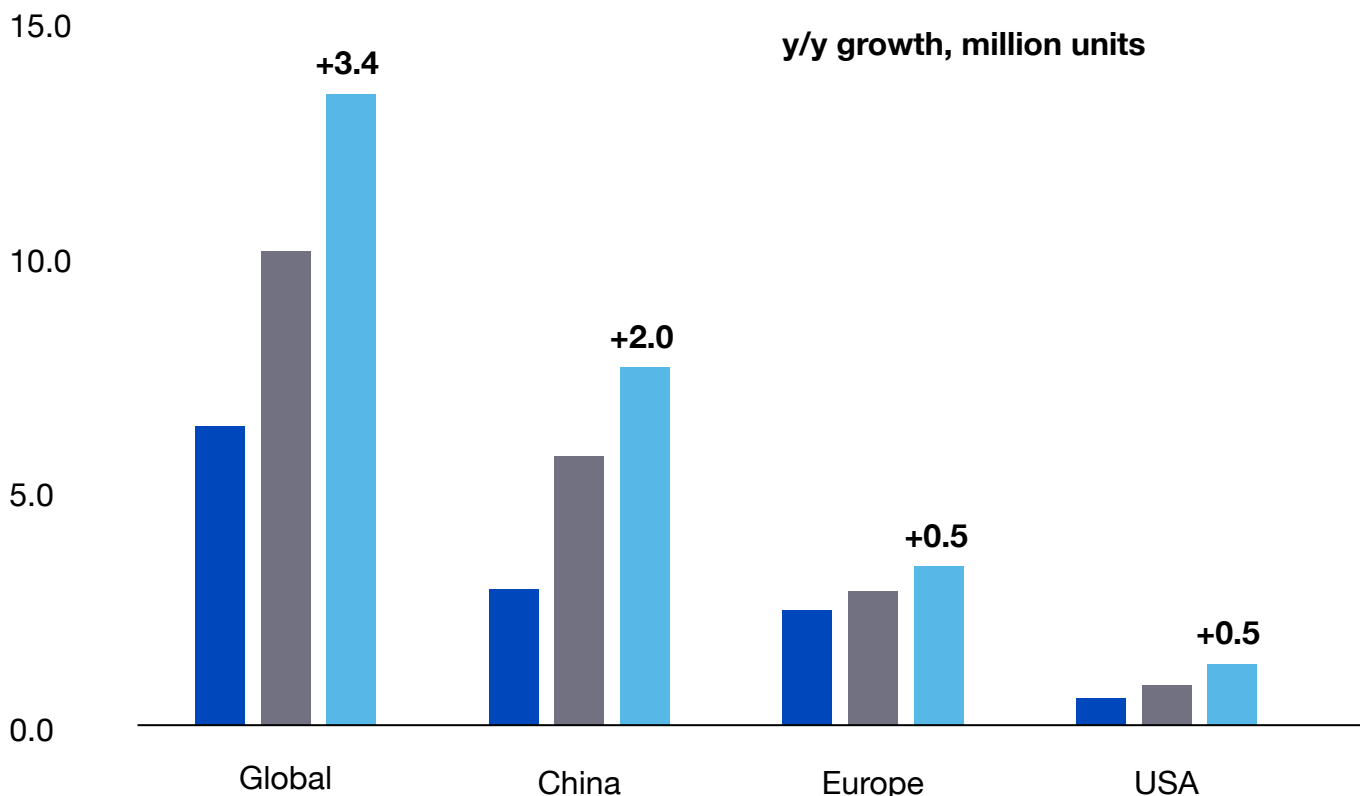
Data: CAAM.

China remained the largest global EV market in 2023, with 57% of total passenger sales. The country’s sales rose by 2 million units in 2023, representing 58% of global growth. Europe lost some overall share, falling to 25% of total sales, however EV sales still rose by 0.5 million units. US sales rose by the same magnitude (0.5 million) with the market share increasing to 10%.

Figure 5: Growth in EV sales by major region – top: y/y %, bottom: million units



■ 2021 ■ 2022 ■ 2023



Data: Benchmark Mineral Intelligence. Note: passenger & light duty vehicles only, includes BEV and PHEV.

Growth is continuing to slow in the first quarter of 2024 across these markets. Flat growth is expected in Europe in Q1 as sales slow under challenging economic conditions, while individual countries also reduce financial incentives. For example, Germany abruptly ended its EV purchase subsidy in December 2023, originally due to continue in 2024, removing the incentive for consumers in the region's largest auto market.

EV sales growth in North America, primarily driven by the US, remains above both China and Europe in Q1 2024. However, 2024 presents a more challenging year as new IRA rules for battery cells become active, with fewer models eligible for the EV tax credit that has to date underpinned sales. In addition, the US has recently made future vehicle emissions regulations less stringent compared to initial proposals for light-duty vehicles. This will allow automakers more time to sell ICE vehicles and hybrids in the mid-term with a reduced requirement for BEV sales.

Despite overall demand growth in 2023, global battery supply chains began 2023 with considerable raw material inventories. During 2022, overstocking took place in anticipation of higher EV demand in early 2023. However, growth underperformed initial expectations, partially due to the removal of Chinese EV incentives at the end of 2022 as well as broader macroeconomic conditions, such as high interest rates. Driven by weaker demand, cell makers reduced capacity utilization which led to supply chain wide destocking of raw materials (running down of inventories). This led to reduced spot market purchasing from the battery supply for much the year, including for cobalt.



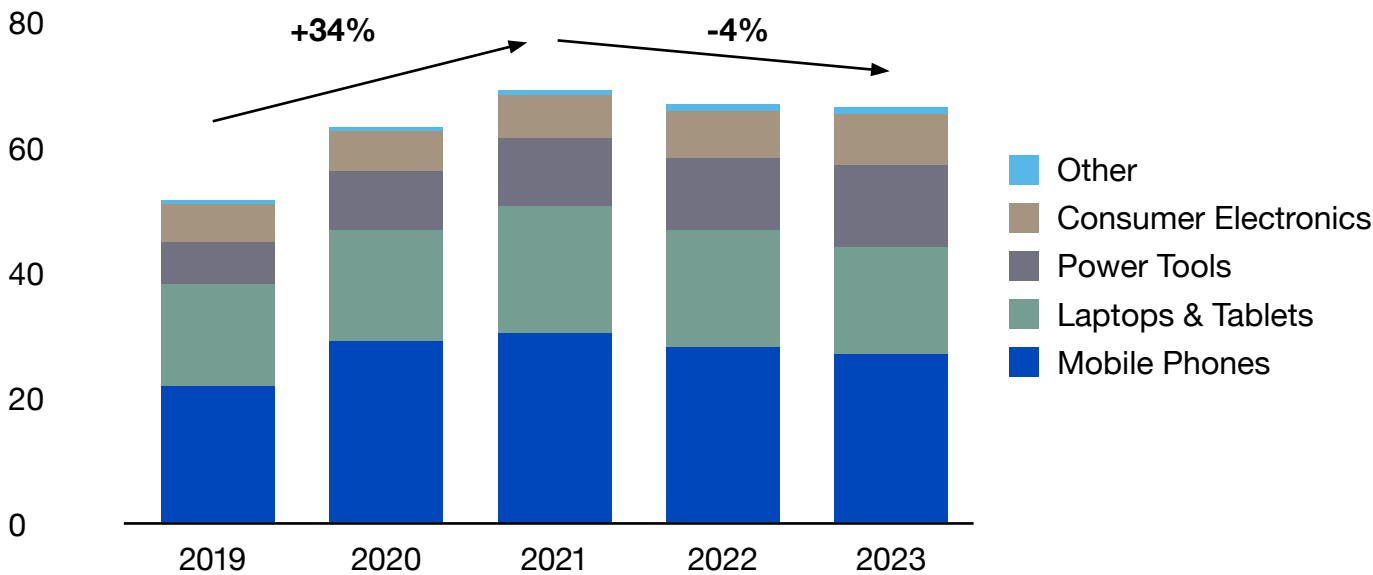
3.3 OTHER BATTERY APPLICATIONS – PORTABLES & ENERGY STORAGE SYSTEMS

The portables market remained under pressure in 2023, facing the second consecutive year of declining battery demand. Total battery demand for portables fell to 66.4 GWh in 2023, down 4% from close to 70 GWh in 2021.

After strong demand for portable electronics during the start of the Covid-19 pandemic, 2022 and 2023 saw a substantial slowdown in global battery demand across portable applications. This was exacerbated by inflationary economic conditions and rising interest rates in many regions, combined with market saturation for cell phones.

Global shipments of portables continued to see consistent y/y declines in the first half of 2023. However, in the second half of the year, smartphone markets started to display signs of recovery driven by robust demand in developing regions. Smartphone sales started to consistently rise from mid-year and October marked the first y/y growth after a two-year decline. **The outlook is more optimistic with rising semiconductor sales and an expected economic recovery in 2024-25.**

Figure 6: Battery demand for portables by sector, GWh



Data: Benchmark Mineral Intelligence – Battery Forecast.

LCO is the dominant cathode chemistry for consumer electronics and an important sector for cobalt demand – accounting for 96% of portables-related cobalt demand in 2023. The stability, density, and availability of LCO cathodes means this will remain the primary chemistry choice in these markets, although higher nickel intensity chemistries are being deployed to satisfy higher power requirements in some power tool and powerpack applications.

LCO cathode demand fell 10.3% y/y to below 50 GWh in 2023. Cobalt demand for portables fell further than cathode demand as the highest cobalt intensity variation of LCO (4.2 V) declined faster than higher voltage (lower cobalt intensity) variations. As a result, cobalt demand from



portables fell 2.4% y/y to 52 kt. It is expected that it will take until 2026-27 to recover above the last demand peak of 2022.

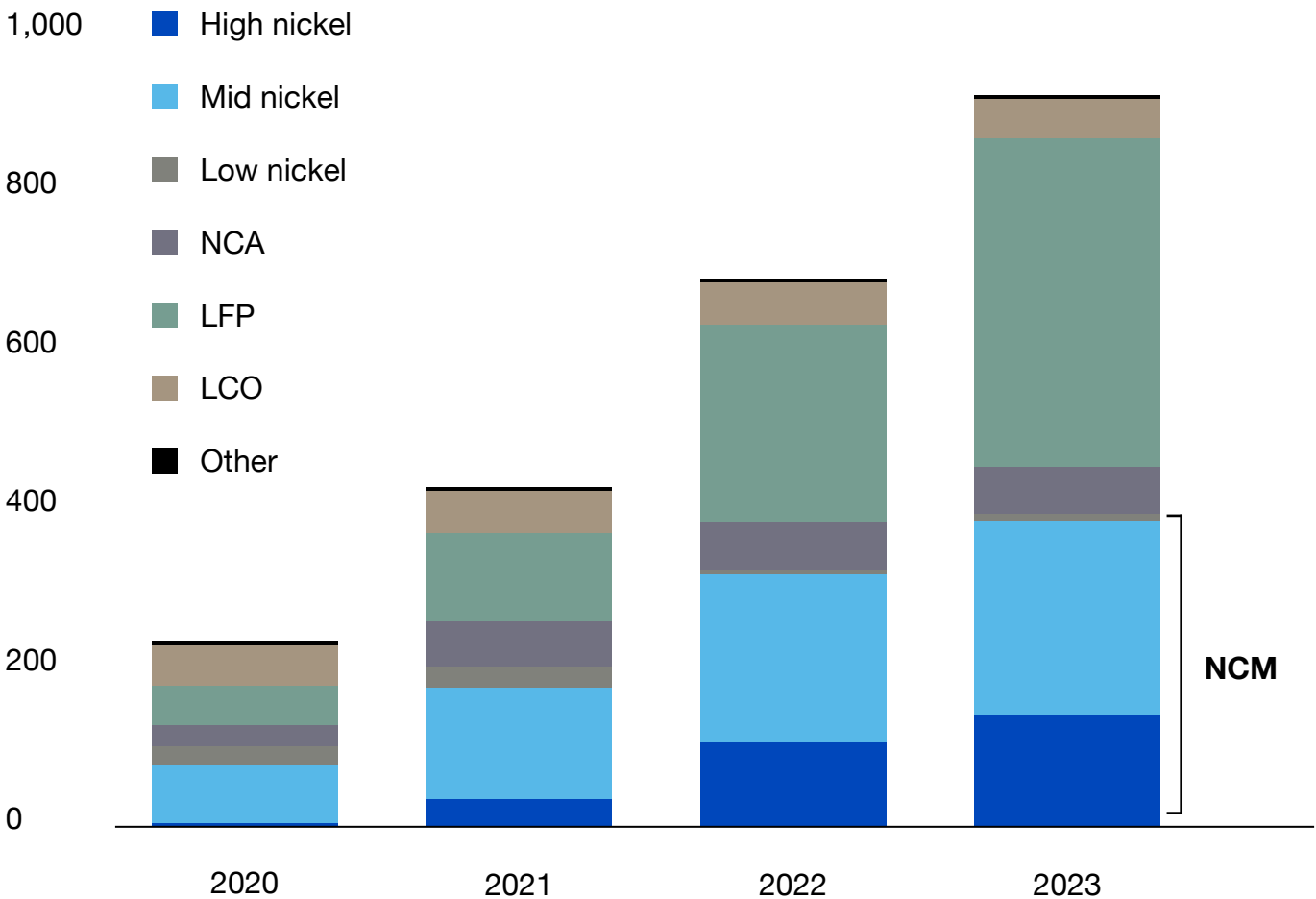
Energy storage systems (ESS) demand for cobalt remains a small sector, accounting for only 2% of total cobalt demand in 2023. Although, this sector has potential with strong y/y growth (21%), albeit from a low base. Volumes will remain relatively small in comparison to EVs and portables, as cobalt-free LFP chemistries are the preferred choice of lithium-ion battery for this application.

3.4 CATHODE CHEMISTRY DEVELOPMENTS REMAIN KEY FOR COBALT

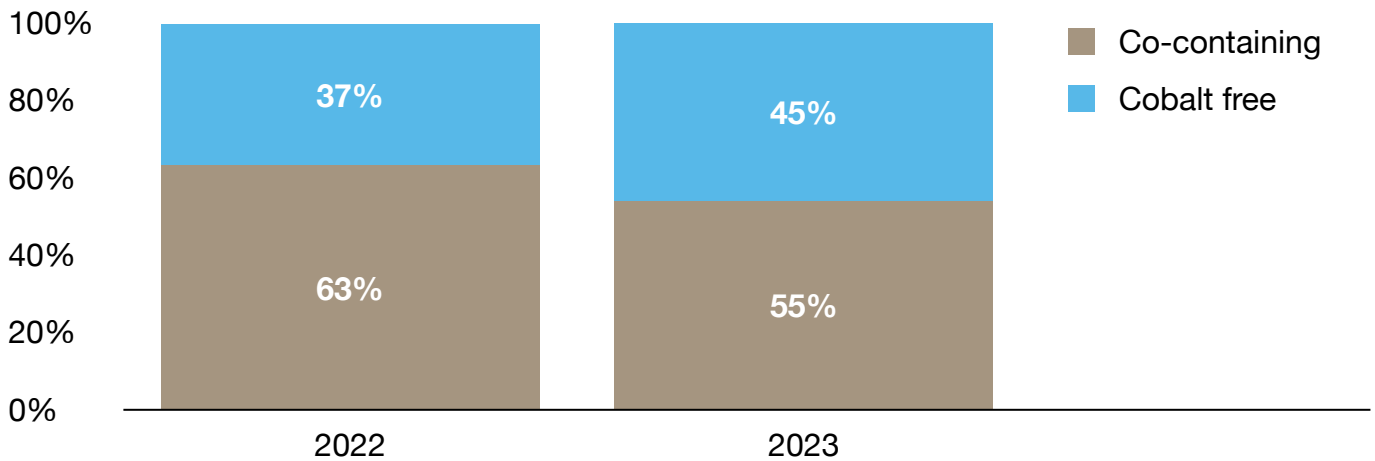
Cobalt is a key part of several major battery chemistries, providing important stability and safety benefits. Demand for cobalt-containing chemistries rose 15% y/y in 2023, to around 500 GWh. This equated to around 55% of battery demand in 2023, down from 63% in 2022. Despite this fall, **demand for cobalt-containing chemistries is expected to continue to see strong growth and maintain market share in the medium to long term.**

Figure 7: Cathode demand by chemistry (all battery applications), %

Cathode demand by chemistry



Share of total cathode demand



Data: Benchmark Mineral Intelligence – Cathode Forecast.

Cobalt demand from batteries rose 13% y/y in 2023. At the chemistry level, cobalt demand from high and mid nickel chemistries experienced the highest growth rates at 32% and 15% y/y, respectively, with low nickel and LCO both falling 11% and 13% y/y, respectively.

After being neck and neck in 2022, **mid nickel has now overtaken LCO as the primary driver of cobalt demand from the battery sector.** In 2022, NCM chemistries combined (low, mid, and high nickel) accounted for more cobalt demand than LCO – 54% versus 44%. But in 2023, mid nickel alone accounted for close to half of cobalt demand from batteries (48%) as it pulled away from LCO (37%) – this was driven by the EV sector gaining ground and portable electronics faltering. The high nickel share rose to 11% (+2% y/y). The decline of cobalt demand from low nickel NCM chemistries slowed in 2023 but fell below NCA demand for the first time.

Cobalt-free chemistries gained ground in 2023, with total demand rising to 413 GWh in 2023 – 66% annual growth. The cobalt-free share rose to 45% of total cathode demand – LFP continues to drive this growth trend, with only minor contributions from other cobalt-free (manganese-based) chemistries. On a global basis, LFP overtook NCM for the first time in 2023 with 45% market share compared to 43% for NCM (LFP trends discussed further below).

Cobalt remains an important battery raw material but continues to face pressure in the battery supply chain from the following:

- **Cost** – as the most expensive battery raw material on a unit basis and an increased focus on margins from the downstream. However, declining cobalt prices have supported cell cost competitiveness in the last year.
- **Energy density** – efforts to increase battery energy density, primarily the shift to higher nickel intensity NCM chemistries. However, there has been some shift in this trend recently, as discussed further below.
- **Responsible sourcing and sustainability considerations** – particularly from the DRC and increasingly Indonesia.



This is of particular importance as battery demand now accounts for three quarters of total cobalt demand, increasing the sensitivity of the entire market to changes in cathode chemistries and battery technologies.

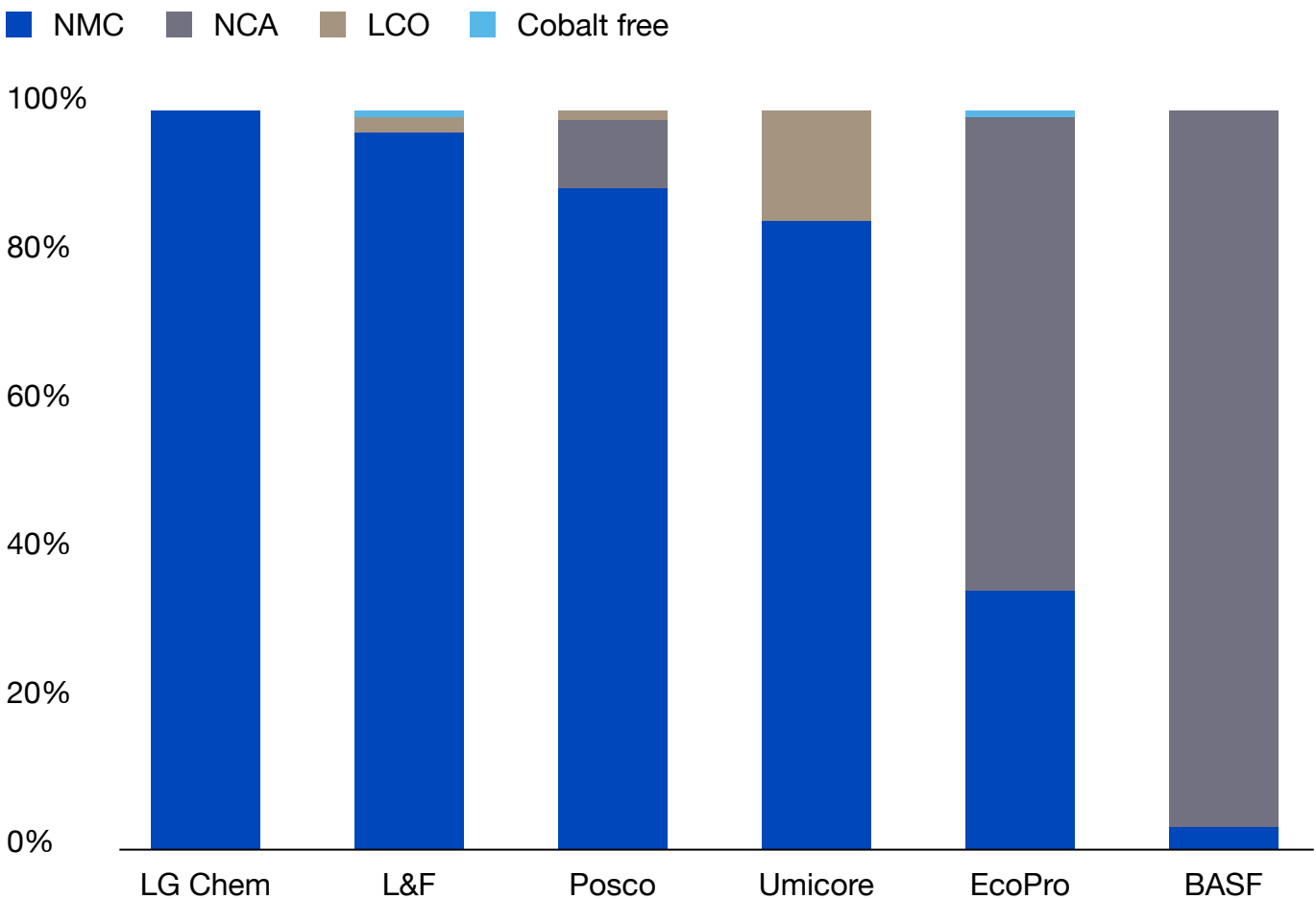
The following sections provide further details on the latest cathode chemistry trends.

COBALT CHEMISTRIES REMAIN IMPORTANT IN THE WEST

NCM and LFP chemistries are the leading technologies for the Li-ion battery supply chain and accounted for 88% of global cathode demand (across all battery applications) in 2023.

NCM has been favoured by OEMs with higher performance and higher range EVs, finding an optimal balance between energy density, power output and cost efficiency. This is particularly the case for Europe and North America where range is a higher priority. NCM is the focus for most of the major ex. China CAM suppliers, with EcoPro and BASF focussed on NCA, another cobalt-containing chemistry. This demonstrates that **cobalt remains a key part of battery chemistry choices despite the recent strength of LFP.**

Figure 8: 2023 CAM product mix from the major ex. China CAM suppliers, %



Data: Benchmark Mineral Intelligence – Cathode Forecast.

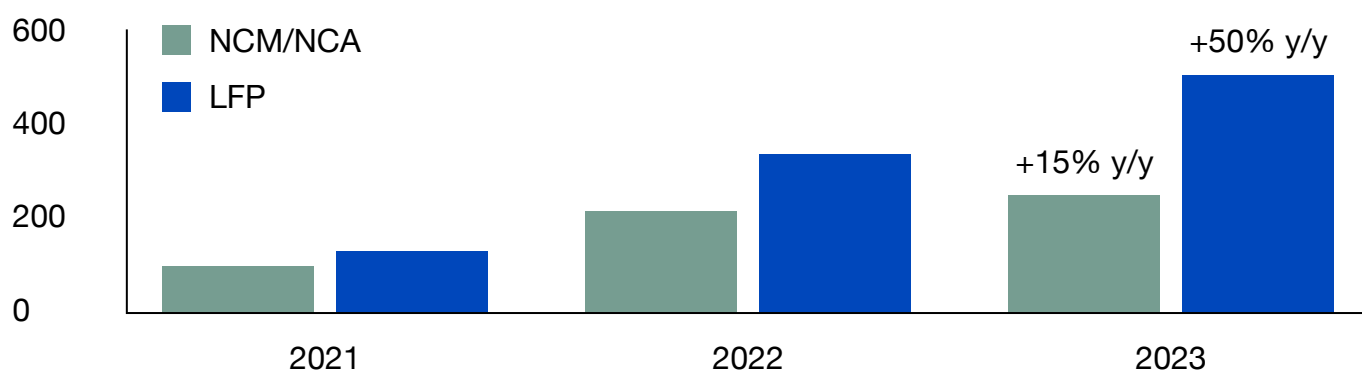


LFP GAINING GROUND IN CHINA

LFP has been the mainstay of Chinese EV producers due to its cost competitiveness and suitability for lower range and affordable vehicles to suit the Chinese market. LFP is gaining share outside of China, particularly as Chinese EV exports rise.

2023 was the first year in which LFP marginally overtook NCM chemistries in global market share, although LFP still remains a China-centric story. New LFP cathode installations, according to the China Automotive Battery Innovation Alliance (CABIA), totalled 261 GWh in 2023 – more than double that of NCM (126 GWh). The output data shows a similar picture, with LFP growing faster than nickel-cobalt chemistries in 2023, after pulling ahead in 2022.

Figure 9: Cathode capacity output in China by chemistry, GWh



Data: China Association of Automobile Manufacturers (CAAM), Benchmark Mineral Intelligence.

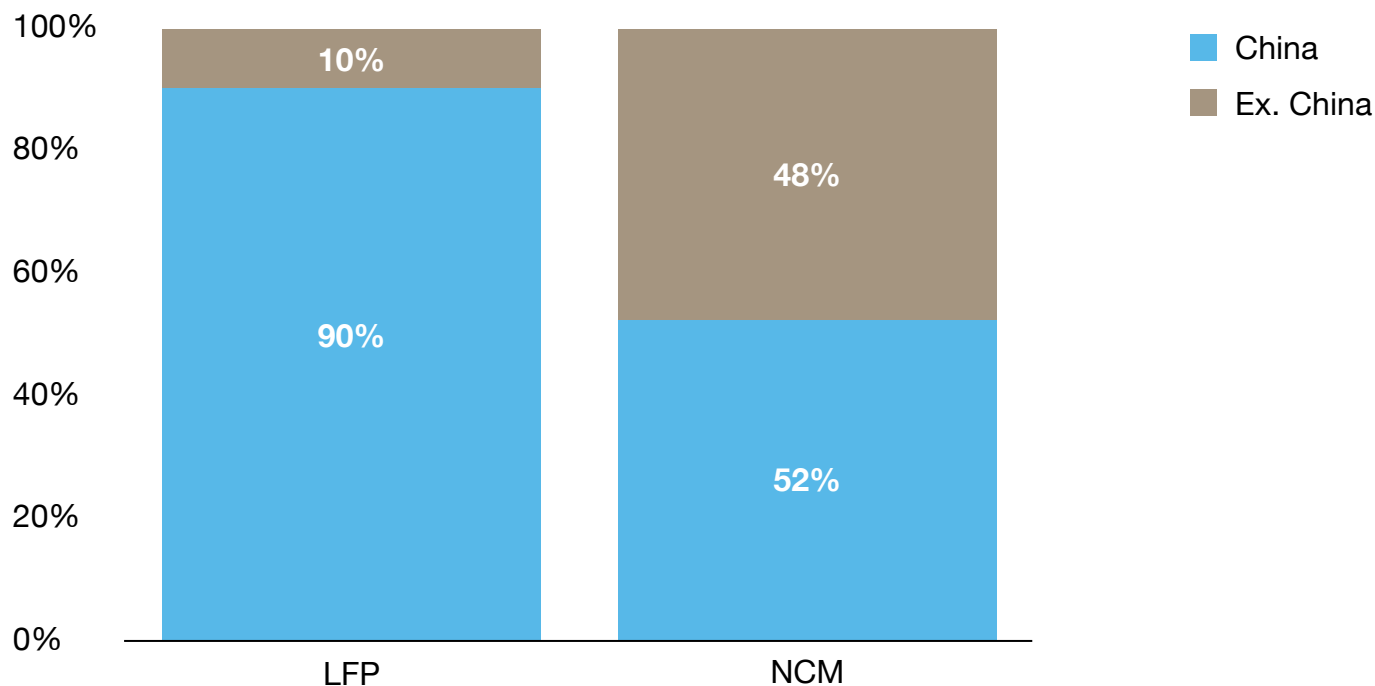
On the demand side, the LFP share overtook NCM on a global basis in 2023 for the first time, but this is driven by China which accounts for half of global battery demand and virtually the only global supplier of LFP CAM currently.

In 2023, the announced pipeline for global LFP capacity doubled, whereas NCM capacity announcements increased by only 34%. Major players such as LG Energy Solutions (LGES), remain focussed on nickel-based chemistries but are starting to diversify their supply chain. Around 90% of LGES's 2030 cell capacity pipeline is for nickel-based cells, although they signed a long-term supply deal with Changzhou Liyuan, a Chinese cathode producer, in March 2024 for LFP cathodes. LFP cells are being produced at their Michigan plant and the company has also agreed to build a LFP cathode plant in Morocco with Huayou.

In 2023, China supplied 99% of global LFP CAM supply. Despite recent announcements for planned LFP capacity elsewhere in the world, the LFP supply landscape remains dominated by China. The 2030 forecast (unweighted by project development status) indicates that just 10% of LFP cathode supply will come from outside of China, compared to 48% for NCM – demonstrating the clear regional preferences for nickel-cobalt chemistries from the North American and European markets. Limited LFP plans outside of China will limit any further substantial growth in market share in the short term.



Figure 10: Share of 2030 cathode supply, %



Data: Benchmark Mineral Intelligence – Cathode Forecast.

A SLOWER SHIFT TO HIGH NICKEL CHEMISTRIES COULD BENEFIT COBALT DEMAND

In recent years there has been a gradual trend towards higher nickel intensity chemistries, particularly for NCM, which comes at the expense of cobalt. However, the shift to chemistries such as 811 has been slower than expected in the passenger vehicle segment. **Cobalt is key for safety and stability – some Chinese OEMs have removed high-nickel NCM models from the market owing to safety concerns and are shifting back towards mid-nickel NCM or LFP.**

There have been similar reports from some major ex. China battery producers who have decided to remain with mid nickel chemistries as cobalt prices have declined – this has reduced some cost pressure from higher cobalt intensities.

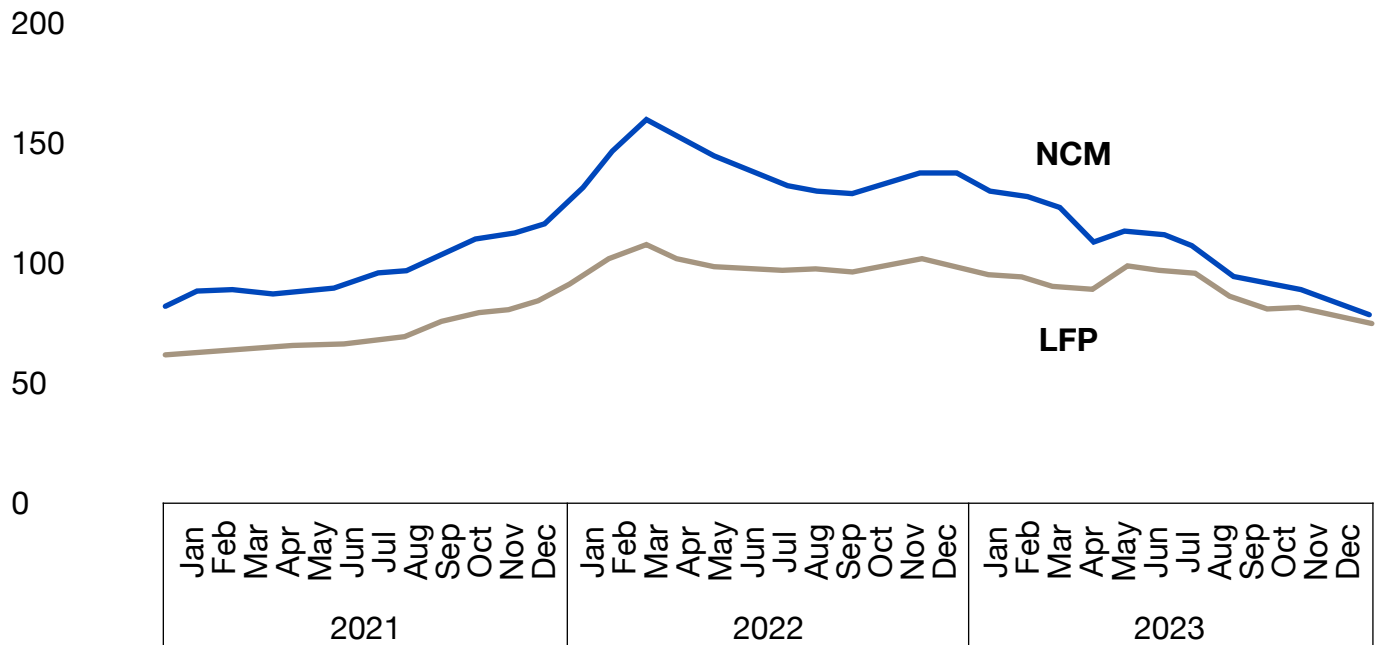
With weaker demand for EVs, narrowing margins and economic headwinds, cost is paramount for OEMs and the downstream. The substantial fall in nickel and cobalt prices has benefitted the cost competitiveness of NCM cells relative to LFP. Since cobalt prices started to decline in early 2022, NCM prices have fallen and converged with LFP. It is worth noting that both NCM and LFP cell prices are highly sensitive to lithium pricing which also declined substantially through 2023.

Due to the decline across raw materials prices, the share of cathode raw materials in total cell costs has also fallen from around 63%, on average, in early 2023 for NCM 622, to 39% in early 2024.

These factors have the potential to support cobalt demand further if the slower switch to high-nickel chemistries continues. This could lead to a slower decline in the average cobalt intensity in batteries.



Figure 11: Weighted average global cell prices, \$/kWh



Data: Benchmark Mineral Intelligence – Cell Price Assessments.

PERFORMANCE CONSIDERATIONS

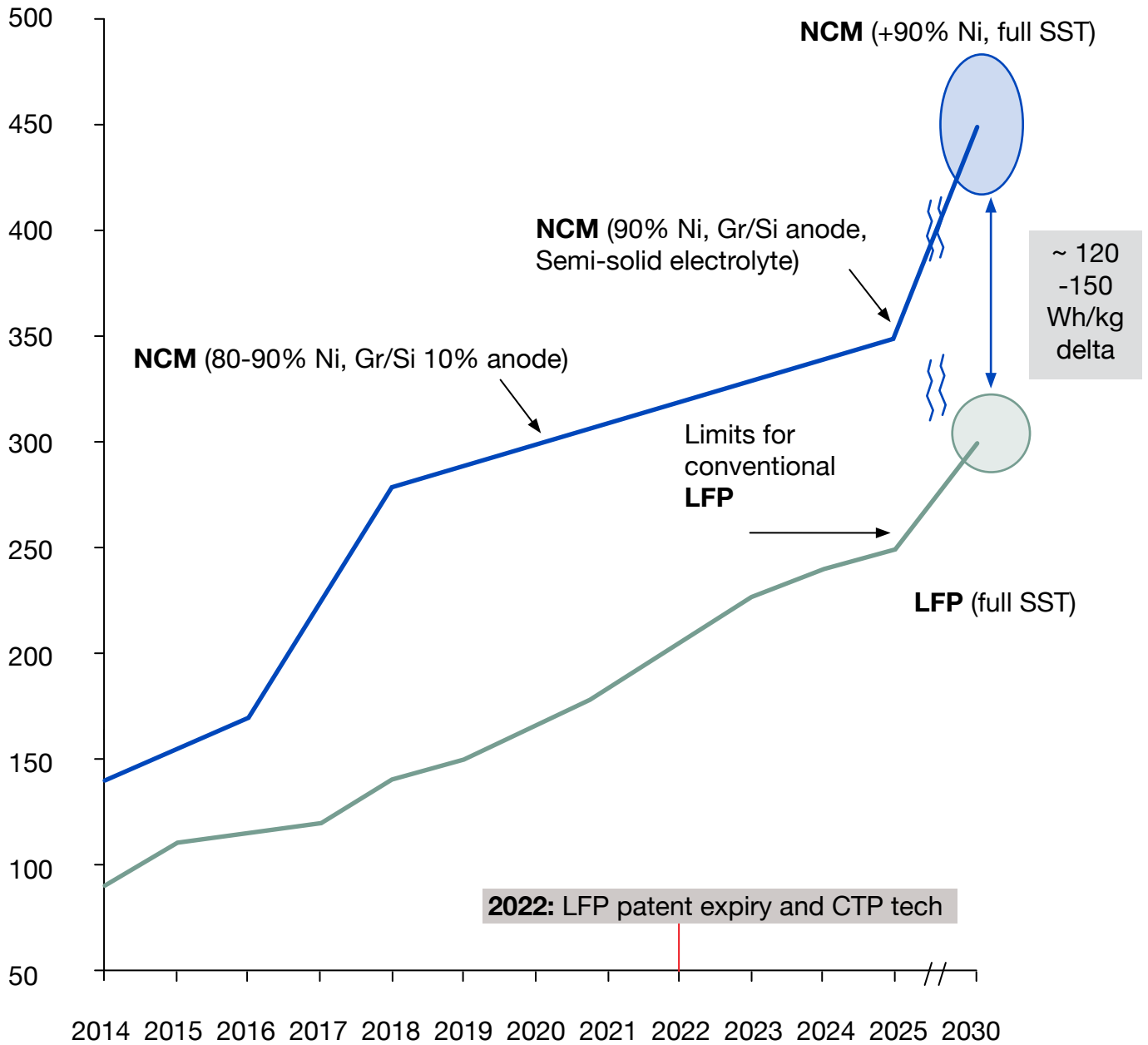
NCM and LFP are mature and established technologies that enable the fastest possible scaling up of battery production and EVs. Whilst up to now LFP (lower performance) and NCM (higher performance) have been complementary with similar market share, they are now increasingly competing for the middle market.

Manganese-rich cathode technologies are expected to reduce the cost-performance gap between NCM and LFP and crowd out further the middle range, particularly with competitively priced models from China being exported to other regions. The gap is being closed in both directions with LMFP (LFP with added manganese) attempting to increase density for no additional cost, and NMx (nickel-manganese chemistries with various other additions) targeting lower cost with modest loss in performance – although these chemistries are still under development and not expected to be commercially viable, at scale, until at least 2026. The EV supply chain is committed to NCM and LFP in the short term to allow a rapid scale up in production – emerging technologies are considered with medium to long term potential as any earlier adoption could delay production expansions.

LFP has gained ground recently although, importantly for cobalt, NCM is still expected to maintain a higher share in the medium to long term based on the technology development profile shown below. LFP will continue to dominate the low-range mass market. Competition between LFP and NCM technologies will take place in the mid-range EV market subject to LFP reaching its theoretical energy density limit and maintaining cost efficiency. NCM will continue to dominate the high-end EV market and has further upside potential in performance improvements.



Figure 12: Development of NCM and LFP energy density, Wh/kg



Data: Benchmark Mineral Intelligence. Note: SST = solid state technology. CTP = cell to pack.

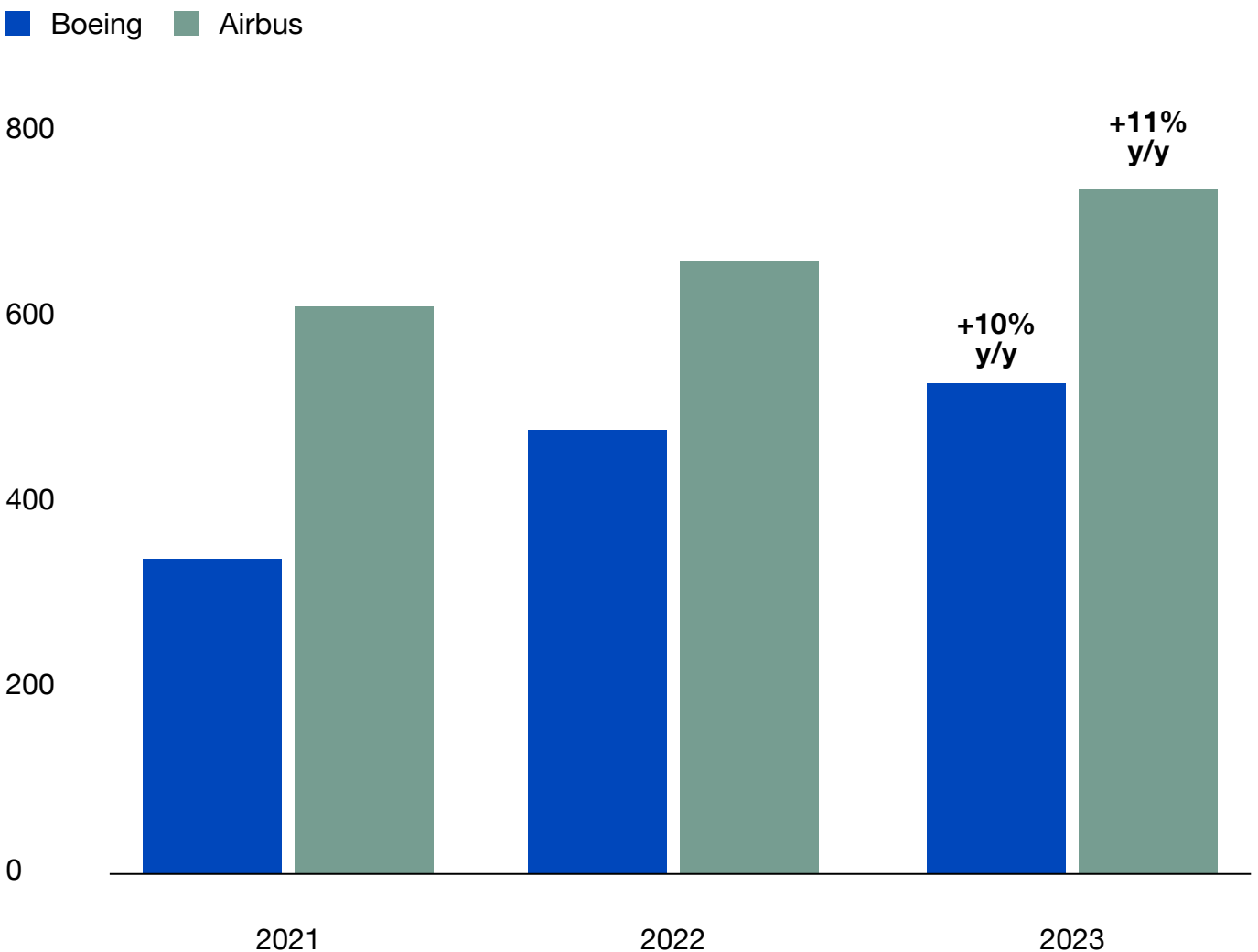


3.5 NON-BATTERY APPLICATIONS

Super alloys demand experienced continued recovery in 2023 as the aerospace market performed well as the industry returns to normal following the Covid-19 pandemic. International air traffic rose by 42% and domestic traffic by 30% in 2023. Boeing and Airbus both saw improved demand, with commercial aircraft deliveries rising by 10% and 11% y/y in 2023, respectively.

Airbus' order book rose by 23% y/y and they reported strong demand from airlines to refresh fleets, with industry demand recovering faster than their expectations post-pandemic. They are targeting 800 deliveries in 2024 (+9%) although this still remains below their 2019 peak of 870 units.

Figure 13: Boeing & Airbus commercial aircraft deliveries, units

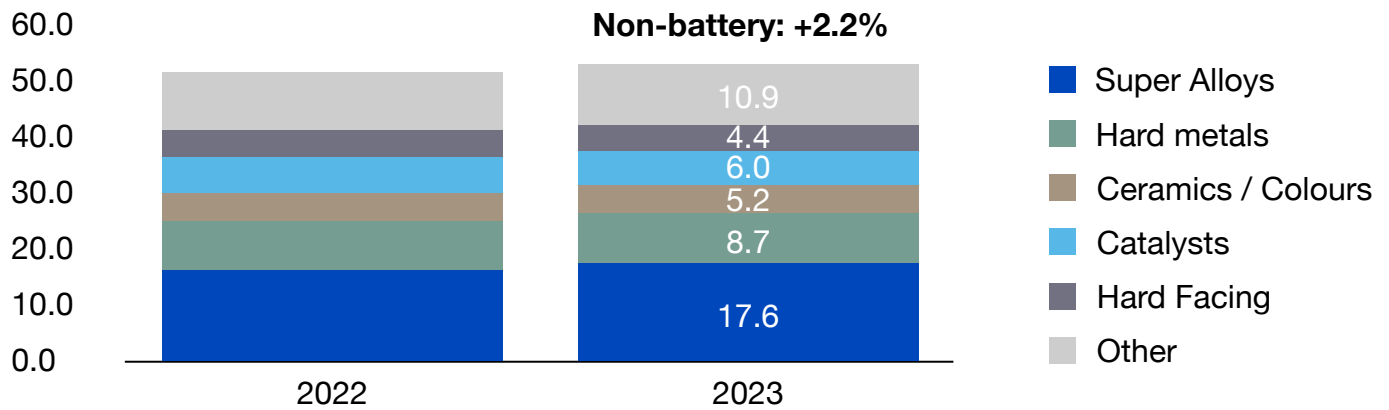


Data: Boeing & Airbus.

Primarily driven by the aerospace sector, cobalt demand from super alloys rose to 17.6 kt in 2023. This is the largest of the non-battery end use markets for cobalt and is an important sector for alloy grade demand.



Figure 14: Demand from non-battery cobalt end uses in 2022 & 2023, kt cobalt



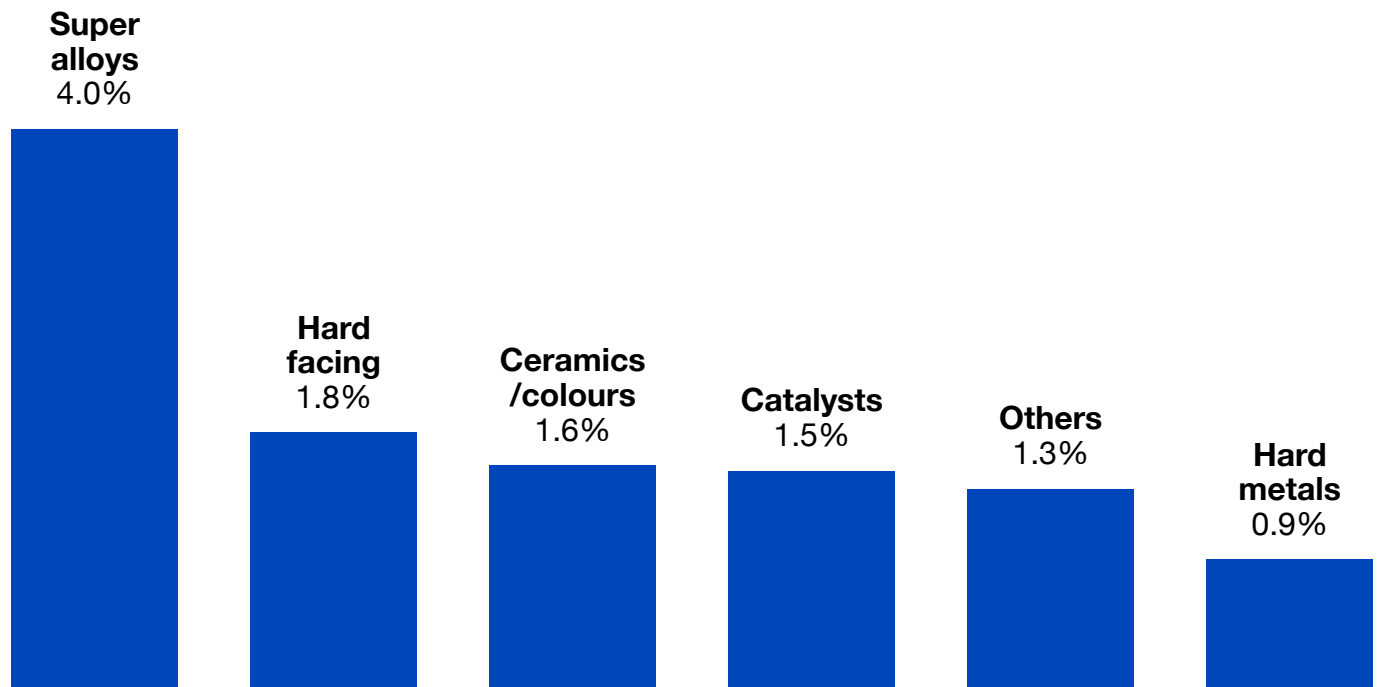
Data: Benchmark Mineral Intelligence – Cobalt Forecast.

Note: Others includes tyres, soaps, paint driers, magnets and other smaller end uses.

Alloy grade cobalt metal demand from aerospace and defence applications was steady in Q1 2023 and outperformed slower conditions elsewhere but adjusted down into Q2. Spot demand improved again in Q4.

Annual cobalt demand growth for super alloys (+4%) outperformed all other non-battery sectors, with other sectors seeing 1-2% annual growth.

Figure 15: 2023 annual cobalt demand growth by non-battery sector, % y/y



Data: Benchmark Mineral Intelligence – Cobalt Forecast.

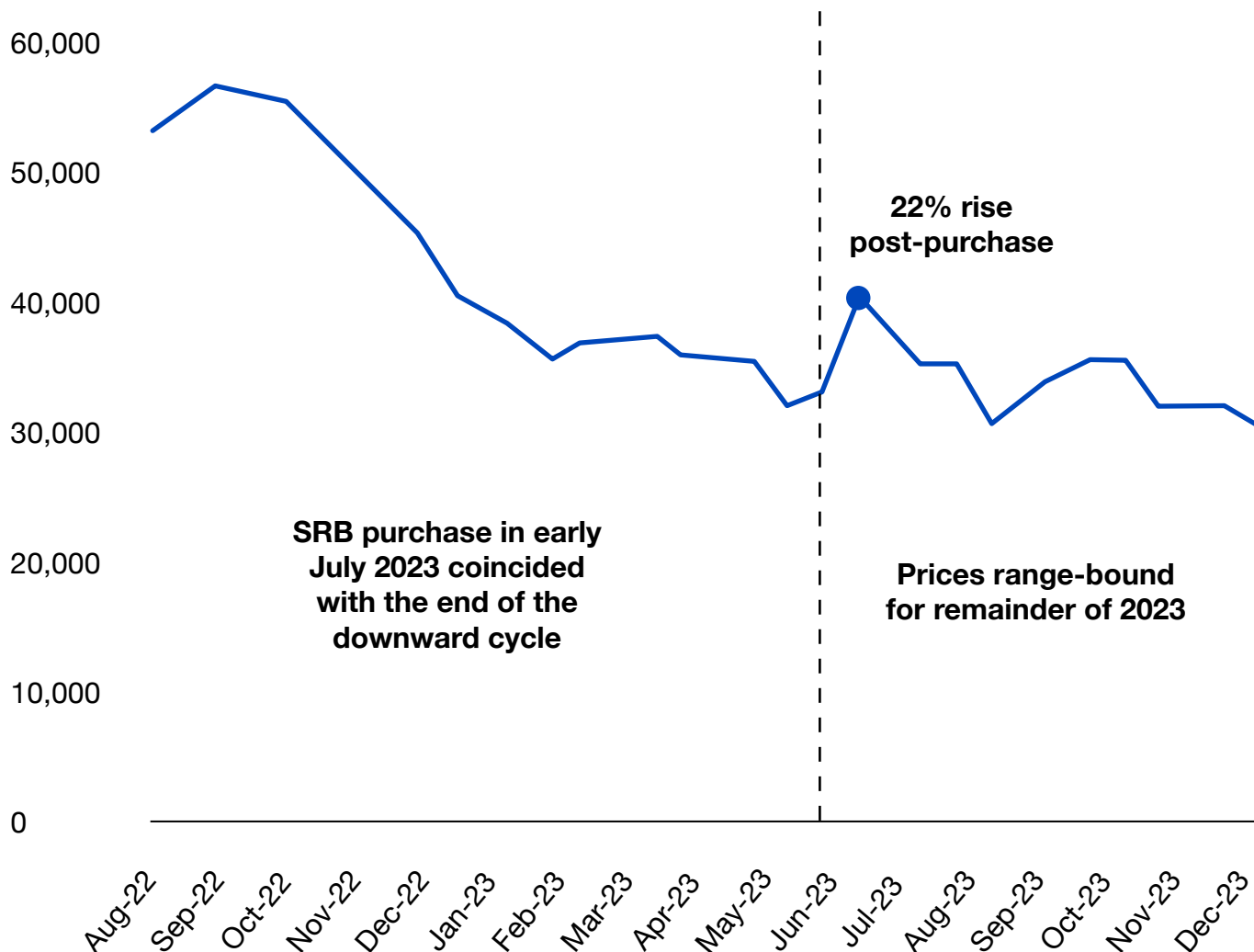


3.6 SRB PURCHASING

A notable contributor to cobalt demand in 2023 was purchasing of metal by China’s State Reserve Bureau (SRB), the first time they have added to strategic reserves since September 2020. In July 2023, the SRB agreed to purchase 5.6 kt over a six-month period with Huayou Cobalt and Yantai Cash reported as being two of the suppliers. Another purchase, of 3.1 kt, was announced in October to be delivered over a 4-month period. Total purchasing was equivalent to around 4% of cobalt demand in 2023.

Purchasing by the SRB is typically a sign of prices close to the bottom of the cycle. In September 2020, SRB purchasing triggered the start of a 50% price run over the following 6 months. The reaction to the early July 2023 was more muted, as prices rose by 22% through mid-July but retreated again on broader market weakness. However, it did mark the end of a 9-month price decline from the last peak in September 2022 and prices remained range-bound for the remainder of 2023.

Figure 16: Cobalt metal prices – EXW Europe, \$/tonne



Data: Benchmark Mineral Intelligence – Cobalt Price Assessment.



3.7 DEFENCE APPLICATIONS

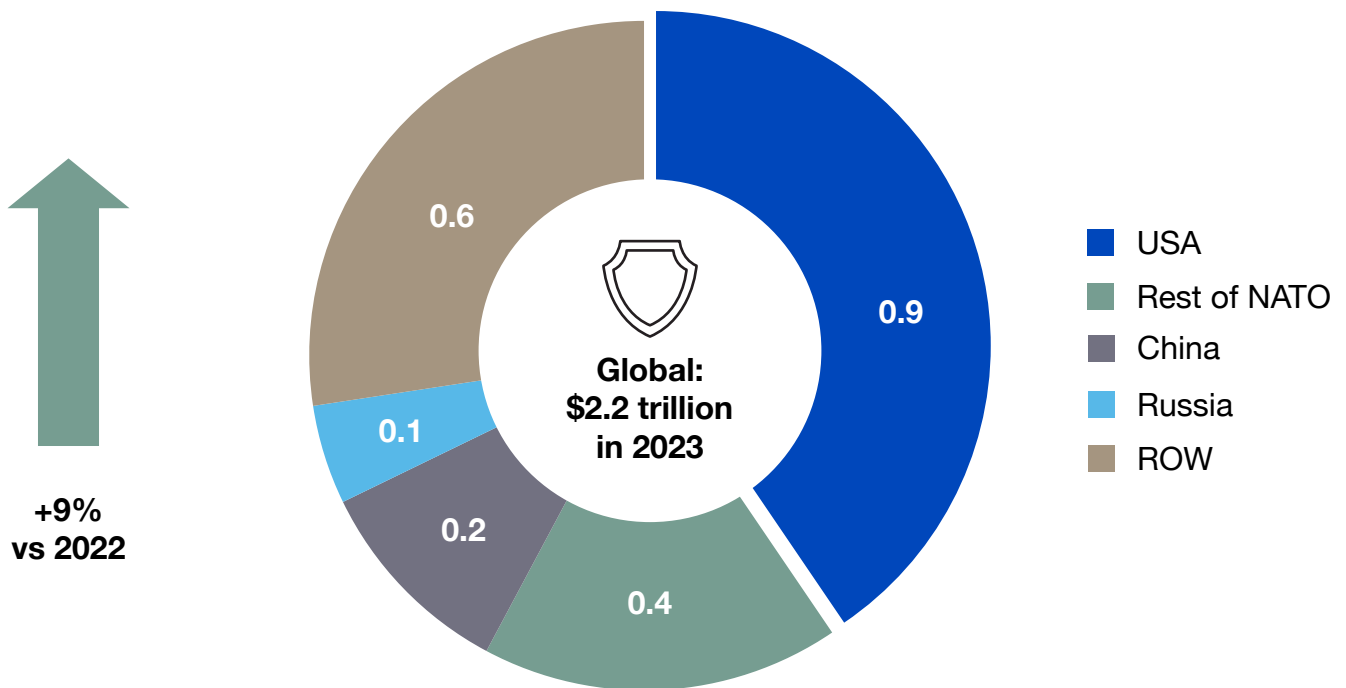
Despite limited information, cobalt demand from defence applications is expected to be rising as global military spending hit a new record in 2023, reaching \$2.2 trillion according to the IISS, a defence and security think tank¹. Following a decline in 2021 and 2022, growth in 2023 of 9% y/y reflected rising geopolitical tensions. Over the year, the war in Ukraine continued with Ukraine’s spending alone rising by 9 times y/y and the Israel-Gaza war began. NATO member states and primarily the US accounted for more than 50% of military spending in 2023. The rising trend is expected to continue through 2024.

In addition, the value of Airbus’ Defence and Space order intake rose by 15% in 2023; eight A400M military airlifters were delivered.

Finally, sales of drones (using lithium-ion batteries) are expected to rise by close to 50% by 2030. Drones for defence applications are much larger than personal or commercial drones, requiring larger batteries and therefore larger volumes of battery raw materials such as cobalt.

The volume of cobalt demand from niche and secretive defence applications is difficult to assess due to limited information available from the sector. In addition, military uses are likely to span the cobalt end use sectors in our analysis, including super alloys, hard facing applications and magnets, for example.

Figure 17: Military spending in 2023 by country, trillion US\$



Data: International Institute of Strategic Studies Military Balance 2024.

¹ The International Institute of Strategic Studies (IISS).



4 | SUPPLY: DRC & INDONESIAN GROWTH LIFT THE MARKET ABOVE 200 KT FOR THE FIRST TIME

4.1 KEY SUPPLY SIDE EVENTS IN 2023

- **January:** first shipment of MHP from QMB's new HPAL operation in Indonesia; the US announces a MoU on electric vehicle value chains with the DRC & Zambia, marking growing US efforts to counter Chinese influence in the region.
- **March:** PT Lygend begins cobalt and nickel sulphate production in Indonesia; the EU earmarks an investment of €50m (\$54m) in the DRC's critical minerals sector and associated infrastructure projects.
- **April:** Jervois suspends construction at the Idaho Cobalt Operations (ICO) citing the prevailing low price environment and US inflationary impacts on construction costs; also announce early plans for a potential cobalt refinery in the US.
- **May:** CMOC's Tenke Fungurume operation restarts exports after a 10-month dispute; the DRC suspends operations at ERG's Boss operation.
- **July:** Managem Group working on a feasibility study for a new cobalt sulphate refinery in Morocco.
- **September:** plans for a new copper-cobalt refinery in the DRC are announced by Buenassa.
- **October:** the EU and US sign a MoU to develop a corridor between the DRC/Zambia and the Atlantic port of Lobito in Angola.
- **December:** DRC president Félix Tshisekedi wins a second term in office.

4.2 OVERVIEW OF MINED SUPPLY

Mined cobalt supply surpassed 200 kt for the first time in 2023, rising 17% y/y (+33 kt) to 232 kt. The DRC was the major contributor with mined supply increasing by 26 kt y/y. However, the main story from 2023 was the ramp up of a single operation. CMOC's Kisanfu mine started operating and ramped up at pace through the year, outperforming all market expectations and producing 32.5 kt. Driven primarily by Kisanfu, the DRC maintained market share in 2023, at 76% of global mined production.

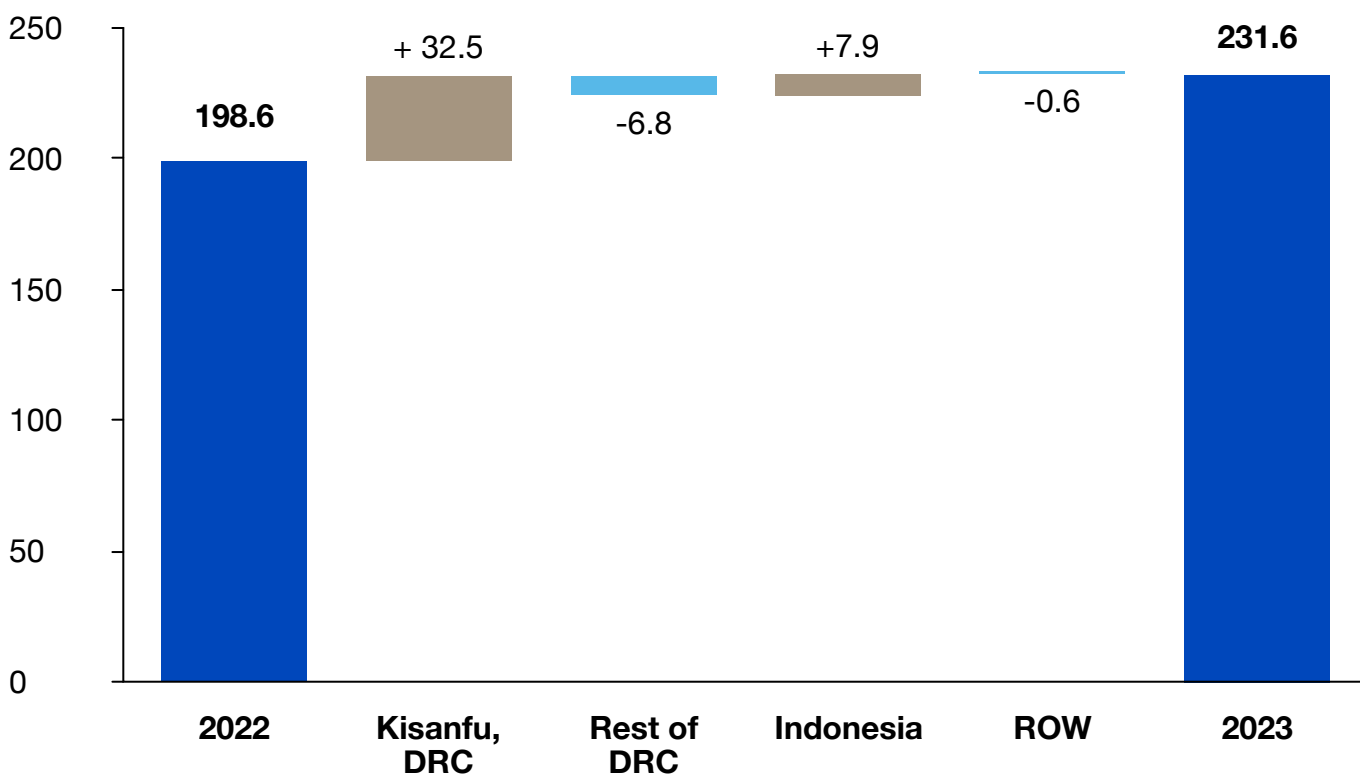
Indonesia's output rose 86% y/y and contributed 24% of global supply growth as the country's cobalt production continued to rise as a by-product of nickel production. Mined supply rose to 17 kt with market share up to 7%, cementing Indonesia's position as second largest mined cobalt producer. Volumes currently account for just 10% of the DRC's output, however by 2030, following major nickel-cobalt expansions, Indonesia is expected to account for 16% of global



cobalt production. The DRC's share will fall to around 67% of supply but overall production will rise by 26%.

Amongst the other major producing countries, with Australia, the Philippines and Cuba making up the top five, their combined share fell to 6%, down from 8% in 2022. Supply from the Philippines was steady, with Cuba seeing a small decline in output. Australian supply fell 14% y/y as production slowed at Glencore's Murrin Murrin and FQM's Ravensthorpe. In January 2024, Ravensthorpe announced that mining would be suspended due to weak nickel prices, although stockpile processing will continue.

Figure 18: Changes to mined supply in 2023, kt cobalt



Data: Benchmark Mineral Intelligence – Cobalt Forecast.

4.3 KEY MINE SIDE DEVELOPMENTS

CMOC LEADS THE WAY

Following many years with Glencore as the largest producer of mined cobalt in the world, the company was overtaken by CMOC in 2023. CMOC took control of the cobalt market as the company became the largest producer and accounted for three quarters of global supply growth.

The Chinese player, who owns the Tenke Fungurume and Kisanfu mines in the DRC exceeded market expectations last year, as it surpassed its own cobalt production guidance for 2023, having only brought the Kisanfu mine into the market in the first half of the year. Kisanfu produced 32.5 kt of cobalt in 2023, with Glencore's KCC operation the next largest at 28 kt. Over the

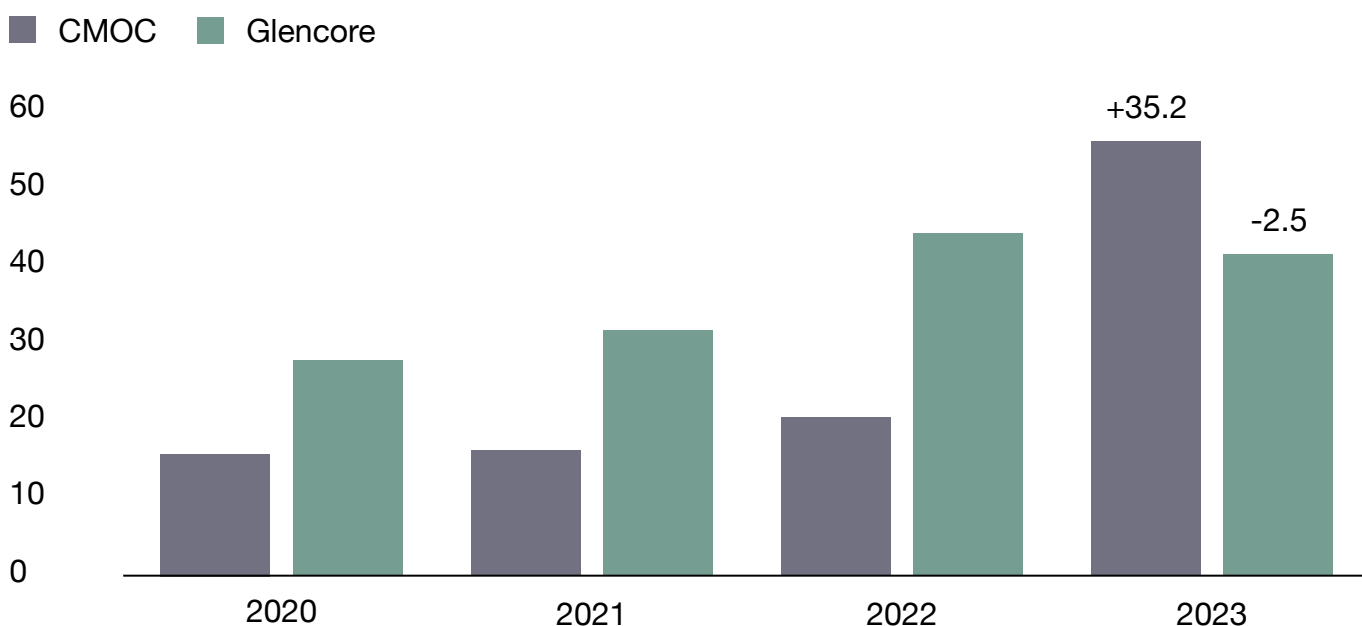


past four years, CMOC has increased its share of mined cobalt from 11% in 2020 to a quarter of the market (24%) in 2023.

Glencore now accounts for 18% of global supply, down from 22% in 2022. The company announced that cobalt was stockpiled in 2023 due to low prices and old stockpiles are continuing to be processed at the Mutanda mine in the DRC prior to re-starting oxide mining. The company has said that stockpiling and reduced production could be prolonged depending on market conditions. In 2023, the KCC operation in the DRC increased output by 2.1 kt in 2023, although Glencore’s total output fell 2.5 kt y/y as production declined at both Murrin Murrin in Australia and at Mutanda.

Facing challenging market conditions, Glencore has substantially decreased previous cobalt production guidance. In late 2022, the company planned to produce up to 60 kt of cobalt in 2024 – the latest guidance is now at 35-40 kt. This is a clear demonstration of the impact of weak market pricing at the same time as a need for strategic decisions at Mutanda for the restart of oxide mining and when to begin the proposed sulphide expansion.

Figure 19: CMOC & Glencore mined cobalt production, kt cobalt



Data: Benchmark Mineral Intelligence – Cobalt Forecast.

After a challenging year for CMOC in 2022 following the 10-month export ban on Tenke Fungurume, the dispute with DRC state-owned Gécamines was resolved in April 2023. The ban was introduced in July 2022 as it was alleged that CMOC deliberately under reported copper-cobalt reserves at the mine to avoid paying additional royalties.

CMOC continued to operate the mine at normal run rates and expand production capacity throughout the export ban, amassing a stockpile estimated to be in the region of 16 kt of cobalt, worth upwards of \$300 million at the time.



LIMITED PRODUCTION CUTBACKS DESPITE EXTENDED LOW PRICE ENVIRONMENT

Cobalt prices have been falling since April 2022 which has resulted in some projects slowing production or adjusting their strategy – for example, Glencore are stockpiling additional volumes. However, widespread industry production closures have not followed despite the weak price environment.

Copper is the revenue driver for most DRC operations and due to cobalt's by-product nature, it is not always at the forefront of miners' operational or strategic decision making, particularly when cobalt prices are low. Operations in the DRC will be favouring copper production and stockpiling cobalt, where possible, until cobalt prices improve; but copper prices are not the major driver of limited supply closures. Copper prices have been volatile but have not been markedly above previous cobalt price cycles in real terms, particularly when considering much higher levels of inflation post-Covid.

Instead, it is the strategic importance of copper, particularly for China, that has been behind operational decisions at some of the major operations. In fact, growth from the likes of CMOC's Kisanfu and Tenke Fungurume have outweighed supply reductions elsewhere.

The Chinese government has been clear about its intention to source as much copper as possible given its importance in infrastructure, EVs, renewables and the broader energy transition. Chinese-owned companies are supporting this strategy, with CMOC and Zijin Mining at the forefront:

- As discussed above, CMOC has pushed ahead with a rapid ramp up of the new Kisanfu copper-cobalt operation in the DRC despite cobalt industry headwinds. This has defied all market expectations, and the operation may even be loss-making given a greater dependence on cobalt revenues due to higher-than-average cobalt grades. CMOC is targeting 600 kt of copper production in 2024, double that of 2022 levels which will be supported by the major ongoing expansion at Tenke Fungurume.
- Zijin Mining, who operate the COMMUS copper-cobalt mine in the DRC, is also expanding quickly and aim to be a top 5 global copper player, producing 1 Mt of copper. Zijin has invested in the low grade Julong copper mine in China which could potentially become the largest copper mine in the world following planned expansions. CMOC and Zijin reference one another in their company reports, signalling the coordinated efforts of China to capture greater copper market share, even at lower margins.

There have been some casualties during the price slump – for example Jervois Global's Idaho Cobalt Operations (ICO). In April 2023, the company announced that it was putting its US-based project into care and maintenance due to cobalt's prevailing low price environment and US inflationary pressures hiking up construction costs.

SWING EFFECT OF ASM SUPPLY IS NOW MORE MUTED

Artisanal and small-scale mining (ASM) supply is highly price elastic and typically correlates well with global benchmark cobalt prices. Volumes fluctuate depending on both cobalt and copper



price levels. The sector has traditionally been seen as the swing supplier to the global cobalt market.

ASM has been an important contributor to cobalt supply in the past – estimated to supply ~10% of DRC supply (7-8% globally) in 2020, according to the USGS, with this share rising higher as cobalt prices spiked in 2022. However, with global mined supply doubling since 2017 and up more than 50% since 2021, ASM supply has lost market share. ASM volumes have been impacted further by weak cobalt prices, meaning that the number of artisanal cobalt miners in the DRC dwindled through 2022 and 2023 from the last peak in late 2021-early 2022. This now means that the impact of the ASM sector on the wider cobalt market is more muted.

The strategic importance of copper to China and the rising share of large Chinese-owned copper-cobalt operations may mean that the supply response from large-scale mining (LSM) is slower to react than in the past. The smaller ASM share, and reduced swing supply impact, will add to this dynamic and may have an impact on how quickly prices respond to oversupply going forwards.

More recently there have been some promising developments on the state of the ASM cobalt sector. In February 2024, Gécamines, the state-owned mining company of the DRC, made a significant decision to grant exclusive mining rights for five artisanal mining areas to its subsidiary, Entreprise Générale du Cobalt (EGC). This strategic move, alongside the appointment of new management, aims to revitalise the EGC by providing access to ore reserves. Other organisations such as the Fair Cobalt Alliance (FCA) continue work in the DRC to professionalise artisanal sites and improve working conditions, safety and sales prices for artisanal miners and cooperatives.

FURTHER SUPPLY DEVELOPMENTS IN THE DRC

The Boss operation, a joint venture between Eurasian Resources Group (ERG) and Gécamines, was restarted in early 2023 after a 3-year period of care and maintenance. However, operations were suspended again in May 2023 reportedly due to a flooding-related tailings dam breach in March which led to multiple fatalities and mine waste leaking into farmland, a nearby town and river.

This was the first in a series of reported issues for ERG in the DRC in 2023. In Q3 2023, the DRC's Ministry of Mines issued multiple decrees to suspend more than 20 mining licences, including several copper-cobalt licenses owned by ERG at the Boss and Comide operations. The DRC government claimed that ERG had been too slow in developing the deposits, as it reportedly seeks to drive the development of licences to provide greater access to critical minerals crucial to the energy transition.

In February 2024, Gécamines also offered to buy three of the company's assets in the DRC (details on specific assets not announced). ERG is the latest miner to face heightened government scrutiny, following attention on CMOC and Sicomin. CMOC eventually agreed to pay a \$800m settlement to Gécamines to end a long-standing dispute over royalty payments at Tenke Fungurume. As of April 2024, the Boss operation remains offline.

President Félix Tshisekedi has pledged to re-evaluate mining contracts signed by the previous



administration to secure ‘win-win’ agreements for the country and its people.

His subsequent re-election in December 2023 will see a continuation of the increased attention on historical resource extraction agreements. The DRC has firmed its stance against Chinese investors, as has been highlighted previously by the re-negotiated with CMOC’s Tenke Fungurume asset and more recently by the announced re-negotiated deal with Sicominex.

The Sicominex deal – made between Gécamines and a consortium of Chinese companies, including China Railway Resources Group and Sinohydro Corp – means the DRC will receive \$4 billion in additional road financing (now totalling \$7 billion) and Gécamines will receive 1.2% royalties (up from 0% previously) and the offtake rights to 32% of Sicominex’ minerals. The DRC’s share of the Busanga hydroelectric dam was increased from 10% to 40%.

The DRC is leveraging its emergence as a cobalt and copper powerhouse to its advantage as it finds itself at the frontline between China and the West in the race to control the critical minerals space. It is the largest producer of cobalt and vies with Peru to be the second-largest copper producer after Chile.

The DRC’s firming stance creates additional challenges for new investors. The country has long attracted Chinese investors over Western counterparts, demonstrating a greater willingness on their part to operate in a challenging environment. The DRC has some of the highest copper and cobalt grades in the world and a short permitting process, but investors raise concerns around poor logistical infrastructure, unstable power supply, weak governance, corruption risk, opaque sustainability practices and political instability.

Despite this, interest from potential new investors from the West, including the US government, and the Middle East is rising. **A shift in investment origin for cobalt mining, or even refining, is possible in the years ahead.**

4.4 INDONESIA MARKET CONTEXT & DEVELOPMENT

Indonesia has quickly become a critical part of the energy transition. In 2015, the country produced just 5% of global nickel and less than 1% of cobalt. As of last year, its nickel share reached half of the global market. For cobalt, a by-product of nickel production in Indonesia, supply is also rising quickly with Indonesia becoming the second largest cobalt producer in 2022. **This position was cemented further in 2023 as cobalt production rose 86% y/y, and contributed 24% of global supply growth – Indonesia contributed 7% of global mined cobalt.**

Nickel production in Indonesia has previously focussed on the stainless steel and metal demand markets with the dominant share of nickel demand. Stainless steel remains the major end use market, however, development in recent years has turned to the building wave of demand expected from the battery supply chain.

Nickel resources in Indonesia are within laterite deposits, typically formed from prolonged weathering of rocks in tropical or sub-tropical environments with appropriate geological characteristics. Up until recently, the saprolite portion of these laterite deposits has been targeted by Indonesian nickel miners and refiners to produce ferronickel (FeNi) and nickel pig iron (NPI). The limonite portion, sitting above the saprolite, was removed, effectively as overburden, and stockpiled.



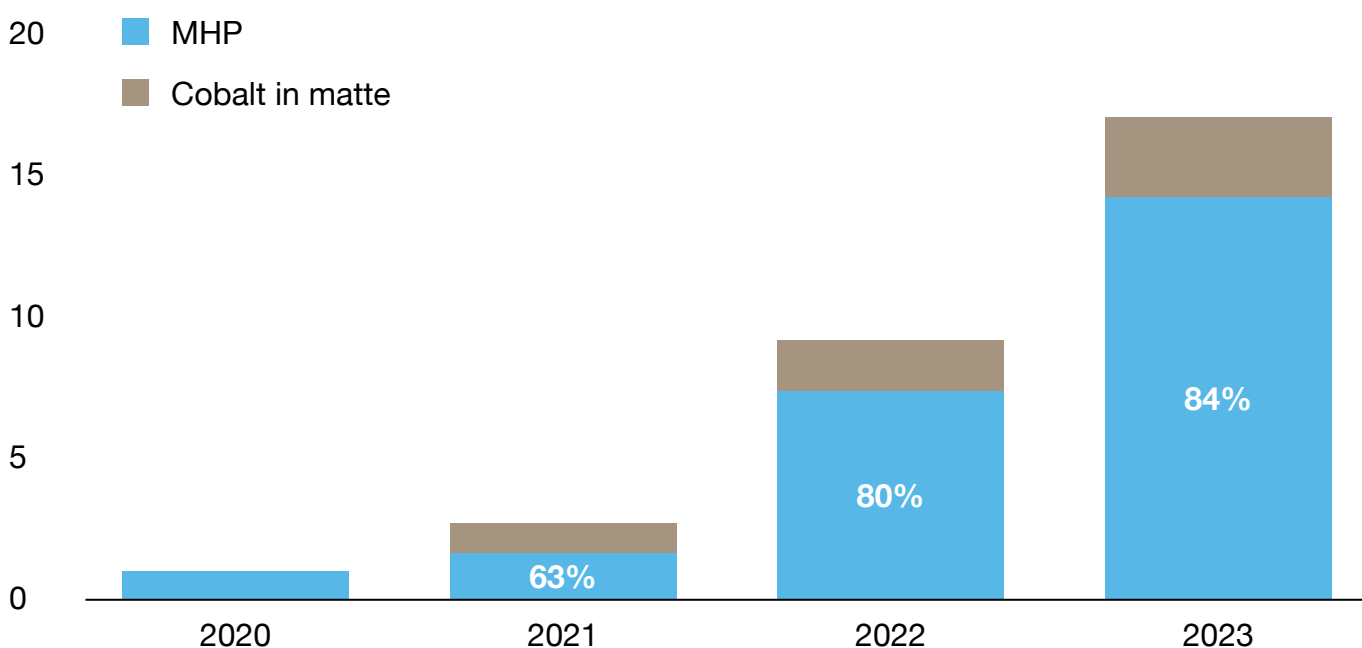
In 2020, the Indonesian government banned all nickel ore exports, forcing producers to add value to their resources and to encourage further downstream development in the country. The value of the limonite ore was not fully realised until high pressure acid leaching (HPAL) facilities were planned and built. The technology had been used in the past in other parts of the world, but with varying success and with a number of projects going significantly over budget. Despite initial scepticism, the four operations which have started to date in Indonesia have ramped up successfully and committed to further expansions. A lot of this success has been down to Chinese JV partners, bringing extensive technical expertise and key equipment from China. The current producers include PT Lygend (started in 2021), Huayue and PT QMB (2022) and Huafei (2023).

The development of planned HPAL capacity in Indonesia has been rapid – in early 2021, just 10 nickel-cobalt projects were being tracked in Indonesia. As of early 2024, that number has risen close to 60 with two thirds from HPAL projects. The remainder comes from cobalt in matte driven by developments in the matte process route for nickel. This route is also seeing further project development but to a lesser extent than HPAL.

HPAL capacity produces a mixed hydroxide precipitate (MHP) product containing both nickel and cobalt. This is typically at between a 8:1 and 10:1 ratio. Similarly to the DRC copper-cobalt operations, cobalt is a by-product of the nickel production process.

In 2023, Indonesia produced 17 kt of cobalt, up from 9.2 kt in 2022. Cobalt in MHP has risen to 14.3 kt, a 84% share. Looking ahead, 95% of cobalt supply growth in Indonesia will come from MHP with multiple new HPAL operations in the pipeline – supply has the potential to increase by 10 times. Cobalt in matte supply could quadruple over this period but will remain much lower than from MHP.

Figure 20: Share of Indonesia’s cobalt production by intermediate product, kt cobalt



Data: Benchmark Mineral Intelligence – Cobalt Forecast.



MHP has quickly become the key feedstock for nickel sulphate which is used in the production of precursor active materials (pCAM) for Li-ion battery production. In 2023, the first nickel and cobalt sulphate facility started production in Indonesia – the PT Lygend JV between Harita Nickel and Lygend Resources. PT Lygend produces sulphate from the integrated mine and HPAL facility on Obi Island in eastern Indonesia.

Further momentum in downstream development is building with LG Energy Solutions (LGES) and Hyundai to start battery cell production and Hyundai to start EV production in 2024. VW and BYD also have EV production plans in the country. The Indonesian government is keen to develop a domestic battery supply chain and leverage the substantial nickel and cobalt resources.

SUSTAINABILITY CONCERNS POSE RISKS TO INDONESIA'S ROLE

Sustainability of mined and refined products is high on political agendas and under increasing levels of scrutiny from end users, particularly in the battery supply chain. Indonesia has been a particular focus – the rising production of cobalt and nickel has highlighted numerous ESG concerns and poses risks to its growing role in the global energy transition.

There has been reports of illegal mining, corrupted practices, health and safety breaches and social unrest. The threat to biodiversity resulting from deforestation and land use change is also a major topic, given that laterite mining in Indonesia occurs in or near tropical rainforest ecosystems. This correlates with lower remediation efforts reported by companies². The results show that 32% of miners and 0% of refiners in Indonesia reported mitigating actions for biodiversity loss resulting from the land use change or other related mining activities. This is a concern with recent research from Mighty Earth³ and its collaborators showing large areas of deforestation in Indonesia in recent years, with 30% of the area identified having been cleared since 2019 as the volumes of nickel mining (and cobalt as a by-product) continues to rise.

As well as terrestrial land use change, electricity consumption in the HPAL production route is a significant contributor to various environmental impact categories, particularly for freshwater eutrophication⁴. This is primarily due to the large proportion (>60%) of lignite coal in Indonesia's high-voltage electricity mix.

Eutrophication in freshwater ecosystems can have significant impacts on biodiversity. This phenomenon causes algal blooms, reducing light and oxygen levels and threatening aquatic plants, fish, and invertebrates. Changing the source of fuel and moving to renewable electricity can significantly reduce these impacts, although Indonesia's high reliance on coal and significant capital costs for renewables adoption will mean that this will not be possible in the short to medium term.

In response, regulations and standards are evolving to integrate nature-related risks into sustainability reporting. Initiatives such as new pledges from the International Council on Mining and

² Benchmark Mineral Intelligence, Cobalt Sustainability Index - assesses the reporting and best practices of cobalt miners and refiners based on 79 environmental, social and governance indicators.

³ <https://mightyearth.org/article/from-forests-to-electric-vehicles>

⁴ Benchmark Mineral Intelligence, Cobalt Life Cycle Assessment (LCA).



Metals (ICMM) members and the release of the Global Reporting Initiative (GRI) Biodiversity Standard highlight this shift. By 2030, ICMM members, including major cobalt mining companies, must avoid mining in protected areas and commit to ‘No Net Loss’ of biodiversity at mine sites compared to 2020 levels. The GRI has also issued a revised biodiversity standard (GRI 101) with reporting guidelines to address biodiversity loss and promote international best practices for conservation.

4.5 REFINED COBALT SUPPLY

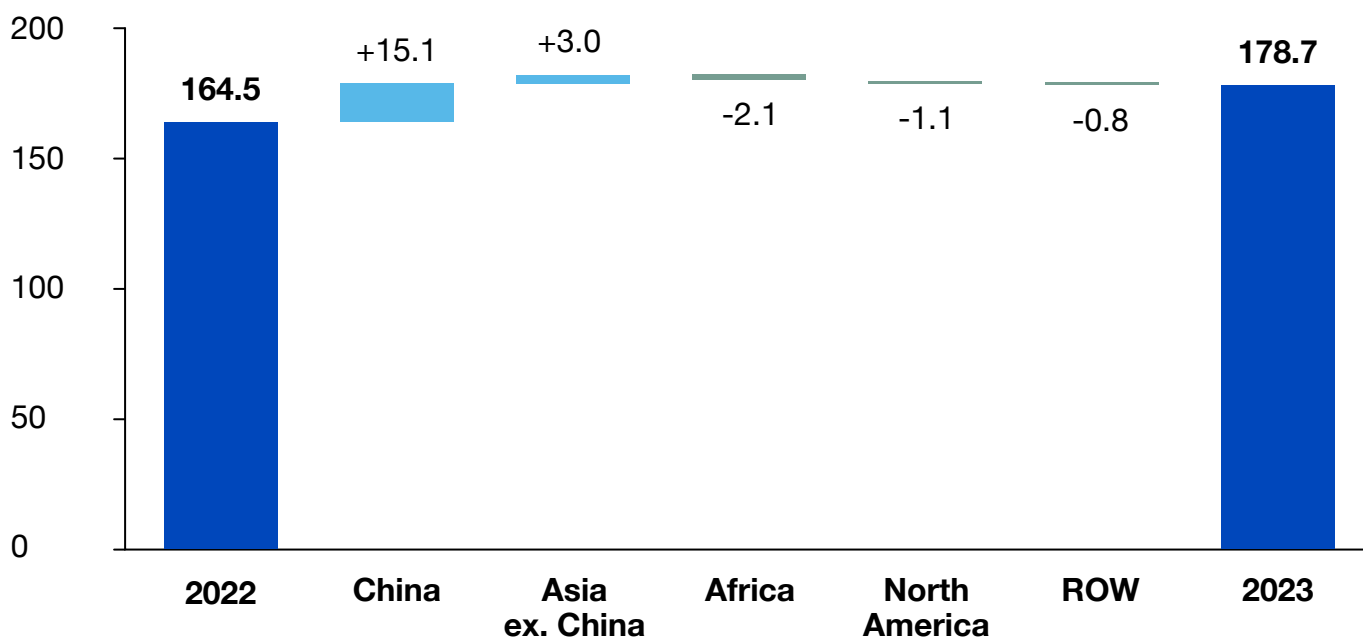
Global refined cobalt production saw 9% y/y growth in 2023, reaching 179 kt of cobalt, compared to 165 kt in 2022. Most of this growth came from chemical and powder producers, with an increase of 8.0 kt and 5.3 kt, respectively, compared to less than 1 kt for cobalt metal refining. Chemical refining saw growth despite a decline in cobalt sulphate production. Output of cut cathode grew in 2023 but was offset by falls in briquette and rounds output.

Cobalt chemicals accounted for around 72% of global refined production in 2023, with 28% for metal products.

China, the largest refiner of cobalt, produced 140 kt of refined cobalt in 2023, increasing their global share to 78%. Finland and Canada, the second and third largest cobalt refiners, accounted for 9% and 3%, respectively, of global production.

On a regional level, Asia ex. China was the second largest refined cobalt growth market in 2023 behind China. Japan contributed all of the region’s growth of 3 kt. All other regions saw a decline in output in 2023.

Figure 21: Changes in refined supply by region in 2023, kt cobalt



Data: Benchmark Mineral Intelligence – Cobalt Forecast.



Table 1: Share of global refined production by country, %

Country	Share of global refined production	
	2022	2023
China	76.1%	78.5%
Finland	9.9%	8.8%
Canada	4.0%	3.1%
Japan	0.2%	1.9%
Norway	1.9%	1.7%
Australia	2.0%	1.7%
Madagascar	1.9%	1.7%
Morocco	1.1%	1.0%
ROW	2.9%	1.6%

Data: Benchmark Mineral Intelligence – Cobalt Forecast.

4.6 SECONDARY COBALT SUPPLY

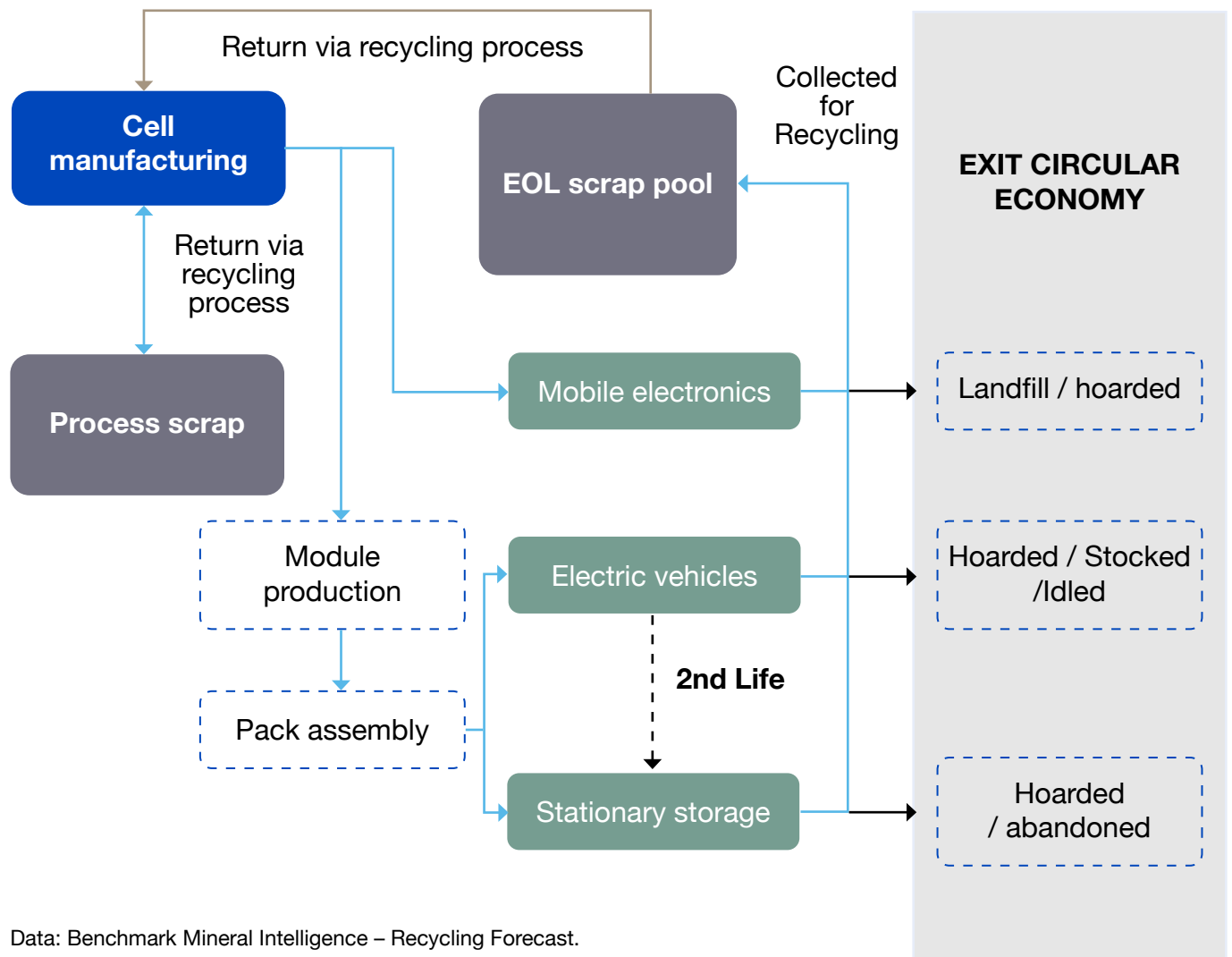
Secondary, or recycled, cobalt supply rose to 11.5 kt in 2023. This represented 5.2% of total cobalt supply, down marginally from 2022. Strong mined supply, up 17% y/y, did somewhat contribute to the weaker secondary share but it was primarily due to a marked slowdown in the growth of secondary supply.

The global cathode scrap pool grew by 20% y/y in 2023, down from 89% and 67% y/y in 2021 and 2022, respectively. Process scrap, contributing 85% of the scrap pool currently, experienced a significant slowdown in growth in 2023 as the expansion in global battery cell supply slowed. Cobalt sourced from process scrap was particularly impacted with minimal growth y/y in 2023 due to changes in cell chemistry production trends; although growth will resume from 2024 onwards.

Benchmark forecasts that process scrap will remain the dominant contributor to the scrap pool until the mid-2030s, when end of life (EOL) supply will see substantial growth.



Figure 22: Sources of recycled material – process and end of life (EOL) scrap



Despite short term headwinds, the outlook for secondary cobalt supply remains positive. Comparing cobalt, lithium and nickel (the major battery raw materials) the cobalt market is expected to see the highest proportion of demand coming from secondary supply. Secondary cobalt is expected to increase from 6% of demand in 2023 to 10% by 2030 and 29% by 2040. This is due to not only scrap availability, but also the advancement of recycling technologies and recovery of cobalt from these techniques. Recycled cobalt volumes have the potential to grow by more than 16 times to 2040.

Historically, recycling technology has been focussed on the pyrometallurgical (pyro) route which favoured cobalt and nickel recovery at the expense of lithium. More recently, investments in new recycling facilities are favouring hydrometallurgical (hydro) technologies, promising higher lithium recovery rates but still ensuring high cobalt and nickel recovery. The increasing use of hydrometallurgical processes aligns with both changes to the feedstock pool (from cell chemistry changes) and the strategic importance of efficiently recycling lithium. The advanced mechanical pretreatment and hydrometallurgical routes provide further upside for recovery across the major raw materials.



Europe and North America are poised to grow in recycling capabilities, driven by policy incentives. However, China currently has a significant head start on other regions in terms of recycling capacity.

Figure 23: Key recycling process routes

Chemical Component	Pyro	Mechanical Pretreatment & Pyro	Pyro Pretreatment & Hydro	Mechanical Pretreatment & Hydro	Direct
Status	Mature	Mature	Mature	Advanced	Developing
Co	40-60%	40-60%	>95%	>99%	>99%
Ni	40-60%	40-60%	>95%	>99%	>99%
Li	0%	0%	50-60%	90%	99%

Data: Benchmark Mineral Intelligence – Recycling Forecast.

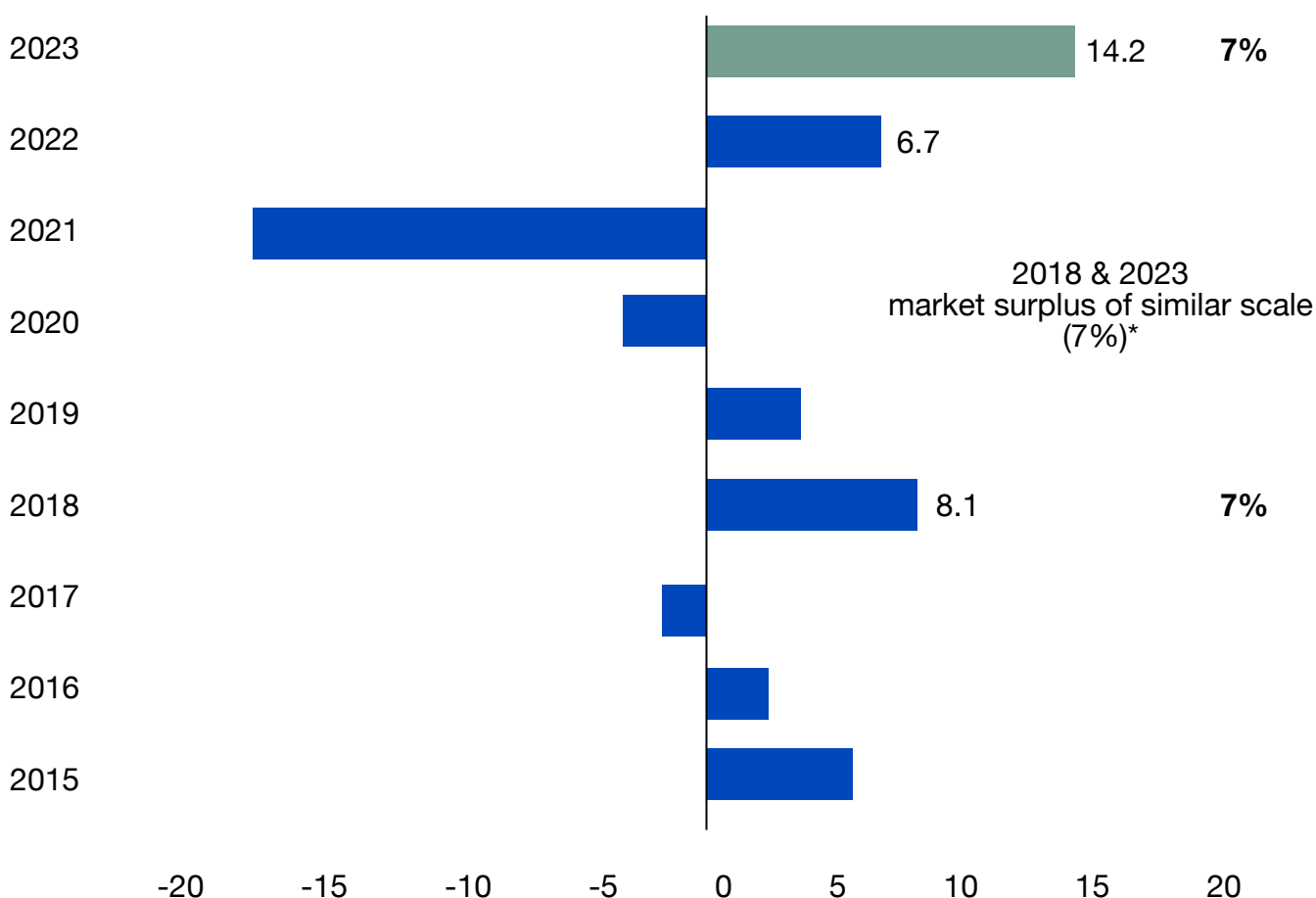


5 | MARKET BALANCE & PRICES: RECORD SURPLUS ADDS FURTHER PRESSURE TO WEAK PRICING

5.1 OVERVIEW OF MARKET BALANCE AND PRICES

The global cobalt market surplus in 2023 increased to 14.2 kt, up substantially from 6.7 kt in 2022. **This was the cobalt market's largest market surplus seen in volume terms**, although equivalent to 2018 in percentage (%) terms, given the substantial market size growth since.

Figure 24: Cobalt market balance, kt cobalt

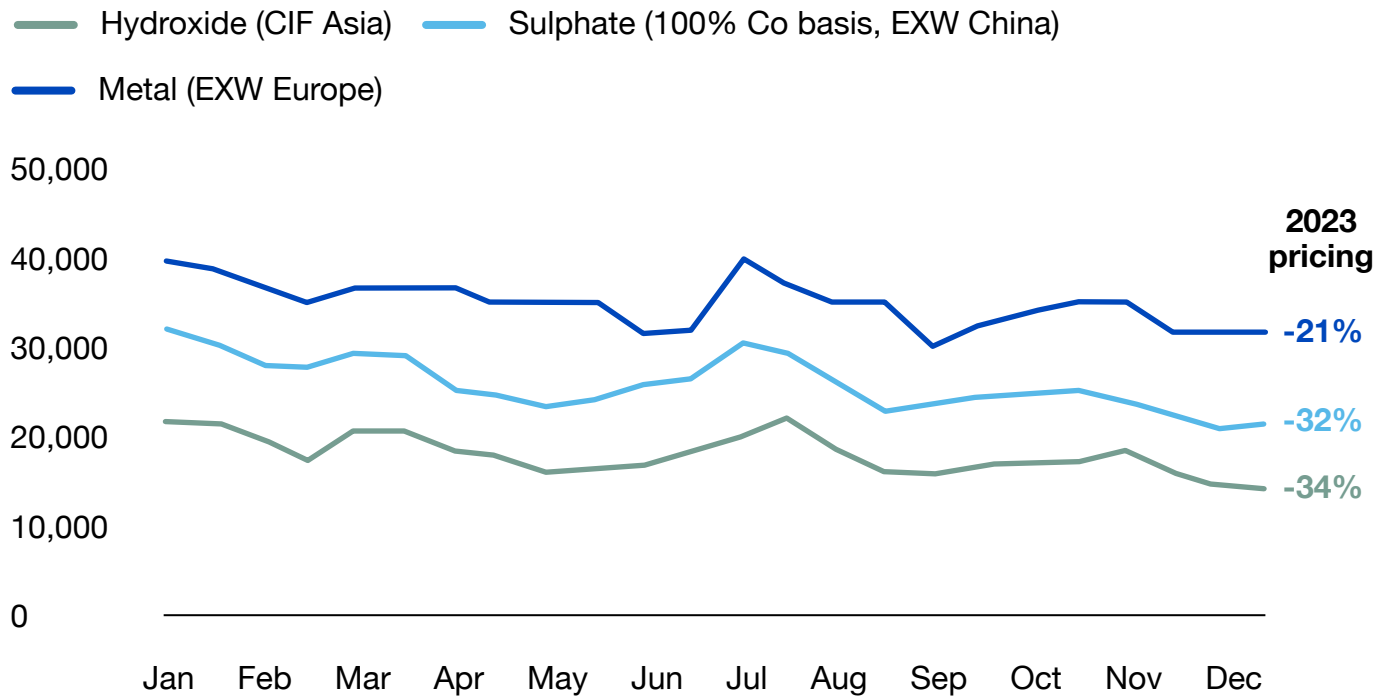


Data: Benchmark Mineral Intelligence – Cobalt Forecast. Note: * as a share (%) of total demand.

Cobalt prices continued to decline through 2023 across all grades, despite short term improved sentiment in Q3. Weighed down by a significant market surplus, hydroxide prices suffered the greatest fall of 34%.



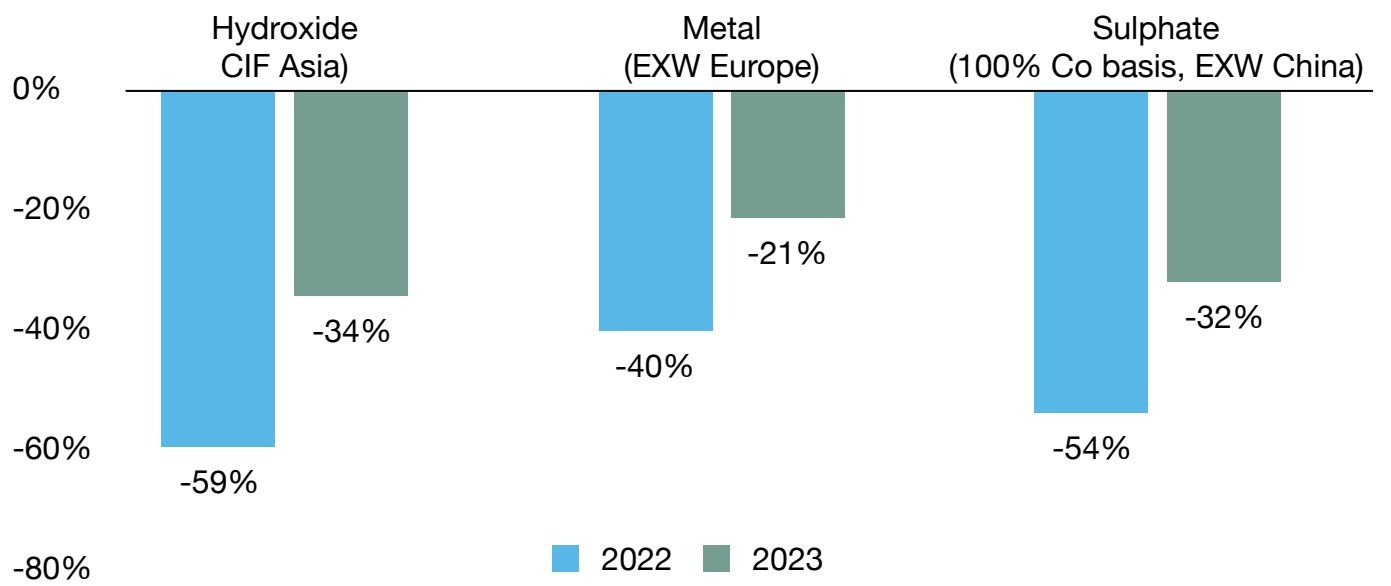
Figure 25: Cobalt prices in 2023, \$/tonne cobalt contained



Data: Benchmark Mineral Intelligence – Price Assessments.

However, the price decline did slow in 2023 compared to 2022 when prices fell from the high point in the cycle.

Figure 26: Price performance in 2022 and 2023, % change



Data: Benchmark Mineral Intelligence – Price Assessments.



5.2 COBALT HYDROXIDE

Chinese EV subsidies came to an end in late 2022 leading to slowing demand growth for the EV battery industry, with the market expecting that Q1 2023 EV sales would fall. This compounded with a significant buildup of raw material inventories throughout the supply chain, leading to very bearish market sentiment moving into the start of the year.

Cobalt hydroxide prices declined significantly at the beginning of 2023, as spot market prices fell below \$10/lb (\$22,046/tonne) for the first time since mid-2020.

Q1 was dominated by weak demand for hydroxide, as consumers opted to work through existing inventories over procuring new material. Limited increases in EV demand were largely absorbed by long term contracts and existing inventories, leaving minimal purchasing in the spot market to support prices increasing.

In April, exports from CMOC's Tenke Fungurume mine resumed, leading to a significant volume of hydroxide becoming available to the market. CMOC's new operation, Kisanfu, starting production in a similar window further contributed to the already tumbling cobalt prices, pushing hydroxide below \$8/lb (\$17,637/tonne) in May.

Q3 provided the first relief opportunity for hydroxide prices, as an oversupply of sulphuric acid in the DRC led to fewer trucks entering the country to help transport copper and cobalt out of the region. Winter in the southern hemisphere further exacerbated the trucking delays, leading to a significant supply tightness of cobalt hydroxide out of Durban. This allowed prices to rebound into July, with hydroxide reaching \$10/lb in late July, the only time that prices would reach this level in 2023. The following months saw a swift correction, with prices falling rapidly in August. Moving into Q4, hydroxide failed to rise above \$8/lb, despite multiple offers by sellers at much higher prices. A growing disconnect between buyers and sellers became more apparent in October, as weak demand emboldened buyers to pass on purchasing cobalt at an elevated price. This dynamic was flipped in November, as buyers pushed to purchase below \$7/lb (\$15,432/tonne); producers were resistant at first, however, by December some hydroxide producers showed willingness to sell at a considerable discount to what was previously perceived as a floor.

Overall, cobalt hydroxide had the most significant price decrease of any cobalt grade, falling by 34% through 2023. The huge increase in production in the DRC, particularly from CMOC, coupled with the weak growth in demand led to a significant oversupply of cobalt hydroxide available to the market.

5.3 COBALT METAL

Cobalt metal began the year having fallen below \$20/lb for the first time since early 2021. Although there was some initial optimism from the market that the price decline would stabilise in Q1, this was short lived, as prices had fallen below \$17/lb by the end of the quarter.

Moving into the second quarter, increased cobalt hydroxide from the DRC as a result of Tenke Fungurume's exports resuming weighed heavily on prices. Cobalt metal suitable for super alloys saw an increasingly wide margin, however, producers struggled to take advantage.



Chinese producers in particular were the first to experience signs of lower prices, as Chinese material was being traded as low as \$12/lb in June, almost \$4/lb lower than the prevailing market.

Prices rose rapidly early in Q3, with a 22% price increase in just the first half of July. Although some of this can be attributed to less low-priced material being available to the market, a much more significant contributor was the supply tightness of hydroxide due to an aforementioned truck shortage. However, this was short lived, and by the end of the quarter prices had fallen to their lowest point in the year, as another wave of Chinese metal entered the European market, undercutting prices.

By the fourth quarter, news of a large SRB purchase helped prices recover from the low of \$14/lb. The increased demand, along with some tightness from producers going offline for care and maintenance bolstered metal prices. However, the SRB purchase was not able to hold off Chinese cut cathode from entering the European market for long, and a few weeks later prices had fallen back down as Chinese metal once again was offered at a significant discount to ex-China metal. Bearish sentiment took over the market as the end of year approached, with activity slowing considerably in December, particularly from western countries due to the Christmas period approaching.

Although 2023 was an exceptionally bearish year for cobalt metal prices, it was the least significant decline of the three major grades (hydroxide, metal and sulphate), falling 21% through the year compared to 34% for hydroxide and 32% for sulphate.

5.4 COBALT SULPHATE

Cobalt sulphate prices entered 2023 having fallen sharply as Chinese EV subsidies came to an end. Market attitude was incredibly bearish as the expectation for EV sales in the quarter was far lower than the previous year. Prices saw a small recovery following the Spring Festival due to increased speculative sulphate purchases in China, although a lack of improvement to demand meant this was short-lived and prices quickly began retreating.

Although the expectation for Q2 was that an increase in EV sales would bolster sulphate prices, this took a few weeks to materialise, due to cathode cell manufacturers having substantial stocks to work through. However, as the increase in NCM demand materialised, prices began rising at the end of May. A successful 618 festival (major shopping festival) in China further reinforced this, increasing LCO demand as well due to increased sales in consumer electronics.

Q3 supply saw significant constraints due to the previously mentioned delays in hydroxide leaving the DRC, and as a result sulphate prices reached their highest point of 2023, at RMB 45,500/tonne (\$6,325/tonne). Yet despite this, sulphate prices quickly took a downturn as wider macroeconomic trends in China slowed consumer purchasing. Cathode manufacturers saw little incentive to build inventories until the end of September, as this represents one of the most active months for consumers.

As the end of year approached, prices initially rose through October, as news of the SRB's intention to purchase cobalt metal allowed bullish sentiment to permeate the Chinese market. However, this was short-lived and prices quickly fell back in line with the wider 2023 trend.



NCM demand in the final months of the year was weaker than in September, and as the supply constraints had fully passed, prices fell to their lowest point of RMB 31,000/tonne (\$4,371/tonne) in mid-December. However, the final weeks of the year did present an increase in prices as cathode manufacturers took advantage of the historically low prices to begin stocking ahead of the Spring Festival.

Over the course of 2023, prices fell by 32%, as the market continued to grapple with weaker than expected demand growth and a considerable oversupply of cobalt hydroxide.

5.5 DEVELOPMENTS IN PRICING MECHANISMS

As the battery market continues to grow and evolve, alternative sources of feedstock have become increasingly relevant to the industry. Indonesia is now responsible for 7% of cobalt mined supply, and its market share will continue to grow in the coming years. As Indonesia becomes a greater part of both the battery market and the wider cobalt market, there is an increasing need for the market to price the cobalt contained in MHP used for refining.

The continued trend of battery dominance in the market has further reinforced cobalt hydroxide moving away from a metal payable model. Much of hydroxide trading has moved to a fixed cost (in USD), with China still preferring to price based on the current sulphate price (in RMB) and refining costs. Liquidity for both hydroxide and sulphate continues to improve as volumes rise in line with growing cobalt demand.



6 | OUTLOOK: COBALT MARKET TO CONTINUE STRONG GROWTH TREND

DEMAND CONTINUES TO TREND UPWARDS

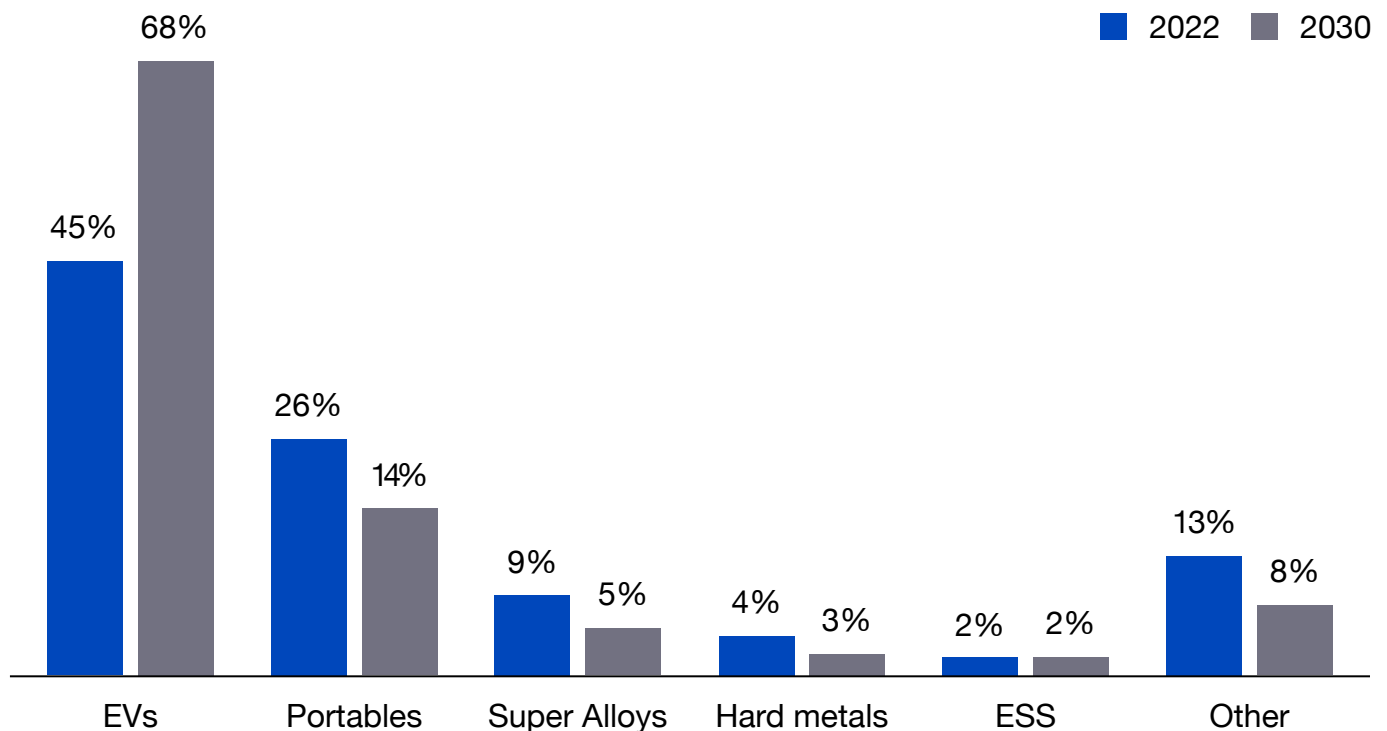
Cobalt demand is forecast to rise by 14% in 2024, building on 10% annual growth in 2023. Demand from EVs, the largest demand driver for cobalt, is expected to rise 25% y/y and contribute 81% of total market growth. Recovery in portable electronics markets will contribute a further 11% of cobalt demand growth.

By 2030, we expect cobalt demand to more than double on 2023 levels and for the total cobalt market to exceed 400 kt. Robust demand growth of 11% CAGR in the last seven years is expected to continue to the end of the decade.

95% of cobalt demand growth will come from battery applications as global cell demand is forecast to increase almost 4-fold. Cobalt demand from EV is expected to more than triple, energy storage systems (ESS) to double and portables to increase by 13%. Super alloys will remain the largest non-battery driver, growing by 22%.

Cobalt remains an important part of the major battery chemistry technologies. Cobalt-containing cathodes are expected to maintain a share of around 54% of total cathode demand despite the growth of some alternative technologies, which will underpin cobalt's continued demand growth.

Figure 27: Share of cobalt demand by sector in 2023 and 2030, %



Data: Benchmark Mineral Intelligence – Cobalt Forecast.



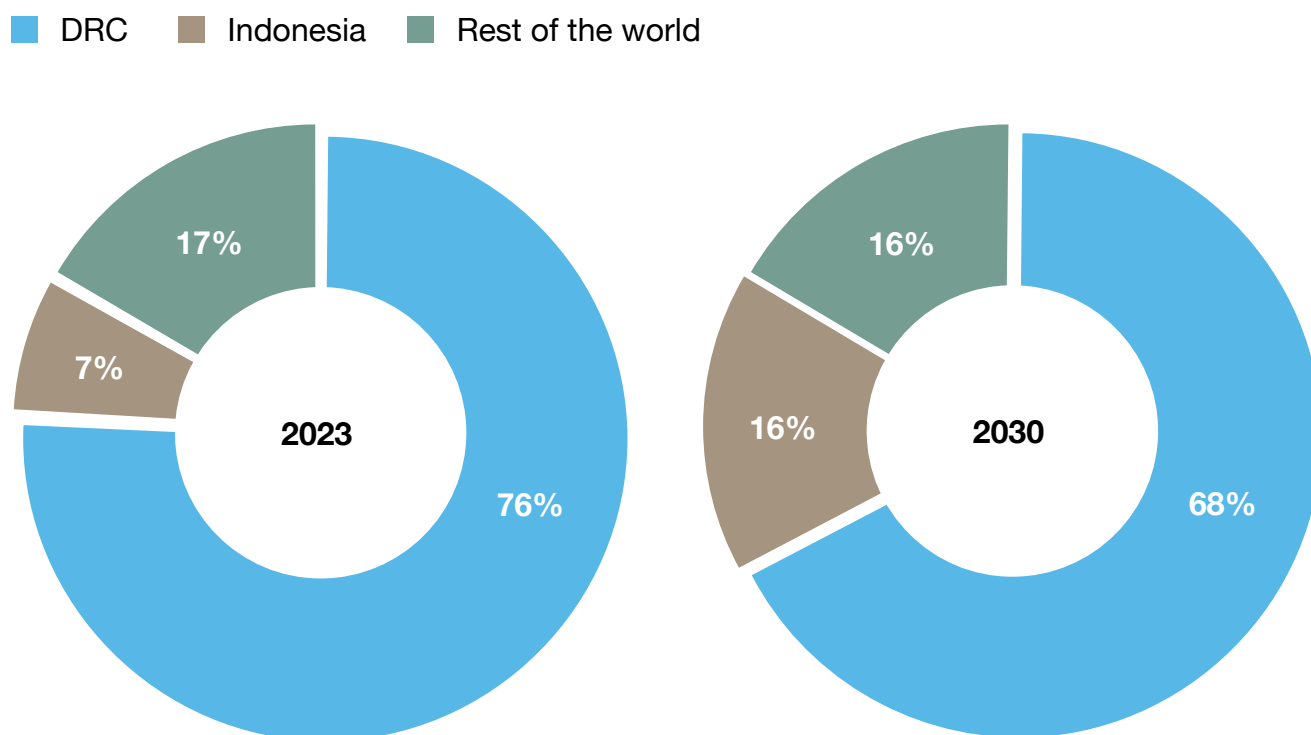
SUPPLY GROWTH WILL LARGELY COME FROM THE DRC AND INDONESIA

Primary cobalt supply will support three quarters of supply growth to 2030, with the remainder from secondary, or recycled, sources.

Primary cobalt supply is forecast to grow by a CAGR of 5.2% between 2023 and 2030. By the end of the decade, supply is estimated to reach nearly 300 kt. The share of secondary supply is forecast to account for 12% of total cobalt supply by 2030, up from 5% in 2023, growing at a CAGR of 19.6%.

84% of mined cobalt growth to 2030 will come from the two currently dominant cobalt producing nations, the DRC and Indonesia. 48% of growth will come from the DRC, with 37% from Indonesia. While both countries are forecast to increase production in absolute terms, Indonesia's output is expected to more than triple – this will see Indonesia's share rise to 16% of global supply, while the DRC's share will reduce to 68%.

Figure 28: Share of DRC and Indonesia mined cobalt supply, 2023 vs 2030, %



Data: Benchmark Mineral Intelligence – Cobalt Forecast.

Rest of the World includes Australia (2.2% in 2023, 2.4% in 2030), Philippines (1.6%, 1.8%) and Cuba (1.9%, 1.5%) as the next three largest producing countries after the DRC and Indonesia.



COBALT MARKET TO REMAIN IN SURPLUS UNTIL THE MID-2020s, BUT LARGE CALL FOR MATERIAL EMERGING IN THE LONG TERM

Following the large market surplus in 2023, the cobalt market is forecast to remain oversupplied in the short term as supply growth continues from the DRC and Indonesia and outpaces demand growth.

However, to 2030, demand will grow at a CAGR of 11% compared to 6% for total supply. From the mid to late 2020s onwards, the balance will shift to a deficit, with an increasing call for material emerging over the forecast period, as current plans from miners, refiners and recyclers are not expected to meet rising cobalt demand.

Expectations of a surplus in the short term will keep prices subdued but as the deficit approaches, prices are expected to recover which would be further supported by a widening deficit.

Current low prices will support cobalt's application in cost competitive sectors such as the battery market but this also risks disincentivising new investment in additional mined and refined capacity to support growing cobalt demand.



7 | KEY CONSIDERATIONS FOR THE COBALT MARKET

- **Short term pressure:** the cobalt market is enduring a sustained period of market weakness which is expected to persist as supply outpaces demand, extending market surpluses. Prices will remain under pressure in the short term.
- **Technologies for the energy transition:** EVs and energy storage will be integral to the global energy transition, with double-digit annual growth expected for lithium-ion battery demand. Cobalt maintains a key role in a number of the major battery chemistries for stability and performance – this mega trend will underpin cobalt’s continued, and robust, growth.
- **Traditional applications remain steady:** demand will continue to grow from all non-battery applications, albeit at much slower growth rates than the battery sector. This will continue to support a large number of important industrial applications of cobalt.
- **Supply diversification:** the DRC will remain the major supplier of mined cobalt with substantial further growth expected, primarily from existing producers. Indonesia’s rapid nickel supply growth, producing cobalt as a by-product, will see the country gain global market share. Cobalt supply growth going forwards will be dominated by these two major players.
- **Switching market balance:** from the mid to late 2020s, strong demand growth is expected to outstrip supply. Prices are forecast to recover to incentivise further supply investment and support rising future market demand.



8 | GEOPOLITICS IS MOVING QUICKLY UP THE GLOBAL AGENDA

Geopolitics is now at the forefront of decisions around the future of supply chain development worldwide. It is a high-priority topic for a rising number of major global economies, with critical minerals strategies increasingly overlapping with national security priorities.

The Covid-19 pandemic, the ongoing trade war between the US and China and Russia's invasion of Ukraine have demonstrated the complex regional dependencies for a number of markets that are key to the global economy.

The critical mineral and battery industries, including cobalt, are increasingly exposed to geopolitical and supply chain risks. China's export restrictions on graphite and rare earths have further highlighted the sensitivity of supply chains that are key to the global energy transition.

This section summarises the major geopolitical themes impacting cobalt, critical minerals and associated supply chains.

8.1 GLOBAL RACE FOR CRITICAL MINERALS AND THE NEED FOR SUPPLY DIVERSIFICATION

Since the Paris Agreement in 2015 and at COP (Conference of the Parties) events since then, the commitment to reduce greenhouse gas emissions and limit global warming has triggered a wave of action from countries across the world.

The start of the energy transition has been characterised by a global race for critical minerals needed for developing new, green technologies and moving away from fossil fuels to achieve net zero targets. The rapid development of lithium-ion batteries and associated supply chains has been pivotal – this is the key driver of current and future cobalt demand.

Many of the key parts of the battery value chain are geographically concentrated, adding further supply security risks. For cobalt, 76% of mined supply comes from the DRC and 79% is refined in China. This is just one example of China's dominance in the battery supply chain – the country controls high proportions of refining for other major upstream battery raw materials and around 80% of both CAM and cell supply in the mid and downstream. Western economies have a substantial task in re-gaining some of this lost ground.

In addition, rising geopolitical tensions such as the war in Ukraine and instability elsewhere resulted in military spending reaching \$2.2 trillion in 2023⁵ – global defence spending has now increased for nine consecutive years⁶. This has brought increased demand for a variety of critical minerals, including cobalt.

⁵ The International Institute of Strategic Studies (IISS).

⁶ Stockholm International Peace Research Institute (SIPRI).



Against this background, policies have developed over the last few years focussing on two broad strategies:

- **Ensuring critical minerals supply to support the build-out of domestic ‘green’ industries.**
- **Improving supply diversification and reducing reliance on China.**

This has been seen most prominently in the US and the EU. The US perceives its dependence on China as a national economic security issue and is therefore determined to reduce it across the critical mineral and battery supply chains. At the same time, the US aims to foster its green industrial competitiveness by accelerating new technology and domestic industry development through the Inflation Reduction Act (IRA) and other policies.

Similarly, with its goal of achieving carbon neutrality by 2050 and increasing its open strategic autonomy, balancing between security and competitiveness, the EU has taken steps to address its strategic supply vulnerabilities and dependencies on China through the EU’s Critical Raw Materials Act (CRMA).

Besides the traditional, major Western economies, new players such as the UAE and Saudi Arabia have entered the critical mineral space and are ramping up investments in a bid to diversify their existing fossil fuel-dependent economies. Mining and metals are part of Saudi Arabia’s Vision 2030 – the government’s plan to diversify its economy. Saudi Arabia signed a Memorandum of Understanding (MoU) in January 2024 on cooperation in critical minerals with the DRC. Last year, the UAE signed a partnership with the DRC, and the UAE’s International Resources Holdings (IRH) announced it would invest \$1.1 billion in Zambia’s Mopani Copper Mine in return for 51% ownership.

8.2 US AND EU BOTH FOCUSED ON SUPPLY DIVERSIFICATION & CHINA DE-RISKING

THE IRA HAS BEEN PIVOTAL BUT FURTHER LEGISLATIVE GUIDANCE MAKES COBALT SUPPLY LOCALISATION AND DIVERSIFICATION MORE CHALLENGING

The IRA has been instrumental in the development of the battery supply chain in both the US and globally, with a particular acceleration of downstream capacity in the US driven by tax incentives, grants and loans. Supply diversification and security have been targeted through Section 30D Clean Vehicle Credits via FTA partner countries.

However, with the December 2023 Foreign Entity of Concern (FEOC) guidance applicable to Section 30D and aiming to de-risk US supply, particularly from China, companies may struggle to source enough IRA-compliant supply in the short and medium term. For cobalt, this is of particular importance due to China’s major role in cobalt supply from both the DRC and Indonesia and China’s dominance in the mid and downstream sectors.



The broader industry has raised concerns about the lack of clarity of some provisions in the FEOC guidance regarding ownership structures and the creation of a category of non-traceable battery materials. The final rules are expected to be published in mid-2024, which will be pivotal for the development of a number of key parts of the battery supply chain, both in the US and globally.

The cobalt industry in the US is still lagging due to domestic ore resource availability, slow permitting and limited capital investment in project development. The recently proposed guidance to exclude domestic miners from the generous Section 45X Advanced Manufacturing Production Credit could create further headwinds to ramping up US domestic cobalt supply. Similarly to Section 30D, these rules were open for comments from the industry and the final rules are expected to be published later this year.

US EFFORTS INTO SUPPLY DIVERSIFICATION

The US and the EU co-chair the Minerals Security Partnership (MSP) Forum, launched in April 2024 and linked to the MSP. This new joint cooperation platform builds further on the MSP and brings together mineral-consuming and resource-rich countries to increase supply security through policy dialogue and the development of global sustainable mineral projects, including cobalt.

In addition, the US has also signed an MoU with the DRC and Zambia to support both countries' joint ambition to develop a local EV battery supply chain. This aims to start with regional processing, refining, and ultimately producing NMC battery precursors. However, aside from a pre-feasibility study for a precursor cathode active material (pCAM) facility that was published in December 2023, progress has been relatively slow to date.

Further efforts for supply security have come from the US Partnership for Global Infrastructure and Investment (PGI) to support the upgrade of the Lobito Corridor. The corridor upgrade entails improving the existing rail line from Angola (the port of Lobito) to the DRC and extending the rail line to Zambia. This would look to easing logistical bottlenecks, support local value addition (for cobalt and copper) and counter Chinese involvement in the African Copperbelt. This is underpinned by a seven-way MoU signed by the US, the EU, Angola, DRC, Zambia, the African Development Bank, and the Africa Finance Corporation (AFC).

The first copper concentrate cargo from the Kamo-Kakula operation in the DRC to the Lobito port was shipped in December 2023, with the extension set to begin in 2026. However, the Lobito Corridor faces competition, with China proposing revitalising the Tazara railway connecting Zambia's Copperbelt to the Tanzanian port of Dar es Salaam through a public-private partnership.



Figure 29: Position of the Lobito Corridor relative to other freight routes



Source: Benchmark Mineral Intelligence.

US PRESSURE IS MOUNTING TO ENTER THE DEEP SEA SPACE TO REDUCE ITS RELIANCE ON CHINA

The deep-sea mining debates continue, with some countries announcing a moratorium, while others are in support of the activity being allowed in its waters. The International Seabed Authority (ISA) missed its 2023 deadline to adopt a deep-sea extraction code, due to insufficient knowledge on biodiversity impacts and outstanding financial considerations, and has set 2025 as the year to adopt the final code. Research continues to identify living species in the deep sea and more clarity is needed on the overall potential environmental impact of deep-sea extraction.

China has strengthened its grip on the deep-sea extraction industry and has positioned itself as a central rule-maker in the International Seabed Authority (ISA) – tasked with setting up an international deep-sea extraction code. The US, in contrast, initially sidelined itself from the international debate and is only an observer due to its failure to ratify the United Nations Convention on the Law of the Sea (UNCLOS) thus far.

However, US lawmakers have pushed for domestic support for deep-sea mineral extraction and processing, with the recent ‘Responsible Use of Seafloor Resources Act’ intended to diversify the supply of critical minerals and reduce reliance on China.



DESPITE AMBITIONS OF THE CRITICAL RAW MATERIALS ACT (CRMA) TO LOCALISE COBALT SUPPLY, THE EU WILL BE LARGELY DEPENDENT ON THIRD-COUNTRY SUPPLY FOR RAW MATERIALS

The EU sees critical raw materials, such as cobalt, as essential for its strategic industries, including clean technologies and defence, and for securing its industrial competitiveness. Therefore, as part of its Green Industrial Plan, the EU proposed the CRMA in order to reduce its import reliance on third countries such as China. This will be achieved through localising supply chains, supply diversification and circularity. A list of strategic projects benefitting from accelerated permitting procedures and easier access to EU funding will be drawn up.

The EU's CRMA was billed as a response to the IRA, but the EU's regulatory approach takes a different trajectory. The CRMA aims to localise and de-risk cobalt and other critical raw materials supply without stringent local content requirements and not with the same level of transparent funding mechanisms as the IRA. Despite European industry calls for adequate funding at the EU level, no dedicated European critical raw materials fund has been foreseen in the CRMA.

For cobalt, the EU will struggle to localise the supply chain, particularly for mined volumes, in time for 2030 targets based on the current pipeline. As a result, the EU will remain largely dependent on third-country mined cobalt supply. Given China's substantial role in both the DRC and Indonesia, reducing reliance on China remains a challenge.

This could be made more acute throughout the value chain – including refining, cathode manufacturing and recycling – if future EU chemicals regulations are applied in an overly burdensome way. For example, the proposed Occupational Exposure Limit for cobalt could, by some estimates, result in the closure of up to 100% of affected battery precursor manufacturers, 82% of affected cobalt recycling and 70% of metallurgical alloy manufacturing in Europe⁷.

EU SUPPLY DIVERSIFICATION FOCUSED ON STRATEGIC PARTNERSHIPS

Alongside a strategic partnership on critical raw materials with cobalt-producing Canada, the EU has also concluded strategic partnerships with the DRC and Zambia. Negotiations to secure a strategic partnership and free trade agreement with Australia are ongoing. These partnerships are aimed at political de-risking, forging public-private cooperation to generate investments and integrating critical raw material supply chains, while meeting rigorous ESG criteria. However, little progress has been achieved in securing a roadmap for implementing the EU-DRC strategic partnership.

The recently concluded EU-Rwanda strategic partnership made negotiations between the DRC and the EU more difficult, as this partnership sparked criticism from DRC policymakers, given Rwanda's alleged role in the growing conflict in Eastern Congo.

Strategic partnerships align with the Global Gateway strategy, the EU's global infrastructure development and investment scheme. This strategy supports the development of strategic mineral

⁷ OEL socioeconomic impact assessment conducted by etfec, commissioned by the Cobalt Institute.



corridors in mineral-rich regions, such as the Lobito Corridor. Furthermore, as mentioned above, the EU is a member of the MSP and co-leads the recently created MSP Forum with the US.

8.3 ELECTIONS COULD SHIFT THE GEOPOLITICAL LANDSCAPE

After elections in the DRC in December 2023 and in Indonesia in February 2024 (the two largest cobalt producers), the EU and the US will go to the polls in June and November of this year. 2024 will set a new record for the largest number of voters globally involved in elections. Election outcomes could potentially shift the existing geopolitical landscape and the direction of the global energy transition.

PRESIDENT TSHISEKEDI WINS ANOTHER TERM AND HAS STRONG POSITION

President Félix Tshisekedi and his allies won the DRC general election in December 2023, although turnout was relatively low and widespread irregularities were reported. With approximately 73% of the vote, Tshisekedi secured a second five-year presidential term and was sworn in as President of the DRC in January 2024. Tshisekedi's coalition of parties won more than 90% of the seats in the lower house of parliament. These results give the President a clear mandate and the coalition a dominant position in the legislature to adopt policies impacting the domestic cobalt industry. Negotiations to form a new government are ongoing and the President's party is expected to be a dominant factor in the future DRC government. Elections for the national senate and provincial governors still need to take place.

The biggest priority and challenge for Tshisekedi and the future DRC government is the growing instability in Eastern Congo and the US- and UN-sanctioned M23 armed group, which according to UN reports, is understood to be backed by Rwanda. Although this conflict is not in the copper-cobalt mining area around Kolwezi, the growing instability in the East might lead to investor concern about the country's stability and a heightened political mood.

Other priorities include value addition, such as through the implementation of the DRC-Zambia EV battery supply chain agreement, as well as the diversification of foreign investments. As mentioned earlier, the EU, US, Japan, Saudi Arabia, and the UAE have recently sought to deepen their involvement in the DRC in a bid to secure supply. President Tshisekedi and the future DRC government will continue to reassess mining agreements and joint ventures (JVs) with foreign companies, such as the recently reviewed Sicominex deal.



NEW INDONESIAN LEADERSHIP IS UNLIKELY TO CAUSE MAJOR CHANGES IN THE COBALT SUPPLY CHAIN

Prabowo Subianto, the current Minister of Defence, won the February 2024 presidential election with an ample majority of 58.6%. In October 2024, Prabowo will be sworn in for a five-year term, with his running mate, Gibran Rakabuming (President Jokowi's eldest son) as Vice President.

Prabowo ran on a “continuity” platform, claiming to continue implementing Jokowi's “commodity downstreaming” policy to increase domestic mineral processing and battery manufacturing. Despite acknowledging the need to address climate issues, Prabowo's further support of domestic processing and the need for Indonesian energy independence, which relies heavily on cheap coal, may result in further ecological degradation.

Furthermore, Prabowo reaffirmed continuing Indonesia's foreign policy of “non-alignment” and underlined the importance of active cooperation with both the US and China, tactfully balancing between the two amid US-China geopolitical competition. China is Indonesia's largest trading partner and a major source of investment. President Jokowi previously sought to conclude a limited critical minerals agreement with the US to access the IRA, which has failed to materialise given the US' concerns over Indonesia's ESG issues and China's deep involvement in Indonesia's nickel and cobalt industry.

Prabowo has been critical of engagement with the EU, largely due to the EU's stringent anti-deforestation regulation and the dispute over Indonesia's 2020 ban on unprocessed nickel. This casts doubts over the successful outcome of the ongoing free trade negotiations between the EU and Indonesia, through which the EU aims to increase its cobalt supply security.

THE EU'S GREEN INDUSTRIAL COMPETITIVENESS COULD EMERGE AS THE CORE OF THE POLICY AGENDA

In June, EU citizens are electing the European Parliament for a five-year term. Following these elections, a new European Commission, the EU's executive arm, will be appointed.

The election outcome will impact the implementation of the EU's green industrial policy, together with the rising importance of its security and defence agenda, amid Russia's war in Ukraine and geopolitical competition between the US and China.

Climate-sceptic parties are gaining traction in the polls which has raised some concerns about the level of support for sticking to the existing EU climate agenda. However, it remains likely that the EU's green industrial competitiveness, reliant on critical raw materials supply, will be one of the key priorities for the next EU Commission.

THE US ELECTION OUTCOME COULD IMPACT THE IMPLEMENTATION OF THE IRA AND US CRITICAL MINERAL POLICY

US citizens will head to the polls in November 2024 to elect the next US president. Incumbent US President Biden is looking to secure a second term in power, whereas former President Donald Trump has secured enough support to be nominated as the Republican candidate.



Voters will also choose new members of the US Congress.

With the IRA being one of the key components of “Bidenomics”, it has already been challenged by Trump and the Republican leadership ahead of the US elections. A Trump presidency and the Republican leadership could seek to alter the IRA, although Republican states have benefitted the most from the financial support provided by the IRA so far, meaning that introducing major changes involves political risks.

Altering or repealing the IRA through the US legislative system would also be challenging, as this would require a majority in both houses of Congress to pass new legislation. However, through its executive power, a future Trump Administration could opt to alter the implementation of the IRA and Bipartisan Infrastructure Law, including the funding (loans and grants) for critical mineral projects. During Trump’s first term in office, his Administration initially held back billions in DOE loans before reopening them to develop critical mineral projects. A future Trump Administration could also tighten the proposed FEOC requirements for China, increasing the pressure on supply diversification efforts.



9 | NORTH AMERICAN SPOTLIGHT – COBALT AND THE BATTERY SUPPLY CHAIN

Ahead of the Cobalt Congress 2024 in New York, this section provides an overview of the key developments in North America, with a focus on battery supply chains as the primary and rapidly growing driver of cobalt demand growth.

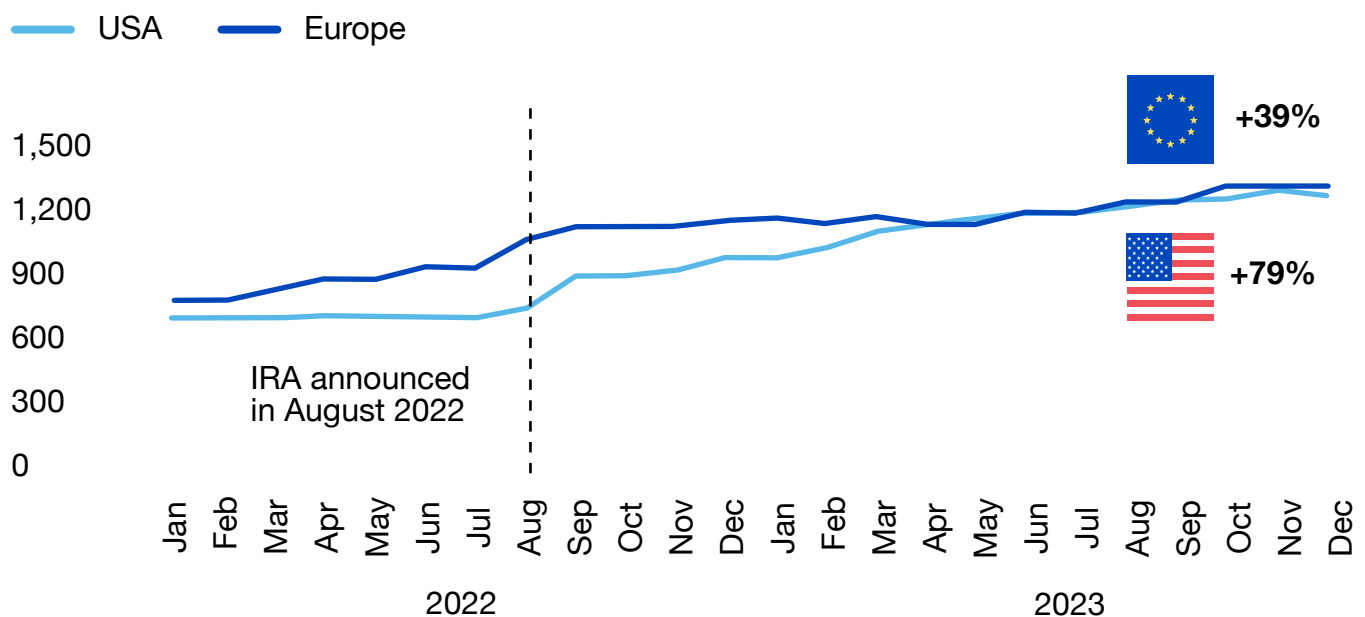
US POLICY IS RE-SHAPING GLOBAL SUPPLY CHAINS

The introduction of the Inflation Reduction Act (IRA) in August 2022 has been instrumental in shaping the direction and magnitude of developments in global battery supply chains, the dominant driver of cobalt demand.

To spur the domestic industry, the US government is providing support through tax credits, grants and loans under both the IRA and the Infrastructure, Investment and Jobs Act (IIJA).

The downstream impact of the IRA announcement is clear from the magnitude of growth of the US battery pipeline. It has grown by 79% to 1.3 TWh since the IRA was announced in August 2022, compared to just 39% and 36% in Europe and China, respectively. The developing relationships within the US between numerous major battery cell producers and OEMs are further evidence of the positive impact of the policy. This demonstrates the efficacy of the IRA to encourage greater vertical integration and OEM value chain responsibility. However, the US 1.3 TWh battery capacity pipeline remains substantially behind China's 6.3 TWh.

Figure 30: Growth in the 10-year battery capacity pipeline, GWh



Data: Benchmark Mineral Intelligence – Battery Forecast.



The IRA has further incentivised direct involvement at the cell level as well as greater control in upstream procurement strategies as part of the Section 30D Clean Vehicle Credits (CVCs). Since the IRA was announced, close to 400 GWh of capacity has been added to the US pipeline involving major OEMs including Tesla, Hyundai, Honda, Ford, Stellantis, GM, Toyota and Mercedes-Benz. This will mean that automakers are increasingly pivotal in the future direction of battery performance, corresponding chemistries and their subsequent use of cobalt. Approximately 75% of the 2030 US cell pipeline involves major car partnerships. This differs to other regions where automakers represent less; just 40% and 20% in Europe and China, respectively.

NORTH AMERICAN UPSTREAM LAGGING THE DOWNSTREAM

The IRA has undoubtedly accelerated the development of the downstream. However, the upstream is still lagging due to domestic ore resource availability, slow permitting and limited capital investment into project development. Recently proposed guidance to exclude domestic miners from the generous Section 45X credits could create further headwinds to ramp up US domestic supply.

In terms of the existing and planned upstream cobalt capacity in the US, only Lundin's Eagle mine is operating after Jervois put their ICO operation into care and maintenance in 2023 – due to low cobalt prices and inflationary impacts to construction costs. US Strategic Minerals aim to start production at the Madison project in the short term. Existing mined cobalt producers in Canada include Vale's Voisey's Bay and Sudbury operations as well as Glencore, also at Sudbury. The Dumont and Nico projects continue to be developed.

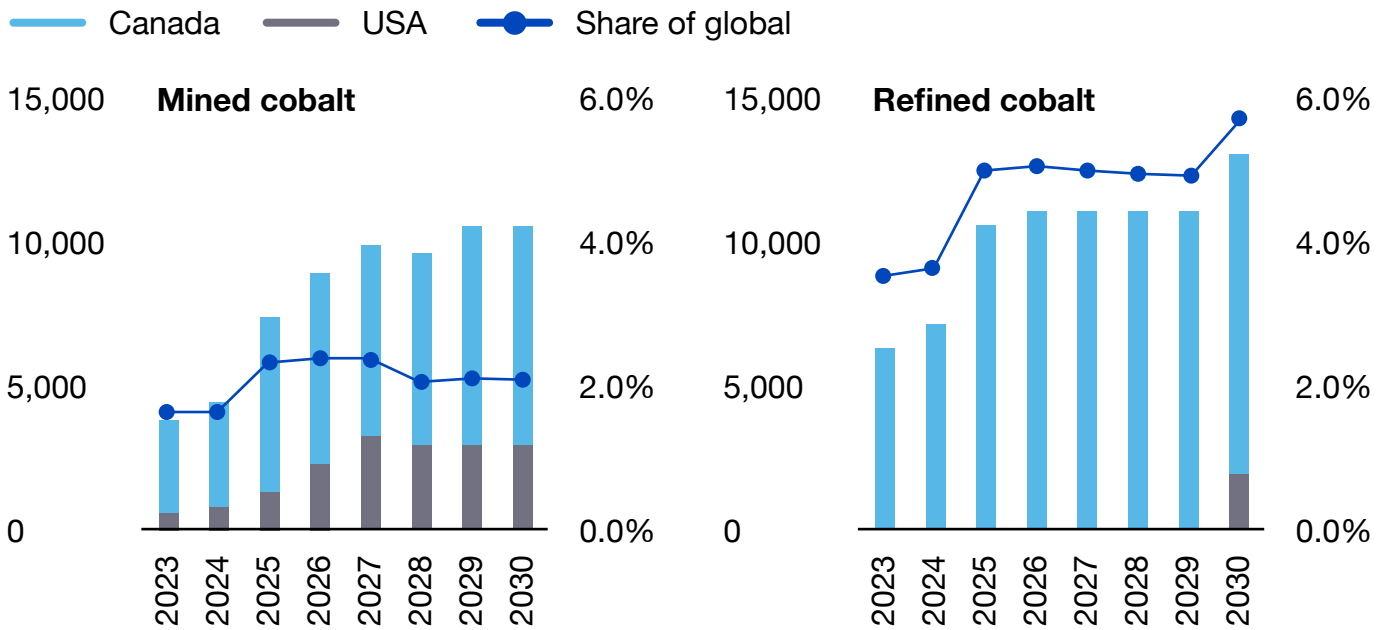
Sherritt and Vale both produce refined cobalt metal – primarily briquettes and rounds – in Canada. Electra Battery Materials is continuing to develop their project in Ontario, targeting to become North America's first cobalt sulphate refinery for the battery supply chain. This project could add significant additional volume to the North American landscape. The project has recently gathered more support – in February 2024, Electra received a USD 5 million grant from the Canadian government to support further development, and signed a binding letter of intent from ERG for mined cobalt supply in April 2024.

Evelution Energy is developing a refinery project in the US, aiming to start production in 2027. The project has received further support recently following the signature of a Letter of Intent with Glencore in relation to feedstock supply and potential offtake. In addition, Jervois engaged an engineering consultancy in October 2023 to begin a study on a potential cobalt sulphate refinery in the US.

Despite these developments, North American cobalt supply is expected to remain low. The US produced just 0.3% of global mined supply in 2023, with no refined capacity. By 2030, the outlook remains similar with minimal project development underway. Looking more broadly at the North American region, Canada presents some improved growth potential, but the volumes are still relatively low on a global basis. The result of this will be a continued dependence on countries outside North America for the supply and refining of cobalt.



Figure 31: Potential mined and refined cobalt supply in North America, kt cobalt



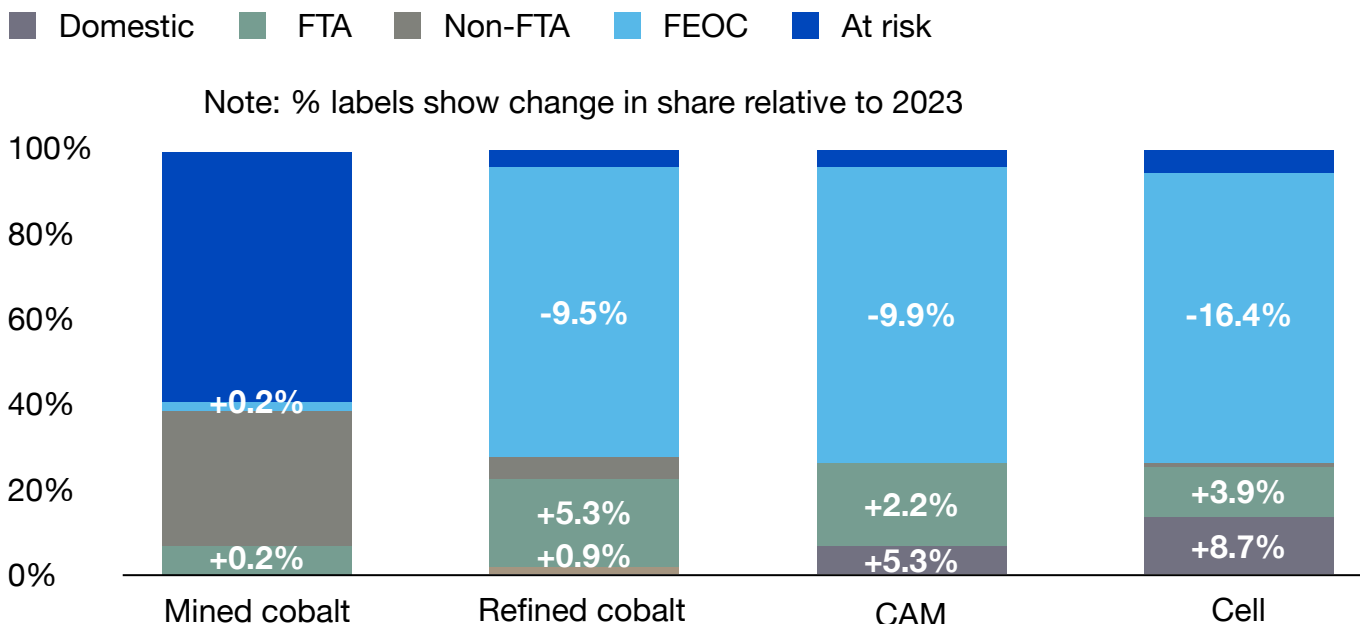
Data: Benchmark Mineral Intelligence – Cobalt Forecast.
 Note: total potential supply is unweighted by the probability of project development.

Some growth is expected from FTA (free trade agreement) partner countries, with the share of global refined cobalt supply increasing by 5.3% to 2030, although not all of this will be sold into the US market. The dominance of the DRC and Indonesia (both non-FTA partners) for mined supply and China (defined as a Foreign Entity of Concern, FEOC) for cobalt refining poses risks to battery producers and auto OEMs in their cobalt sourcing strategies.

The exact details of the FEOC guidelines and how, primarily Chinese, ownership will be considered are still under development – further guidance is expected in mid-2024. This may place significant volumes of DRC and Indonesian cobalt supply at risk – both with high levels of Chinese investment.



Figure 32: Cobalt production and the battery value chain in 2030 by IRA status



Data: Benchmark Mineral Intelligence. Notes: FTA = free trade agreement with US; FEOC = Foreign Entity of Concern; at risk is subject to further clarification on FEOC guidelines.

POTENTIAL OPPORTUNITIES IN THE MIDSTREAM

Given upstream challenges, and little prospect of substantial regional supply growth, an alternative strategy for cobalt's role in the North American battery supply chain market may sit in the midstream (pCAM and CAM).

Cathode active material (CAM) processing in the US, or an FTA country such as South Korea, would mean that cobalt units are likely to be eligible, even if mined in a non-FTA country such as the DRC (subject to FEOC guidelines). Given these dynamics, US engagement in Africa is rising. The extreme concentration of cathode manufacturing under Chinese control places tight constraints on IRA-compliant procurement options for the US, with FEOC supply representing around 70% of global output by 2035.

Efforts are underway for supply chain diversification, with ex-China CAM supply expected to increase from 22% to 32% by 2035. Additional FTA capacity is originating from Canada, South Korea and also Japan (not an FTA partner but a separate trade agreement in place) – these countries could provide alternative sourcing options for the US. The US would require a substantial proportion of FTA supply to support demand, noting that the existing FTA pipeline is predominantly from Europe where regional consumption is being prioritised.

Despite additional CAM projects being added to the pipeline and further supply agreements with major OEMs, CAM capacity in both North America and Europe is lagging regional demand. New projects will take time to be developed and brought online, even before considering potential delays to financing, construction and product qualification. The global CAM market will remain in surplus for most of this decade although widening deficits are forecast for both the North



American and EU CAM markets, with the Chinese and Asian markets in surplus.

The IRA and IIJA offer sizable financial incentives to build out domestic CAM supply in the US. Foreign investments have been attracted, particularly from experienced South Korean producers such as Posco and EcoPro.

However, further investment is still required. To support the US' ambitions, CAM capacity expansions must match the momentum of further downstream, particularly if the US wants to avoid a large reliance on imports from China and the rest of Asia. This highlights the importance of further investment and robust cathode technology partners, to support a similar build out of capacity as seen for battery cells, and given the ambitions to reduce reliance on China's CAM supply chain.

FTA PARTNERS IN THE DRIVING SEAT

To gain access to CVCs, OEMs will look to ensure their raw material and CAM supply chains are compliant with sourcing requirements. With domestic supply limited, this has created significant opportunity for FTA partners, such as South Korea.

2023 saw more than USD 5 billion worth of investments into pCAM and CAM capacity in South Korea, in response to growing demand for US IRA-compliant battery materials. Planned pCAM production capacity grew by 60%.

South Korea has significant pCAM and CAM manufacturing expertise and the country can help reduce the US' reliance on China for battery materials – by 2030, the country is expected to be the second largest pCAM supplier after China, and South Korea is already the second largest global CAM producer. South Korean cathode producers have always sold significant quantities into North America, however, capacity investments geared towards the market have grown since the IRA was announced and particularly given South Korea's existing FTA status.

Similar trends have also been seen in Morocco, also an FTA partner, for CAM capacity as well as a USD 100 million investment from Management into a cobalt sulphate plant in the country, with feedstock from its domestic mine and from recycled sources.

COBALT'S ROLE IN THE NORTH AMERICAN BATTERY SUPPLY CHAIN

Despite limited upstream development, there are several hubs developing across the region in the mid and downstream.

The South East corridor and the Midwest are seeing significant investments in the downstream, with midstream projects now also being announced. This is driven by supportive policy (within and beyond the IRA), both at the federal and state levels, with substantial incentives available. This is further supported by industry expertise in regions such as the long-standing Midwest automotive hubs, for example.

Ontario and Quebec, particularly Bécancour, are also gaining momentum supported by automotive expertise in Ontario, low cost and low emissions power in Quebec and proximity to the US Midwest. Some existing mining and refining operations are proximal to these hubs, although most are of course determined by resource availability.



Substantial changes to the landscape of the upstream cobalt industry are likely to be limited beyond the established producers and (mostly small scale) developing projects in the region. Cobalt's role in the growing US battery supply chain and the regional preference for nickel-cobalt battery chemistries will likely be focussed in the midstream and supported by cobalt supply from FTA partners.

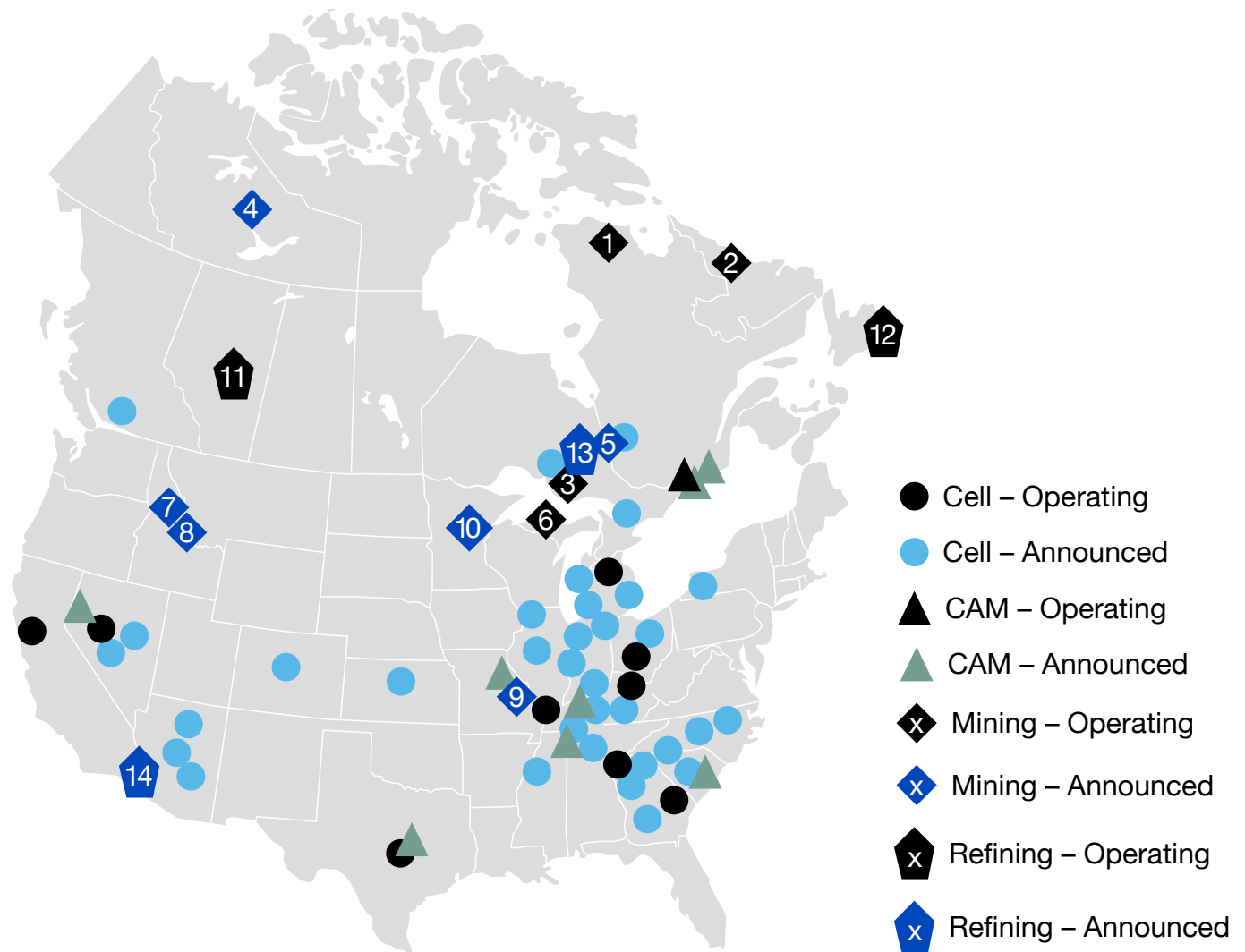
The US downstream requires strong partnerships with experienced cathode partners to develop additional capacity, either domestically or in FTA countries. This will require close collaboration with upstream cobalt, and other raw material, suppliers:

- **Domestic** CAM projects could benefit from both CVCs and manufacturing tax credits as part of Section 45X. Proximity to the developing hubs will provide synergies and promote robust downstream relationships, as well as potential further benefits from state-level support.
- **FTA partners** will be eligible for CVCs even if using non-FTA cobalt sources (subject to FEOC clarification), such as from the major producers DRC and Indonesia. The role of China as the dominant cobalt refiner is yet to be clarified through the FEOC definitions but is likely to be challenging. Further development in FTA CAM supply is expected, as has already been observed in South Korea.

The map below provides an overview of the supply pipeline in North America for cobalt and the battery supply chain.



Figure 33: North American cobalt and battery value chain



Source: Benchmark Mineral Intelligence

Mining

Canada

- 1: Raglan, Glencore
- 2: Voisey’s Bay, Vale
- 3: Sudbury, Vale & Glencore
- 4: Nico, Fortune Minerals
- 5: Dumont, Nion Nickel

USA

- 6: Eagle, Lundin Mining
- 7: Idaho (ICO), Jervois Mining
- 8: Iron Creek, Electra Battery Materials
- 9: Madison, US Strategic Metals

Refining

Canada

- 10: Tamarack, Talon Metals
- 11: Sherritt
- 12: Vale
- 13: Electra Battery Materials

USA

- 14: EValution Energy



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11 | ABBREVIATIONS & DEFINITIONS

GENERAL

ASM: artisanal and small-scale mining.

Cobalt chemical: refined chemicals containing cobalt, in the form of cobalt sulphate for batteries, and other specialty products.

Cobalt metal: refined metal products in the form of briquettes, cathodes, broken cathodes and rounds.

CAGR: compound annual growth rate, %.

DRC: Democratic Republic of the Congo.

EOL: end of life material for recycling.

HPAL: high pressure acid leaching process for cobalt and nickel refining.

kt: kilotonnes, equivalent to 1,000 metric tonnes.

Li-ion or LiB: lithium-ion battery, the current dominant battery technology.

MHP: mixed hydroxide precipitate containing cobalt and nickel.

m/m: month on month change.

OEM: original equipment manufacturer, e.g. automotive company.

RHS: right hand size, typically for a chart axis.

y/y: year on year change.

CATHODE CHEMISTRIES

CAM: cathode active materials

LCO: lithium cobalt oxide

LFP: lithium iron phosphate (no cobalt)

NCA: lithium nickel cobalt aluminium oxide

NCM: lithium nickel cobalt manganese oxide. Typically referred to with the ratio of each metal e.g. 622 contains a 6:2:2 ratio of nickel to cobalt to manganese.

ELECTRIC VEHICLES:

BEV: battery electric vehicle.

EV: electric vehicle.

ICE: internal combustion engine, powered by either petrol or diesel.

NEV: new energy vehicle is a term typically used in China to describe battery electric (BEV), plug-in hybrid (PHEV) and fuel cell (FCEV) electric vehicles.

PHEV: plug-in hybrid electric vehicle.





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