

COMMODITY PROFILE

Cobalt

27

Co

 Cobalt
 58.933

1.0 Geological Considerations

1.1 Material Properties



Melting point
(1,495°C)



Ductile



Good electric conductivity



Heat and corrosion resistant



Alloys easily with Cr, W, Mo, Ni, to make superalloys and magnets



Ferro magnetic

1.2 Major Cobalt Producers

1.2.1 Top five cobalt producers globally ranked by production share in metric tonnes (mt), 2024e*

Global rank	Country	Reserves	Production
		Quantity in metric tonnes (mt), 2024e* – (Global share in %)	
1	Democratic Republic of the Congo (DRC)	6,000,000 (54.5%)	220,000 (75.9%)
2	Indonesia	640,000 (5.8%)	28,000 (10%)
3	Russia	250,000 (2.3%)	8,700 (3%)
4	Canada	220,000 (2.0%)	4,500 (2%)
5	Philippines	260,000 (2.4%)	3,800 (1%)
	Rest of world	1,523,000 (14.0%)	22,900 (8.0%)

1.2.2 Top five cobalt refining countries globally, 2023e*

Global rank	Country	Refining**
		Quantity in metric tonnes (mt), 2023e* – (Global share in %)
1	China (a)	140,000 (80%)
2	Finland	10,627 (6%)
3	Canada (c)	4,923 (3%)
4	Japan	3,900 (2%)
5	Madagascar	3,500 (2%)
	Rest of world	11,753 (7%)

* "e" indicates that the value is an estimate.

** Note: Refined cobalt includes various forms such as metal, oxides, carbonates, sulphates, and many other compounds. Efforts are made to avoid double counting.

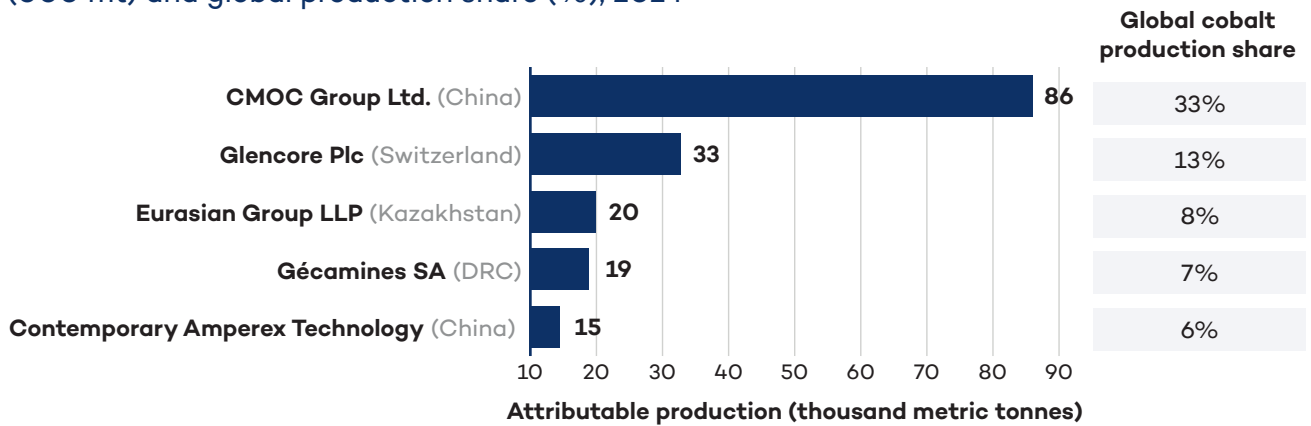
(a) some refined cobalt production in China is recorded in Belgium.

(b) including oxides.

Source: British Geological Survey, 2025; U.S. Geological Survey, n.d.-a, n.d.-b.

1.3 Top Cobalt-Producing Companies

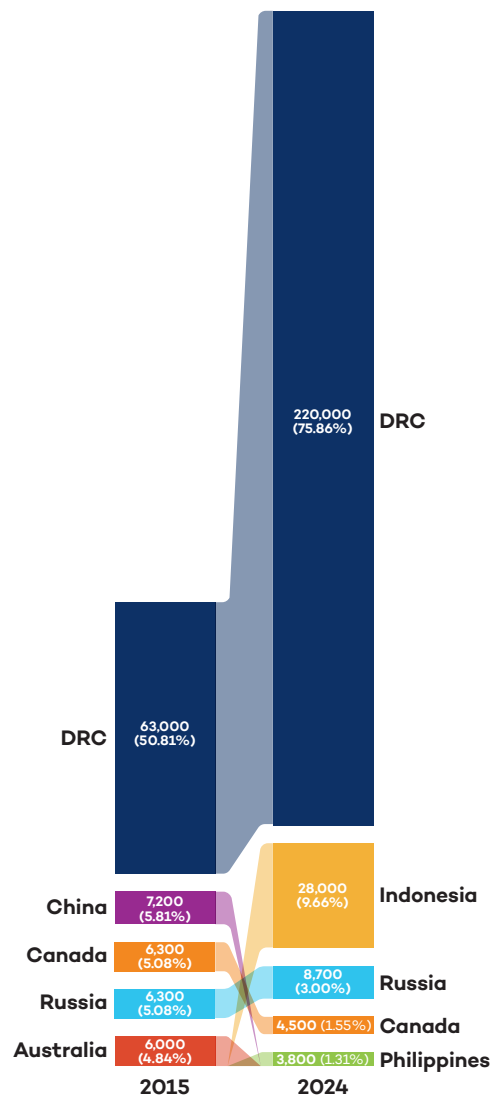
Top five cobalt-producing companies by attributable production in thousand metric tonnes (000 mt) and global production share (%), 2024



Source: S&P Global Market Intelligence, 2026.

1.4 Top Cobalt Producers 2015 vs. 2024

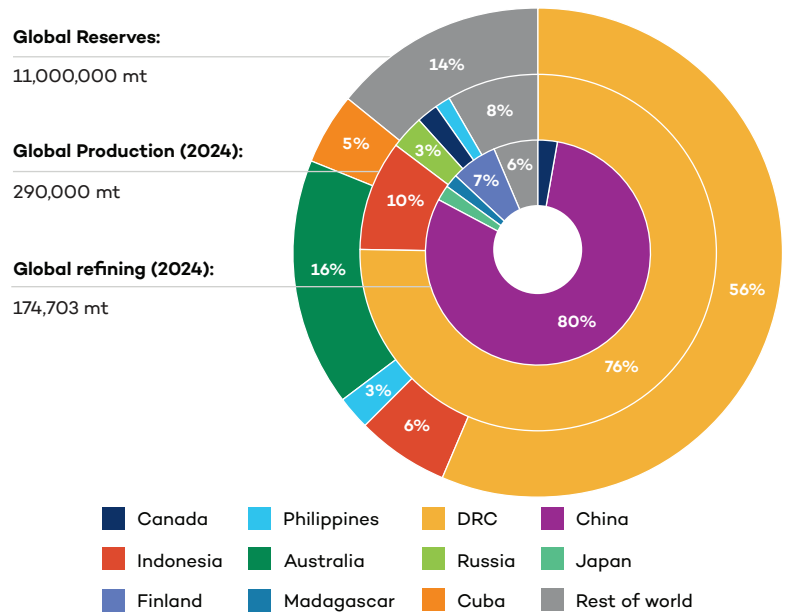
Top five cobalt producers 2015 vs. 2024 (production in mt, share of global production in %)



Sources: U.S. Geological Survey, n.d.-a.

1.5 Market Distribution

Global distribution of the cobalt market: global reserves, mine production, and refining shares (%)



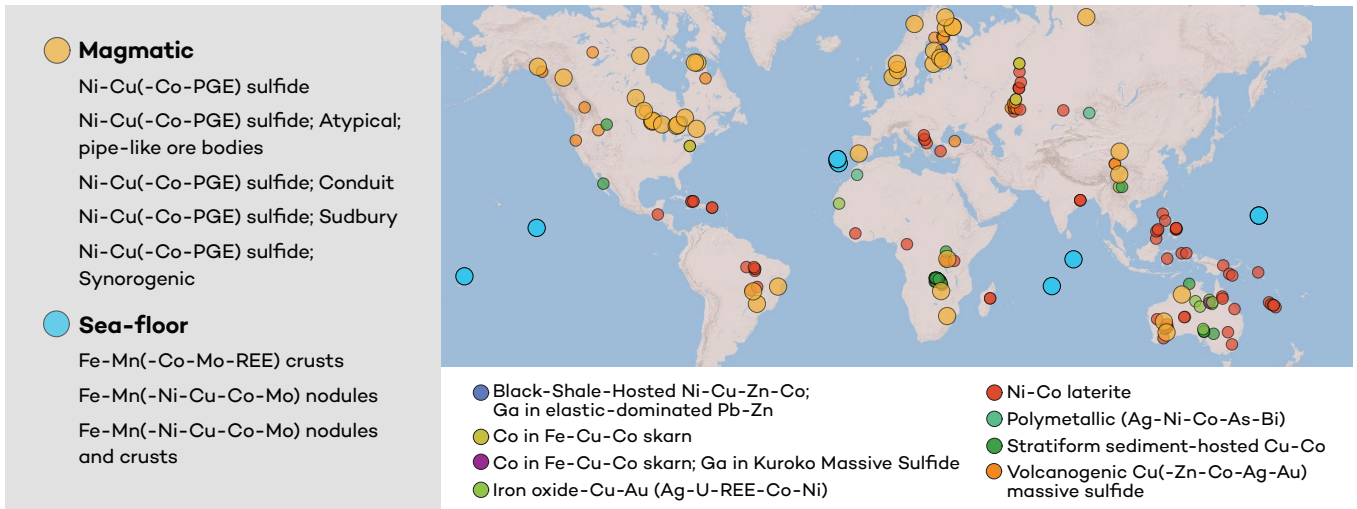
Methodology note: The figure shows the concentration of global cobalt reserves (outer), production (middle), and refining (inner) circle. Refined cobalt can be in the form of metal, oxides, carbonates, sulphates, and many other compounds. Efforts have been made to avoid double counting within a margin of error. Countries selected in the pie chart represent the top five countries by global share (%) within each category, with the remainder aggregated to "Rest of world."

Source: British Geological Survey, 2025; U.S. Geological Survey, n.d.-a, n.d.-b.

Globally, it's how cobalt reserves and mine production are concentrated in the DRC, which accounted in 2024 for 75.9% of mined output globally, an increase of 25% from 2015. The DRC also holds an estimated 6 million mt of cobalt reserves, the majority of which is recovered as a by-product of copper mining and processing (U.S Geological Survey, n.d.-a). Refined cobalt production is overwhelmingly dominated by China, with Chinese production reaching 140,000 mt in 2024 (88.5% of world production), with production reaching 140,000 mt in 2023 (British Geological Survey, 2025).

1.6 Reserves, Resources and Geology

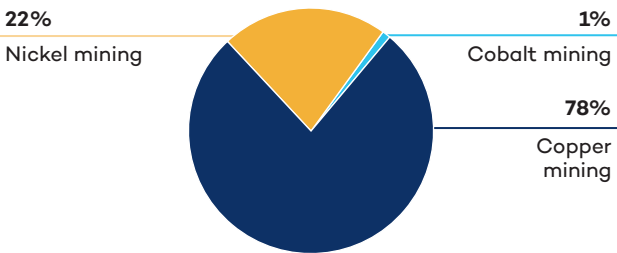
Distribution and geology of cobalt deposit types globally



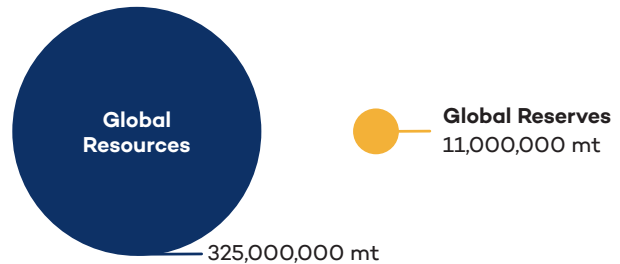
Methodology note: All magmatic deposits are grouped under a single category. The same approach is applied to seafloor deposits and skarn deposits.

Cobalt mine supply and by-production potential

World production and supply



World Reserves vs resources

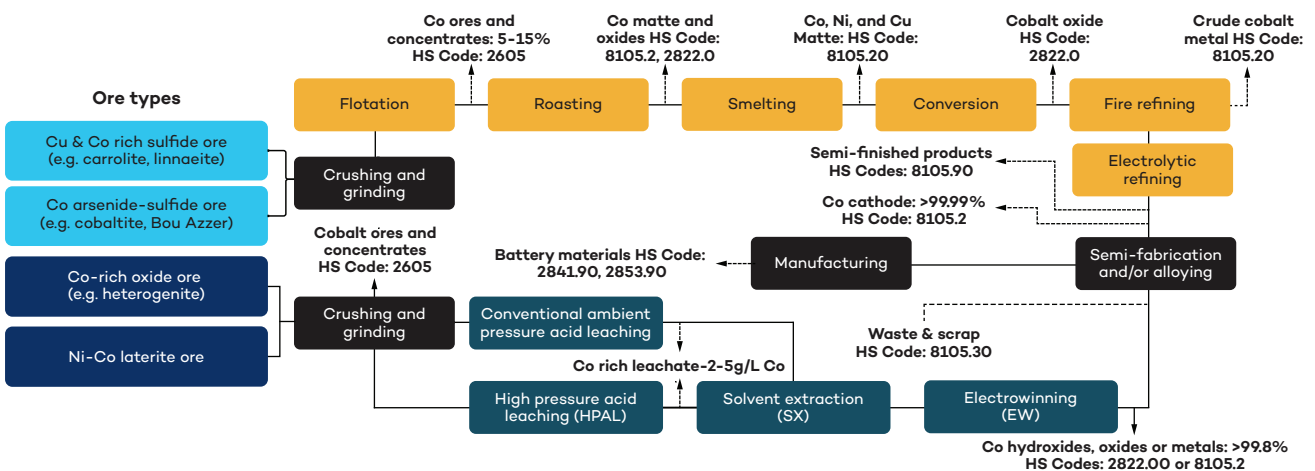


Source: Cobalt Institute, 2025a; U.S. Geological Survey, n.d.-a.

Global terrestrial cobalt resources (excluding deep sea cobalt resources) are estimated to be around 25 million mt, of which 11 million have been identified as reserves (economically viable deposits). Most cobalt is produced as a by-product in copper (78%) and nickel (22%) ore deposits, rather than as the primary mined commodity. The majority of deposits are sediment-hosted stratiform copper deposits in the DRC and Zambia's Copperbelt, nickel-bearing laterite deposits in Australia, Indonesia, the Philippines, and Cuba, and in magmatic nickel-copper sulfide deposits in Australia, Canada, Russia, and the United States.

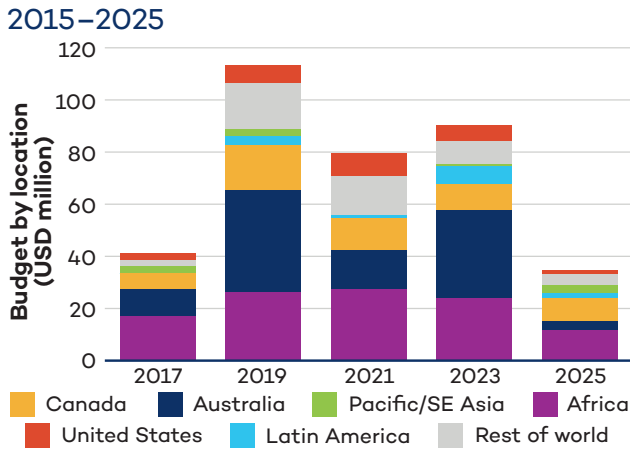
1.7 Value Chain Diagram

Simplified cobalt value chain diagram and by-production pathways



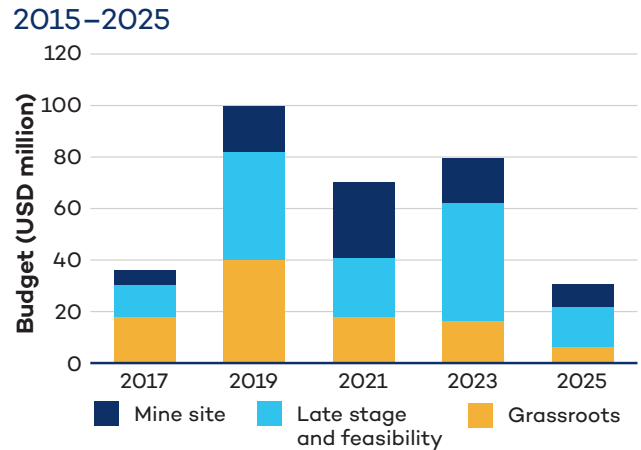
Source: Çoban & Baş, 2024; Li et al., 2025.

1.8 Exploration Budget by Location



Source: S&P Global Market Intelligence, 2026.

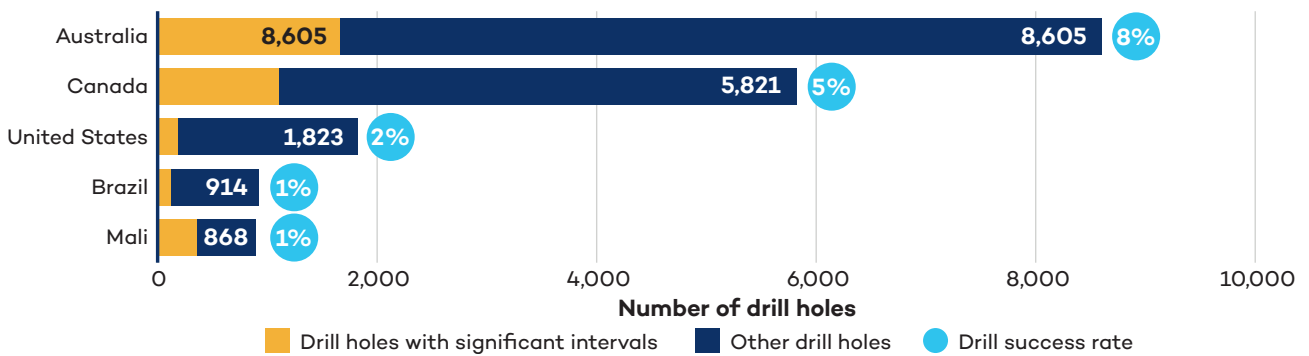
1.9 Exploration Budget by Mine Stage



Source: S&P Global Market Intelligence, 2026.

1.10 Drilling Success Rate

Top five countries by drill hole success rate 2015–2025 (% share, number of drill holes)



Methodology note: S&P Global Market Intelligence assesses the significance of drill results by considering both the objective of the drill hole and the quality of the intercepted interval. A result is deemed significant if it has the potential to add to or extend known mineralization or resources at a project, and if it surpasses a value threshold determined by prevailing commodity prices.

Source: S&P Global Market Intelligence, 2026.

1.11 Future Resource Trade-Offs

Overview of potential future cobalt resources and supply

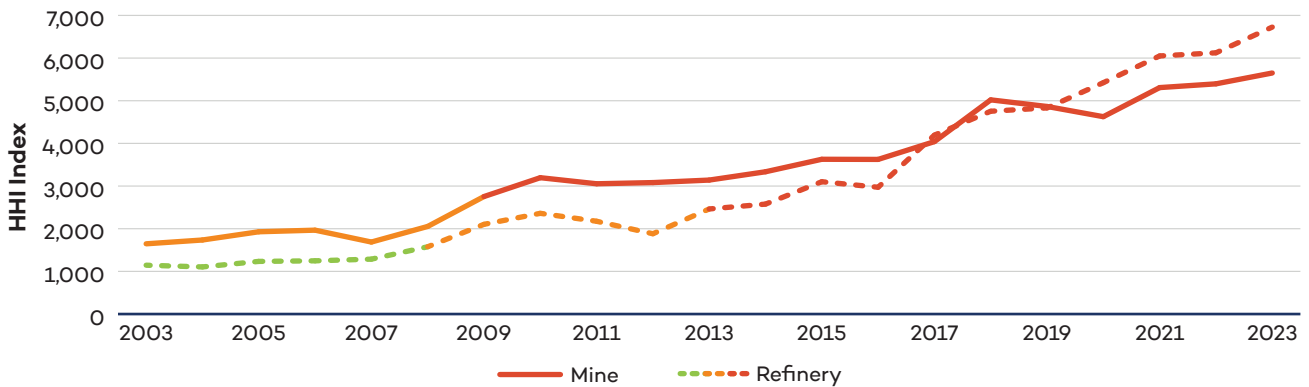
Future sources of cobalt	Description
Recycling	The current 10% cobalt recycling rate is expected to rise, driven by the lithium-ion electric vehicle (EV) battery market. End-of-life recycling rate was expected to grow to 25% in 2025 and further to 39% in 2050 with increasing flows of metal scrap (Cobalt Institute, 2025).
Tailings	Nearly all extracted cobalt is mined as a by-product of copper (78%) and nickel (22%), with less than 0.5% of global production coming from primary cobalt mines (African Development Bank & Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development, 2025). Future cobalt resources may be derived from tailings re-mining and reprocessing via gravity, magnetic separation techniques, and flotation (Lutandula & Maloba, 2013; Na et al., 2024) or bioleaching (Mäkinen et al., 2020).
Deep sea mining	Approximately 120 million mt of cobalt resources are located within polymetallic nodules, hydrothermal vents, and cobalt-rich ferromanganese crusts on the floor of the Atlantic, Indian and Pacific oceans (Wang et al., 2025; U.S. Geological Survey, 2022).

Source: African Development Bank & Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development, 2025; Cobalt Institute, 2025a, 2025c; Lutandula & Maloba, 2013; Mäkinen et al., 2020; Na et al., 2024; U.S. Geological Survey, n.d.-a; Wang et al., 2025.

2.0 Economic and Geopolitical Considerations

2.1 Market Concentration Trends

Cobalt market concentration by supply chain step (HHI index)



Methodological note: Herfindahl–Hirschman Index is a commonly accepted measure of market concentration of an industry, where a low value below 1500 indicates a more diversified sector and high values above 2,500 indicates high market concentration. HHI lines by market concentration, green for values below 1,500 (low concentration or competitive market), orange for 1,500–2,500 (moderate concentration, some market power), and red for values above 2,500 (high concentration or limited competition and potential monopoly or dominant players).

Source: U.S. Geological Survey, n.d.-a, n.d.-b.

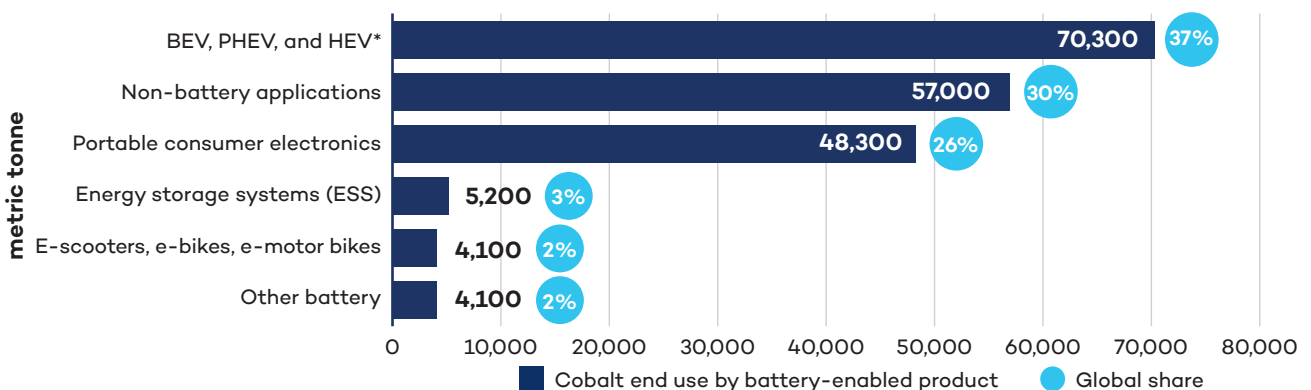
From 2003 through 2023, cobalt mine production became heavily concentrated in the DRC, increasing the global cobalt market HHI from 1,650 in 2003 to 5,650 in 2023. The DRC’s share of global mine production rose from 28% in 2003 to 55% in 2013, reaching 74% in 2023. Future increases in cobalt mine production outside the DRC will mainly come from Indonesia as a result of increased planned production of nickel–cobalt laterite ore deposits operating in partnerships between Chinese and Indonesian firms.

Over the same period, cobalt refinery production became heavily concentrated in China, increasing cobalt refining HHI from 1,150 in 2003 to 6,700 in 2023. China’s share of global refinery production rose from 11% in 2003 to 46% in 2013, and to 80% in 2023. World refinery production data combines cobalt metal and various cobalt chemical compounds production. Regarding cobalt chemical refining, which provides the inputs for lithium-ion battery cathode production, China refined 95% of the world’s cobalt chemicals in 2022 (Gulley, 2024).

2.2 Industrial Considerations

2.2.1 End Use by Industry and Product

Cobalt end use by battery-enabled product by tonnage (mt) and % share



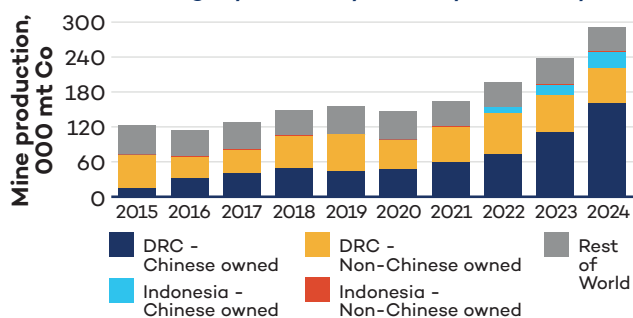
* Battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), and hybrid electric vehicles (HEVs).

Source: Darton Commodities Limited, 2024.

Over half of global cobalt demand can be attributed to battery end-use applications, reflecting growing global demand for EVs, energy-storage systems, and consumer electronics. Common non-battery applications include use in superalloys, magnets, catalysts, and chemicals.

2.2.2 Cobalt Mining by Country

Cobalt mining by country and by majority ownership (Chinese versus non-Chinese)



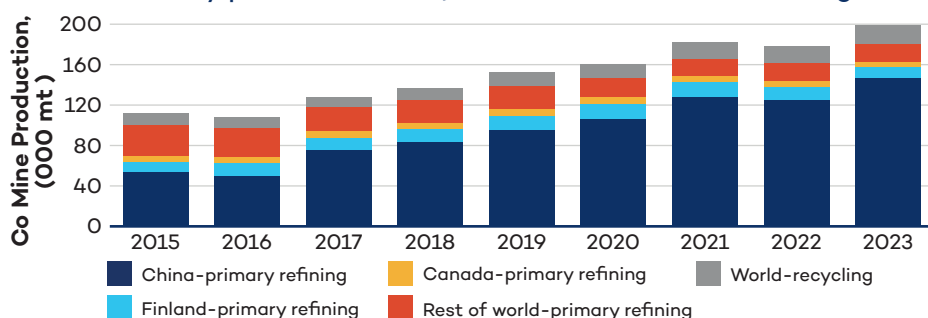
Methodological note: Cobalt-producing facilities that are more than 50% owned by one or more Chinese firms are listed as “Chinese-owned.” The purpose of this distinction is to indicate the contribution of Chinese firms to world cobalt mine production.

Sources: Darton Commodities Limited, 2025; Gulley, 2025; U.S Geological Survey, n.d.-a.

Most of the growth in global mine production between 2015 and 2024 was driven by Chinese investment, particularly in the DRC through projects such as the Kisanfu copper–cobalt mine. Outside the DRC, increased output came mainly from Indonesia, again largely due to Chinese-backed developments. In Indonesia, higher cobalt production is a by-product of rising nickel output linked to the expansion of HPAL processing, with cobalt primarily produced as nickel–cobalt mixed hydroxide precipitate for battery applications.

2.2.3 Cobalt Refining by Country

Cobalt refinery production (major refiner countries) versus global recycling



Sources: Darton Commodities Limited, 2025; Gulley, 2024; U.S Geological Survey, n.d.-b.

World cobalt refinery production is driven by expansions in China. While accounting for a fraction of global supply, recycling capacity is expanding, largely due to EV battery recycling facilities in China.

2.2.4 Substitutability

Substitutability by application: Alternatives and challenges

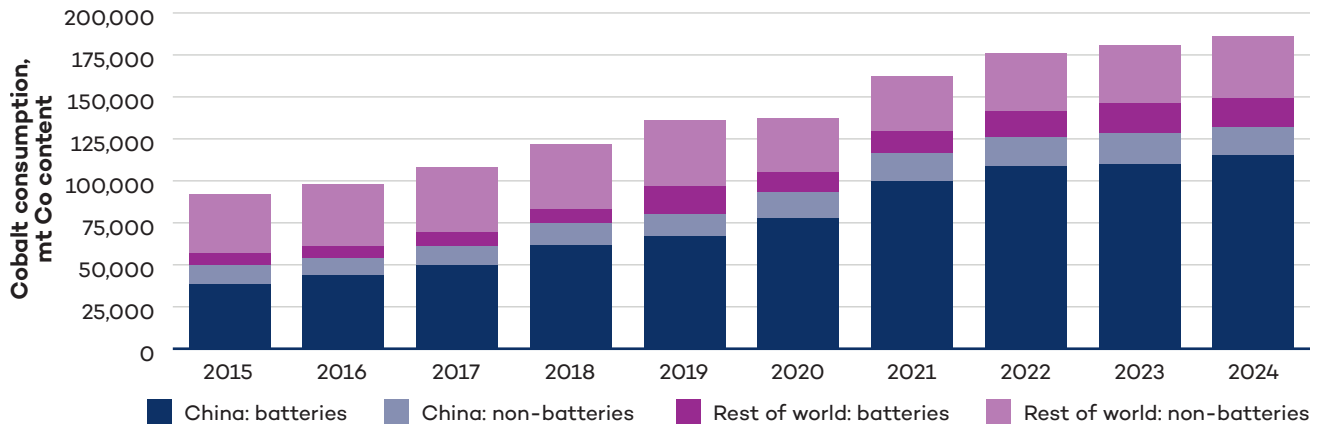
Application	Substitute/alternative	Substitution potential and risks
Batteries	Lithium-iron-phosphate (LFP), nickel-cadmium (NiCd) and nickel metal hydride (NiMH) batteries	LFP batteries have a lower energy density than cobalt-based batteries but are cost-effective and have better thermal stability. NiCd and NiMH both have lower performance than cobalt batteries, but can be more cost-effective.
Superalloys	Nickel-based alloys, iron-based alloys, or other alloys	Nickel-based alloys can be used along with other alloying elements, and iron-based alloys can be used in lower temperature/lower stress environments. Generally, cobalt substitutes in superalloys have inferior performance.
Hard materials	Nickel or iron binders	Nickel and iron binders are associated with lower-cost carbide mixes. Generally, substitutes for hard materials result in a loss of product performance.
Catalysts	Nickel, rhodium	Cobalt catalysts provide higher yields and have longer lifetimes than substitutes when the feedstock material is natural gas. Nickel can be used as a substitute as well as rhodium in specialized catalysts, but the latter is more than twice as expensive.
Magnets	Neodymium-iron-boron (NdFeB) magnets, nickel-iron alloys	NdFeB magnets have the highest energy density in comparison with other permanent magnets. Weaknesses are still present in applications where size/weight are key requirements, so cobalt coating is used to mitigate.

Sources: Davies, 2025; U.S Geological Survey, n.d.-a.

2.3 Consumption and Price

2.3.1 Cobalt Consumption by Region

Cobalt consumption by application in China and the rest of the world

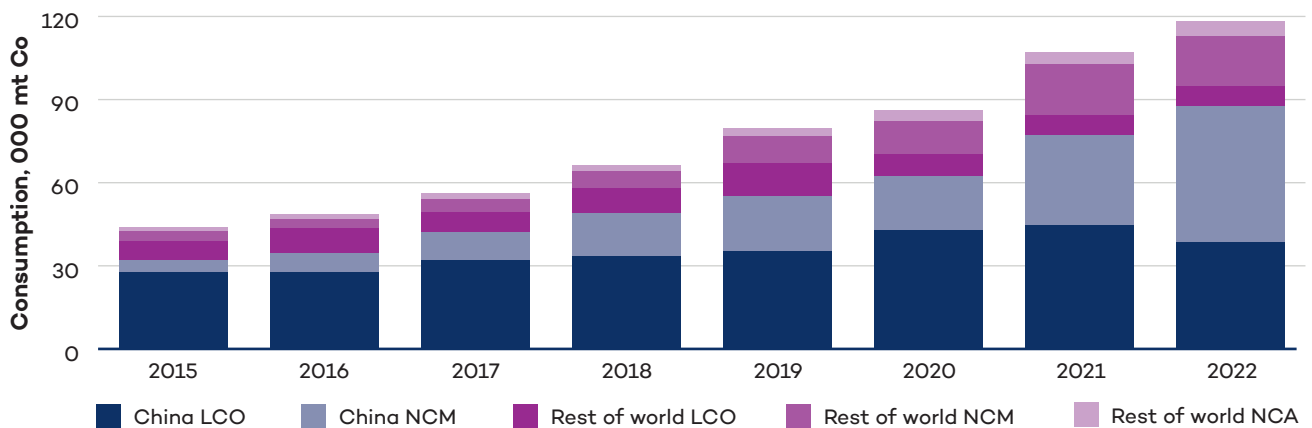


Sources: Darton Commodities Limited, 2025; Gulley, 2024.

World cobalt consumption growth is chiefly driven by battery manufacturing in China. As China's EV battery market expanded and its cobalt refining capacity scaled up during the latter part of the 2010s, demand for cobalt imports increased for domestic refining and use in battery production.

2.3.2 Cobalt Consumption by Application

Emerging applications: Cobalt consumption for battery manufacturing by battery chemistry for China and Rest of World

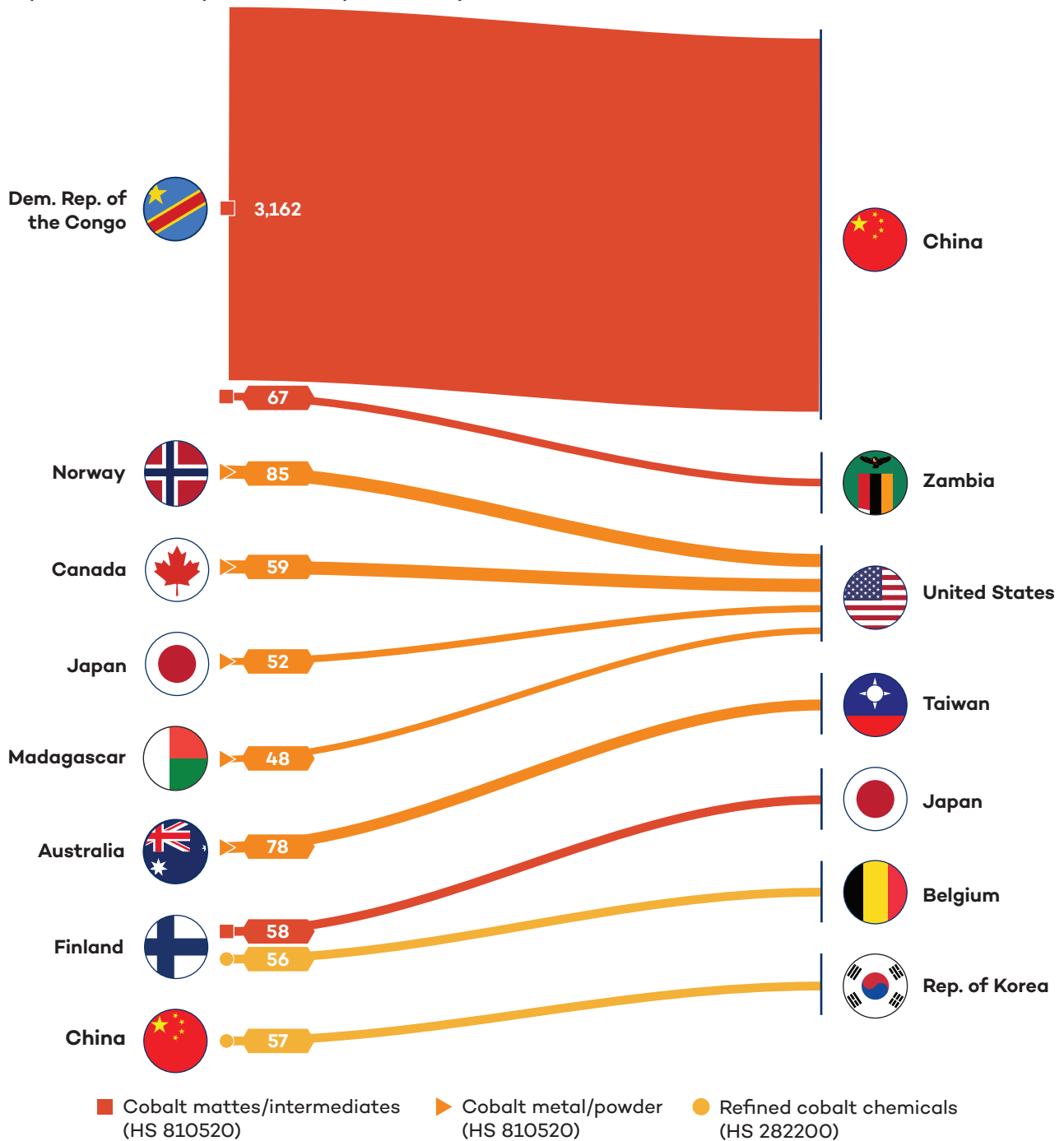


Source: Gulley, 2025.

Lithium-cobalt-oxide (LCO) was the first battery chemistry to be used widely in products such as cameras, laptops, and flip-phones. LCO is losing market share to relatively newer nickel-manganese cobalt (NMC) battery chemistry that gives EVs faster charging and longer range. Nickel-cobalt aluminum (NCA) chemistries are still a small portion of the market. NCA batteries are characterized by high energy density, which supports extended driving range and strong performance in EVs, although performance advantages over other chemistries vary depending on operating conditions, including temperature (Kim et al., 2019; Li et al., 2020; Wang et al., 2024).

2.4 Cobalt Trade Overview

Top major country-to-country trades by value (USD billion, 2024)



Methodological note: Exports are estimated based on mirror import data because imports are often tracked more diligently to collect import duties. This may bias trade values upwards because reported import values include the cost of insurance and freight, while export values do not. For trade code 810520 (Cobalt; mattes and other intermediate products of cobalt metallurgy, unwrought cobalt, powders), the supply chain stage is assumed to be based on the cobalt-producing and consuming facilities of each trade partner. For trade code 2822 (cobalt oxides/hydroxides), UNCOMTRADE data show the DRC exporting USD 142.3M to Namibia and USD 67.2M to Zambia. The DRC did not produce refined cobalt oxides/hydroxides in 2024, so these trades are assumed to be cobalt mattes/intermediates (most likely crude cobalt hydroxide) that should have the HS code 810520. Namibia does not have cobalt refining, so this trade is assumed to continue to China.

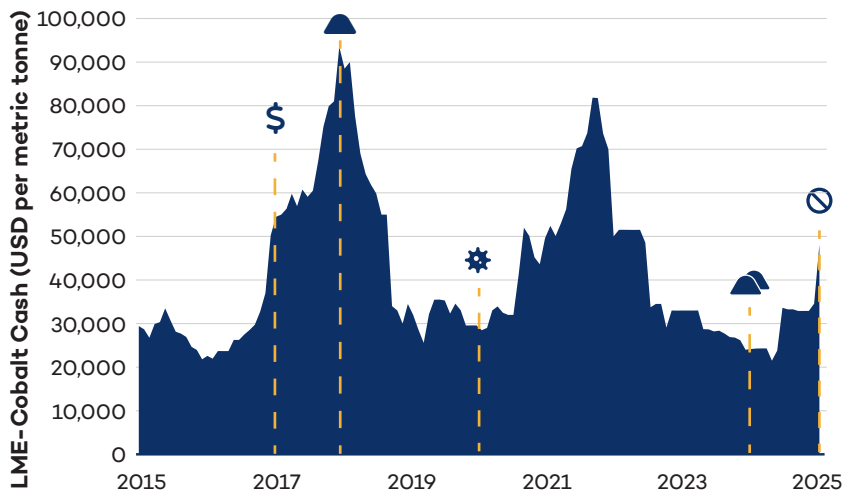
Source: United Nations Statistics Division, 2025.

The trade of cobalt intermediate products from the DRC to China is by far the largest trade because China imports these intermediate materials, refines them, manufactures products with them, and then either exports those products or consumes them domestically.

2.5 Geopolitical Considerations

2.5.1 Price Trends

Cobalt historical prices, 2015–2025, USD/metric tonne

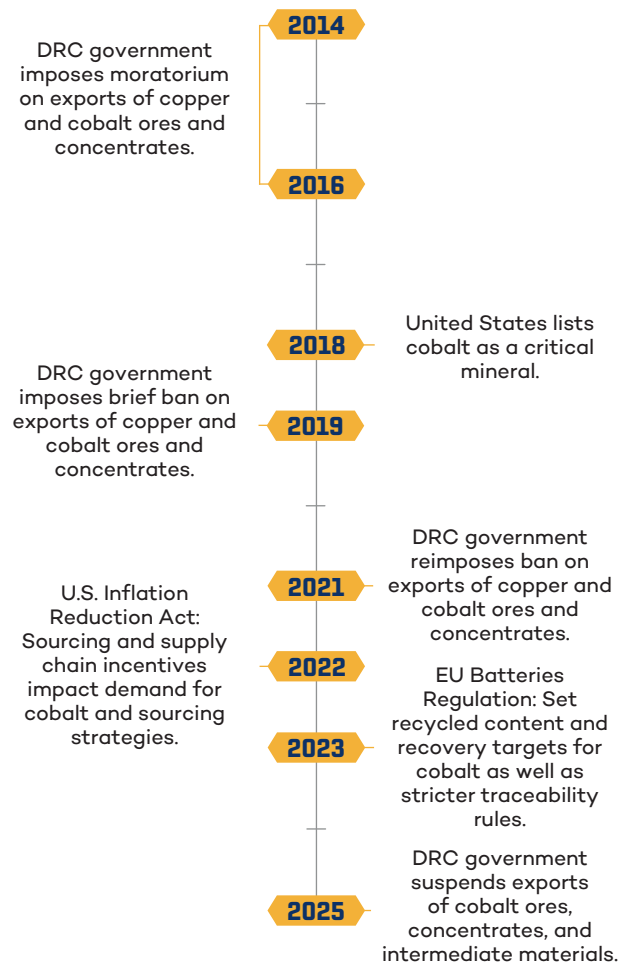


- \$ 2017** Major price spike going into early 2018 as EV demand expectations surge
- ▲ 2018** Rising supply causes market correction
- ⚙️ 2020** COVID disrupts supply chains, while battery demand keeps increasing
- ▲ 2024** Oversupply emerges as by-product supply from nickel and copper grows
- ⊘ 2025** DRC export bans/quotas cause price spikes

Sources: S&P Global Market Intelligence, 2026; U.S. Geological Survey, n.d.-a, n.d.-b.

2.5.2 Regulatory Timeline

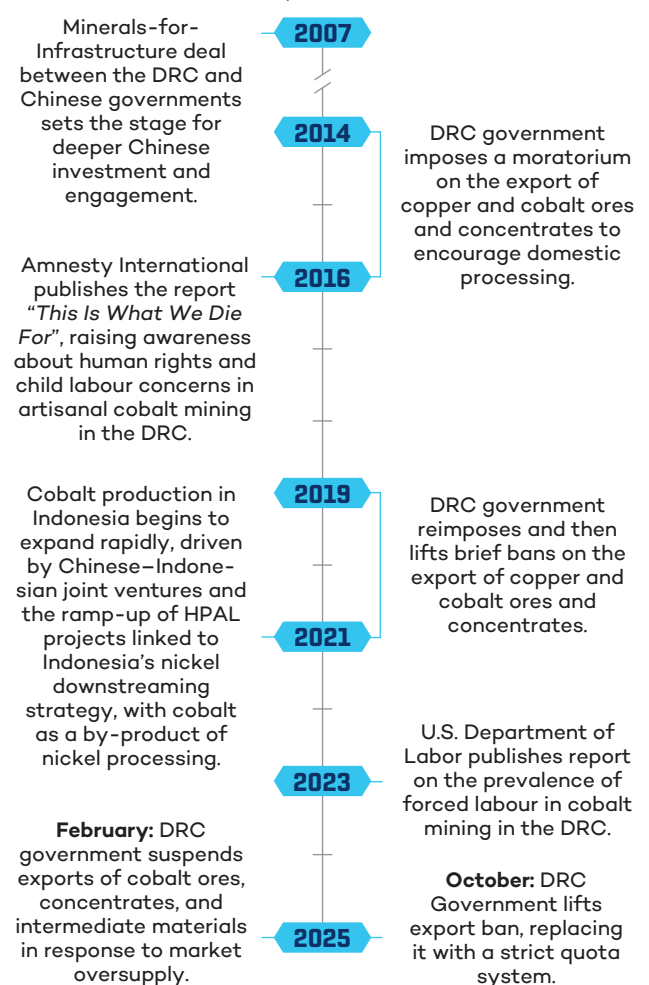
Timeline of restrictions impacting cobalt value chains, 2015–2024



Sources: DRC Ministry of Mines 2025; European Parliament, 2023; Office of the Interior Secretary, 2018; U.S. Department of the Treasury, 2023; U.S. Bureau of International Labor Affairs, 2023; U.S. Geological Survey, n.d.-a, n.d.-b.

2.5.3 Geopolitical Dynamics Timeline

Timeline of geopolitical events impacting cobalt value chains, 2015–2024

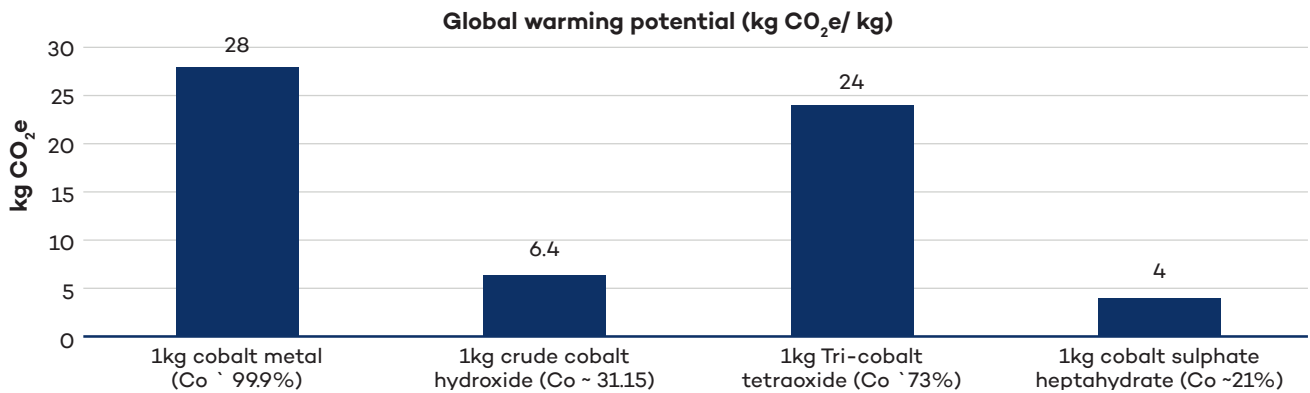


Sources: Amnesty International, 2016; Beale, 2017; DRC Ministry of Mines, 2025; Guley, 2022; Hodgson, 2025; Home, 2024; Reuters, 2025.

3.0 Environmental and Social Considerations

3.1 Emissions Profile

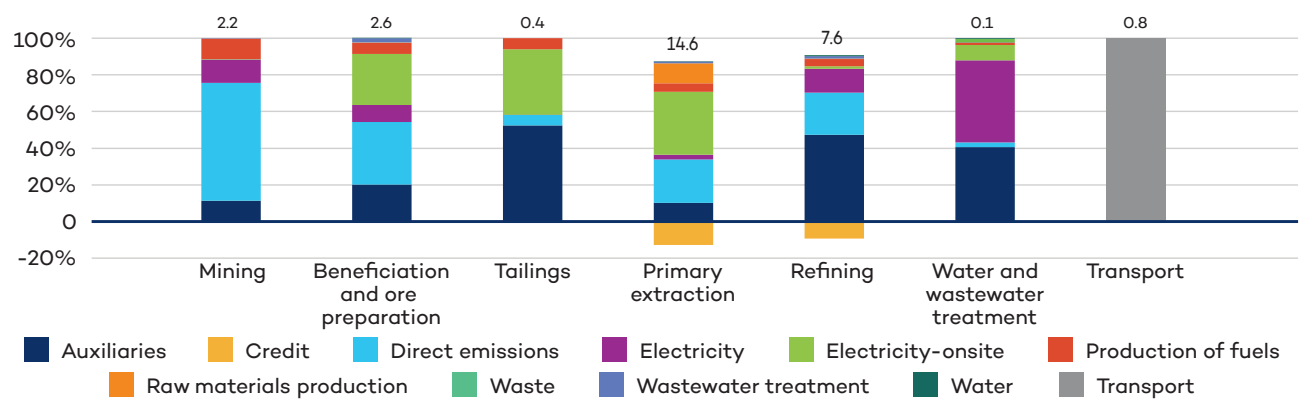
GHG Emissions intensity by cobalt product type (kg CO₂e/kg Co)



Source: Cobalt Institute, n.d.-a.

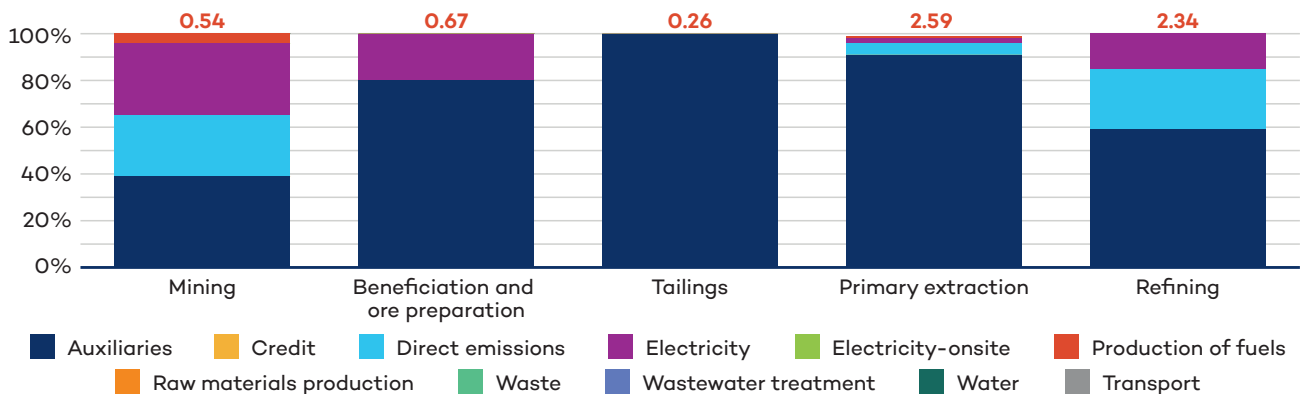
3.2 Global Warming Potential (GWP)

3.2.1 Global Warming Potential (GWP 100 years) - Cobalt metal (kg CO₂e/kg Co)



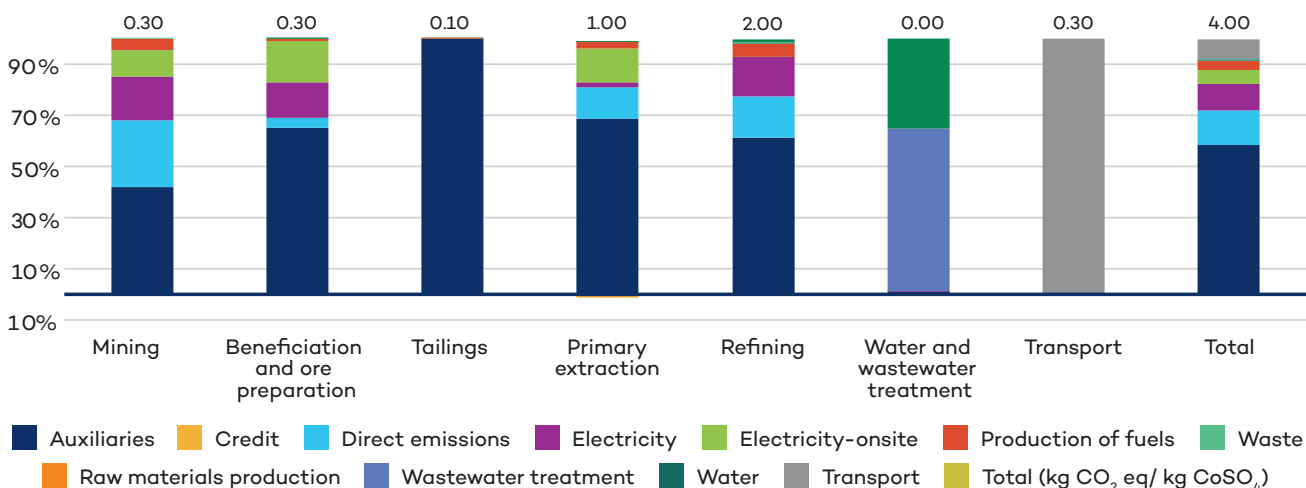
Source: Cobalt Institute, 2022.

3.2.2 Global Warming Potential (GWP 100 years) - Crude cobalt hydroxide (kg CO₂e/kg)



Source: Cobalt Institute, 2022.

3.2.3 Global Warming Potential (GWP 100 years) - Cobalt sulphate heptahydrate (kg CO₂e/kg)

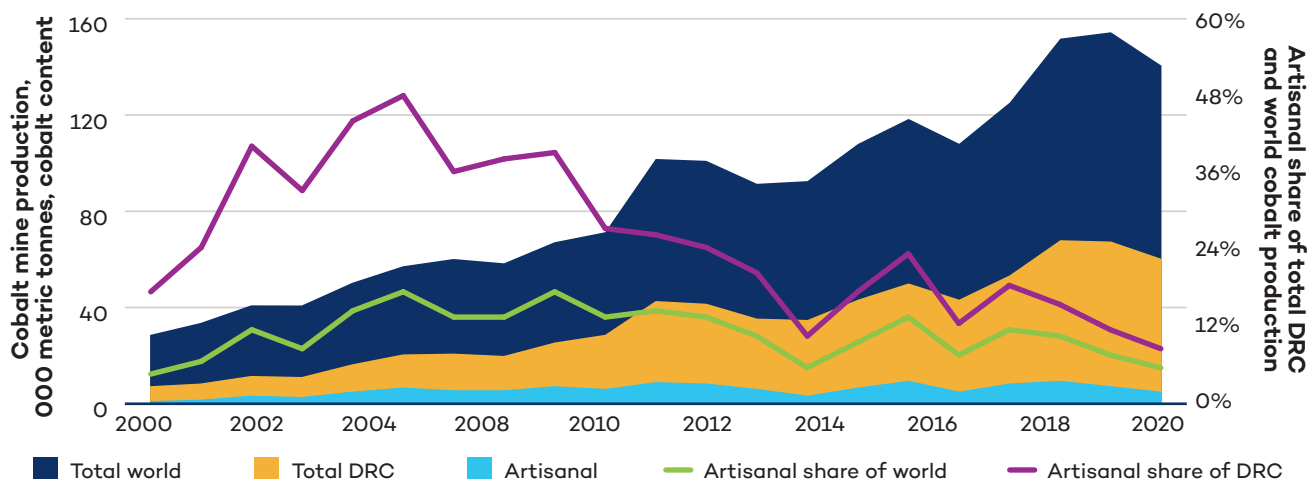


Source: Cobalt Institute, 2022.

3.3 Artisanal and Small-Scale Mining

3.3.1 Cobalt Mine Production and Artisanal Share, DRC vs. World

Artisanal, DRC, and world cobalt mine production from 2000 to 2020 in 000s metric tonnes

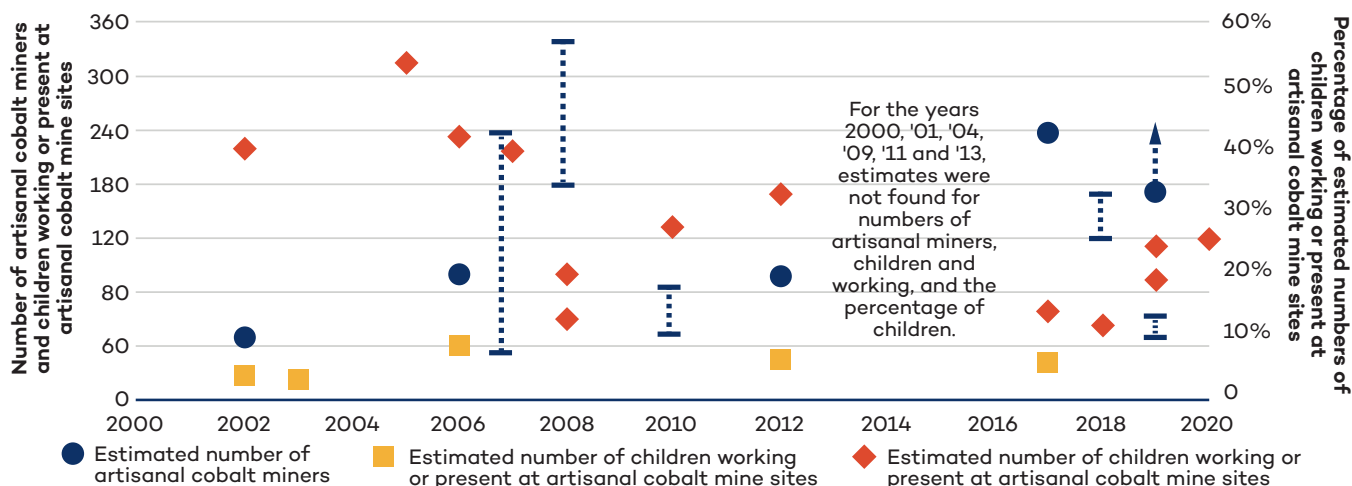


Artisanal production is essentially from the DRC.

Source: Gulley, 2023.

Artisanal cobalt mine production results for artisanal-production-A, dark purple area; total DRC cobalt mine production, light blue area; total world cobalt mine production, dark blue area. Artisanal-production-A as a percentage of world and DRC mine production, light and dark rose lines on the Right axis, respectively. Artisanal production's share of DRC cobalt mine production peaked around 2008 at roughly 50% before trending down to roughly 10% in 2020.

3.3.2 Estimated Number of Artisanal Cobalt Miners and Child Working or Present at Artisanal Cobalt Mine Sites, 2000–2020



Source: Gulley, 2023.

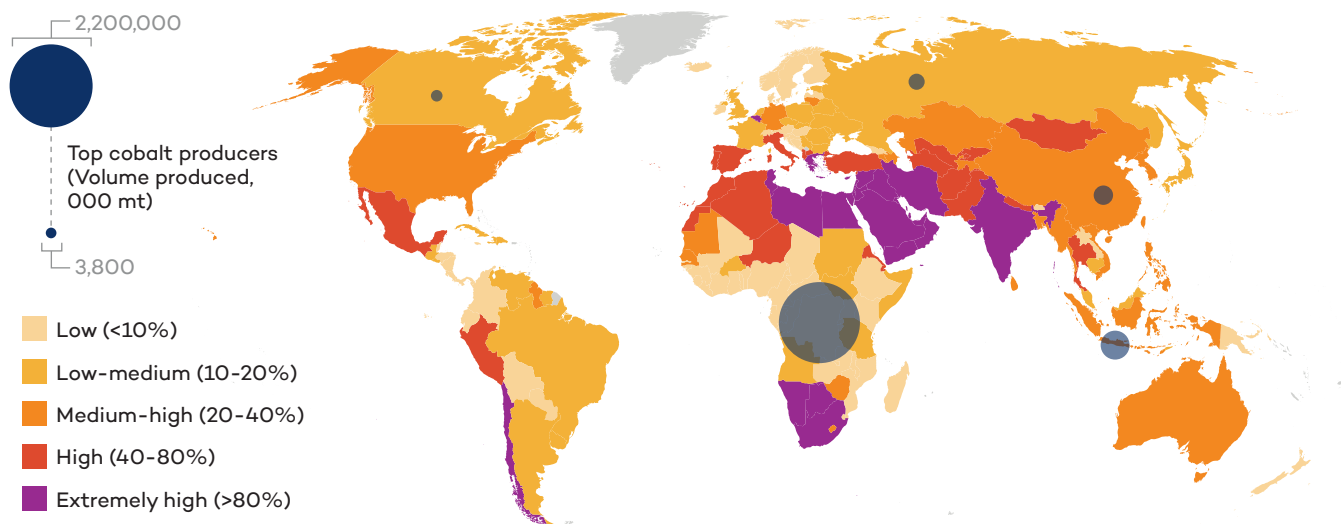
Estimates of the number of artisanal miners rely on a range of secondary literature studies, hence are approximations (Bundesanstalt für Geowissenschaften und Rohstoffe, 2019, 2021; Faber et al., 2017; Global Witness, 2004; Groupe One, 2007, as cited in Tsurukawa et al., 2011; Kara, 2018; Pact, 2010; Tshilobo, 2005, as cited in Tsurukawa et al., 2011; Walther, 2012; World Bank, 2008).

Estimates of children working or present at artisanal cobalt mine sites indicate the estimated number of individuals under 18, at mining or processing sites. Based on cited literature, this includes those observed or reported to be engaged in ASM work but also those present without direct involvement. Recorded estimates therefore reflect site presence rather than verified employment and may include children accompanying caregivers or living in nearby communities.

The chart shows three values for the years presented: the estimated number of artisanal cobalt miners (aqua dots), the estimated number of children working or present at artisanal cobalt mine sites (light orange squares), and the percentage of the estimated numbers of children working or present at artisanal cobalt mine sites relative to the rest of artisanal cobalt miners (dark orange diamonds). Dotted bars represent reported estimate ranges, and upward arrows indicate values described in the literature as “greater than” a specified number.

3.4 Water Scarcity Risk

Baseline water scarcity risk in key cobalt-producing regions

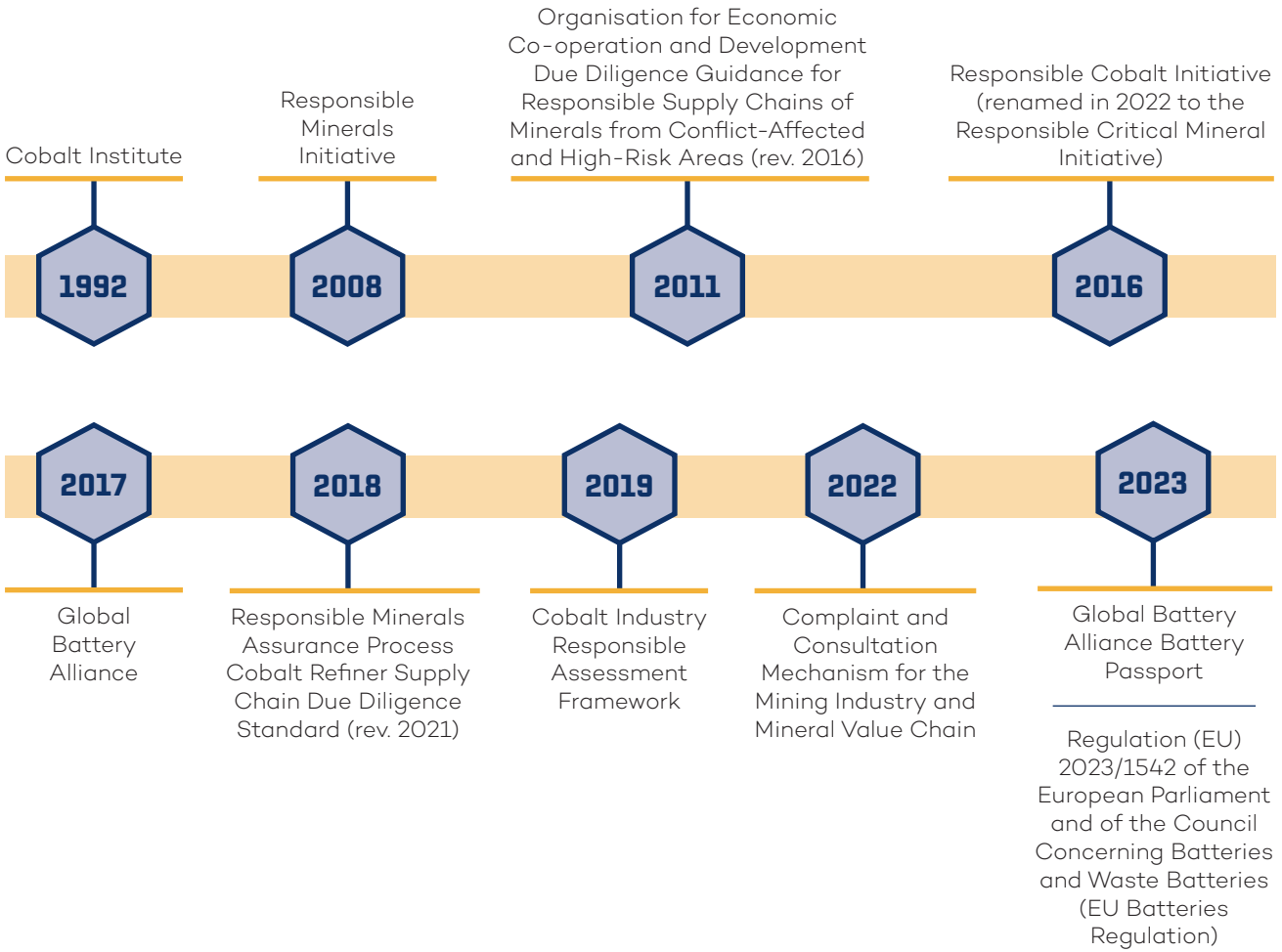


Methodological note: Baseline water stress measures the ratio of total water demand (domestic, industrial, irrigation, and livestock uses) to available renewable surface and groundwater supplies. Higher values indicate more competition among users.

Sources: U.S. Geological Survey, n.d.-a; World Resources Institute, 2025.

3.5 Timeline of Sustainability Standards and Initiatives

Voluntary sustainability standards, frameworks, and bodies impacting the cobalt value chain



Sources: Cobalt Institute, n.d.-b, 2019; European Parliament & Council of the European Union, n.d., 2023; Global Battery Alliance, n.d.; Organisation for Economic Co-operation and Development, n.d.; Responsible Critical Mineral Initiative/China Chamber of Commerce for Metals, Minerals and Chemicals Importers and Exporters, 2022; Responsible Minerals Initiative, n.d.

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