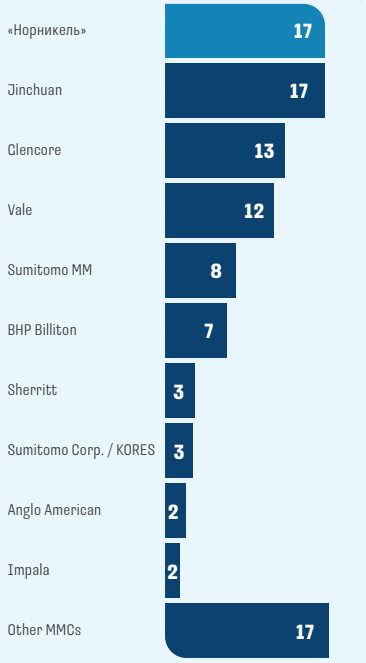
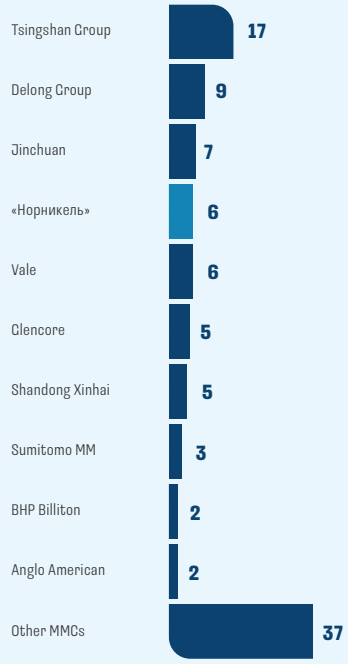
NICKEL (Ni)

No. 1 in high-grade nickel production (%)



No. 4 in primary nickel production (%)

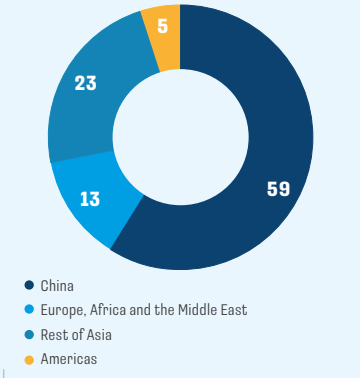


Sources: producer reports, Company analysis as of 5 March 2022.

Key trends in the nickel market

In 2021, the nickel market moved into a deficit of 159 kt, or 6% of annual consumption (compared to a surplus of 89 kt in 2020). This was due to a strong recovery in stainless steel smelting and a high demand from the battery sector amid slow ramp-up in Indonesia's nickel pig iron (NPI) production and lower output of nickel metal due to production constraints.

Primary nickel consumption by region (%)



Source: Company data

Early in 2021, the nickel price was growing steadily, hitting a seven-year high of USD 20,000/t at the end of February. The growth came on the back of market optimism about the pace of global economic recovery, the dollar weakening as the new Biden administration announced a USD 1.9 trillion stimulus package, as well as industrial incidents in Norilsk, affecting the metal supply on the market.

In early March, China's Tsingshan announced plans to convert low grade nickel (NPI) into nickel matte for subsequent battery production, resulting in a price drop of more than 20% to USD 16,000/t. In April, the nickel price was consolidating between USD 16,000/t and USD 16,500/t, but grew to USD 18,000/t in May on the back of non-ferrous metal rally.

In early June, the nickel price stood at USD 18,000/t, but news that Russia was going to impose temporary duties on base metals exports and Indonesia was considering restrictions on the construction of new NPI and ferronickel plants caused the London Metal Exchange (LME) nickel price to reach a five-month high of USD 20,000/t at the end of July.

In August, increased price volatility was caused by concerns over the spread of the COVID Delta variant potentially hitting global economic recovery. A month later, despite pessimistic comments from the US Federal Reserve, the nickel price surged to a new seven-year high of USD 20,400/t on 10 September, as strong market fundamentals and falling LME stocks increased speculative demand. However, the Evergrande's debt crisis and widespread power outages in

China eventually sent the price to below USD 18,000/t in early October – the lowest level since June.

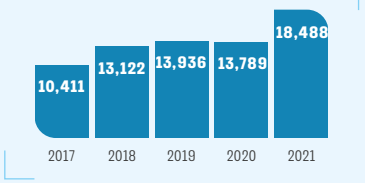
The LME Week demonstrated market optimism and triggered a price rally amid bullish sentiments among traders and concerns over nickel supply due to a number of reasons from Vale's reduced production guidance to suspension of Onça Puma's ferronickel production in Brazil to unfavourable weather in the Philippines affecting nickel ore mining volumes in Q4. The price increase was also due to fundamental factors: the nickel market deficit, dwindling LME stocks, high market premiums on all forms and in various markets, opening of the arbitrage between the Shanghai Futures Exchange (SHFE) and LME, and significant backwardation. As a result, the LME nickel price topped USD 21,000/t at the end of November, hovering around this level for the remainder of the year despite significant volatility.

The LME nickel price averaged USD 18,488/t in 2021, up 34% from the 2020 average of USD 13,789/t.

The LME nickel price averaged in 2021

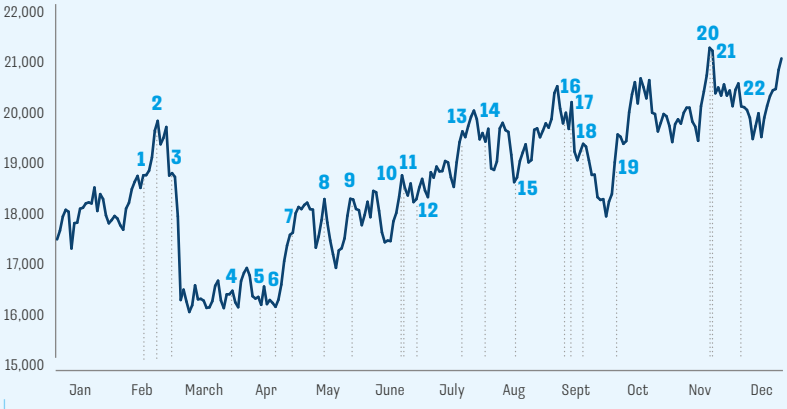
18,488 USD/t

Average annual nickel prices (USD/t)



Source: London Metal Exchange (cash settlement)

LME nickel price in 2021 (USD/t)



Source: London Metal Exchange

1. Industrial incidents in Norilsk
2. Nickel price hits a seven-year high
3. Tsinghan announces plans to supply nickel matte to Chinese battery material makers
4. Ambatovy resumes production following a 12-month closure
5. The Philippines lifts moratorium on new mines
6. LME non-ferrous metals prices surge amid record-high copper and iron ore prices
7. Start of LME inventories' drawdown
8. Startup of the first high-pressure acid leaching (HPAL) project in Indonesia
9. Strike starts at Vale's Sudbury operation
10. Indonesian government announces plans to limit construction of NPI and ferronickel plants
11. Temporary taxes on base metals exports in Russia from 1 August
12. Opening of SHFE/LME arbitrage, available for most of the second half of the year
13. Indonesia bans entry of foreign workers, slowing down the construction of NPI plants
14. End of the strike at Vale's Sudbury operation
15. LME slips into persistent backwardation for the remainder of the year
16. Indonesia considers export tax on products with <70% Ni content
17. Debt crisis of the Chinese developer Evergrande
18. Start of the power crunch in China
19. Bullish market sentiment after the LME Week
20. New seven-year high on market tightness
21. Massive spread of the Omicron strain begins
22. Launch of the first project to convert NPI to nickel matte in Indonesia

Market Balance

Primary nickel consumption surged in 2021 by a record 17% y-o-y to 2.85 mln t. Falling stainless steel production in China (–1% y-o-y) caused by the energy crisis is offset by smelter production growth in Indonesia (+90%) and strong demand for battery-grade nickel (+73%) on the back of healthy sales of electric vehicles (EV). Other consumption segments (apart from stainless steel and batteries) grew by 9% on the back of economic recovery from the acute phase of the coronavirus pandemic and inventory restocking across the entire value added chain.

Primary nickel production totalled 2.69 mln t in 2021 (+7% y-o-y). Our production guidance was sharply revised down vs the start of 2021, as new Indonesian NPI capacity was slower to come on stream than initially expected amid the COVID-related constraints at Tsingshan's facilities and Delong's projects. This was accompanied by falling nickel metal production caused by a strike at Vale's Sudbury operation and incidents in Norilsk, as well as lower ferronickel production due to production curtailments at the Koniambo in New Caledonia and Doniambo projects and high energy prices impacting Kosovo's Ferronikeli.

As a result, the market plunged into a major deficit of 159 kt in 2021 amid a strong demand recovery and slow production growth. This led to a shortage of metal available for spot buying, which was reflected in dwindling exchange inventories, high market premiums for all forms of metal, opening of the arbitrage between SHFE and LME, and a significant backwardation of the forward curve..

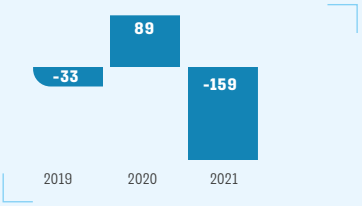
In 2021, total nickel inventories of LME and SHFE dropped by 60%, or 158 kt, to 107 kt at the year end. This major outflow of inventories was caused by a metal shortage as market participants rushed to buy metal from exchange warehouses amid a nickel market deficit. LME-approved warehouses in Malaysia, Singapore, and Taiwan saw the largest outflows in the second half of the year. Nickel briquette inventories decreased more than others, largely due to the fact the nickel briquettes can be dissolved to produce nickel sulphate used as a raw material to produce batteries for the EV sector.

Market premiums (markup on the metal price for buying a particular form in a particular location) for all forms of nickel soared by more than 50% in all regions amid high consumer demand and limited supply, and for some products by about 700%. Logistical issues (high freight costs, container shortages, difficulties in securing vessel space, major sea-routes disruptions) also put upward pressure on premiums. Major shortages of nickel briquettes as well as other small shapes (rondelles, shot, etc.) persist amid strong demand from the battery sector and restocking across the value chain.

Also in the second half of the year, the arbitrage between SHFE and LME (difference in contract value between the stock exchanges which allows buying an asset at one exchange for resale at the other) remained open for most of the period, indicating a consistently high demand for nickel in China and contributing to the reallocation of metal to the Chinese market.

In 2021, backwardation (a situation on the futures market where spot contract prices, i.e. contracts with immediate delivery, are higher than forward contract prices, i.e. contracts with delivery at a future date) put an extra pressure on the nickel market since mid-August, hitting USD 200/t and compounding the effects of steadily declining stocks and rising premiums. This trend reflects the persistent supply tightness and robust demand for spot metal.

Nickel production and consumption balance (kt)



Source: Company data

Primary nickel production totalled in 2021

2.69 mln t

+7% y-o-y

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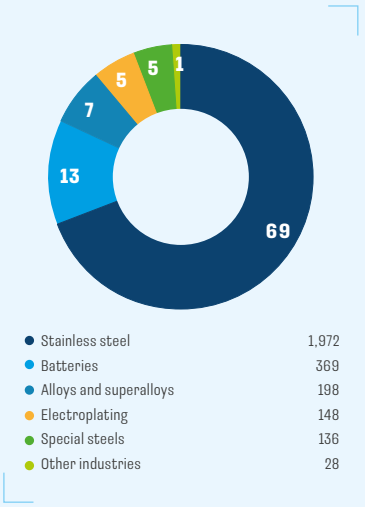
Consumption

Nickel consumption by industry in 2021 (kt)



Source: Company data

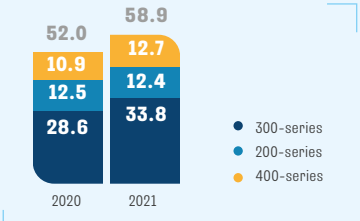
Stainless steel production continues to be the key driver of nickel consumption (about 70% of total consumption) in 2021. Adding nickel as an alloying element to stabilise the austenite structure enhances steel's corrosion resistance, high-temperature creep resistance, weldability, ductility, and resistance to aggressive environments.

The 300-series stainless steel is the most widespread grade (about 60% of global steel output) and offers a higher nickel content, mainly from 8% to 12%. Therefore, nickel consumption is primarily driven by the output of this particular grade. This non-magnetic steel series has high corrosion resistance, strength and flexibility, can be easily processed using different methods, which makes it the most versatile type of steel, driving its wide use in the construction, food, chemical, transport, energy, and other industries.

The 200-series steel features low nickel content (about 1%–2%, although it can be as low as 4% in some cases) due to manganese alloying. Compared to the 300-series steel, it is more susceptible to surface corrosion and does not have comparable high-temperature creep resistance and resilience, but its lower cost makes it widely used in the production of consumer goods, such as household appliances.

Ferritic and martensitic stainless steels (400-series) typically do not contain nickel. Their key properties include an increased content of chromium and low content of carbon, making it highly flexible and ductile. Its main applications include the automotive industry, in particular car exhaust systems, as well as the manufacture of cutlery, kitchenware, shipping container frames, interior architectural design elements, and razor blades.

Stainless steel production by eries (mln t)



Sources: Eurofer, ISSF, USGS, SMR, METI, TSIIA, Company data

Stainless steel production uses almost all types of nickel feed (except for some special products, such as nickel powder and compounds). Since the quality of nickel used has almost no effect on stainless steel quality, steelmakers primarily use cheaper low-grade nickel such as NPI, ferronickel, and nickel oxide. As a result, the share of high-grade nickel used in stainless steel production has decreased in recent years.

In 2021, global stainless steel output grew 13% to 59 mln t amid a strong post-pandemic recovery in demand, while the output of 300-series nickel-intensive steel increased by 18% to 34 mln t. The highest steel production growth rates were seen in Indonesia (up 86% y-o-y), Japan (18%), North America (16%), and Europe (14%), while Indonesia and China were the leaders for production growth in absolute terms (2 mln t each).

About 60% of the total stainless steel output is concentrated in China. In 1H 2021, China's stainless steel production increased significantly by 25% y-o-y, driven by the economic stimulus programme launched by the Chinese government in 2020 in an attempt to help the country's business activity recover after the acute phase of the COVID-19 pandemic. However, in 2H 2021, China's stainless steel production slowed down due to power shortages caused by both coal deficit and power outages organised to meet the CO2 emissions target, as well as by lower supplies of ferrochromium from South Africa due to logistical constraints. As a result, in the second half of the year, stainless steel output fell by 9% y-o-y, while total steel production in 2021 only rose by 7%. Despite the higher steel output, primary nickel consumption in China's stainless steel sector dropped 1% to 1.2 mln t amid the increased use of recyclables.

In 2021, stainless steel output in Indonesia almost doubled to 5 mln t driven by the commissioning of new facilities by China's Tsingshan and Delong, which are already integrated with their NPI operations, resulting in significantly lower production costs. China is the largest importer of Indonesian stainless steel.

In 2021, stainless steel production in Europe grew by 14% to 7 mln t. The recovery that started in 2H 2020, following the pandemic-related disruptions in stainless steel supply and demand, accelerated in 2021 as market participants continued restocking amid the recovery in business activity. Lead times at European mills were increased, and order books are extending now up into Q3 2022 in some cases. This recovery in demand, coupled with low inventories, import restrictions under protectionist trade policies, and the rising cost of raw materials, logistics and energy, has led to a twofold surge in stainless steel prices in Europe. In this market context, major European manufacturers showed record financial performance in 2021.

Just like in Europe, the stainless steel industry in the United States has seen a strong rebound starting in Q4 2020, supported by increased end use demand from the industrial machinery, appliances, construction, and automotive industries, driving stainless steel output up by 15% to 2.5 mln t.

Supported by the global growth of stainless steel output, primary nickel consumption in this sector increased by 12%, or 218 kt, in 2021. This growth was partially offset by a stronger NPI output (up 17% or 186 kt), while the production of other low-grade nickel (ferronickel, nickel oxide, and utility nickel) decreased by 17 kt in total. As a result, consumption of high-grade nickel in stainless steel production, sluggish in recent years, grew by 23% to 263 kt driven by the shortage of low-grade nickel units due to slower than expected commissioning of new NPI production capacities in Indonesia. Nevertheless, NPI supply is expected to grow in the coming years, putting further significant pressure on high-grade nickel consumption by the stainless steel sector.

The battery industry uses nickel as a key element in the production of cathode precursors for batteries. In 2021, nickel consumption in this sector increased by 73% to 369 kt. Lithium-ion batteries (Li-ion) are the key type of batteries because of their high energy storage capacity and long life cycle.

Growth in lithium-ion battery production is primarily driven by road transport electrification. In 2021, sales of electric vehicles (plug-in HEVs and battery electric vehicles) more than doubled to 6.5 million units, growing at a CAGR of over 50% between 2015 and 2021. The impetus for transport electrification comes from government incentives, more stringent environmental regulations, improved battery performance, and lower production costs of battery cells.

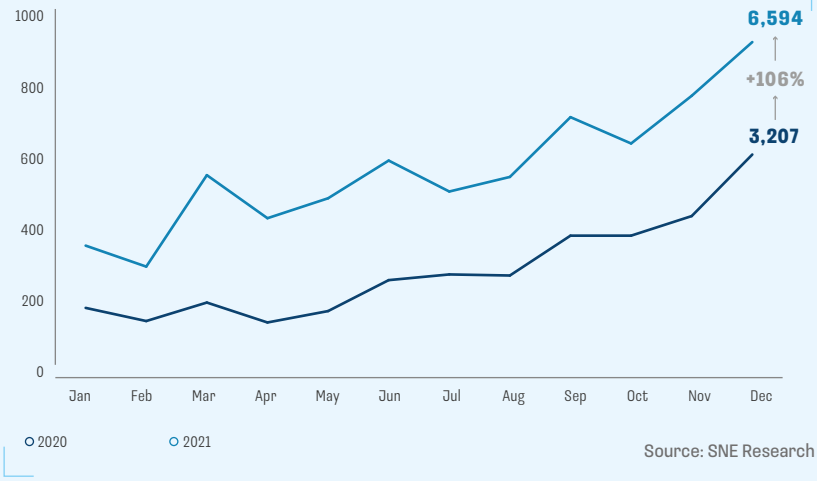
The global electrification race continues to gather pace as an increasing number of battery-related investments have been announced in the last year in China, Europe and North America. Global car manufacturers have also set targets for EV sales by 2030 and have earmarked a total of over USD 500 billion so far to invest in EV production.

In recent years, China has been one of the most important growth hubs for EV manufacturing. Electric vehicle sales grew 2.5 times in 2021 to 3.5 million units even despite the planned reduction in subsidies. China aims to increase EV sales to 20% of total vehicle sales by 2025 and to 50% by 2035. Initiatives to stimulate transport electrification, including mandatory requirements for large carmakers to manufacture electric vehicles, will also work towards these targets.

In Europe, the drive for building a local supply chain continues to be propelled by public policy and legislation. In July 2021, the EC unveiled its Fit for 55 climate package containing legislative initiatives for achieving the goals of the Green Deal, among which there is a provision that all new cars registered as of 2035 should be zero-emission. In addition, member states will be required to install charging and hydrogen refuelling points at regular intervals on major highways (every 60 km for electric charging and every 150 km for hydrogen refuelling).

In anticipation of stronger demand, the EU is building a battery production chain, with the announced total capacity of key manufacturers (Tesla, Volkswagen, Northvolt, LG Energy Solution, FREYR, Samsung SDI, etc.) estimated at about 1 TWh by 2030, which is equivalent to the annual consumption of over 800 kt of nickel.

Global sales of electric vehicles in 2021



Source: SNE Research

The pace of electrification initiatives has recently accelerated in North America, too. On the policy side, in August 2021, President Biden signed an executive order, which sets a target for half of all cars sold in the country to be zero-emission vehicles by 2030. This paradigm shift to an electric future is also underlined by the Bipartisan Infrastructure Deal, which will provide funding of USD 7.5 billion for building a nationwide EV charging network and USD 3 billion as a grant programme to support the development of the North American battery industry.

Amid this "green tidal wave", some American carmakers have started partnering with the battery cell makers to build gigafactories meeting their future requirements. These collaborations include GM and LG Energy Solution, Ford and SK Innovation, Stellantis and LG Energy Solution, Stellantis and Samsung SDI. While a year ago, there were only eight existing and announced plants in North America with Tesla leading the way, today, there are around 20 new and expansion projects in the US and Canada with the expected total capacity of over 750 GWh by 2030.

Considering the significant influx of the end of life batteries in the next decade as well as massive demand for raw materials by the gigafactories, battery recycling is becoming a key legislative priority in the West. The EU is currently adopting a new Battery Regulation to create a legal framework for a circular economy in batteries and make certain recycled contents (for Ni, 4% as of 2030 and 12% as of 2035) mandatory for battery producers, inter alia. At the same time, the US Bipartisan Infrastructure Deal authorises a USD 3 billion grant programme for the development of the domestic and North American battery manufacturing and recycling facilities. Increasingly, battery recyclers and carmakers seek to cooperate to form closed loop systems.

Currently, there are several key types of lithium-ion batteries available depending on the cathode materials used: LCO (lithium, cobalt oxide), LFP (lithium, iron, phosphate), NCM (nickel, cobalt, manganese), and NCA (nickel, cobalt, aluminium).

LCO batteries are principally confined to mobile electronics. The small size of the market, high cobalt prices and low energy density of LCO batteries prevent them from being used in EVs, but other types of batteries are widely used in the sector.

LFP batteries are a cheaper alternative to nickel-containing NCMs and NCAs. Therefore, LFP batteries cost 10%–20% less on average than NCM 5:3:2. Tesla has recently announced that it is shifting to cheaper LFP batteries globally, reaffirming its last year's strategic move to resort to the use of cheap components only to deliver the lower-cost models. Mercedes has also claimed to switch to less powerful LFP batteries for its electric models in the lower price segment from 2024.

However, LFP batteries suffer from a number of serious drawbacks, such as lower energy density, longer charging time, higher self-discharging rate, poor performance in low temperatures, and limited recyclability. They significantly limit the potential for the LFP batteries' deployment in the long-range, high-tier EVs, which have to use the more advanced nickel-intensive NCM 8:1:1 and NCA chemistries.

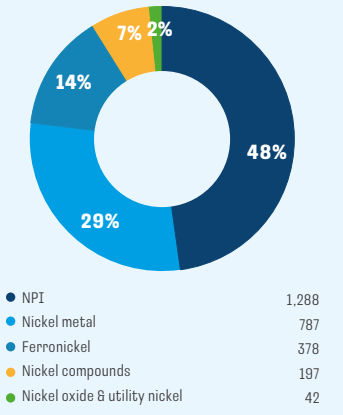
The dominating technologies include nickel-containing NCM and NCA batteries, owing to their higher specific energy and energy density, which increases drive range. Growing nickel consumption in batteries is driven by a higher average nickel content in the cathode material caused by the need to replace expensive cobalt units and increase energy density. In comparison to 2015, when NCM 1:1:1 (with a nickel mass fraction of 20% of the total cathode mass, which is equivalent to about 25 kg of nickel per battery electric vehicle on average) accounted for the lion's share of compounds in cathode materials, 2021 saw nickel-intensive compounds – NCM 5:2:3, NCM 6:2:2 and NCM 8:1:1 (with a nickel share exceeding 50%, about 50 kg per EV) – take the lead. Going forward, conversion to NCMA (nickel, cobalt, manganese, and aluminium) and NCM 9:0.5:0.5 with a higher content of nickel is expected.

The growing popularity of electric and hybrid cars, along with the evolution of cathode technology towards nickel-intensive types add to the tailwinds for significant growth in primary nickel consumption by the industry in the longer run. In our base case scenario, we estimate the nickel consumption in batteries to reach 1.5 mln t of nickel by 2030, or 30% of total primary nickel demand (compared to 13% in 2021), which may require further revisions given the continuous introduction of more ambitious carbon neutrality goals, subsidies-driven electrification, and cost optimisation of battery cell production.

In 2021, nickel consumption in other industries (alloys, electroplating, special steels) increased by 9% or 41 kt amid the gradual recovery of business activity after the acute phase of the COVID-19 pandemic with steady strong demand from end users in the automotive, transport engineering, construction, and oil & gas industries.

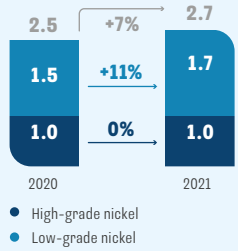
Production

Primary nickel production by industry in 2021
(kt)



Source: Company data

Primary nickel production
(mln t)



Source: Company data

Global primary nickel production can be roughly divided into high-grade and low-grade nickel production.

High-grade nickel is produced in the form of nickel cathodes, briquettes, carbonyl shot and powder, rondelles, as well as chemical compounds, both from sulphide and from more common and available lateritic raw materials. 2021's main producers of high-grade nickel were Nornickel, Jinchuan, Glencore, Vale, Sumitomo Metal Mining, and BHP.

Low-grade nickel includes NPI, ferronickel, nickel oxide, and utility nickel, which are produced from lateritic raw materials only. In 2021, the key producers of low-grade nickel were Chinese and Indonesian NPI smelters, as well as the largest ferronickel producers: POSCO, Anglo American, Eramet, South32, Solway, etc.

In 2021, many producers were affected by production restrictions due to the coronavirus pandemic. Nonetheless, primary nickel production in 2021 grew by 167 kt, or 7%, y-o-y to 2.69 mln t, led by higher NPI output in Indonesia. This was accompanied by falling nickel metal production caused by a strike at Vale's Sudbury operation and temporary suspension of production in Norilsk as well as lower ferronickel output at the Koniambo and Doniambo projects in New Caledonia due to production curtailments and high energy prices impacting Kosovo's Ferronikeli.

Production of high-grade nickel decreased marginally by 2 kt to 984 kt in 2021.

Production of nickel metal slipped 6% y-o-y to 787 kt in 2021. Operational issues, labour strikes, and the coronavirus pandemic prevented producers from increasing output to pre-pandemic levels. For example, Vale's production in Canada suffered from a strike at its Sudbury operation. Nornickel's production was affected by temporary suspension of production at the Norilsk Concentrator and flooding of the Oktyabrsky and Taimyrsky Mines, while Glencore reduced production at the Murrin Murrin site in Australia due to prolonged repairs. BHP's nickel production was impacted by scheduled maintenance at its smelting shop, refinery, and concentrators. BHP's nickel metal production also decreased on the back of the switch from nickel briquettes to nickel sulphate crystals production.

On the other hand, the Ambatovy plant in Madagascar ramped up to planned capacity following a year-long closure, and Anglo American delivered strong performance following the restart of its Anglo Convertor Plant (ACP) Phase A unit in South Africa.

Production of nickel compounds, including nickel sulphate from primary sources (excluding sulphate produced by high-grade nickel dissolution), increased by 35% y-o-y to 197 kt in 2021 on the back of robust EV sales and solid nickel demand from the battery sector.

Nickel sulphate can be produced from a variety of raw materials by different processes: directly from nickel intermediates such as mixed hydroxide precipitate (MHP), mixed sulphide precipitate (MSP), nickel matte, and crude nickel sulphate (copper chain product) or by dissolving high-grade nickel metal (as nickel briquettes or powder) or from recycled materials.

In 2021, nickel metal dissolution volumes (this source of feedstock is used to compensate for lacking nickel units) more than doubled due to the shortage of nickel intermediates and delays in launching HPAL projects, which produce MHP for export to China, and NPI-to-nickel matte conversion capacities in Indonesia, amid exceptionally strong demand from battery manufacturers remains extremely high. This was one of the main reasons for a major outflow of exchange stocks from LME-approved warehouses in Asia.

Given the growing importance of ESG as well as the global ambition to reach carbon neutrality, Nornickel started producing carbon-neutral nickel in 2021. Production of nickel with a neutral carbon footprint was enabled by efforts to reduce GHG emissions (CO_2) across all stages of production from ore mining to beneficiation and refining to finished products. The Company's products boast one of the lowest carbon footprints in the industry with a fully transparent production chain.

Low-grade nickel output grew by 11%, or 169 kt, to 1,708 kt.

Indonesian NPI production was the main driver of low-grade nickel supply growth in 2021; however its growth rates fell significantly short of expectations due to slower commissioning of new capacity, restricted entry of workers due to the coronavirus pandemic, and the conversion of some furnaces to converter matte production. Overall, we estimate the total 2021 NPI production in Indonesia at 862 kt (+46% y-o-y).

China's NPI production continued to decline, dropping 17% y-o-y to 426 kt in 2021. The decline was caused by significantly lower ore inventories due to the robust NPI demand in 2020, lower nickel content in ores imported from the Philippines, falling imports from New Caledonia, and power curtailments in China in the second half of the year.

Ferronickel output in 2021 remained almost unchanged at 378 kt (–1% y-o-y) mainly because of Glencore's Koniambo project operating only one production line out of two due to technical issues and the production cuts at Tagaung Taung's operation in Myanmar due to a military coup. Eramet's Doniambo in New Caledonia production declined as the mine and ferronickel plant were affected by the COVID-related disruptions. Brazilian Onça Puma hasn't yet reached its design capacity because of operational challenges, extended maintenance and a short-term license suspension, while the Greece-based Larco has been gradually reducing its ferronickel output for a few years as it balances on the verge of bankruptcy. Also, production at NewCo Ferronikeli in Kosovo was suspended indefinitely due to high electricity prices.

On the other hand, Colombia's Cerro Matoso facility returned to planned production volumes after an overhaul, while the Falcondo mine in the Dominican Republic increased the output closer to its nameplate capacity. Japan's Pamco was also recovering after the 2020 output cuts.

NPI production (kt)

Source: Company data