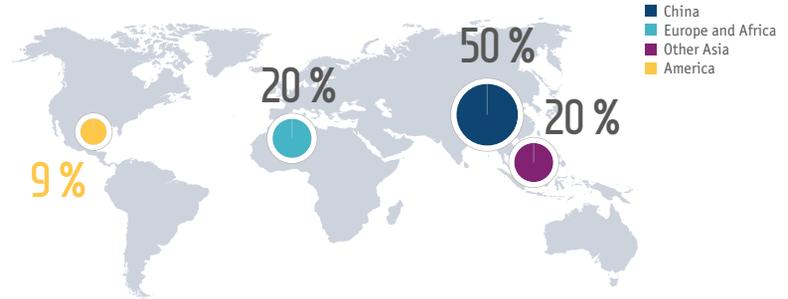


Metals Market Overview

Ni Nickel

PRIMARY NICKEL CONSUMPTION BY REGION



KEY TRENDS IN THE NICKEL MARKET

Due to the significant economic slowdown in China, key nickel consumer, and declining demand for stainless steel and alloys in the oil and gas industry, global primary nickel consumption increased by only 1% in 2015. On the other hand, nickel production decreased drastically (by 4%) on the back of:

- slump in the Chinese NPI production resulting from the shortage of production grade nickel ore¹;
- shutdown of some NPI facilities in China due to stricter environmental regulations and high production costs;
- lower output of end NPI products from certain high-cost primary nickel manufacturers as at the end of 2015;
- the 2015 output falling short of the original estimates made for new nickel projects launched in 2011–2013.

In 2015, the nickel price followed price declines across the commodity spectrum (primarily in the oil market), dropping from the maximum of USD 15,500 per tonne in January to the minimum of USD 8,160 per tonne in November and then stabilising in the lower range at USD 8,500–9,000 per tonne.

¹The ban on supply of Indonesian high nickel content ore is still in place. As China's rich nickel ore inventories keep shrinking, cost optimisation initiatives involving mixing of rich Indonesian feedstock with poor Philippine ore are no longer feasible.

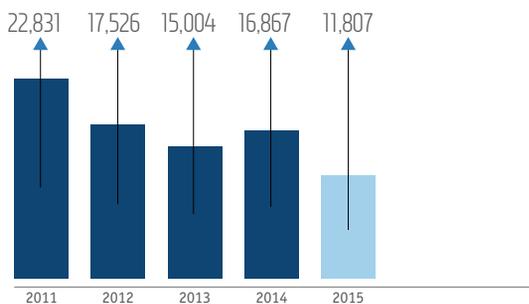
In 2015, the average nickel price went down by 30% y-o-y settling at USD 11,807 per tonne.

■ Nickel price in 2015, USD/t



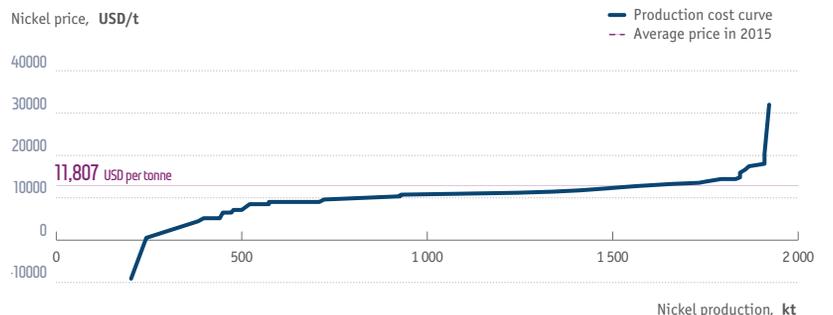
Source: LME

■ Average nickel prices over the past five years, USD/t



Source: LME

■ Nickel production cost curve



Source: LME

MARKET BALANCE

The slowdown in nickel production coupled with a slight increase in consumption contributed to significant tightening of the nickel market's surplus to 45 kt in 2015. This surplus was partly accumulated in the LME and SHFE warehouse stocks (Shanghai Futures Exchange launched nickel trading in 2015) and, by the year end, amounted to the record 490 kt or about 14 weeks of global consumption.

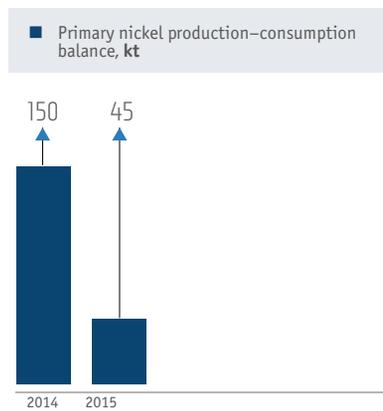
CONSUMPTION

In 2015, global consumption of primary nickel increased by 20 kt, up 1% y-o-y.

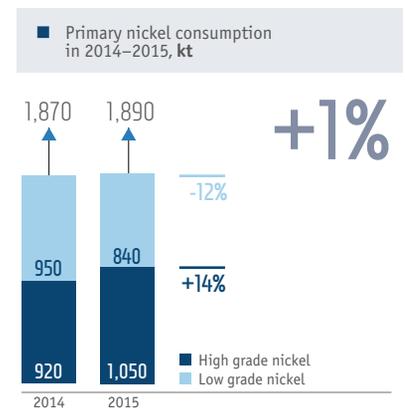
Consumption of high grade nickel grew steadily in 2015 due to the shrinking supply of low grade feedstock. Given the slump in the Chinese NPI output, in 2015 there was a reverse in the trend of substituting higher grade nickel with its cheaper grades for the purposes of stainless steel production.

China is the world's leading nickel consuming region. Its share in the global metal consumption market keeps growing, albeit at a slower pace than previously.

Nickel consumption is still predominantly driven by the stainless steel industry (67% in 2015). The addition of nickel enhances steel's mechanical and anti-corrosion properties, and improves its resistance to aggressive environments. Nickel is also broadly used in alloys and special steels, coating, chemical and battery making industries.

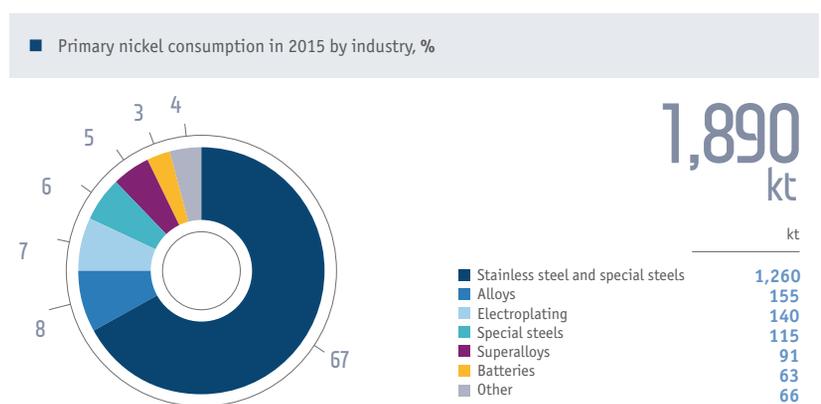


Source: Company data



Source: Company data

Primary nickel consumption in 2015 vs 2014 by region		
China	+30 kt (+3 %)	Slowdown in consumption growth replicates the general trend of economic development
Europe and Africa	-5 kt (-1 %)	The decrease was caused by weaker demand in the oil and gas market
Americas	-5 kt (-3 %)	
Other Asia	0 kt (0 %)	Consumption remained flat (lower volumes of stainless steel output were offset by the increasing demand in the battery making industry)
TOTAL, kt	+20 kt (+1 %)	



Source: Company data

Metals Market Overview

Primary nickel consumption in stainless steel production

Stainless steel comes in various brands all over the world, whereas its smelting structure ultimately determines the consumption of primary nickel. Stainless steels are classified by the alloy's crystalline structure (austenite, martensite, or ferrite).

Austenitic stainless steel is the most widespread type of stainless steel (over 70% of the global production).

Austenitic steel contains increased amount of chromium, and enough nickel and manganese to form the austenitic structure, which adds to the steel's mouldability, ductility and corrosion resistance and enhances its non-magnetic properties.

According to the international classification, this group of brands includes the 300 series stainless steels, which determine primary nickel consumption in the industry (nickel content of 8% to 12–16% and even higher in some select brands). Apart from the 300 series, austenitic brands also include the 200 series with a lower nickel content due to the addition of manganese. Over 90% of the 200 series steels are produced in China and India.

The 200 series steels cannot be used as a full-fledged substitute for the brands with a high nickel content. They are susceptible to surface (pitting) corrosion and non-resistant to heat and aggressive environments. Due to lower production costs, they are often used in the production of consumer goods such as home appliances. In 2015, the 300 series steels started to gain in popularity in China, replacing the low grade 200 series.

Austenitic-ferritic (duplex) stainless steels are characterised by a higher content of chromium (18–25%) and molybdenum (1–4%), and a lower nickel content (1–7%). These brands are mainly used in manufacturing, construction, and items exposed to seawater.

Ferritic stainless steels (400 series) contain 0–0.5% of nickel and have properties similar to those of low-carbon and highly corrosion-resistant steels. However, their mechanical properties are inferior to those of austenitic stainless steels. Ferritic stainless steels are mainly used in automotive exhaust systems, cargo container frames, water heaters, washing machines, utensils and cutlery, kitchenware and home decor items.

Martensite steels (select brands of the 400 series)

are characterised by a higher carbon content (up to 1.2%) and a lower chromium content. Sometimes nitrogen is also added to strengthen the steel. Such steels are the least widespread. They are used to manufacture turbine blades, cutlery, and razor blades.

Laterite nickel can be used as an alternative to high grade nickel in stainless steel production.

Nearly all types of nickel feedstock are used in stainless steel production (except for some specific products such as nickel powder and compounds). Since the quality of nickel barely affects the quality of stainless steel, the manufacturers opt for the cheaper nickel feedstock turning to high grade nickel as their last resort. This is the reason why high grade nickel consumption has been shifting from stainless steel production to some other metals related sectors in recent years. The trend was only reversed in 2014–2015 due to the shortage of low grade nickel supply in the market.

Primary nickel consumption in alloys and superalloys

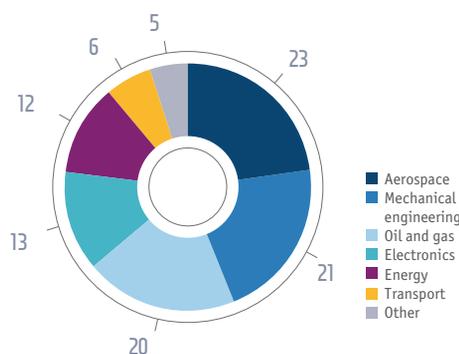
The oil and gas, automotive and aerospace industries are the main drivers behind the demand for alloys and superalloys used in the engine production.

In 2015, primary nickel consumption across the industry decreased by 1%, or 2 kt, which was mainly attributable to the crisis in the oil and gas sector. However, the drop was partly offset by higher demand from the aerospace, defence and electroplating industries.



Source: Company data

Alloy and superalloy consumption in 2015 by industry



The main reason for the decline in demand for primary nickel was the crisis in the oil and gas sector. However, the drop was partly offset by higher demand from the aerospace, defence and electroplating industries.

Source: SMR, Company data

Primary nickel consumption in electroplating

Nickel is widely used in decorative and protective platings with its thickness ranging from 1 to 100 microns (nickel electroplating).

Nickel coating is highly corrosion-resistant, hard and pleasing aesthetically. It is used for decorations, corrosion protection, and as an alternative to chromium plating.

In 2015, primary nickel consumption in the electroplating industry grew by 1% (2 kt) mainly due to the increased demand in Asia. In recent years, China has been the leading manufacturer of nickel electroplating products. Since 2012, though, the electroplating industry has started to develop in other Asian countries, and the Chinese businesses are now outsourcing their production there to optimise manufacturing costs.

Primary nickel consumption in the battery making industry

The battery making industry uses nickel as a major component of cathodes for battery cells. The extent of nickel utilisation depends on the battery type.

↓ **Nickel-cadmium batteries (Ni-Cd).** Nickel-cadmium batteries were invented in 1899. Currently, their use is restricted, since cadmium is banned as a toxic substance under the EU directive of 2014. Producers of these batteries use nickel as their feedstock. Nickel-cadmium batteries are now only used in special purpose items, and are no longer produced in the mass market.

↔ **Nickel-metal hydride batteries (Ni-MH).** Ni-MH batteries were developed in 1989 as a substitute for Ni-Cd batteries to avoid using cadmium. Producers use nickel to manufacture this type of batteries. Currently, the nickel-metal hydride battery market is however growing at a slow pace (with hybrid vehicles as the only growth driver) and faces tough competition from lithium-ion batteries.

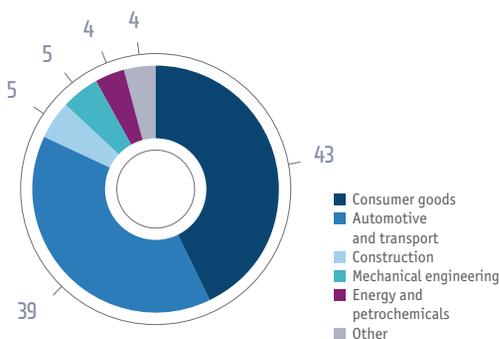
↑ **Lithium-ion batteries (Li-Ion).** Li-ion batteries were first commercially released in 1991 and became widespread due to their lightweight, high energy density, and low self-discharge. There are several types of lithium-ion batteries depending on the cathode materials.

In 2015, primary nickel consumption in the battery making industry saw steady growth of 9% (or 5 kt).

Starting from 2014, primary nickel consumption in this sector has been advancing at an accelerated pace due to the marketing success of Tesla electric cars with lithium-ion batteries (nickel content of up to 60–80 kg per car).

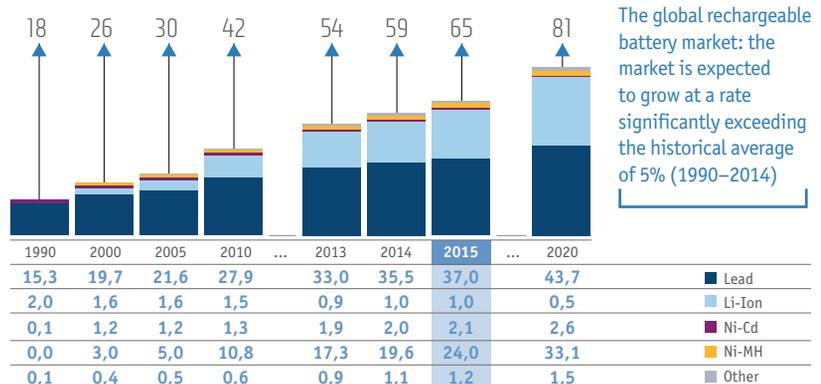
Further expansion of the automotive industry, which is currently experiencing an upsurge in popularity of electric and hybrid cars, augurs well for the longer-term growth in primary nickel consumption, even though it strongly depends on the development of battery technologies going forward.

■ Consumption of nickel electroplating products in 2015 by industry



Source: Heinz Pariser, Company data

■ The global rechargeable battery market, USD bn



Source: Avicenne, Company data

Metals Market Overview

PRODUCTION

In 2015, primary nickel production decreased by 4%, or 85 kt year-on-year, mainly due to the decline in the Chinese NPI output.

In 2015, high grade nickel production grew by 2%, or 25 kt. Among the key contributors to the greater output were:

- Sherritt's Ambatovy (Madagascar), which began producing briquettes in 2012;
- Sumitomo Metal Mining (Japan), which produces cathodes and chemical products (mainly sulphates) and receives feedstock from the ongoing Taganito project in the Philippines;
- Vale, which resumed production after the technical issues in 2014;
- Ningbo Yinyi (China), which expanded production of cathodes.

The key factor affecting nickel production in 2015 was the decline in China's NPI output due to the ongoing ban on exports of nickel ore from Indonesia. Production dropped by 130 kt, which was not only attributable to the disruption in ore supplies, but also to the shutdown

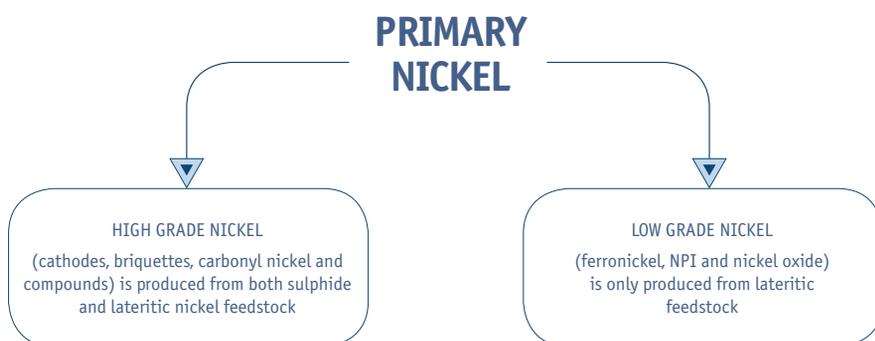
of some NPI facilities in China due to the environmental constraints and high production costs. The launch of NPI projects in Indonesia led to a production increase of 25 kt. However, due to the considerable funding and infrastructure development difficulties, currently there are only two successfully completed projects in Indonesia – Indoferro and Tsingshan (launched in early 2015).

At the end of 2015, there were announcements about production curtailments and shutdowns by some high-cost low grade nickel producers, including Cunico and Loma de Niquel.

In 2015, slight high grade nickel production curtailments were implemented at¹:

- Norilsk Nickel (part of the Company's production reconfiguration drive);
- cathode manufacturing plants in China (December 2015).

PRIMARY NICKEL CAN BE SPLIT INTO TWO MAJOR GROUPS

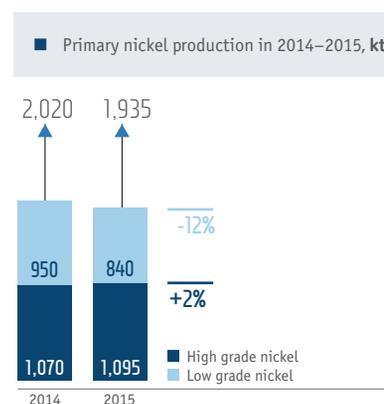


In 2015, the main high grade nickel producers were

- Norilsk Nickel, Vale, Jinchuan, Glencore, and BHP Billiton

In 2015, the main low grade nickel producers were

- Chinese and Indonesian NPI companies, Tsingshan, South 32, Eramet, Pamco, and Anglo American



¹Empress (Zimbabwe) was closed due to high production costs.

Source: Company data