

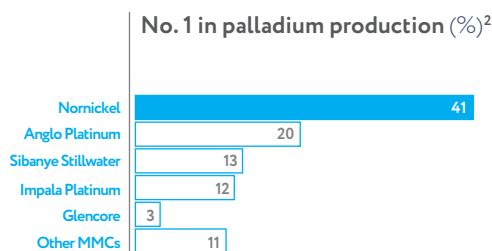
PALLADIUM (Pd)

KEY TRENDS IN THE PALLADIUM MARKET

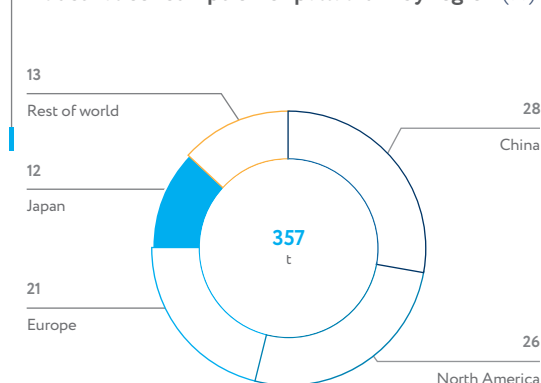
2019 was another year of growing palladium prices due to the steady increases in consumption from the automotive industry amid tougher environmental standards worldwide. Deficit was offset by primary production growth and improved recovery of automotive catalysts as supplies from previously accumulated stocks were much smaller.

The price growth of palladium that began in the second half of 2018 continued into the first quarter of 2019. At the end of March, the price hit an all-time high of USD 1,604/oz. Palladium benefited from a fundamental market deficit and a continued shortage of metal available for spot buying. Price growth was also supported by macroeconomic factors. At its January and March meetings, the US Federal Open Market Committee (FOMC) decided to put interest rate hikes on hold, which had a positive effect on precious metals prices. Moreover, the revived growth of stock market indices increased interest in palladium as a metal widely used in industrial applications.

March peaks were followed by price correction early in the second quarter to USD 1,350/oz due to additional supply from South African palladium producers and recyclers which had built up significant work-in-progress inventories by the end of 2018. Besides, consumers sold some of their inventories



Industrial consumption of palladium by region (%)



Source: Company data

to reduce hedging costs and improve balance sheet structures. Another significant driver was speculators locking in profits at the close of the first quarter of the financial year, which in some countries ends on 31 March.

Statements made by the US FED in early June gave rise to expectations of possible interest rate cuts in 2019. This weakened the dollar and had a positive effect on precious metals prices, resulting in resumed growth in palladium prices, which exceeded USD 1,500/oz by the end of the first half of the year. After a moderate correction seen in late July, palladium prices began growing from August to September and came close to a USD 1,700/oz mark. This was, in part, caused by the increased net long speculative positions in NYMEX; however fundamental factors and news of metal shortages in both warehouses and on the spot market contributed the most to the price increase.

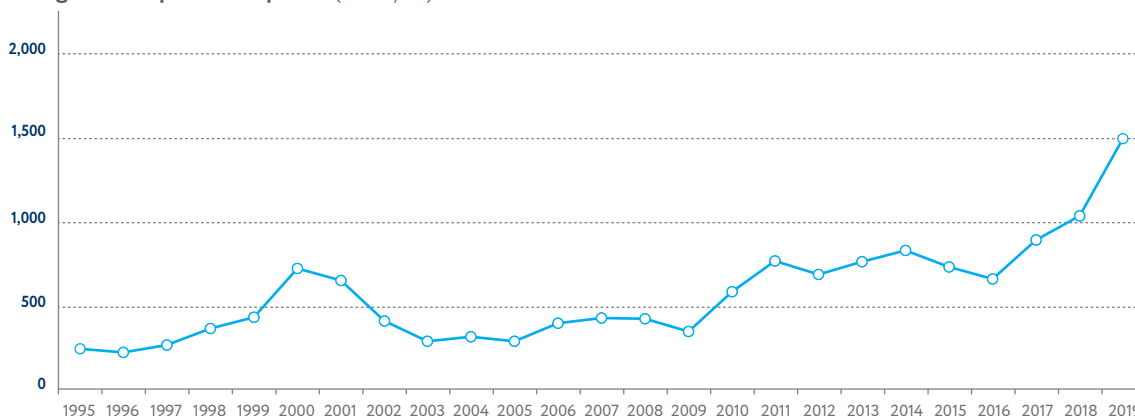
The price rally continued into the fourth quarter, with palladium prices hitting another all-time high of USD 1,990/oz amid stronger backwardation in the forward market, increased demand from automakers, and structural deficit in the market. Lease rate increases were moderate and long speculative positions remained at moderate levels.

Average annual palladium prices (USD/oz.)					
2014	2015	2016	2017	2018	2019
803	691	613	869	1,029	1,538

Source: LBMA

^{2/} Refined metal including production from own feedstock by third-parties under tolling agreements.

Average annual palladium prices (USD /oz)



Thus, it can be argued that prices were supported by long-term fundamental factors such as a multi-year, persistent market deficit with palladium production lagging behind consumption; an increasing share of petrol cars; a growing production of vehicles with hybrid propulsion systems; and expectations of a surge in palladium use in the catalysis of automobile exhaust treatment systems – a trend initiated by tougher environmental standards in key markets.

However, the negative effect from car production decrease in absolute terms, especially in China, was fully offset by the increased per unit use of palladium in exhaust treatment systems, which was facilitated by new vehicle emissions testing standards (WLTP and RDE tests) and environmental regulations (China 6, Euro 6d, the US's Tier 3, etc.).

The average palladium price in 2019 reached USD 1,538/oz, 49% more than the previous all-time high in 2018.

Palladium, together with rhodium, remained among the strongest performers in the commodity markets, with its premium to platinum rising throughout the year and coming close to 100% by the year-end.

MARKET BALANCE

Since 2010, there has been a sustained undersupply in the physical palladium market covered by the inventories accumulated in previous years. Even though production grew faster than industrial

Palladium market balance¹ (t)

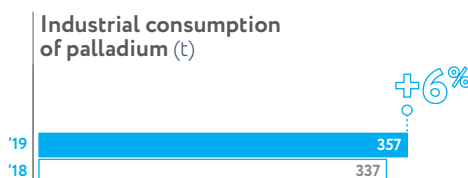
Palladium production and consumption balance	-29
Outflows from ETFs	4
Destocking by mining companies	1
Supply and demand balance	-24

¹/ Excluding reallocated other reserves

consumption in 2019, market deficit stood at 24 t due to dwindling government reserves of palladium and ETF inventories.

CONSUMPTION

In 2019, industrial consumption of palladium increased by 20 t (up 6%) y-o-y, hitting a new all-time high of 357 t.



AUTOMOTIVE INDUSTRY

Exhaust treatment systems account for the bulk of total palladium consumption. In this sector, palladium is used in catalytic converters to detoxify exhaust fumes. In most countries, such converters are legally required to be installed on all motor vehicles.

Due to its unique catalytic properties ensuring effective chemical reactions throughout the entire vehicle life cycle, there are almost no alternatives to palladium in this sector except for platinum, which is used mostly in diesel vehicles, and rhodium. Given the already significant share of the automotive industry in rhodium consumption and small market size (annual global production stands at 23 t), rhodium is subject to high price volatility and constant risk of physical metal shortage.

In 2019, palladium consumption by the automotive industry increased by 25 t, hitting a new all-time high of 294 t. This was mostly driven by tougher

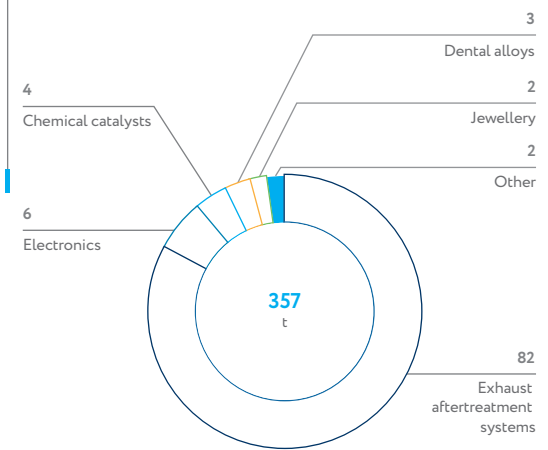
regulations on pollutant emissions, including the Worldwide Harmonised Light Vehicle Test Procedure (WLTP) – a new procedure for testing cars’ emissions that took effect in the EU and Japan in September and October 2019, respectively. WLTP is designed to make tests more rigorous by extending their distance and duration, increasing the car weight, requiring faster acceleration, and stipulating that testing should be performed at different altitudes and temperatures. The Real Driving Emissions (RDE) test is another recently introduced regulation, in effect as of September 2019. These developments forced automakers to implement more sophisticated exhaust treatment systems and expand the use of PGMs per catalytic converter.

The marked increase in palladium consumption by the automotive industry in China came in the wake of tougher environmental requirements as part of the China 6b rollout across the country starting from 2019. The China 6b standard is based on best practices in emission control as developed in the USA and the EU, and sets out certain additional requirements. About 70% of all cars manufactured in China in 2019 met the new standard.

Changes in the fleet mix also boosted palladium consumption among automakers as light diesel vehicles were further replaced with petrol cars and hybrids, which make greater use of palladium-based catalytic converters for exhaust fumes. In 2019, the market share of diesel cars in Europe (27 countries) dropped from 36% to 31%, an all-time low since 2000.

Vehicle hybridisation is another trend driving palladium consumption. In 2019, production of mild, full and plug-in HEVs (PHEVs) increased by 22%, 26% and 3%, respectively. Since hybrids include petrol engines, they mostly use palladium-based catalytic

Palladium consumption by industry (%)



Source: Company data

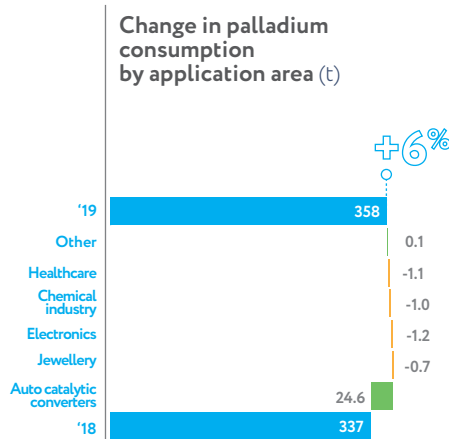
converters. With the same engine displacement as the regular petrol vehicle, the hybrid uses more of the metal due to more frequent cold starts.

The growing use of PGMs in the automotive industry is also indirectly driven by consumers migrating from sedans to larger-engine crossovers. In 2019, the share of SUVs and pickups in the USA increased by 2% to 64%, completely offsetting the overall decline of the national automotive industry’s output in terms of palladium consumption.

Vehicles using batteries without PGM-based exhaust catalytic converters have remained a niche market (under 2% of the global car production), which showed no significant growth in 2019 due to cuts in government subsidies for buyers of electric vehicles in China.

The global automotive industry’s overall output and sales declines (down 4% y-o-y) were a drag on the industry’s palladium consumption, with the world’s largest market, China, showing the biggest decline (down 8%). Vehicle production in the North America, Europe and Japan largely remained flat from 2018, and none of the world’s regions saw any significant growth. The negative effect from the decreasing overall global vehicle production was fully offset by more extensive use of palladium per vehicle.

The average premium of palladium vs platinum ranged from USD 400/oz to USD 1,000/oz and stood at USD 950/oz as of the end of the year. Contrary to most players’ expectations expressed in the last two years regarding imminent substitution of palladium with platinum in catalytic converters used for petrol engines, no signs of such substitution were observed in 2019.



Source: Company data

ELECTRONICS

Palladium consumption in the electronics industry continued a moderate downward trend in 2019 (down 1.2 t). In recent years, the use of palladium in multi-layer ceramic capacitors has been in decline, becoming limited to the most sophisticated products with a focus on reliability and performance in harsh environments, such as those in the defence and aerospace industries. Given the metal price inelasticity of demand, consumption in these sectors is expected to remain flat. However, the use of palladium as an electroplating material for connectors and lead frames continued to decrease due to a decline in the global production of electronic devices.

CHEMICAL INDUSTRY

The use of palladium in chemical catalysts decreased by 1 t y-o-y after significant growth in 2018. In the mid-term, growing consumption of palladium in the chemical industry will be driven by newly launched terephthalic acid projects in China.

HEALTHCARE

The consumption of palladium in the healthcare sector continued a downward trend and declined by 11%, or 1 t, y-o-y due to the substitution of palladium with composite material alternatives. In Japan, the largest consumer of the metal for dental prostheses, demand for palladium has been declining in recent years by an average of 5% to 10% per year.

JEWELLERY

Palladium is used in white gold alloys or, in its pure form, to make wedding rings among other items. In 2019, jewellery-related consumption of palladium decreased by another 0.7 t. A drop in Chinese demand for these products amidst a general slowdown in consumer spending

Russia, the leading palladium producing country, posted an output increase (up 6 t)

and a shift to other luxury goods were the primary cause of the continued sales decline. Palladium jewellery sales were also affected by growing prices for the metal.

INVESTMENTS

Investor demand for palladium kept shrinking in 2019 mostly due to outflows from exchange-traded funds (ETFs), which had their inventories reduced by 4 t to 22 t – an all-time low since 2008. The outflows amid growing palladium prices were driven by a wave of profit taking and by investors reallocating their capital to other palladium investment options to benefit from a swing to backwardation.

PRODUCTION

In 2019, primary refined palladium production increased by 3% to 220 t.

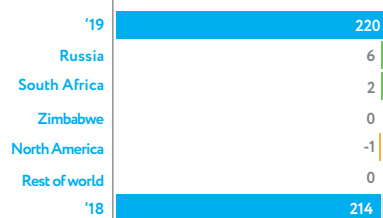
South Africa, the world second largest palladium producer, also demonstrated a y-o-y increase (up 2 t). In Zimbabwe, palladium output remained stayed flat from 2018.

Primary palladium production in Canada declined by 1 t, while in the USA it remained largely flat.

The main sources of recycled palladium are scrapped auto catalytic converters, as well as jewellery and electronic scrap. In 2019, recycled output grew by 12 t to 109 t as demand grew for catalytic converter scrap on the back of increased prices for palladium and steel scrap. Recycling capacity utilisation rates are currently near 100%. Jewellery and electronic scrap volumes remained flat.

The sources of previously accumulated palladium stockpiles include trading companies, financial institutions, government reserves, and consumers' surplus inventories. In 2017–2018, Nornickel's Global Palladium Fund (GPF) supplied the market with more than 1 Moz of palladium on top of Nornickel's own output. The stockpile had been created through purchases from third parties.

Primary palladium output
by countries (t)



Source: Company data