IPA
INTERNATIONAL PLATINUM GROUP METALS ASSOCIATION

PGM Fact Sheet Ruthenium

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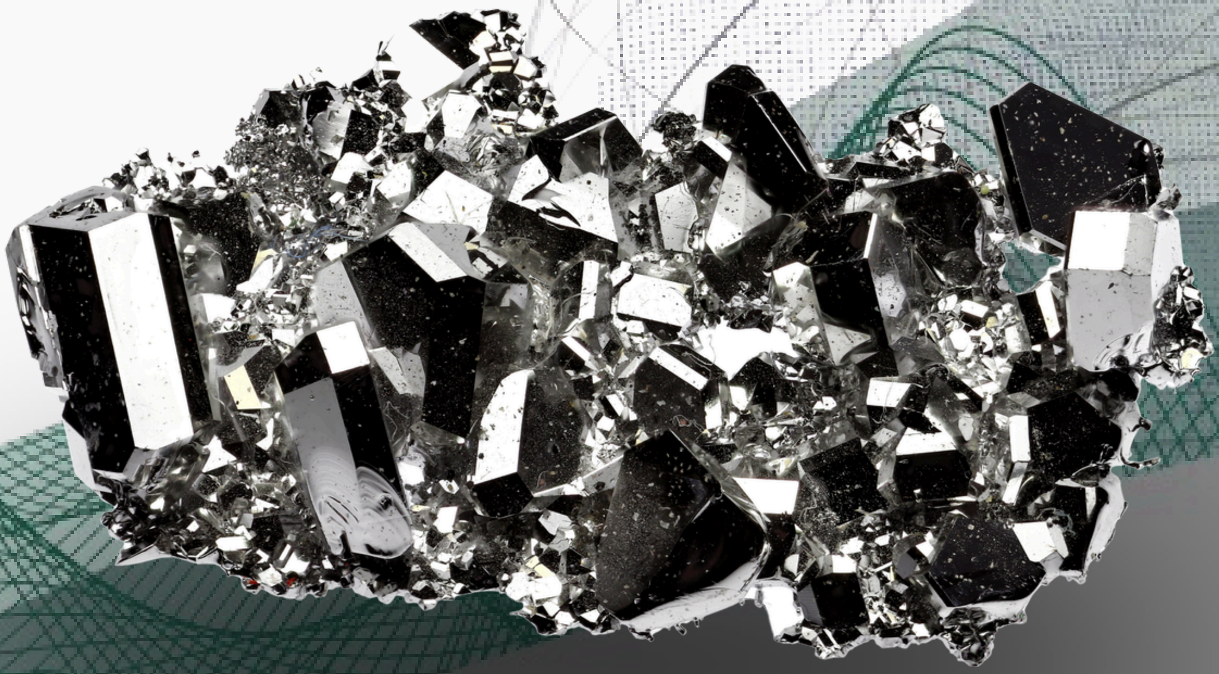
Ruthenium



Supply & Demand

Applications

Trends

Geology

May 2026

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PGM FACTSHEETS 2026 - RUTHENIUM

Written by SFA (Oxford)

March 19, 2026

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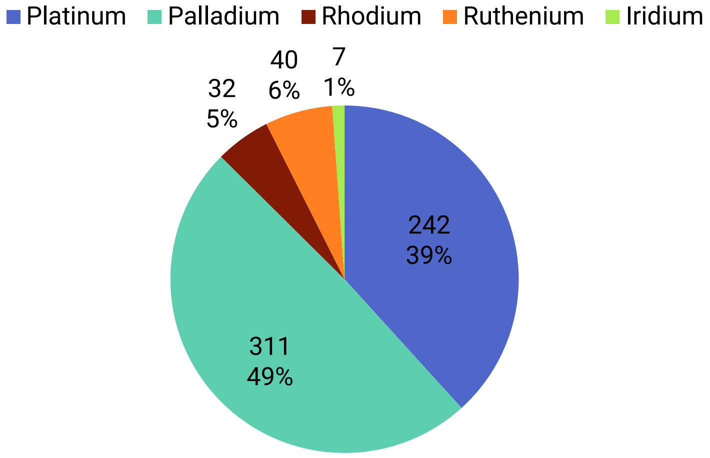
OVERVIEW

Platinum group metals (PGMs), platinum, palladium, iridium, rhodium, ruthenium and osmium, share similar chemical properties and are classed as precious metals. Despite being used in relatively small volumes, they are essential to a wide range of industrial applications. Ruthenium has gained increasing attention in recent years because of its role in advanced catalysts and emerging low-carbon technologies, including applications linked to the hydrogen economy, where it is often used alongside iridium and platinum.

More broadly, PGMs underpin a wide range of technologies, from established chemical processes and autocatalysts (catalytic converters) to newer applications supporting the transition to net zero. European companies continue to play a leading role in PGM-based processing and catalyst technologies, with manufacturing plants in Europe and worldwide. Alongside these established players, a growing group of Europe-based start-ups and spinouts, often using computational methods, is developing new catalysts and novel materials for low-carbon applications.

The demand split across the five main PGMs is shown below. Palladium accounts for nearly half of total demand, followed by platinum at 39%. Together, these two metals represent almost 90% of total demand by mass. Ruthenium accounts for only 6%, but its importance is greater than this share suggests, given its specialised role in high-value catalytic and advanced technology applications.

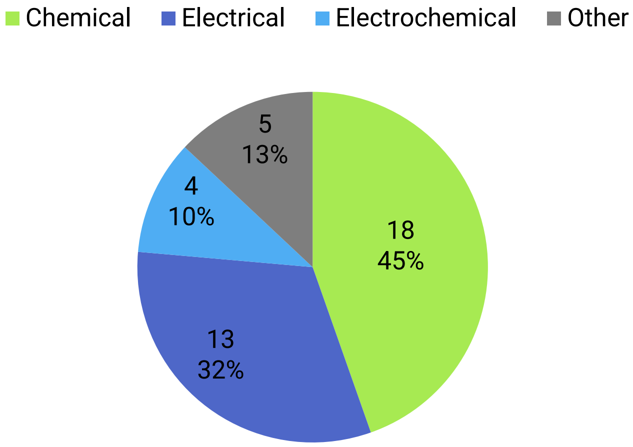
Global PGM demand by metal: 2025 tonnes



Source: Johnson Matthey (January 2026); demand excluding closed loop recycling and reuse

Ruthenium demand is well diversified across chemical, electrical and electrochemical sectors, each of which comprises a range of processes and products.

Global ruthenium demand by sector: 2025 tonnes



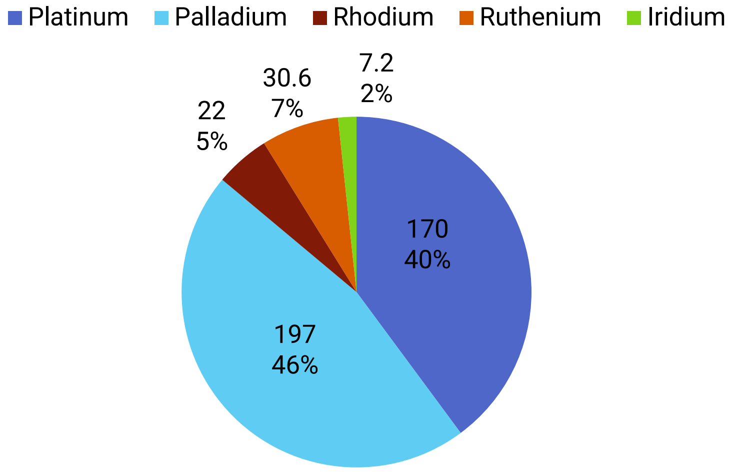
Source: Johnson Matthey (January 2026); demand excluding closed loop recycling and reuse; "other" includes jewellery and automotive anti-glare mirror coatings

All PGMs, typically in combination with one another or with other metals, can act as highly efficient catalysts, which are exploited in a wide range of applications, including automotive catalysts for emissions control, chemical and petroleum processing and many large-volume industrial reactions.

PGM mine production is highly concentrated in just a few countries. In general, PGMs are always produced together, as they occur together in nature. Platinum and Palladium are considered the main metals, with the other PGMs (rhodium, ruthenium, iridium and osmium) considered by-products. Most PGM imports from primary sources are in concentrated form after a first refining stage.

Globally, platinum and palladium make up 86% of the PGM basket by mass of metal produced, while ruthenium comprises just 7%:

Global PGM primary supply by metal: 2025 tonnes



Source: Johnson Matthey (January 2026)

South Africa dominates PGM primary supply and is estimated to comprise >90% of ruthenium output. Other important regions for ruthenium production include Zimbabwe and Russia while there are minor amounts of ruthenium from North America. There is essentially no primary supply from EU27/European countries.

MARKET ANALYSIS, TRADE & PRICES

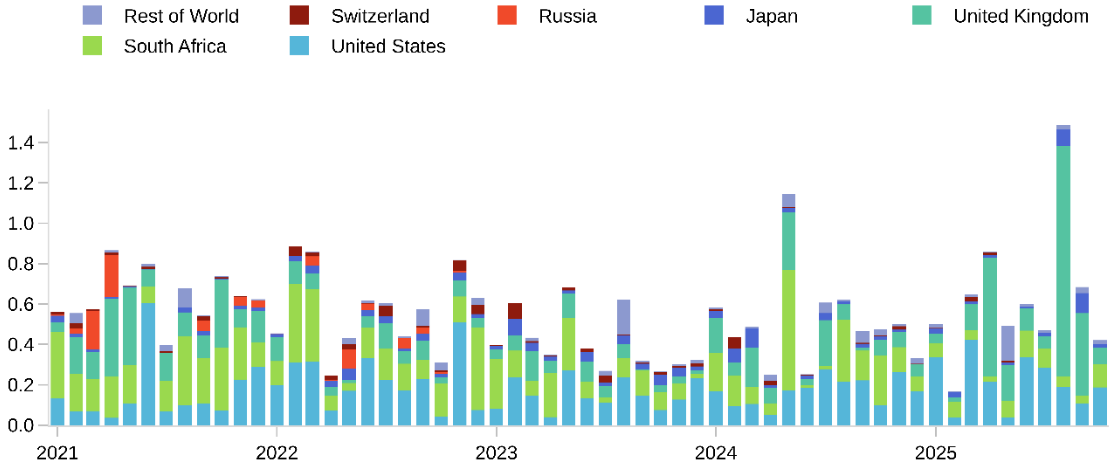
GLOBAL MARKET

In 2025, global primary ruthenium mine production is estimated at around 30 tonnes. The principal producing countries are South Africa, Russia and Zimbabwe, with other regions contributing very little supply.

EU TRADE

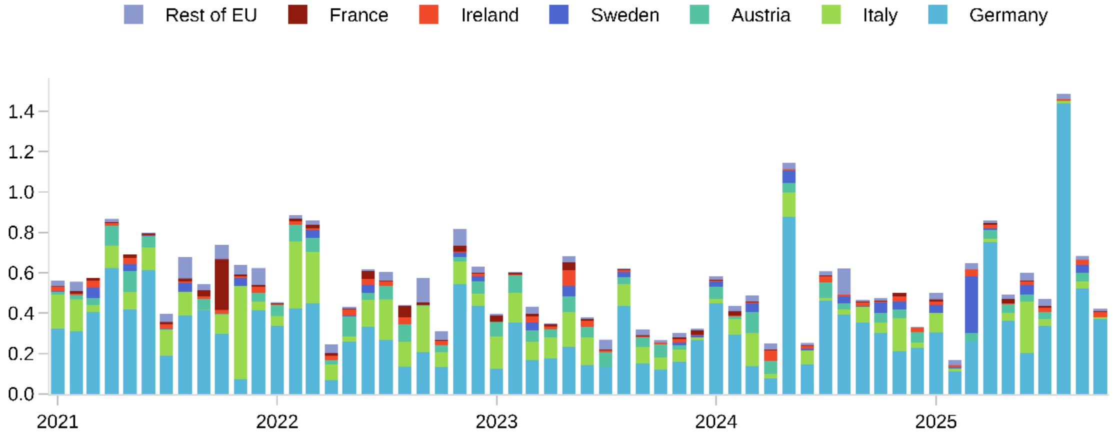
The EU imports and exports iridium and ruthenium in unwrought or powder-form (HS 711041) and semi manufactured form (HS 711049). South Africa, the UK and the US are the largest sources for EU imports of iridium and ruthenium, with Germany and Italy being the largest recipients.

Iridium & Ruthenium: Largest exporters into the EU market
tonnes



Source: Eurostat. NB trade data does not distinguish between iridium and ruthenium

Iridium & Ruthenium: Largest importers into the EU market
tonnes



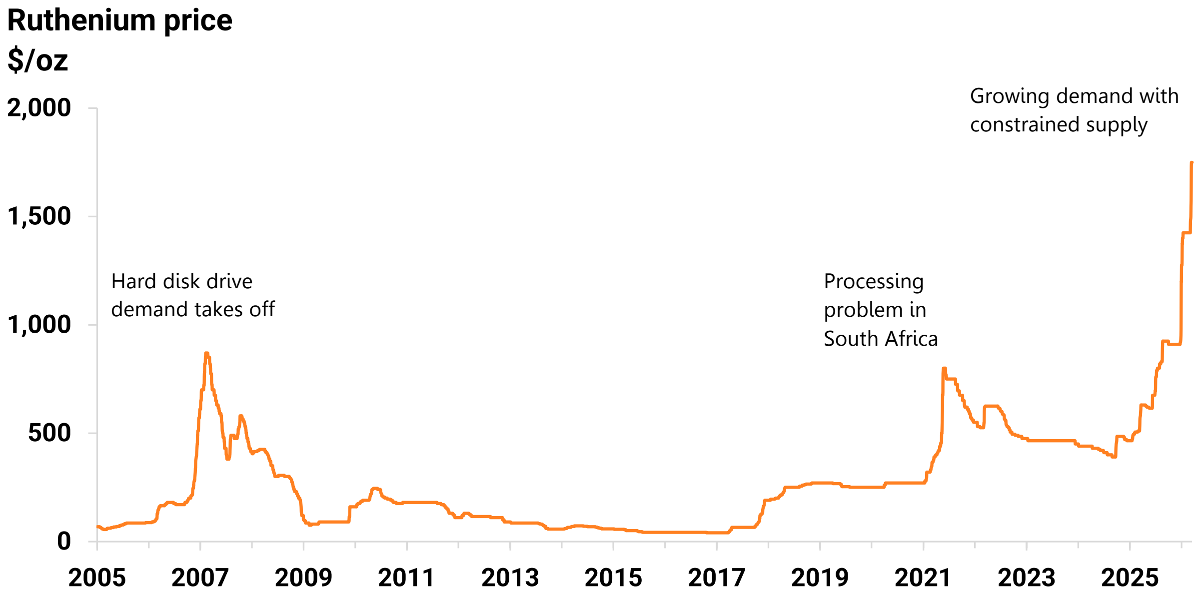
Source: Eurostat. NB trade data does not distinguish between iridium and ruthenium

EU IMPORT RELIANCE

With negligible primary supply or open-loop recycling in the EU, the region is reliant on imports of ruthenium to provide new metal for industrial uses.

PRICE & PRICE VOLATILITY

PGM prices are volatile with demand or supply shocks causing extremely sharp price movements.



Source: Bloomberg Finance LP

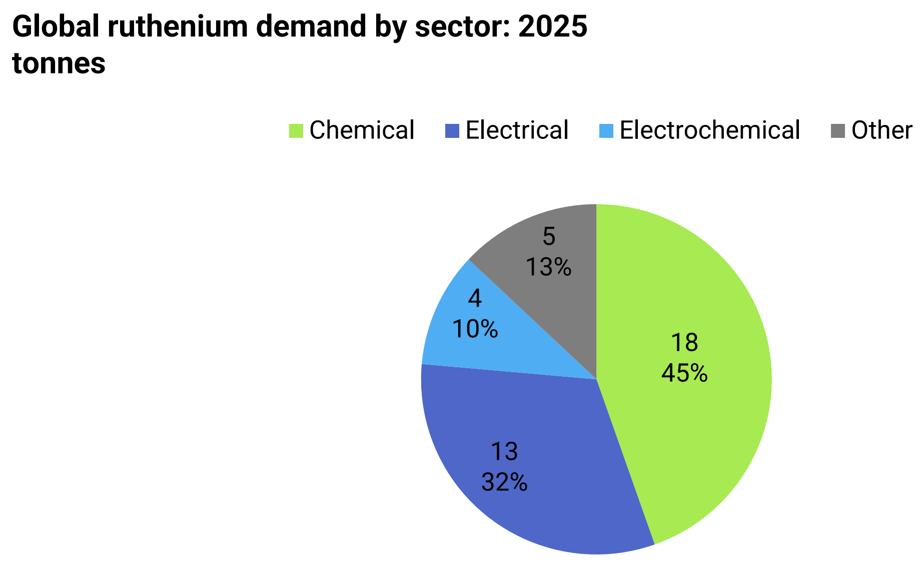
DEMAND OUTLOOK

GLOBAL AND EUROPE END-USES

Ruthenium and iridium share many properties and so are frequently used together. Their synergy can increase performance, especially the industrially important combination of activity plus durability, even at low metal loadings. This reduces the risk of substitution to other metals and technologies, so supporting demand despite high prices.

Ruthenium demand is well diversified across chemical, electrical and electrochemical sectors, each of which comprises a range of processes and products.

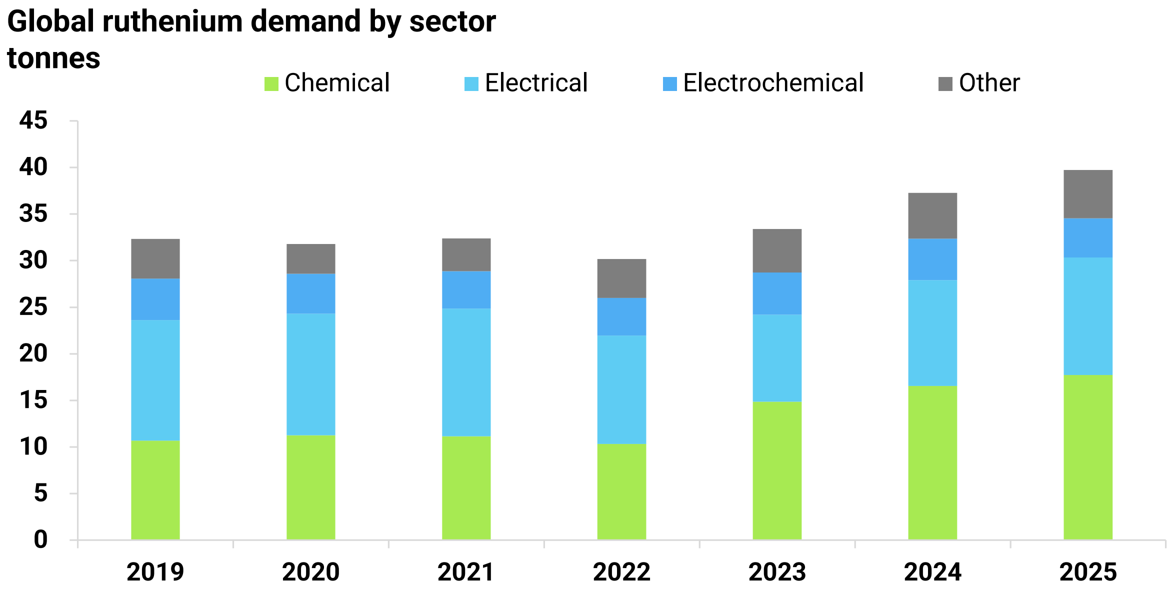
Its most high-profile end use currently may be in the electrical sector, where ruthenium-based technologies provide a cost-effective and reliable solution for data storage. Hard disk drive technologies are advancing, increasing the amount of data that can be stored per disk, supporting data centre growth. Ruthenium-based technologies though are expected to reach a capacity limit; alternative storage technologies, including heat-assisted magnetic recording (HAMR) which uses much lower amounts of ruthenium, are already in production, to deliver higher capacity drives.



Global ruthenium demand by sector: 2025
tonnes

Source: Johnson Matthey (January 2026); demand excluding closed loop recycling and reuse; "other" includes jewellery and automotive anti-glare mirror coatings

Global demand has increased by 7 tonnes by 2025 from 2019, with growth led by the chemical sector, while electrical and electrochemical demand have been essentially stable.



Global ruthenium demand by sector
tonnes

Source: Johnson Matthey (January 2026)

APPLICATIONS & SUBSTITUTION POTENTIAL

CHEMICAL

Current applications: Ruthenium is used as a chemical catalyst in several established and emerging processes. Applications include caprolactam production, acetic acid production, and catalytic wet air oxidation for industrial wastewater treatment. Ruthenium complexes are also key for asymmetric and transfer hydrogenation, as well as other homogeneous-catalysis applications. In the hydrogen value chain, ruthenium is also important in ammonia cracking. Ruthenium is a highly active catalyst for ammonia decomposition. For ammonia synthesis, while Ru-based catalysts are very effective, commercial plants still use far lower-cost iron-based catalysts.

Substitution potential: Ruthenium is valued for its ability to improve catalyst activity, selectivity, or operating conditions. For ammonia cracking, while cheaper Ni-based catalysts are commercially available, they normally require higher temperatures than Ru-based systems, increasing energy input costs and adding to the carbon footprint of the process and product. As iron remains the mainstream catalyst in ammonia synthesis, and multiple non-Ru catalyst families are already in use, it is clear that ruthenium catalysts face competition. So, ruthenium chemical demand can be substituted in processes where users can accept lower performance or can redesign around a different catalyst package.

ELECTRICAL

Current applications: Ruthenium's main electrical/electronic uses are in electrical contacts, wear-resistant coatings, and ruthenium-oxide resistor materials. Ruthenium is one of the most effective hardeners for platinum and palladium contact alloys, providing high wear resistance. In the electronics sector, ruthenium is used for chip components, hard disk drives, and electrical contacts. Ruthenium plays a significant role, albeit in relatively small quantities, in current hard disk drive technologies for data storage applications. Ruthenium oxide-based ceramic paste is used in resistor components for almost every chip device, hybrid integrated circuitry, and arrays. Ruthenium precursors are also used for chemical vapor deposition of ruthenium metal on a nm scale, where such films are used as interconnect materials in very small device architectures. Ruthenium is expected to play an increasing role as device miniaturisation continues.

Substitution potential: While ruthenium has significant performance advantages, especially hardness, wear resistance, and electrical reliability, many electrical applications already have viable alternatives. Contacts can also use gold-, palladium-, rhodium-, or platinum-based systems depending on the duty cycle and environment, and semiconductor metallization is a highly competitive space where ruthenium competes with incumbent or alternative materials and architectures. Ruthenium may face technology-driven substitution in hard disk drives, as alternative heat-assisted magnetic recording (HAMR) technology advances to deliver higher data storage capacities. The ruthenium content in these new media is expected to be lower than in the current technologies.

ELECTROCHEMICAL

Current applications: Ruthenium is widely used in electrochemical applications, especially as ruthenium oxide or mixed-metal-oxide (MMO) coatings on electrodes. The main uses include electrode coatings in the chloralkali process, electrocatalysts in gas diffusion electrodes, salt-water chlorination, and electrochemical ballast water treatment. Ruthenium is commonly used with iridium in electrolysis. Ruthenium oxide-based dimensionally stable anodes (DSAs) are widely recognised in chlorine evolution and chloralkali systems. Ruthenium is increasingly used with iridium in PEM water electrolysis electrocatalysts for hydrogen production; ruthenium confers higher activity while iridium confers higher durability, so a well-designed combination has the potential to be optimal for commercial electrolyser operation.

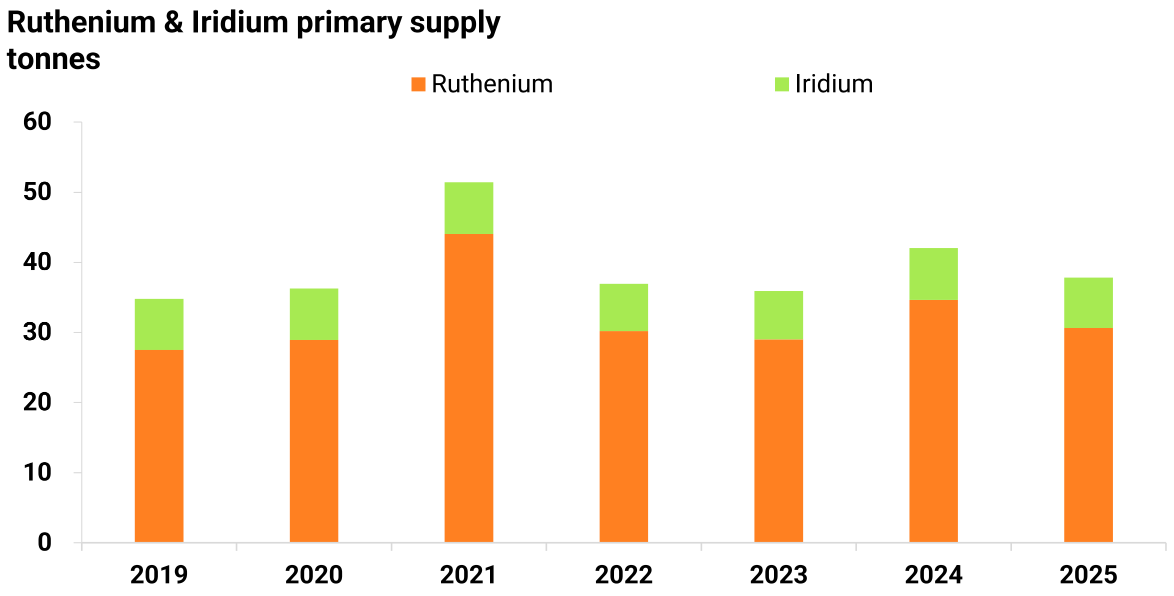
Substitution potential: In mature chloralkali and chlorine-evolution electrode systems, the substitution potential is relatively low as Ru-based MMO/DSA technology is deeply embedded in a capital-intensive process and is valued by process operators for its activity and corrosion resistance. In less demanding electrochemical systems, developers aim to thrift the PGM content wherever possible.

SUPPLY OUTLOOK

SUPPLY FROM PRIMARY MATERIALS

GLOBAL & EU MINE PRODUCTION

Ruthenium and iridium comprise the minor metals, and the primary supply is reported here as global totals, dominated by South African output. Refined ruthenium output has increased slightly to 31 tonnes in 2025, by about 3 tonnes from 2019, though as a by-product of major PGM mining, ruthenium output depends on the pricing and demand for the overall PGM basket.



Source: Johnson Matthey (January 2026)

Global PGM mine supply is concentrated among a relatively small group of major producers. In South Africa, most PGM mines operate at depths ranging from less than 500 metres to around 2.2 kilometres. PGM-bearing ores in the country typically contain between 2 and 6 grams of PGMs per tonne. Depending on ore grade, between 10 and 40 tonnes of ore may be required to produce one troy ounce (31.10 g) of platinum.

Mined ores contain only low concentrations of ruthenium, so several stages of processing are required after extraction to upgrade and purify the metal. Refining is carried out mainly in producing countries, which are also the main exporting countries.

Mining also takes place at the Norilsk-Talnakh operations in Russia and at several sites in Zimbabwe, Canada and the United States, but these operations contain much lower concentrations of ruthenium than in South African orebodies.

By contrast, PGM mining in Europe is very limited and essentially no primary ruthenium is produced.

PGM production facilities are extensive and complex, with many steps from approval to fully operational. Brownfield restarts and shallower mechanised decline projects with existing infrastructure typically take from 8-18 months, mechanised shallow greenfield projects can take 3-4 years, while large deep level vertical shafts can take around 6–8 years.

PROCESSING

Concentration is usually carried out at or near the mine site. The resulting concentrate is then sent either to a central processing facility for conversion into metal or to a refining plant. Since PGM concentrates are too low-grade to be refined directly, they must first undergo beneficiation. This generally takes place near the mine and typically includes both pyrometallurgical and hydrometallurgical processing.

Further smelting and refining may take place on-site or at facilities near the mine. The concentrate is then transferred to a precious metals refinery, where the individual PGMs are separated and purified through a series of hydrometallurgical steps. The PGM-bearing material is dissolved in hydrochloric acid, and the six PGMs are then refined to high purity through selective precipitation and other separation techniques, including solvent extraction, distillation and ion exchange. The final refined metals typically exceed 99.95% purity and may be produced as ingots, grains, or a fine powder known as sponge.

Once refined to sponge (or ingot), primary and secondary PGMs are indistinguishable and are traded and used as equivalents.

GEOLOGY, GLOBAL RESOURCES & RESERVES

GEOLOGY

PGMs are among the rarest elements on Earth, and ruthenium is one of the least abundant within this group. The combined abundance of PGMs, including platinum, palladium, osmium, iridium and ruthenium, is around 1.5 ppb in the upper continental crust and 3.7 ppb in the bulk continental crust. Ruthenium itself is estimated to occur at around 0.57 ppb in the Earth's crust and 0.34 ppb in the upper crust, underlining its geological rarity.

PGMs occur together in nature and are typically associated with nickel and copper. They are mainly found in base-metal sulphide minerals or in a wide range of PGM-bearing minerals, where they occur bonded to one another, to other metals in alloy form, or to elements such as sulphur, arsenic, antimony and tellurium. As a result, ruthenium is not mined as a standalone metal but is recovered together with the other PGMs from the same ore deposit, either as a by-product of platinum- or palladium-led operations or from nickel-copper sulphide deposits. Although ruthenium usually contributes only a small share of total revenue, it can still be economically important due to its high value and specialist applications.

Economically significant PGM enrichment occurs in only a limited range of geological settings. Mineable PGM deposits are geologically rare, and most PGM-bearing ores are very low grade. In the main commercial deposits in South Africa, Russia and Zimbabwe, ore grades typically range from 1 to 10 grams per tonne for combined PGMs and gold. Commercially significant PGM deposits are mainly hosted in mafic and ultramafic rocks, where PGMs have been concentrated through igneous processes.

Most global PGM resources and reserves are hosted in two main deposit classes: the PGM-dominant class and the nickel-copper sulphide class. In the PGM-dominant class, platinum is usually the principal economic product, with palladium and rhodium also contributing significantly. Ruthenium, by contrast, is generally a minor constituent by volume, but its supply is closely tied to the mineralogy and processing characteristics of these deposits.

Two PGM-dominant ore types account for most global production, the Merensky Reef type and the Chromitite reef type, both of which are best developed in South Africa's Bushveld Igneous Complex. The Merensky Reef consists of extensive, laterally continuous but thin mineralised layers within large layered mafic-ultramafic intrusions. Current mill-head grades are typically 4 to 7 ppm 6E, referring to the combined content of platinum, palladium, rhodium, ruthenium, iridium and gold, or 4 to 6 ppm 4E, covering platinum, palladium, rhodium and gold. Similar deposits are also mined in the Great Dyke in Zimbabwe.

The Chromitite Reef type has a similar geometry to the Merensky Reef, but consists of thin, continuous layers of chromite. Typical mined grades are in the range of 2.5 to 4 ppm 4E, with a platinum-to-palladium ratio of around 2:1 [IPA Industrial expert, 2019]. From a ruthenium perspective, these ores are especially important because they contain significantly higher proportions of ruthenium, as well as rhodium and iridium, than the Merensky Reef [Hagelüken, 2019]. The most important example is the UG2 Chromitite in the Bushveld Igneous Complex, which is the largest known repository of PGM resources in the world and a major source of ruthenium-bearing ore.

Ruthenium concentrations in PGM ores are significantly lower than those of platinum and palladium, which helps explain why supply remains limited. The most common ruthenium minerals are laurite ($(Ru,Ir)S_2$) and cuprorhodsite ($CuRh_2S_4$). Even where ruthenium is present, it is generally recovered only as part of a wider PGM refining circuit rather than through dedicated mining.

The nickel-copper sulphide class includes deposits in which PGMs are associated with sulphide ores, mainly pyrrhotite, chalcopyrite and pentlandite. These deposits are mined primarily for their nickel and copper content, but cobalt, gold, silver and PGMs can also make a significant contribution to value when present in economically recoverable quantities. In such deposits, ruthenium is again recovered only as a by-product.

The so-called minor PGMs, rhodium, ruthenium, iridium and osmium, are generally present in platinum-palladium ores only in very small amounts, rarely exceeding a few per cent of total PGM content. However, the proportion of ruthenium, along with iridium and rhodium, is much higher in UG2 ore than in the Merensky Reef and may exceed 20% [IPA Industrial expert, 2019]. As mining of UG2 has increased over recent decades, the potential availability of ruthenium has also expanded.

GLOBAL RESOURCES & RESERVES

World PGM resources are estimated at more than 100 million kilograms, with the largest reserves and resources located in South Africa’s Bushveld Complex [USGS Mineral Commodity Summaries, 2000–2025]. Although the Bushveld is best known for its platinum endowment, it is also of major importance for ruthenium, which occurs alongside the other platinum group metals and is recovered from the same mineralised systems.

South Africa is the world’s leading producer of platinum, accounting for around 70% to 80% of global output, and it is also central to global supply of the minor PGMs, including ruthenium. The country’s largest PGM ore deposits are found in the Bushveld Complex, a vast igneous formation containing two principal PGE-rich layers, the Merensky Reef and the UG2 Chromitite Reef.

The Merensky Reef consists of extensive layered mafic to ultramafic intrusions containing platinum, palladium, rhodium and other PGEs. These deposits are characterised by a thin mineralised layer of platinum-rich sulphide ores within the broader layered intrusion. Current mill-head grades are typically 4 to 7 ppm 6E, referring to the combined content of platinum, palladium, rhodium, ruthenium, iridium and gold, or 4 to 6 ppm 4E, which includes platinum, palladium, rhodium and gold. At the largest operating mines, the platinum-to-palladium ratio generally ranges from 2.0:1 to 2.5:1. Although the Merensky Reef is a major source of PGMs overall, it is less important for ruthenium than the UG2 reef.

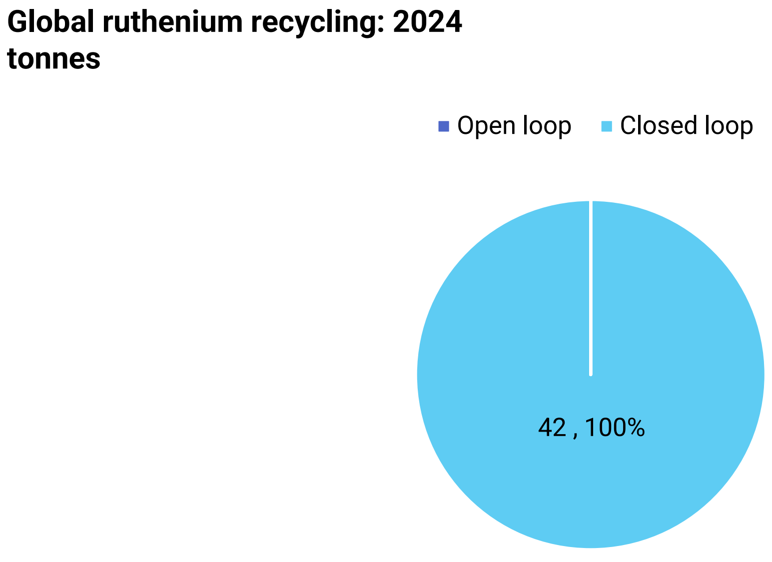
The Chromitite reef type has a similar geological form to the Merensky Reef, but consists of thin, continuous layers of chromite. Typical mined grades are in the range of 2.5 to 4 ppm 4E, with a platinum-to-palladium ratio of around 2:1. Its particular significance lies in its substantially higher content of rhodium, ruthenium and iridium compared with the Merensky Reef. For this reason, the UG2 Chromitite is one of the most important sources of ruthenium-bearing ore in the world.

The UG2 Chromitite of the Bushveld Igneous Complex is the largest known repository of PGM resources globally and contains more than 75% of known platinum resources. Its significance, however, extends beyond platinum alone. Since ruthenium is produced almost entirely as a by-product of PGM mining and refining, its availability depends heavily on production from Bushveld ores, particularly UG2. The Bushveld Complex is therefore not only the foundation of global platinum supply, but also a critical pillar of global ruthenium availability.

SUPPLY FROM SECONDARY MATERIALS/PRODUCTION

RECYCLING

Closed-loop recycling volumes have not been very visible historically. In its 2024 Circularity Whitepaper, Johnson Matthey has provided estimates for the total (open + closed-loop) global recycling volumes, shown below. In its 2026 Whitepaper, Heraeus Precious Metals shows similar results. Most ruthenium recycled volumes arise from closed-loop systems, where the original owner retains metal ownership, rather than in open-loop markets, recognising the importance of retaining control of a metal with such a low primary supply. Open-loop recycling is not yet well developed, as the ruthenium content is often very low in final products and recovery processes have not been developed, given the economics of dealing with small amounts of metal despite its value.



Source: Johnson Matthey (January 2026)

The PGMs are highly recyclable from a technical perspective. The recycling processes implemented vary depending on the material or combination of materials being processed, the contaminants to be removed, and the specific PGM mixture to be separated.

To separate and purify ruthenium from spent catalysts, the raw material must first be prepared to remove other materials from the spent industrial catalyst. PGM recovery is most often achieved through hydrometallurgical processing, via leaching steps in acidic or alkaline solutions in the presence of strong oxidants. Finally, individual PGMs are purified using chemical processes, including precipitation, dissolution, extraction, distillation, ion exchange, electrolysis, pyrolysis, or reduction. Each process step may need to be repeated to achieve the required purity.

OTHER CONSIDERATIONS

HEALTH AND SAFETY ISSUES

Ruthenium metal and simple insoluble ruthenium compounds do not have any health hazard classifications. Some soluble ruthenium compounds are acidic and can be corrosive to skin and eyes, and some complex ruthenium compounds have shown skin sensitisation potential in regulatory toxicity testing. Metal powders have low acute toxicity, but can cause mechanical irritation of the respiratory tract.

Ruthenium tetroxide is much more toxic and requires strict occupational hygiene controls to prevent exposure, but it exists in only very small quantities. Ruthenium (IV) oxide is much more common and is non-hazardous (it is not classified for any health hazards under the EU CLP Regulation).

The International Platinum Group Metals Association (IPA) has developed comprehensive guidance on the safe use of PGMs in the workplace. This guidance is used by PGM producers and downstream users to design and continually improve occupational health and safety programmes, helping to ensure that the benefits of PGM-containing technologies are delivered while protecting workers along the supply chain. *Source:* IPA

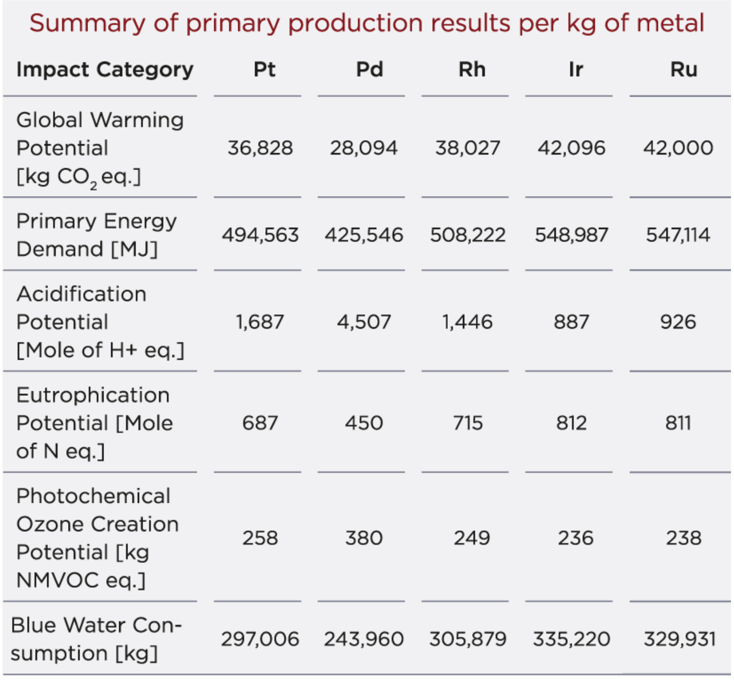
ENVIRONMENTAL ISSUES

Ruthenium exhibits complex speciation and, in certain soluble forms and at sufficiently high concentrations, can be very toxic to aquatic organisms, which is why industrial ruthenium compounds are handled under strict environmental and wastewater controls. Documented environmental concerns mainly relate to specific nuclear-release events rather than to widespread, chronic ruthenium pollution.

The IPA routinely conducts Life Cycle Assessments of the PGMs to assess the potential environmental impacts of their production and makes the results for key impact categories available at its website.

In 2025, the IPA has published a CO_2 scenario for primary production in 2030, based on investments by South African producers and the South African government into renewable energy, which shows a potential decrease in the CO_2 footprint of mining of between 35% and 61%, depending on the metal (Bossi/Gediga, Decarbonisation in the Mining of Platinum Group Metals – A CO2 Outlook to 2030 | Johnson Matthey Technology Review).

The results for the key impact categories of the primary production of PGMs, as assessed in IPA's last LCA on production year 2022, can be found below:



Summary of primary production results per kg of metal

Impact Category	Pt	Pd	Rh	Ir	Ru
Global Warming Potential [kg CO_2 eq.]	36,828	28,094	38,027	42,096	42,000
Primary Energy Demand [MJ]	494,563	425,546	508,222	548,987	547,114
Acidification Potential [Mole of H+ eq.]	1,687	4,507	1,446	887	926
Eutrophication Potential [Mole of N eq.]	687	450	715	812	811
Photochemical Ozone Creation Potential [kg NMVOC eq.]	258	380	249	236	238
Blue Water Consumption [kg]	297,006	243,960	305,879	335,220	329,931

Sources: Johnson Matthey: and IPA

For the secondary production route (recycling), the IPA has published values for Pt, Pd, and Rh, but could not publish data on recycled ruthenium due to limited availability of data (at least three reporting companies would be needed for confidentiality reasons).

The environmental footprint of primary ruthenium production remains material, but intensity metrics have improved over time through operational efficiency gains, increased secondary supply from recycling, and the progressive adoption of recognised responsible mining frameworks. Leading PGM producers are implementing structured water and energy management systems, enhanced tailings governance in line with the Global Industry Standard on Tailings Management (GISTM), and biodiversity programmes. These efforts are increasingly aligned with frameworks such as the IRMA Standard for Responsible Mining, ICMM Performance Expectations, ISO 14001 environmental management systems, and climate disclosure and target-setting initiatives including TCFD and the Science Based Targets initiative (SBTi).

NORMATIVE REQUIREMENTS

Normative requirements include REACH compliance (EC 1907/2006) for handling, strict particulate ventilation, personal protective equipment (PPE), and waste disposal in accordance with local environmental regulations. Safety Data Sheets must be provided with materials.

At the sector level, the International Platinum Group Metals Association (IPA) has developed comprehensive guidance on the safe use of PGMs in the workplace, including recommendations on exposure monitoring, medical surveillance and best practices for controlling occupational exposures to certain soluble PGM compounds that can cause respiratory sensitisation. This guidance is used by PGM producers and downstream users to design and continually improve occupational health and safety programmes, helping to ensure that the benefits of palladium-containing technologies are delivered while protecting workers along the supply chain.

Source: IPA

SOCIOECONOMIC AND ETHICAL ISSUES

The extraction and refining of platinum group metals (PGMs) can place significant pressures on local environments; however, the environmental and social impacts of PGM extraction are taken seriously by industry and have been the focus of substantial improvements in recent years, particularly in water stewardship, air emissions control and waste management. Water remains a critical input to flotation and processing, but major PGM mines in South Africa and elsewhere now operate closed-loop systems that recycle a large share of process water, supported by site-specific water balances and dedicated treatment plants that repurpose mine water for cooling and other uses. Recent case studies from deep-level PGM operations in Limpopo show that membrane-based treatment and reuse can replace a significant portion of potable “board” water, delivering both cost savings and reduced pressure on local water resources, in line with IRMA’s detailed requirements for water management. South Africa continues to face structural water stress in some areas, with renewable water resources of around 800–900 m^3 per person per year, but national water use efficiency and mine water management programmes, together with company-level integrated water and waste management plans, are designed to ensure that mining does not crowd out essential domestic and agricultural uses.

Sources: PGM mining and processing in the circular economy: A framework towards circularity (J. Kruger, 2022) and UN

Tailings and waste rock are an inherent byproduct of all hard rock mining, but in the PGM sector, they are managed as engineered storage facilities rather than unmanaged “waste dumps”, with design, monitoring and closure governed by international standards such as the Global Industry Standard on Tailings Management and, increasingly, IRMA requirements. Leading PGM producers report full conformance with these standards for high-consequence facilities and are investing in tailings re-treatment, re-vegetation, and long-term stability measures to reduce legacy impacts and recover additional metal value. Through the IPA, member companies have committed and continue to align their operations with recognised responsible mining and sourcing frameworks, including IRMA and other sustainability assurance schemes (such as the forthcoming Consolidated Mining Standard Initiative – CMSI), demonstrating measurable progress over time and helping ensure that PGM production supports local development while minimising environmental impacts.

PGM mining companies operate under comprehensive mining legislation, environmental regulation, and binding social and labour obligations. Mining companies adhere to rigorous sustainability reporting, environmental permitting and labour compliance requirements.

All IPA PGM mining companies are publicly listed (LSE, JSE, NSE) companies which routinely report about their environmental, social and governance performance and abide by the regulations set out by national/local authorities and the respective stock exchanges.

IPA members apply sustainability reporting principles to ensure organizations communicate and demonstrate accountability for their environmental, economic, and social impacts, in line with global best practices such as the UN Sustainable Development Goals (UN SDGs), the Global Reporting Initiative (GRI), and the UN Global Compact.
Source: IPA

ECONOMIC IMPORTANCE OF RUTHENIUM FOR EXPORTING COUNTRIES

Ruthenium and the PGM industry are economically significant for South Africa and, to a far lesser extent, for Zimbabwe and Russia. In South Africa, platinum group metals are a major mining industry, a source of export earnings, industrial employment and fiscal revenue, and an anchor for local refining and fabrication capabilities.

PGM mines in South Africa and Zimbabwe are not government-owned but are owned by publicly listed companies and their shareholders.

For producers and their downstream customers, the government policies, infrastructure performance and macroeconomic conditions in the countries where they mine can significantly affect supply. Such issues may cause short-term disruptions, while, of course, the fundamental geology determines the long-term potential of a mine region.

RESEARCH AND DEVELOPMENT TRENDS

Ruthenium and all the PGMs continue to feature in R&D projects, from the highly academic to those close to market.

A new collaboration was launched in February 2026 to develop high-impact PGM technologies and drive the next wave of industrial innovation. This recognises that currently, some 60% of global PGM supply is used in autocatalysts; in the long term, this is threatened by the increasing share of battery-electric vehicles. Johnson Matthey, Sibanye-Stillwater, and Valterra Platinum launched the programme to explore and scale technologies that leverage the exceptional performance and durability of PGMs, as well as their robust, circular supply chains. Expected to expand with additional partners in the coming months, the collaboration will explore uses across multiple sectors, including clean hydrogen, enhanced emissions detection and reduction across stationary and mobile sources, new electronic materials, and high-performance alloys and other advanced materials.

APPENDIX: RELEVANT HS/CN CODES

RUTHENIUM METAL, SEMI-MANUFACTURED AND SCRAP

Level	Code	Description
7110	71104100	Iridium, osmium and ruthenium — unwrought or in powder form. Covers ruthenium bars, ingots, sponge, granules and powder. Ruthenium shares this 6-digit code with iridium and osmium; no dedicated WCO subheading exists for ruthenium alone.
	71104900	Iridium, osmium and ruthenium — other semi-manufactured forms. Includes ruthenium sputtering targets (semiconductors/data storage), pellets for CVD, wire, foil and sheet. At the US HTS 10-digit level, 7110.49.00.10 separates iridium specifically; ruthenium falls under 7110.49.00.50 ("Other").
7112	7112.30	Ash containing precious metal or precious metal compounds — principally for recovery. Covers ruthenium-bearing furnace ash, sweepings and spent catalyst fines.
	7112.92	Waste and scrap of platinum-group metals. Standard WCO 6-digit code for PGM scrap; ruthenium scrap (e.g. spent electrodes, worn sputtering targets) is typically declared here where no dedicated national sub-split exists.
	7112.99	Other precious metal waste and scrap not elsewhere specified. Used for mixed or unspecified PGM scrap containing ruthenium when not classifiable to a specific single-metal line.

RUTHENIUM COMPOUNDS (SALTS ETC)

Level	Code	Description
2843	2843.10	Colloidal precious metals. WCO notes to heading 2843 explicitly list ruthenium as one of the precious metals covered in colloidal suspension form. Covers colloidal ruthenium used in catalysis and coatings.
	2843.90	Other inorganic or organic compounds of precious metals; amalgams. Primary code for all ruthenium salts and chemical intermediates — ruthenium(III) chloride ($RuCl_3$), ruthenium(IV) oxide (RuO_2), ruthenium nitrosyl nitrate, ruthenium acetylacetonate ($Ru(acac)_3$), ruthenium tetroxide (RuO_4) and organometallic ruthenium complexes (e.g. Grubbs catalyst precursors). No dedicated ruthenium sub-split exists at WCO 6-digit level.

RUTHENIUM REAGENT SOLUTIONS AND KITS

Level	Code	Description (short)
3815	3815.12	Supported precious metal catalysts where the active substance is a precious metal or compound. Covers ruthenium-on-carbon (Ru/C), Ru/Al_2O_3 and other heterogeneous ruthenium catalytic preparations widely used in hydrogenation, ammonia synthesis and metathesis reactions.
	3815.90	Other reaction initiators and accelerators not elsewhere specified. Used for homogeneous ruthenium catalyst systems (e.g. Grubbs

		catalysts in solution form, Ru-bipyridyl complexes) where 3815.12 does not apply.
	3822.19	Prepared diagnostic or laboratory reagents (other), including kits. Standard code for ruthenium ICP/AAS standard solutions and analytical reagent preparations without certified reference material status.
	3822.90	Certified reference materials. Covers ruthenium single-element CRM standards (e.g. 1,000 mg/L Ru in HCl). Plain ruthenium chloride solutions without CRM certification remain under 2843.90.

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DEFINITIONS & METHODOLOGY FOR DATA

The demand, primary, and secondary data used to create charts and quoted in the text are based on Johnson Matthey's PGM Market Report dataset (most recent edition: May 2025) and have been updated with estimates to reflect the situation as of December 2025.

Primary supply

Supply figures represent producers' sales of primary PGM and are allocated to the region where mining took place, rather than to the region of subsequent processing.

Secondary supply

Secondary supply is the quantity of metal recovered from open-loop recycling (i.e. where the original purchaser does not retain ownership of the PGM).

Outside the automotive, jewellery and electronics markets, open-loop recycling is negligible.

Automotive recycling represents the weight of metal recovered from end-of-life vehicles and aftermarket scrap. It does not include warranty or production scrap.

Demand

Demand figures for any given application represent the sum of industry demand for new metal in that application, net of any closed-loop recycling (i.e. where industry participants retain ownership of the metal: an example would be recycling of spent chemical catalysts, where the metal is retained to be used on fresh catalyst that replaces the spent charge).

Automotive demand is allocated to the region where the vehicle is manufactured and is accounted for at the time of vehicle production. It includes emissions catalysts on vehicles, motorcycles and three-wheelers, as well as fuel cell vehicles. Non-road mobile machinery is counted as industrial demand, in the pollution control category.

Jewellery demand is allocated to the region where the finished jewellery is manufactured, not to the region where it is sold.

Regional definitions

Europe: EU+ (includes UK and Turkey but excludes Russia)

Open-loop recycling

When the original purchaser of the metal does not retain control over the PGM, the metal is available to the market again once recovered. The main source of open-loop metal is automotive catalytic converters, which are widely recovered from scrapped vehicles and recycled to recover the contained platinum, palladium or rhodium contained. Some metal is also recovered from the jewellery and electronics markets.

Closed-loop recycling

Refers to the situation where the metal remains within the application, e.g., when metal is recovered from used chemical catalysts and is used to produce fresh catalysts to replace the spent charge. While this metal is processed by PGM refiners, the equivalent amount of metal is usually returned to the original owner, who retains the metal value. As the net amount of metal in use has not changed, this returned metal is not counted towards market supply. Re-using metal in such way avoids the need for virgin mined metal, thereby contributing to make demand more sustainable.