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Platinum Group Metal Supply Chains: Mature and Global

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Introduction

This paper seeks to increase understanding of the nature of platinum group metal (PGM) supply chains and recycling networks to ensure that:

- There are no unintended consequences to PGM supply chains from regulations primarily aimed at battery metals and other critical materials.
- Policymaking is tailored to capitalise on existing PGM supply chains and recycling infrastructure to support the future uses of these metals.

It provides a broad overview of how global PGM supply chains and trade function today.

It also highlights six takeaways for policy makers (page 9), with recommended measures to optimise the functioning of PGM supply chains, avoid unnecessary risks, enhance circularity, and support existing standards in responsible sourcing.

PGMs as critical materials

Increasing focus on the energy transition, energy security, and supply chain risk is leading many countries and the EU to develop and maintain lists of 'critical' or 'strategic' raw materials[1]. Some or all the PGMs are usually included in such lists, due to their use in automotive catalytic converters, aerospace and defence, and because of their numerous energy transition applications.

However, the PGMs do not face the same challenges that are seen in other critical materials, notably the battery metals and rare-earth elements (REEs) – a fact that may be obscured by the inclusion of PGMs in such lists. Policy in the West that is primarily targeted at battery metals and REEs focuses on building up domestic supply chain capability and diversifying away from China. Neither of those is applicable to PGMs.

In contrast to these two classes of materials, China plays no significant role in global PGM supply or processing. Nor is recycling a challenge, being a long-established practice for PGMs and already undertaken at high rates. And, perhaps most importantly, the supply-demand situation is completely different: clean energy applications for the PGMs will largely come in as replacement demand for current markets, so existing supply levels and supply chains can accommodate most of this new demand and are not expected to be stressed. In fact, as catalytic converter demand will decline, new markets for the PGMs are eagerly sought by established PGM suppliers and refiners[2].

"PGMs do not face the challenges seen in other critical materials"

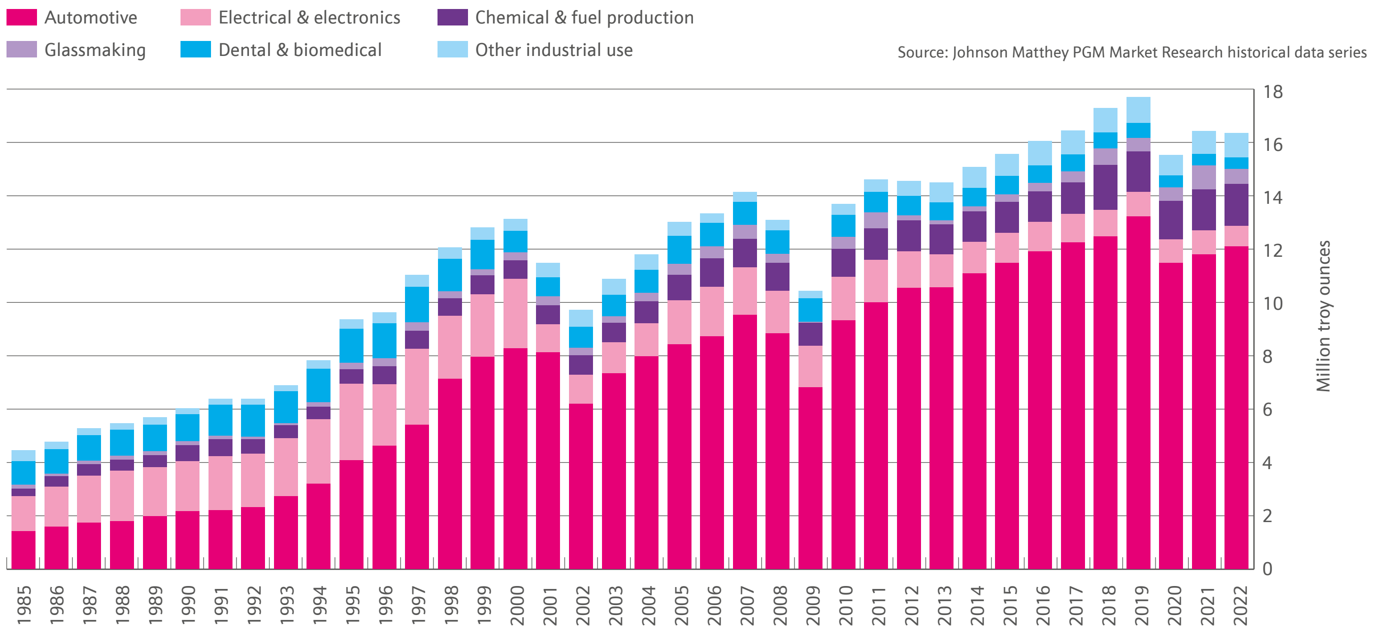

Figure 1 Global consumption of platinum, palladium, and rhodium as industrial metals since 1985, net of closed-loop recycling

Well-established PGM supply chains

The PGMs have been in widespread industrial use for decades. Johnson Matthey's PGM market data series goes back to 1975, when automotive use of these metals in catalytic converters was beginning to ramp up, but the beginnings of large-scale use of PGMs in electronics, chemicals production, and petroleum refining date back to the mid-20th century.

PGM supply chains have matured over the past fifty years and more to serve the global use of these metals. These supply chains are concentrated in the West and Japan because the earliest regional markets for the PGMs were Europe, North America, and Japan. China was later to emerge as an industrial user of PGMs (it developed initially as a jewellery market) and has established its own, highly regionalised supply chains, but it remains reliant on imports of PGM.

Recycling was undertaken from an early stage of industrialisation and is now well-established as a routine, value-driven practice[3]. This means that PGM recycling infrastructure is also mature in the West and Japan. China is a closed recycling market, in that PGM-containing spent material arising in China must be recycled in China, and therefore its recycling capability is geared to serving its domestic requirement.

As this illustrates, in some cases trade and export barriers exist that restrict PGM movements and are important to consider for countries such as China, India and Russia. However, for the rest of the world, the salient feature of PGM supply and recycling chains is their global nature: regular cross-border movements of PGM ingot, sponge (powder), product, and end-of-life material are an important part of the functioning of PGM supply chains. As a result, metal that is first sold in a particular region is not necessarily used, recovered, processed, or resold in that same region, and metal can quite often be located in a different region from its owner.

This characteristic has arisen due to the technical and commercial complexity of using and recycling these metals, which has led to several large companies that specialise in PGMs and serve a global market from centralised locations. Of course, there is still scope for SMEs to fulfil specialist functions within PGM supply chains, but these often will work in partnership with the larger PGM companies to supply end-to-end solutions.

As a result, the PGM market functions far more optimally and cost-effectively than it would if numerous individual companies were to undertake all the specific functions that are needed to serve the industrial use of these metals within each domestic or regional market.

"PGM recycling infrastructure is mature in the West and Japan"

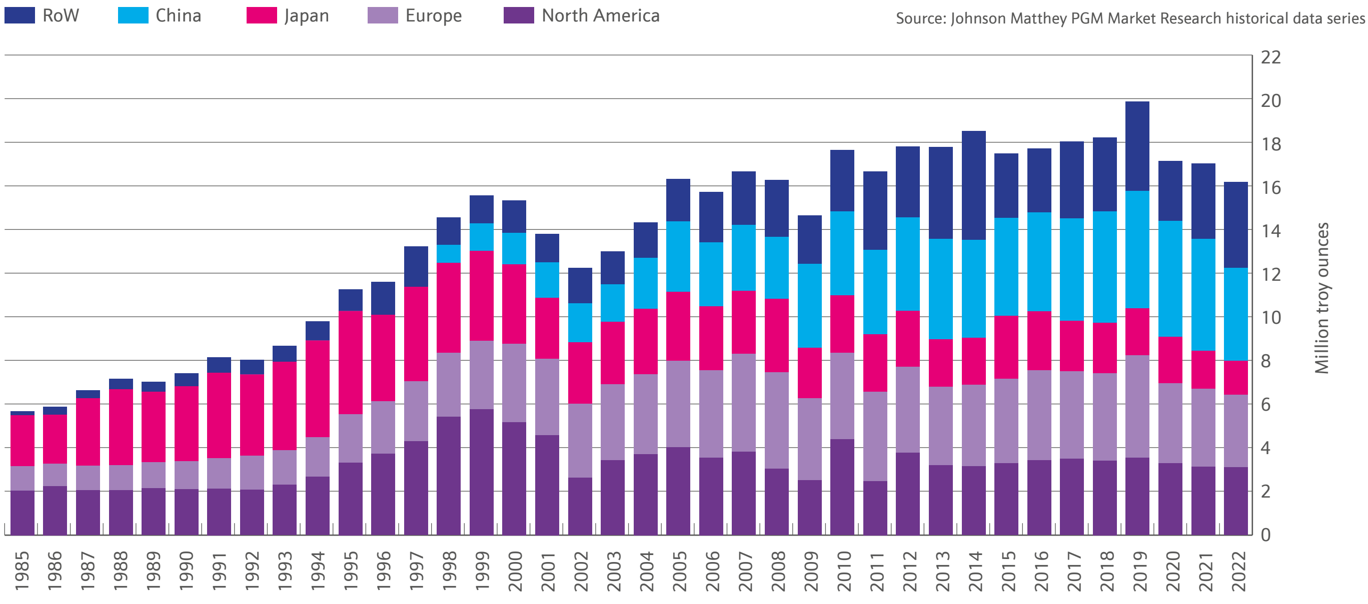

Figure 2 Regional consumption of platinum and palladium since 1985, inclusive of jewellery and net of closed-loop recycling

PGM trade facilitation today

Figure 3 Good-delivery palladium plates

Figure 4 Rhodium sponge

As well as being useful industrial metals, the PGMs are valuable commodities. Consideration must be given to security of storage and shipment, and financing arrangements.

Responsible sourcing and procuring the correct form of metal are further important considerations. An industrial purchaser will typically require 'raw' PGM to be in the form of sponge – which is a powdered form of the metal that is more easily used in chemical or metallurgical processes – while metal bought for the purposes of investment will usually be supplied as ingot or plate. Either way, metal must be in the appropriate form and verified to meet the applicable quality and responsible sourcing standards.

The PGM industry has established processes to support the users of these metals with these requirements.

Accreditation and responsible sourcing

To facilitate trading, the London Platinum and Palladium Market (LPPM) maintains lists of refiners, fabricators, producers, and assayers that are accredited as suppliers of 'good delivery' platinum or palladium plate or ingot, which must conform to certain specifications, with audits every three years.

Similarly, the LPPM maintains lists of refiners who are accredited suppliers of sponge that meets certain specifications, known as accredited or 'good delivery' sponge. This applies only to platinum, palladium and rhodium, because ruthenium and iridium are not traded at sufficient scale to merit inclusion.

All refiners accredited as suppliers of 'good delivery' plate,ingot or sponge must also conform to the LPPM Responsible Sourcing Guidance, which is subject to continual revision and improvement. This audited programme provides assurance that 'good delivery' metal is conflict-free and is aligned with OECD guidance on responsible sourcing.

Platinum and palladium refiners have been required to comply with this guidance since 2019. As rhodium, ruthenium and iridium are only ever mined in association with platinum and palladium and they are almost always refined in the same facilities, this guidance in effect applies to refiners of these minor PGMs too.

The trading hubs

Rather than PGMs moving directly between seller and buyer as consumer goods would, a substantial proportion of global trade takes place via certain liquidity centres or hubs, which also act as storage and verification locations for the market.

Only verified 'good delivery' or accredited metal can be traded through the trading hubs. 'Good delivery' metal is fully fungible[4] and considered good currency when moving metal from account to account. This is a system that industry players in the West use frequently, minimising the need for physical metal shipments.

The hubs allow for location or 'loco' swaps of metal as electronic transfers between them (except the Shanghai hub, which exclusively serves the Chinese market). They also enable form swaps, where ingot can be exchanged for sponge, or the reverse.

This functionality supports industrial users of PGMs who may buy ingot but require sponge; form swaps are an arbitrage-based instrument, so premiums or discounts would apply depending on the availability of one form over the other. This only applies to platinum and palladium; the minor metals (rhodium, ruthenium, and iridium) are only ever traded in sponge form, and no form swaps are possible.

The hubs also play an important role in enabling PGM recycling. The various global PGM refiners have different capabilities and typically target different types of scrap, optimising global PGM processing. PGM refiners need the hubs to facilitate refined metal sales or transfer back to customers to pay off leases, etc. Four of the largest global PGM refiners are European companies (three headquartered in the EU and one – Johnson Matthey – in the UK) but they also have refineries outside of Europe and rely on the hubs to move metal between their operations and to/from their customers, who are typically located all over the world.

There are four main hubs for global trade in good delivery metal, which are known as the clearing locations: one in Switzerland, one in the USA, and two in the UK. (As stated, a separate hub exists to serve the Chinese market).

Sponge hubs: UK and USA

Two locations with the ability to store, clear or trade 'good delivery' sponge are located at (1) Johnson Matthey Valley Forge in the USA and (2) Johnson Matthey Royston in the UK. As the use of PGMs in catalytic converters took off in the 1970s, JM became established as a global depository for PGMs, a role it still fulfils as a trusted name in the industry.

The sponge clearing locations are a key facilitator of global use of the PGMs as industrial metals, offering users significant convenience with relatively low fees.

"There are four main hubs for global trade in good-delivery metal"

Ingot hubs: UK and Switzerland

The ability to store physical ingot in vaults and have the metal cleared or moved to other trading counterparts is concentrated in (1) Zurich and (2) London, with the functionality provided by various banks.

Ingots that have been certified to meet LPPM good delivery standards may be delivered into bank depositories at the London or Zurich ingot hubs for trading purposes, instead of being used in industrial applications. The good delivery metal held in Western vaults is interchangeable and can move around from location to location to satisfy contractual obligations without ever being used for a manufactured product.

Terminal markets

A terminal market is a commodity exchange that facilitates trade and allows suppliers and buyers of the commodity to hedge their price risk using market makers (such as banks and trade houses who also face consumers, investors, and speculators); i.e., there is always price discovery.

Of the PGMs, only platinum and palladium have designated status as commodities that are tradeable through a terminal market. The London Metal Exchange (LME) and London Bullion Markets Association (LBMA) Auctions are the main industry benchmarks for nearly all platinum and palladium refiners and traders, and the terminal market for delivery is London (the same applies to silver and gold, and for base metals on the LME). Terminal markets do not exist for the minor PGMs (rhodium, ruthenium, and iridium) which makes trade in these metals less liquid, with potentially greater price volatility.

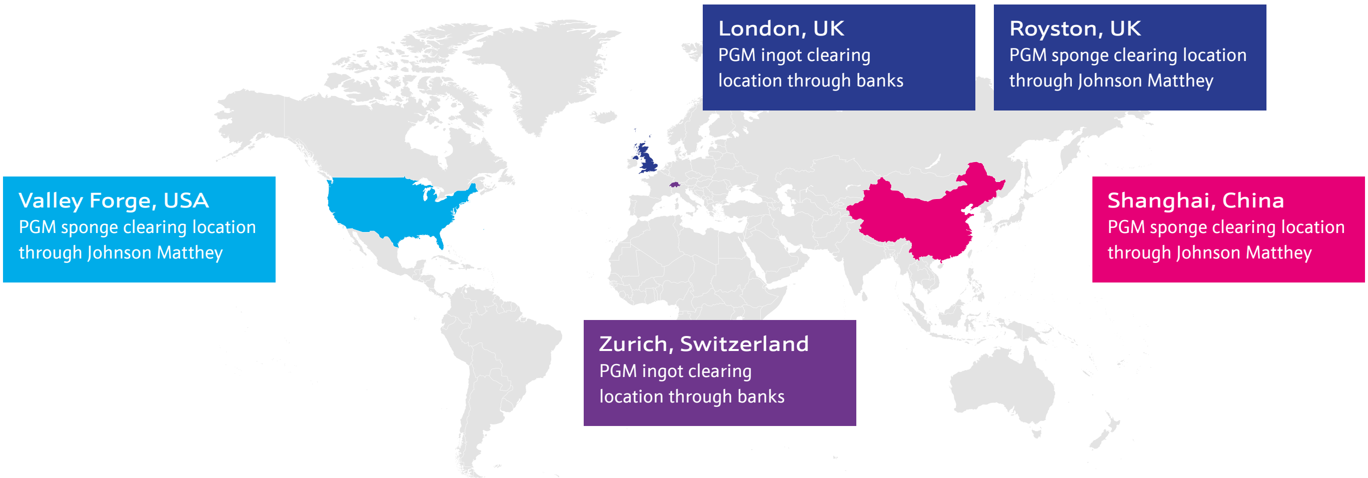

Figure 6 PGM liquidity centres or hubs facilitate global trade in PGMs

Global PGM trade flows

Trade in PGMs is difficult to track accurately. PGMs move across borders in a vast range of different parts and products and the metals may not appear explicitly in trade data. For example, automotive emissions control catalysts containing PGM may be produced in one region, shipped to another region for canning, then to another for fitment onto new vehicles, and then these vehicles can be exported to yet another region for sale; none of this will be captured as an obvious PGM movement in trade data.

In addition, determining location of ownership is not straightforward. Metal held on account at a hub is usually 'unallocated' (see box). As stated, ownership can transfer in a seamless electronic process without any metal physically moving between owners in different locations. Metal is also often leased rather than sold outright; for example, an original equipment manufacturer (OEM) may borrow metal from a bank to cover work-in-progress.

It is, in fact, normal within the PGM industry for the physical location of metal to be a different region or country from the owner, greatly complicating any determination of domestic 'self-sufficiency' in PGMs. The refiners and fabricators frequently process metal on behalf of their customers and do not own the metal themselves during this process. This also means that imports are not always undertaken by the owner of the metal – particularly for recycling, which is often performed as a service by the secondary refiner on behalf of the metal owner (referred to as toll-refining).

Unallocated vs allocated metal

If metal is unallocated this means that a particular lot of physical metal is not specifically assigned to a particular owner, since good-delivery metal is interchangeable. Instead, account holders have a claim on the pool of physical metal. This is like account holders at a bank having a claim to money held by the bank without specific banknotes or coins being allocated to them. In those instances where metal accounts specify that metal will be held on an 'allocated' basis, this is akin to having a safety deposit box at a bank with specific quantities segregated and labelled as belonging to that account holder.

"The industrial use of PGMs relies on multiple cross-border movements"

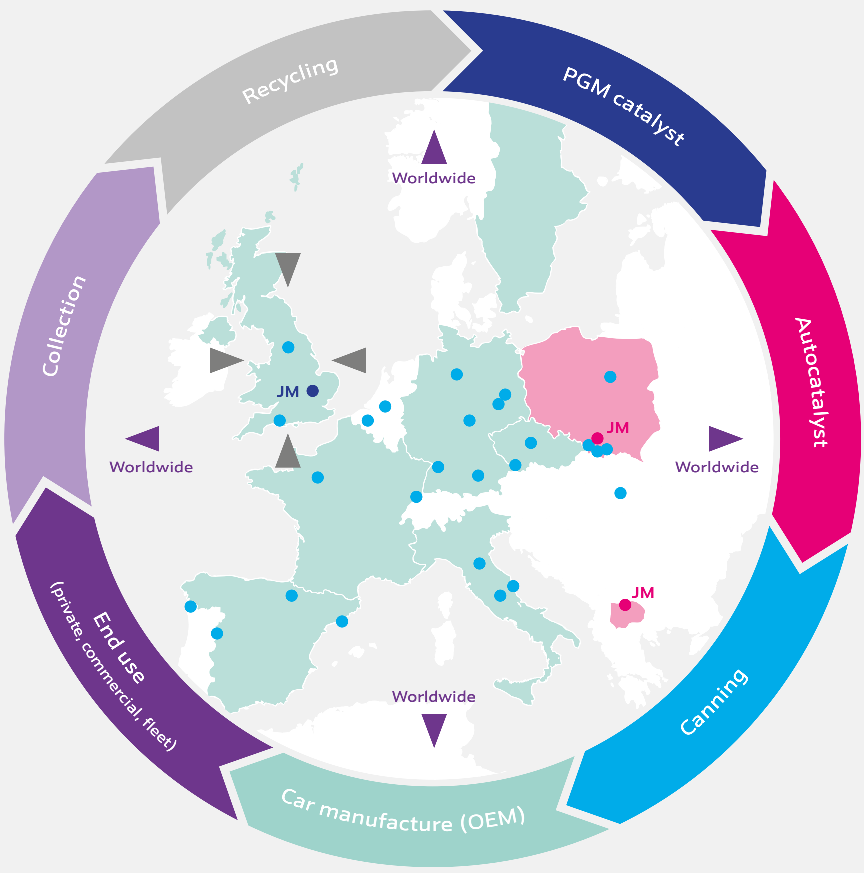

Figure 7 The industrial use of the PGMs relies on cross-border movements of metals in various forms, often multiple times in the end-to-end supply chain. This is exemplified by Johnson Matthey's European operations. Its PGM refinery in the UK supplies PGM catalyst for production of autocatalysts at two locations in Europe, from where they are shipped to various other locations for canning before being fitted to vehicles, which are then sold worldwide. At the end of their lives, PGM from scrapped catalytic converters comes from all over the world to be recycled and refined at JM's UK facility, before being reused on new catalytic converters or in other applications, or sold to the market.

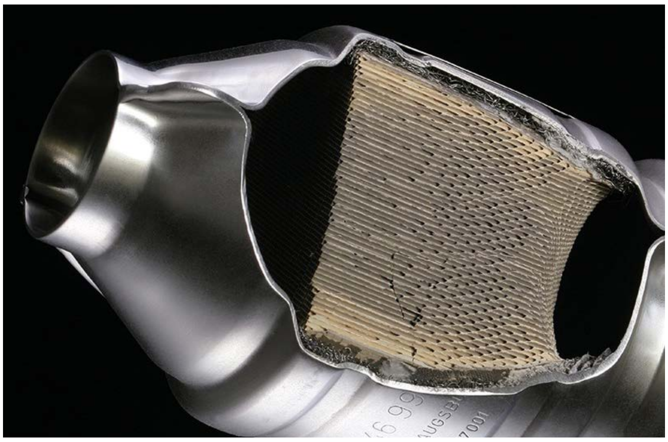

Figure 8 Automotive emissions control catalyst cutaway, showing the can containing the PGM-coated support

Figure 9 An example of a PGM process catalyst, comprising pellets of support material carrying very small quantities of PGM catalyst

Case study 1[6]

A vehicle OEM based in France holds an account at Johnson Matthey. It chooses to purchase the platinum, palladium, and rhodium for its catalytic converters directly from one of the South African PGM producers, rather than buying it through its catalyst suppliers. This metal is credited to the OEM's account on purchase and a physical shipment of metal in sponge form is delivered from South Africa to the hub at Johnson Matthey Royston in the UK – not to France.

The OEM has contracts for catalyst supply with two PGM companies, Company A in the UK, and Company B in Germany. The appropriate quantities of metal are then allocated from the OEM's metal account to each PGM catalyst provider to cover production needs, and this may require an additional physical shipment of metal in sponge form to each appropriate location. If it does, then Johnson Matthey will prepare the shipment on behalf of the catalyst provider or OEM to move the metal into the EU.

Once coated, the autocatalysts (the substrate covered with PGM catalyst nanoparticles) are sent from the UK and Germany to a canner, located in Poland, and then the canned autocatalysts are shipped to the OEM's various vehicle production lines in the EU, US, and UK. It is only at that point that the OEM takes physical possession of the metal at its location, in the form of the catalyst on the support, although it has held the title to the metal all through the process.

The metal is then sold with the vehicle, becoming available for collection, refining, and resale once the vehicle is scrapped, typically fifteen years or so after sale. That may require yet another shipment to a different region to ensure the scrap reaches an appropriate refiner, and the metal may either be bought by the refiner or may be toll-refined on behalf of the collector and sold through the clearing locations.

Case study 2

Process catalysts[7] have a lifetime, after which they must be renewed to maintain the required activity. Typically, almost all the PGM used in the process catalysts is recovered for reuse at the end of the catalyst life. A significant amount of the spent platinum catalyst from petroleum refining that is generated globally (excluding China) is refined by a major PGM refiner at its location in the EU, because this operation is one of the few in the world that specialises in this low-grade (low PGM concentration) material. This means that platinum within such scrap is shipped from all over the world to this location in the EU.

Ownership of the metal (or the lease of the metal) is retained by the original owner, so the scrap is toll-refined on the owner's behalf – in other words, the refiner is providing the refining as a service. This means that the importer of the scrap into the EU could be the owner of the metal, but it may also be the refiner acting as agent.

The recovered metal is credited back to the owner at the refiner's location to allow the owner to 'reuse' its recycled platinum on the fresh charge of replacement catalyst, which may be manufactured in a different region altogether before being shipped back to the petroleum refinery (so in reality, given the time and location mismatches, the 'reused' metal in the new catalyst is not physically the same metal that was recovered from the old batch of catalyst).

The refiner (or its customer) will typically move the high-grade refined material from the EU to the UK hubs for onward shipment for new catalyst fabrication, or in settlement of contracts such as leasing arrangements or bridge loans. Frequently, financing arrangements such as leases need to be paid off with the credit of physical metal to banks, who contractually take it back at the JM UK hub.

Policy to support PGM supply chains

Existing PGM supply chains and recycling infrastructure stand ready to serve the new applications of these metals, particularly their crucial energy transition applications in hydrogen energy and sustainable fuels. Recognising the mature and global nature of this infrastructure, which is unique among critical metals, tailored policy is needed to maximise the potential for PGMs to deliver climate and economic benefits.

The following policy measures are recommended to minimise friction to cross-border movements, to ensure a level playing field, and to support high standards in extraction and processing of PGM:

Taxation and duties

Recommendation: Zero value-added tax (VAT) levied on imports of PGM ingot, sponge, intermediates (salts) and on PGM-containing scrap imported for the purpose of recycling. This recognises that the importing agent may be a service provider (rather than the owner of the material) and can be achieved through adjustments to taxation policy in applicable jurisdictions.

Recommendation: Zero import duty levied on PGM-containing waste and scrap imported for the purpose of recycling, in recognition of the global benefits of a circular economy. And zero import duty levied on PGM-containing intermediates, products, or parts, in recognition of their critical benefits to environment, health, electronics, and defence. This can be achieved through either zero duty rates committed to under WTO, and/or Free Trade Agreement (FTA) negotiations.

Addressing carbon

Recommendation: PGMs exempted from carbon border adjustment mechanisms. The use of lower-carbon PGM can be incentivised in ways that do not create drag on cross-border movements. Further, in recognition of the significant socioeconomic benefits attached to PGM extraction in the Global South (South Africa and Zimbabwe), it is recommended that policy measures in the Global North should instead seek to assist the decarbonisation and sustainability of those operations.

Domestic benchmarks

Recommendation: PGMs exempted from domestic quotas for extraction, processing, and recycling of critical materials, in recognition of the long-established and effective supply and recycling infrastructure already in place.

Even if quotas and benchmarks are non-binding, any attempt to measure progress towards domestic benchmarks risks creating administrative burden and disincentivises sourcing of services outside of domestic markets, reducing customer choice.

A more helpful approach to promoting appropriate standards in extraction and processing would be through international partnerships between countries and regions where infrastructure already exists.

Responsible sourcing initiatives

Recommendation: Recognition and support of existing measures already in place for PGMs, specifically the LPPM Responsible Sourcing Programme, or in the process of being implemented such as IRMA, the Initiative for Responsible Mining Assurance, rather than the introduction of new or separate regional initiatives.

Strategic stocks

Recommendation: extreme caution and rigorous consideration exercised in any plan for PGM stockpiling to avoid unintended consequences, especially in the less liquid markets for iridium and ruthenium.

Because of the smaller volume of supplies of these metals and the nature of trading conditions in their markets, prices can move significantly even when relatively modest volumes are either required for immediate need or are shown to multiple market participants. Consideration must also be given to procuring the metal in the right specification, and then efficiently storing and supplying it to production (given that these metals do not trade on an open exchange and are unable to be stored in typical terminal market depositories).

A more effective approach would be to target increased recycling rates of metal already in use. For example, in the case of iridium, significant quantities are used for premium spark ignition tips in gasoline fuelled vehicles and today these are not generally recovered from vehicles when scrapped (because the quantity of iridium per individual plug is very small).

Increasing recycling rates

Recommendation: Introduction of mandated producer responsibility or other measures that increase efficiency of collection of PGM-containing spent material at the end of equipment life.

If continued investment in refining facilities by the established PGM recyclers is supported, secondary PGM refining capacity will be sufficient and technically capable of serving recycling in the new uses of the PGMs. The technical recyclability of PGMs is extremely high and the specialist recyclers will ensure that processes are optimised for new forms of spent material. Where significant losses of PGMs are seen today (i.e., less than optimal recycling rates), it is overwhelmingly due to inefficient collection practices.

Regulatory measures to support PGM recycling should therefore focus on incentivising collection of all spent material containing PGMs at end of life and ensuring that this material enters the established global recycling infrastructure.

Conclusion

This paper broadly illustrates the complexities that occur in PGM supply and recycling chains, making any determination or control of trade flows difficult and probably detrimental. To ensure robust and efficient PGM supply chains for the future, regulatory measures should be tailored to support and optimise what already exists.

Regulatory measures primarily aimed at other critical materials that impede cross-border movements of PGMs in any way would introduce inefficiencies and lead to local market distortions (as often seen in the Chinese PGM market today). At best, this would impose additional administrative burdens on users, producers, and processors of these metals. At worst, it could create a two-tiered market whereby PGMs in 'protected' markets trade at a significant differential to markets without the same barriers to movement and in which competition is severely curtailed.

An additional challenge to the continued smooth functioning of PGM supply chains arises from protectionist instincts to diversify and localise critical materials supply to reduce import dependencies. Geological constraints mean that there are no realistic prospects for significant and economic production of PGMs from primary sources outside of the known deposits. Those deposits are concentrated in only a few places, and by far the largest is the Bushveld Igneous Complex in South Africa. While that deposit holds sufficient metal to serve global needs for decades, the limitation is investment. An apparent desire in some jurisdictions to reduce reliance on South African PGMs (however unachievable that might be in practice) risks weakening the case for that investment.

Further, the maturity of PGM recycling – coupled with the perfect fungibility[4] of recycled and virgin PGMs – means that supply is already diversified. A substantial amount of recycling infrastructure already exists in the West, specifically the EU, UK, and USA, as do substantial aboveground 'deposits' of PGMs that can be 'mined' by recycling.

PGM supply chains and recycling work today and they work well – particularly from a Western perspective. The challenges that Western markets are facing in the supply and recycling of other critical metals do not apply to the PGMs. If policymaking recognises this unique status and seeks to capitalise on the maturity of these industrial metals, their full benefits for the energy transition and other new applications can be delivered by the global PGM industry and its stakeholders.

Further, the valuable experience gained in the successful scale-up and operation of PGM supply chains and recycling networks over many decades can inform more embryonic supply chains and circularity in other materials.

"To ensure robust and efficient PGM supply chains for the future, regulatory measures should be tailored to support and optimise what already exists"

Glossary of terms

Good delivery	PGM quality specifications set out by the London Platinum and Palladium Market (LPPM) https://www.lppm.com/good-delivery/
Metal holding	An amount of PGM held on a customer's metal account in ounces
Platinum Group Metals (PGMs)	Platinum, palladium, rhodium, ruthenium, iridium, and osmium (Johnson Matthey publishes market data for all of these except osmium, which has only niche applications)
Settlement	This is the point at which the customer receives the type and quantity of the PGM contained within the refining batch on its metal account in ounces, at which point this quantity is available to the customer to withdraw, transfer etc.
Sponge	A powdered form of a PGM
Unallocated metal	PGM that is held in a pool and cannot be allocated to a particular customer

Endnotes

1. For simplicity, this paper uses 'critical materials' as a catch-all term.
2. Catalytic converters currently account for about 60% of net PGM consumption (measured across all six metals, although only platinum, palladium, and rhodium are used on catalytic converters).
3. This is not evident in Johnson Matthey's historical data series, because only figures for open-loop recycling (which supplies recycled metal back to the market) are published. The bulk of industrial PGM recycling takes place in closed loop, in which recycled metal is retained within the application and reduces the requirement for fresh metal. Reported demand figures are net of closed-loop recycling.
4. Meaning they are completely interchangeable, with no difference in properties.
5. Guidance Documents | LBMA: https://www.lbma.org.uk/responsible-sourcing/guidance-documents.
6. Fictional; illustrative only.
7. A process catalyst is a material used in a chemical processing/production facility that enables or increases the reaction rate without itself being consumed in the process.

For more information please see our website:
https://matthey.com/pgm-markets

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