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Quintessentially PGMs

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KEY TAKEAWAYS

The PGM market of early 2022 was again stunned by black swan events, causing a lot of uncertainties. Geopolitical tensions raised questions about the future stability of supply from Russia and the pace of recovery of the automotive sector, which is PGM's major consumer industry.

Moreover, COVID, the major supply chain disruptor of recent years, is still there and still hits unexpectedly, as we are seeing in China these days. This, together with continuing bottlenecks in logistics, will likely delay chip shortage easing until 2023 at the very least, undermining car production plants around the world.

Palladium. The conflict in Ukraine affected the demand, yet not fully recovered from the chip shortage, as European automakers cut its production due to the lack of wiring harnesses supplied from Ukraine. Nevertheless, we expect global palladium demand to rise by 3% to 10.3 MOz in 2022 mainly on the back of a partial automotive sector recovery from the low base of 2021. Metal supply will grow slightly as well, predominantly due to recovering after the 2021 accidents production at Norinickel's assets. As a result, it is expected that palladium market will be close to balance this year with the deficit of 0.1 Moz.

Risks associated with palladium supply from Russia are creating additional uncertainty for consumers and contributing to the rising price volatility. However, Norinickel confirms its production guidance for 2022 and continues to deliver metals according to its contract obligations despite logistic obstacles associated with the limited international flights' availability as Russian government has imposed no restrictions on the PGM export from Russia.

The decision of LPPM to remove two major Russian state-owned PGM refineries from the Good delivery list had no material impact on Norilsk Nickel sales since the company has always prioritised sales to the consumers rather than to the London OTC market. A new UK 35% import duty on Russian palladium and platinum will also have no material impact on the market as British import of Russian metals was only 31 koz of palladium and 5 koz of platinum in 2021.

Palladium, YoY change	2022E	2023E
Demand ex. investment	+0.1Moz +1%	+0.6Moz +5%
Supply ex. stocks sales	+0.1Moz +1%	+0.6Moz +5%

Platinum. We expect the demand for platinum from the automakers to stagnate this year as the global auto sector partial recovery will be offset by lower consumption in China, where metal use in car manufacturing will decline in 2022 on the back of PGM loadings optimisation caused by thrifting after strong loadings growth in 2021 driven by the introduction of the China VI heavy-duty regulation. Moreover, the diesel-powered share of new passenger cars in Europe shrank in 1Q 2022 by -5 percentage points compared to Q1 last year to 16% creating additional pressure on platinum demand.

On top of that, negative impact from the glass industry due to fewer new fabrication facilities in China will also contribute to the platinum demand growth's slowing in 2022. Even with the US platinum jewellery sales showing a record performance, we still maintain the view that the jewellery demand is on a gradual downward trend on the back of China's structural changes in the social behaviour and the lack of marketing support. The medium-term downside risk of the global recession may impact jewellery demand further as luxury goods tend to suffer the most from the purchasing power weakness.

Hydrogen economy is expected to create significant additional demand for platinum, but it will take at least another 5 years for the industry to become an important platinum offtaker. At the same time, this process can still be accelerated as Europe takes more aggressive stance on the way for energy independence.

South African supply is expected to decrease this year as most of accumulated work-in-progress materials were already processed during 2021. There is also a significant risk regarding South African primary supply, as all the major PGM producers are to enter new wage negotiations with their local unions, which carries the risk of weeks-long strikes.

Platinum, YoY change	2022E	2023E
Demand ex. investment	-0.3Moz -4%	+0.5Moz +7%
Supply ex. stocks sales	-0.4Moz -5%	+0.2Moz +2%

MARKET BALANCE

PGM market balance is sensitive to the automotive production. We have to adjust our car production expectations to geopolitical crisis and slower than expected chip shortage easing. [We revise the global light vehicle production outlook down to 80 million and 91 million for 2022 and 2023 respectively, relatively to the November 2021 expectations of 86 million and 93 million for 2022 and 2023 respectively, which translates into 570 koz and 170 koz demand decreases in 2022 and 370 koz and 120 koz demand decreases in 2023 of palladium and platinum respectively.](#)

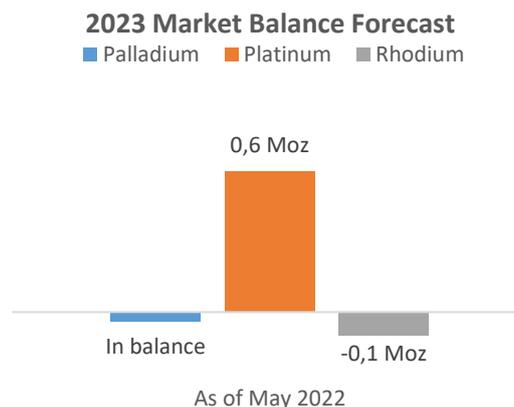
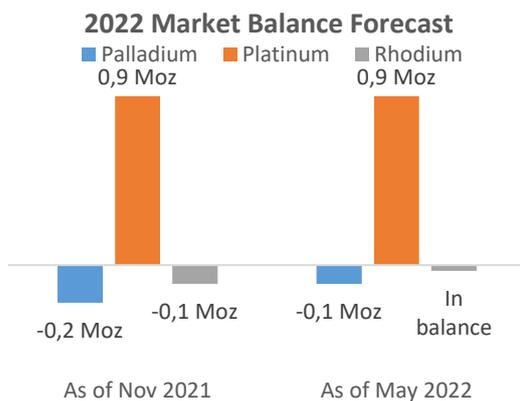
Despite the pace of automotive recovery this year being significantly lower than expected, **palladium** is to be in balance due to lower primary supply as South African companies have revised down their production guidance as well as subdued recycling. Moreover, there is a further potential downside risk due to strikes caused by unresolved labour disputes. Almost all WIP materials,

which could have offset South African production fall this year, were already refined in 2021. On the other hand, Norinickel operations are to recover in 2022 fully after the temporary suspensions of Oktyabrsky and Taimyrsky underground mines and an incident at the Norilsk Concentrator.

In 2023, we expect palladium market to remain in balance and the automotive demand recovery to be mostly offset by the rise in secondary supply.

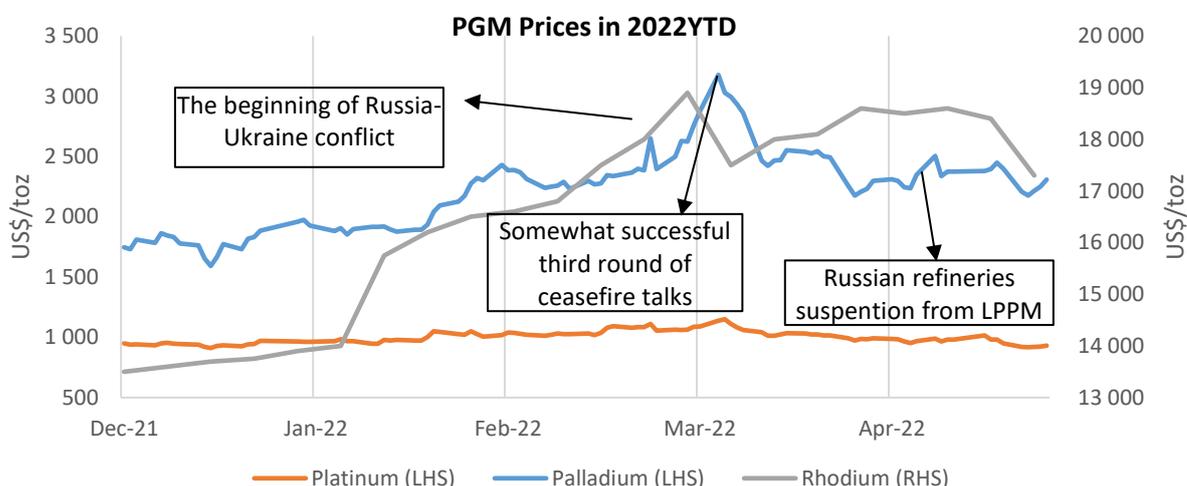
As for **platinum**, we maintain that the 2022 surplus is to be approximately 0.9 Moz. In 2023, the surplus is to shrink to 0.6 Moz, mostly due to the automotive sector recovery.

Supply and demand for **rhodium** are seen balancing each other this year, while we expect the market to slip into deficit next year on the back of a higher offtake by the automotive industry.



Source: NN Analysis

MARKET SENTIMENT



Source: LBMA

In the middle of January 2022, palladium price started to rise on the back of potential supply disruptions from Russia, as Russia-Ukraine tension was building up. Since the end of February, palladium price was mainly driven by the geopolitical crisis's escalation.

As there is no direct sanction on PGM supply from Russia, indirect restrictions (e.g. Russian state-owned refineries' suspension from the LPPM's Platinum and Palladium Good Delivery and Sponge Accreditation lists and NYMEX trading) mostly result in price volatility while the impact on the physical market remains negligible.

While platinum price did not experience significant volatility as about 90% of platinum is mined outside Russia, palladium price reached its historical maximum in March on the back of supply concern as Russia accounts for about 40% of the global palladium primary production. This led to a noticeable 3M leasing rate rise.

Another evidence of the importance of geopolitics in the palladium price discovery was a 10% price correction after the Russia-Ukraine peace talks' progress in the middle of March, which returned the prices to the pre-conflict levels.

In the first weeks since the beginning of the Ukrainian conflict, panic in the market led to a massive palladium short position covering, moving net long positions to a positive territory on March 8, for the first time since August 2021. Ever since, palladium net long positions started moving down towards the late January levels as the third round of ceasefire talks calmed down the panicking market.

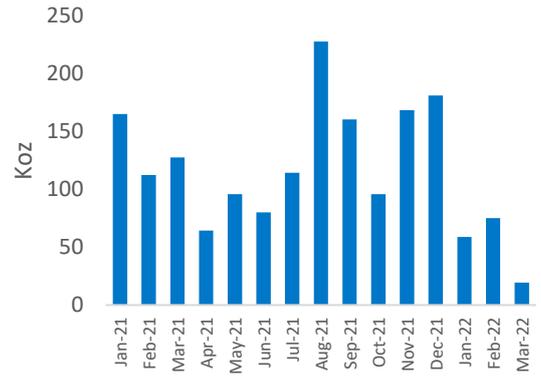
Looking at the trade data, we can see mixed results. China and Hong Kong PGM net import looks low. 2022 YTD palladium net import is 153 koz, which is -50% lower than a year ago. After huge platinum imports in December as China was building up its stocks when the average price dropped below \$950/toz, import volumes slowed down, which led to China and Hong Kong 2022YTD platinum net import to fall by -37% to 336 koz.

Japan demonstrated mixed results as palladium net import fell by -10% YoY to 312 koz in 2022YTD, while platinum net import more than doubled in 2022YTD to 331 koz.

Platinum 3M Leasing Rate



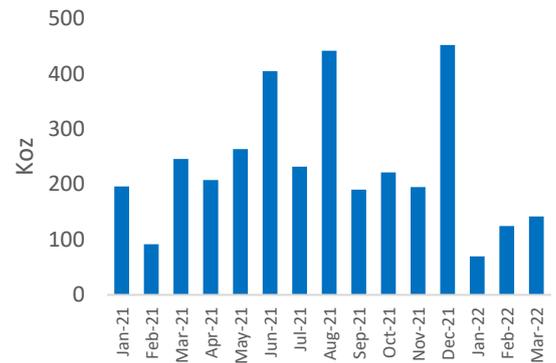
China and Hong Kong Palladium Net Import



Palladium 3M Leasing Rate



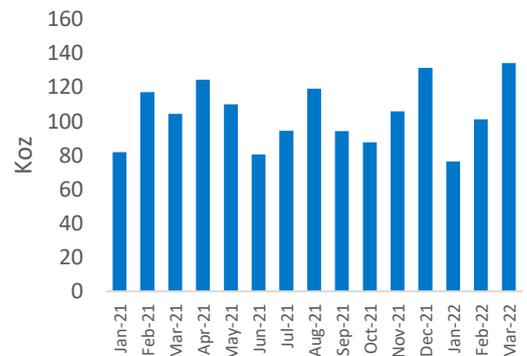
China and Hong Kong Platinum Net Import



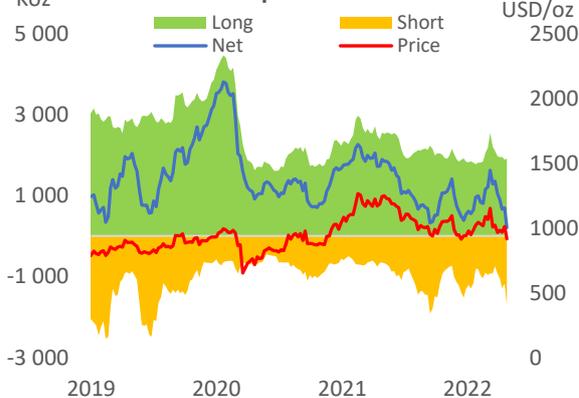
Palladium: Net Speculative Positions



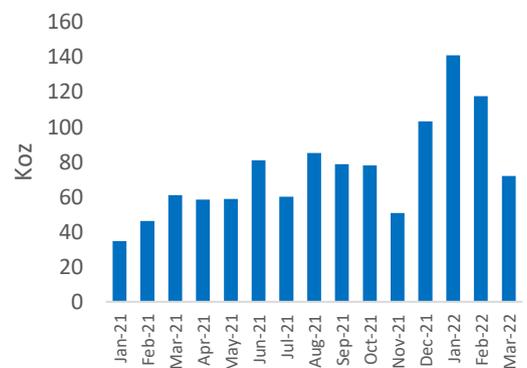
Japan Palladium Net Import



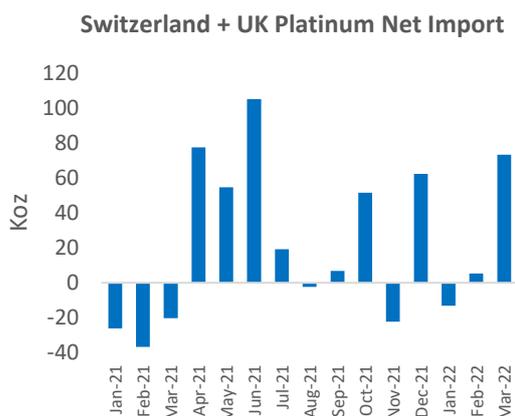
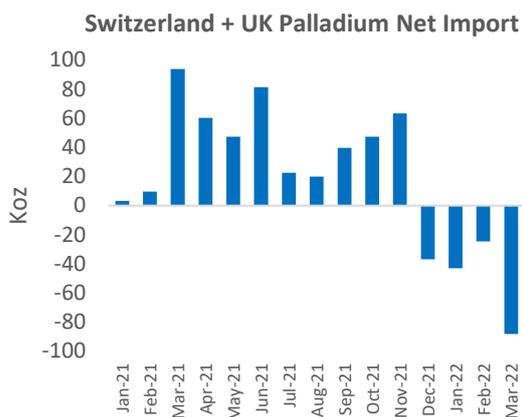
Platinum: Net Speculative Positions



Japan Platinum Net Import



Source: Trade data, NYMEX



Source: Trade data

North Macedonia's net import statistics could provide some signals of the fundamental changes of the PGM use in the automotive industry as a major Johnson Matthey's autocatalyst plant is located there. In 3M 2022, Macedonian platinum net import fell by -24% YoY to 68 koz, while their palladium net import increased by +15% YoY to 76 koz.

For the last 4 months, Switzerland and the UK have been recording negative palladium net imports, which indicates the demand growth for the metal from the manufacturers, as automakers were preparing for the industry recovery. This is also confirmed by positive sponge/ingot premiums currently seen in the market. Although the car production was still affected by a number of factors, palladium net import in Switzerland and the UK recorded -88 koz in March as manufacturers stockpiled the metal on the back of supply concerns.

As for rhodium, all the major regions demonstrated significant growth in net imports. USA, Japan and China with Hong Kong 2022 YTD rhodium net import increased by 202%, 76% and 93% YoY to 37 koz, 30 koz and 33 koz respectively, indicating that the automakers regard the current price levels as comfortable and have started restocking in preparation for a more robust car output by the middle of the year.

GLOBAL PGM DEMAND

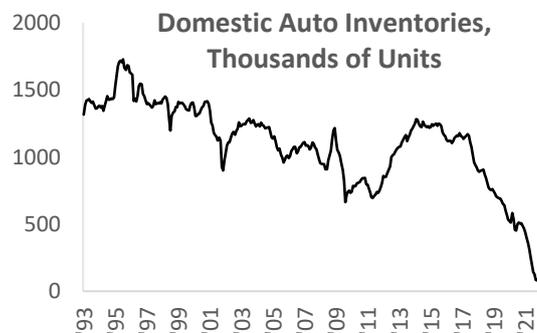
AUTOMOTIVE

As a major PGM consumer, the automotive sector has been experiencing hard times on its way to a full recovery to the pre-COVID volumes. The pandemic led to supply chain disruptions, which, alongside with other economic and natural factors (discussed in full detail in our last report) caused the structural semiconductors' shortage across many industries, including automotive.

In 2021, the major stakeholders of the chip shortage - car manufacturers and chipmakers - expected the crisis to ease in 2022 significantly and ultimately, to be over in 1H 2023. *As the time goes by, the chip shortage easing always seems to remain 6 to 12 months away, and now the carmakers expect the chip shortage to last throughout 2023 and into 2024.*

North American light vehicles' sales continue to fall on a year-on-year basis with a 19% fall in April and a disappointing -16% YoY in Q1 2022, as production losses caused by the chip shortage are estimated at around 400,000 units in this region in Q1. Moreover, high inflation and long waiting lists affect consumers, causing them to re-assess the need for a new car.

Car inventories in North America reached its historical minimum in February of just below 65,000 units, which indicates significant deferred demand, and sales are to surge as the availability recovers. Nevertheless, we expect the car availability to remain at reduced levels at least throughout 2022.



Source: Federal Reserve Bank of St. Louis

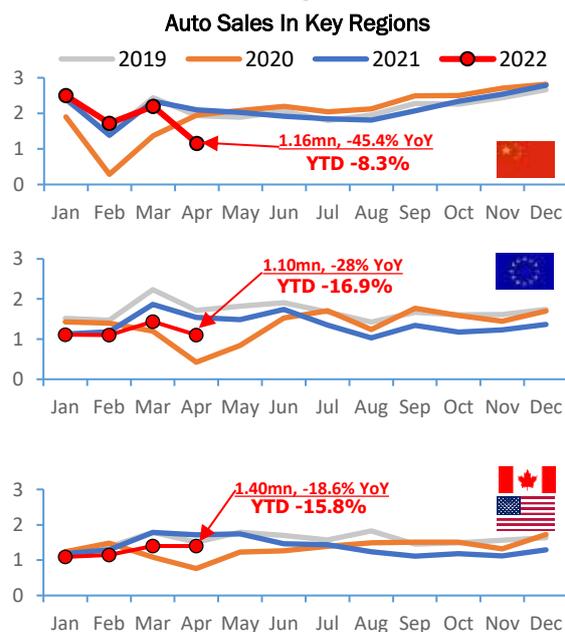
China has experienced another COVID outbreak recently, which caused a total lockdown of some largest cities, almost completely halting the production plants' operations. As a result, the year-on-year auto sales recovery in China was disrupted in March with the monthly sales falling by 6% but with Q1 2022 sales still being up by 5%. However, April sales were devastating with a 45% monthly fall, bringing 2022 YTD sales down by 8%. Shanghai, the epicentre of the current COVID outbreak, has been under a lockdown for about a month. This city is not only an important car market, but also a major car and car components' production base. Strict lockdown in Shanghai had serious impact on all car industry in China in April. There also were COVID outbreaks in Jiangsu province, which is not far from Shanghai and is also an important hub for car components' production. Volkswagen and Toyota, who have major joint ventures

with China's huge SAIC Motor, were forced to scale back their production in mid-March. After a month-long downtime, automakers resumed operations in Changchun. VW's Shanghai factory remained closed until April 25, when it started to re-open gradually. Although the automotive demand is deferred rather than lost, the already sustained COVID-related production losses are not likely to be made up this year.

As for the emissions' regulations, China 6b RDE standard will be implemented in July 2023 without a "cold start" requirement and with a conformity factor of 2.1, which, however, can still be re-evaluated towards a more stringent 1.5. In this case, a positive impact on PGM demand will lead to a medium-term market balance re-assessment as the current conformity factor value corresponds to our base case scenario. China VI for HDD boosted platinum demand in 2021, however, now manufacturing processes are stabilised and there are attempts to optimise loadings which slows down the platinum demand growth.

European car production faced yet another challenge of the auto parts' shortages as the Ukrainian conflict caused production cuts of wiring harnesses, which European automakers heavily relied on, and German OEMs being most susceptible with the additional loss of production of about 150 thousand units in March alone. However, Volkswagen Group, the worst affected by this disruption, has already announced that it is increasingly sourcing affected components from Romania and Hungary as well as from outside Europe to offset the shortfall from Ukraine. Nevertheless, European market experienced yet another monthly sales slump of -28% YoY in April with 2022 YTD sales fall of -16% YoY.

The long-awaited Euro 7 standard announcement is scheduled for this summer and is expected to affect the automobile production in Europe from 2025 onwards. Its impact on the PGM demand could be quantified only after the official announcement of the regulation. However, it is already obvious that the relative PGM loadings (grams of PGM used in catalysts per vehicle) will have to increase in order to meet a more stringent standard.

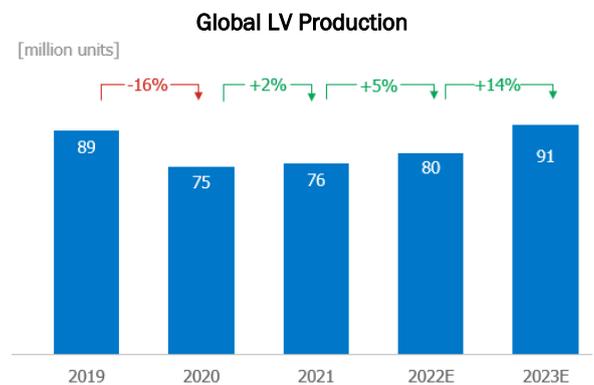


Source: LMC Automotive

All the aforementioned factors exacerbate the automotive crisis, which resulted in a revision of the medium-term global vehicle production down from 86 to 80 million units in 2022 (570 koz and 170 koz of palladium and platinum respectively) with Europe being the most affected region due to its exposure both to the chip shortage and supply disruptions from Ukraine. In 4M 2022, global LV annualized selling rate plunged to 75 million units for 2022. The major contributor was China with a -45% YoY sales' fall in April.

With the average monthly selling rate of 6.9 million units (equal to annualized rate of 83 million), which we expect to be achieved in May-December 2022, annual LV sales are to reach 80 million units this year.

Thus, we revise down our estimates of the palladium, platinum and rhodium use in the automotive industry in 2022 to 8.2 Moz, 2.5 Moz and 0.9 Moz respectively. 2023 PGM demand by the automotive industry is also revised down to 8.8 Moz, 2.9 Moz and 1.0 Moz for palladium, platinum and rhodium respectively on the back of a lower car output (91 million vehicles to be produced next year vs 93 million forecasted earlier).



Source: NN Analysis

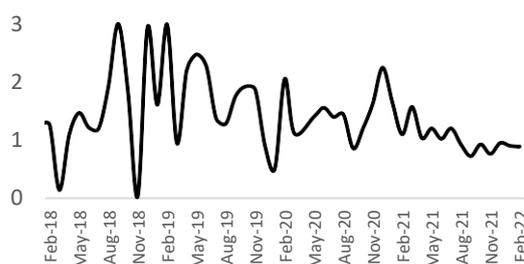
Palladium substitution with platinum received an additional impulse as automakers' concern about potential supply disruptions from Russia incentivise them to switch from the Russian PGM supply. This can be achieved either by switching to alternative PGM suppliers or by accelerating palladium substitution with platinum. Either way, it does not seem to be realistically feasible, at least in the short term, as Russia accounts for around 40% of the global primary palladium supply, which means it cannot be substituted by other market participants quickly and the current South African miners' rhetoric shows their inability to ramp up production quickly.

Secondly, *given the cost associated with the PGM substitution in autocatalysts, and, most importantly, the technical limitations, the pace of palladium substitution with platinum cannot be increased beyond the level, which is incentivised by the price difference between these metals.* Substitution will take place in catalysts for the most popular models and as part of the presentation of new model lines, which happens once every few years, and it will be financially unfeasible to speed up this process, as investments in changes and recertification will not be offset by the difference in the metals' prices. Moreover, automakers have already committed billions of dollars into R&D expenses associated with the fleet

electrification. This, in a way, ties their hands regarding additional R&D in the catalyst chemistries' review.

A way to look at the market's sentiment regarding palladium substitution with platinum in autocatalysts is to analyse the dynamics of the platinum-to-palladium net import ratio in North Macedonia where a major Johnson Matthey's European autocatalysts' plant is located. The declining trend started in 2021 meaning more palladium has been bought by the manufacturer, which, in turn, gives no signal of acceleration of palladium substitution with platinum in autocatalysts. However, lower diesel car share in the European market also contributes to this trend.

Platinum-to-palladium Net Import Ratio In Macedonia



Source: Trade data

JEWELLERY AND OTHER INDUSTRIAL DEMAND

The 2022 platinum demand in **jewellery** is expected to continue its gradual decline by 1% to 1.83 Moz. China, which accounts for over a half of platinum jewellery demand, registered its eighth consecutive annual marriages' drop in 2021. This is caused by a variety of social and economic factors, such as lower job availability and other shifts in social behaviour. Moreover, rising costs of education incentivise young couples to postpone child birth, which creates a snowball effect for the demographic difficulties.

Although the US platinum jewellery sales showed a record performance in 2021 on the back of strong holiday sales, a potential global economic crisis, caused by the current geopolitical situation, threatens with recession and high inflation, which creates a significant downside risk for the jewellery demand as luxury goods tend to suffer the most from the purchasing power fall.

We maintain our existing expectations of the platinum demand by the **glass industry**, which is expected to drop by over -100 koz in 2022 on the back of fewer new fabrication facilities in China, same as for the **chemical** demand for palladium, which is expected to drop by 4%

GLOBAL PGM SUPPLY

In 2021, global primary refined PGM supply increased by 12% to 7.0 Moz palladium, 33% to 6.5 Moz platinum and 54% to 0.8Moz rhodium, exceeding the pre-pandemic levels of 2019, as the earlier closed mines restored their operations and logistical challenges eased. In addition to that, some extra PGM supply came from the refining of South African work-in-progress stocks mined in 2020.

2022 primary PGM production is expected to stabilise as South African miners have already refined the lion's share of the previously accumulated work-in-progress

YoY to 600 koz due to a slower caprolactam capacity expansion in China.

We reiterate our previous forecast published in November 2021 of the **PGM demand from other industries** and believe that the effects of geopolitics on the market will wane as the markets adapt to the new reality with the demand recovering in the second half of the year. Although there still are downside risks, mostly associated with COVID-related lockdowns in China, which can affect the demand and we will provide an update on this in our next report when more information becomes available.

Platinum is expected to be widely used in a **hydrogen technology**, which is becoming an important pillar of the European energy plan to achieve net-zero emission targets set by the Paris Agreement. The European Commission has developed an ambitious plan to reach 80 GW of electrolyzers by 2030, including 40 GW in Europe and 40 GW in Europe's neighbourhood countries with some further hydrogen import into the EU. The Hydrogen Council reported more than 520 green hydrogen projects announced last year alone, representing a +100% increase since January 2021. Around 70% of the projects have already announced full or partial commissioning by 2030.

We estimate the potential PGM use in the hydrogen economy as up to 1.4 Moz of platinum and 0.4 Moz of palladium per year by 2030.

This is a likely ceiling for the PGM demand, which can be reached if 1 million light-duty and 100,000 heavy-duty FCEV are produced annually by this time and an accelerated penetration of the LOHCs technology in hydrogen storage materialises.

We consider this to be the most optimistic, yet perfectly feasible scenario of the hydrogen economy development. Moreover, recent conflicts, which forced Europe to create a new strategy of lowering its dependency on imported fossil fuels, might lead to a further acceleration of the hydrogen infrastructure deployment. This strategy, called REPowerEU, aims to nearly triple the currently installed wind and PV capacity in the EU, reaching 980 GW of installed wind and solar PV capacity combined. This entails installing 280 GW of PV and 260 GW of wind, as prescribed by FitFor55, and deploying an additional 80 GW dedicated to renewable hydrogen production. The World Platinum Investment Council estimates this plan alone to generate additional annual platinum demand of 240koz by 2030.

China also bets on hydrogen as Chinese authorities have recently released a three-phase plan to develop the hydrogen energy sector in 2021-2035 as the country races toward its carbon peaking and neutrality goals.

materials and Russian operations will recover after the temporary suspensions of Oktyabrsky and Taimyrsky underground mines and an incident at the Norilsk Concentrator. Global PGM refined production is expected to decrease by 1%, 6% and 14% to 6.9 Moz, 6.1 Moz and 0.7 Moz of palladium, platinum and rhodium respectively, aligning with pre-COVID 2019 levels.

However, there are significant downside supply risks regarding the South African supply as South African miners might experience additional production cuts as

they are entering new wage negotiations with the South African miners' unions. As we know from the past, labour disputes can lead to production stoppages due to strikes. However, if the unions' terms are accepted, the mid-term production will be indirectly affected by the cost inflation, which will limit the capital expenditure flexibility.

RUSSIA

Nornickel reported a Q1 2022 PGM production decrease of 8% to 706 koz palladium and 12% to 163 koz platinum owing to the high base of the 1Q21, when a new line for the precious metals' production from the chlorine leaching residues at Kola MMC was ramped up to its design capacity and, as a result, all the accumulated inventory of work-in-progress in transit materials was processed.

The 2022 production guidance of 2,451-2,708 koz palladium and 604-667 koz platinum is maintained. The recovery of Oktyabrsky and Taimyrsky underground mines has been fully completed and the Concentrator in Norilsk operates normally while the launch of the upgraded South Cluster open pit mine is also proceeding on schedule.

In spite of certain challenges in logistics and deliveries of equipment, spares and consumables due to complicated geopolitical situation, Company's operations remain unaffected.

The company continues to fulfil all its obligations in full, our clients do not pull out of contracts, so our trade and cash flows remain fully on schedule and in accordance with the existing contractual agreements. We see that our customers are keen to enhance their cooperation with the company even further as Nornickel has proved its status as a highly reliable business partner through many decades of seamless co-operation and regardless of external geopolitical shocks.

The Company monitors the changing environment and responds to all developments effectively and in a timely manner. Our long-term production guidance and investment plans will be reviewed and made public later on reflecting the evolving geopolitical situation. The Company fully delivers on its ESG strategy aiming to reduce its environmental impact in the regions of operations and Nornickel will continue to implement all its social, industrial, and environmental projects fully despite the challenges.

Although Krastsvetmet and Prioksk refineries are used by Nornickel for toll refining of its PGMs, the decision by LPPM to suspend them from the LPPM's Good Delivery and Sponge Accreditation doesn't impact Nornickel's sales as the company sells its PGM to industrial users through long-term supply contracts and doesn't supply its metals to the LPPM banks.

At the same time, while the UK has recently introduced a 35% import duty on Russian palladium and platinum, it will also have a negligible impact on the market, despite the fact that London still remains a global centre of precious metals bank trading. According to trade statistics, the trade flow between Russia and the UK is very limited. Britain imported no Russian palladium and only 5 koz of Russian platinum in Q1 2022. British import of Russian metals in 2021 was 31 koz of palladium and 5 koz of platinum. The key reason for this is Nornickel's strategy of sales to end users rather than banks.

As for other PGM producers in Russia, the launch of the new projects will mostly depend on the development of the geopolitical situation. The plans of second-largest PGM producer in Russia, **Russian Platinum**, to develop Chernogorskoye deposit and Southern part of Norilsk-1

deposit will depend of the company's ability to overcome limitations caused by sanctions.

British-owned Eurasia Mining operating in West Kytlim, located in the Urals, says it is closely monitoring the evolving sanctions. Their Board maintains that no individual or entity identified in the sanctions on Russia is associated with their company in any way, nor do these sanctions from any Western nation prevent their company from executing its strategy. We estimate their last year's platinum production as not exceeding 1 koz.

Koryakgeoldobycha, which operates in Kamchatka region, will not carry out mining operations in 2022. According to the Russian Ministry of Natural Resources, since 2017, the company has been mining once every two years only. Last year's platinum production in Kamchatka region is estimated at 5 koz.

SOUTH AFRICA

In 2021, South African refined palladium, platinum and rhodium production increased by 58%, 54%, and 54% to 2.9 Moz, 4.9 Moz and 0.7Moz, respectively due to the year-on-year recovery from COVID-19 and the release of the accumulated work-in-progress materials.

In 2022, we expect South African refined PGMs' production to decline by -12% to 2.5Moz palladium, -11% to 4.4Moz platinum and -17% to 0.6Moz rhodium due to the high base effect, as WIP returns to its normal levels.

Anglo American Platinum's 2021 refined PGM production increased by 80% and 100% YoY to 1.6Moz and 2.4Moz for palladium and platinum respectively, due to the partial pandemic recovery, the use of the accumulated work-in-progress inventory and the robust performance of the ACP converter plant.

As to this year's performance, Anglo American Platinum's Q1 2022 refined production made up 228 koz, 334 koz and 46 koz of palladium, platinum and rhodium respectively, *while the 2022 refined production guidance was revised down to between 4.0 - 4.4 million PGM ounces from 4.2 - 4.6 million PGM ounces due to excessive rainfall and the ongoing effects of COVID-19 impacting supply chains.* The planned maintenance at Polokwane smelter and Mogalakwena South Concentrator in Q3 leaves little chance to make up the Q1 shortfall by the end of 2022. At the same time, work-in-progress stocks to be processed in 2022 provide limited leverage to support refined production this year, as WIP material inventories are estimated at only 67 koz, 60 koz and 27 koz of palladium, platinum and rhodium respectively.

As to the longer term horizon, Anglo American Platinum announced in December 2021 that its Board had approved the Mototolo/Der Brochen life-extension project. The development of the project leverages the existing Mototolo infrastructure, enabling mining to extend into the adjacent and down-dip Der Brochen resource, which will extend the life of the mine for more than 30 years. With the completion of the concentrator debottlenecking project in Q3 2021, production from Mototolo/Der Brochen is expected to be maintained at around 250 koz PGM ounces per year. Work on developing the long-term future of Mogalakwena continues and its production is expected to start in 2026, however no new official announcement has been made since our last issue.

As far as Anglo American Platinum's plans to target energy shortfalls and carbon neutrality at its mining operations, the company and EDF (Électricité de France SA) have recently agreed to develop on-site and off-site solar and wind farms with 3,000 to 5,000 megawatts of production capacity over the next decade with some

storage facilities to be built as well. This will reduce the miner's dependence on state-owned Eskom, which not only uses coal-fired plants for almost all of its electricity but cannot ensure the stability of its electricity supply either.

Sibanye-Stillwater's South African mining operations' 2021 results were 0.6 Moz (+20% YoY), 1.1 Moz (+19% YoY) and 0.17 Moz (+25% YoY) of palladium, platinum and rhodium respectively. This was achieved despite some significant operational headwinds, including safety stoppages, employee unavailability due to COVID-19 and ongoing power disruptions in South Africa.

4E PGM production guidance for South African PGM operations for 2022 is expected to be between 1.75 Moz and 1.85 Moz (on average -5% comparing to their 2021 production). However, the earlier mentioned potential strikes caused by labour disputes could still affect their annual production. We estimate the potential production cut could reach 75 koz, 150 koz and 20 koz of palladium, platinum and rhodium respectively, as strikes typically last up to 6 weeks, which might halve the expected Q3 production.

Sibanye-Stillwater announced on 31 January 2022 that it had entered into an agreement with Rustenburg Platinum Mines Limited (AAP subsidiary), which will result in acquiring full ownership of the Kroondal operation. Required condition for transaction execution is the production of 1.35 4E Moz (less than 0.9 4E Moz remains) according to the pre-existing agreement. This condition is expected to be fulfilled early in 2024. However, Anglo American Platinum will continue to process the concentrate produced from Kroondal concentrators until 2026 under the toll-and-purchase agreement. This transaction is expected to extend life of the Kroondal operation to 2029 and will add 1.32Moz attributable reserves to the company allowing earlier extraction of Rustenburg reserves.

Impala Platinum's palladium and platinum refined production in South Africa marginally grew in 2021 by 2% YoY and 1% to 1.09 Moz and 1.49 Moz respectively. Rhodium production decreased by 8% to 183 koz.

FY 2022 (from July 2021 to June 2022) production guidance was revised down from 3.30-3.56 Moz 6E to 3.10-3.20 Moz 6E due to the furnace maintenance at Rustenburg. One of the Rustenburg furnaces was scheduled for a partial rebuild during Q1 2022. However, after the inspection of this furnace, a decision was made to undertake a full rebuild, thus extending the maintenance period to approximately four months, as it was impacted by inconsistent power supply arising from Eskom's load curtailment measures. This resulted in a production cut for 1H 2022 of approximately -70 koz and -140 koz for palladium and platinum respectively. Though accumulated materials can be refined by the end of this year, this could be delayed further to 1H 2023 as Impala's financial year ends June 2023 and they will have more time to meet its production guidance.

At the end of March, Impala Platinum committed R50 billion to a Five-Year Capital Program. This investment will increase 6E PGM production by approximately 220 koz per annum from 2028 onwards and processing capacities by additional 600 koz 6E per annum. The extra smelting capacity will service new Impala projects and provide additional treatment capacity for the third-party customer requirements. This investment might be the response to the earlier mentioned problems with furnaces and a preparation to the RBPlat acquisition.

Speaking of RBPlat, the takeover race between Northam and Impala Platinum continues as Impala increased its

stake by up to 37.79% on April 15. Despite the lingering battle, Impala Platinum remains determined to acquire 100% of the company. On April 29, the Competition Commission has recommended that the Competition Tribunal approve the company's proposed acquisition of all JSE-listed RBPlat shares not already owned by it. This is an important milestone in the ongoing saga, which means that the bidding war with Northam might be over soon.

Northam, Impala's rival in the months-long bidding war for RBPlat, currently holds a 35% share. However, its strategic incentives towards the acquisition are still challenged by the market. Given that the premium paid by Northam for RBPlat shares was noticeably higher than that paid by Impala, it will definitely not want to give up its stake.

Northam production guidance for FY2022 (year ended June 2022) is 730-760 koz 4E comparing to 655 koz 4E in FY2021, which is about +15% YoY. Company plans to reach 1 Moz refined 4E PGM production per annum by 2026.

ZIMBABWE

Zimbabwean 2022 refined production is expected to increase by 6% to 410koz palladium, 4% to 505 koz platinum and 7% to 45 koz rhodium.

Zimplats' 1Q 2022 PGM production increased by 5% to 54 koz, 67 koz and 6 koz of palladium, platinum and rhodium respectively. We expect 2022 Zimplats production to be in line with the previous year of 215 koz, 275 koz and 25 koz of palladium, platinum and rhodium. This matches Impala's FY2022 production guidance of 580-600 koz 6E, which remained unchanged relative to FY2021 production of 579 koz 6E.

As a part of Impala's investment program, US\$521 million (R8.2 billion) will be invested in the expansion of the existing Zimbabwean smelting capacity and the construction of an SO₂ abatement plant to mitigate the air quality impacts. This expansion is reported to accommodate an additional 600 koz of 6E PGM per annum in 5 years, which post-smelting will be transported to Implats' South African processing facilities for further refining.

As for Anglo American Platinum's performance in the country, Q1 2022 PGM production at **Unki** increased by 5% to 53 koz 6E PGM, following the the completion of the debottlenecking project at the concentrator n Q4 2021. We expect Unki's PGM output to increase by 20% in 2022.

Continuing with the theme of developing projects, Tharisa Capital has recently exercised an option to increase its stake in **Karo Mining Holdings Limited** from 26.8% to 66.3%. The development of the first phase of the Karo platinum group metals project in Zimbabwe is expected to see its PGMs production doubling within 24 months. Having said that, we expect this might be delayed as there is a lack of available information regarding the current status of this project, especially regarding secured funding and its sources. When the project commences in two years, the annual output is expected to be 150 koz ounces of PGMs in concentrate during the first phase. The Karo project's resources are split between platinum (45%), palladium (42%), rhodium (4%) and gold (9%).

No operational updates on **Darwendale** project have become available since our last issue, as Impala Platinum stalled it over the ownership concerns. The miner is waiting for a clarification on the ownership structure from the Zimbabwean authorities as there is a risk of sanctions.

NORTH AMERICA

Unlike the increased South African production, **Sibanye's** US PGM operations delivered 441 koz (-6% YoY) and 129 koz (-4% YoY) of palladium and platinum in 2021 respectively, primarily due to the ongoing impact of the rail collision incident in June 2021.

As to this year's performance, Sibanye-Stillwater Q1 2022 refined production from US PGM operations made up 95 koz, 28 koz of palladium and platinum respectively, while 2E PGM production guidance for US PGM operations for 2022 is forecast to be between 550-580 koz, which is in line with 2021 2E PGM production of 570 koz.

As for another major PGM producer in this region, Impala Platinum, we expect its North American asset, **Impala Canada**, to increase its output by 9% YoY, delivering 240 koz of palladium this year, as its production guidance between 270-300 koz 6E in concentrate in FY2022 exceeds 260 koz 6E in FY2021.

Vale is expected to recover its production volumes from 98 koz and 78 koz to 170 koz and 130 koz of palladium and platinum respectively after a two-month strike in Canada last year.

Currently, we anticipate this year's **Glencore's** PGM production to be in line with the 2021 results of 220 koz and 73 koz of palladium and platinum respectively, which is backed by its Q1 production results as their PGM output changed insignificantly by +4 koz and -3 koz for palladium and platinum respectively.

In total, we forecast the 2022 North American refined production to increase by 7% to 1.0 Moz palladium, 22% to 0.4 Moz platinum and 7% to 45 koz rhodium as Vale is to recover its production to the 2020 level.

RECYCLING

Although the automotive sector recovery is expected to underperform last year's expectations, the increase of the new car availability will still boost the autocatalysts' recycling - the major source of the secondary PGM production. Thus, we anticipate palladium and rhodium recycling to rise by 6% and 3% to 3.1 Moz, and 0.3 Moz respectively. On the other hand, we expect platinum recycling to fall by 4% as European automakers are exposed to the Ukrainian crisis to a greater extent.

Fabricators also admit that the recycling volumes recovery is not as fast as it could be. The supply environment for the PGM-rich materials is somewhat less favourable in the current volatile environment as collectors tend to hold on to the scrap material longer. Additionally, logistical disruptions due to the ongoing geopolitical crisis impact international transport and lead to erratic supply of various materials.

As to secondary material processors, Sibanye-Stillwater reported a marginal decline in its Q1 2022 recycling operation as geopolitics and COVID caused further logistical, transport and fuel cost difficulties. Nevertheless, Sibanye's US Recycling operations are forecast to feed between 750 and 800 koz 3E, comparing to 755 koz 3E last year, as the tightness in the PGM-rich supply may ease over the coming months, which should boost the PGM secondary supply in H2 2022 and offset the somewhat stagnating beginning of the year.

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GLOSSARY OF TERMS

Abbreviation	Term
(t)oz	Troy ounce
2E	Platinum, palladium
3E	Platinum, palladium, rhodium
3M	3 months
4E	Platinum, palladium, rhodium, gold
6E	Platinum, palladium, rhodium, iridium, ruthenium, and gold
ACP	Anglo American Platinum’s Converter Plant
COVID-19 (COVID)	Coronavirus Disease 2019
EU	European Union
FCEV	Fuel cell electric vehicle
HD	Heavy duty
HDD	Heavy duty diesel
JSE	Johannesburg stock exchange
koz	Thousand troy ounces
LHS	Left hand side
LMCA	LMC Automotive
LOHC	Liquid organic hydrogen carriers
LPPM	London Platinum and Palladium Market
LV	Light vehicle
M&A	Mergers and acquisitions
MMC	Mining metallurgical company
Moz	Million troy ounces
MW	Megawatt
NYMEX	New York Mercantile Exchange
OEM(s)	Original equipment manufacturers
OTC	Over the counter
PGM(s)	Platinum group metals
R&D	Research and Development
RHS	Right hand side
SO2	Sulphur dioxide
WIP	Work-in-progress material
YoY	Year-on-year
YTD	Year to date