

PLATINUM ESSENTIALS

Updating WPIC's two- to five-year supply/demand outlook: Consecutive years of deficits

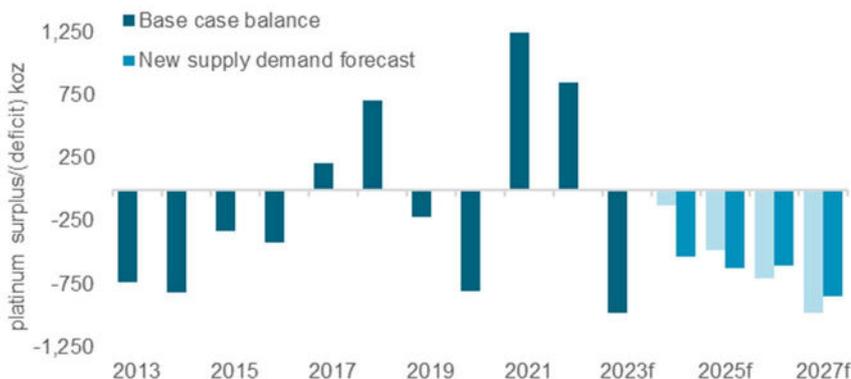
Our most recent [Platinum Quarterly](#) presented data for Q1 2023 and an updated outlook for full year 2023, including an expected full-year deficit of almost 1 Moz. This *Platinum Essentials* contains revised estimates for platinum supply/demand balances in the years 2024 to 2027. Since our [previous two- to five-year supply/demand update](#), both our total supply and total demand forecasts have been reduced. The net result is that we continue to expect a trend of consecutive deficits from 2024 to 2027. We are now expecting deeper deficits on average, at 8.3% of supply, versus 7.0% of supply previously.

The theme of downside risks is prominent across both platinum supply and demand (with the exception of [investment demand](#)). On the supply side, risks stem from operational challenges, electricity curtailments in South Africa and sanctions relating to Russia. From 2024, we are using the mid-point of published guidance. Published guidance is yet to reflect a prolonged impact of South African power supply shortages and hence suggests a recovery in production from 2024. Elsewhere, 2023 could prove informative as to Nornickel's ability to sustain production as it undertakes maintenance (including a smelter rebuild) without support from specialist Western OEMs.

From a demand perspective, the primary risks to platinum stem from absolute vehicle sales, battery electric vehicle penetration rates and the pace of hydrogen fuel cell electric vehicle adoption within the heavy-duty segment. Given global economic challenges, we have lowered our forecasts for the medium-term growth trajectory of light-duty vehicle production and expect volumes to remain below pre-pandemic levels until 2026 (previously 2024). In addition, we have raised our BEV penetration forecast by 3% to 27% in 2027f (which reaches 34% in 2030).

All estimates in this report are based upon publicly available information and WPIC in-house analysis*. Our demand forecasts accommodate a similarly subdued economic outlook as presented in March 2023. *This report complements, but is entirely separate from, the one year forward outlook we publish in our Platinum Quarterly (PQ), which is prepared independently for us by Metals Focus.*

Figure 1. WPIC projects platinum deficits from 2023



Source: SFA (Oxford) from 2013 to 2018, Metals Focus from 2019 to 2023f, Company guidance, WPIC Research from 2024f

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*WPIC in-house supply research is based solely on published supply data, including forward looking guidance, with any adjustments noted. It does not represent the views of any WPIC members or those of Metals Focus which independently prepare our Platinum Quarterly reports. Demand data is based on public data but includes WPIC in-house analysis.

Figure 2. Supply/demand summary table

	PUBLISHED PLATINUM QUARTERLY ESTIMATES†				WPIC ESTIMATES‡			
	2020	2021	2022	2023f	2024f	2025f	2026f	2027f
PLATINUM SUPPLY								
Refined mine production								
- South Africa	3,298	4,678	3,915	3,873	4,262	4,304	4,257	4,227
- Zimbabwe	448	485	480	502	502	603	603	603
- North America	337	273	263	284	311	321	331	336
- Russia	704	652	663	647	624	624	624	624
- Other	202	208	201	205	204	205	204	204
- Producer inventory movement	-84	-93	43	0	0	0	0	0
Total mining supply	4,906	6,204	5,565	5,511	5,902	6,056	6,019	5,993
Total recycling	1,997	2,079	1,691	1,682	1,869	1,832	1,868	1,861
Total supply	6,903	8,283	7,256	7,193	7,771	7,888	7,886	7,854
PLATINUM DEMAND								
Automotive	2,324	2,555	2,897	3,255	3,605	3,713	3,708	3,845
Jewellery	1,830	1,953	1,899	1,861	1,831	1,829	1,860	1,886
Industrial	2,018	2,538	2,245	2,628	2,406	2,508	2,461	2,513
Total investment	1,536	-56	-640	433	460	460	460	460
- Bar and coin	571	324	225	403	310	310	310	310
- ETF	507	-241	-558	30	150	150	150	150
- Stocks held by exchanges	458	-139	-307	0	0	0	0	0
Total demand	7,709	6,990	6,401	8,176	8,302	8,510	8,489	8,705
Supply/demand balance	-806	1,293	854	-983	-531	-621	-602	-851

†The Platinum Quarterly report and data are prepared independently for the WPIC by Metals Focus

‡WPIC estimates and analysis are based upon publicly available information

Source: Metals Focus from 2020 to 2023f, Company guidance, WPIC Research from 2024f

Introduction

The WPIC's two- to five-year platinum supply and demand projections are intended to complement the estimates and forecasts published in our *Platinum Quarterly*, but they look further into the future and allow for longer-term scenario analysis. The *Platinum Quarterly* report and data are prepared independently for the WPIC by Metals Focus, with Metals Focus's estimates provided on a one year forward basis (currently 2023). For the avoidance of doubt, all estimates for 2024 to 2027 included in this report are WPIC forecasts, with the exception of mine supply which is based upon publicly published company guidance. Specifically, WPIC has made no use of any data or views included in Metals Focus's separate five-year forecast available to its customers, that provides an outlook for all PGMs.

The WPIC has not attempted to develop further in-country and in-industry relationships to obtain fresh/incremental data and the information and sources used to develop our supply/demand model are all in the public domain.

Please see the appendix for a complete description of the methodologies we have used to develop each model and section of this report as well as a risk analysis for our forecasts.

WPIC's base case published supply/demand projections for 2024 to 2027 provide the ability to run scenario analysis on different parts of the supply/demand landscape.

Key projections

Our revised outlook is compared to the supply/demand *Platinum Essentials* published in [March 2023](#). Since then, we have seen the macroeconomic overlay remain volatile for the world as a whole. Most notably, China’s relaxing of COVID restrictions has not resulted in a post-pandemic economic boon that many had predicted, with industrial activity recovering at a slower rate than service sectors. In developed markets, the US approved a raising of the debt ceiling after months of stalemate. However, expectations have continued to vacillate regarding the potential tapering (or not) of rate increases as the central banks fight inflation and reasonably robust labour markets. We have accommodated the additional economic considerations in our revised two- to five-year outlook.

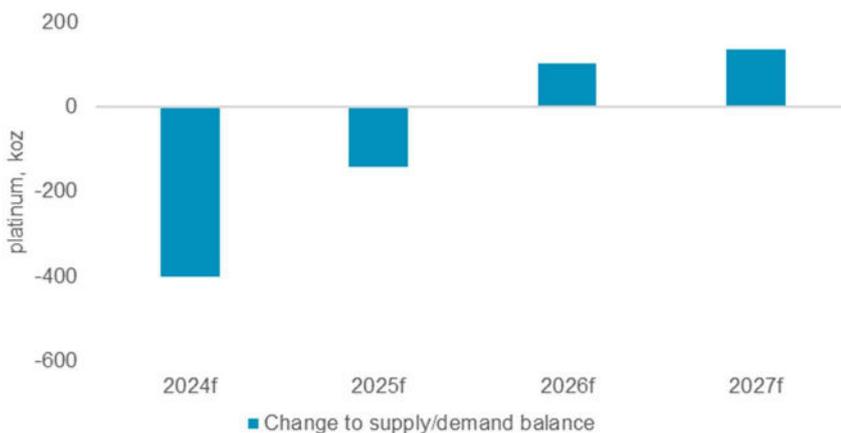
For the period 2024-2027, we have made the following key revisions to our projections:

- **Total mining supply** is forecast to be 5% lower on average following a re-evaluation of metal flows through the mine to market value chain. This includes how the non-integrated producers utilise a combination of purchase of concentrate and/or tolling contracts.
- **Automotive demand** is forecast to be 5% lower on average, attributable to revisions in vehicle production forecasts and drivetrain mix. Revisions are more heavily weighted to 2026 and 2027.
- **Investment demand, always measured on a net basis**, is forecast to be 100 koz lower on average based on our methodology of averaging annual demand since 2013 (i.e. since the beginning of the *WPIC Platinum Quarterly* dataset). We note, however that the projected deficits may prove an attractive lure to investors, which could result in investment demand running ahead of our long-term average based methodology.

Both supply and demand has been lowered in our latest outlook

Both mine supply and automotive demand have been trimmed by 5% on average, but with automotive demand representing only 37% of total demand and mine supply representing 76% of total supply, the changes increase the supply/demand imbalance in favour of deeper average deficits. There is also a timing differential in the magnitude of the reductions to mine supply and automotive demand, which act to deepen the deficits in 2024 and 2025 but reduce the deficits in 2026 and 2027.

Figure 3. Changes to platinum markets deficits are most material in 2024f, while less material through 2025f to 2027f



Source: WPIC Research

Conclusion – Year-on-year deficits

As shown below, the net impact of the changes to our 2027 forecast is a 130 koz reduction in the forecast deficit to 851 koz. Although we have reduced our 2027 deficit forecast, the route towards what remains substantial deficits in 2027 has evolved to reflect a deeper starting deficit in 2024 with a less volatile trajectory over the four years. Notably, consecutive years of platinum market deficits are still forecast to occur. Moreover, the result of our changes is that deficits are expected to average 8.3% of total platinum supply between 2024 to 2027 compared to previous forecasts for deficits to average 7.0%.

Consequently, we estimate that above ground stocks will fall to only seven weeks of demand by the end of 2027, potentially their lowest level since records began (*historical data*).

Risks biased to the downside – at least for supply

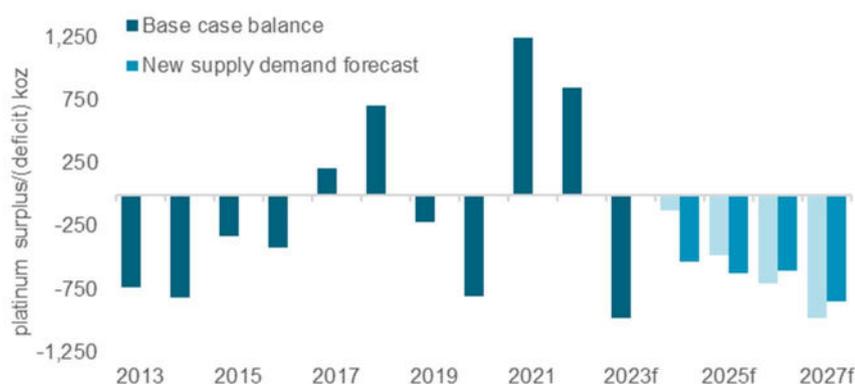
Whilst we are confident in the outlook for sustained deficits, there is the potential that the deficits could be deeper than projected. We are continuing to use the mid-point of aggregated published mining company production guidance, which results in a ~400 koz bump in mine supply between 2023 (estimated by Metals Focus) and 2024 (mid-point of aggregate published company guidance). We note that this 7% year-on-year increase in mine supply comes despite the threats of power shortages in South Africa and the impact of sanctions on production from Russia.

Quantifying the risks of worsening power shortages and sanctions on Russian output: The South African miners have cautioned that a worsening of power availability from current levels could negatively impact output by between 5% to 15% in 2023 alone. Equally, whilst Nornickel has provided no definitive indication of the potential impact of sanctions on future output, a 5-15% downside risk feels intuitively about right.

Factoring in the mine supply risks at the midpoint of the range (10% downside), the projected deficits would be about 500 koz p.a greater than presented.

Supply will require support from above ground stocks to meet platinum demand as consecutive years of deficits accrue

Figure 4. The platinum deficit is expected narrow in 2024 on increasing supply before returning to deeper and increasing deficits from 2025 and beyond



Source: SFA (Oxford) from 2013 to 2018, Metals Focus from 2019 to 2023f, Company guidance, WPIC Research from 2024f – 2027f

Platinum demand outlook relatively resilient in the near-term despite a soft economic outlook

With persistent geopolitical tensions and macroeconomic uncertainties, the global economic outlook has continued to be depressed. In terms of the forecast period, current projections are for 2023 to be the year that is most significantly challenged economically, with the outlook improving in 2024, although still remaining subdued.

Significant macro uncertainties remain.

The platinum outlook for 2023, as published in the last *Platinum Quarterly*, incorporates recessionary risks, whilst the demand outlook for 2024 and beyond presented in this report, include the economic overlay in the table below. Note that we expect deteriorating real consumer purchasing power as determined by taking consensus GDP less consensus CPI estimates.

Figure 5. Estimated changes to real consumer purchasing power versus the end of 2021

	2023	2024
North America	-3.1%	-1.8%
Western Europe	-5.2%	-1.5%
Japan	-1.7%	-0.4%
China	3.9%	2.7%
Rest of the World	-2.9%	-0.8%

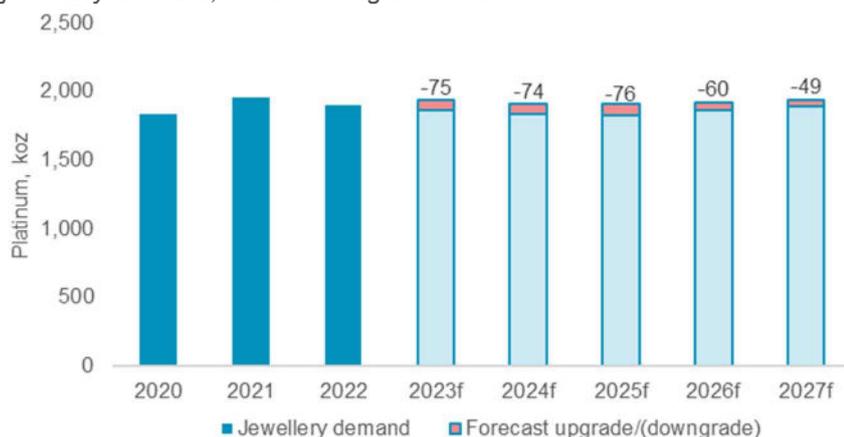
Source: Bloomberg, WPIC Research

Notably the 28% year-on-year growth in platinum demand is the primary driver that transitions supply demand balances from a surplus in 2022 to sustained deficits from 2023 and beyond. Whilst the economic outlook appears somewhat shaky, the platinum market is, perhaps, surprisingly well insulated from the challenges ahead. Platinum demand volatility is dampened by platinum's diverse end markets which are underpinned by different economic drivers.

Platinum demand is diverse, with end-uses typically underpinned by different economic drivers.

As evidence, downward revisions to our platinum jewellery demand forecasts have been offset by upward revisions to our industrial platinum demand forecasts between 2024 to 2027 (-4% on average versus +3% on average). The cessation of China's zero-COVID policies at the end of 2022 supported previous optimism for a recovery in Chinese platinum jewellery demand. However, Chinese jewellery demand growth has not materialised in Q1 2023, with domestic consumers showing a preference for gold at present.

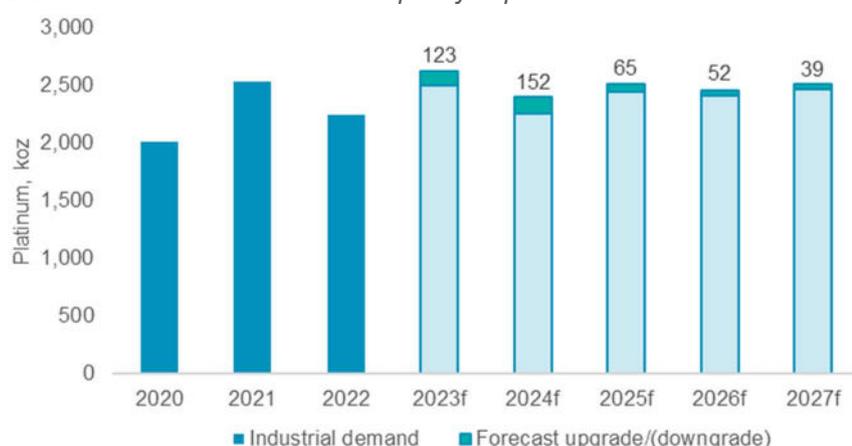
Figure 6. China's "re-opening" has not materialised in higher platinum jewellery demand, necessitating downward revisions



Source: Metals Focus 2020 - 2023f, WPIC Research 2024f - 2027f

Conversely, Industrial demand is relatively well protected from near-term recessionary headwinds. Industrial demand for platinum is influenced more by multi-year capacity addition decisions rather than short-term demand fluctuations, with 2023 forecast to reflect record industrial platinum demand of 2,628 koz. With capacity additions for 2023 mostly committed to financially and in terms of construction progress, downside risks are biased towards 2024 and beyond. Reflecting the economic overlay, as well as an approximation of the impact of the timing of capacity additions, industrial demand in 2024 is expected to decline by 8% year-on-year to 2,407 koz. It is then expected to grow modestly to average 2,494 koz over the rest of the period between 2025 to 2027. Note that industrial demand includes hydrogen demand for platinum for use in PEM electrolyzers, which is expected to grow substantially in the coming years, supported by significant government subsidies. Deducting PEM electrolyser demand for platinum, we are projecting a fall in industrial demand (~3% CAGR to 2027) for other applications. This represents a conservative outlook when contrasted with the 5% CAGR industrial demand has achieved since 2013.

Figure 7. Industrial platinum demand is forecast to reach record levels in 2023 attributable to committed capacity expansions



Source: Metals Focus 2020 - 2023f, WPIC Research 2024f - 2027f

Automotive demand

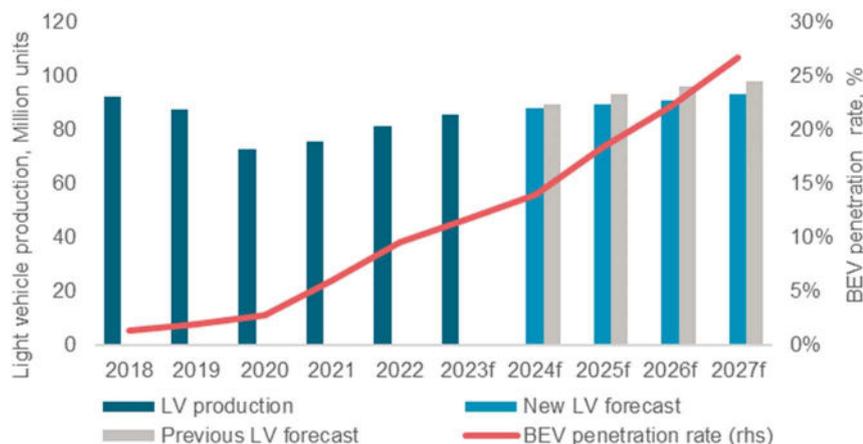
Less disposable income will impact the ability for some consumers to purchase new vehicles. However, we estimate that recessionary levels of consumer demand are, at worst, in line with the production levels that the automakers are expecting to be able to deliver. Additionally, after three years of significant automotive production shortfalls, we believe that there remains an element of pent-up demand for replacement vehicles, partially offset by the lower mileages driven during COVID allowing for some vehicles to be run for longer. Furthermore, automaker inventories remain suppressed, and although we do not expect them to return to historical levels, there is likely to be some continued restocking.

We expect these challenges to have largely washed through by 2024 with production of light vehicles to grow by 3% to 88M units. However, where we previously expected steady light vehicle demand growth between 2024 to 2027, we now anticipate that higher long run interest rates and eroded purchasing power will likely weigh on automotive growth. As a consequence, we now expect that light vehicle sales will only exceed pre-pandemic figures of ~92M units in 2027 compared to 2025 previously.

Recessionary levels of automotive demand are above automakers currently constrained supply capabilities.

Additionally, we have revised our forecasts for zero-PGM containing battery electric vehicles (BEV). BEV production increased by 73% year-on-year in 2022. We expect BEV production to increase by a 26% CAGR between 2022 to 2027 to 25M units to reach a global penetration of 27% (24% previously). For reference: although beyond the scope of our supply/demand projections, we expect BEV penetration rates to reach 34% in 2030. Upward revisions to our BEV penetration forecasts are attributable to further policy announcements (notably in the US and UK), whilst corporate announcements for BEV production capabilities in the US have accelerated into 2023 following the 2022 announcement of the Inflation Reduction Act.

Figure 8. Light-duty vehicle production volumes are expected to increase through our forecast period



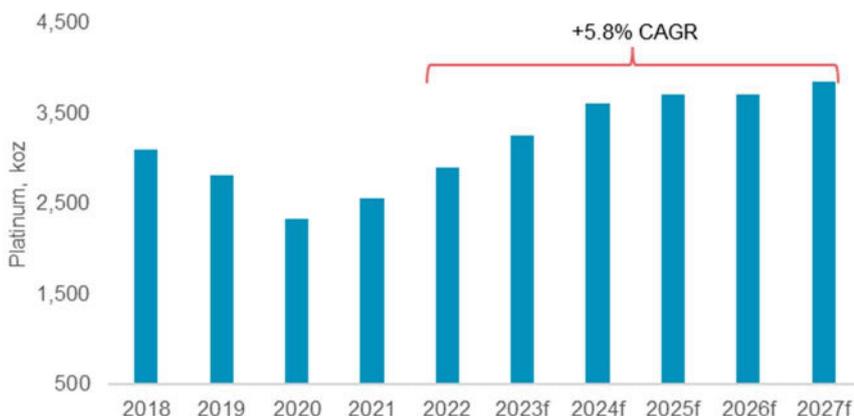
Source: OICA data 2018 - 2022, WPIC Research 2023f - 2027f

The combination of lower absolute vehicle production and higher BEV penetrations accounts for lower automotive platinum demand forecasts of 187 koz on average between 2024 to 2027. Nevertheless, we forecast platinum automotive demand will increase by a 5.8% CAGR between 2022 to 2027 to 3,845 koz attributable to ongoing growth in substitution from Palladium, higher loadings on heavy-duty vehicles (principally in China) and increasing fuel cell electric vehicle production (initially underpinned by heavy-duty) as part of a growing hydrogen economy.

Automotive platinum demand should increase through 2027 despite the electrification of the drivetrain

To add some additional colour to the outlook for ICE vehicles, we expect ICE production to peak in 2024, albeit at levels well below the previous high-water mark in 2027. However, increasing substitution and higher loadings mean that ICE demand for platinum doesn't peak until 2025 - 2026.

Figure 9. Automotive platinum demand is forecast to increase over the medium term



Source: Metals Focus 2018 to 2023f, WPIC Research 2024f - 2027f

Investment demand

Investment demand is another area of uncertainty. Whilst bar and coin demand tends to be resilient, or even grows, during recessions or periods of heightened uncertainty (e.g. during COVID’s peak years), the outlook for ETF investments and exchange stocks is harder to call. Recent ETF disinvestment during 2021 and 2022 has been a function of macro asset allocation in a rising interest environment, assisted by asset class agnostic investors rotating into the futures or forward markets, which have been in backwardation. Our methodology is to use a ten-year historic average of investment demand as the basis for our forecasts, which following ETF divestments in 2022 results in a reduction in forecast ETF demand by 100 koz to 150 koz p.a. between 2024 to 2027. Elsewhere, bar and coin demand assumptions are unchanged at 310 koz pa.

We note, however that a series of deficits may prove an attractive lure to investors, which may result in investment demand running ahead of our long-term average based methodology.

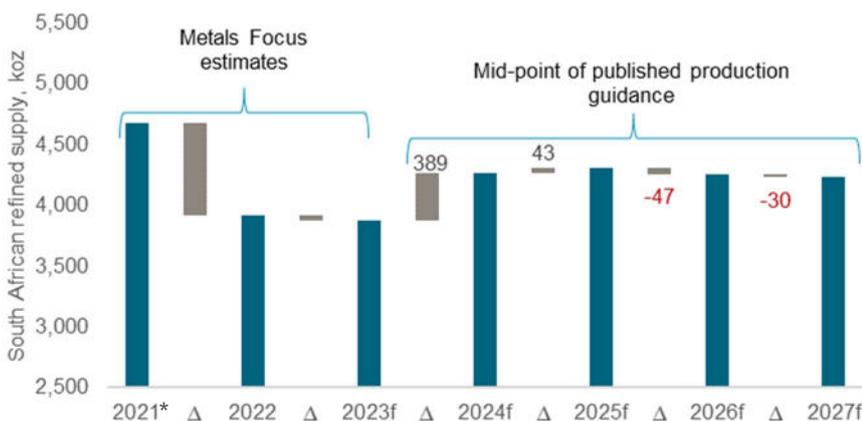
Mining – risks biased to the downside

South Africa’s platinum production declined by 16% year-on-year in 2022. The 2023 South African supply forecast provided in our latest *Platinum Quarterly* includes a 1.1% year-on-year decline in refined production following a 62 koz downward revision to the initial supply forecast. South Africa has been impacted by a worsening of load shedding (i.e. power curtailments), other externalities (security etc.), planned and unplanned maintenance and project ramp-up timing. Notably average annual South African refined platinum mine supply over 2022 and 2023f of 3.9 Moz is 11% below South Africa’s average production of 4.3 Moz between 2015 to 2019 (i.e. the five years prior COVID).

Using the mid-point of published guidance suggests that South Africa’s primary supply recovers to near pre-COVID levels between 2024 to 2027. South African output largely plateaus from 2025, with currently announced capital investments predominantly appearing geared to maintaining existing production levels rather than growing output. This reflects the recent basket price volatility, as well as inflationary and recessionary risks weighing on investment decisions for large capital projects. For new projects, rising interest rates also compress expected returns unless there is a corresponding increase in commodity prices, which have not yet manifested.

ESKOM represents an ongoing risk to South African PGM supply.

Figure 10. Without incremental investments, current project growth is offset by aging assets leading to a plateauing of platinum supply



Source: Metals Focus 2021-2023f, Published company guidance, WPIC Research 2024f - 2027f, *note that refined mine supply in 2021 was boosted above average annual production rates by the unwinding of work in progress inventory associated with the 2020 ACP outage

Recent trends suggest downside risks are more prevalent to platinum supply. Mining supply represents a risk looking forward particularly as management teams have not begun detailing the impacts of persistent load shedding on their production guidance beyond 2023. During Q1 2023, South Africa's two largest producers reported in quarterly updates a combined 43 koz build in 6E PGM work-in-process (WIP) inventories due to load shedding. If power constraints deteriorate during the South African winter, this could imply similar or higher WIP builds in the coming quarters. Whilst at London Platinum Week in May 2023, PGM miners reiterated previous commentary about load shedding potentially causing a 5% to 15% impact to refined production.

The WPIC makes no assumptions about the timing of when PGM miners will work through excess WIP inventories.

Whilst Nornickel has provided no definitive indication of the potential impact of sanctions on future output, a 5-15% downside risk feels intuitively about right (similar to expectations for the South African producers). We note that Nornickel has planned smelter maintenance scheduled for 2023. The rebuild will occur without Western OEM expertise and we believe the success of Nornickel's project execution could prove illuminating with regards to future production expectations. Thus far, Nornickel has managed to maintain output at planned levels, despite the sanctions enacted against Russia since the onset of the Ukraine war. The mid-point of Nornickel's platinum production guidance for 2023 is 624 koz which is a 4.1% implied reduction in output relative 2022.

Notwithstanding supply side risks, we deliberately do not take a view on production levels, and so stick to the mid-point of published company guidance, particularly with updates provided alongside recent financial reporting. Nornickel has pulled medium- and longer-term guidance, and we have rolled 2023 production guidance forward to 2024 and beyond.

Supply/demand balances for 2024-2027

Having updated our supply/demand outlook for 2024 to 2027, we highlight three considerations. Firstly, platinum markets are expected to record consecutive years of supply deficits, which, given inelastic supply, will likely require the market to draw down above ground stocks to meet demand. It is not known what platinum price will be necessary to attract the portion of above ground stocks required to meet the supply shortfall. Nor, what impact having almost 80% of above ground stocks located in China (and effectively unavailable), will have on metal flows and price.

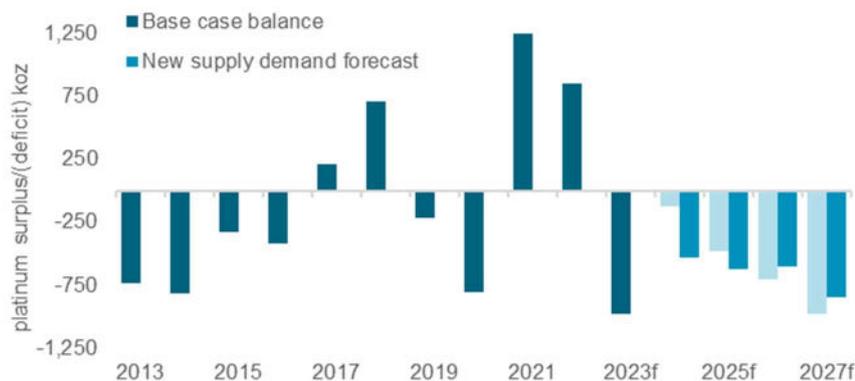
Secondly, with refined production forecast to recover in 2024 and thereafter plateau, the increasing supply deficits from 2024 to 2027 are illustrative of continued growth in demand. Platinum demand growth is underpinned by the automotive sector where substitution, tighter regulation and the hydrogen economy are expected to increase platinum demand. Elsewhere, industrial platinum demand has historically grown at ~two times global GDP over the past decade.

Nornickel has flagged an impact from sanctions underpinning risks to Russian production.

Finally, despite a ~130 koz reduction in our 2027f platinum supply deficit forecast to 851 koz, we highlight that deeper deficits forecast for 2024 and 2025 result in larger average supply deficits for the period as a whole. We now estimate platinum supply deficits will average 8.3% of supply between 2024 to 2027 compared to our previous forecast of 7.0% on average.

After a narrowing of deficits in 2024, platinum supply deficits should be sustained and increase to 2027.

Figure 11. Supply/demand balances at the mid and lower points of aggregate guidance.

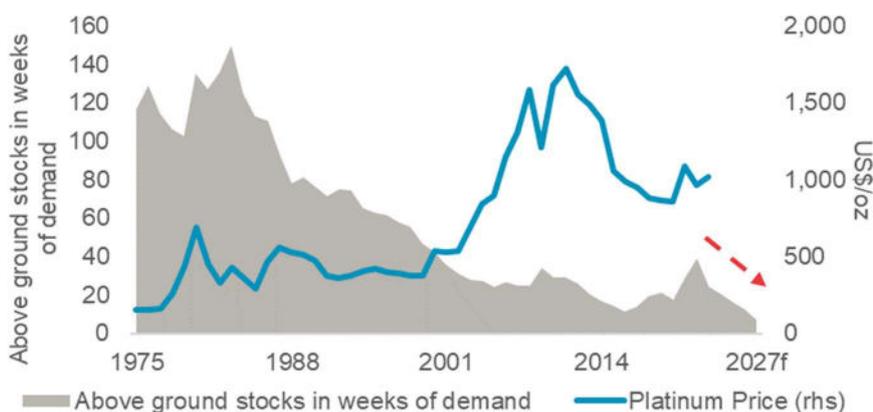


Source: Metals Focus 2019-2023f, SFA (Oxford) 2013-2018, Published company guidance, WPIC Research 2024f – 2027f

Above ground stocks

The significant deficits projected for 2023 and beyond are expected to result in the market drawing heavily from above ground stocks in order to meet demand requirements. We estimate that above ground stocks will fall to only seven weeks of demand by the end of 2027, potentially their lowest level since records begin.

Figure 12. Above ground stocks in weeks of demand, have risen fourfold since 2016, but are expected to fall precipitously this year, and with no change to supply/demand fundamentals, continue to fall in 2024 and beyond.



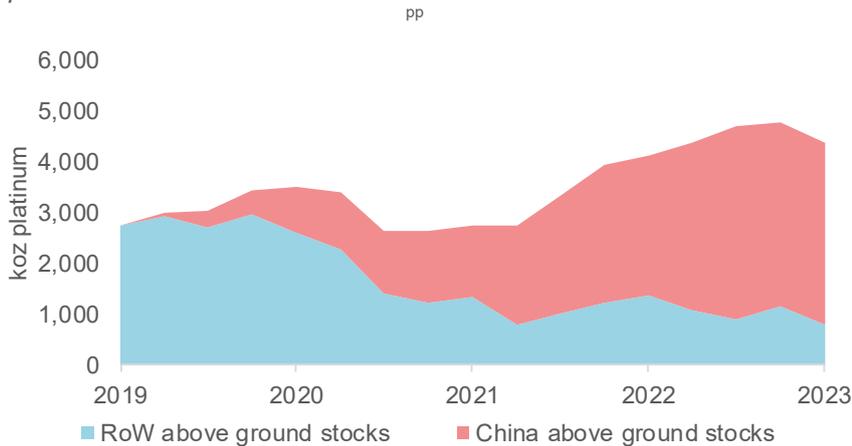
Source: Johnson Matthey supply/demand balance pre-2013, SFA (Oxford) 2013-2018, Metals Focus 2019-2023f, WPIC research 2024f onwards and above ground stock estimate pre-2012

The question is, are sufficient above ground stocks available at the current platinum price to meet demand requirements or will the price need to move higher to entice material into the market?

In addition, we again note that China’s imports, well in excess of identified demand, have resulted in the majority of above ground stocks becoming concentrated there, with stocks in the rest of the world seemingly scarce. Given China’s export restrictions for strategic minerals, including PGMs, mean that platinum stocks are effectively locked up in China, it is not clear whether above ground stocks are available to the rest of the world users of platinum beyond 2023.

Above ground stocks have become concentrated in China, creating uncertainty around the availability of above ground stocks to the rest of the world (note this is up to date to the end of Q1'23).

Figure 13. With >80% of above ground stocks concentrated in China, export restrictions mean there is limited reserves in the rest of the world



Source: Bloomberg, Metals Focus, WPIC research

WPIC aims to increase investment in platinum

World Platinum Investment Council -WPIC- was established by the leading South African PGM miners in 2014 to increase investment ownership in platinum. This is done through both actionable insights and targeted development. We provide investors with information to support informed decisions e.g. through [Platinum Quarterly](#), [Platinum Perspectives](#) (monthly) and [Platinum Essentials](#) (now monthly). We also analyse the platinum investment value chain by investor, product, channel and geography and work with partners to enhance market efficiency and increase the range of cost-effective products available to investors of all types.

WPIC is not regulated to provide investment advice: see [Notice and Disclaimer](#).

Appendix I – Risks to forecasts

- Small changes can have significant impacts on supply/demand balances. For example a 5% change in total mine supply moves the supply/demand balance by an average of 316 koz p.a. over the years 2024-2027.
- The most significant risks to our outlook derive from macroeconomic factors which would similarly impact the demand for all commodities. Principally the risks that the combination of slowing economic growth and inflation bring to bear on consumer demand for goods that either contain platinum or for which the manufacturing process uses platinum.
- We think automotive production levels remains constrained below the level of consumer recessionary demand, but a worsening of the outlook could prove our estimates to be optimistic. Potentially balancing this risk, we have taken a conservative view on the levels of platinum for palladium substitution in gasoline vehicles.
- The impact of a recessionary environment on industrial and jewellery demand could be more severe than we have allowed for.
- Investment demand is potentially where the greatest risks lie. We are most confident in our projections for bar and coin demand and exchange stocks, but the risk of a continuation of the momentum behind ETF disinvestment is potentially significant. However, a clear shift in supply/demand balances into deficits should act to discourage further “net” selling.

Appendix II – WPIC outlook methodologies

Preamble

The WPIC’s platinum supply and demand model is intended to complement the one year out forecast published in our *Platinum Quarterly*, but to look further into the future to provide the basis for longer-term scenario analysis of particular aspects of supply and demand. The *Platinum Quarterly* report and data are prepared independently for the WPIC by Metals Focus.

The WPIC has not attempted to develop in-country and in-industry relationships to obtain data and the information and sources used to develop the underpinnings of WPIC’s supply/demand model are all in the public domain.

Despite us having granular views of each demand segment, we have chosen, to use a simplified and conservative approach to forecasting. This provides us with our best current base case to allow scenario analysis while we increase modelling detail and publish more granular results in future reports.

Different methodologies in different segments

The WPIC’s platinum supply/demand methodology is built up as follows for the years 2024-2027:

Refined mining supply: Our refined mining supply outlook is strictly based on each company’s public guidance for future production. This applies for WPIC members and non-members alike.

The production outlook for 2022 was characterised by continual downgrades to the annual production guidance as producers were caught off-guard by production challenges over and above the levels anticipated when setting guidance at the beginning of the year. Specific to South Africa, these were accentuated by power shortages related to ESKOM's well publicised difficulties, whereas in Russia, Nornickel cautioned that sanctions were restricting its access to mining equipment spares and reagents. Companies typically only change longer-term guidance once a year, usually around year end, so although a number of guidance adjustments were made for 2022 the longer-term guidance ranges were not revised until annual investor updates (mainly in the first two weeks of December), which resulted in us using the bottom end of guidance ranges for the first two two-five-year outlooks. Now that longer term guidance ranges have now been updated, for the most part, we have moved to using the mid-point of production guidance ranges, which feed into our overall supply/demand forecasts.

The guidance published by the PGM mining companies is typically provided for the combination of PGMs contained in the ore bodies mined by the respective companies, and expressed on a six-, four-, or two-element basis (6E, 4E or 2E respectively) including either: platinum, palladium, rhodium, ruthenium, iridium and gold; platinum, palladium, rhodium and gold; or platinum and palladium. Where guidance excludes specific reference to platinum, we have calculated refined platinum guidance by using the historical production ratios of these metals as published by the specific company. Where individual PGM mining companies do not provide refined mine supply guidance or where such guidance does not cover the period to 2026, we forecast that platinum mining supply remains at the level of the final year for which guidance, or production, is available. We have remained impartial to: the extent of mineral reserves and resources, the ability to extend mine lives, any potential smelter, precious or base metal refinery capacity constraints, the technical hurdles or timelines to complete capital projects, and the impact a change in PGM prices might have on mined supply.

Recycling supply: Automotive recycling can be determined by purchasing consecutive annual global vehicle registration data and determining detailed regional scrappage rates to apply to average vehicle platinum loadings, when manufactured, per region. We have not chosen to fund this high-cost exercise and have used a simplified approach using the published average vehicle life across all regions and determining the portion of annual platinum demand in the year of manufacture that reflects as recycled supply at the end of that average life. We use the average of this ratio over the past 20 years to calculate our forecast. Jewellery and industrial recycling rates are projections based upon historical ten-year trends.

Automotive demand: Automotive demand projections are a function of the WPIC's drivetrain outlook in combination with estimated autocatalyst platinum loadings and engine sizes for different vehicle categories in different geographies. Automotive production and the drivetrain estimates are based upon historical production numbers and trends as well as announced future regulations and WPIC's view of the pace of electrification and the phasing out of internal combustion engines. Future platinum loadings in autocatalysts are based upon historical loadings that are available in the public domain or can be calculated from published data, adjusted for WPIC's estimates of the impact of regulatory changes in different geographies, such as tightening emissions standards, as well as the rate of substitution of platinum for

palladium in gasoline engines. FCEV demand for platinum has been added to the automotive demand outlook as a separate demand component.

Jewellery demand: The outlook for jewellery is predicated on recent historical trends by geography, projected into the future, with some allowance for a slowing of the trend away from platinum jewellery in China, and a return to modest growth in India.

Industrial demand: Industrial demand projections are based upon historical trends within each sub-category. This results in relatively steady trend projections, whereas in practice industrial demand is more volatile, depending upon the timing of capacity additions. Nonetheless, while industrial demand can be volatile, the multi-year trends have been very consistent and do provide a good guide to the future, added to which, in practice the annual volatility seen within each industrial sub-category tends to even each other out when totalled up. Platinum industrial demand is the demand segment most closely correlated to global economic growth over the long term. Despite the compound annual growth of platinum industrial demand over the past 30 years significantly exceeding global growth, our forecast, based on more recent historical trends, is closer to forecast global growth. Projected stationary fuel cell and electrolyser demand have been included in the other industrial category.

Investment demand: While we have granular insight into investment demand due to the views of our many product partners around the world and our regular interaction with investors, we have chosen to use a ten-year historic average of investment demand as the basis for our forecasts. This is to reduce the dramatic positive impact of extremely strong global ETF demand in 2019 and 2020 and similarly strong bar and coin demand in 2020 and 2021. Furthermore, we have not included the likely impact on investment demand of any material changes in price. For example, if the market is seen with successive, and increasing deficits as we are projecting, then it is likely that investors might expect the platinum price to move higher to reflect the shortage of metal available to the market and consequently increase their exposure by purchasing platinum metal or ETFs. This would in turn accentuate future deficits. We do not attempt to capture this iterative process and rather choose to maintain future investment demand at a level based on a ten-year historic average. Consequently, we include bar and coin investment demand of 310 koz p.a., and ETF demand of 150 koz p.a. We have assumed a net change in stocks held by exchanges of zero each year over the forecast period as those flows are typically short-term in nature to address atypical developments in the physical market and furthermore, primarily reflect the movement of metal between visible and non-visible inventories.

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