

THE PLATINUM STANDARD

SEPTEMBER 2014



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Foreword

The importance of the US to platinum

Following on from the resounding success of the first issue of *The Platinum Standard* earlier this year, putting together the second, for release at New York Platinum Week, raised an interesting question: *just how important is the US to the platinum market?*

Back in 1975, the US kick-started automotive demand for platinum – now the PGM market's biggest end-use – when the country promulgated tighter tailpipe emissions standards which required for the first time catalytic converters to be installed in automotive vehicles. In order to achieve this without poisoning the catalysts, the country led the way on removing lead from gasoline. At its peak in the early 2000s, the automotive industry in North America consumed close to 1 moz of platinum. However, that figure has since reduced to less than 400 koz, owing largely to substitution to the cheaper palladium.

Last year, North America consumed just 13% of global demand, supplying only 12% of the world's platinum intake, including recycling.

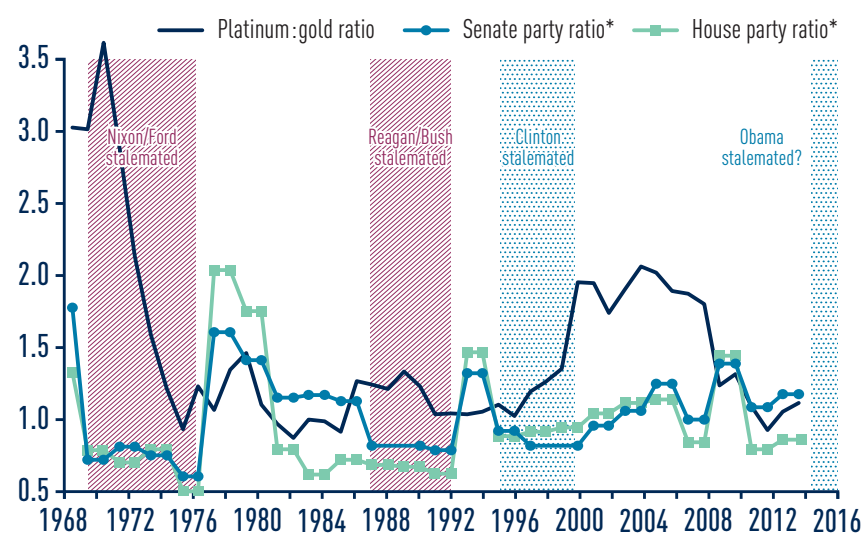
In terms of dictating the price, however, the US continues to make the difference. While its ETFs now account for only 19% of global holdings, the NYMEX remains the centre of the world for the platinum futures market.

Below, precious metals expert *Andy Smith* offers his take on the link between the US and platinum prices against those of gold.

America decides... the platinum:gold ratio

In November 2014, some 36 Senate seats will be contested by US politicians. The Democrats currently enjoy a 55-45 majority, but recent polls [Realclearpolitics] show a swing to the Republican side, leaving the Senate race split down the middle, with Democrats holding 45 seats and Republicans 46 seats. It is likely, therefore, that the Senate, like the House, will soon be run by the party in opposition to the President – only the fourth such instance since 1968 (when the gold price was freed).

DC deadlock unlocks platinum:gold ratio



Source: Andy Smith

Platinum:gold price ratio when:		Macro Memo:
President stalemated		GDP growth%
1969-76	2.08	2.1
1987-92	1.19	2.8
1995-00	1.32	4.0
Average	1.53	3.2
President party majority Senate+House		GDP growth %
1977-80	1.25	3.3
1993-94	1.05	3.4
2003-06	1.97	3.2
2009-10	1.28	-0.2
Average	1.39	2.4

Source: Andy Smith

The notion that this Washington deadlock benefits platinum's premium over gold – in tying Presidential hands, allowing markets to operate more freely and so the economy to grow faster – has some statistical support; the average platinum:gold ratio in 'stalemate' periods is higher than when the President has enjoyed majorities in both the Senate and House (so could do 'more' to hamper US growth).

However, averages can – and in this case do – mask extremes. When Presidents Nixon and Ford faced united Congressional opposition by the Democrats, the platinum:gold ratio plummeted – mainly because Nixon severed the dollar's fixed link to gold in August 1971, revaluing gold. In sharp contrast, when President Clinton was hamstrung by Republican majorities in both the Senate and House, the platinum:gold ratio soared, in part because of a technology-driven economic renaissance/bubble.

Might a similarly stymied President Obama seek to devalue the dollar, and so goose gold disproportionately, or go golfing, thus allowing the US, and platinum, relatively, to prosper? Or, since little can be below it, is the platinum:gold ratio above US politics?

In this issue

As before, in this issue of *The Platinum Standard* we have written three feature articles on the key themes we deem the most interesting and important as we look ahead within an industry rife with change and development. These articles are:

Breaking new ground: The search for new sources of primary supply

Samantha Trickey, Principal Supply Analyst, SFA (Oxford) Ltd

The realities of physical platinum investment

Dr Ralph Grimble, Senior Market Analyst, SFA (Oxford) Ltd

Fuel cell vehicles: Coming to a car park near you. Eventually.

Dr Kerry-Ann Adamson, CEO and Founder, 4th Energy Wave

As ever, a sincere thank you for your on-going support of SFA (Oxford) as we endeavour to bring you an independent, authoritative take on PGMs and their markets.

THE SFA (OXFORD) TEAM

**Breaking new ground:
The search for new sources
of primary supply**



Breaking new ground: The search for new sources of primary supply

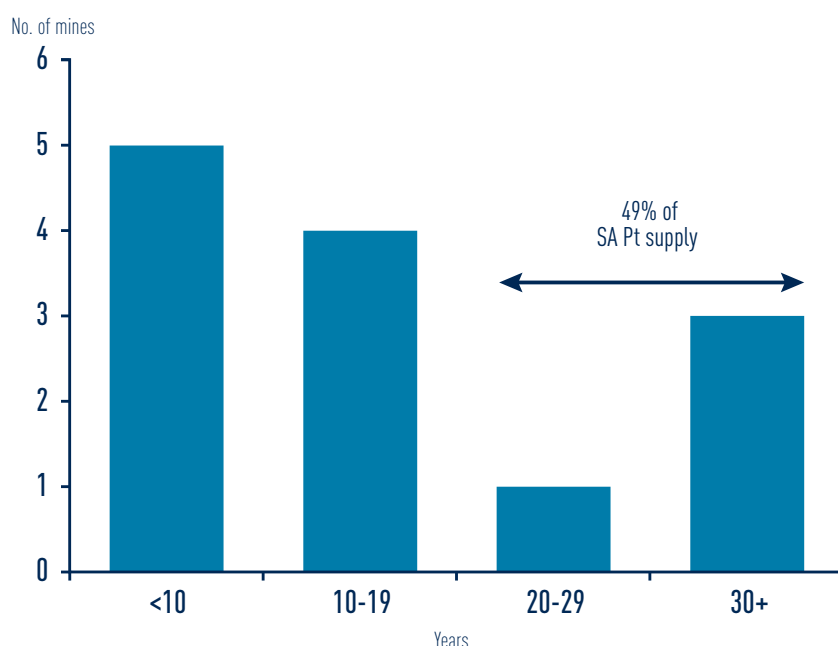
Samantha Trickey, Principal Supply Analyst, SFA (Oxford) Ltd

The supply landscape

Global primary PGM supply is in decline. South African platinum mine supply peaked at 5.3 moz in 2006, accounting for 78% of global output. Production is forecast to dip below 3 moz this year (62% of global supply), for the first time since 1992.

Of South African platinum production, 1.5 moz derives from mines that are at least 20 years old and just 0.4 moz from operations that have been commissioned within the past ten years. As mature mines extract reserves from deeper levels, this has an important bearing on cost competitiveness. Mining high-quality Merensky ore at deep levels (>1,500 mbs) has been shown to be economic, even in recent years, but chasing UG2 ore deeper is a high-risk strategy given volatile rhodium price exposure.

Age of South African operations



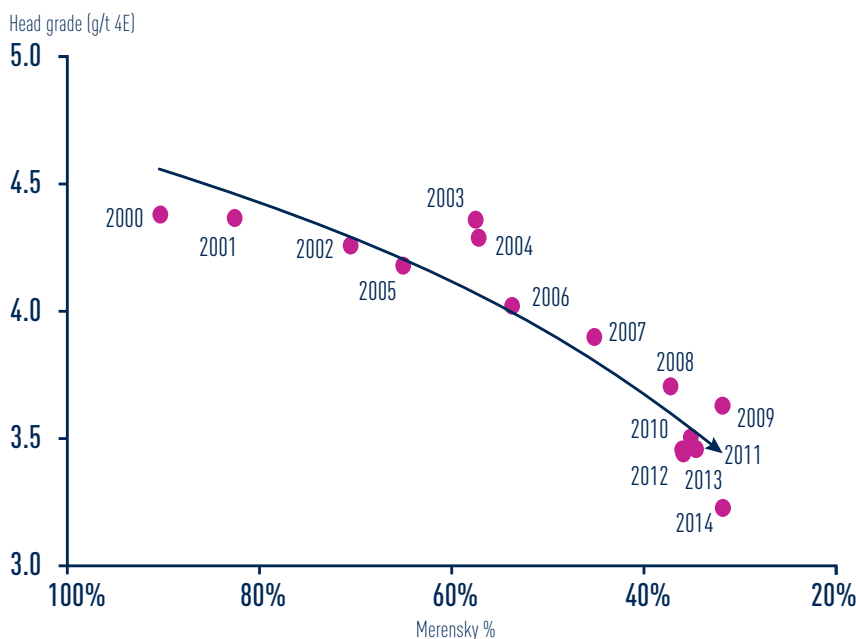
Source: SFA (Oxford)

The ore mix of production for South Africa is becoming increasingly weighted towards the UG2 Reef. The Merensky Reef accounted for 92% of ore mined in 2000, excluding the Platreef, decreasing to 34% today (shown in the chart overleaf). Concurrently, the weighted average PGM head grade has decreased by 26%. For mature capacity (20+ years old), Merensky production has reduced by 69% since 2000, while UG2 Reef extraction has declined by 8%, with a resultant 28% drop in PGM head grade.

Almost 50% of South African production capacity is mature

UG2 ratio of output is increasing, at the expense of head grade

South African production

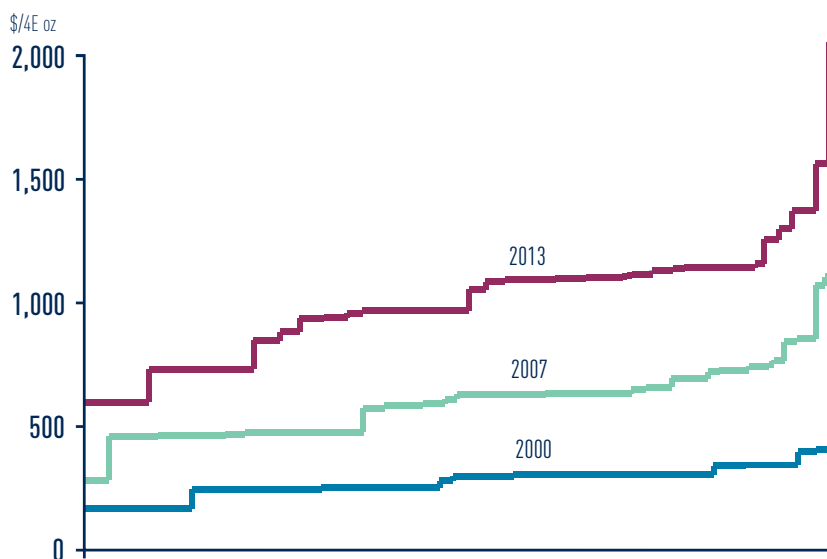


Source: SFA (Oxford)

The increasing depth of operations and rising expenses, combined with lower output, are driving the South African unit cost of production higher at an average rate of 12% p.a. (ZAR/4E oz basis for total cash costs). South African production has dropped by the equivalent of an Impala Lease Area (1.1 moz Pt) since the 2006 peak, and the impact of this loss in volume alone is sufficient to lift unit costs by 3% p.a. Producer results for the first half of 2014, much of which was marred by the AMCU strike, indicate that the average South African unit cost could increase by up to 68% y-o-y. This means that 45% of South African platinum production would be unprofitable in 2014 without efficient recovery of the strike-affected operations or a substantial uplift in prices.

Increasing depth, lower volumes and inflation are driving costs higher

South African net cash costs

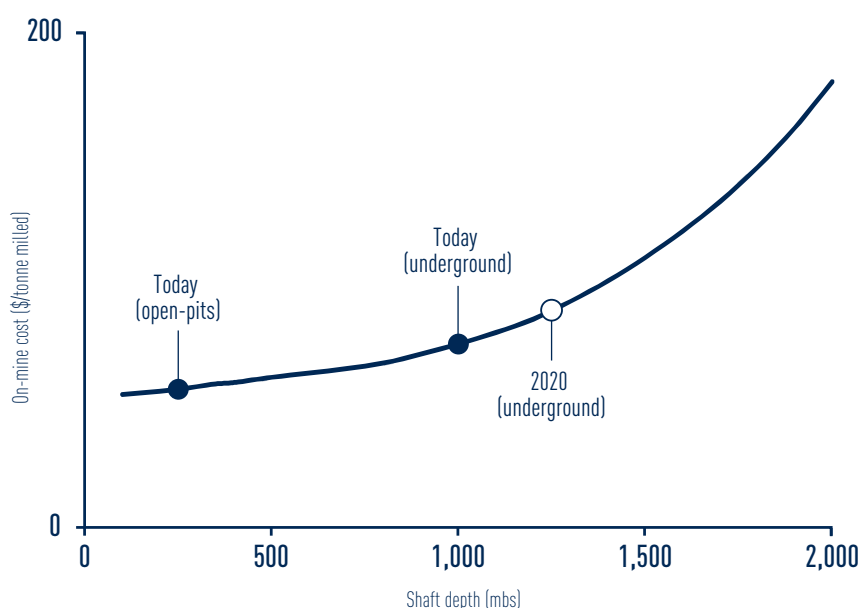


Source: SFA (Oxford)

An extrapolated fitted line for on-mine costs versus shaft depth is shown in the chart below.

Underground mines today have an average depth of 1,000 mbs, and an average on-mine cost that is 33% higher on a per tonne milled basis compared to open-pit mines. By 2020, the average shaft depth may increase by 250 mbs, raising on-mine costs by 18% (\$/t basis) in real terms, excluding other inflationary aspects such as rising wages and cost of consumables. Therefore, without new project development on the Bushveld Complex, South Africa's cost profile will continue its upward trajectory.

On-mine costs versus depth



Source: SFA (Oxford)

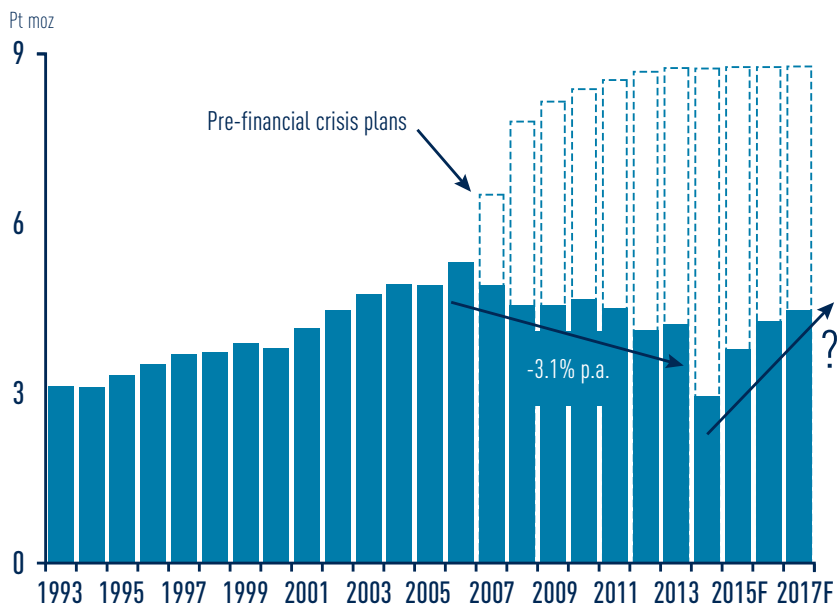
Since the global financial crisis, eight South African mines have closed for economic reasons. Almost 900 koz of annual platinum production capacity has been closed out, versus 475 koz of palladium and 140 koz of rhodium capacity. A number of projects have also been deferred. Much of this relates to the impact of the low rhodium price on UG2 mine economics in an environment of rising costs, but also the suspension of project capital and operational restructuring.

There have been only two mine start-ups in South Africa in this timeframe (replacement shafts excluded) – Northam's Booysendal and Tharisa's namesake mine – yielding new production capacity of 240 koz p.a.

Producers pared back expansion plans following the global financial crisis and, as shown in the chart overleaf, over 4 moz of previously planned new supply from South Africa has not materialised. In essence, today's production levels are equivalent to just half of those planned in the early 2000s. At a time of strong demand pull, the three major producers were targeting a combined 6.9 moz of annual platinum output, but are producing at only 65% of this level today (impact of industrial action aside).

Since the global financial crisis, 900 koz of Pt capacity has closed

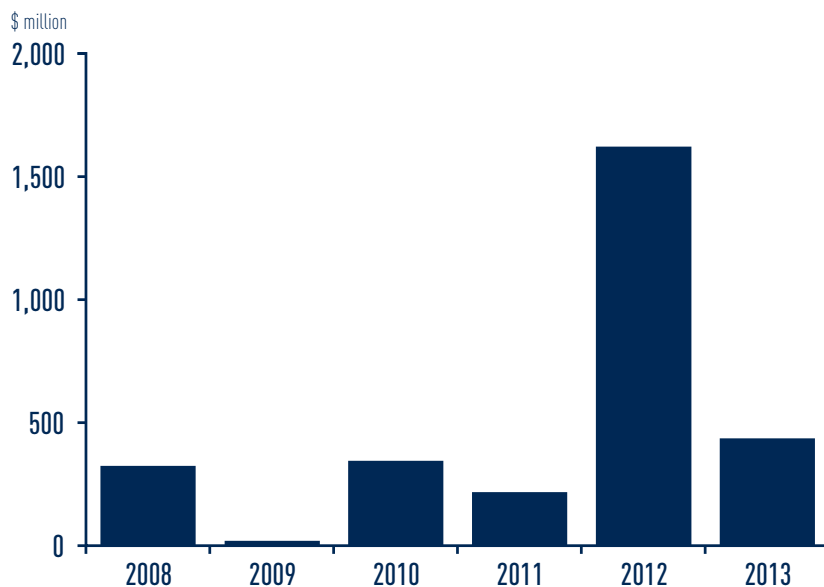
Planned South African platinum production



Source: SFA (Oxford)

In 2012 and 2013, the South African PGM industry recorded asset impairments of \$2.1 billion (shown in the chart below). Of this, \$1.2 billion is directly attributable to restructuring by major producers and UG2 mine closures.

PGM asset impairments



Source: SFA (Oxford), company reports

Total capital expenditure by the major producers has decreased by an average of 9% (ZAR1.9 billion) per year since 2008. Even so, these companies are currently sitting with negative or zero cash balances as head grades fall, productivity levels are at historically low levels, and safety-related interventions and expenditure drain cash. This has been

South African production is now half that planned in the early 2000s

Capital expenditure has decreased by 9% p.a. since 2008

exacerbated by the recent labour issues experienced at their flagship mines. As such, project momentum will be further lost as asset sales (on the agenda since 2010) and deferral of replacement production are now taking place in the aftermath.

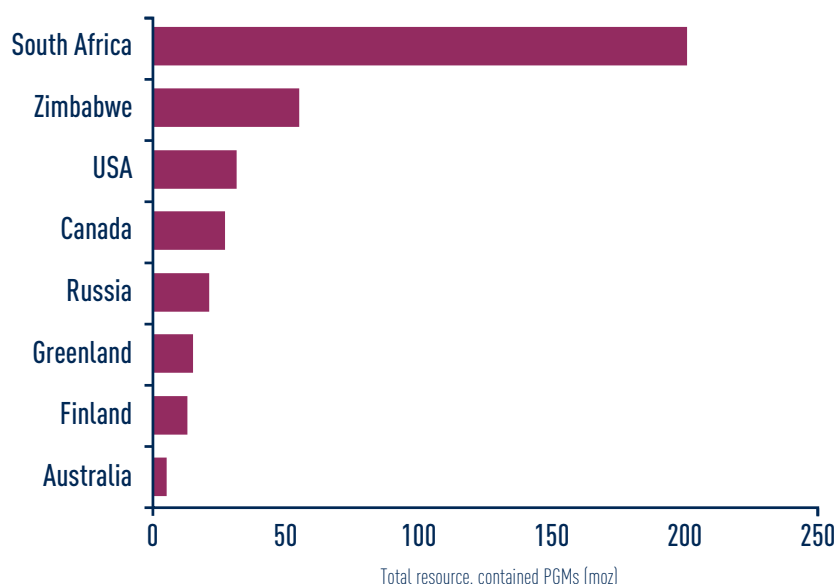
Outside of South Africa, there have been five new mines commissioned in the past three years: Amplats' Unki mine (Zimbabwe), First Quantum Minerals' Kevitsa mine (Finland), Vale's Totten (partial replacement capacity) and Wallbridge Mining's Broken Hammer mines (both in Canada), and Lundin Mining's Eagle mine (US). However, combined steady-state capacity for these operations totals <130 koz of platinum p.a., an average of just 26 koz p.a. for each mine.

Exploration trends

There are eight main areas in which PGM projects are currently being advanced. Here we focus on active projects (those currently allocated expenditure to advance) with resources delineated. The following chart shows the total PGM resource rankings for these projects by country.

South Africa leads the way with 200 moz of PGM project resources. Mounting interest in the Platreef means that Northern Limb projects now account for over 50% of this total. Platinum Group Metals' Waterberg project comprises 29 moz PGMs and Ivanplats' Platreef project comprises 76 moz PGMs.

Project resources by country



Source: SFA (Oxford), company websites and reports

The Great Dyke hosts the second-largest PGM orebody globally, ranking behind the Bushveld Complex, and is comparatively under-exploited. Uncertainties relating to the Indigenisation and Economic Empowerment Act (IEEA) and withdrawal of foreign direct investment from the country have curbed funding of mining development, despite this sector being perceived as the main catalyst and driver for economic development going forward.

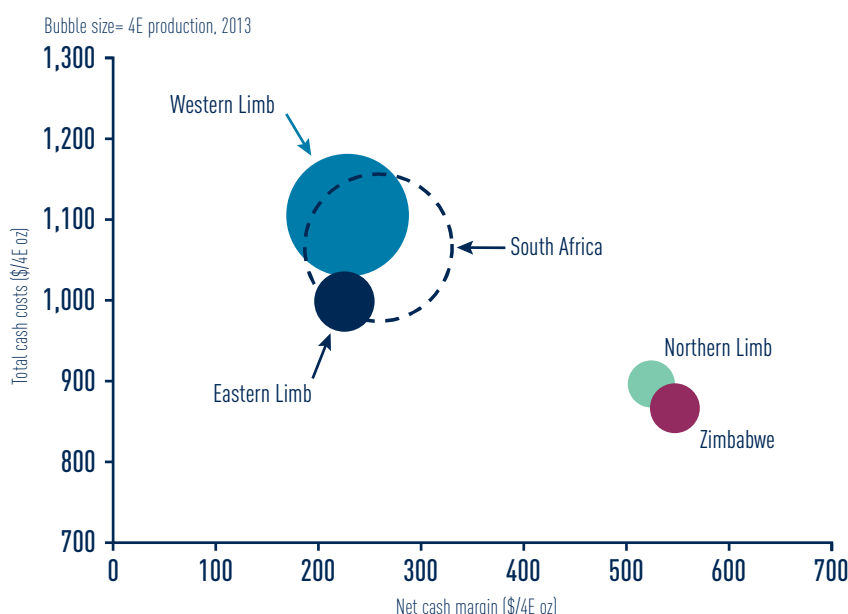
South Africa is superior
in terms of project
resources

Investment in Zimbabwe
has been curbed by IEEA
uncertainties

Current project resources in Zimbabwe are estimated at 55 moz PGMs. Recent exploration activities have been led by a Russian consortium which is planning to invest \$1.6 billion in developing the Darwendale project, plans for which include a smelter. Darwendale is located in the Darwendale sub-chamber, north of Zimplats. The smaller-scale Bokai project, located in the Selukwe sub-chamber (adjacent to the southern portion of Unki), is currently owned by ENRC. Under private ownership, and given the context of Zimbabwe's political challenges, production schedules are uncertain, although open-pit potential for Darwendale for the first two to three years of production could yield a swift start-up.

Projects on the Northern Limb and in Zimbabwe have piqued interest for their similar characteristics. Both orebodies are wide reef, ranging from 2 m to 24 m. The average stoping width elsewhere on the Bushveld Complex is c.1.2 m. A wide reef is usually amenable to mechanisation, which is an inherently safer mining method with a lower labour component of operating costs. Historically, operations in these regions have outperformed their Western and Eastern Bushveld counterparts for mine economics, as shown in the chart below.

Regional mine economics



Source: SFA (Oxford)

Broadly speaking, mechanised operations can achieve labour cost savings of around 20% compared with conventional operations, but will result in an increase in consumables and stay-in-business capital expenditure. However, labour efficiencies are historically more than three times higher for Zimbabwean mechanised operations than for South African underground operations and, combined with the shallow depth (average 230 mbs) and by-product components, the cost advantages are compounded. Projects on the Platreef are deeper than in Zimbabwe, with resources extending to 1,000-1,100 mbs, though they may be accessed from 100-700 mbs.

In the US, exploration is focused on Minnesota, with three projects giving a combined resource of 31 moz PGMs. Duluth Metals' Twin

Zimbabwean and
Platreef operations
outperform their peers

Metals project and PolyMet Mining's NorthMet project are located on the Duluth Complex in north-eastern Minnesota. These projects are at pre-feasibility and environmental permitting stages respectively. Talon Metals' Tamarack North project lies to the south-west, on the Tamarack Igneous Complex. Current resource statements indicate the latter is higher grade for both PGMs and base metals, but with the maiden resource published in September 2014, meaningful conclusions on scale and production potential cannot yet be drawn.

The mine permitting process in the US is among the most stringent, so while relatively advanced in proceedings, time to production for PolyMet remains indeterminate. The deposit is open-pit, and production plans are in the region of 100 koz/year PGMs over 20 years.

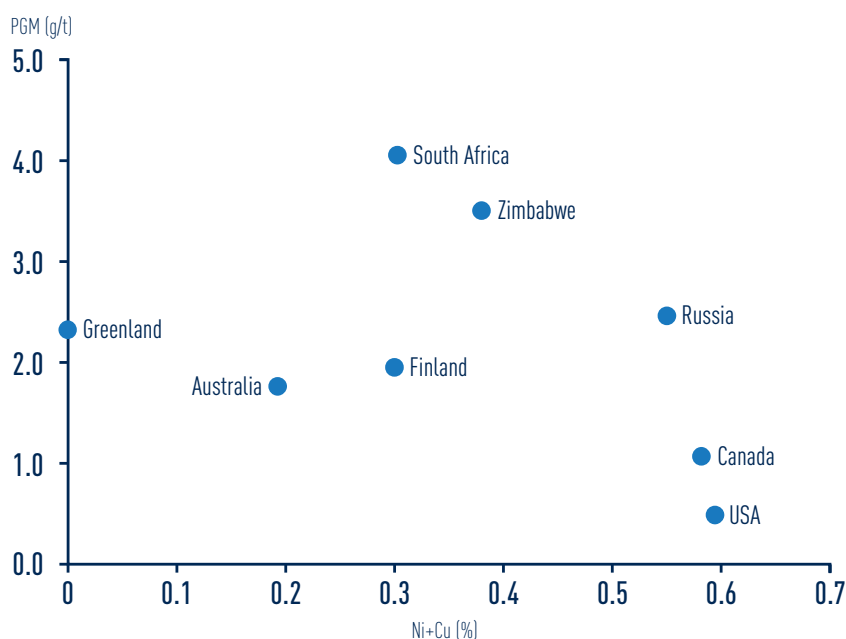
Canada has the highest number of PGM projects, located across three provinces. Project resources total 28 moz PGMs. Wellgreen Platinum's namesake project, located in Yukon, is the largest at 19 moz PGMs, though the remaining projects are comparatively small. The preliminary economic assessment for Wellgreen is to be completed in September 2014. Stillwater Mining recently suspended permitting and scaled back funding for one of the more advanced projects, the Marathon joint venture (4 moz PGMs), as it proves uneconomic at today's prices.

Environmental permitting for Noront Resources' Eagle's Nest project (Ontario) is scheduled for completion this year and potential for first production in the medium term exists. The deposit is deep, extending to 1,600 mbs (extraction to c.1,100 mbs), but is amenable to bulk mining techniques and benefits from a higher grade than is typical of most projects in Canada (average grades are shown in the chart below). Production could average 120 koz/year PGMs.

Mine permitting in the US is an arduous process

Canadian projects are typically small scale

Grade of project resources



Source: SFA (Oxford), company websites and reports

Projects in Russia comprise the Chernogorskoye deposit (Russian Platinum), located on the southern part of the Norilsk-1 deposit, the

Kun-Manie project (Amur Minerals) in the far east of the country, and the West Kytlim alluvial platinum project (Eurasia Mining). Resources total 21 moz PGMs. Chernogorskoye is advanced, with production potential within five years (ramping up to capacity of c.600 koz/year PGMs), and West Kytlim is currently undergoing the permitting process.

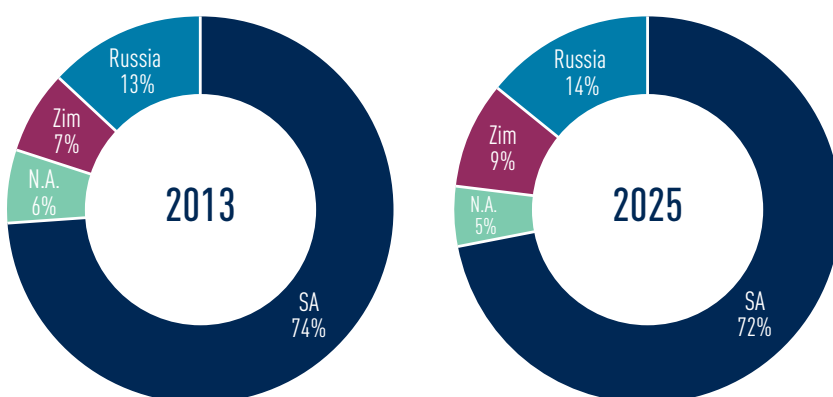
Remaining projects in Finland, Greenland and Australia are less advanced and total between 5 and 15 moz of PGM resources per country. New production is unlikely to materialise in the short to medium term.

Projects in Russia are advanced

Filling the supply gap

Based on estimates for those projects that are most likely to come into production, the following charts highlight the long-term production split by region compared to today. Clearly there is scope for other projects to come to fruition (and mines to close/re-start) within this timeframe, but for scenario purposes this analysis is based on the current state of affairs.

Platinum production by region



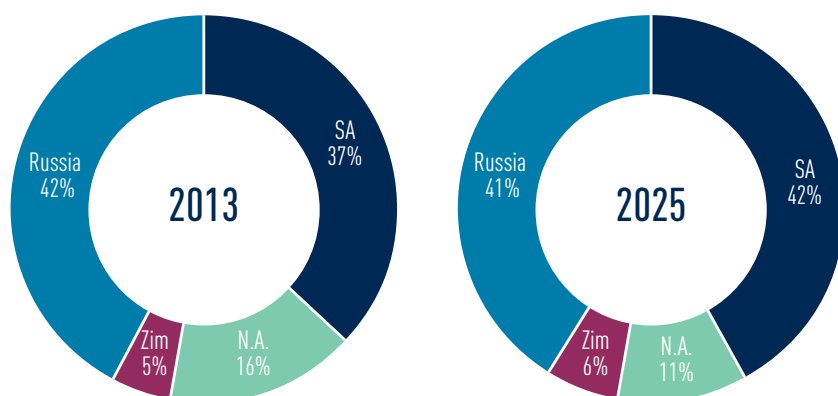
Source: SFA (Oxford)

South African platinum production loses a small percentage of global production share by 2025. The large-scale Platreef projects and expansion at Mogalakwena offset the impact of depletion at Western Limb mines for the most part. The more advanced North American projects are small scale with good PGM grades or large-scale with low PGM grades, limiting production growth potential.

Zimbabwe has the resource base to support significant expansion in market share, though immediate options are constrained by legislative uncertainties and funding requirements for beneficiation infrastructure. Upside exists for Zimbabwe. Russia can maintain its share through the large-scale Chernogorskoye project and, beyond this, Norilsk's Maslovskoe project.

Upside exists for Zimbabwe

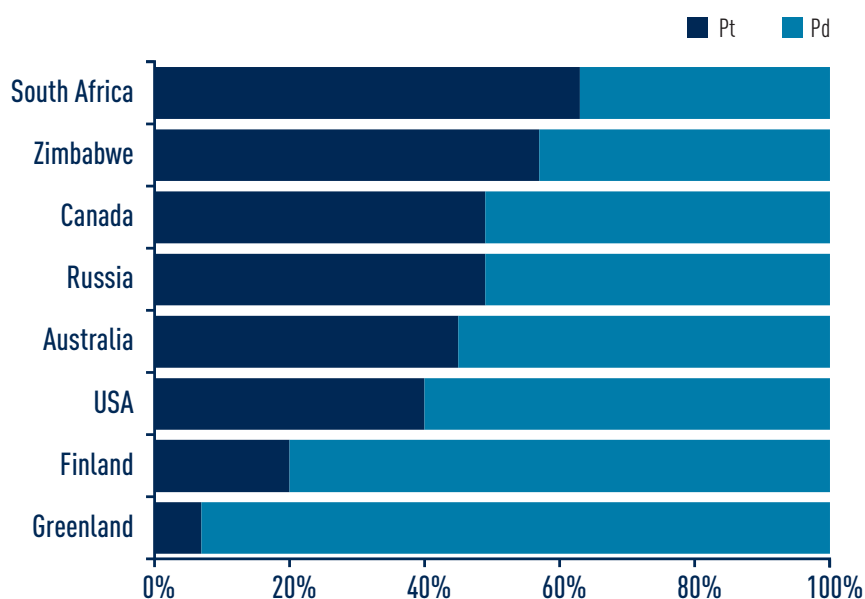
Palladium production by region



Source: SFA (Oxford)

The metal ratios of the Platreef mean the South African share of global palladium production may grow. Resources outside of Africa are also typically palladium-rich (shown in the chart below), although there are exceptions to this rule (e.g. Broken Hammer mine). In this scenario, new supply from projects yields 870 koz p.a. of palladium versus 500 koz p.a. of platinum.

Pt:Pd ratio of project resources



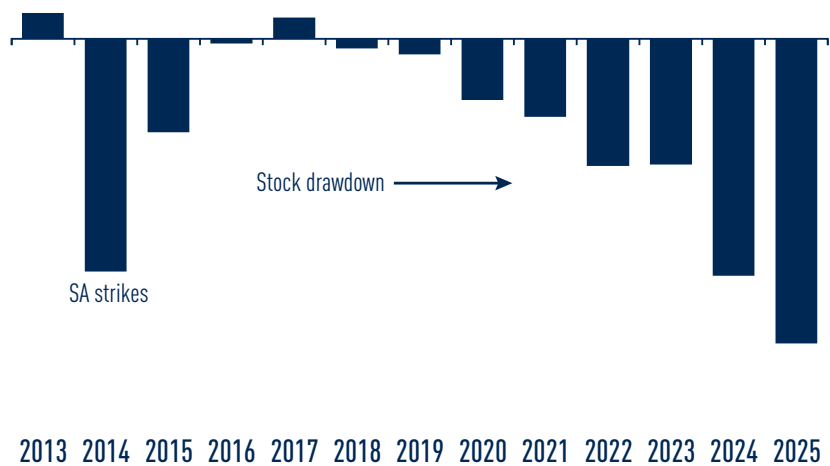
Source: SFA (Oxford), company websites and reports

Non-African projects are also relatively devoid of rhodium, so the long-term production split remains South African-centric. The Platreef's contribution to South African rhodium supply could grow to almost 30% by 2025.

In the context of PGM market balances, a significant drop in South African output resulting from recent industrial action follows five years of oversupply for platinum and rhodium. Stocks are likely to be drawn down in the next few years, and substantial deficits open up in the early 2020s as demand recovers (see the chart overleaf).

Projects outside of Africa are typically palladium-rich, rhodium-poor

Platinum market balance

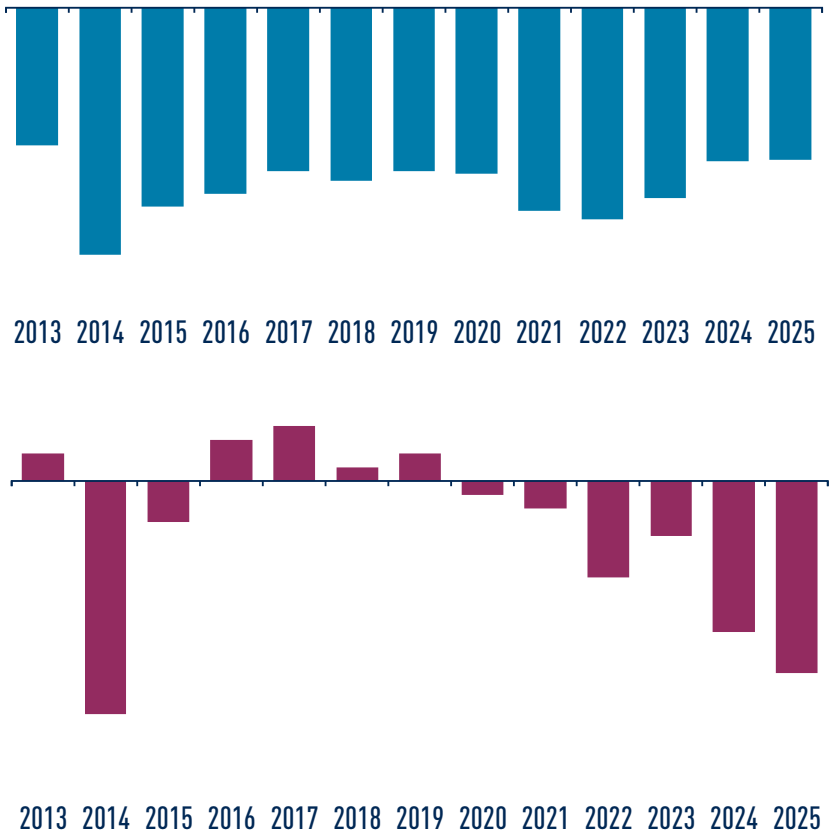


Source: SFA (Oxford)

It is then that the impact of the lack of overall investment in PGM supply, particularly in South Africa, will fully materialise. Projected output from the current project pool is not sufficient to fill the PGM supply gap. The lead time to production for South African shafts is now averaging eight to ten years, but the industry is in a state of flux and decisions on large-scale investments are not high on the agenda of the larger PGM producers today.

Current projects are unlikely to plug large deficits opening up in early 2020s

Palladium (top) and rhodium (bottom) market balances



Source: SFA (Oxford)

The realities of physical platinum investment



The realities of physical platinum investment

Dr Ralph Grumble, Senior Market Analyst, SFA (Oxford) Ltd

Platinum investment is a niche area

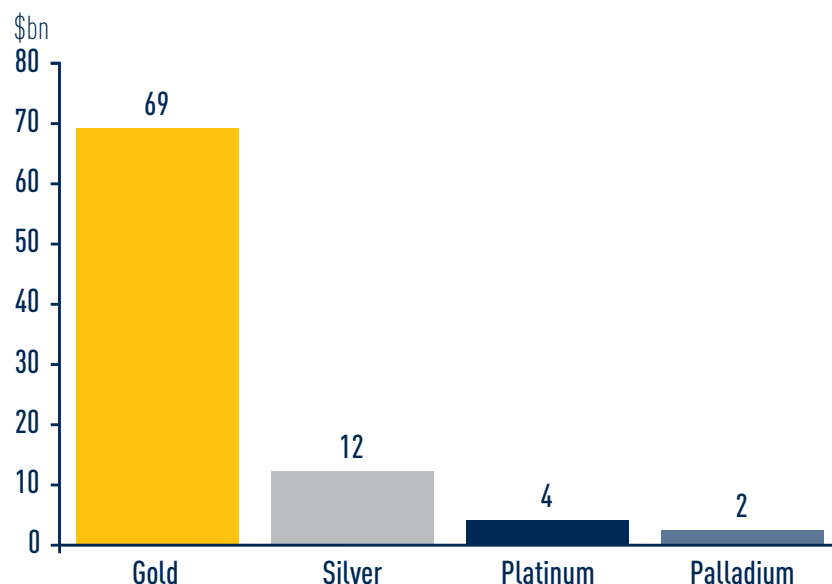
Investment in precious metals has historically been dominated by gold and silver, and that remains the case today. The silver market is much smaller than the gold market and silver is generally considered a more volatile, and hence riskier, prospect than gold. Investment in PGMs is a niche area within precious metal investing.

Historically, direct investment in gold and silver has been achieved by purchasing coins or bars. However, the introduction of ETFs added a new investment option.

ETFs were a boon to investors because they were convenient and cheap. They could be traded like equities but were backed by physical metal holdings and hence directly linked to the value of the underlying metal. This avoided the company and market specific risks of owning mining shares. ETFs also had much lower costs than those associated with trading and storing bars or coins.

The first-ever gold ETF was launched in Australia in 2004 and a UK version followed soon after. The SPDR Gold Trust was launched in the US later in 2004 and it became the largest gold ETF by value of holdings. Silver and other ETFs soon followed, with the first platinum and palladium ETFs appearing in the UK and Switzerland in 2007.

Value of ETF holdings



Source: SFA (Oxford), Bloomberg

Looking at the current value of precious metals held in ETFs it is clear that gold dominates this form of investment, with nearly six times more money in gold ETFs than in silver ETFs. The value of the metal held in platinum and palladium ETFs is a small fraction of that in gold ETFs.

Historically, precious metal investment has been via coins and bars – ETFs added a convenient new option

Gold dominates precious metals investment

While this could be taken to mean that there is potential for much more investment in platinum ETFs, the amount of possible investment is limited because the platinum market is much smaller than the gold market.

Liquidity is an issue for platinum investment

Liquidity, or the ease of trading in a particular investment, is important, particularly for large investors. If one looks at the value of daily transactions, a picture emerges that shows platinum is a very small part of the larger investment universe.

2013 average daily value of transactions, \$bn

US Treasuries	543
NYSE	23
COMEX Gold Futures	27
SPDR Gold Trust ETF	1.5
NYMEX Platinum Futures	1
UK, US, Swiss Platinum ETFs	0.02

Source: SFA (Oxford), Bloomberg, US Federal Reserve

The US bond market has by far the largest value traded on a daily basis. The value of stocks traded on the New York Stock Exchange is similar to the value of gold futures contracts traded on COMEX.

The SPDR Gold Trust, which is the largest single gold ETF and holds about 40% of the total amount of gold in ETFs globally, has around \$1.5 billion worth of trades on a daily basis, and this is a larger amount than the value of platinum futures traded on NYMEX. All of the US, UK and Swiss platinum ETFs combined trade only a small fraction of the value of the SPDR Gold Trust ETF.

ETF investment is almost entirely driven by developed markets. Platinum ETFs are available in the US, Europe, Japan, Australia and South Africa. Japanese investors have been actively buying bars and participating on the TOCOM futures market. However, the platinum ETF in Japan holds very little metal and the Australian ETF is also very small. Gold ETFs are available in many more countries than platinum ETFs, but the majority of holdings are in Europe and the US, reflecting both the level of sophistication in different markets and the historical affinity of large parts of the world to gold jewellery as a store of wealth. Investment in platinum is driven by different considerations than investment in gold: platinum demand is industrial first, jewellery second and then comes investment. The rationale for investing in

The platinum market is much less liquid than gold

Platinum investment is geographically limited

platinum is tied to its industrial use and the outlook for the price based on forecast supply and demand.

While platinum investment could be encouraged in new markets, with China being an obvious candidate, it would require careful positioning and a concerted effort to inform investors of the benefits of holding platinum as an investment proposition.

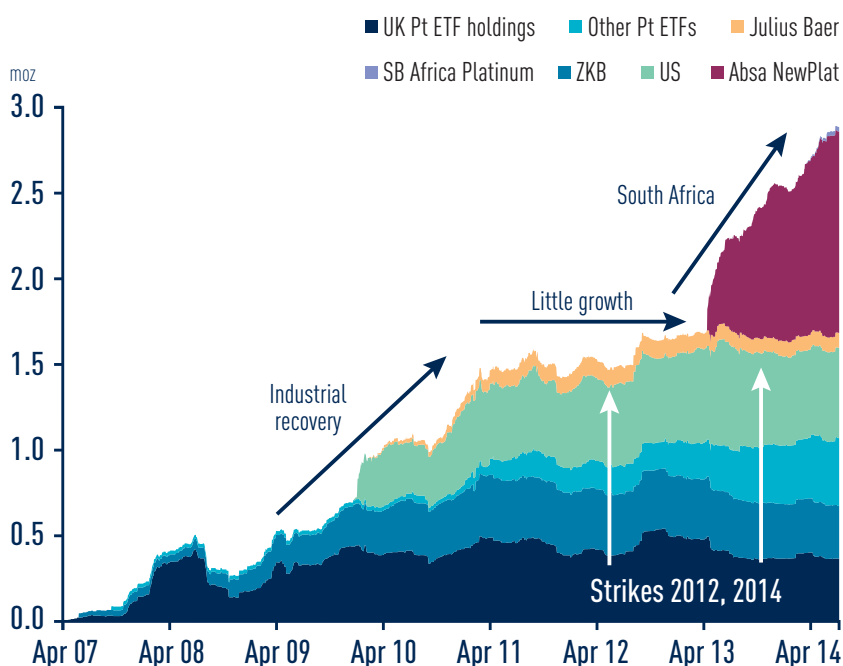
South Africa has become the driver of ETF investment

The first platinum and palladium ETFs were launched by ETF Securities in April 2007 in the UK. These were followed by ZKB which introduced platinum and palladium ETFs in July of that year. The US platinum and palladium ETFs were launched in January 2010.

As shown in the chart below, the UK and ZKB ETFs grew to around 300 koz over the course of two years and have fluctuated between 300 koz and 500 koz ever since. The US ETF grew rapidly and surpassed the UK ETF in terms of holdings by reaching 400 koz in just under a year, and it continued to grow, passing 600 koz in June 2013. Its holdings have since fallen to 530 koz.

ETF holdings grow rapidly after launch but then flatten off

Global ETF holdings

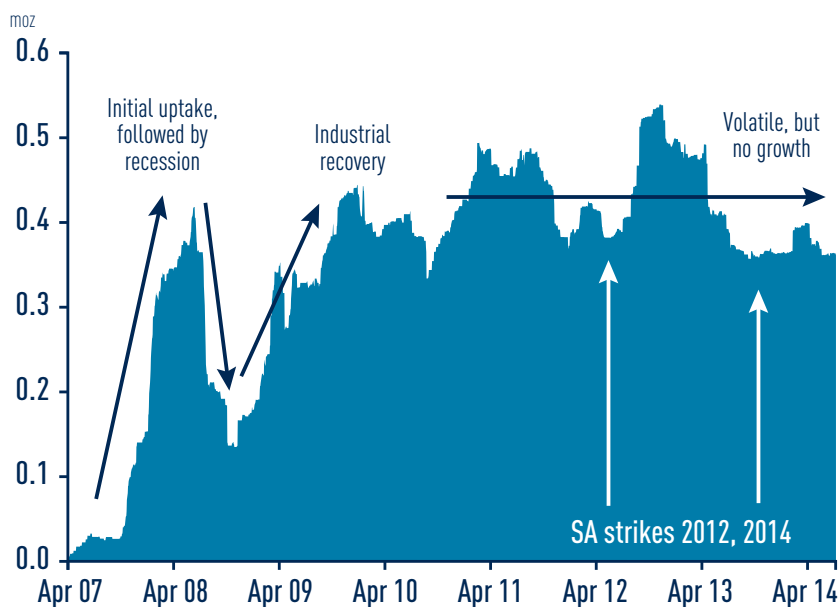


Source: SFA (Oxford), Bloomberg, Absa, Standard Bank

More recently, in May 2013 Absa launched a platinum ETF (NewPlat) in South Africa. This ETF gained support from the South African fund management community and quickly expanded its holdings. It surpassed 500 moz after just over two months, became the largest platinum ETF within four months and reached 1 moz within a year. Standard Bank launched a platinum ETF in April 2014 but it has not gained much traction.

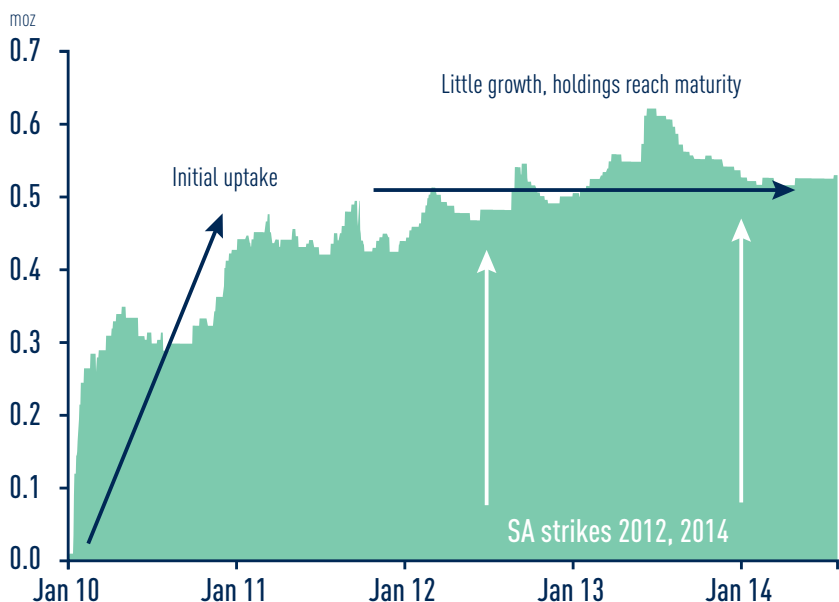
The US and European ETFs have maintained roughly the same level of holdings since 2011 despite the mine strikes in 2012 and 2014. This suggests that most investors who want to hold a position in platinum have already invested and that there has not been a great deal of new investor interest.

UK ETF holdings



Source: SFA (Oxford), ETF Securities

US ETF holdings

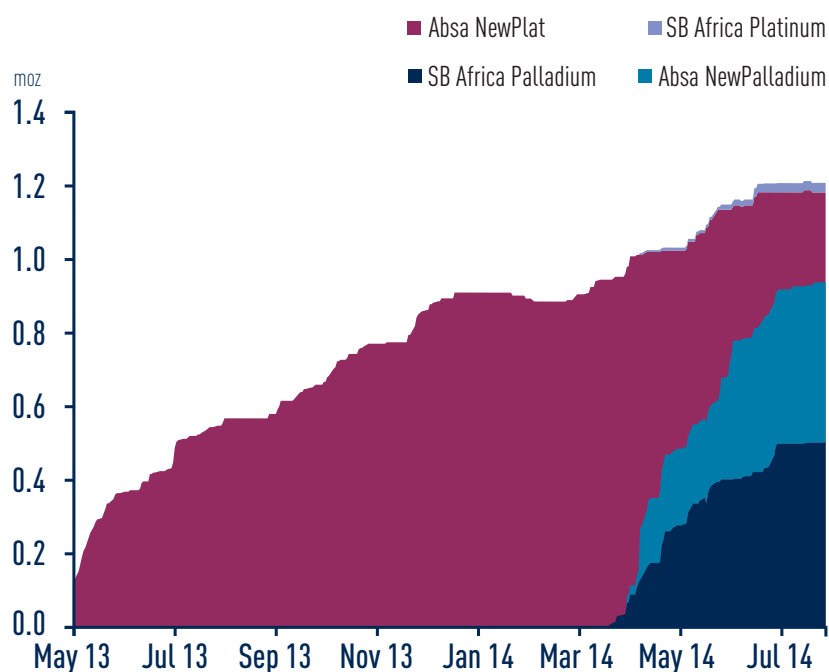


Source: SFA (Oxford), ETF Securities

Strikes failed to encourage ETF investment

The mineworkers' strikes in South Africa had only a temporary impact on the platinum price and ETF holdings in 2012 and no impact in 2014. This lack of impact has been attributed to the large level of stocks in the market, of which ETFs are the most visible part.

South African platinum and palladium ETF holdings

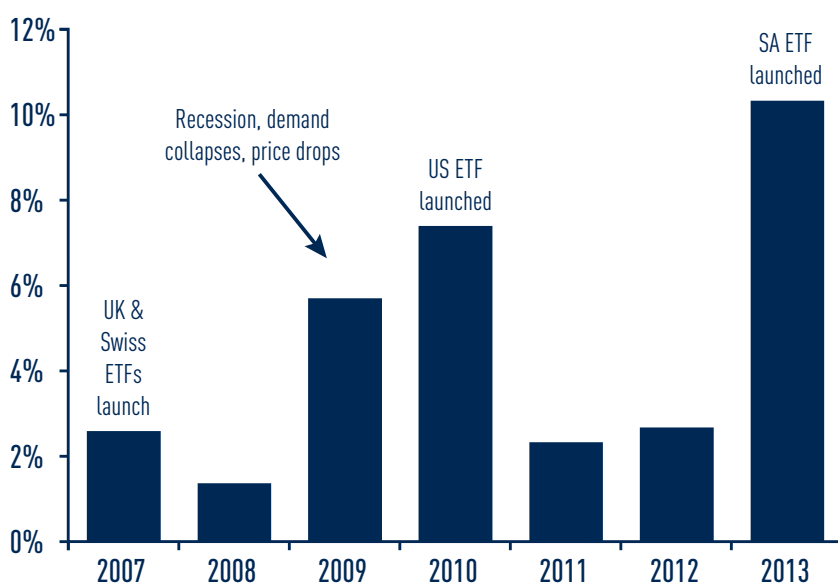


Source: SFA (Oxford), Absa, Standard Bank

Standard Bank launched a palladium ETF in March 2014 and Absa launched its own palladium ETF the following month. Both of these have gained significant holdings in just a few months, with the Standard Bank ETF exceeding 500 koz and the Absa ETF clearing 400 koz. This does not appear to have been at the expense of platinum ETFs, but it has provided a closely related alternative to platinum ETFs in South Africa.

The NewPlat ETF holdings have been little changed over the last couple of months at just under 1.2 moz, perhaps a sign that the South African ETFs are reaching maturity as those of the UK and US have done.

Platinum ETFs as % of total platinum demand



Source: SFA (Oxford), Bloomberg, Absa

NewPlat ETF may be reaching maturity

So far, Pd ETFs have not been substituted for Pt

New ETFs dominate the demand profile

ETFs are still a relatively new investment medium and the amount of metal added in a calendar year has varied widely. In 2013, the huge demand for the NewPlat ETF saw investment exceed 10% of total platinum demand. There has been very little correlation between the metal price and the amount of ETF buying, which has so far mostly depended on whether a new ETF was launched in any given year.

ETF investment exceeded
10% of total platinum
demand in 2013

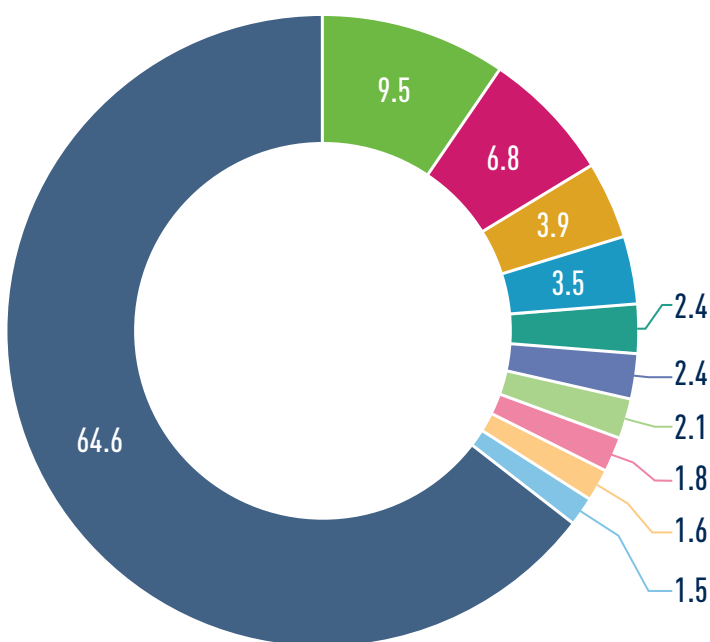
South African funds have loaded up on platinum ETFs

Fund managers in South Africa saw the launch of Absa's NewPlat ETF as an opportunity to gain direct exposure to the platinum price without having to hold the mining companies' shares, thereby avoiding the risks associated with holding equities. As the ETF was denominated in rand, it also acted as a hedge against a weaker rand.

A survey of available information reveals that several South African mutual funds have large holdings in the NewPlat ETF. Within those fund managers' portfolios, several funds may have exposure to the platinum ETFs, and in those funds the allocation to the NewPlat ETF represents several per cent of the funds' total holdings.

Ownership of NewPlat shares

■ Allan Gray ■ Coronation ■ Life Assurers Ltd ■ Liberty Life Assurance ■ Eskom Pension & Prov
■ Investment Solutions ■ Global Balanced Portfolio ■ Old Mutual ■ Absa Capital ■ Metlife ■ Others



Source: SFA (Oxford), Bloomberg

Allan Gray and Coronation are the fund managers with the largest holdings of shares in the NewPlat ETF. Allan Gray's Balanced Fund has the largest single exposure to the NewPlat ETF, holding over 6 million shares worth almost ZAR1 billion. The fund holds almost 5.5% of the outstanding NewPlat shares and this represents 1.8% of the fund's asset value. For Coronation, the NewPlat ETF is the tenth-largest single holding within the Balanced Plus Fund.

SA funds have large
holdings in NewPlat

	Allan Gray Balanced Fund	Coronation Balanced Plus Fund
Amount of NewPlat shares held	6,394,781	5,922,958
% of NewPlat shares held in fund	5.5	5.1
Pt ounces held	63,948	59,230
NewPlat % of fund	1.8	2.4
Value of NewPlat holding (ZAR M)	984	911
Total fund asset value (ZAR M)	53,885	39,112

Source: SFA (Oxford), Bloomberg

Many funds have between 1% and 2% of their assets invested in the NewPlat ETF. In addition, many of these funds also have holdings of gold and palladium ETFs, which raises the funds' overall allocation to commodities. The Allan Gray Balanced Fund also has 4.3% of its assets in the NewGold ETF, taking its overall exposure to precious metals to 6%. Some precious metal specific funds have as much as 8% of their assets in the NewPlat ETF.

The question is: how much more can ETF holdings grow in South Africa? Funds that can hold commodity investments have already invested a typical percentage of their assets in the NewPlat ETF. As was shown above, the UK and US funds added the majority of their holdings over the first two years, after which the level fluctuated but held relatively steady. From now on changes to holdings in South Africa are more likely to be shifts in the weighting within portfolios rather than position-building, as has been the case over the last year or so.

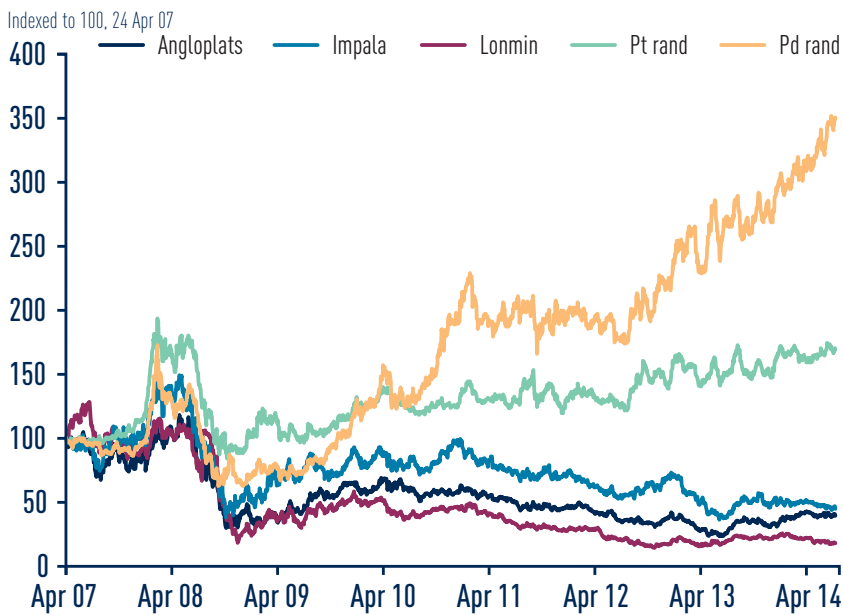
SA funds' large positions
in NewPlat may limit
further accumulation

The platinum price does not always outperform the miners' equities

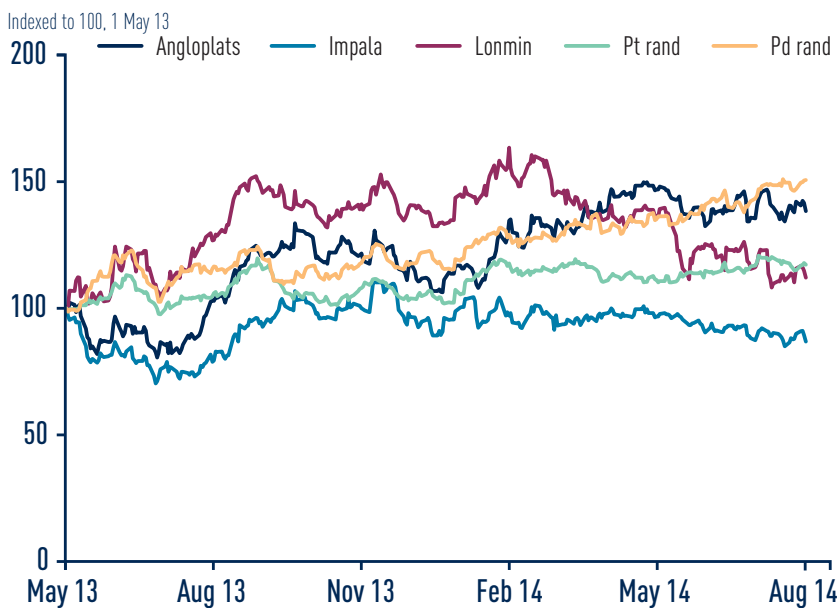
A benefit of investing in ETFs rather than the mining companies' equities is that while still gaining exposure to the performance of the underlying metal price, it removes company-specific risks. Companies' shares are generally considered a leveraged investment in a commodity, meaning that when the commodity price increases, the shares are expected to rise faster and vice versa.

As shown in the chart overleaf, the price of platinum and palladium in rand has outperformed the rand value of the shares of the three major platinum mining companies from the launch of the first platinum ETF in the UK in April 2007. The metals' outperformance is even more marked in US\$ terms (not shown).

Shares vs. metal performance



Source: SFA (Oxford), Bloomberg



Source: SFA (Oxford), Bloomberg

However, since May 2013 when Absa launched its ETF in South Africa, Angloplats' shares have given a better return than platinum and Lonmin's shares outperformed for most of the period but have recently started to lag the metal price. Palladium has recently started outperforming both platinum and the miners' shares. The question for fund managers is: if palladium or the equities outperform platinum going forward, how long will they hold on to an underperforming asset?

While the results are influenced by the choice of start date, if the prices had been indexed from the beginning of 2000 the mining companies' shares would have had periods of outperformance (early and late 2000s) and underperformance (mid-2000s and since 2013) compared to the metal price.

Metal prices have outperformed the miners' equities since 2007

Angloplats' shares have outperformed the platinum price since NewPlat was launched

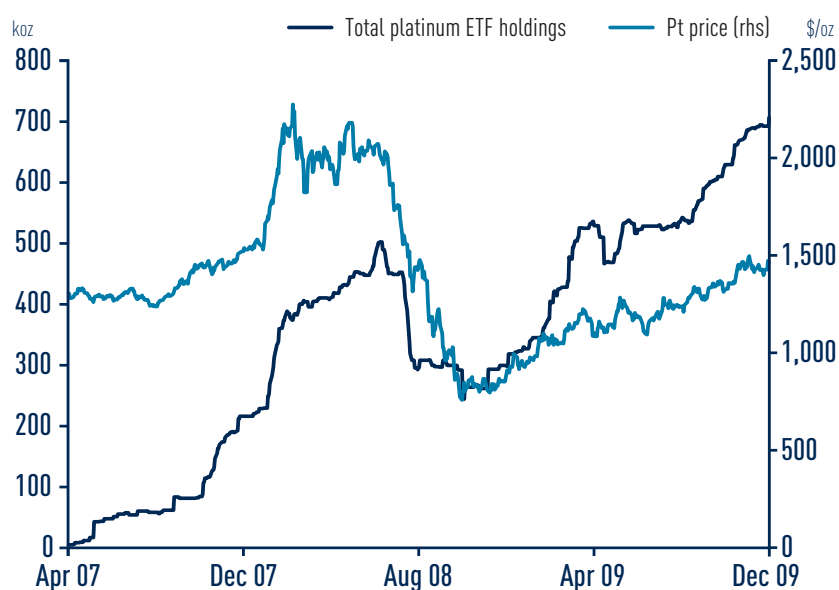
How long will fund managers hold on to an underperforming asset?

ETF holdings can be pro-cyclical

In 2008 the platinum and palladium ETFs were still relatively new, having been launched only the year before. Comparing the performance of the ETFs against the metal price shows some differences. The price performance of platinum, palladium, gold and silver was similar, with peaks in March 2008 and lows in October. The size of the price decline varied. However, only the platinum ETFs had lower holdings in October, with total holdings declining 48% as the UK ETF's holdings shrank by 68% (284 koz), while the Swiss ETF added 43 koz in the five months from July to November. The other three precious metals' ETFs had either minor selling or continued to accumulate metal.

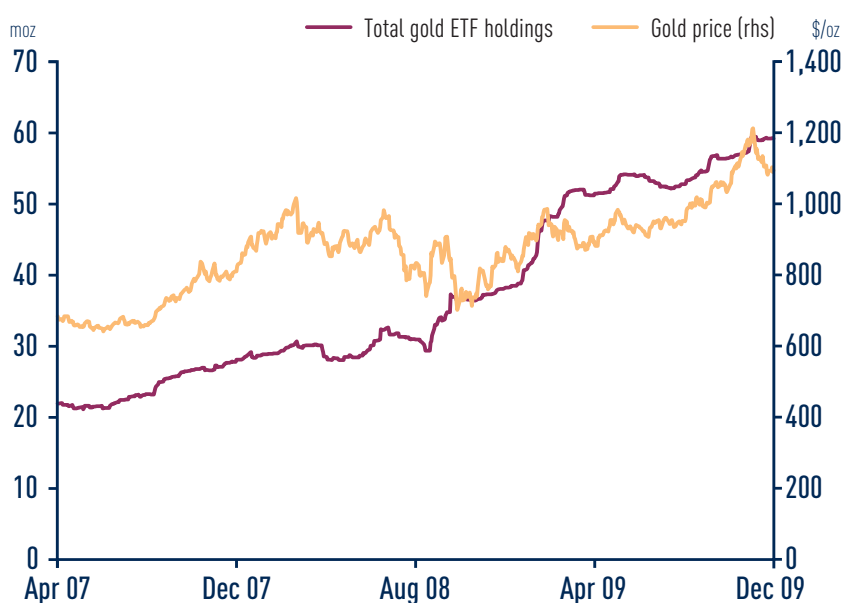
Platinum ETF holdings
fell 48% in mid-2008

Platinum: ETF holdings and price 2007 - 2009



Source: SFA (Oxford), Bloomberg

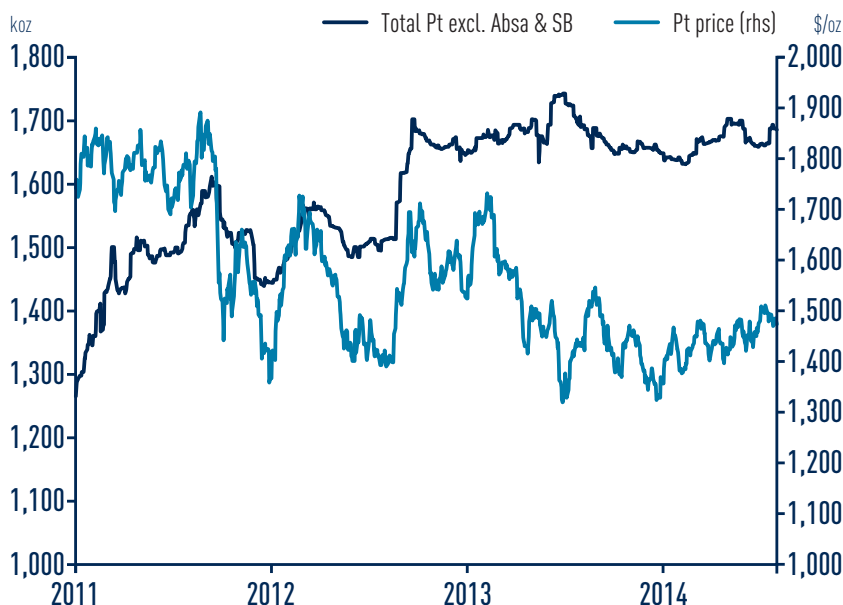
Gold: ETF holdings and price 2007 - 2009



Source: SFA (Oxford), Bloomberg

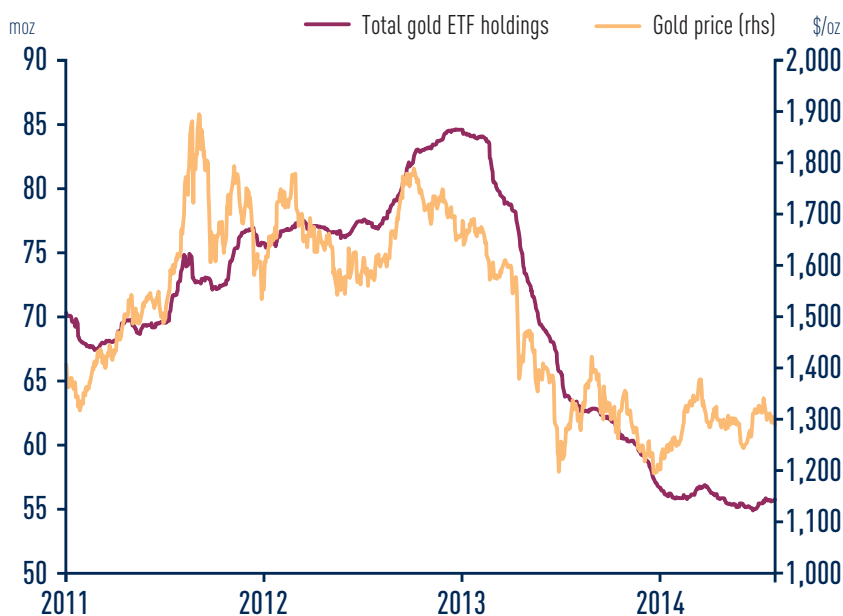
The four precious metals' prices also peaked together in 2011. Since then ETF holdings are up in platinum and down in palladium (excluding the South African ETFs), much lower in gold and higher in silver. The introduction of the platinum and palladium ETFs in South Africa has resulted in a dramatic increase in the ETF holdings of these metals.

Platinum: ETF holdings and price 2011 - 2014



Source: SFA (Oxford), Bloomberg

Gold: ETF holdings and price 2011 - 2014



Source: SFA (Oxford), Bloomberg

Gold ETF holdings
declined 33% in 2013

The gold price peaked in September 2011 and then traded lower to between \$1,800/oz and \$1,520/oz. Gold ETFs continued to accumulate metal until the end of 2012 at which point the gold price had already started to fall back from \$1,800/oz. In 2013, gold ETF investors sold

28 moz or 33% of total global ETF holdings. If platinum ETF holders decided to sell just 20% of their current 2.9 moz, this would increase platinum supply by 580 koz.

Clearly, ETF demand can be pro-cyclical but as these investment vehicles are still very new, investors' behaviour has not been tested under a wide range of market conditions and this makes forecasting future demand extremely difficult.

Summary: Platinum investment needs a new impetus

The outlook for platinum investment appears to be less favourable than it has been over the last few years as the easiest gains have been made. The introduction of ETFs made investment in platinum much more straightforward, but the relatively small size of the platinum market and the limited liquidity are constraints on how much investment can flow into platinum.

There are two options to increase investment in platinum: encourage more investment in existing regions or expand opportunities to new regions. Both of these options come with challenges.

Currently, the main regions with ETFs are the US, Europe and South Africa. Platinum ETFs see large additions when new ETFs are launched but then their holdings tend to vary around a particular level. The ETFs have reached maturity in the US and UK and may be reaching that point in South Africa. South African funds already hold several per cent of their assets in the NewPlat ETF, leaving the potential for further accumulation looking limited.

Since the launch of the UK and US platinum ETFs, the platinum price has outperformed the mining companies' equities. However, since the launch of the NewPlat ETF, Angloplats' shares have outperformed the metal. Palladium ETFs in South Africa have seen a very rapid increase in holdings but this does not appear to have been to the detriment of platinum ETFs. However, the palladium price has outperformed that of platinum and the mining companies' equities. Fund managers will only hold on to underperforming assets for so long before they switch to a better prospect.

Platinum ETFs have expanded in the US, Europe and South Africa but have struggled in other areas. Despite platinum jewellery having a long history in Japan, investors there have shown little interest in their local platinum ETF, which is very small. While China is the largest market for platinum jewellery and an obvious candidate to have a platinum ETF, it could prove to be a tough sell.

ETF holdings are 100% liquid and can be sold instantly if the outlook or investors' attitudes were to change. The pro-cyclical nature of ETF holdings was demonstrated in 2008 for platinum and in 2013 for gold when large percentages of the metal held in ETFs were sold.

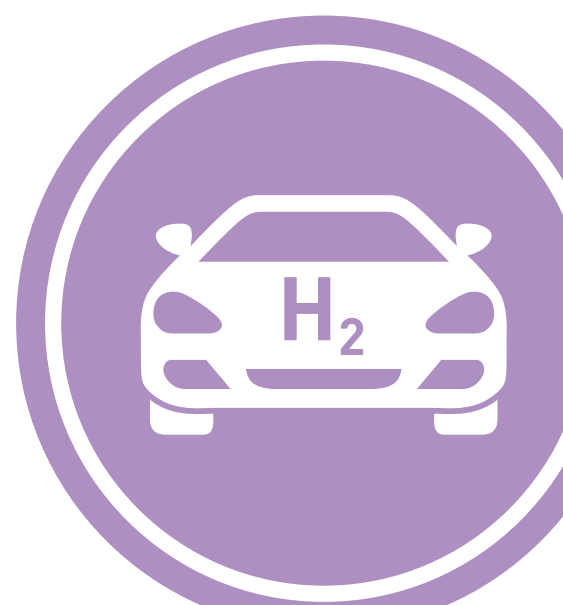
So far, precious metal ETFs have existed under a falling and, since 2008, an abnormally low interest rate environment, with real interest rates often being negative. As such, the opportunity cost for holding an investment that has no yield is reduced. Rates will not stay low for ever and it is possible that in a rising interest rate environment these ETFs would be seen as a much poorer investment option.

ETF holdings are
reaching maturity

Demand for ETFs can be
pro-cyclical

ETF holdings are 100%
liquid – the metal can
also be sold

**Fuel cell vehicles:
Coming to a car park
near you. Eventually.**



Fuel cell vehicles: Coming to a car park near you. Eventually.

by Dr Kerry-Ann Adamson, CEO and Founder, 4th Energy Wave

The long-awaited launch of fuel cell vehicles is finally on the horizon and interest in the potential impact of adoption on platinum demand is understandably high.

To date, most of the world's major automotive manufacturers have a planned release date for fuel cell vehicles around the 2015 to 2017 timeframe. With the standardisation of components, cost reduction, construction of refuelling infrastructure and stack durability at an acceptable level, it is safe to say that this time round the releases will take place.

However, these releases will not be global but, at least initially, will be concentrated in a small number of geographical locations. These are likely to be California (US), Japan, South Korea and Germany, with a handful of vehicles in other areas such as the UK, Denmark, France, Canada, West Coast US and the nascent Chinese market. However, the Chinese market will be led by local marques and is unlikely to be selling imported fuel cell vehicles.

The world's major automotive manufacturers have a planned release date for fuel cell vehicles around the 2015 to 2017 timeframe

Automotive companies' fuel cell vehicle plans

BMW, which has access to Toyota's fuel cell stack technology, is potentially redeveloping a version of the battery 'i3' to be powered by a fuel cell. No date for release has been given, suggesting that this is a minimum of three to five years away.

Daimler is working with Ford and Renault-Nissan, via the Ballard (Canada) spin-out, AFCC, to co-develop a fuel cell vehicle system with common components. The aim of the agreement is that by using standardised components which are designed into a fuel cell system, overall costs will be lower from the start. Of the three companies, only Daimler has put any date on vehicle release; so far this is 2017. Currently, there are no predictions on volume from 2017.

General Motors is developing fuel cell vehicles with Honda (Japan), though it is clear that at present it is far more focused on developing its diesel car range.

Honda's FCX is currently being retired from Californian streets as the company gears up for the launch of its next generation fuel cell vehicle in 2015. The first launches will be in Japan and California. Honda is one of the leading, if not the main, companies in terms of the development of automotive fuel cell stacks.

Hyundai-Kia is another company developing its own in-house fuel cell vehicles and stacks. By the end of 2015 Hyundai has said it plans to have shipped up to 1,000 fuel cell vehicles, with tens of thousands from 2016 onwards. This vehicle is already on the market in California, at a lease price of \$499 and a down payment of \$2,999. Since Hyundai-Kia is the leading developer of fuel cell vehicles in South Korea, it is likely that it will take a majority share of the South Korean fuel cell vehicle market.

Toyota is the most bullish car company in terms of fuel cell vehicle development and deployment plans. From 2015 the company plans to release an increasing number of fuel cell vehicles up to 2020 with full mass commercialisation. At present, it is known that Toyota's 'Mirai' fuel cell car will be deployed to California and across Japan. It is also likely that Germany will be added to this list.

Volkswagen is focusing on battery EVs, with very little current interest in fuel cell vehicles.

In terms of other companies developing fuel cell vehicles, *Microcab* and *Riversimple*, both of which are in the UK, are developing innovative city FCVs that use the fuel cell as a range extender to the battery. In China a number of local companies, such as *Shanghai Shen-Li High Tech Co. Ltd* and *Sunrise Power*, as well as *SAIC Motor Corporation*, are developing fuel cell vehicles for the home market but these are unlikely to be ready for export for some time to come.

Finally, three PEM stack companies in the UK, namely *Intelligent Energy*, *ACAL Energy* and *ITM Power*, are known to be working with automotive companies on future generations of fuel cell vehicles.

Of all the geographical areas being targeted for initial release, the first lead markets for fuel cell vehicles are clearly going to be Japan and California, as a result of both proactive government intervention and long-term clear intent.

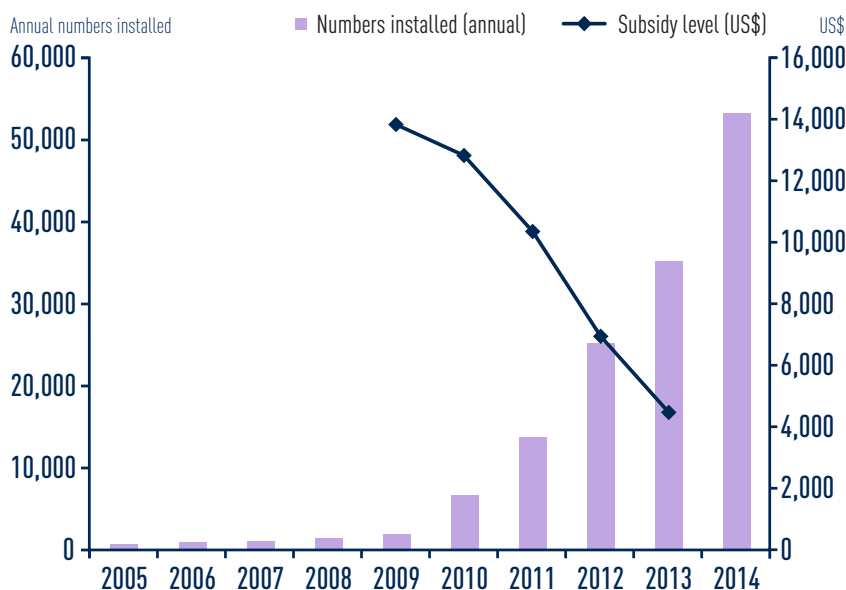
Japan: Subsidy and an initial government offtaker

In July 2014, Prime Minister Shinzo Abe announced that the Japanese government would support the introduction of fuel cell vehicles with a ¥2 million (\$20,000) subsidy. On top of the national subsidy, it is reported that Aichi Prefecture may provide a further ¥1 million (\$10,000) for local purchases. As Toyota is based in Aichi Prefecture, this will be welcome news. With the ticket price of a Toyota fuel cell vehicle being published at ¥7 million (\$70,000), the total subsidy of ¥3 million (\$30,000) takes the price down to a much more affordable ¥4 million (\$40,000).

The apparent level of surprise at this announcement has been confusing, as this is very clearly the Japanese *modus operandi*: pick a technology, develop a local industrial base and help to subsidise its initial deployment. Japan has already very heavily, and successfully, subsidised the market introduction of locally developed residential fuel cells, shown in the chart below, and it is highly likely that the fuel cell vehicle subsidy will also see a sliding scale approach.

The first lead markets for fuel cell vehicles are clearly going to be Japan and California, as a result of both proactive government intervention and long-term clear intent

Japanese residential fuel cell deployment and subsidy level, 2005 - 2014



Source: 4th Energy Wave

A point of note from this chart is that in 2012 the subsidy flipped from going to the technology developer to the adopter.

Apart from the clear success of local deployment, cost reduction and refinement of the product, the impact of this long-term support has been to allow Japanese companies to break out of the home market and start to develop overseas markets. Two examples are Panasonic, with a development facility for residential fuel cells in Cardiff, UK, and Toshiba Fuel Cell Power Systems Corporation, which has a partnership with BDR Thermea for the exclusive co-development and marketing of fuel cell micro-CHP heating systems for European homes.

The automotive fuel cell financial subsidy complements the 2013 announcement, again by the Japanese government, that it would support the development and deployment of 100 hydrogen refuelling stations in four major urban areas by 2015. It is likely that these urban areas will be Tokyo, Nagoya, Kyoto and Hiroshima. The budget for these deployments is \$460 million, which is anticipated to cover around 50% of the installation costs. Of the 100 stations, JX Energy is slated to deploy 40, with Toho Gas and Iwatani Corporation a further 20.

To round off the support for fuel cell vehicles provided by the Japanese government, was the statement on 25 July 2014 that all ministries and other offices across Japan are to introduce fuel cell cars as official vehicles. This move has created an initial stable offtaker market for fuel cell vehicles.

There will be a range of impacts arising from the Japanese support for fuel cell vehicles. SFA forecasts these will include:

- The uptake of fuel cell vehicles in Japan will be higher than any other country in the world until the mid-2020s at the earliest.

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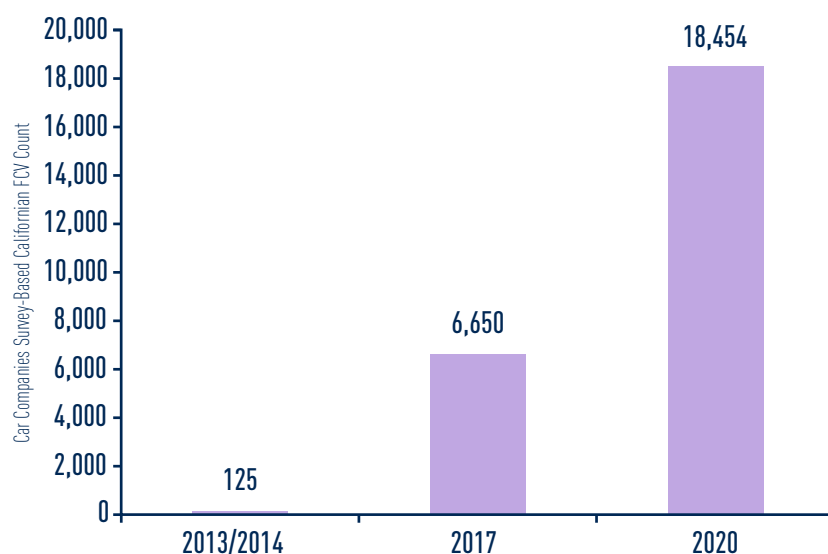
- By 2020 the price of fuel cell vehicles made in Japan will be lower than from other manufacturers, and will exhibit a steeper cost reduction rate than their competitors.
- There is potential that the standards created in Japan for hydrogen will become the de facto standards around the world.

California: Leading the way in legislation

The California Fuel Cell Partnership is an organisation part-funded by, and working with, the automotive industry. As well as providing comprehensive education about fuel cell vehicles, it annually surveys its members on their vehicle release plans. The 2013 survey asked the vehicle companies to respond regarding the number of cars they planned to bring to California over the next few years. The collated responses from the survey show that by 2020, 18,454 vehicles are planned to be deployed across California. The survey was created to ensure that no one company can be identified but we can safely assume that the vehicles will come from a handful of companies such as Honda, Toyota and Daimler.

The collated responses from the survey show that by 2020, 18,454 vehicles are planned to be deployed across California

Survey responses for cumulative Californian fuel cell vehicle deployment, 2013 - 2020



Source: California Fuel Cell Partnership

In a somewhat similar manner to Japan, the deployment in California is being driven by government action. In this case it is the highly modified, altered, re-altered, re-written and re-modified Zero Emission Vehicle (ZEV) programme.

Under the ZEV mandate, BMW, Chrysler, Ford, General Motors, Honda, Hyundai, Kia, Mazda, Mercedes, Nissan, Toyota and Volkswagen are all required to sell a certain number of zero emission vehicles, which are either battery or fuel cell EVs, or transitional zero emission vehicles (TZEVs). The specific mix of vehicles released on the road provides the company with 'credits'. By law, the companies must reach a certain credit level and this level ramps up by volume of vehicles sold in California and over time.

Whilst the equations to calculate the credit available per vehicle type can be complex, the baseline is that a minimum of at least one-fifth of a company's credits must be made up from sales of pure ZEVs. The remainder can be a mix of TZEVs and ZEVs. To date, the ZEV mandate has seen 330 fuel cell vehicles, 5,200 battery EVs and 28,800 neighbourhood EVs released onto California's roads, all of which are classed as ZEVs.

California, though leading the way, is not the only state in the US with a ZEV mandate. New York, Massachusetts, Oregon, Vermont, Maryland, Connecticut and Rhode Island have joined with California to push for zero emission vehicles. Within the '8-State Coalition', California is so far the only state to legislate on the quantity of vehicles, but there is discussion that some of the other states will legislate on this matter sooner rather than later. If and when they do, it is these states that will pick up the baton from California and start to see deployment of infrastructure and vehicles.

In terms of infrastructure, California plans to install 100 hydrogen fuelling stations by 2020. In July 2014 the California Energy Commission gave final approval to proposals for \$46.6 million to build and deploy an initial 28 hydrogen refuelling stations state-wide.

As a result of actions in regions and countries such as Japan, California, Germany and South Korea, this time around the deployment of fuel cell vehicles into the global automotive parc will take place, and is already starting. By the time of the launch of the next generation fuel cell vehicle and automotive fuel cell stack in 2020, volumes on the road will be tens of thousands of vehicles, with ramp-up post-2020 being much steeper.

Fuel cell cars and platinum

Fuel cell cars employ a low temperature polymer electrolyte membrane (PEM) fuel cell stack, which itself employs a PGM catalyst. The fuel cell, the 'engine' of the vehicle, is usually around 80 kW (approximately 114 bhp).

The US Department of Energy (US DOE), the European Union and the Japanese government have funded well over \$1 billion worth of research over the last decade into reducing platinum loadings in PEM stacks for vehicles. The results, shown in the chart overleaf, are the 2013 best-in-class, non-laboratory bench loadings for an 80 kW PEM automotive fuel cell stack. In 2013, an 80 kW automotive stack contained 0.172 g Pt/kW.

A few points to take into account about this figure are:

- A general rule of thumb is that the best-in-class figures are thought to be one to two generations behind in-use stacks. For automotive stacks though, as stack generations tend to be much longer, this figure is probably much closer to on-road vehicles. From this we can impute that a vehicle on the road today contains approximately 13.6 g of platinum.
- Going forward, developers are confident that the 0.125 g Pt/kW in 2017 is achievable in the given timeframe and that post-2020, when the next generation of automotive fuel cell stacks is released on the

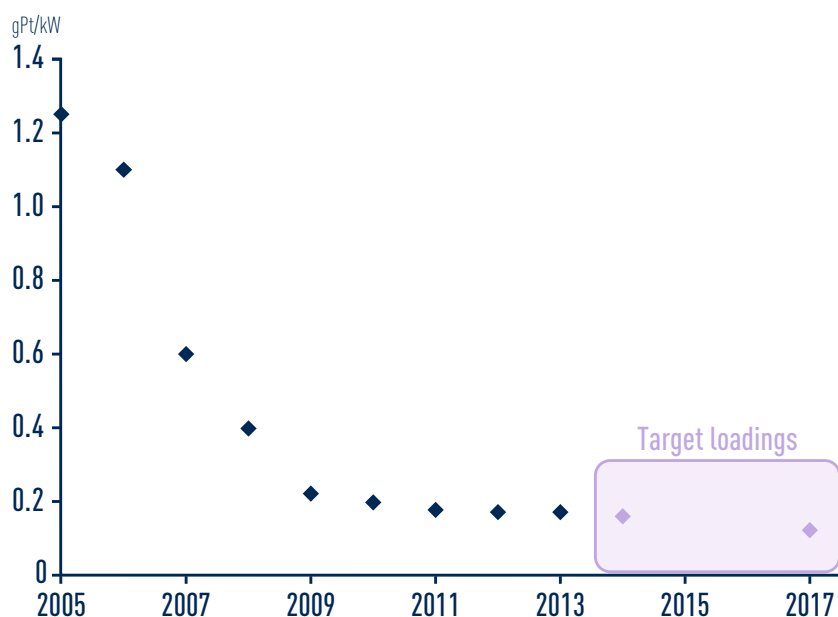
California, though leading the way, is not the only state in the US with a ZEV mandate

California Energy Commission gave final approval to proposals for \$46.6 million to build and deploy an initial 28 hydrogen refuelling stations state-wide

road, this will be much lower again, potentially bringing automotive fuel cell stack loadings only a factor or two higher than current autocatalyst loadings.

- The PGM loadings on a stack are not equally divided between the cathode and the anode. The cathode typically has a much higher percentage of the loadings than the anode. Research, therefore, is more heavily focused on the cathode side of the stack.
- No such detailed figures currently exist for palladium usage in fuel cells, though it is known to be increasing.

80 kW automotive fuel cell stack platinum loadings, 2005 - 2017



Source: Collated from US DOE reports

Primary platinum usage is only half of the developing picture. Although at present recycling of platinum from fuel cells is minimal, it is forecast to be one of the largest growth industries in the sector. We are already seeing dedicated recyclers spring up in the US, and this will likely be mirrored in China and potentially South Africa.

Targets for recycled platinum are 98%, which means that for any automotive fuel cell carrying 13.6 g, at the end of its life, e.g. in seven years, 13.3 g could be stripped out and reused.

Though at present the 98% target is not achieved, it is a key development target for a number of organisations. With the development of recycling of the actual MEA membrane, which is currently dominated by Nafion, a perfluorosulfonic membrane, it is likely that this 98% platinum recyclability will be achieved within the next decade – only a couple of years after the end-of-life of the first fuel cell vehicles.

The use of recycled platinum in fuel cells, which is already in some circles being dubbed “green platinum”, will be based more on politics and marketing than engineering. By 2025, therefore, primary platinum demand from automotive fuel cells will be as dependent on the

marketing of this green platinum as the availability of the vehicles. Secondary to this, in California, the US, and probably initially in Europe, the vehicles are being leased, which means that recycling of used fuel cell systems should be a lot simpler than the tracking and collection of dead autocatalysts. This implies that recycling rates will be high from market inception onwards.

What does the platinum industry need to do?

The platinum industry is undoubtedly going to play a major role in the evolving fuel cell sector, and not just in the fuel cell vehicle industry. What is clear is that an understanding of the jewellery or autocatalyst markets is not tantamount to that of the fuel cell market; it is a different beast entirely. There are no grand challenges that, once removed, mean everything will fall into place and allow adoption to sprint up the S-curve. There are numerous smaller challenges, each one needing to be worked through, or addressed, and these will take time and potentially require support.

If the platinum industry wants to be involved in the growth of the fuel cell sector rather than merely take a supply chain role, it will need to be actively engaged in the sector for some time to come.

The PGM markets in 2014



The PGM markets in 2014

The platinum market

Summary and stocks

In the last few years the market has become preoccupied with stocks and there is general confusion over what to include or exclude in reconciliations and the computation of the supply-demand balance. However, there has clearly been more than sufficient metal available to meet market requirements this year.

The market is forecast to be in fundamental deficit of 1.51 moz in 2014, which excludes sales of pipeline inventories by producers (+484 koz) and additional metal allocations by ETFs (+245 koz, January-August). Including the net impact of ETF changes and producer sales would yield a deficit of 1.27 moz. However fundamentals are compiled, there will be a major destocking of the market.

Yet the difference between monthly average platinum prices in January and August is just \$27/oz. In fact, prices contracted by \$37/oz throughout August to the low \$1,400s of early this year, which is lower than the annual averages of the last four years despite the largest fundamental deficit that SFA has ever recorded.

One of the reasons is that stocks have built up since the financial crisis when automotive sales collapsed, palladium was increasingly substituted for platinum in diesel catalytic converters, and recycling rose to largely offset stagnant primary supply growth.

SFA's estimate of all-in stocks is 10 moz by the end of this year. This includes metal allocated to investment (incl. ETFs) and working inventory in all end-uses, but excludes consumer stocks (jewellery) and catalysts in vehicles on the road. Much of this metal can be considered relatively sticky and unlikely to return to market in the near term, but could be considered a risk over the longer term. Take a shutdown of an oil refinery or redemptions of ETFs as an example where metal can return to market. SFA takes a holistic view on stocks to avoid surprises.

If we consider short-term market liquidity however, i.e. to exclude working inventory required for the closed-loop part of the market (oil, chemical and glass industries) and metal allocated to ETFs, there will still be in the region of 1.4 moz of excess stock by the end of the year.

Furthermore, it should be highlighted that the demand pull that sent platinum prices to over \$2,000/oz in 2008 no longer exerts the same force today. Autocatalyst demand accounted for 50% of total demand in 2008 but only 38% today. Conversely, more price elastic jewellery demand accounted for 26% of demand in 2008, but has risen to 37% today. Industrial users have also shifted from an attitude of securing supply to trading in and out of the market and hedging.

Mine production

Mine output is forecast to contract by a net 1.31 moz year-on-year to 4.69 moz, with yield from South Africa at 2.9 moz, a drop of 1.33 moz, of which 1.1 moz was a result of the five-month AMCU strike. However, in sales

Fundamental deficit
of 1.51 moz

But prices are flat

Stock overhang of 1.4
moz of excess liquidity
estimated by year-end

Demand has become
more price elastic

Supply down 1.31 moz;
1.1 moz due to the
strike

STRIKE-HIT MARKET IN 2014 (-1.51 moz)



Mine supply



South Africa

2.9 moz
(-31.3%)



Russia

730 koz
(-1.7%)



Zimbabwe

380 koz
(-6.9%)



North America/
Canada

360 koz
(+0.7%)

Recycling and demand



3.2 moz
(+4.4%)



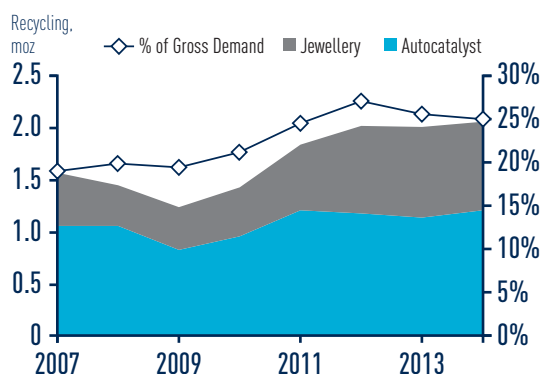
3.1 moz
(+3.8%)



2.1 moz
(+8.5%)

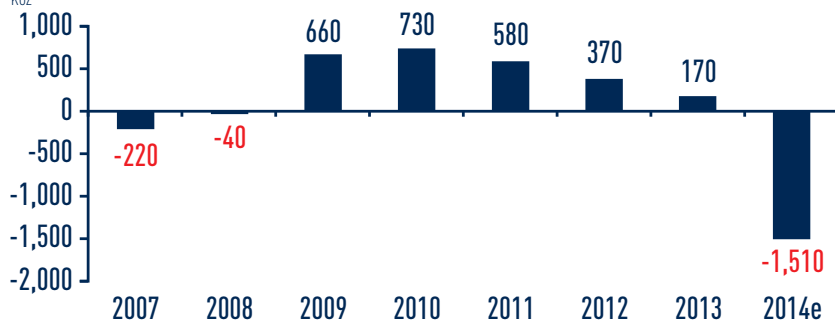


2.1 moz
(+1.3%)

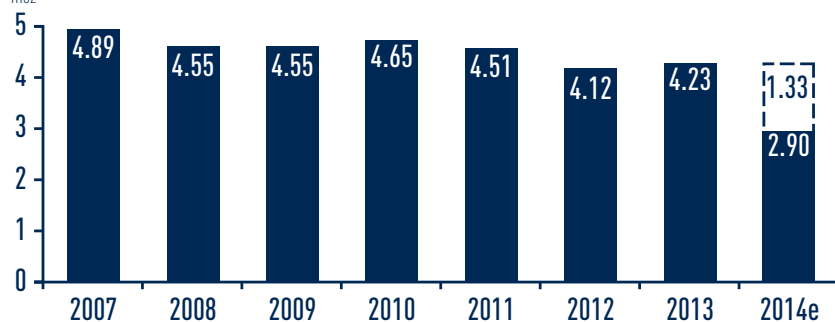


Market summary

Market surplus/deficit,
koz



South African supply,
moz



Source: Source: SFA (Oxford)

rather than production terms, South African supply will be an estimated 3.38 koz, accounting for producer pipeline destocking during the strike, though there will be pipeline restocking in H2'14 of potentially 100-150 koz.

There is great uncertainty as to how South African supply profiles will look going forward as producers evaluate the next six months of recovery and cash generation. Expect announcements on business plans, restructuring and strategy early next year and this will dictate the severity of market deficits going forward.

Outside South Africa, supply looks set to remain almost flat year-on-year at 1.79 moz, with some variations by country. Output from Russia is forecast to be down just 10 koz to 730 koz, while production in Zimbabwe is set to fall 30 koz to 380 koz owing to the underground collapse at Zimplats' Bimha mine, which is now closed for safety reasons. This is the first drop in the country's output since mining began in the mid-1990s. Increased supply from the 'Other' category, which includes tailings and other by-product output, is forecast to offset falls in Zimbabwe and Russia, rising 60 koz to 680 koz. This is mainly due to the ramp-up at Tharisa's PGM-chrome operation, the addition of some Broken Hammer ounces from Canada and slight improvements elsewhere.

Demand

Demand is forecast to rise by 5.4% to 8.27 moz in 2014, the highest growth rate since 2011, and finally exceeds pre-financial crisis levels in 2007. Nonetheless, in net demand terms, after recycling which is estimated to be up 500 koz over the same period, consumption will still be 400 koz lower than in 2007.

Automotive demand

Automotive demand is set to be up 130 koz (4.3%), mainly from higher PGM loadings associated with Euro 6 emissions legislation, despite relatively flat production in the region, which adds 80 koz. Meanwhile, North America and India add 20 koz each and the Rest of the World the remainder on higher vehicle production.

Euro 6 legislation for diesel and gasoline light vehicles came into force for new vehicle approvals on 1 September 2014, and will apply to all new registrations from 1 September 2015. The main change is to cut the diesel NO_x limit by more than half to 80 mg/km. Selective catalytic reduction (SCR) technology, which does not use PGMs, is being deployed on larger diesel cars to comply with Euro 6. Other NO_x-reducing technologies, such as lean NO_x traps (LNT), which contain platinum as the oxidation catalyst and rhodium as the reduction catalyst, are being deployed by vehicle manufacturers.

Euro 6 for diesel heavy-duty vehicles came into force on 1 January 2014 and tightened particulate emissions from 0.02 g/kWh to 0.01 g/kWh and NO_x emissions from 2.0 g/kWh to 0.40 g/kWh compared to Euro 5, which has boosted the use of platinum in diesel particulate filters (DPFs).

Non-road heavy-duty diesel vehicles are also now increasingly legislated, and the introduction of Stage 4 in Europe and Tier 4 final in North America has supported platinum demand through the use of diesel oxidation catalysts (DOCs) and DPFs.

Too early to say how supply profiles will look next year

Supply flat outside South Africa

Demand 5.4% higher

Automotive demand up 4.3%

Emissions legislation tightening

The net result is that the platinum intensity of use for all on-road vehicles in Europe is estimated to rise by 4.4% in 2014 compared to 1.7% in 2013, owing to higher loadings of platinum per diesel catalyst to adhere to tighter legislation. This is the largest rise in the use of platinum since 2011 (5.1%), when the diesel share of passenger car registrations rose to peak at 56% from 52% the previous year (source: ACEA). However, it falls well short of the pre-crisis/pre-palladium substitution 2000s when platinum's intensity of use rose by an average of 12.6% p.a. At the same time, diesel's share of registrations grew from just 33% to 54% by 2007.

According to vehicle data from LMC Automotive, global vehicle sales growth for 2014 has been downgraded from 5.0% at the end of last year to 3.6% currently. Despite this, regional numbers have been supportive of platinum demand, with Western European sales up 5.9% to the end of July and forecast to rise 4.9% for the year.

Jewellery demand

Global jewellery consumption is expected to increase by 4.1% to 3.06 moz in 2014, which equates to 120 koz of extra demand versus 180 koz in 2013.

Demand in China is estimated to be up 2% (40 koz), breaching 2 moz for the first time. However, trade flows and trading of platinum in China are well down on exceptional levels in 2013 during periods of lower prices. An estimated 2.48 moz was exported to China and Hong Kong in 2013 versus annualised trade of 1.89 moz in 2014. Meanwhile, cumulative trade on the SGE, a traditional source of metal for the jewellery industry, is only 700 koz year to date to the end of August compared to 900 koz over the same period in 2013.

Jewellery demand in the Rest of the World is forecast to accelerate by 20% this year, albeit from a low base of 200 koz in 2013. This is mainly due to an estimated 25% rise in consumption in India to 175 koz. A successful marketing campaign by the PGI is bearing fruit and is leading not only to an increased sales volume of platinum jewellery, but also to greater average weights per item of jewellery.

Industrial demand

Total industrial usage is projected to grow 9% to 2.06 moz. More than half of the growth (+91 koz) is expected to come from the building of new glass capacity. The next major contributor is chemical demand (+24 koz). Both are cyclical in nature, so demand may not grow as strongly next year.

New flat panel display capacity for glass in China and South Korea is forecast to provide a one-off boost to industrial demand. Year-on-year growth in platinum for use in glass plants is estimated at 35% to 350 koz. This also includes growth in other glass capacity in South America, Thailand and China.

Chemical demand is being lifted by new plants for the production of propylene using the propane hydrogenation catalytic process requiring platinum. Fifteen new plants are scheduled over the next couple of years, mainly in China but also in the US.

There is now an abundant supply of propane feedstock from the US (from shale gas) and the Middle East.

Platinum loadings rise
4.4% in Western Europe

Jewellery demand up
4.1%, but slower growth
in China

Industrial requirements
to grow 9%

Recycling

Total recycling is forecast to increase just 2.5% to 2.07 moz in 2014. Autocatalyst recycling is estimated to rise by 6.1% to 1.21 moz. On-going growth from the scrapping of diesel catalysts in Western Europe is expected to lift recycling by 91 koz.

Recycling would have been higher, but growth in Europe is partially offset by a decline in the US, where the availability of scrapped second-hand cars has fallen – a hangover from the financial crisis. Jewellery recycling is estimated to remain largely flat, losing just 20 koz on 2013 levels to 850 koz, 67% of which comes from China.

Recycling growth limited
to 2.5%

The palladium market

Summary and stocks

The palladium market is projected to destock by 1.75 moz this year, compared to a deficit of 960 koz in 2013. The majority of the greater drawdown is due to a 490 koz drop in supply to 8.26 moz, while demand grows 300 koz to 10.01 moz.

By the end of 2014, total stocks are estimated at over 15 moz. However, relatively liquid stocks (excluding ETF holdings of 2.79 moz at the end of August and illiquid stocks) would leave the market with close to 6 moz of near-term liquidity. Sponge-to-ingot premiums reached highs of up to \$11/oz in April, but have settled back to normal levels of \$4/oz or below. It appears that the squeeze on sponge supplies has arrested for now. This could be linked to the sharp rise in ETF holdings from new offerings from Standard Bank and Absa in South Africa, which launched at the end of March and early April respectively. Between the end of March and the end of August, ETFs in South Africa have accumulated 967 koz of palladium.

However, like sponge premiums, global ETF holdings have declined recently, peaking at 2.93 moz in early August but then dropping to 2.79 moz by the end of the month. The majority of the decline was recorded in the London ETF which lost 121 koz over the period.

A fundamental market
deficit of 1.75 moz
this year

Mine production

Supply from South Africa is estimated to fall by 23.8% to 1.76 moz in 2014, the lowest yield since the mid-1990s. Including producer sales, supplies are close to 2 moz (est.), which is well down on mine output of 2.31 moz in 2013.

Russian production is forecast to decline slightly to 2.54 moz. Meanwhile, in Zimbabwe consistent growth over the last six years has been curtailed by the Bimha mine closure, which keeps output flat at an estimated 310 koz for the year. Other supply is up just 30 koz to 1.37 moz.

Demand

Global demand is forecast to breach 10 moz for the first time in 2014. Automotive usage is estimated to grow by 460 koz (6.4%) to 7.63 moz in 2014 at the expense of other end-uses, which are expected to drop by 160 koz (6.3%) to 2.38 moz.

Demand breaches
10 moz for the first time

LARGE DEFICIT IN 2014 (-1.75 moz)



Mine supply



Russia

2.5 moz
(-1.6%)



South Africa

1.8 moz
(-23.7%)



North America/
Canada

990 koz
(+1.4%)



Zimbabwe

310 koz
(-1.2%)

Recycling and demand



7.6 moz
(+6.3%)



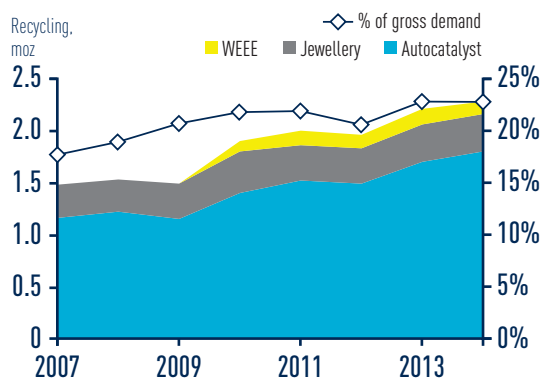
1.7 moz
(-3.5%)



440 koz
(-9.6%)

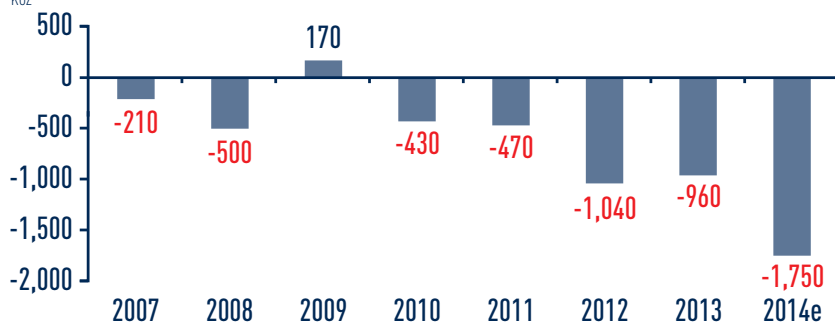


2.3 moz
(+3.6%)

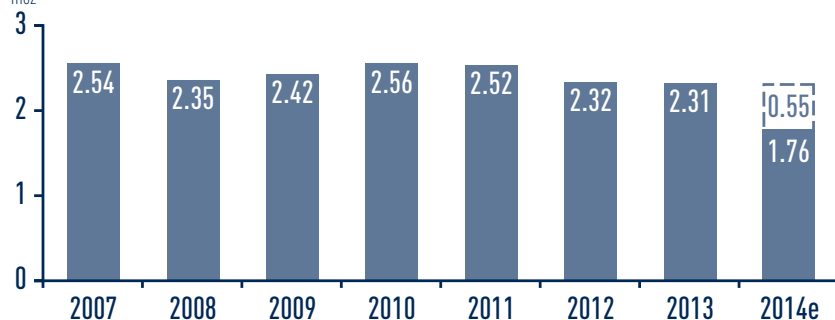


Market summary

Market surplus/deficit,
koz



South African supply,
moz



Source: Source: SFA (Oxford)

The 'perfect storm' of supply shortages, new ETF products and strong automotive demand has served to lift prices by 25.6% from January to August. Consequently, electronics, chemical, dental and jewellery requirements are forecast to fall by 4.4%, 3.9%, 9.6% and 16.9% respectively. It could be argued, therefore, that palladium demand has entered the substitution zone.

Palladium has entered
the substitution zone

According to LMC Automotive, light vehicle sales in China have risen by 9.2% in the year to July and are forecast to reach 10.3% for the year. This increase, combined with growth of 4.9% in US sales over the same period and a year-on-year forecast of 3.9%, means that demand pull for palladium remains strong. Requirements in China and North America are projected to rise by 170 koz and 140 koz respectively. China is promoting electric vehicles and curbing urban registrations, but the net impact will be limited. Expect strong sales growth to continue for years to come. In North America, however, significant sales incentives and very long credit terms of up to seven years pose a risk to future growth.

Recycling

Secondary supplies are forecast to be up just 3.2% this year to 2.28 moz compared to 12.8% growth in 2013. Much of the expansion in recycling in 2013 was due to the flow of scrapped catalysts from a sharp rise in the number of end-of-life vehicles in the second half of 2012. In 2013, however, the number of scrapped vehicles available to recycle fell and this has affected the pipeline of catalysts for recycling in 2014. Other recycling is forecast to remain largely flat year-on-year. Secondary jewellery supplies are likely to be down 30 koz, but this is a result of declining demand in China.

The rhodium market

Summary and stocks

The market is estimated to be in deficit by 200 koz in 2014 owing mainly to a 130 koz drop in output from South Africa. Supply from elsewhere remains essentially flat.

Rhodium market
destocking

Automotive requirements, the metal's main end-use (81% of demand), continue to recover steadily, up by 50 koz to 870 koz. However, this is still 130 koz down on 2007 levels. The lean NO_x trap (LNT), containing rhodium, continues to offer a practical solution to NO_x removal, which is critical to Euro 6 compliance for light vehicles.

Other industrial demand, namely glass, is expected to increase by 40 koz following numerous plant capacity builds, as highlighted in the platinum section earlier.

SFA's global stock estimates are just under 1 moz at the end of the year. However, the short-term, relatively liquid fraction of stock, when excluding ETF holdings and non-automotive working inventory, is much lower. The future rate of stock exhaustion going forward depends on the speed at which producers ramp up production in the coming years to avert oversupplying the market. Likewise, rhodium arguably has the best catalytic properties of the PGMs, so there should be inherent growing requirements from automakers as emissions legislation continues to

MARKET DEFICIT IN 2014 (-200 koz)



Mine supply



South Africa

440 koz
(-22.5%)



Russia

70 koz
(0.0%)



Zimbabwe

30 koz
(-7.3%)



North America/
Canada

30 koz
(+4.2%)

Recycling and demand



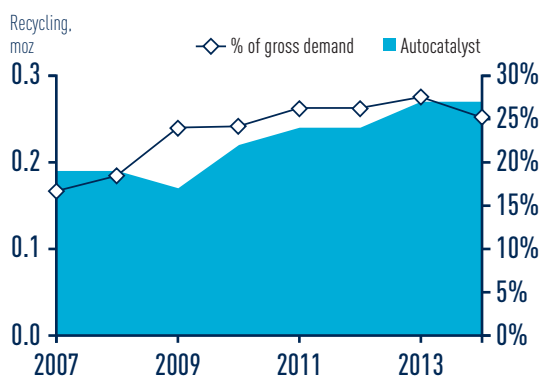
870 koz
(+5.8%)



200 koz
(+17.0%)

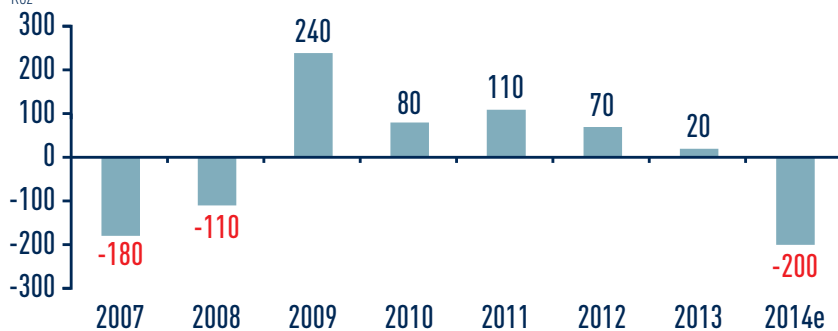


270 koz
(+1.6%)



Market summary

Market surplus/deficit,
koz



South African supply,
koz



Source: Source: SFA (Oxford)

tighten. Producers are working with end-users to encourage greater use of rhodium in future. As discussed in the first issue of *The Platinum Standard*, higher rhodium prices are required to secure increased quantities of palladium and platinum from South Africa.

The price outlook for the next six months

Platinum \$1,440/oz

The market fundamentals appear to have weakened to pre-strike levels and output from South Africa is ramping back up, increasing the risk of a stock build. Nonetheless, a great deal of uncertainty remains as regards the mine production profile for 2015 and beyond. Only when post-strike operating cost and capital budgets have been reset will decisions be made on the shape of mining profiles ahead. In the near term, therefore, expect prices to languish around current levels and perhaps dip lower. In the first quarter of 2015, however, prices should start to recover as company restructuring and operational strategies become clear. Ultimately, it is likely that production will be lower rather than higher than historical guidance.

Palladium \$850/oz

Record deficits and the consistent erosion of stocks ahead suggest the market can only tighten going forward unless a major intervention in fundamentals occurs. However, the perceived tightness of the market this year, which sent sponge premiums soaring, appears to have subsided. NYMEX futures contracts remain very close to record highs, while short positions, which were weighty at the beginning of August, have largely exited. ETF holdings fell by 136 koz in August to 2.79 moz with little reason to rally in the near term as South African holdings appear to have levelled out for now. A further price dip in the near term is possible therefore, but underlying fundamentals remain overwhelmingly positive and we expect palladium prices to continue to narrow the gap to platinum going forward.

Rhodium \$1,200/oz

While the market is in deficit this year, there is still a stock overhang, and as producers in South Africa lift output, there is the risk of oversupply over the medium term. The strategy announcements for platinum in early 2015 will dictate how high rhodium prices will go in future. For now, SFA believes that there will be a number of false starts as prices rally and dip to get sustainably over \$1,300/oz early next year.

Appendix



Platinum supply-demand balance, koz

	2007	2008	2009	2010	2011	2012	2013	2014e
Primary supply								
Regional								
South Africa	4,890	4,550	4,550	4,650	4,510	4,120	4,230	2,900
Russia	930	810	780	790	800	780	740	730
Zimbabwe	170	180	230	280	340	360	410	380
Other	390	370	270	390	580	580	620	680
Total	6,380	5,910	5,830	6,110	6,230	5,840	6,000	4,690
Demand & recycling								
Autocatalyst								
Gross demand	4,330	3,750	2,520	2,850	3,020	3,040	3,020	3,150
Recycling	1,060	1,060	830	960	1,210	1,180	1,140	1,210
Net demand	3,270	2,690	1,690	1,890	1,810	1,860	1,880	1,940
Jewellery								
Gross demand	1,980	1,940	2,690	2,170	2,460	2,760	2,940	3,060
Recycling	510	390	410	470	630	840	870	850
Net demand	1,470	1,550	2,280	1,700	1,830	1,920	2,070	2,210
Industrial demand								
	1,860	1,730	1,210	1,800	2,020	1,700	1,890	2,060
Other recycling								
	0	20	10	10	10	10	10	10
Gross demand								
	8,170	7,420	6,420	6,820	7,500	7,500	7,850	8,270
Recycling								
	1,570	1,470	1,250	1,440	1,850	2,030	2,020	2,070
Net demand								
	6,600	5,950	5,170	5,380	5,650	5,470	5,830	6,200
Market balance								
Balance (before ETFs)	-220	-40	660	730	580	370	170	-1,510
ETFs (stock allocation)	220	100	390	540	180	220	910	340
Balance after ETFs	-440	-140	270	190	400	150	-740	-1,850

Source: SFA (Oxford)



Platinum demand & recycling by region, koz

	2007	2008	2009	2010	2011	2012	2013	2014e
Demand								
Autocatalyst	4,330	3,750	2,520	2,850	3,020	3,040	3,020	3,150
North America	790	570	330	370	340	370	370	390
Western Europe	2,290	1,920	1,290	1,310	1,450	1,280	1,300	1,380
Japan	500	540	310	480	500	600	560	560
China	180	150	100	130	120	120	130	130
India	90	90	100	150	180	210	160	180
RoW	480	480	390	410	430	460	500	510
Jewellery	1,980	1,940	2,690	2,170	2,460	2,760	2,940	3,060
North America	230	200	140	160	160	190	200	220
Western Europe	200	200	190	180	180	170	220	230
Japan	490	450	430	370	320	330	330	340
China	980	1,020	1,860	1,370	1,670	1,910	1,990	2,030
RoW	80	70	70	90	130	160	200	240
Industrial	1,860	1,730	1,210	1,800	2,020	1,700	1,890	2,060
North America	420	380	280	370	410	440	450	470
Western Europe	350	350	270	370	440	420	440	450
Japan	230	200	140	240	250	150	150	210
China	300	200	90	290	200	230	370	420
RoW	560	600	430	530	720	460	480	510
Total	8,170	7,420	6,420	6,820	7,500	7,500	7,850	8,270
North America	1,440	1,150	750	900	910	1,000	1,020	1,080
Western Europe	2,840	2,470	1,750	1,860	2,070	1,870	1,960	2,060
Japan	1,220	1,190	880	1,090	1,070	1,080	1,040	1,110
China	1,460	1,370	2,050	1,790	1,990	2,260	2,490	2,580
RoW	1,210	1,240	990	1,180	1,460	1,290	1,340	1,440
Recycling								
Autocatalyst	1,060	1,060	830	960	1,210	1,180	1,140	1,210
North America	630	580	550	580	600	580	590	510
Western Europe	270	310	130	200	420	410	360	460
Japan	110	120	110	140	110	110	90	110
China	0	0	0	0	10	10	20	30
RoW	50	50	40	40	70	70	80	100
Jewellery	510	390	410	470	630	840	870	850
Japan	310	220	130	150	280	280	250	260
China	200	170	280	320	350	560	610	580
RoW	0	0	0	0	0	0	10	10
WEEE	0	20	10	10	10	10	10	10
Total	1,570	1,470	1,250	1,440	1,850	2,030	2,020	2,070
North America	630	590	560	590	610	590	600	520
Western Europe	270	320	130	200	420	410	360	460
Japan	420	340	240	290	390	390	340	370
China	200	170	280	320	360	570	630	610
RoW	50	50	40	40	70	70	90	110

Source: SFA (Oxford)



Palladium supply-demand balance, koz

	2007	2008	2009	2010	2011	2012	2013	2014e
Primary supply								
Regional								
South Africa	2,540	2,350	2,420	2,560	2,520	2,320	2,310	1,760
Russia	3,050	2,700	2,680	2,720	2,700	2,630	2,580	2,540
Zimbabwe	140	140	180	220	260	280	310	310
Other	960	880	610	900	1,190	1,270	1,340	1,370
Total	6,690	6,070	5,890	6,400	6,670	6,500	6,540	5,980
Demand & recycling								
Autocatalyst								
Gross demand	5,000	4,800	4,090	5,650	6,190	6,700	7,170	7,630
Recycling	1,160	1,220	1,150	1,400	1,520	1,490	1,700	1,800
Net demand	3,840	3,580	2,940	4,250	4,670	5,210	5,470	5,830
Jewellery								
Gross demand	730	870	710	610	480	430	350	290
Recycling	0	0	0	100	140	130	150	120
Net demand	730	870	710	510	340	300	200	170
Industrial demand								
	2,650	2,430	2,410	2,470	2,470	2,370	2,190	2,090
Other recycling								
	320	310	340	400	340	340	360	360
Gross demand								
	8,380	8,100	7,210	8,730	9,140	9,500	9,710	10,010
Recycling								
	1,480	1,530	1,490	1,900	2,000	1,960	2,210	2,280
Net demand								
	6,900	6,570	5,720	6,830	7,140	7,540	7,500	7,730
Market balance								
Balance (before ETFs)	-210	-500	170	-430	-470	-1,040	-960	-1,750
ETFs (stock allocation)	280	380	510	1,080	-530	310	10	880
Balance after ETFs	-490	-880	-340	-1,510	60	-1,350	-970	-2,630



Source: SFA (Oxford)

Palladium demand & recycling by region, koz

	2007	2008	2009	2010	2011	2012	2013	2014e
Demand								
Autocatalyst	5,000	4,800	4,090	5,650	6,190	6,700	7,170	7,630
North America	1,950	1,550	1,010	1,310	1,490	1,730	1,830	1,970
Western Europe	990	970	920	1,290	1,490	1,410	1,540	1,650
Japan	850	930	600	810	670	740	740	740
China	340	400	700	1,010	1,130	1,290	1,510	1,680
India	80	90	110	150	160	170	160	170
RoW	790	860	750	1,080	1,250	1,360	1,390	1,420
Jewellery	730	870	710	610	480	430	350	290
North America	60	60	60	70	50	50	40	40
Western Europe	40	50	50	70	70	80	70	60
Japan	80	90	70	70	70	80	60	60
China	520	640	500	370	260	190	150	110
RoW	30	30	30	30	30	30	30	20
Industrial	2,650	2,430	2,410	2,470	2,470	2,370	2,190	2,090
North America	570	520	500	500	500	480	480	460
Western Europe	460	380	360	410	380	380	350	370
Japan	640	610	590	580	550	560	450	420
China	440	330	430	430	420	400	420	370
RoW	540	590	530	550	620	550	490	470
Total	8,380	8,100	7,210	8,730	9,140	9,500	9,710	10,010
North America	2,580	2,130	1,570	1,880	2,040	2,260	2,350	2,470
Western Europe	1,490	1,400	1,330	1,770	1,940	1,870	1,960	2,080
Japan	1,570	1,630	1,260	1,460	1,290	1,380	1,250	1,220
China	1,300	1,370	1,630	1,810	1,810	1,880	2,080	2,160
RoW	1,440	1,570	1,420	1,810	2,060	2,110	2,070	2,080
Recycling								
Autocatalyst	1,160	1,220	1,150	1,400	1,520	1,490	1,700	1,800
North America	770	850	890	970	980	930	1,060	960
Western Europe	240	250	130	210	330	330	340	410
Japan	110	100	100	180	130	130	130	140
China	0	0	0	0	10	20	50	140
RoW	40	20	30	40	70	80	120	150
Jewellery	0	0	0	100	140	130	150	120
Japan	0	0	0	10	20	20	20	20
China	0	0	0	90	120	110	130	100
WEEE	320	310	340	400	340	340	360	360
North America	90	90	80	80	70	70	70	60
Western Europe	70	70	70	110	80	80	80	80
Japan	120	110	120	130	120	110	130	130
China	10	10	20	20	10	20	20	20
RoW	30	30	50	60	60	60	60	70
Total	1,480	1,530	1,490	1,900	2,000	1,960	2,210	2,280
North America	860	940	970	1,050	1,050	1,000	1,130	1,020
Western Europe	310	320	200	320	410	410	420	490
Japan	230	210	220	320	270	260	280	290
China	10	10	20	110	140	150	200	260
RoW	70	50	80	100	130	140	180	220

Source: SFA (Oxford)



Rhodium supply-demand balance, koz

	2007	2008	2009	2010	2011	2012	2013	2014e
Primary supply								
Regional								
South Africa	640	610	660	640	630	590	570	440
Russia	90	80	80	80	80	80	70	70
Zimbabwe	10	10	20	20	30	30	40	30
Other	30	30	20	30	50	50	50	60
Total	770	730	780	770	790	750	730	600
Demand & recycling								
Autocatalyst								
Gross demand	1,000	910	600	730	740	770	820	870
Recycling	190	190	170	220	240	240	270	270
Net demand	810	720	430	510	500	530	550	600
Industrial demand								
	140	120	110	180	180	150	160	200
Other recycling								
	0	3	2	1	1	1	1	2
Gross demand								
	1,140	1,030	710	910	920	920	980	1,070
Recycling								
	190	190	170	220	240	240	270	270
Net demand								
	950	840	540	690	680	680	710	800
Market balance								
Balance (before ETFs)	-180	-110	240	80	110	70	20	-200
ETFs (stock allocation)					20	40	50	20
Balance after ETFs					90	30	-30	-220

Source: SFA (Oxford)



Rhodium demand & recycling by region, koz

	2007	2008	2009	2010	2011	2012	2013	2014e
Demand								
Autocatalyst	1,000	910	600	730	740	770	820	870
North America	350	270	150	180	180	200	230	240
Western Europe	300	270	190	200	220	190	210	230
Japan	220	240	120	160	130	150	140	140
China	30	30	50	70	80	90	100	110
India	10	10	10	20	20	20	20	20
RoW	90	90	80	100	110	120	120	130
Industrial	140	120	110	180	180	150	160	200
North America	30	10	10	20	20	20	20	20
Western Europe	20	10	20	20	20	20	20	20
Japan	40	40	30	50	50	40	30	60
China + RoW	50	60	50	90	90	70	90	100
Total	1,140	1,030	710	910	920	920	980	1,070
North America	380	280	160	200	200	220	250	260
Western Europe	320	280	210	220	240	210	230	250
Japan	260	280	150	210	180	190	170	200
China + RoW	180	190	190	280	300	300	330	360
Recycling								
Autocatalyst	190	190	170	220	240	240	270	270
North America	120	110	130	160	140	140	180	160
Western Europe	40	50	20	30	60	60	50	70
Japan	20	20	20	30	30	30	30	30
China	0	0	0	0	0	0	0	0
RoW	10	10	0	0	10	10	10	10

Source: SFA (Oxford)



Glossary of terms

Anode

An electrode through which positive electric charge flows into a polarised electrical device

Base metals

Copper and nickel

Basket price

Collective revenue of metals divided by 4E oz

By-products

Copper, nickel, iridium and ruthenium

CAPEX

Capital expenditure

Cathode

An electrode from which a conventional current leaves a polarised electrical device

Emissions legislation

Tailpipe regulations affecting particulate matter, hydrocarbons and oxides of nitrogen

ETF

Exchange traded fund

Euro 5/6 emission standards

Euro 5 legislation introduced in 2009, Euro 6 in 2014, will be widely adopted later in other regions

Fuel cell

A device that converts the chemical energy from a fuel into electricity through a chemical reaction with oxygen or another oxidising agent

Gross demand

A measure of intensity of use

HDV

Heavy-duty vehicle

Head grade

Grams of 4E PGMs per tonne of ore milled

koz

Thousand ounces

LCV

Light commercial vehicle

Lean NO_x trap (LNT)

Platinum and rhodium-based, catalyses the chemical reduction of NO_x in diesel engine exhaust to harmless nitrogen

Lease rates

Fees payable for the rental of an asset

Low temperature polymer electrolyte membrane (PEM)

A semi-permeable membrane generally made from ionomers and designed to conduct protons while being impermeable to gases such as oxygen or hydrogen

Merensky Reef

A layer of igneous rock situated in South Africa that contains most of the world's PGMs

Metal cocktail

The make-up of polymetallic orebodies

Mine lease area

Area defined by farm boundaries

moz

Million ounces

Net demand

A measure of the theoretical requirement for new metal, i.e. net of recycling

Net supply

Proxy supply of metal surplus to requirements

Net total cash costs

Total cash costs net of by-product credits (copper, nickel, iridium and ruthenium)

OPMs

Other platinum-group metals

oz

Ounce

Particulate filter (DPF, GPF)

Platinum-rich catalyst on ceramic filter, removes harmful fine particles from diesel and gasoline exhausts

PGMs

Platinum-group metals

Price elastic

Susceptible to changes in price

Primary supply

Mine production

Secondary supply

Recycling output

Selective catalytic reduction (SCR)

PGM-free, converts harmful NO_x in diesel exhaust to harmless nitrogen, via tank of urea solution; used in heavy-duty diesel vehicles, increasingly competes with LNT in light-duty diesel vehicles

Three-way catalyst

Used in gasoline cars to remove hydrocarbons, carbon monoxide and NO_x; largely palladium-based now, with some rhodium

Tonnes milled

Concentrator throughput of ore

UG2 Reef

Also found in South Africa, this chromite-rich layer of rock contains fewer by-products than the Merensky Reef

4E

Platinum, palladium, rhodium and gold

Currency symbols

ZAR South African rand
\$ US dollar
£ UK pound

Methodology notes

Primary supply is calculated from actual mine production and excludes the sale of stock in order to provide pure production data. Stock sales are treated separately in SFA's database as movement of stocks. Therefore, state stock sales from Russia are excluded in tabulations.

Gross demand is a measure of intensity of use.

Net demand is a measure of the theoretical requirement for new metal, i.e. net of recycling.

Automotive demand is based on vehicle production data not sales.

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Please note: Some tabulated data may not add up owing to rounding of individual numbers.

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