



GFMS PLATINUM GROUP METALS SURVEY 2018

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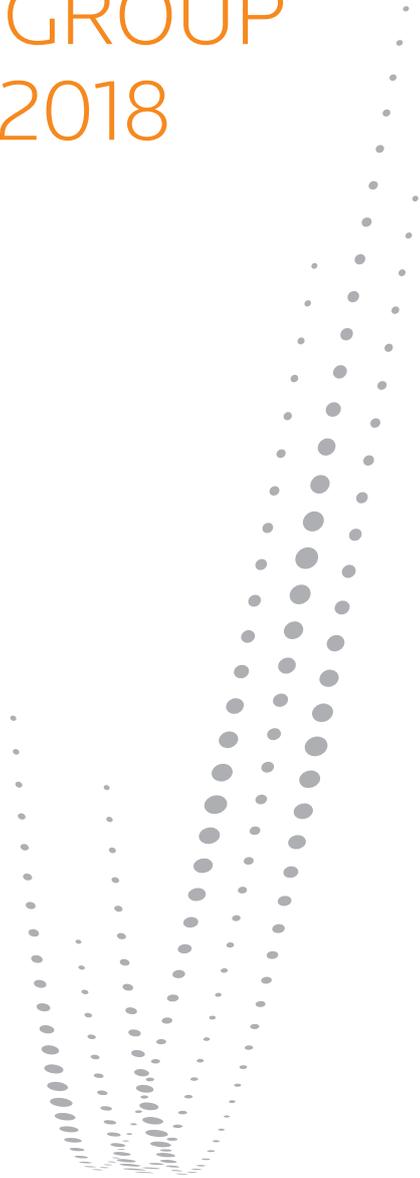


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MAJOR 2018 RELEASES

- | | |
|------------------------------------------------|---------------------------------------------------------------------------------|
| • GFMS GOLD SURVEY 2018 | 8 th May 2018 |
| • WORLD SILVER SURVEY 2018 | 12 th (New York) May 2018
13 th (Mexico City) May 2018 |
| • GFMS BASE METALS REVIEW AND OUTLOOK | 17 th May 2018 |
| • GFMS GOLD SURVEY 2018: H1 UPDATE AND OUTLOOK | 26 th July 2018 |
| • GFMS BASE METALS REVIEW AND OUTLOOK | 8 th October 2018 |
| • GFMS GOLD SURVEY 2018: Q3 UPDATE AND OUTLOOK | 25 th October 2018 |

ACKNOWLEDGEMENTS

The estimates shown in *GFMS Platinum Group Metals Survey* for the main components of mine production, scrap, fabrication, investment and stock movements are calculated on the basis of a detailed supply/demand analysis for each of the markets listed in the main tables. In the vast majority of cases, the information used in these analyses has been derived from visits to the countries concerned and discussions with local traders, producers, refiners, fabricators and central bankers. Although we also make use of public domain data where this is relevant, it is the information provided by our contacts that ultimately make *GFMS Surveys* unique. We are grateful to all of them.

NOTES

UNITS USED:

troy ounce (oz) =	31.1035 grammes
tonne =	1 metric tonne, 32,151 troy ounces

- Unless otherwise stated, all statistics on supply and demand are expressed in terms of fine metal content.
- All references in this publication to “ounces” refer to troy ounces.
- Unless otherwise stated, US dollar prices and their equivalents are for the p.m. fixes of the London Platinum and Palladium Fixing Company Limited for prices prior to 1st December 2014 and the p.m. LBMA Platinum Price and LBMA Palladium Price from 1st December onwards and the Johnson Matthey London a.m. Rhodium Price.
- Throughout the tables, totals may not add due to independent rounding.

TERMINOLOGY:

“-”	Not available or not applicable.
“0.0”	Zero or less than 0.05.
“dollar”, “\$”	U.S. dollar unless otherwise stated.
“3PGM”	Platinum, palladium & rhodium
“4E”	Four elements: platinum, palladium, rhodium and gold (3PGM+Au).
“6E”	Six elements: 4E plus iridium and ruthenium (5PGM+Au).

Estimates of **supply** include mine production and the recycling both of scrapped autocatalysts and old jewellery, but exclude contributions from above-ground stocks, such as supplies from stocks controlled by state institutions in Russia. **Demand** estimates are net of recycling with the exception of autocatalyst and jewellery, where gross demand is shown - i.e. the total amount of metal absorbed to these two sectors. Estimates of recycling from scrapped autocatalysts and jewellery are shown separately as part of supply given their scale and potential for change. Estimates of demand exclude the movements of any above-ground stocks held within the specified industries, for example any changes in stocks held by the automotive industry.

By simple arithmetic, this leaves either a **“Physical Surplus or Deficit”** (in previous publications “Gross Surplus or Deficit”) before any movements in above-ground stocks are considered. This is a critical measure of the underlying fundamentals of platinum and palladium and indicates the extent to which fabrication demand may have depended on the release of above-ground stocks, or otherwise. At the same time, this also indicates the change in global above-ground stocks.

Unless otherwise stated, all references to **“above-ground stocks”** of platinum and palladium refer to stocks of refined metal, of a form and quality accepted as good delivery in the London and Zurich market and the world’s principal commodity exchanges. Our supply/demand tables also show **“Estimated Movements in Stocks”**. These specific movements relate only to above-ground stock holdings for which reasonable estimates of movement can be made and attributed. A listing and breakdown of these appears in the more detailed tables in the Appendices section of this Survey.

Having allowed for the Estimated Movements in Stocks as defined above, the **“Net Balance”** (previously “Residual Surplus or Deficit”) is arrived at by deduction. A negative Net Balance implies the extent to which other **above-ground stocks**, including those held by financial institutions and/or investors, were released to meet fabrication demand. Conversely, positive Net Balance implies the extent to which these other **above-ground stock** holdings were augmented. However, this should not be construed as indicating the change in global above-ground stocks. For this, please refer to the reported Physical Surplus or Deficit.

1. SUMMARY AND OUTLOOK

After a very tough 2016 for platinum group metals, 2017 saw starkly contrasting performances for the individual metals. The price of platinum continued to drift lower, albeit unspectacularly compared to prior years, with the price falling by the lowest amount since the cyclical downtrend began in 2011 and to a twelve-year low. Meanwhile palladium, and even more spectacularly the minor PGMs including rhodium, saw prices soar as the former recorded a record annual average and rhodium increased by 59%. The fluctuating fortunes led to the unusual situation of all three major PGMs having the highest price at different stages of the same year.

These performances occurred despite deficits for platinum and palladium. However, the scale of these was very different, with palladium's deficit more than twenty times that of platinum. As a result, the ability of these markets to meet this shortfall by mobilising above-ground stocks differed widely. Against a negative media backdrop for diesel, and in turn platinum, and a broadly balanced platinum market stayed in contango.

In the case of palladium, and as we forecast in last year's Survey, there were sharply higher lease rates and bouts of tightness, sending the market into backwardation at times. Indeed, the situation would have been even more acute if there hadn't been substantial profit taking from ETF holders. Palladium's stellar price increase occurred despite a 4% rise in supply, due to higher Russian mine output and an increase in autocatalyst scrap flows. Instead, it was fuelled by the remorseless downtrend in stocks aided by another year of strong demand growth from the autocatalyst sector and substantial purchases for the Global Palladium Fund.

Turning to rhodium, and after years of being in the doldrums the price of the third largest platinum group metal market finally caught alight. This was underpinned by stronger fundamentals as mine supply slipped by 2%, chiefly due to a slump in Russian output as stocks of PGM-rich pyrrhotite concentrate were depleted, while offtake from autocatalyst rose.

WORLD PLATINUM SUPPLY AND DEMAND

(000 ounces)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018f	Chg (17/16)
Supply											
Mine Production											
South Africa	4,603	4,750	4,740	4,182	4,368	3,220	4,522	4,283	4,252	4,140	-1%
Russia	793	785	818	803	741	687	721	678	708	686	5%
North America	294	238	389	338	337	397	365	396	363	355	-8%
Others	358	411	457	472	565	541	529	610	598	591	-2%
Total Mine Production	6,048	6,183	6,404	5,796	6,011	4,844	6,137	5,966	5,922	5,773	-1%
Autocatalyst Scrap	786	904	996	927	1,050	1,093	1,065	1,126	1,187	1,230	5%
Old Jewellery Scrap	542	681	778	864	752	731	679	695	661	650	-5%
Total Supply	7,377	7,768	8,178	7,587	7,813	6,669	7,881	7,788	7,769	7,653	0%
Demand											
Autocatalysts	2,539	3,017	3,094	2,960	2,952	3,086	3,157	3,196	3,255	3,268	2%
Jewellery	2,678	2,291	2,420	2,595	2,744	2,662	2,597	2,318	2,204	2,136	-5%
Chemical	283	482	487	398	435	587	439	588	573	609	-3%
Electronics	278	283	256	227	202	195	183	178	197	204	11%
Glass	91	505	338	361	22	(71)	189	274	333	436	22%
Petroleum	163	168	144	126	107	122	96	135	172	180	27%
Other Industrial	431	494	559	621	649	700	681	742	784	808	6%
Retail Investment	313	95	312	282	136	141	582	550	303	292	-45%
Total Demand	6,776	7,335	7,610	7,571	7,247	7,423	7,924	7,981	7,822	7,933	-2%
Physical Surplus/(Deficit)	601	434	568	16	566	(754)	(42)	(193)	(53)	(280)	
Stock Movements	281	(579)	(256)	(538)	(1,891)	1,079	142	35	15	(100)	
of which ETF Release/(Build)	(384)	(579)	(156)	(238)	(891)	(221)	192	(15)	15	(100)	
Net Balance	882	(146)	312	(522)	(1,325)	325	99	(158)	(38)	(380)	
LBMA PM Price (US\$/oz)	\$1,203.50	\$1,608.98	\$1,721.87	\$1,551.48	\$1,486.72	\$1,387.57	\$1,052.91	\$988.76	\$948.49	\$981	-4%

Source: GFMS, Thomson Reuters; LBMA

PLATINUM IN 2017

Despite an uptick in autocatalyst recycling and resilient mine production, platinum supply was tempered by a fall in jewellery scrap, leaving total supply almost unchanged in 2017. On the demand side offtake was slightly weaker as stronger industrial demand was more than offset by falls in jewellery and retail investment, leaving the overall market in a **Physical Deficit** for the fourth consecutive year at 0.05 Moz (1.6 t).

Platinum **mine production** inched lower in 2017, by 1%, to stand at 5.92 Moz (184.2 t) driven by lower production from South Africa, Zimbabwe and Canada. Production disruptions in the form of maintenance work, safety stoppages, and mine suspensions were predominantly behind the drop in South Africa. Elsewhere, a normalisation in ore stockpiles led to losses, together with a drop in metal in mined ore. The closure of high cost shafts and higher metal prices pushed costs down by 2% on a Total Cash Cost + Capex basis, while increasing the peer group's EBITDA by 14% to \$1,702 M (excluding Russia), year-on-year. The drop in costs placed 32% of production under water, down from 35% in 2016.

Jewellery **recycling** weakened by 5% in 2017 to 0.66 Moz (20.5 t), the lowest level since 2009. Weaker platinum prices were largely to blame, reducing the incentive to sell back old jewellery. The biggest falls were seen in Japan and China which retreated 7% and 4% respectively although most markets saw a decline last year with the exception of North America, which inched 2% higher, and our Other Regions category, which recorded a double-digit increase, albeit from a very low base.

Autocatalyst scrap recorded a healthy 5% year-on-year rise in 2017, the second in succession, to an estimated 1.2 Moz (36.9 t). Weaker steel prices in recent years had tempered the number of end-of-life vehicles (ELVs) being presented to scrap yards but there were signs of a solid recovery last year following a modest rise in 2016. The more mature markets were mixed with strong gains in Europe and a slight uptick in North America partially offset by a slight contraction in Japan. Collection from emerging markets was more impressive, rising by double digits, led by a 23% increase from China.

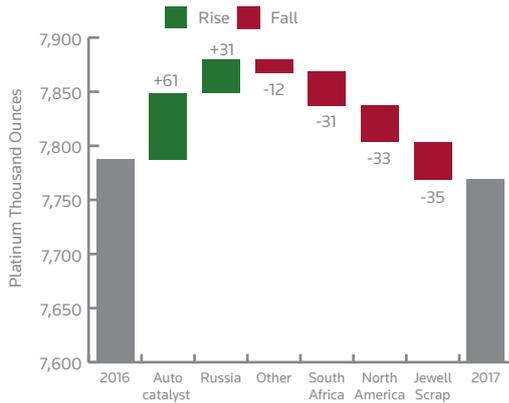
Turning to demand, platinum consumed in the production of **autocatalyst applications** last year

WORLD PALLADIUM SUPPLY AND DEMAND

(000 ounces)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018f	Chg (17/16)
Supply											
Mine Production											
South Africa	2,481	2,646	2,686	2,391	2,432	2,008	2,653	2,467	2,529	2,417	2%
Russia	2,677	2,722	2,704	2,624	2,527	2,582	2,575	2,526	2,728	2,680	8%
North America	688	726	959	953	934	978	925	932	896	967	-4%
Others	475	518	512	528	575	568	561	615	588	589	-4%
Total Mine Production	6,321	6,612	6,861	6,497	6,468	6,136	6,713	6,540	6,741	6,653	3%
Autocatalyst Scrap	1,077	1,307	1,514	1,472	1,587	1,826	1,763	1,956	2,160	2,265	10%
Old Jewellery Scrap	217	215	194	203	182	118	82	65	47	52	-28%
Total Supply	7,615	8,134	8,569	8,172	8,238	8,080	8,558	8,561	8,948	8,969	5%
Demand											
Autocatalysts	4,032	5,324	5,667	6,159	6,361	6,745	7,057	7,613	7,880	8,090	4%
Jewellery	1,110	797	674	595	525	478	324	293	285	280	-3%
Dental	602	590	567	546	511	475	449	426	408	394	-4%
Chemical	306	369	385	379	409	385	374	459	506	498	10%
Electronics	1,140	1,260	1,250	1,242	1,134	1,109	991	938	892	852	-5%
Other Industrial	84	101	103	110	110	117	116	113	124	123	9%
Retail Investment	170	80	61	37	38	45	45	45	53	59	19%
Total Demand	7,444	8,521	8,707	9,068	9,089	9,354	9,355	9,887	10,148	10,297	3%
Physical Surplus/(Deficit)	171	(388)	(138)	(896)	(850)	(1,273)	(797)	(1,326)	(1,201)	(1,327)	
Stock Movements	593	(290)	1,282	(148)	(300)	(299)	577	877	294	190	
of which ETF Release/(Build) (507)		(1,090)	532	(448)	0	(899)	727	637	384	350	
Net Balance	765	(677)	1,143	(1,044)	(1,150)	(1,572)	(220)	(449)	(907)	(1,137)	
LBMA PM Price (US\$/oz)	\$263.22	\$525.24	\$733.63	\$643.19	\$725.06	\$803.23	\$691.63	\$613.72	\$868.96	\$1,039	42%

Source: GFMS, Thomson Reuters; LBMA

WORLD PLATINUM SUPPLY



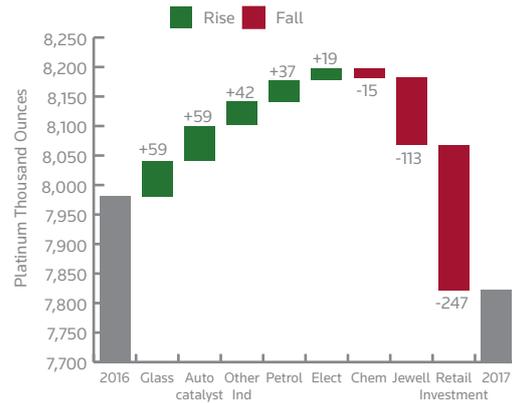
Source: GFMS, Thomson Reuters

rose by a healthy 7.1% to 3.48 Moz (108.2 t) despite all the negative sentiment from the vital diesel market, particularly in developed economies. This was the fourth consecutive rise and saw offtake reach the highest level in a decade. Still accounting for the largest consuming region, Europe reduced its share of platinum demand from 46% to 45% in 2017, which was a reflection of lower average platinum loadings, with platinum demand contracting 2% to 1.4 Moz (45.1 t). China was again the stand out, rising 16% in 2017, albeit from a relatively lower base. Meanwhile demand in North America and , Japan both rose by 3% last year, while our Other Regions category increased 4% year-on-year.

Jewellery demand retreated 5% year-on-year to an estimated 2.20 Moz (68.6 t), the fourth consecutive annual decline. The biggest falls were seen in China and Europe, with fabrication in these key markets falling by 8% and 6% respectively. In China, competition from carat gold jewellery eroded market share while another drop in demand from the watch segment in Switzerland and a price related decline in the UK accounted for the bulk of the losses in Europe. Elsewhere, Japanese and North American offtake were broadly stable, falling by just 1%.

Platinum consumed in **industrial** applications (excluding autocatalyst) rose by a combined 7% to a record high. The most pronounced gains were seen in the **petroleum** and **glass** sectors which rebounded 27% and 22% respectively, the former boosted by additional capacity in China. Moreover, **electronics** and the **other industrial** sectors also enjoyed a healthy increase with the former benefitting from stronger demand from hard-disk drives and secondary storage market. The only outlier last year was **chemical** demand which dipped 3% year-on-year.

WORLD PLATINUM DEMAND



Source: GFMS, Thomson Reuters

Retail investment fell by 45% in 2017 to an estimated 0.30 Moz (9.4 t). The material fall, the second in succession, has now seen investment demand decline 279,000 ounces (8.7 t) from the peak in 2015. Japanese demand slumped 55% last year, despite platinum remaining below the psychologically important ¥4,000 per gramme level. Elsewhere, demand in North America and Europe also wavered as competition from other higher yielding asset classes tempered demand.

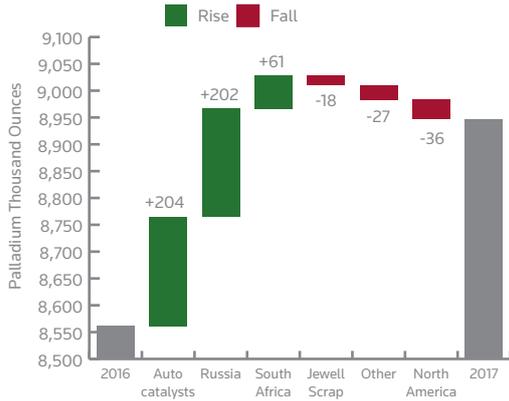
PALLADIUM IN 2017

Palladium's **Physical Deficit** edged lower last year to 1.20 Moz (37.3 t), retreating slightly from the record level seen in 2016. A 5% rise in total supply was partially offset by further modest gains on the demand side. Adjusting for stock movements (from ETF redemptions and industry stocks) the **Net Balance** slipped to a deficit of 0.91 Moz (28.2 t), the deepest deficit since 2014.

Mine production of palladium rose by 3% to total 6.74 Moz (209.7 t) last year as output rose in Russia, South Africa and United States, but was capped by the losses in Canada. An increase in palladium content in mined ore managed to raise the balance despite bottleneck issues at the South Africa's platinum belt. At the asset level, the largest increase was registered at Norilsk's Russian operation led by the processing of concentrate purchased from Rostec and work-in-progress material in transit from the Polar to Kola division.

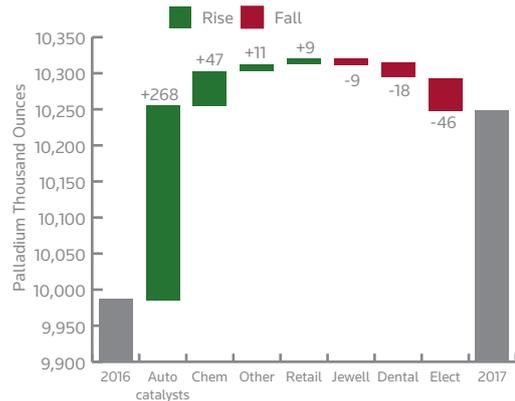
Autocatalyst scrap supply reached a record high last year, increasing 10% over 2016 volumes to an estimated 2.16 Moz (67.2 t). A recovery in end-of-life vehicle (EVL) scrappage volumes, coupled with higher palladium prices saw stockpiled inventory recycled. The fastest growth in percentage terms was seen in China which jumped

WORLD PALLADIUM SUPPLY



Source: GFMS, Thomson Reuters

WORLD PALLADIUM DEMAND



Source: GFMS, Thomson Reuters

22%, but Europe was the standout in volume terms rising almost 17% to a record as higher commodity prices motivated recyclers to process their metal. Elsewhere, scrap collection in North America was boosted by the higher palladium loadings of older vehicles.

Palladium **jewellery scrap** supply fell 28% last year to 0.47 Moz (1.5 t), the lowest level since 2003. This outcome may appear counter-intuitive given that the average palladium price rose 39% last year but it was a material fall in Chinese recycling following the collapse of the domestic jewellery industry that accounted for the bulk of the drop. Elsewhere, scrap volumes increased as a result of higher prices, most notably in Europe which rose 5%.

Palladium demand in **autocatalyst applications** rose 4% to 7.9 Moz (245.1 t) last year, slightly faster than new vehicle demand and to a new record high. This was generally a reflection of rising loadings in particular in parts of our Other Regions category and China, but also North America, driven on continued tightening emissions legislation. China introduced China 5 for LDV in 2016 and China V for HDV last year which both had a significant impact on PGM demand with it rising 5% on a year on year basis. North America in turn started to phase in its Tier 3 regulation which we believe also had a positive effect on loadings, albeit not to the same degree as in China. European demand rose only at the margin in 2017, boosted in the main by real-world driving emission testing which have supported higher PGM loadings and a rise in gasoline vehicle market share.

Despite a mixed outcome, aggregate demand from the other **industrial applications** remained almost unchanged last year, retreating less than 1% to 1.93 Moz (60.0 t). Falls were seen in the **electronics** and **dental** markets, both of which have been trending lower in recent years due to substitution losses. On the other

hand, **chemical, petroleum,** and the **other industrial** segment all recorded healthy year-on-year gains, the former driven by capacity expansions in purified terephthalic acid (PTA) plants.

Palladium **jewellery fabrication** declined for the ninth consecutive year, by 3% to 0.28 Moz (8.9 t). The complete collapse of the Chinese market in recent years has seen offtake in this sector fall acutely. Global demand last year was 78% or 1.0 Moz (31.1 t) below that of a decade earlier. In volume terms it was the drop in European and North American offtake that accounted for much of the global decline as acutely higher palladium prices attracted less interest from consumers and saw fabricators look to more affordable alloying options for white gold carat jewellery.

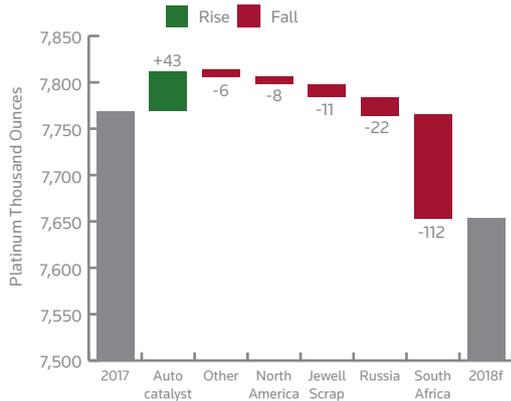
Finally, a modest pick up in demand from North America and Europe saw **retail investment** for palladium jump 19% last year to 0.53 Moz (1.7 t), the highest level since 2009. Demand from North America, which dominates this space at over 70% of the global total, rose 18% over 2016 volumes, bolstered by the US mint launching its first palladium American Eagle coin, while European offtake increased 12% year-on-year.

PLATINUM, PALLADIUM AND RHODIUM, US\$/OZ



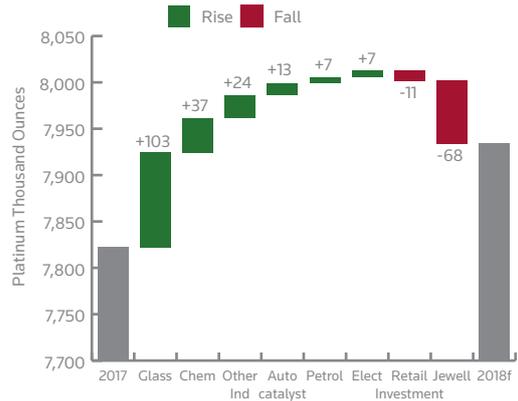
Source: Thomson Reuters

WORLD PLATINUM SUPPLY FORECAST



Source: GFMS, Thomson Reuters

WORLD PLATINUM DEMAND FORECAST



Source: GFMS, Thomson Reuters

OUTLOOK FOR 2018

After a six year downswing we expect the price of **platinum** to finally start a recovery this year, but only a gradual one. Our expectation of a price rise is predicated on a small deficit this year, of nearly 0.3 Moz (22.5 t). We think this will be fuelled by both a contraction in supply, chiefly from South African mines as well as rising demand. In the case of mine output the decline is due to a combination of the sustained reduction in capital expenditure in recent years leading to a denuded pipeline of new projects, combined with closures from some marginal operations, particularly Bokoni & Maseve.

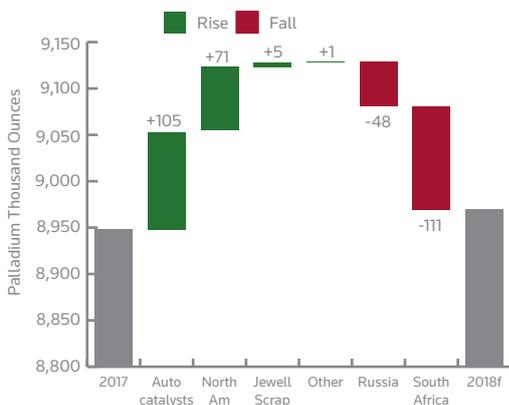
Meanwhile demand will be aided by robust economic growth underpinning usage across a variety of industrial applications, with glass showing the fastest growth. Despite the prevailing doom and gloom around platinum use in the automotive sector we expect it to grow, albeit marginally. This will be supported by growth in emerging markets and from the heavy duty on road and non-road mobile machinery segments globally. Unsurprisingly, this will be offset by a loss of market share for diesel in light duty vehicles in Europe and Japan.

Given this backdrop, we expect platinum to exceed \$1,000/oz at times in the second half of the year, a level that has exceeded spot prices for all but one week since February 2017.

Despite all this, **palladium** is set to exceed platinum on an annual average basis for the first time in 2018. We also expect further bouts of tightness in supply leading to higher lease rates. Our longstanding bullishness for this metal continues to being underscored by the growth in demand from the automotive sector which is set to continue apace despite record prices as substitution is not happening at present (although various manufacturers are exploring options in case the price gap widens). A further prop is set to arrive from declines in mine output from the two dominant producing countries, Russia and South Africa. That said, total supply will barely change due to increased autocatalyst scrap and higher output from both Canadian and U.S. mines.

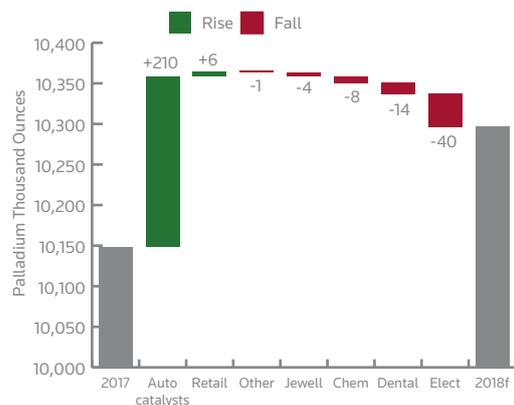
As a result we expect palladium to average over \$1,000 on an annual average basis for the first time ever this year. For more information please visit: financial.tr.com/eikon-metals.

WORLD PALLADIUM SUPPLY FORECAST



Source: GFMS, Thomson Reuters

WORLD PALLADIUM DEMAND FORECAST



Source: GFMS, Thomson Reuters

2. PGM PRICES

PLATINUM & PALLADIUM

The annual average platinum price retreated last year, from \$989/oz in 2016, down to \$949/oz in 2017. The average 20-day rolling price volatility fell to 17% last year, from 24% in the prior year. Price volatility peaked for the year in January as it averaged 24% for the month, as platinum had bottomed in December 2016, and rebounded from sub \$900/oz levels to close to \$1,000/oz level towards month end. Total ETF holdings recorded net outflows for the year, albeit losing just 14,683 ounces (0.46 t), and ended the year with 2,574,773 oz (80.1 t).

Meanwhile, after increasing 20.7% in 2016, **palladium** outperformed its peers by posting a 58% return in 2017. In the year, not only did palladium break above the \$1,000/oz barrier, but the price has also surpassed that of platinum. The annual average price also increased by 42%, to \$868/oz in 2017. The average 20-day rolling price volatility fell from 29% in 2016 to 24% in 2017. Total ETF holdings recorded net outflows as well, losing 383,519 ounces (12 t) or 22%, and ended the year with 1,324,869 oz (41.2 t). The strong performance in the palladium price last year was mainly attributed to the better than expected performance from the auto production industry, particularly from China. Indeed, there was a global shortage of available palladium last year, with strong demand coming from China. Total Chinese vehicle production reached 29 million units in 2017, increasing 3.2% year-on-year. While that is sharply slower than the 14.5% annual growth recorded in 2016, it was mainly skewed by the higher base in 2016 and the reduced tax benefits in 2017.

Platinum surged from sub-\$900/oz levels towards the

PGM PRICES: SOUTH AFRICAN RAND



Source: Thomson Reuters

end of 2016, to close to \$1,000/oz level in January, and finally breached this level in February. However, the price soon retreated, and fell below the \$1,000/oz level again in March. According to the weekly CFTC reports, activities of the managed money positions were also in sync with these price actions. Net long positions were built up in January, and peaked for the year at the end of February, at 49 net tonnes and at \$1,029/oz. Palladium started strongly out of the gate, and never looked back. Closing at \$670/oz in 2016, palladium quickly breached \$700/oz, and flirted with the \$800/oz level by the end of March. Speculators also began building up long positions towards the end of January, and net long positions jumped 70% in three months to the equivalent of 68 tonnes at the end of March.

In the second quarter, platinum regained some strength in early April but quickly lost steam, and ended up losing 3% in the quarter. That was in spite of a weaker dollar, as the dollar index fell from above 100 to slightly below 96 at the end of June. Speculators lost interest in platinum, as managed money positions fell to net short from early May until early August (with an exception of one week which was actually at net zero). It was also the first time that platinum fell to net short since the weekly report was made available to the public in its current format in June 2007. On the other hand, after trading within a somewhat flat range in the first two months of the second quarter, palladium finally broke out in June, advancing 3.3% for the month.

Platinum reached a 7-month low in July, but a bottom was formed and even breached the \$1,000/oz threshold again in late August/September. However, platinum price weakened quickly towards the end of September, giving up all the gains during the quarter, and ended up \$2/oz lower than the price at the end of June, leaving a sour taste in the mouths of many disappointed investors. Unlike platinum, palladium's strong momentum carried forward into the third quarter, as the price surged 11%, and even surpassed platinum towards the end of the quarter. This marked the start of the palladium price trading above platinum that lasted for more than the next six months until the palladium price slipped below platinum again (though just for days) in April 2018.

Initially in the final quarter of 2017, platinum again rebounded and it looked as if it was gaining momentum in November, only to lose steam again and give up most of its gains in December, with the price falling

PRECIOUS METALS PRICE PERFORMANCE

	Au	Ag	Pt	Pd	Rh
2016	1,251	17.14	989	614	693
2017	1,257	17.05	948	869	1,105
Change (yoy)	0.5%	-0.5%	-4.0%	41.6%	59.4%

Source: GFMS, Thomson Reuters; LBMA; Johnson Matthey

below \$900/oz at some points. Managed net positions also recorded six weeks of net short in platinum in the fourth quarter, indicating a lack of speculative interest. Again, palladium continued its stellar price trajectory, as speculative investors continued building long positions. The palladium price finally broke through the \$1,000/oz barrier in October, and remained at such levels in December after some price volatility in between.

Platinum was in general regarded as a disappointment in 2017. While a recovery was seen in the global industrial sector, as well as a weakening dollar, both were insufficient to prevent platinum recording its lowest annual average in 12 years. Part of this could be blamed on the share of diesel cars continuing to decline, and the pain of diesel cars was gasoline's gain. The platinum/palladium ratio averaged 1.61 in 2016, and fell substantially to an annual average of just 1.09 in 2017, as palladium outperformed and even surpassed platinum in the third quarter. In the first four months of 2018, the average ratio fell to 0.95.

RHODIUM

Rhodium outperformed even palladium, and more than doubled last year, as its price increased from a mere \$770/oz to \$1,715/oz. Rhodium prices averaged \$1,105/oz in 2017, a 59% year-on-year increase. Total ETF holdings recorded net outflows of 17,957 ounces (0.6 t) or 17% and resulted in 86,464 oz (2.7 t) left in total holdings. After 18 months of attempts, rhodium finally broke over the \$1,000/oz threshold towards the end of the first quarter. Supplies increased initially, but were all absorbed by buyers in the market quickly. As the year moved on, any marginal reduction in price was immediately met with new purchases, particularly from industrial customers. In early October, massive buying interest, predominantly from Asia, emerged that took the price up by more than \$100/oz in a week.

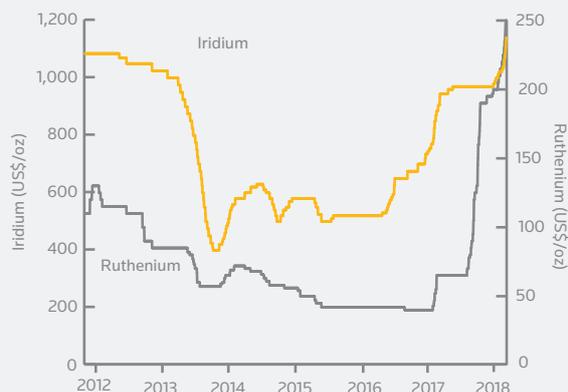
Rhodium continued higher and reached just under \$1,700/oz on 26th October, but then buying activity dwindled and once again supplies flooded into the market. The price then fell all the way to \$1,325/oz before finding support. Large orders re-emerged in November, taking the rhodium price back above the \$1,700/oz level at the end of the year. Rhodium was a tight and nervous market, and some buyers worried that they could miss the boat if they failed to make timely purchases.

RUTHENIUM & IRIIDIUM PRICES

Ruthenium's price performance was even more impressive than rhodium, more than quadrupling in 2017, as its price soared from \$40/oz to \$190/oz. Ruthenium prices averaged \$75/oz in 2017, compared to \$42/oz a year before. After trading more or less on the same level since mid-2015, a scientific report on using ruthenium based catalyst to split water into hydrogen almost as well as platinum published in early 2017 changed the market, with some speculative interest driving ruthenium prices higher. By the third quarter of 2017, physical demand for ruthenium was sharply higher, mostly from the magnetic data storage sector, and existing supply failed to satisfy demand. As a result, ruthenium rose approximately 20% in just ten days in late September/early October. Various reports of new applications using ruthenium provided support to the price thereafter, and another push of physical demand in late November boosted the price up, rising 32% in just 21 days. Rising demand is expected to be supportive of ruthenium prices in 2018.

Iridium is mainly used in electronics, as well as spark plugs, electrodes and chemical catalysts. The price of iridium also advanced along with other PGM metals, increasing by 44% in 2017. Price rose from \$675/oz to \$970/oz for the year. Iridium averaged \$898/oz in 2017, compared to \$576/oz in 2016. While demand was relatively stable, iridium was in deficit last year, as supply was less than demand, driving prices higher.

RUTHENIUM & IRIIDIUM PRICES



Source: GFMS, Thomson Reuters

PLATINUM AND PALLADIUM PRICE CORRELATIONS

Platinum and palladium belong to the same group in the periodic table and therefore share similar physical and chemical properties. They also tend to occur together in mineral deposits. Both are used in automotive catalytic converters, electronics, jewellery and act as catalyst during chemical process. The automotive sector dominates platinum and palladium usage in autocatalysts, representing 42% and 78% of gross usage respectively in 2017. From the supply side, both metals are also fairly concentrated, with mine production from South Africa accounting for over 55% of total platinum supply last year. Supply for palladium is more diversified, with mine production from South Africa and Russia accounting for 28% and 30% of total supply respectively last year.

Despite the similarities of the two metals, their price correlations were actually decreasing throughout 2017 and towards the year end. The weakness in the platinum price last year was in sharp contrast to the strong performance of palladium, which surged 58%. Platinum has become the victim of the Volkswagen emissions incident, and diesel engines continued losing market share to gasoline, which did not exactly enhance platinum's profile to investors. A lack of a compelling story and spotlight on platinum also caused market apathy, which resulted in further price weakness, and even the story of potential supply disruption in South Africa failed to propel the price much. Despite the fact that platinum is used in fuel cells, a technology that could potentially change the landscape of the global auto industry, the large-scale implementation of this technology is still at a very early stage, and the amount consumed last year was relatively insignificant. On the other hand, the fact that gasoline has been taking market share away from diesel engines, as well as China's higher than expected demand for palladium in the country's vehicle production slightly outperforming market's expectation last year, attracted the market spotlight. As a result, the platinum ratio surged from 1.34 by the end of 2016 to 0.88 by the end of 2017, as palladium surpassed platinum towards the end of September.

Another interesting observation was that platinum had a higher correlation with gold than palladium last year. As mentioned, a lack of compelling story on platinum last year forced the market to value platinum in terms of gold, despite platinum's industrial characteristics compared with gold's monetary properties. However, despite a global recovery in the industrial sector last year, platinum also lagged behind gold, and the gold to platinum ratio rose from an average of 1.29 during the fourth quarter 2016, to

QUARTERLY CORRELATION COEFFICIENTS

(daily log returns)

	2016	2017	2017	2017	2017	2018
	Q4	Q1	Q2	Q3	Q4	Q1
Platinum-Palladium	0.27	0.58	0.39	0.37	0.31	0.55
Platinum						
Gold	0.62	0.68	0.65	0.71	0.65	0.59
US\$/Euro Rate	0.32	0.39	-0.01	0.05	0.09	0.31
CRB Index	0.18	0.01	0.08	-0.15	0.21	0.23
Oil (WTI)	-0.05	0.00	0.20	-0.11	0.11	0.18
Palladium						
Gold	0.25	0.56	0.25	0.32	0.23	0.34
US\$/Euro Rate	-0.06	0.23	-0.07	-0.13	-0.10	0.17
CRB Index	0.36	0.11	0.19	-0.02	0.10	-0.03
Oil (WTI)	0.05	0.00	0.06	0.09	0.06	0.27

Source: GFMS, Thomson Reuters

above 1.30 by the end of the first quarter of 2017, and broke above 1.40 by December last year. The gold to platinum ratio averaged at 1.33 throughout 2017, while the historical average for 1985-2017 was 0.82.

In 2018, platinum's price correlation with both gold and palladium remained at relatively high levels, as the major theme in the first quarter was a weaker dollar, along with the rising of geopolitical concerns, including secondary sanctions on Russia, and the potential of a global trade war. Platinum continued to underperform gold, as the gold to platinum ratio rose beyond 1.40, a historical high. On the other hand, speculators took profits on palladium after its massive run in 2017, as large long positions were unwound in the futures market, according to the CFTC weekly reports. Indeed, palladium lost 9% in the first four months of 2018, and the price was actually below that of platinum for days in April, when the market worried about the escalation of the global trade war. Nevertheless, palladium rebounded quickly, but was still mostly trading below the \$1,000/oz

PLATINUM, PALLADIUM AND OTHER COMMODITIES



Source: Thomson Reuters

3. INVESTMENT

- **Total identifiable investment in platinum, which includes retail investment and ETF inventory build, declined by 49% to 318,148 ounces (9.9 t). On the other hand in the case of palladium it increased by 19% to 53,160 ounces (1.7 t).**
- **Much of the decline is attributed to the low volatility in prices and with stronger palladium prices, leading to a shift in investor sentiment.**
- **Rhodium investment declined sharply with ETF holdings having decreased 17% year-on-year.**

COMMODITY EXCHANGES

TOCOM platinum futures had a strong build up in net long positions in the first quarter of 2017, increasing from 66,000 ounces (2.0 t) at the end of December 2016 to 1.7 Moz (52.9 t) in three months. This was largely driven by expectations for higher prices and a 73% increase in net longs on COMEX during January and February which eventually led to the addition of longs in Japan. Also, the stronger Japanese yen which appreciated by 4% in the first two months meant prices were relatively lower though in dollar terms platinum prices increased. More particularly this was amidst stronger speculative demand. The investor activity later turned tepid with net long positions dropping to 0.3 Moz (8.6 t) by the end of the first half; a sharp decline compared to the end of March. Longs however failed to hold as the Japanese yen stabilised with the dollar seeing some short covering, which resulted in long liquidations. The trend continued for the rest of the year while net long positions declined to 71,000 ounces (2.2 t). This was partly a reaction to higher interest rate expectations, as that was seen to have a negative influence on the price in yen, and it wasn't a surprise to note that while the platinum price in dollar terms gained 3% year-on-year in Japanese yen terms it declined by a percentage point during the same period.

Turning to palladium, and on a sharp increase in price speculators increased their net short positions on TOCOM. These rose from a net short position of 1,000 ounces (40 kilogrammes) at the beginning of the year to 4,000 ounces (0.13 t) by end of the year. For a brief period the market shifted to net long of 400 ounces in February but net speculative short positions continued to increase.

CFTC reports on managed money positions on NYMEX, which include both futures and options, provide a good proxy for investor activity on the exchange. Looking to platinum in 2017, the net long positions increased from 1.4 Moz (44.9 t) as of December 2016 to 2.5 Moz (77.7 t) as of 28th February, which was also the highest for the year. In the same period the differential of platinum with that of palladium had increased from \$220 to \$248, however the price for both had increased by approximately 13%. However, sentiment changed in the second week of March with the differential first dropping to \$186. This was an indication that there was a shift in investment from platinum to palladium.

On NYMEX the net speculative platinum long position declined by 0.9 Moz (28 t) in March to end the first quarter at 1.6 Moz (51 t). The decline continued into the second quarter, falling 0.8 Moz (26 t) to 0.7 Moz (23.6 t). The third quarter however saw a significant build up in speculative long positions, almost making up for the loss in second quarter. However, by the end of the year total net long positions were 1.1 Moz (35 t), the lowest year end holdings since 2011. While investor interest declined in platinum, palladium on the other hand pulled out of the woods ending 15% higher than the price of platinum. That said, the net palladium long position increased by 1.1 Moz (35 t) last year and ended at 2.6 Moz (81.6 t), the highest in any year. The gains continued to be extended to the second week of January 2018, post which it has been on a steady decline and net longs ended the first quarter of 2018 at 1.3 Moz (39.8 t), with the palladium

IDENTIFIABLE INVESTMENT*

(000 ounces)	Platinum					Palladium				
	2014	2015	2016	2017	Change	2014	2015	2016	2017	Change
Retail Investment	141	582	550	303	-45%	45	45	45	53	19%
Exchange Traded Funds	(221)	192	(15)	15	n/a	(899)	727	637	384	-40%
Total Identifiable Investment	(80)	774	535	318	n/a	(854)	772	682	437	n/a
Indicative Value \$M**	(111)	815	529	304	-43%	(686)	534	419	372	-11%

*Excludes investment activity in the futures and OTC markets.

**Indicative value calculated using annual average volume and prices.

Source: GFMS, Thomson Reuters

NET INVESTOR POSITIONS ON TOCOM AND NYMEX

(end-period; positive represents net longs)

	Platinum				Palladium			
	Q1.17	Q2.17	Q3.17	Q4.17	Q1.17	Q2.17	Q3.17	Q4.17
TOCOM Futures Contracts	105,797	17,226	14,021	4,424	(123)	(291)	(374)	(274)
- equivalent in ounces (000)	1,701	277	225	71	(2.0)	(4.7)	(6.0)	(4.4)
NYMEX Futures Contracts	32,157	15,203	32,118	22,461	21,282	21,472	21,412	26,226
- equivalent in ounces (000)	1,608	760	1,606	1,123	2,128	2,147	2,141	2,623

Source: TOCOM, CFTC

price at just 3.6% higher than platinum. The narrowing of premia is attributed to slowdown in demand from China.

Platinum contracts traded on the Shanghai Gold Exchange (SGE) in 2017 were 18% lower year-on-year, down to 0.7 Moz (21.6 t). The increase in secondary supplies (scrap and smuggled metal) makes purchasing platinum on the SGE relatively unattractive due to the hefty premia, which averaged \$68/oz in 2017.

RETAIL INVESTMENT

Investment demand for platinum last year declined by 45% to 0.3 Moz (9.4 t), primarily due to a drop in demand from Japan of approximately 55% year-on-year to 182,000 ounces (5.7 t); the lowest in three years. Japan's share of total retail investment was 60% last year, lower than its share in 2016 which was at 73%; it has declined in the last three years from the exceptional 86% in 2015. At 182,000 ounces its share of mined platinum was only 3% last year as compared to 7% in 2016. Platinum prices traded in a range of 3,100 to 3,800 yen per gramme, but demand failed to pick up, primarily attributed to lower volatility in prices. This was in complete contrast to 2016 when investors had lined up at stores as the price ranged between 3,100 to 3,200 yen per gramme. Also it was an indication that much of the demand had skewed towards Q4 2016, which had resulted in lower offtake in the continuing period. Furthermore, looking at coin sales, we notice much of the investment was centred in Q1 and Q2 2017 and falling steeply thereafter.

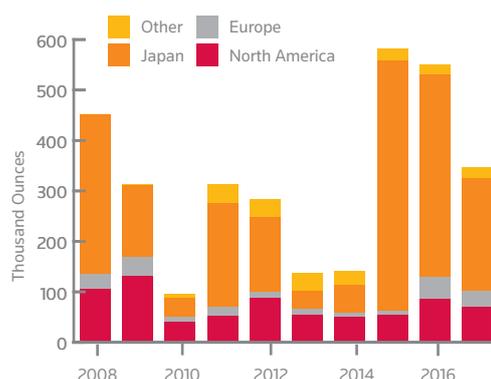
In North America, platinum retail investment declined by 26% year-on-year, this was due in particular to a greater shift to palladium amongst investors with demand increasing 18% year-on-year. Although at 39,000 ounces (1.2 t) it was the highest in seven years, it still wasn't particularly impressive given that the price last year rose by 56% on an intra-year basis and that palladium was repeatedly in the news amongst the professional investment community.

Physical investment in platinum declined by 5% year-on-year in 2017 to 41,000 ounces (0.9 t) in Europe; this

was in complete contrast to a 564% gain in 2016. With hindsight the decline is not a surprise as we have seen patterns earlier when demand surges in a year and drops steeply the following year. For example, in 2009 when demand touched 38,000 ounces (0.5 t) it was followed by a sharp drop; that said 2009 was the highest level recorded in any year. This was partly a function of prices drifting unspectacularly lower and that the higher demand in 2016.

In the coin sector, platinum demand declined sharply by 41% year-on-year in 2017 to 0.07 Moz (2.1 t). This was in sharp contrast to 2016 where demand had surged to a record high. Much of the demand was recorded in the first quarter, with its share of the total year at 52%. This was largely in anticipation that the rally could continue but with range bound price action, investors were less willing to add to their holdings. North America, which is responsible for the lions share of the coins market, saw market share increase from 54% in 2016 to 65% in 2017, however total sales fell by 29%. That said, demand from Japan declined even more steeply, falling 64% year-on-year as much of the offtake happened in Q4 2016. Sale of American Eagles were steady at 20,000 ounces (0.6 t), compared to 2016, while that of Maple Leaf and European Philharmonic Coins noticed a steep decline in offtake.

PLATINUM RETAIL INVESTMENT



Source: GFMS, Thomson Reuters

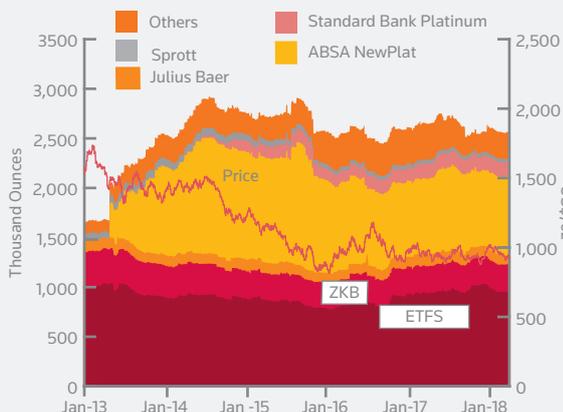
PLATINUM, PALLADIUM AND RHODIUM EXCHANGE TRADED FUNDS

ETF investment activity was primarily driven by the factors that were leading to a weakening of the US dollar, the spread between platinum and palladium which were in turn driven by underlying supply and demand fundamentals which has been discussed in detail in the Summary, Mining and Autocatalyst fabrication sections. At a macro level US interest rates, and Chinese and US industrial production numbers were of significance too.

Platinum ETF holdings ended 2017 at 2.56 Moz (80.1 t), marginally lower than a year earlier. Taking a look at the trend on a quarterly basis, ETF holdings noticed a steady increase from 2.58 Moz (80.5 t) at the start of the year to 2.65 Moz (82.6 t) by the end of the first quarter. The trend continued into the second quarter with total holdings rising to 2.75 Moz (85.7 t) on 16th June 2017 when prices were at \$923. This was the highest since 31st October 2015, and the price on that day was at \$988/oz. The rest of the year remained weak, with holdings in the third quarter falling to 2.61 Moz (81.3 t), with the declines stretching into the first week of October to 2.51 Moz (78.2 t) before settling at 2.56 Moz (80.1 t) by the end of the year. The trend however has remained negative in the first quarter of 2018 with total ETF holdings ending the period at 2.5 Moz (79.5 t). Much of the reason has been attributed to poor price prospects due to competition from palladium and a lack of volatility in platinum prices.

Taking a look at each of the major ETFs in platinum, holdings at ETF Securities increased by 123,099 ounces (3.8 t) to end at 1.0 Moz (32.1 t), that is 40% of the total volume. On the other hand, Source Physical platinum ETF declined by 64,454 ounces (2.1 t). Holdings of the

PLATINUM ETF HOLDINGS



Source: GFMS, Thomson Reuters; collated from respective ETF issuers' data
*Others: Mitsubishi, DB ETC, iShares, Source Physical, and Granite Share

NET MOVEMENTS IN PLATINUM, PALLADIUM & RHODIUM ETFS

(000 ounces)	2016	2017	YoY%	Jan-Mar* 2018
Platinum	15	(15)	n/a	(17)
Palladium	637	(384)	n/a	(196)
Rhodium	4.1	(18)	n/a	(27)

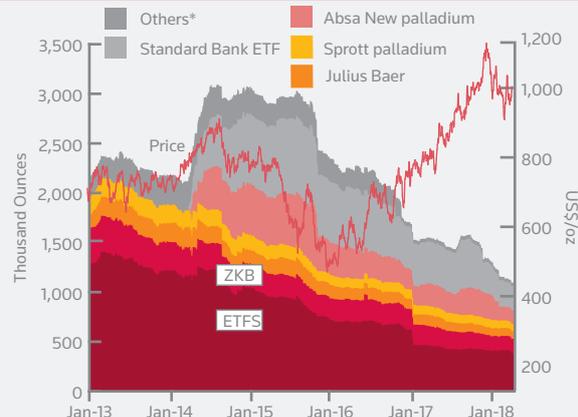
Source: Respective ETF issuers

four major ETFs, ETF Securities, ZKB, NewPlat, and Standard Platinum together were 87% of the total.

In the case of palladium, ETF holdings declined by 22% year-on-year to 1.3 Moz (41.2 t), thereby falling to the lowest since January 2010 and in value terms it was at \$1.4 bn. The bright spot here is the steep increase in price due to which in value terms it is higher than 2016 despite a 22% decline in volumes. Incidentally the higher price was also the reason for the decline in holdings as investors were taking profits at higher price levels. The biggest decline in 2017 was on 12th January, falling 5%. The biggest decline was in ETFs, where total holdings were down by 34%, that was followed by Standard Bank ETF reporting a fall by 29%. Meanwhile, gains were seen in ABSA, iShares and DB's ETF. The weakness has extended into 2018 with a 15% increase in outflows in the first quarter from the beginning of the year.

Total holdings in rhodium ETFs declined by 17% year-on-year in 2017 to total 86,464 ounces (2.7 t). Declines were highest for holdings at Africa Rhodium ETF, falling 23%, followed by the DB Physical Rhodium ETC fund. The liquidation has extended into the first quarter of 2018 with total holdings already falling 31% to 59,513 ounces (1.8 t) due to profit taking. Looking at the data suggest that this was liquidating some of the purchases from March 2016 when prices were much lower.

PALLADIUM ETF HOLDINGS



Source: GFMS, Thomson Reuters; collated from respective ETF issuers' data
* Mitsubishi, DB Physical Palladium, Source Physical and iShares Physical Palladium ETC



4. SUPPLY

- **Global refined platinum mine production fell by 1% to total 5.92 Moz (184.2 t) in 2017 led by losses in South Africa, Zimbabwe and Canada.**
- **Palladium mine production recovered by 3% last year to 6.74 Moz (209.7 t) thanks to a strong result from Russia and South Africa, partially offset by weaker Canadian output.**
- **Global Total Cash Costs (expressed in U.S. dollars) fell by 5% in 2017 to \$794/PtEqoz.**
- **Total Cash Costs + Capex (sustaining and expansionary) dropped by 2% to an average of \$925/PtEqoz**

WORLD PLATINUM MINE PRODUCTION

(000 ounces)	2016	2017	2018f	Chg(17/16)
South Africa	4,283	4,252	4,140	-1%
Russia	678	708	686	5%
Zimbabwe	484	470	465	-3%
Canada	268	232	215	-13%
United States	129	131	140	2%
Others	126	127	126	1%
World Total	5,966	5,922	5,773	-1%

Source: GFMS, Thomson Reuters

WORLD PALLADIUM MINE PRODUCTION

(000 ounces)	2016	2017	2018f	Chg(17/16)
Russia	2,526	2,728	2,680	8%
South Africa	2,467	2,529	2,417	2%
Canada	512	468	508	-9%
United States	420	428	458	2%
Zimbabwe	388	386	381	-1%
Others	227	202	208	-11%
World Total	6,540	6,741	6,653	3%

Source: GFMS, Thomson Reuters

WORLD RHODIUM MINE PRODUCTION

(000 ounces)	2016	2017	2018f	Chg(17/16)
South Africa	612	615	594	0%
Russia	77	65	66	-16%
Zimbabwe	41	40	39	-7%
Canada	23	22	22	0%
United States	3	3	4	-2%
Others	-	-	-	-
World Total	757	745	724	-2%

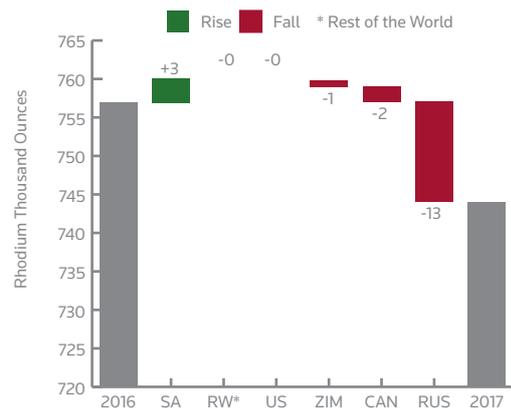
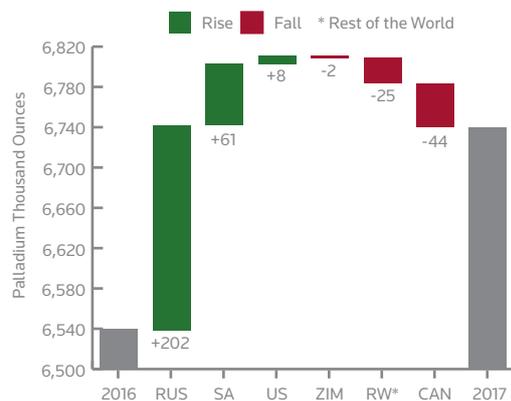
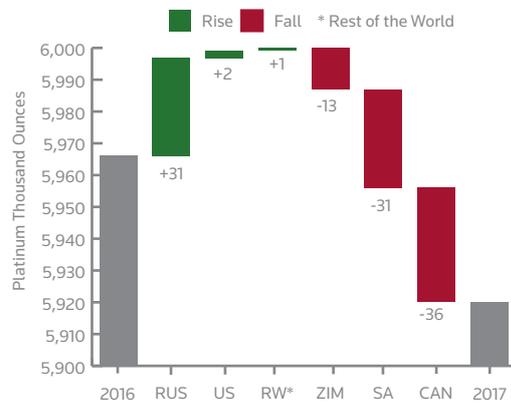
Source: GFMS, Thomson Reuters

MINE PRODUCTION

SOUTH AFRICA

South African palladium production rose by 2% last year despite a 1% contraction in platinum output. An increase in palladium content in platinum concentrate led to a 61 koz (1.9 t) gain year-on-year to total 2.53 Moz (78.6 t) chiefly driven by Amplats' Mogalakwena mine. At Impala Platinum, refined output was impacted by maintenance work at two of the company's furnaces. Bottleneck issues led to a build-up in work-in-progress material which is scheduled to be processed in 2018. A similar

PGM PRODUCTION VARIANCE



Source: GFMS, Thomson Reuters

build-up was also noted at Northam Platinum ahead of the commissioning of a new furnace in December 2017. Additional processing interruptions were registered at Mototolo, following a seepage on the tailing dam wall which deferred nearly 50 koz (1.56 t) of platinum production. Community unrest and government pressure on mining companies to keep producing, coupled with lower platinum prices, and above average inflation, left many producers struggling to keep up with the previous years' production rates. As a result, Platinum Group Metals Ltd's Maseve mine and Atlatsa Resources' Bokoni mine were closed.

RUSSIA

Palladium output from **Russian** mines rose by 8% to the highest level since 2007 led by the processing of concentrate purchased from Rostec and work-in-progress material in transit from the Polar to Kola division. Norilsk had a challenging start to the year with processing constraints originating from the retirement of Norilsk's Nickel Plant that caused production to drop by 17% in Q1 2017. Record run rates at the Kola division over Q2 managed to reverse losses by the end of the first half, with gains mounting on higher content in mined ore in the second half. The company expects to produce 2.68 Moz (83.4 t) from Russian feedstock in 2018, pointing to a decrease of 0.05 Moz (1.5 t) owing to the possible build-up of work-in-progress material from the ongoing refinery upgrades at Kola division. Though 2018 was off to a strong start with a 12% increase in the first quarter to 0.58 Moz (18.1 t), the jump in production owed mostly to the lower base effect in Q1 2017. As a result, we expect output to normalise over the coming quarters and remain supported by further inventory draw downs.

Platinum production from Russia rose by 5% last year to 0.71 Moz (22.0 t). Production at Norilsk's Russian operations were up 7% at 0.65 Moz (20.2 t) after

accounting for the Russian feed processed at the company's Harjavalta Oy Plant in Finland. Gains were partially offset by lower metal content in mined ore over the first half of 2017 when output was down 7% year-on-year. Meanwhile, full year losses were registered from the second largest player, Russian Platinum, where production fell for a second consecutive year to total 41 koz (1.3 t). This was a function of weaker production from the country's largest alluvial operation, Kondyor in Khabarovsk Krai. Based on government statistics, we estimate that Koryakgeoldobycha alluvial operations in Kamchatka also recorded a slight drop last year.

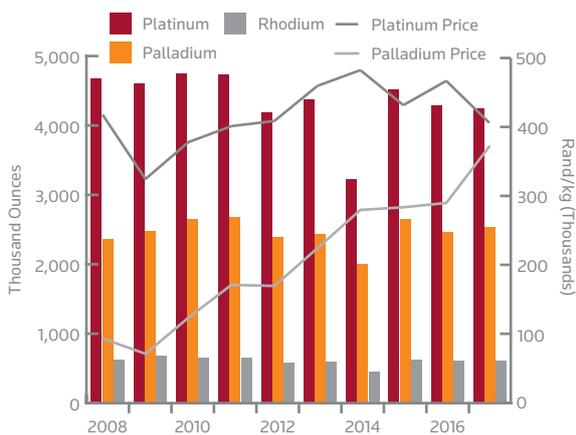
Rhodium production is estimated to have dropped by 23% to 67 koz (2.1 t) last year as the company's stocks of PGM-rich pyrrhotite concentrate were depleted. We expect production to remain near these levels over 2018 as the company continues to process concentrate purchased from Rostec.

ZIMBABWE

In Zimbabwe 3E PGM production fell by 2% to 0.90 Moz (27.9 t) due to lower output at Ngezi across all three metals. Ore mined increased moderately in tandem with an uptick in ore milled due to the ramp-up in production at Bimha mine and higher rates at the South Pit Mine. The modest decline in production should be seen against a high base in 2016; a year which benefited from the processing of stockpiled ore from an outage at Zimplats' smelter in 2015. Capital expenditure rose by 7% to \$70 M, and is to rise in 2018 as redevelopment work continues at the Bimha mine - on course to reach design production in April 2018.

Elsewhere, platinum in concentrate output at Mimosa rose modestly on the back of higher throughput, while at Unki, a slight uptick in head grades was behind the increase.

SOUTH AFRICAN MINE PRODUCTION



Source: GFMS, Thomson Reuters

RUSSIAN MINE PRODUCTION



Source: GFMS, Thomson Reuters

TOP 10 PLATINUM PRODUCING COMPANIES

Rank	Rank		Company	Output (000 ounces)	
	2017	2016		2016	2017
1	1		Anglo American Platinum Ltd. ¹	1,688	1,420
2	2		Impala Platinum Holdings Ltd. ²	1,089	1,046
3	6		Sibanye-Stillwater ³	239	780
4	3		Lonmin plc. ⁴	720	718
5	4		OJSC MMC Norilsk Nickel	644	670
6	5		Northam Platinum Ltd. ¹	271	293
7	8		ARM Platinum	163	163
8	7		Vale S.A. ⁵	166	144
9	10		Royal Bafokeng Platinum Ltd. ⁶	127	136
10	9		Glencore plc.	148	116

¹ Refined production from mining operations

³ Company registered as Sibanye Gold Ltd.

Source: GFMS, Thomson Reuters

TOP 10 PALLADIUM PRODUCING COMPANIES

Rank	Rank		Company	Output (000 ounces)	
	2017	2016		2016	2017
1	1		OJSC MMC Norilsk Nickel	2,618	2,780
2	2		Anglo American Platinum Ltd. ¹	1,091	1,035
3	10		Sibanye-Stillwater ³	136	663
4	3		Impala Platinum Holdings Ltd. ²	665	657
5	5		Lonmin plc. ⁴	332	332
6	6		Vale S.A. ⁵	322	214
7	9		North American Palladium Ltd.	150	202
8	7		Glencore plc.	209	161
9	8		ARM Platinum	152	160
10	11		Northam Platinum Ltd. ¹	128	142

² Attributable mine production including Zimplats

⁴ Calendar year refined sales; ⁵ Including custom feeds

⁶ Estimated metal in concentrate;

CANADA

Canadian output of PGMs extended losses for a second consecutive year, with platinum and palladium output dropping by 36 koz (1.1 t) and 44 koz (1.4 t), respectively. Vale reported group sales, inclusive of custom feeds, as 27% lower year-on-year. Excluding toll refining, we calculate that attributable mined production of platinum fell by 20 koz ounces (0.6 t), while palladium production dropped by 55 koz (1.7 t). Glencore's Canadian nickel assets registered the second largest production decrease year-on-year as platinum and palladium output fell by 15 koz (0.5 t) and 37 koz (1.1 t), respectively. Further losses came from KGHM International's Sudbury Basin mines, where lower quality ore resulted in a 16% decrease in precious metal production.

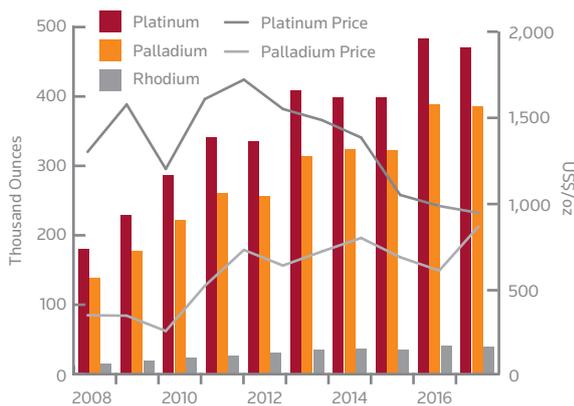
Canada's sole primary palladium mine, Lac des Iles, reported a 35% increase in payable palladium production to 0.20 Moz (6.3 t) due to the successful ramp-up of the new, lower-cost sublevel shrinkage (SLS) mining method. As a result of the increase in tonnes mined, the mill transitioned to full-time in September 2017

UNITED STATES

Mine production from the United States extended gains for a third year in a row with platinum and palladium posting increases of 2% each. Fresh ounces from the newly commissioned operation, Blitz, and record 2E PGM production at East Boulder managed to lift the country's balance by 2E PGM 11 koz (0.3 t).

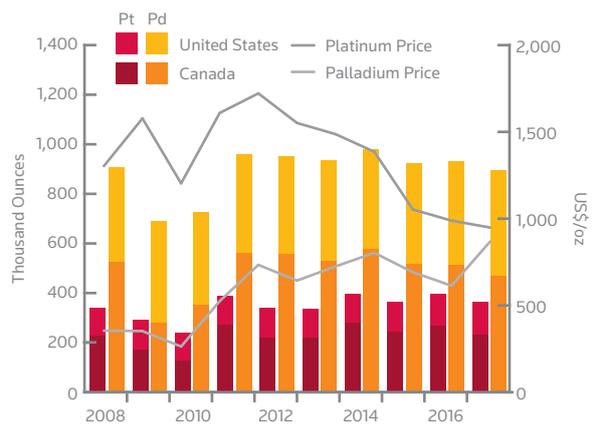
Meanwhile, production from the country's largest operation, Stillwater, was relatively unchanged year-on-year. Combined capital expenditure jumped nearly threefold in 2017 to an estimated \$166 M as efforts focused around the Blitz project area (adjacent to the Stillwater mine), and further ore reserve development. This investment is expected to bear fruit in 2018 and raise 2E PGM production by 7% with an average AISC of US\$670/2Eoz. Providing a partial offset, lower grades due to mine sequencing at Lundin Mining's Eagle Ni-Cu mine in Upper Michigan caused PGM production to drop as evidenced by lower by-product credits.

ZIMBABWEAN MINE PRODUCTION



Source: GFMS, Thomson Reuters

NORTH AMERICAN MINE PRODUCTION



Source: GFMS, Thomson Reuters

SIBANYE AIMS TO BECOME WORLD'S SECOND LARGEST PGM PRODUCER

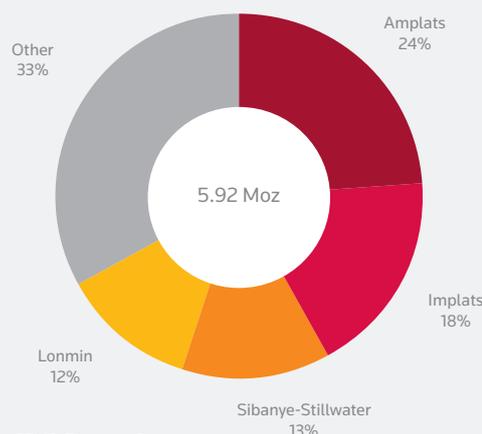
Sibanye took some investors by surprise by announcing plans to take over Lonmin in an all-share deal valued at US\$382M (£285M) in mid-December 2017. Although it had been less than seven months since the completion of the Stillwater acquisition, the tangible synergies in the Lonmin deal aligned strongly with management's decision to first enter the PGM industry in March 2016.

The most recent wave of M&A activity in the PGM sector brought a new PGM player following the acquisition of Aquarius Platinum in March 2016, Amplats' Rustenburg operations in November 2016, and Stillwater Mining in May 2017. In the span of 15 months, Sibanye became the world's third largest platinum producer with 1.6 million 4E PGM ounces produced in 2017.

Management's decision to venture into the platinum industry revolved around four key points: 1) the operational similarities with gold mining; 2) positive long-term PGM fundamentals; 3) leveraging the company's operating model and South Africa's labour intensive mining competency; and 4) enhance cash flows and achieve sustainable dividends.

On December 14th, 2017, Sibanye took centre stage again to present its stakeholders with another acquisition. The company agreed to buy Lonmin in an all-share deal valued at US\$382M (£285M) – on the face of it a bargain considering the capital invested (~US\$362M) by Lonmin on Generation 1 & 2 shafts over the last two years. If approved, Sibanye would become a fully integrated PGM producer, and better able to absorb the elevated fixed overhead costs that have forced Lonmin to continuously fill processing capacity. A similar cost cutting strategy is underway following the group's acquisition and consolidation of Rustenburg and Kroondal.

2017 MINE PRODUCTION BY COMPANY



Source: GFMS, Thomson Reuters

Given the similarities in cost structures between Marikana and Rustenburg, Sibanye aims to achieve higher overhead cost reductions than estimated under the Kroondal tie-up. (See chart "Sibanye's Latest Acquisitions: A Barbell Exercise"). This is a possibility given the contiguous nature of the Siphumelele No.2 (Sibanye) and K3 shafts (Lonmin), which allow management to utilise Siphumelele's existing infrastructure to mine higher grade ore from K3 while saving on capex and closing productivity gap levels (i.e. tonnes milled per employee and 4E ounces per employee). Although the opportunity to mine across the shafts' boundaries is also present, output would be capped as lower reserve grades offset higher throughput within these areas. Ultimately, relieving such cost pressures would allow for a more prudent capital investment on Generation 2 shafts, and ensure the sustainability of throughput at K3.

Production from Generation 1 shafts (Hossy, Newman, W1, E1, E2, E3 and Pandora (100%)) at 1.98 M tonnes was 13.6% lower in 2017 than in the prior period. Over the next three years, these shafts will reach their end-of-life, removing just under 50koz of platinum production from the market.

SIBANYE'S PGM OPERATIONS - QUARTERLY SERIES

	Q1-2016	Q2-2016	Q3-2016	Q4-2016	Q1-2017	Q2-2017	Q3-2017	Q4-2017	Q1-2018
Gold ('000 oz)	-	2	2	5	10	3	7	7	7
Platinum ('000 oz)	-	51	52	135	168	198	208	206	200
Palladium ('000 oz)	-	31	32	73	89	167	201	207	204
Rhodium ('000 oz)	-	8	8	19	20	29	26	25	24
Capital Expenditure, US\$M	-	5	3	16	9	55	66	71	64
TCC + Capex/oz ¹	889	963	1,089	1,048	1,173	1,132	1,157	1,155	1,175
TCC + Capex/4Eoz ²	-	710	712	831	870	807	899	895	905
All-in-Sustaining-Cost/4Eoz ³	-	-	-	-	802	734	749	729	778

¹Gold equivalent basis including Gold Division; ² Consolidated results. Includes sustaining and expansionary capex; ³ Mimosa is equity accounted, includes corporate credits

Source: GFMS, Thomson Reuters; Company Reports

A revised mine plan following the announcement has placed 12,600 jobs at risk, a number which will not be received lightly by the communities in the platinum belt region. The last time community protests disrupted production at these shafts was in Q3 2017, costing the company around 56,000 tonnes of mined production or 10k platinum ounces. Similar disruptions were also noted in Q2 2017. We view this as a risk that could potentially escalate as Sibanye looks at cutting some of Lonmin's loss-making production faster.

Production from the larger and newer shafts (K3, Rowland, 4B, and Saffy) represents almost 80% of the group's production. Under the assumption that the merger does go through, the higher grades at Marikana, particularly at K3, combined with the higher recoveries at Rustenburg (higher Merensky ore content), may well provide a cost advantage to both operations.

To illustrate the impact these operations have had on Sibanye's margins, we can look at two periods: Q1-2017 (Sibanye post-Rustenburg acquisition) and Q3-2017 (Sibanye post-Stillwater acquisition).

Total Cash Costs plus Capex (including sustaining and expansionary capex) on a co-product basis rose by 32% year-on-year in Q1-2017 from \$889/oz to \$1,173/oz led by an almost uniform drop in yields at the Gold Division and higher operating costs at Rustenburg. Since then, costs have slightly improved as Rustenburg and Kroondal operations were consolidated.

If the takeover is approved, Sibanye will be in a position to start processing concentrate at Lonmin instead of

TOTAL CASH COSTS PLUS CAPEX PER EQUIVALENT OUNCE (US\$)

	2016	2017	Change
North America	846	752	-11%
South Africa	958	979	2%
Zimbabwe	874	725	-17%
Russia	594	567	-4%
World*	940	925	-2%
Unprofitable ounces*	35%	32%	
Unprofitable ounces**	25%	18%	

*Excluding Russia; **Including Russia.

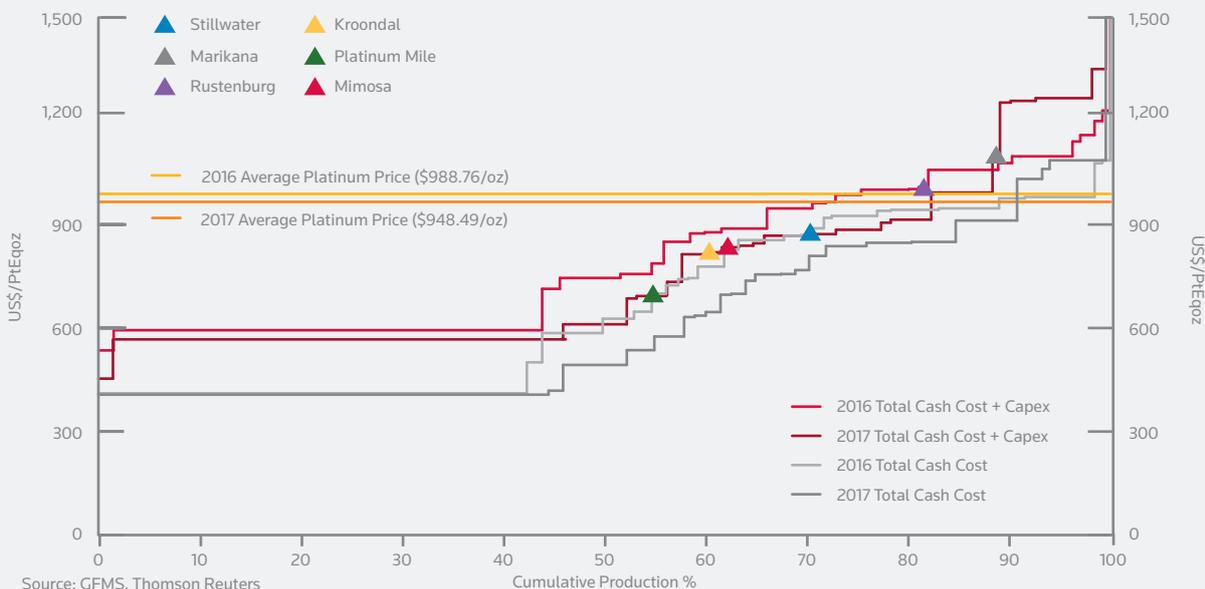
Note: Figures include sustaining and expansionary capex

Source: GFMS, Thomson Reuters

at Amplats. The deal is expected to close in H2 2018 following a string of regulatory conditions: 50% approval from Sibanye shareholders, 75% approval from Lonmin shareholders, South Africa Competition Act approval, and environmental clearance. So far, it's not clear whether the deal will be approved by Lonmin's biggest shareholder, South Africa's Public Investment Corporation (PIC), which given its 30% ownership of the company, will be critical to "get inside" if the deal is to move forward.

By end-2018, Lonmin may lose its London listing if the merger goes through, forcing index-tracking funds to liquidate their positions. The alternative would have been a fourth cash call in nearly ten years to only temporarily alleviate an everlasting liquidity constraint. Clearly, Sibanye saw value in Lonmin.

SIBANYE'S LATEST ACQUISITIONS: A BARBELL EXERCISE



Source: GFMS, Thomson Reuters



AUTOCATALYST RECYCLING

- **For the second consecutive year, autocatalyst recycling continued to rise for both platinum and palladium reaching a new record high for both of 1.2 Moz (37 t) and 2.2 Moz (67 t) respectively.**
- **Growth was strongest in China and Europe, in the case of the latter, driven particularly by various scrappage schemes in the aftermath of the diesel saga.**

Automobiles consist of many materials that are subject to recycling other than just PGM's. In fact, around 80% of materials found in a car today are reusable. Recycling spent autocatalysts, however, has become an increasingly challenging business. The supply chain has become competitive whereas at the same time recyclers have to make sure they have the latest equipment to avoid being conned. And even if a batch of high grade autocats eventually is purchased, various materials, such as silicon carbide, can poison or harm your recycling process. It is obvious that the recycling step is not always taken into consideration when aftertreatment applications are designed. Granted, various regulations make it already challenging to manufacture autocatalysts that are compliant, but stronger collaboration between cradle and grave of autocatalyst applications would facilitate a smoother recycling process that benefits all.

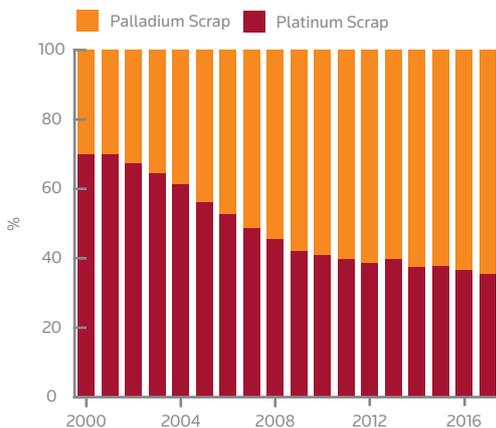
Global spent autocatalyst recycling performed well last year, rising by 5% to 1.2 Moz (37 t) in the case of platinum and by 10% to 2.2 Moz (67 t) for palladium. This performance was a second consecutive year of increases for both platinum and palladium generated scrap from autocatalysts. In 2015, recycled metal from autocatalysts fell on sharply lower steel prices which motivated scrap dealers to hold on to their material in anticipation of a higher prices in the underlying commodity prices.

Over the last two years, recycled volumes in Europe and North America were lifted by the aftermath of the emission scandal. One particular OEM had to scrap approximately 500,000 diesel vehicles that were not compliant with the EPA and European emission standards. A summit that discussed the best way to trade in old polluting vehicles for new cleaner ones was labelled with the slogan "Welcome to Fort NOx" by a prominent organisation devoted to environmental activism. Some in Germany voiced saving the diesel technology by letting the OEMs pay for the retrofitting of noncompliant vehicles.

To a certain extent that is what has happened last year. A flurry of car brands started to offer customers monetary incentives to scrap their old vehicles with aftertreatment options only compliant to Euro 1-4 standards. Up to 5 M of VW noncompliant models needed a software upgrade which would supposedly bring them back into line. OEMs have come to the fore themselves with scrappage incentives after governments decided a diesel tax would be the preferred way forward for them this time. This is in contrast to the cash for clunkers scheme that was introduced following the financial crisis in order to stimulate the lagging automotive industry and at the same time get older polluting models off the road.

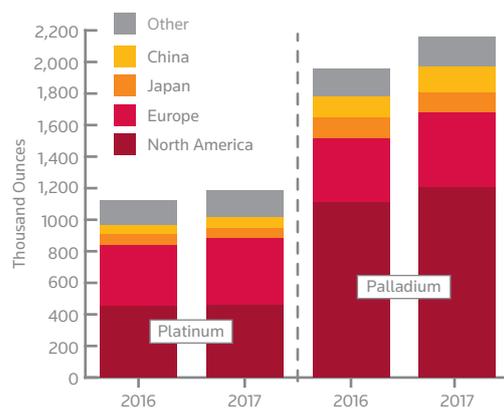
At around 25-30%, recycling rates in Europe (and globally) are still disappointingly low. A lot of the deregistered cars have gone missing in recent years. The European Commission has introduced the End of Life vehicle directive in order to get these vehicles scrapped and for at least 85% stripped and recycled from their materials and hazardous waste. The only issue is, the EC does not know where they are. Many fall through the cracks. Illegal scrapping explains some of the discrepancy, exports to emerging markets more. Although the exports do not necessarily

TOTAL OPEN LOOP SCRAP SHARE OF TOTAL SUPPLY



Source: GFMS, Thomson Reuters; LMC

GLOBAL AUTOCATALYST RECYCLING



Source: GFMS, Thomson Reuters

carry the autocatalysts on them. Due to the lack of emissions legislation or enforcement in some countries, autocatalysts get cut from the vehicle and stay behind to be recycled. Autocatalysts can also represent 30-50% of the vehicles' rest worth. This practice can skew recycling of PGMs in one year compared to the vehicles scrapped in another.

Countries within **Europe** have various scrappage schemes in place. Some offer a small premium for old cars since they will be able to sell parts or recycle some of the material, such as PGMs; others charge a premium. Deregistered vehicles in Europe account for about 14-15 M units each year, although statistics on scrapped vehicles is usually only half. European autocatalyst recycling rose 9% for platinum, due to increased diesel usage, and 17% for palladium to 0.4 Moz (12 t) and 0.5 Moz (15 t) respectively in 2017. The rise last year came after a few years of tightness with low commodity prices that motivated recyclers to hold on to their metal.

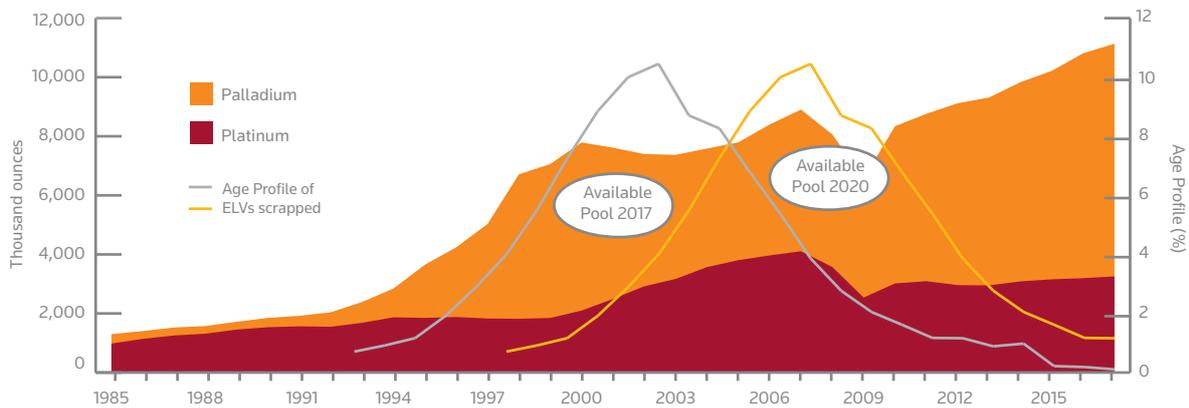
In **North America**, due to the bankruptcy of one major player in the recycling supply chain in recent years, some consolidation has been taking place in the pre-refining stage of the market, which indicates that all major players improved their business last year. In addition to the individual gains, we also believe that the market has grown in absolute size. Platinum recycling crept up marginally by 1% whereas palladium spent autocatalyst recycling rose an impressive 8% to 0.5 Moz (14 t) and 1.2 Moz (37 t) respectively. Traditionally, North America is heavily geared towards gasoline cars which have more palladium and rhodium in them, and superstorms Irma and Harvey also played their part. Platinum also has a role in gasoline vehicles, but much smaller and is more widely recycled from larger pick-up truck catalysts or even heavy duty vehicles powered by diesel. Used car and truck prices contracted for most of 2017 indicating

plenty of availability of used vehicles. In a rising interest rate environment, the average U.S. lending rate for a 48 month new car loan edged up in 2017 to an average of 4.5%. The amount of outstanding car loans further increased as well reaching \$1.1 Tr by the end of Q4 2017. Many analysts keep an eye on this development, since as the average lending rate increases, longer dated car loans might find themselves with a negative car equity value further out as the value of the car depreciates over time. This could slow both new and used vehicle purchases and have a negative effect on scrappage rates.

Japan witnessed a considerable decline in PGM recycling from autocatalysts of 3% for platinum and 2% for palladium reaching 0.07 Moz (2 t) and 0.1 Moz (3 t) respectively last year. The decline was the only drop registered among any of the regions that we cover. Japan imports a significant chunk of spent autocatalyst for domestic refining. Last year, imported recycling volumes from Europe and North America contracted in conjunction with slightly less spent catalyst material available from the domestic market.

Recycling in India is increasing considerably every year, but the efficiency is even worse than that in Europe. Nevertheless, we see higher volumes coming out of developing countries, represented, among others, in our **Other Regions** category. As such, recycled volumes for platinum and palladium from our Other Regions category continued to demonstrate strong growth of 6% and 8% respectively, reaching approximately 0.2 Moz (6 t) for both in 2017. A similar situation is present in **China**. Volumes of catalysts returning from the market tend to rise every year, particularly with the central governments active intervention in the market to get dirty older cars off the road. Platinum recycling rose to 0.07 Moz (2 t) whereas palladium surged by 22% to 0.2 Moz (6 t).

AUTOCATALYST DEMAND AND AGE PROFILE



Source: GFMS, Thomson Reuters (Johnson Matthey demand data for pre-1999)



JEWELLERY SCRAP SUPPLY

- **Global platinum jewellery scrap in 2017 was 661,000 ounces (20.5 t), 5% lower year-on-year, largely due to volumes from China which contributed to 70% of total sales.**
- **Palladium jewellery scrap in 2017 falling by 28% year-on-year to 47,000 ounces (1.5 t), thereby the lowest since 2003.**
- **Higher margins and lower liquidity were seen as the reason for end consumers to scrap jewellery at higher prices.**

Global platinum jewellery scrap in 2017 was 5% lower year-on-year, at 661,000 ounces (20.5 t). This was particularly strong when the price rallied for a brief period. 70% of global jewellery scrap was contributed by China. Platinum jewellery scrap from **China** retreated in 2017, by 4.4% to 0.46 Moz (14.3 t) and accounted for 70% of the global market. Although the absolute scrap volume dropped 21,000 oz (0.65 t), the shares of platinum jewellery fabricated in China using scrap were at a similar level in 2016 and 2017. On an industry wide basis, 36% of platinum jewellery were made using scrap and a few fabricators consumed as much as 50% in 2017. In 2017, according to Shanghai Gold Exchange PT99.95 contracts, the average daily platinum price was CNY 221.8 per gramme, which is 2% lower than the average price in 2016. With the domestic platinum price softening, jewellery scrap return fell slightly compared to the volume in 2016.

North American platinum jewellery scrap increased by 2% year-on-year to 6,000 ounces (0.18 t). Its contribution to total scrap was just 1% compared to 7% in 2009.

Last year the volume of scrap generated from **Europe** was 6,687 ounces (0.2 t), just a percentage point higher and that was partly due to higher sterling prices leading to greater flows there. And in the case of palladium jewellery it increased by 5% to 10,200 ounces (0.3 t), aided by increased scrappage of white gold with palladium content.

Globally, palladium jewellery scrap supply decreased by 28% year-on-year despite the sharply higher prices due to a slump in Chinese flows. Palladium jewellery scrap in **China** decreased by 87% or 20,000 oz (0.61 t) to 3,000 oz (0.09 t) in 2017. Chinese consumers have shifted their taste out of palladium jewellery and therefore there was almost no fabrication of palladium jewellery in 2017 in China. Palladium scrap return has

PLATINUM & PALLADIUM JEWELLERY SCRAP



Source: GFMS, Thomson Reuters

followed the same trend as palladium jewellery demand.

Elsewhere, there was modest increases despite the sharply higher prices in local currency terms. This highlights that receipts of this material are often less influenced by the palladium price and instead reflective of white gold flows, the state of the economy, and divorce rates due to the usage in wedding bands.

ABOVE-GROUND BULLION STOCKS

- **The platinum market was in a small physical deficit for the second successive year leaving above-ground bullion stocks of platinum at 6.7 Moz (219 t) at end-year.**
- **The fall in above-ground bullion stocks of palladium continued at a rapid pace in 2017, leaving the market susceptible to bouts of tightness.**

METHODOLOGY

Our supply/demand balances for platinum and palladium are designed to separate any distorting effect of flows from pre-existing above-ground stocks. Where we are able to identify such flows, these are shown separately as “below the line” items. Consequently, the arithmetical difference between our estimates of new supply (from mining and recycling) and fabrication demand, i.e. the physical surplus or deficit, represents our view of the underlying fundamentals of these metals. When a physical surplus is reported, this shows an excess of new supply over fabrication demand, implying an increase in above-ground stocks. Conversely, a physical deficit, which developed to vastly contrasting degrees for platinum and palladium in 2017, indicates a shortfall of new supply relative to fabrication demand. This implies a similar decline in above-ground stocks as this metal is required to redress that shortfall and satisfy fabrication

needs. Meanwhile, we also quantify the scale of above-ground platinum and palladium bullion stocks. This includes inventories in the terminal markets, allocations to physically-backed ETFs and declared stock holdings on futures exchanges. In addition, we include an estimate for Russian government stocks of palladium and stocks of refined metal that may be held by industrial consumers and producers over and above normal levels.

PLATINUM

In 2017 the platinum market remained in a small deficit at the physical level for the second year in a row. Indeed, both total supply was remarkably similar last year compared to 2016. This was due to a small drop in mine output plus a similarly modest decline in jewellery scrap being counterbalanced by a marked rise in supply from autocatalyst scrap. What's more, total demand only dropped by 2% as a sharp reduction in retail investment and to a lesser extent jewellery offtake were partly offset by an increase in usage across industrial and automotive applications. Our estimate of above-ground stocks at end-2017 is in the region of 67.0 Moz or 219 tonnes, of which 37% are in ETF holdings, and is equivalent to approximately eleven months' fabrication demand.

Similar to 2016 we believe that there were limited net above-ground stock movement of platinum last year. Highlighting this change is the fact that ETF holdings had fallen by a mere 0.6% last year, an almost exact reversal of the tiny change in the prior year, after nine successive years of greater than 100,000 ounce changes. We also believe that, unlike previous years, there was no marked change in industry stocks.

PALLADIUM

The palladium market recorded a physical deficit of approximately 800,000 ounces or larger for the sixth successive year in 2017. Indeed, at 1.2 Moz (37 t) the physical deficit was the third largest since 2001. This occurred despite a 2.6% increase in supply (Russian mine output and autocatalyst scrap rose appreciably), largely as a result of sharply higher autocatalyst demand. As a result, the relentless decline in above-ground palladium stocks continued at a rapid pace and they are estimated to have dropped to 9.6 Moz (300 t) by end-2017, equal to roughly twelve months' fabrication demand. For the third successive year the massive reduction in palladium ETF holdings (albeit at a slower rate) means that the amount of above-ground stocks held outside ETFs dropped by a more modest amount. However, we believe Norilsk made purchases of palladium in 2017 for its Global Palladium Fund. We believe it purchased approximately 600,000 ounces but by year end it had only increased stocks of the metal by approximately 290,000 ounces in 2017. These purchases were reportedly made from both the central bank of Russia and other suppliers. It is also expected to make net purchases of at least five tonnes in 2018.

The remorseless downward trend in palladium inventories due to the string of physical deficits this century significantly affected market liquidity at times last year. As we cautioned in this report a year ago "we note that the market is becoming more susceptible to bouts of tightness as these substantial deficits persist". This trend is only likely to intensify this year, especially if the pace of declines in ETF holdings drops.

ESTIMATED MOVEMENTS IN STOCKS

PLATINUM (000 ounces)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018f
Physical Surplus/(Deficit)	601	434	568	16	566	(754)	(42)	(193)	(53)	(280)
Industry Stocks	665	0	(100)	(300)	(1,000)	1,300	(50)	50	0	0
Exchange Traded Funds	(384)	(579)	(156)	(238)	(891)	(221)	192	(15)	15	(100)
Sub total - stock movements	281	(579)	(256)	(538)	(1,891)	1,079	142	35	15	(100)
Net Balance	882	(146)	312	(522)	(1,325)	325	99	(158)	(38)	(380)
PALLADIUM (000 ounces)										
Physical Surplus/(Deficit)	171	(388)	(138)	(896)	(850)	(1,273)	(797)	(1,326)	(1,201)	(1,327)
Russia	1,100	800	800	400	200	0	0	100	200	0
Industry Stocks	0	0	(50)	(100)	(500)	600	(150)	140	(290)	(160)
Exchange Traded Funds	(507)	(1,090)	532	(448)	0	(899)	727	637	384	350
Sub total - stock movements	593	(290)	1,282	(148)	(300)	(299)	577	877	294	190
Net Balance	765	(677)	1,143	(1,044)	(1,150)	(1,572)	(220)	(449)	(907)	(1,137)

Source: GFMS, Thomson Reuters



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5. DEMAND

FABRICATION BY REGION, 2009-2018

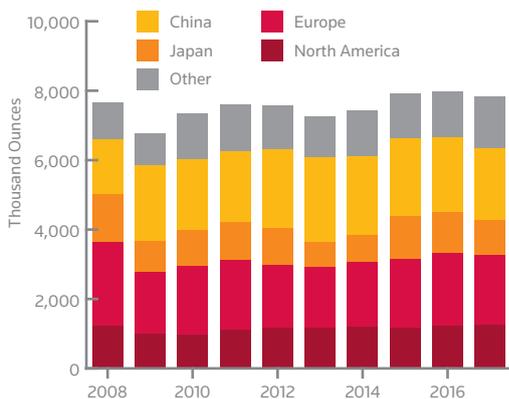
PLATINUM (000 ounces)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018f
North America	986	970	1,106	1,153	1,170	1,188	1,166	1,228	1,243	1,256
Europe	1,785	1,965	2,002	1,810	1,748	1,883	1,987	2,091	2,024	1,989
Japan	899	1,037	1,094	1,081	732	748	1,231	1,181	987	967
China	2,169	2,067	2,050	2,265	2,424	2,284	2,245	2,155	2,097	2,126
Other Regions	936	1,297	1,358	1,260	1,173	1,319	1,294	1,326	1,470	1,597
Total	6,776	7,335	7,610	7,571	7,247	7,423	7,924	7,981	7,822	7,934

PALLADIUM (000 ounces)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018f
North America	1,708	2,026	2,097	2,262	2,282	2,264	2,325	2,463	2,494	2,519
Europe	1,653	2,010	2,222	2,166	2,114	2,194	2,310	2,362	2,352	2,318
Japan	1,368	1,536	1,441	1,606	1,534	1,535	1,424	1,387	1,398	1,333
China	1,633	1,678	1,694	1,787	1,938	2,013	1,949	2,254	2,370	2,487
Other regions	1,081	1,272	1,253	1,247	1,220	1,347	1,347	1,426	1,535	1,640
Total	7,444	8,521	8,707	9,068	9,089	9,354	9,356	9,892	10,148	10,297

Source: GFMS, Thomson Reuters

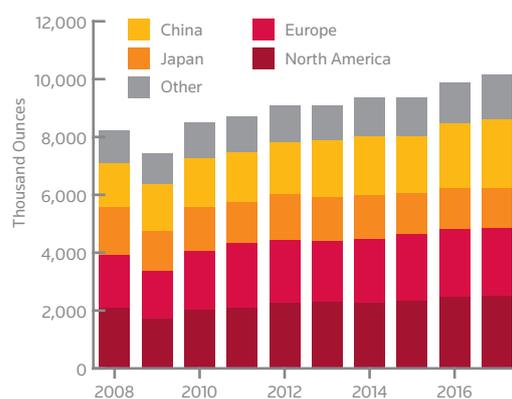
- **Platinum fabrication slipped 2% last year to 7.8 Moz (243.3 t) as stronger industrial demand was offset by falls in jewellery and investment demand.**
- **Palladium fabrication rose 3% last year to an estimated 10.1 Moz (315.7 t) as growth in autocatalyst, chemical, and petroleum demand was tempered by falls in electronics, jewellery, and dental fabrication.**
- **Demand for platinum in autocatalyst applications increased 2% in 2017, the fourth consecutive rise and to a nine-year high, led chiefly by strong gains in China with Europe the only region to register a modest decline.**
- **Palladium used in autocatalyst fabrication rose 4% in 2017 to a new record high. China led the way with the highest year-on-year growth but all markets saw gains as higher loadings and tighter emission control pushed demand higher.**
- **The petroleum, glass, electronics and the other industrial segments all enjoyed solid gains in 2017 but this was partially offset by a modest decline in chemical offtake.**
- **Palladium jewellery fabrication declined by 3% year-on-year. Falls in North America and Europe accounted for the bulk of the decline.**
- **Platinum jewellery fabrication fell 5% in 2017, to a nine year low, dragged lower by sizeable falls in China and Europe. Retail investment slumped 45% in 2017, with Japan accounting for the bulk of the fall.**
- **Retail investment for palladium jumped 19% last year with strongest annual gains recorded in North America.**

PLATINUM DEMAND BY REGION



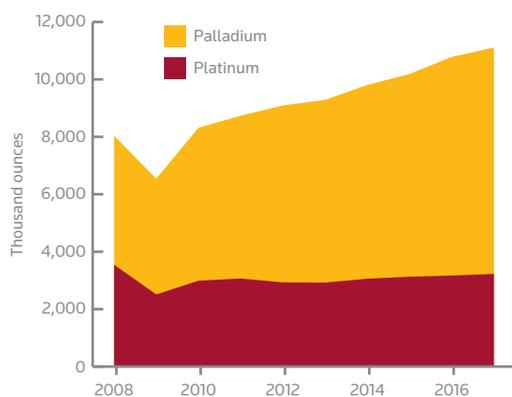
Source: GFMS, Thomson Reuters

PALLADIUM DEMAND BY REGION



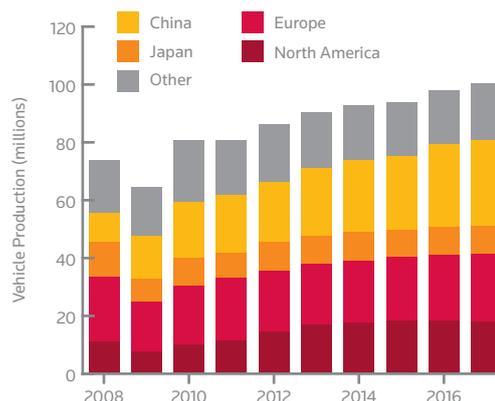
Source: GFMS, Thomson Reuters

PGM AUTOCATALYST DEMAND



Source: GFMS, Thomson Reuters; Johnson Matthey

GLOBAL VEHICLE PRODUCTION



Source: GFMS, Thomson Reuters; LMC Automotive

AUTOCATALYST DEMAND

OVERVIEW

Internal combustion engines generate pollutants that are harmful for human health. In order to reduce these harmful emissions from gasoline and diesel engines platinum, palladium and rhodium are widely used in autocatalysts installed on light duty (LD) and heavy duty (HD) on road and non-road mobile machinery vehicles. The main pollutants from gasoline engines consist of Carbon Monoxide (CO), Hydrocarbons (HC) and Nitrogen Oxides (NOx), whereas diesel engines generally generate NOx and particulate matter (PM). Until recently particulates were not considered an issue in gasoline engines, but with the latest round of tightening in emissions legislation from Euro 6b to Euro 6d TEMP, not only particulate in mass but also particulate in number restrictions have been included leading to the adoption of gasoline particulate filter (GPF) on modern gasoline engines. Precious metals coated substrate filters reduce these harmful emissions by about 90% to mainly CO₂, nitrogen and water.

PLATINUM OVERVIEW

Diesel engines generally feature platinum rich loadings in their aftertreatment solutions. Platinum filters are generally good oxidation catalysts with resistance to poisons such as sulphur, phosphorus or lead, which may be present in the exhaust. Platinum is generally not good for the conversion of NOx. Rhodium does a far better job in reducing NOx emissions and therefore is traditionally widely utilized in conjunction with platinum on Lean NOx Trap (LNT) solutions particularly in smaller diesel vehicles. In addition, platinum is sensitive to the high temperatures that may occur in the catalytic converter

during high engine loads. Platinum finds a wide adoption in the HDV segment of approximately 70% in on road applications (trucks and buses) and around 80% in non-road mobile machinery and features for around 72% in LDD vehicles globally.

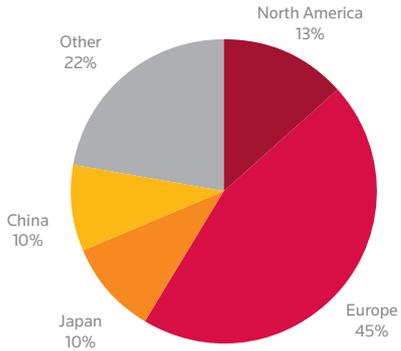
Last year, platinum demand in autocatalyst applications rose 2%, or 0.6 Moz, to 3.3 Moz (101.2 t), raising its market share from 40% in 2016 to 42% of total platinum consumption. Still accounting for the largest consuming region, Europe reduced its share of platinum demand from 46% to 45% in 2017, as platinum demand contracted 2% to 1.4 Moz (45.1 t). Both China and our Other Regions category increased their market share to 10% and 22%, driven on very healthy gains last year reaching 0.3 Moz (9.9 t) and 0.7 Moz (22.4 t) respectively. Somewhat counter-intuitively, North America also recorded gains in platinum consumption and even from the diesel segment, contributing 0.4 Moz (13.8 t) to the

AUTOCATALYST DEMAND

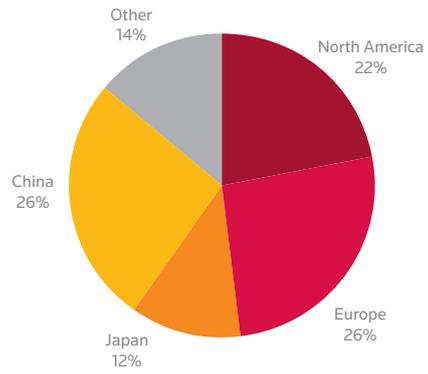
PLATINUM				
(000 ounces)	2016	2017	2018f	Chg(17/16)
North America	431	443	473	3%
Europe	1,486	1,450	1,397	-2%
Japan	314	324	310	3%
China	275	319	341	16%
Other regions	689	720	746	4%
Total	3,196	3,255	3,268	2%
PALLADIUM				
(000 ounces)	2016	2017	2018f	Chg(17/16)
North America	1,902	1,936	1,987	2%
Europe	1,828	1,837	1,816	0%
Japan	855	887	838	4%
China	1,954	2,043	2,153	5%
Other regions	1,074	1,177	1,297	10%
Total	7,613	7,880	8,090	4%

Source: GFMS, Thomson Reuters

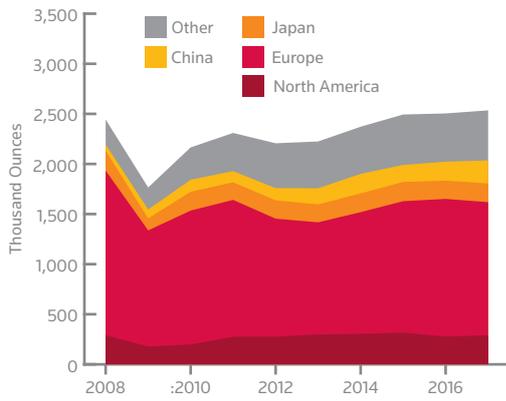
PLATINUM DEMAND IN AUTOCATALYSTS, 2017



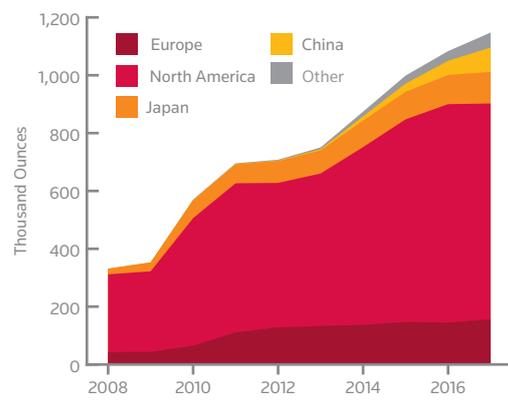
PALLADIUM DEMAND IN AUTOCATALYSTS, 2017



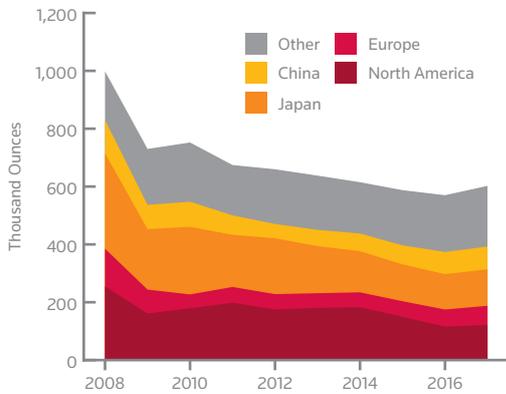
DIESEL PLATINUM DEMAND



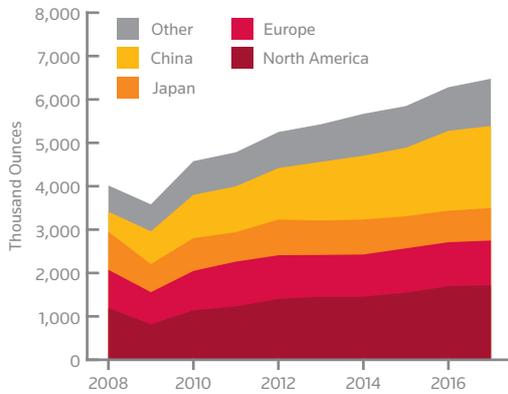
DIESEL PALLADIUM DEMAND



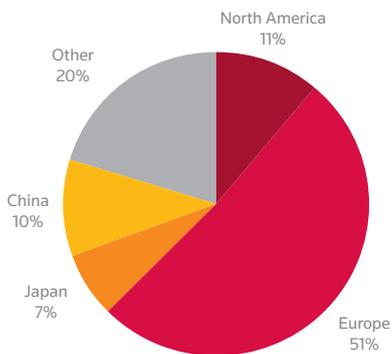
GASOLINE PLATINUM DEMAND



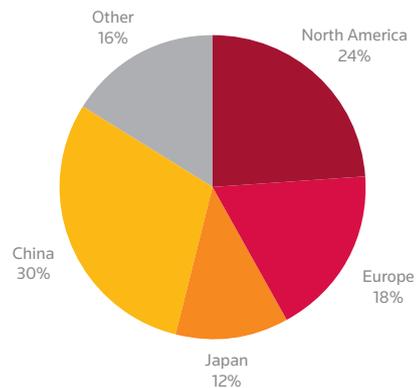
GASOLINE PALLADIUM DEMAND



PLATINUM IN DIESEL, 2017; REGIONAL DEMAND



PALLADIUM IN GASOLINE, 2017; REGIONAL DEMAND



DEMAND

total whereas Japan, good for 10% of total platinum demand in autocatalysts, rose 3% to 0.3 Moz (10.1 t).

DEMAND BY REGION

Unsurprisingly, Europe continued to be the largest consuming region of platinum in autocatalyst applications last year. Europe’s share of platinum consumption in diesels fell to 52%, which was a reflection of lower average platinum loadings. The phase in of Euro 6d-TEMP motivated car manufacturers to switch from lean NOx traps (LNT) to non-platinum containing selective catalytic reduction (SCR) catalysts. As a result, platinum demand in Europe fell 2% to 1.4 Moz (45.1 t) in total. Between the various segments within the region, light duty diesel (LDD) accounts for 80% of platinum demand, followed by robust growth from the heavy duty on road and non-road mobile machinery segments. We expect a further contraction in platinum demand from LDD applications this year driven by continued lower average loadings in combination with lower LDD vehicle production, which peaked last year at 10 M units.

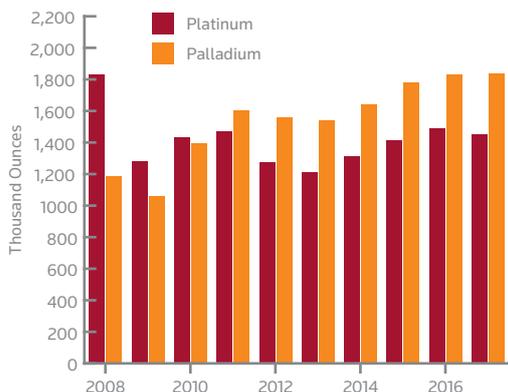
In spite of the diesel scandal that broke in 2015 with VW admitting the presence of a cheat device that would alter emissions in laboratory and road conditions, for the short term OEMs will try to continue to make diesel part of their portfolio mix. This is merely in order to meet the fleet average CO2 targets of 95 grammes of CO2/km by 2021. Diesel fuel carries approximately 20% more energy than gasoline and diesel vehicles emit around 15% less CO2 than their gasoline counterparts. At the same time, however, OEMs are heavily investing in electrification of their powertrains mainly through the route of hybridization first before going all electric. VW was not the only car brand at which irregularities in the emissions stated and tested in real conditions have been detected; other OEMs, mainly European and Japanese, have been

found guilty in not correctly displaying emissions to some degree as well.

Platinum demand in autocatalyst applications in **North America** posted growth to the tune of 3% year-on-year in 2017. Since it was the United States where the diesel scandal broke that might sound surprising. To a certain extent it is and to a certain extent it is not. Following the VW saga, the U.S. Government did demand that VW stop selling its diesel vehicles with almost immediate effect. Diesels in general suffered bad PR. Be this as it may, consumers continued to vote with their wallets and diesel vehicle production only dipped in 2016. In 2017, it rose again and so did demand for platinum from this region to 0.4 Moz (13.8 t).

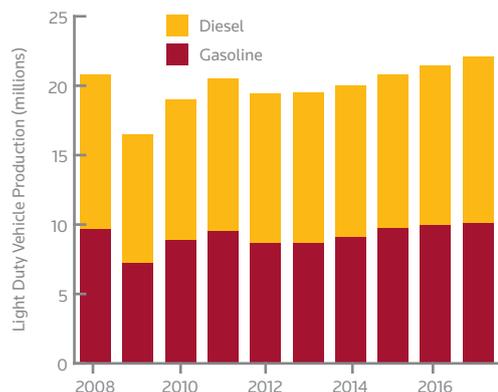
What VW was trying to achieve was to raise North America’s approximately 5% diesel share while at the same time adhering to the strict emissions standards. That didn’t turn out to be a particularly successful strategy and as such North America is not expected to see rapid expansion of diesel powertrains in the future. With the advent of electrification, that now looks even more unlikely. That said, diesels do have a very good base in the small commercial as well as larger personal vehicle space, mainly in the form of pick-up trucks that are able to carry and or pull something significant. Americans love their pick-up trucks and as such sales of those vehicles have done well in recent years. President Trump’s recent attempts to roll back further emission tightening standards has created a bit of a rift within the country between those that supposedly are more “pro-business” in his own words and those that stand firm behind the formally EPA stipulated cleaner air roadmap. As such, North America OEMs will also shift their portfolio towards the electrification of powertrains with increasing use of hybrids or electric vehicles all together. But those will be mainly built for sales abroad, such as Asia/China,

AUTOCATALYST DEMAND: EUROPE



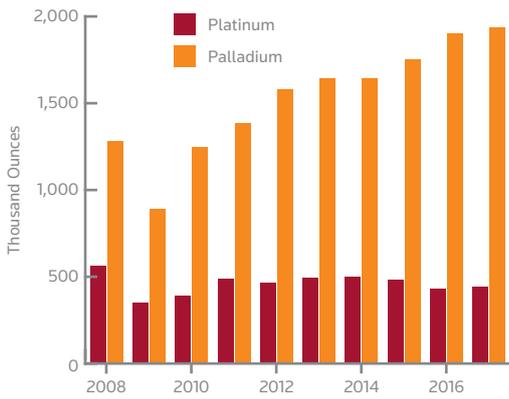
Source: GFMS, Thomson Reuters

EUROPEAN LIGHT DUTY VEHICLE PRODUCTION



Source: GFMS, Thomson Reuters; LMC

AUTOCATALYST DEMAND: NORTH AMERICA



Source: GFMS, Thomson Reuters

with diesel driven pick-up production expected to be in continued high demand at home.

The remaining three regions, Japan, China and Other Regions combined account for 1.4 Moz (42.4 t) (Japan 0.3 Moz, China 0.3 Moz and Other 0.7 Moz), which is 94% of the European total, or 42% of the global total last year. All three regions continued to see increases in demand for platinum. For both China and Other Regions it was mainly more of the same, as a continuation of the steady growth trend that has been in place for several years. Continued tightening of emissions legislation and enforcement has resulted in more compliant vehicles and as such has been good for platinum demand.

Diesel sales in India and China are probably most representative for the majority of platinum consumption outside North America, Europe and Japan. Despite diesel sales in both countries accounting for about half of diesel sales in the Asia Pacific region, both countries tend to use them for slightly different reasons. In China the overriding bulk of diesel use is in the commercial space, indicating that small and medium sized companies use the vehicles

for their business, whereas in India it's the personal segment where diesels are most widely utilised.

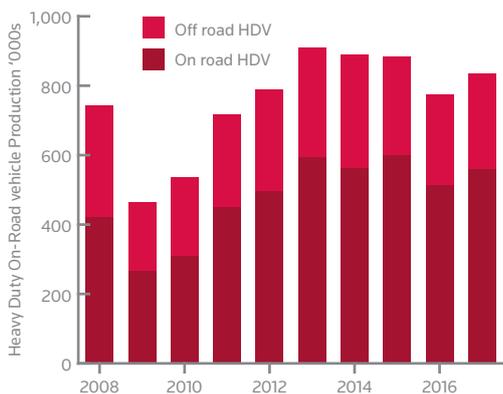
Diesel vehicles are expected to continue to increase in the coming years in India due to the better fuel economy compared to gasoline cars. But beyond 2020, when Bharat Stage VI comes into effect, this could well change considerably. India has six out of the top ten most polluted cities and the government is very keen to clean up its act. At the same time, as elsewhere, some cities are considering restricting diesel vehicles access to cities which could also be a blow for diesel sales. Resale values will decline and as such people will refrain from buying them further out. That is also one of the reasons why we expect sales of diesels to stagnate in China. We estimate that loadings are still catching up with the Western Hemisphere and as such platinum demand has room for further growth but at some point not too far out we could also see a tipping point in China.

PALLADIUM OVERVIEW

As platinum has mainly been a diesel story, palladium is more focused on the gasoline side. Historically, palladium has been a cheaper alternative than platinum, is excellent at oxidation of hydrocarbons, has very good thermal durability and is great at removing NOx. Its most common drawback, however, is sensitivity to poisons. It is mainly for these reasons that you will find palladium in combination with rhodium in many gasoline aftertreatment formulations worldwide.

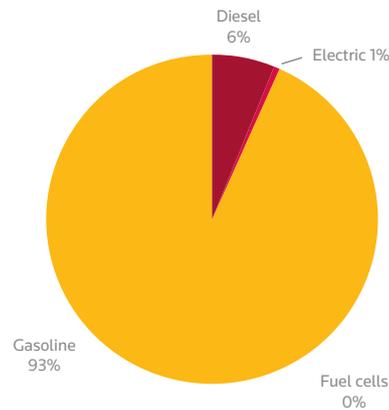
Gasoline driven powertrains (including gas derivatives) dominate global vehicle powertrains, making up 80% of global vehicle production in 2017 (including HDD). Unlike diesel, which is heavily concentrated in Europe, the HDV segment and some parts of Asia, gasoline vehicle demand is more evenly distributed across the

NORTH AMERICA MEDIUM & HEAVY DUTY VEHICLE PRODUCTION



Source: LMC; GFMS, Thomson Reuters

US DOMESTIC LDV PRODUCTION



Source: LMC Automotive; GFMS, Thomson Reuters

DEMAND

various regions globally. Last year was the first year ever, excluding two and three wheelers, that vehicle production, including HDV, reached the 100 M units mark. At 29%, China makes up the largest share of global vehicle production, followed by Europe (23%), Other Regions (20%), North America (18%) and Japan (10%). At a slightly slower rate, gasoline vehicle production rose by 1.9% to 75 M units whereas diesel vehicles increased by 3.7% to approximately 19 M units.

Palladium use in all fuel types rose 4% to 7.9 Moz (245.1 t) last year slightly faster than new vehicle demand. This was generally a reflection of rising loadings in particular parts of our Other Regions category and China, but also North America, driven on continued tightening emissions legislation. China introduced China 5 for LDV in 2016 and China V for HDV last year which both had a significant impact on PGM demand. North America in turn started to phase-in its Tier 3 regulation which we believe also had a positive effect on loadings.

DEMAND BY REGION

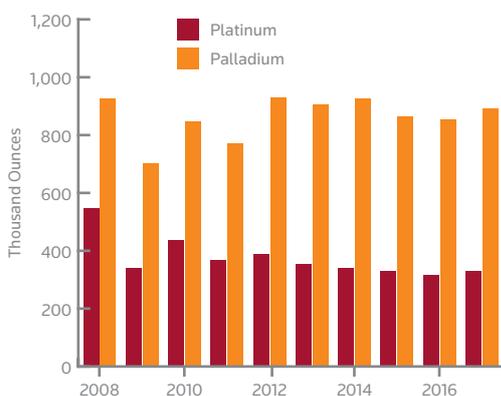
For the second year in a row, **China** remained the largest palladium consuming region in autocatalysts, after surpassing Europe to take top spot in 2016. In spite of number plate restrictions in major cities, gasoline powered vehicle production growth continued in 2017 at 1% to 25 M units, reaching in particular more cities inland where there is still spare capacity. Further tightening emissions legislation continues to support palladium demand too, last year supported by a vehicle fleet that is 86% (including trucks and buses) geared towards gasoline. We estimate that palladium loadings in China are still approximately 15% below those recorded in Europe for example, and therefore still have room for catching up. Palladium demand rose 5% to 2.0 Moz (63.6 t) in 2017.

Enforcing stricter legislation is also something in which China has made great strides, although there also remains room for improvement. Raising emission standards and enforcing them is pointless if the required high quality fuel is not widely available, leaving much of the market with fuel that reduces the functionality of the catalysts through poisoning. But those issues are being addressed and have made great improvement in the recent years as well. The issue with the small “teapot” refineries unable to produce high quality China 5 or 6 compliant fuel is being addressed by either merging them with more modern facilities, closures or upgrading them to the required standard.

In our **Other Regions** we noticed considerable improvements in demand for palladium as well, rising 10% to reach 1.2 Moz (36.6 t) last year. This group represents a wide variety of countries, ranging from some African nations that have no emissions legislation in place whatsoever to various Asian countries that are up to speed with the latest modern standards. The biggest influence is exerted by those who make up the largest part of the composition, such as Brazil, India and Thailand to name a few. In all those countries, without going into the intricate detail of every individual scheme, legislation over emissions is generally catching up with the more established schemes with a certain lag in lockstep. Rising middle classes that are raised out of poverty make up the largest source for vehicle demand growth and as such boost demand for palladium.

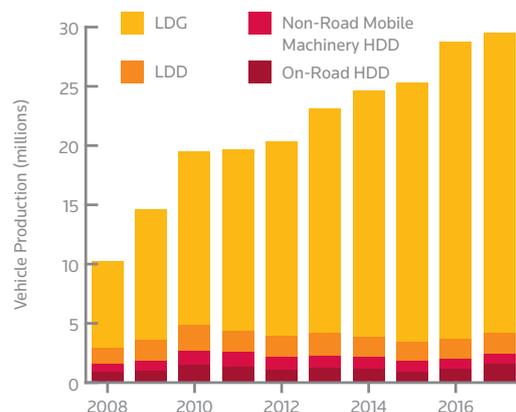
That positive sentiment stood in contrast to what was recorded in **North America**, and in particular in the United States. LDG vehicle production contracted 4% last year to just shy of 16 M units. This was driven by the United States which witnessed an 8% drop in the gasoline segment last year. The United States is a mature market and new car sales are heavily driven by

AUROCATALYST DEMAND: JAPAN



Source: GFMS, Thomson Reuters

CHINESE VEHICLE PRODUCTION



Source: GFMS, Thomson Reuters; LMC Automotive

replacement demand. There is little room for an increase in the pie and the various brands present in this market have to deal with razor thin margins and an ultra-competitive landscape. On the emissions front it looks as if the country is caught in a raft between the intentions of President Trump to roll back some tightening legislation via the EPA in order to give the automotive industry some breathing space and the California Air Resource Board (CARB) and 17 other states that are pressing ahead with stricter emission standards and tighter fuel efficiency rules. Nevertheless, LEV III was introduced in 2015 and further rolled out last year which requires gasoline cars to have a gasoline particulate filter (GPF) to deal with the particulate mass but also the particulates in number. This will be tackled with PGM containing equipment, although not in all cases, a separate brick or a 4-way catalyst.

OEMs will be able to certify their vehicles to 'bins', so long as they comply with fleet average emissions limits, which are set to become increasingly tighter until to 2025. Some vehicles equipped with this palladium rich aftertreatment have already had a positive effect on palladium demand from this region to meet the 2025 SULEV30 target. Demand for palladium rose 2% reaching 1.9 Moz (59.1 t).

Europe also posted a increase in palladium demand from autocatalysts, albeit marginally by 0.5%, to 1.8 Moz (55.9 t). Despite the European auto sector is usually discussed in light of platinum demand, considering its large diesel vehicle fleet, gasoline cars are actually also in abundance supporting demand for palladium. In fact, gasoline LDV account for the slight majority of 55%, which is 1% higher compared to last year. Due to the aftermath of the diesel scandal and the bad PR diesels have had in recent years, gasoline vehicles are becoming and increasingly more popular choice even among the traditionally loyal diesel consumers in Europe.

Real-world driving emission testing will support higher PGM loadings, although some OEM's might recalibrate their cars with the same aftertreatment and make some concessions on performance. Although diesels will remain part of the vehicle fleet of OEMs in order to meet stricter CO2 targets in 2020, we believe that gasoline vehicles have a brighter future on the continent considering the electrification of powertrain trend. This will go via the hybrid route which in many cases is gasoline driven with rich palladium aftertreatments. Last year, Europe accounted for 23% of palladium demand in autocatalyst applications, which represents the third spot after North America at 25% and China with 26%.

Japanese gasoline vehicle production edged up 4% to 8 M units in 2017 following a decline of 1% in the prior year. Japan has reached a level of saturation in the market place and we also believe that loadings have declined considering the maturity of the market and the lack of a new round of emissions legislation on the horizon. That said, Japan will be introducing the World Harmonized Test Cycle (WHTC) which will focus on stricter testing procedures as opposed to reducing pollutants further. Palladium demand rose by 4% to 0.9 Moz (27.6 t).

Frequent discussions at present surround the rapid emergence and uptake of the electric vehicle and the push amongst many OEMs to diversify their portfolio towards electrified powertrains. That trend will have its implications on PGM demand in our view; the question, however, depends on what timeframe you are taking into consideration. Over the 3-5 year horizon there is still room for diesels in the LDV segment, despite the threats from governments to ban them from various cities worldwide. Beyond that the electrification of powertrains will go down the hybrid route which in most instances, despite some initiatives to push for more diesel hybrid vehicles, will go the gasoline route. Palladium and rhodium will benefit from that and platinum might find itself in a more precarious situation from an aftertreatment standpoint. But that does not mean it won't have a role in automotive of the future, quite the contrary. At the same time, although not happening at present, some reverse substitution might occur from palladium rich formulations back to platinum in the case that palladium continues to trade at a significant premium to platinum, in spite of the regulatory and administrative burden. Although a widely discussed topic, last year there was very little evidence of that development in the market and as such merely remains a potential future option.

AUTOCATALYST DEMAND: REST OF WORLD



Source: GFMS, Thomson Reuters

HEAVY DUTY VEHICLES

On road (trucks and buses) and non-road mobile machinery consist almost exclusively of a diesel powertrain. Production of medium and heavy road going trucks and buses and non-road mobile machinery had each approximately half of the market share in HDV last year. Road going trucks and buses production saw a considerable jump of 17.1% last year reaching 3.6 M units whereas NRMM rose 1.5% to 3.2 M units.

A lot of the aftertreatment options of HDV are based on the same emission reduction options: exhaust gas recirculation (EGR); diesel oxidation catalyst (DOC); selective catalytic reduction (SCR) and a diesel particulate filter (DPF). The HDV sector has made great strides in reducing emissions from trucks and buses in recent years, pushed by regulators to comply with stricter standards on the various pollutants while improving fuel consumption and fuel economy.

Platinum consumption from the on road HDD sector rose 14% last year to 0.6 Moz (18.7 t). The rise followed a contraction in demand recorded the prior year which was mainly driven by a weak truck sector in the United States. Excess trucking capacity constrained capital investments there and with North American road going trucks good for 17% of the market, platinum demand fell. Last year the sector rebounded, a sentiment recorded across all the various regions.

PGM loadings in Europe and North America are estimated to be in decline due to thrifting. No new legislation is set to be on the horizon, OEMs will have to battle their way towards getting in line with the fuel economy and fuel efficiency standards as well as reducing the amount of CO₂. That will not require a lot of tooling with the catalysts.

In developing regions though, the story is slightly different due to the catching up that is still necessary. A lot of the aftertreatment options there are equivalent to Euro 4/5 standards and only recently have started adopting proper SCR and DPF aftertreatment technology. As such, we've seen platinum demand, and palladium as well, particularly in China rise as much as 88% to 19% of total platinum consumption in the HDV segment, or 0.13 Moz (4.0 t), including off road equipment. Needless to say, it's small but rapidly rising and we expect that to continue in the coming years. Due to the implementation of China VI and Bharat Stage VI legislation in India in the coming years, we expect the amount of trucks fitted with aftertreatment solutions to rise to approximately 55% this year.

If anything, despite the increased orders at Tesla for the semi-truck, that best caters to the mid-sized truck urban

environment, road going and non-road mobile machinery in particular will continue to be reliant on diesel engines. As such platinum will continue to play a very strong role in this segment, supported by palladium. Battery electric trucks will enter the market but will not make any significant impact for years to come, if ever at all.

FUEL CELLS

Fuel cell powered vehicles have been a promising technology in the transportation space for many years. Despite Toyota, Honda and Hyundai have rolled out their fuel cell powertrains, uptake amongst consumers remains low. As with battery electric vehicles, it remains a chicken and egg conundrum; consumers want infrastructure to be able to refuel their vehicles and not be stuck with range anxiety, whereas infrastructure projects usually are easily pitched when there is a clear trend of future rising usage.

In the LDV space that is not that obvious. We believe that fuel cell vehicles will have a role in the powertrain mix of the future but will not see similar uptake as with battery electric cars anytime soon. To give you a sense of the market, around 5,000 units were produced last year of which 90% was heavily dependent on subsidy provided in Japan. Many argue that the energy conversion rate of fuel cells is much worse compared to BEV, although they do provide better range at present.

We calculated that around 60 koz of platinum are currently used in fuel cell applications, including stationary and portable applications. Transport accounts for 83%. This includes a lot of buses and forklifts too and not just cars. The current understanding is that platinum fuel cell loading are in the range of 30gr/vehicle and that active research is being done to reduce this further to around 15gr or even 10gr. Some go as far as to state that it needs to be similar to what is currently present in an autocatalyst, which means, depending on the region, that loadings will have to be cut in half again.

The Chinese New Energy Vehicle Program and the accompanied subsidies are a welcome development for the fuel cell technology in transportation. The program has been initiated in order to stimulate and facilitate the move from fossil fuels towards zero emission transportation. Fuel cell subsidies remain unchanged whereas those for BEVs are declining. Fuel cells in particular make a lot more sense in the HDV space in terms of range and towing capability. Some OEMs have developed trucks with the promise to provide a good payback period and similar capital investment requirements compared to those with ICE. That sounds promising if not slightly ambitious at present.

HIGHLIGHTS OF EMISSION STANDARD TIMETABLES

Light Duty Vehicles Legislative Overview

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	
Europe	Euro 6b		Euro 6c / Euro 6d TEMP			Euro 6d / 95 g/km CO2						
North America EPA	Tier 2		Tier 3 Introduction									
North America CARB	LEV III Phase in					LEV III Tightning						
Japan	Japan 09 (JC08)			Japan 18 (WLTC)								
South Korea (diesel)	Euro 6b		Euro 6d TEMP			Euro 6d						
China (Nationwide)	China 4			China 5		China 6a				China 6b		
India	Bharat Stage 4					Bharat Stage 6						
Brazil	PROCONVE L6								PROCONVE L7			
Thailand	Euro 4									Euro 5		

Heavy Duty Vehicles Off-Road Legislation Overview

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Europe	Tier 4b				Stage V						
North America	Tier 4b							Carb/EPA			
Japan	Tier 4b										
South Korea	Tier 4b					Possible Stage V					
Brazil	Tier 3				Tier 4a			Tier 4b			
China (major cities)	Tier 3		Tier 4a				Tier 4b				
China (nationwide)	Tier 3				Tier 4a				Tier 4b		

Heavy Duty Vehicles On-Road Legislation Overview

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	
Europe	Euro VI								Possible Euro VII			
North America	Greenhouse Gas Phase 1						Greenhouse Gas Phase 2					
Japan	Japan 09		Japan 16 (WHTC)									
South Korea	Euro VI								Euro VII			
Brazil	PROCONVE P7							PROCONVE P8				
Russia	Euro IV			Euro V								
India (major cities)	Bharat IV				Bharat VI							
India (nationwide)	Bharat III		Bharat IV			Bharat VI						
China (major cities)	China IV		China IV									
China (nationwide)	China IV		China V				China VI					

Source: Various Government Departments; GFMS, Thomson Reuters

JEWELLERY

- *Platinum jewellery fabrication declined by 4% to an estimated 2.20 Moz (68.6 t) in 2017, dragged lower by a sizeable fall in demand from China and Europe.*
- *Palladium jewellery demand declined 3% last year to 0.29 Moz (8.9 t), with the biggest falls in volume terms seen in Europe and North America.*

Last year global **platinum** jewellery fabrication retreated 4% year-on-year to reach an estimated 2.20 Moz (68.6 t), the fourth consecutive annual decline. This took jewellery's share of total demand to 27%, down from 40% in 2009. The biggest falls were seen in China and Europe, with fabrication in these key markets falling by 8% and 6% respectively. In China, weak platinum prices failed to elicit higher consumer demand last year with strong demand for yellow carat gold eroding platinum and white gold market share. Meanwhile, another drop in demand from the watch segment in Switzerland and a price related decline in the UK accounted for the bulk of the losses in Europe. One bright spot last year was India which continues to expand, albeit from a low base, increasing by 16% last year following an 11% rise in 2016.

Palladium used in jewellery fabrication declined for the ninth consecutive year, by 3% to 0.28 Moz (8.9 t). China's share of the global total slipped to just 1% last year with this market now totally collapsed. However, in volume terms it was the drop in European and North American offtake that accounted for much the global decline as acutely higher palladium prices attracted less interest from consumers and saw fabricators look to more affordable alloying options for white gold carat jewellery.

JEWELLERY DEMAND

PLATINUM				
(000 ounces)	2016	2017	2018f	Chg(17/16)
North America	246	244	246	-1%
Europe	213	201	214	-6%
Japan	317	315	309	-1%
China	1,396	1,284	1,194	-8%
Other regions	145	160	174	10%
Total	2,318	2,204	2,136	-5%

PALLADIUM				
(000 ounces)	2016	2017	2018	Chg(17/16)
North America	52	50	45	-3%
Europe	150	145	147	-3%
Japan	44	42	42	-5%
China	4	3	2	-25%
Total	293	285	280	-3%

Source: GFMS, Thomson Reuters

CHINA

Chinese **platinum** jewellery fabrication declined for a fourth consecutive year, falling 8% year-on-year to an estimated 1.3 Moz (40 t) in 2017. In value terms, demand fell by over 7% or \$103 million, to approximately \$1.28 billion, as the platinum price fell over 4% in local terms last year. We had previously suggested that the Chinese jewellery fabrication demand fell by a low double-digit decline on an annual basis in the first half of 2017, but an improved second half limited the downside for the full year. To put this in context, China's jewellery demand for platinum peaked in the early 2000s, when annual demand from the jewellery sector was north of 60 tonnes. During the peak there were many manufacturers producing over 100 kilogrammes of finished jewellery per day. However, platinum's glory days in the Chinese jewellery industry are long gone, despite China being the largest platinum consumer in the global jewellery industry, contributing 58% of the sector's demand in 2017. While China's 2017 GDP growth accelerated for the first time in seven years reaching 6.9% year-on-year growth, the expansion of the economy certainly did not help the country's platinum jewellery consumption.

We can break down the lack of relative success of platinum jewellery in the Chinese market into several factors. First of all, the Chinese have a long cultural affinity to gold, and thus the gold market in China is much more developed and popular than the platinum market. The Chinese have a historical culture of favouring gold colour in jewellery, and the majority of the population has yet to accept jewellery in white colour. It is not only platinum that has suffered; there has also been a lack of major interest in the white-gold (18-carat) segment.

Secondly compared to platinum, gold has greater transparency in terms of price as well as liquidity, which some consumers consider before purchase. For platinum scrap return in China, the bid ask spread could be as high as 15%, compared to just 3%-4% for gold. The large gap of the spread in platinum compared to gold is partly attributed to the higher cost of refining and working platinum. As a result, consumers think buying gold jewellery offers a bigger bang for the buck, an asset that can maintain higher value in the future if they want to trade in or to cash out.

The third reason is a lack of support from the industry participants, from wholesalers to retailers. After several years of hardship following the acute drop in consumption from the peak in 2013, the whole sector

shifted its strategy from bulk volume selling (but low margins) in the past to now focusing efforts on selling higher margin items. The traditional 24-carat gold items, which have been the dominant segment in the jewellery sector in volume terms, usually command a gross retail margin of only 12%-15%. Platinum pieces, which are usually sold by weight in China, can command a gross retail margin of 40%-50%, and as a result should have benefited by the shift in the selling strategy, at least in theory. However in reality, retailers were enamoured by the margins brought by selling other products including carat gold, gem sets and 3-D hard gold, whose retail margins are usually more than double that. Therefore, retailers have more incentive to sell these higher margin products (as reflected in sales commissions) than platinum jewellery, and the market share of platinum has been eroded by the emergence of 18-carat and 22-carat gold segments in the last few years.

For comparison, not only is the white colour in platinum already at a disadvantage to the yellow colour of gold jewellery based on consumer preference, but the designs of 18-carat gold can be relatively more sophisticated and diversified compared to pieces using a platinum alloy, thus offering consumers more choices.

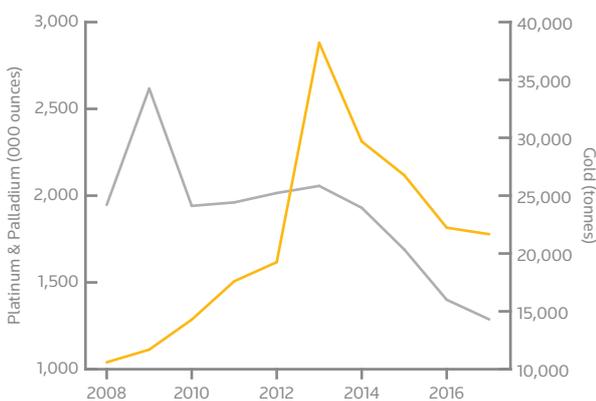
Another tough blow for platinum has been the current preference of consumers choosing 18-carat items (either plain or gem set) over platinum for wedding jewellery. We have noticed that in show rooms, two diamond rings of similar quality (weight of the rings and the quality of the diamonds) with the only difference being that one is made using a platinum alloy while the other uses 18-carat white gold, the price of the latter was close to \$100 higher than the former, indicating inferior market interest in platinum.

Another influencing factor has been the cost of inventories for both the fabricators and retailers. As both need to display inventories in their show rooms and cabinets, it works to their advantage to focus more heavily on promoting 18-carat gold over platinum jewellery, as in general, the cost per 18-carat gold piece is lower than the same platinum piece and the turnover is faster. As a result they prefer filling the display cabinets with 18-carat pieces instead of platinum items - as it can create less stress to their cash flow and benefits their cost controls.

A lack of transparent market pricing mechanism also left with many consumers confused. Many Chinese have in depth knowledge in regards to gold, but not many understand platinum. They would easily be confused as to why two similar platinum products would be priced so differently in the retail market.

In the last two years, China's platinum jewellery fabricators have also been shifting to produce platinum pieces with a lower purity content. China's platinum jewellery market is basically made up of purities in Pt999, Pt990 and Pt950, with the former two previously commanding the lion's share of the market. However, fabricators have been focusing more on producing Pt950 purity in the last two years, as this segment in particular was gaining market share over other purities. The Pt950 purity designs have become the dominant form within the segment, commanding approximately 80% market share in 2017. The popularity of the Pt950 purity product is two-fold: Firstly, working with a higher purity content requires a more sophisticated tooling process and increased costs of fabrication, thus lowering the purity pieces helps producers to contain and even reduce costs; secondly they feel that the metal content in Pt950 is the best alloy to work on so that they can introduce the most sophisticated designs within the platinum segment.

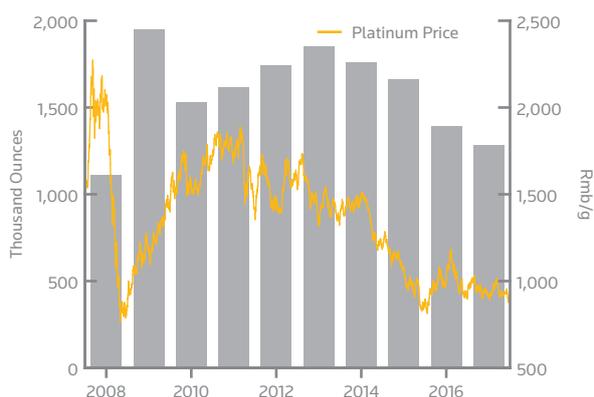
CHINESE JEWELLERY FABRICATION



Source: GFMS, Thomson Reuters

Looking forward, we expect the downward trend for platinum in the Chinese jewellery market to continue in 2018, with sales data in the first quarter of 2018 underwhelming. Fabricators and retailers have continued to focus on sales of higher margin products including carat gold and 3D hard gold. As aforementioned Chinese consumers have a preference for gold and this has led the industry to focus on research and development of new products in the gold segment but not in platinum, when platinum jewellery may actually need more development and promotion including innovative designs to support and raise market awareness. The surge in the rhodium price in 2017 has also increased the cost of rhodium solution, an ingredient needed during the jewellery

CHINESE PLATINUM JEWELLERY FABRICATION

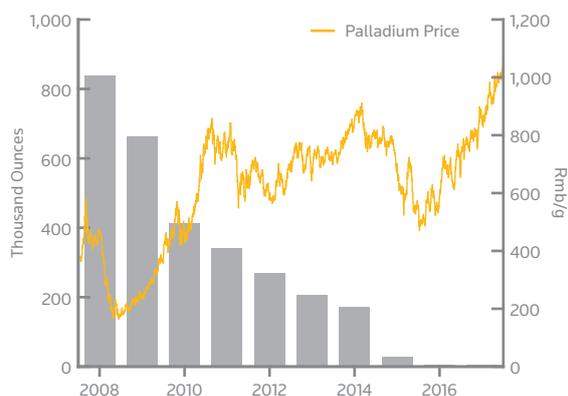


Source: GFMS, Thomson Reuters

fabrication process. Platinum jewellery fabricators are therefore facing more pressure in cost controls, and some have already been re-allocating their production capacities from platinum to carat gold pieces.

Palladium jewellery fabrication in China has plummeted to minimal levels in 2017, to just 3,000 ounces (0.09 t). For comparison, the country's jewellery demand for palladium peaked at 1.0 Moz (32 t) in 2005. Last year saw the last of palladium focused fabricators exit the industry and sadly, there was no major palladium jewellery fabricators now left in China, as a lack of sufficient downstream demand failed to support any sizeable corporates. All the problems mentioned in the platinum jewellery industry fit the bill with palladium, but with even worse market transparency and lower liquidity. Palladium also suffered from misunderstanding and bad reputation in China, as speculators wanted to take advantage of the acute price drop in platinum back in 2008, but purchased palladium instead due to misguidance and fraud.

CHINESE PALLADIUM JEWELLERY FABRICATION



Source: GFMS, Thomson Reuters

JAPAN

Japanese fabrication of platinum jewellery edged just 1% lower in 2017 to 0.31 Moz (9.8 t), accounting for 14% of the global total, the highest level since 2007. The fall last year, the second in succession, was modest at less than 1% and signals that the domestic market has broadly stabilised after recording several material falls earlier this decade. Such a stable outcome looked unlikely in the first half of the year with demand for the period weaker across the jewellery market as a whole, but a solid recovery in the second half, and particularly in the fourth quarter, almost entirely offset this earlier weakness. While the jewellery market in general was underwhelming last year platinum jewellery remained the standout, to outperform gold and eroding white gold market share, rebounding faster than most retail segments once demand began to show the first glimmer of a recovery.

The modest recovery was aided by a drop in the yen platinum price to below ¥3,200/g in December, the lowest level since October 2016. While this had little impact on the ticketed prices as retailers largely failed to pass on the savings, it did stimulate the fabrication sector ahead of the Christmas holiday period due to a rise in restocking levels. In addition to the price influence, an improving economic backdrop and most notably the surge in the equities market buoyed consumer spending. Indeed, Japan's Topix index capped its best annual performance since 2013 last year gaining 20%, while the Nikkei 225 surged 19%, the most since 2013, as global growth helped improve corporate earnings.

Japan is a country with an aging population and a high proportion of retirees but it is this market demographic that fuels retail sales as they often have a greater disposable income. The impressive recovery on the local bourse last year saw profits taken and this stimulated consumer spending and boosting demand for luxury items, hence the high-end outperformed.

Another important boost to domestic retail sales last year, and one that helped offset a deeper decline, was a significant uptick in tourist visitors. According to the Japanese National Tourism Organisation (JNTO), the estimated number of international travellers to Japan reached 28.7 million last year, a year-on-year growth rate of almost 20%. Tourist spending hit a record 4.42 trillion yen (\$41.7 billion), in tandem with the surge in visitor numbers, a jump of 17.8% from a year ago. The impressive gain was again led by a 15% jump in Chinese visitors while those from South Korea surged 40% to 7.1 million attracted in part by the weaker yen

which increased their purchasing power and perhaps helps explain why the branded and high-end sector was broadly well-supported. Research suggests that platinum jewellery sales by the high-street international brands recorded growth last year, buoyed by the inflow of tourism spending and targeted marketing campaigns.

Demand from the larger department stores, a key point of sale for luxury jewellery items in Japan and often regarded as the beating heart of Japan's fashion industry, recovered in the second half of 2017 with reports of increased unit sales in the fourth quarter. Moreover, discount jewellery retailers, which have suffered in recent years, also reported gains as the lower price point attracted new buyers or those looking to replenish old and dated items. The biggest casualties last year were small stand alone retailers, especially those outside the reach of mainstream tourism, with reports of some sizeable falls in this segment. Online sales have continued to gain momentum with the greatest success seen for lower weighted items and for fashion jewellery.

The bridal segment continues to dominate offtake, with platinum jewellery retaining a market share of over 80% in this segment, up slightly on 2016 estimates, but this sector overall is receding. In contrast, the non-bridal segment where platinum maintains a far lower market share than gold enjoyed a rise in offtake. Indeed, there has been a sustained growth in the latter segment over a number of years now and it is seen as an area where the industry expects further expansion. With an aging population and fewer marriages per year the industry is refocusing its efforts on promoting gifting and fashion jewellery in the hope of gaining more ground on 18-carat designs. Consumption in this segment, while far smaller in volume terms will be the catalyst for industry expansion in the coming years.

JAPANESE JEWELLERY FABRICATION



Source: GFMS, Thomson Reuters

Turning to purity, and there were no significant change last year with Pt950 still dominating in volume terms as it is widely used the bridal segment, but it is now also moving rapidly into the fashion segment where retailers are now requesting cast jewellery in higher purity styles. As a result of this shift in demand for Pt850 and Pt900 retreated, with the former losing considerable ground.

Japanese **palladium** jewellery fabrication declined 5% last year to an estimated 42,000 ounces (1.3 t), the fourth consecutive fall. Palladium is principally used in jewellery fabrication as an alloying ingredient, used in both white gold and platinum. Last year, demand for platinum jewellery was relatively stable, but a drop in demand and overall market share loss for white gold drove offtake lower, while sharply higher palladium prices also curbed demand.

NORTH AMERICA

Platinum jewellery fabrication in North America contracted marginally by 1% to 0.24 Moz (7.6 t) in 2017. Domestic fabrication in North America accounts for about two thirds of retail demand with imports accounting for the balance. As such, the decline in domestic fabrication does not necessarily mean retail demand followed a similar fate. In fact, last year, due to the sizeable amount of imported platinum jewellery items in North America, retail demand actually rose 3.6% to 0.32 Moz (10 t) driven by a substantial rise of 45% in platinum jewellery imports. Indeed, all categories, rings, earrings, chains and other items reported increases last year. The biggest contribution came from rings, responsible for half of platinum jewellery imports, which rose 40%. Clearly the willingness to get married still plays a vital role and we believe that marriages actually increased last year in North America. Indeed, last year the amount of married couples increased in the United States from 60.2 M to 60.8 M. New weddings equal around 2.3 M each year in the United States.

But, possibly equally important, is the increased willingness of consumers to purchase not only gold items during weddings but also look at more unique and exotic options such as platinum containing rings. At the same time, the many marketing efforts that have been present in the country to promote platinum in jewellery at the fabricator, retail and consumer level are starting to pay off. Retail stores have also slowly shown an increased interest in displaying more platinum related items in their stores since margins on these items are good.

Palladium jewellery fell 3% to 0.05 Moz (1.6 t) in 2017. This marked the eighth consecutive annual drop which is mainly due to a lack of marketing in the United States. Palladium in jewellery is most widely used as an alloy in gold wedding bands to whiten its colour and as a credible substitute to nickel, which can cause skin irritations.

EUROPE

Last year marked the fourth successive year of declining **platinum** jewellery fabrication in Europe, as offtake dropped by 6%. This fall occurred despite the tailwinds of platinum price declines and its relatively low price level compared to its recent history or that of gold for vast swathes of the region and its strongest and most widespread growth since the global financial crisis. Instead the causes of the disappointing result lay elsewhere, namely in structural issues particularly limited advertising but also due to some factors that hit particular countries more acutely.

One area where demand was particularly weak was **Switzerland**, for the fourth successive year. Platinum usage is, as usual, dominated by the watch industry and offtake in this sector hit rock bottom last year as it dropped by another 9% to less than 40% of the 2013 peak. This poor performance however does mask the fact that 2017 marked a turning point for the industry with demand slowly starting to recover in the second half of the year. This trend has accelerated so far in 2018 and we expect this higher level of demand to be sustained throughout this year and this will be central to not only a very strong upturn in Swiss fabrication but also an increase in demand across the whole region.

Two other countries also saw particularly disappointing declines last year, namely the **United Kingdom** and **Germany**, which had been at the vanguard of increases in 2016. These gains were not sustained though as German

demand reversed all its gains. Meanwhile in the United Kingdom the sustained high sterling price proved a drag on platinum jewellery, albeit it proved far more resilient than offtake of gold. This appears to have been aided by the relative price performance and the resilience of the vital wedding ring market.

Palladium jewellery demand also fell last year, albeit at only half the rate of platinum i.e. 3%. This relative outperformance came inspite of the sharp increase in the palladium price and its rise above that of platinum. A key contributor to this greater resilience was that increased sales of white gold led to higher palladium offtake in this area that offset some of the losses in carat palladium jewellery demand. UK demand was the weakest in the region with the exceptionally strong palladium price in sterling terms fuelling a reduction in the number of pieces and a shift to Pd500 from Pd950.

INDIA

Indian platinum jewellery fabrication rose by 16% year-on-year to 72,285 ounces (2.2 t), the highest on record. The gains were a result of an increase in the number of retail stores. Moreover, higher margins and low price transparency also saw a rise in imports of platinum jewellery, which in value terms increased by more than 200%. In terms of consumption, demand growth was contained to single digits due to weaker demand for diamond jewellery and lower customer conversions from 18 k gold jewellery to platinum jewellery. While the platinum jewellery market is still at a nascent stage in India it was however interesting to observe during field trips that there is a growing interest for silver jewellery plated with platinum. In the high-end segment, the Evara collection by the Platinum Guild has seen good traction. The advertising and promotion is currently limited to just this brand, naturally attracting consumer interest.

NORTH AMERICAN PLATINUM JEWELLERY FABRICATION



Source: GFMS, Thomson Reuters

EUROPEAN PLATINUM JEWELLERY FABRICATION



Source: GFMS, Thomson Reuters

DENTAL

— **Demand for palladium in dental applications retreated 4% last year to 0.41 Moz (12.7 t).**

Dental demand for palladium in **Japan** is estimated to have declined by 3% last year, to reach 227,000 ounces (7.1 tonnes), extending the long term trend of declines. Japan dominates this sector at 56% of the global total as use of Kinpala ('kin' is the Japanese for 'gold', and 'pala' is 'palladium' abbreviated), the alloy that is still widely used in the majority of dental treatments. However, even in this market demand has been wavering as younger consumers in particular are looking to more cosmetically pleasing treatments such as ceramics or porcelain-fused metal. In Japan, the government operates a specific mandate stating that all government-subsidised dental alloys have to include a palladium content of 20% and it is this policy that continues to support the use of PGMs in this sector. Japanese demand was on track for growth midway through the year but dipped towards year's end following the bi-yearly adjustment in October to the medical rebate for the use of Kinpala, as that limited stock building by dentists. In addition, a reduction in cover to only the back teeth, which was introduced in the third quarter, also impacted overall demand.

North American palladium dental offtake retreated 5% last year to 119,000 ounces (3.7 t), the lowest level recorded in our data series. Substitution and the introduction of new technology has been a major force in the decline of palladium demand in this sector with the movement away from noble metal based alloys to more cosmetically pleasing applications such as zirconia and lithium disilicate glass ceramics now common place. Market trends have shifted to lower cost manufacturing including digital scanning and fabrication (3D printing) Finally, the cost of using palladium in amalgams also increased sharply last year with the 41% surge in the average palladium price flowing through to higher costs for the alloy.

DENTAL DEMAND

PALLADIUM

(000 ounces)	2016	2017	2018f	Chg(17/16)
North America	127	119	114	6%
Europe	56	53	50	5%
Japan	234	227	222	3%
China	1	1	1	-4%
Other regions	8	8	7	-7%
Total	426	408	394	-4%

Source: GFMS, Thomson Reuters

Dental fabrication in **Europe** fell by 5% in 2017 to an eight-year low of 53,000 ounces (1.6 t). The stronger economic backdrop provided some support, but in reality, it is substitution that is having a far greater impact on demand in this segment. The shift to zirconia layering ceramic and lithium disilicate restorations due to the improved aesthetics and longevity continues to erode the use of PGMs in this sector.

ELECTRONICS

- **Platinum demand rebounded by 10.6% last year to 0.20 Moz (6.1 t) due to the increase of the metal's usage in hard disk drives.**
- **Palladium from the electronics sector continued to decline, retreating by 4.9% in 2017 to 0.89 Moz (27.7 t).**

One of the largest usages of **platinum** in the electronics sector comes from the hard disk drive (HDD) industry, where the metal is used as part of magnetic storage media to provide thermal stability and enhance data storage capabilities. Shipments of HDD continued to fall for a third consecutive year in 2017, dropping 6% to 385 million units. The figure was also 41% lower than the peak recorded in 2010, when 651 million units of HDD were shipped. The popularity of smartphones has replaced some of the demand for personal computers (PC) and has resulted in either stretching PC life cycles longer, or in some cases totally giving up on the PC. The two largest players in the HDD sector contributed 77% market share last year, compared to 83% in 2015. While the shipments of HDDs have been on the decline, the increase of disks and storage per drive has helped the demand for platinum from this particular sector. The

ELECTRONICS DEMAND

PLATINUM

(000 ounces)	2016	2017	2018f	Chg(17/16)
North America	6	6	5	-6%
Europe	3	2	2	-15%
Japan	18	20	20	8%
China	26	30	31	14%
Other regions	124	139	146	12%
Total	178	197	204	12%

PALLADIUM

(000 ounces)	2016	2017	2018	Chg(17/16)
North America	197	192	179	-2%
Europe	122	114	111	-6%
Japan	225	212	204	-6%
China	197	187	179	-5%
Other regions	197	187	179	-5%
Total	938	892	852	-5%

Source: GFMS, Thomson Reuters

solid expansion of the use of HDDs in cloud applications, as well as the secondary storage market that has been price sensitive, also benefited platinum demand last year. We estimate that platinum use in HDDs amounted to 0.15 Moz (4.6 t) last year, a 14% increase from the previous year, after hitting the lowest level in 2016.

However, it is possible that the healthy growth in demand seen last year may be a one-year wonder. The continual development of the HDD does not look bright. The threat from solid-state drives (SSDs) is real and continuous. SSDs do not adopt magnetic memory, but use interconnected flash memory chips and therefore are typically faster and more reliable. While HDD remained the dominant storage market, SSDs have been gaining traction quickly from a low base and will continue eating into market share held by HDDs. Some industry participants now forecast that SSDs will likely share half of the global storage market with HDDs by 2021. While prices of SSDs in general are higher than HDDs, which is still making HDDs attractive to budget conscious users, the pricing gap of these two storage options will continue to narrow. HDDs have been rapidly losing market share to SSDs in the enterprise drives segment due to prices.

Another problem for HDDs is that capacity growth might have finally stalled. Moving beyond 14 terabyte might prove to be challenging technically. While the HDD industry is supposed to poise for another period of rapid areal density growth, likely driven by the introduction of Heat-Assisted Magnetic Recording (HAMR) and Microwave-Assisted Magnetic Recording (MAMR) HDDs by 2018-2019, mass production of hard drives featuring HAMR has been delayed for a number of times already due to technical challenges. HDDs still have their place in client storage, branded storage and in various consumer electronics applications, but these markets are gradually

moving to NAND flash storage. Perceptions of higher costs in SSDs have been changed as consumers began to realise that the higher performance in SSDs mean fewer servers are needed, which in turn means costs are saved from this perspective. While we forecast that platinum usage in the electronics sector and particularly in the HDD segment will be stable in 2018, in the longer run technology based on magnetic storage may continue to be replaced by NAND storage.

Demand for **palladium** used in the electronics sector declined by 4.9% in 2017 to a total of 892,000 ounces (27.7t), the lowest level in the last decade. It is also 29% less than the peak reached in 2010. The main source of demand in the electronics sector comes from multi-layered ceramic capacitors (MLCCs), where palladium or silver-rich palladium alloys form a conductive electrode material sandwiched between ceramic wafers. These components are widely used in consumer electronics including computers, digital televisions, automotive vehicles and smartphones. Global demand for MLCCs picked up in 2017 and towards the end of the year the market was even under supplied. However manufacturers have been cautious about building new capacity, fully aware that global demand for smartphones might have peaked. MLCCs manufacturers have also been focusing on profit margins, and have become reluctant to use precious metals like ruthenium and palladium in MLCCs. Indeed, more and more MLCCs are using base metals materials due to lower costs, and the massive adoptions of base metals electrode (BME) technology has dragged down palladium usage in the electronics segment.

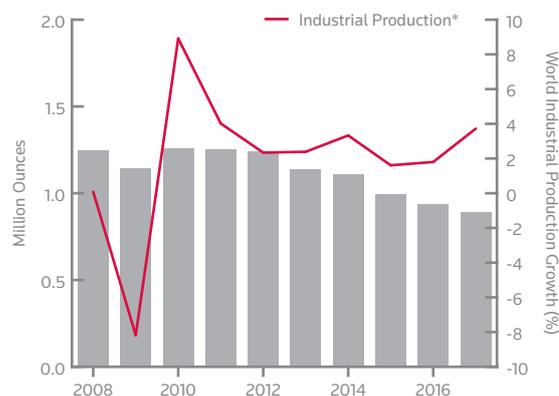
The increase in palladium recovery has also offset some of the demand for fresh metals. We expect the substitution trend to continue to hurt palladium's usage in the electronics sector for years to come.

GLOBAL HARD DISK DRIVE SHIPMENTS



Source: GFMS, Thomson Reuters

GLOBAL PALLADIUM ELECTRONICS DEMAND



Source: GFMS, Thomson Reuters; IMF * Industrialised economies

GLASS

- Demand for platinum enjoyed another solid gain in 2017, rising 22% to total 0.33 Moz (10.4 t), boosted mainly by expansion in fibre glass capacity. Rhodium demand eased 3% to an estimated 0.1 Moz (3.1 t).

PGMs demand from the glass sector can be divided into two main industry segments. The first is fibre glass, which is now widely used for glass fibre reinforced polymers (GFRP). This material is composed of strands of glass with each individual glass fibre woven to form a flexible fabric. GFRP is widely used in the construction industry for non-structural elements, such as facades, panels, piping, and channels. In the automotive industry, where there has been explosive growth in recent years, GFRP is primarily used to reduce weight but it also offers similar strength and corrosion resistance to carbon fibre, allowing it to be used as a replacement for heavier and more expensive alternatives. Polyester resins had the highest market share for the GFRP market in 2017, owing to their use in the construction, pipes & tanks and electronics applications. Properties, such as chemical and mechanical resistance, UV resistance, and shrinkage resistance are boosting the demand for polyester globally. Additionally, there has been increasing demand for the use of fibre glass in wind as well as other power generation (chiefly photovoltaic) with this sector recognised as a driver of fresh demand in the future.

A more robust industrialised world economic footing, coupled with continued strong growth from China has fuelled the growth in the fibre glass market. The rosier outlook has stimulated investment in new fibre glass production capacity which will come on stream in the coming years, most notably from China which dominates global offtake as domestic demand accelerates, but also from renewed investment offshore as Chinese corporations join foreign joint venture partners to build new facilities in order to qualify for local incentives and tax reduction programmes.

The second use for PGMs in this sector, and the largest in terms of platinum offtake, is in LCD or display glass production. This process uses platinum and rhodium alloys in considerable quantities to withstand abrasion, corrosion and the high temperatures of molten glass. The display material market was valued at \$28.9 Bn in 2017 and is expected to reach \$34.6 Bn by 2023, at a CAGR of 3.1% between 2017 and 2023. Applications in television accounted for the largest share of the LCD display material market in 2017. The demand for televisions is declining year-over-year, but the average panel size is

GLASS DEMAND

PLATINUM

(000 ounces)	2016	2017	2018f	Chg(17/16)
North America	17	40	36	130%
Europe	15	15	19	0%
Japan	2	15	22	540%
China	177	143	199	-19%
Other regions	63	120	161	92%
Total	274	333	436	22%

RHODIUM

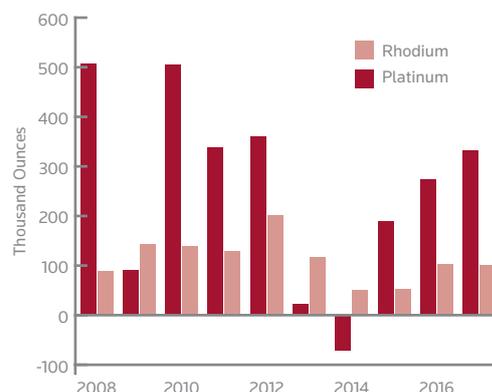
(000 ounces)	2016	2017	2018f	Chg(17/16)
North America	4	3	8	-22%
Europe	8	7	8	-12%
Japan	2	2	2	-3%
China	71	72	44	1%
Other regions	18	17	17	-8%
Total	103	100	78	-3%

Source: GFMS, Thomson Reuters

increasing by a few inches per year. This has led to the increased consumption of display materials used in LCD display panels for televisions. South Korea accounted for the largest share of the display material market in 2017 owing to the presence of industry leaders such as Samsung and LG in the country though LG has recently reported it will be opening a large-scale OLED production facility in China's Guangzhou province in 2019.

Platinum demand rose to an estimated 0.33 Moz (10.4 t) last year, compared to 0.27 Moz (8.5 t) in 2016. This 22% annual growth followed a 45% expansion in 2016, which as outlined was largely driven by increased capacity in China. Rhodium demand totalled 100 koz (3.1 t) in 2017, a modest 3% decline from the 2016 level which had been a three-year high.

GLOBAL PLATINUM & RHODIUM GLASS DEMAND



Source: GFMS, Thomson Reuters

CHEMICAL

- *Platinum demand from the chemical sector was unable to match its stellar performance in 2016, declining by 3% last year.*
- *Palladium use in the chemical sector expanded for a second consecutive year to reach its highest level on record, driven by capacity expansions in purified terephthalic acid (PTA) plants.*
- *Rhodium demand continued to expand, reaching a new record high.*

Demand for platinum, palladium and rhodium from the chemical sector (in which we include demand from the petrochemical industry), arises from their use as catalysts. In the case of platinum, this is historically for the production of paraxylene (PX), nitric acid and Active Pharmaceutical Ingredients (APIs), while it is also used in the curing of silicones. More recent technologies have also recorded the use of platinum catalysts for use in production of on-purpose propylene and isobutylene derivatives via propane (and to a lesser extent butane) dehydrogenation reactions (PDH & BDH). We estimate that platinum use in the chemical sector declined by 3% year-on-year in 2017, falling just below demand levels last year, to bring platinum use in the sector to a total of 0.57 Moz (17.8 t).

Despite total demand falling last year, we recorded a rise in platinum use in every sector (with the exception of nitric acid and PDH). In terms of areas of usage, platinum as a catalyst in PX production was the largest contributor to demand in 2017, rising by 32%. Exceptional demand for polyester products (of which PX is the key feedstock to PTA, which is used to create polyester), resulted in an expansion of already present capacity (with idled plants coming back online), in conjunction with new capacity (focused in our 'other regions' category).

Platinum's use in silicones (which is one of the largest areas of demand), continued to increase for a fourth consecutive year, rising by 3% in 2017. Increased demand for platinum's use in silicones is concentrated in China, which is now responsible for just under 50% of the global market. Meanwhile, rising demand for APIs resulted in platinum use in this industry ticking up 4% over the period.

Reversing last year's gain, platinum's catalytic use in the production of nitric acid weakened in 2017, with global oversupply leading to a surplus. Meanwhile, demand from PDH units, particularly in China, was dampened as

CHEMICAL DEMAND

PLATINUM

(000 ounces)	2016	2017	2018	Chg(17/16)
North America	80	74	77	-8%
Europe	108	85	91	-22%
Japan	40	42	38	4%
China	173	186	213	7%
Other regions	185	187	190	1%
Total	588	573	610	-3%

PALLADIUM

(000 ounces)	2016	2017	2018	Chg(17/16)
North America	68	69	65	-1%
Europe	183	177	170	-3%
Japan	22	22	22	0%
China	90	131	146	45%
Other regions	96	107	95	12%
Total	459	506	498	10%

RHODIUM

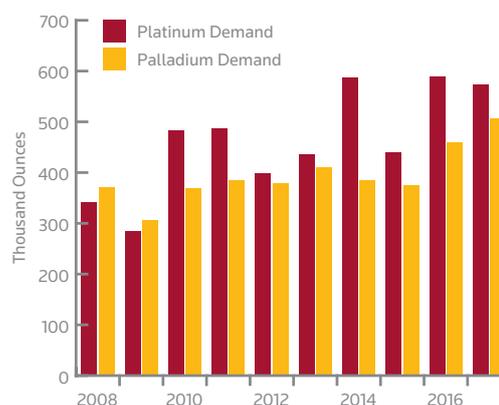
(000 ounces)	2016	2017	Chg(17/16)
North America	17	17	0.7%
Europe	19	19	-0.4%
Japan	7	7	2.7%
China	44	45	2.1%
Other regions	9	9	2.4%
Total	96	97	1.0%

Source: GFMS, Thomson Reuters

high capital requirements and reduced utilisation rates prevented the need for new capacity.

Palladium's usage in the chemical sector primarily derives from demand for catalysts in the production of vinyl acetate monomer (VAM), purified terephthalic acid (PTA), hydrogen peroxide, catchment gauzes in nitric acid synthesis and for use in the removal of acetylene during

PLATINUM & PALLADIUM CHEMICAL DEMAND



Source: GFMS, Thomson Reuters

the production of methyl ethylene glycol (MEG) from coal, palladium salts are used for electroplating purposes. We estimate that palladium use in the chemical sector rose by 10% in 2017, to 0.5 Moz (15.8 t).

As mentioned earlier, the significant increase in polyester demand in 2017 encouraged PTA producers to not only increase utilisation rates at current plants, but to further invest in new capacity, with the largest growth recorded in our ‘other regions’ category. Furthermore, PTA plants run on a biennial cycle, with 2017 having undergone a higher number of plant turnarounds than in 2016.

A second significant area of demand growth last year came from palladium’s use in the production of MEG from coal. China is the leader in the field for this technology and has heavily invested in new capacity, making the most of their large coal supplies. Meanwhile, steady demand persisted from palladium’s use in electroplating. Starting from a smaller demand base, other palladium utilizing technologies recorded a marked growth, with hydrogen peroxide and VAM both recording impressive gains. The only area of decline for palladium use came from nitric acid, falling by 12% year-on-year as the industry faces a market in oversupply.

PETROLEUM

— *Global demand for platinum in the petroleum sector rose for a second consecutive year, rising by 27%, while palladium demand rose more modestly at 15%.*

Demand for platinum and palladium from the petroleum sector arises from their use as catalysts. In the case of platinum, developments in oil refining capacity, specifically new catalytic reforming and isomerisation capacity, remain the largest elements of platinum demand, while it is also utilised in alternative fuel producing technologies, such as GTL plants. Palladium usage in the petroleum sector primarily arises from its use as a bifunctional catalyst, in a two-stage hydrocracking (HC) unit, associated with a large proportion of downstream crude refiners globally. We estimate that platinum’s use in the petroleum sector in 2017 continued to expand increasing by 27% year-on-year, to 0.2 Moz (5.3 t), while demand for palladium rose by 15% to 0.02 Moz (0.52 t).

If we focus on platinum, demand on a regional basis was mixed, with growth stemming from China, North American and our ‘other regions’ category, while Europe and Japan recorded declines. New capacity expansions in China, focusing on new plant designs which will produce

PETROLEUM DEMAND

PLATINUM

(000 ounces)	2016	2017	2018f	Chg(17/16)
North America	57	68	48	19%
Europe	27	24	19	-9%
Japan	4	-7	-3	n/a
China	7	27	31	271%
Other regions	41	60	85	48%
Total	135	172	180	27%

PALLADIUM

(000 ounces)	2016	2017	2018f	Chg(17/16)
Total	15	17	23	15%

Source: GFMS, Thomson Reuters

higher quality fuel products (to meet higher legislation fuel standards), resulted in China being responsible for more than doubling their demand for the metal. This was despite teapot refinery closures. Indeed, China and our ‘Other Regions’ category also benefited from the installation of large projects integrating petroleum and petrochemical refining, in the hope of further diversifying these regions product portfolios. In North America, refineries have been running at high rates on the back of record volume of crude stocks, while damage caused as a result of hurricane Harvey led to an increase in reformer catalyst demand.

The European refining industry has been long suffering, with simple refineries unable to contend with competition in the East. However, persistent low oil prices (granting low margins) and supply cuts from OPEC-led countries (bolstering the supply of light crude which is preferable for Europe’s refineries), prevented the decline this year from being more significant. In Japan, on the back of merger deals between four of the five key players, refinery consolidation led to platinum returning to the market.

GLOBAL PLATINUM & PALLADIUM PETROLEUM DEMAND



Source: GFMS, Thomson Reuters





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APPENDIX 1 - PLATINUM SUPPLY AND DEMAND 2009-2018

(000 ounces)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018f
Mine production										
South Africa	4,603	4,750	4,740	4,182	4,368	3,220	4,522	4,283	4,252	4,140
Russia	793	785	818	803	741	687	721	678	708	686
Canada	170	127	270	220	217	278	242	268	232	215
United States	123	111	119	118	120	119	122	129	131	140
Zimbabwe	229	286	341	335	409	398	398	484	470	465
Other regions	129	124	116	137	156	142	131	126	127	126
Total Mine Production	6,048	6,183	6,404	5,796	6,011	4,844	6,137	5,966	5,922	5,773
Autocatalyst scrap										
North America	393	449	475	413	463	424	433	452	458	471
Europe	259	299	347	313	375	434	381	389	424	432
Japan	56	62	55	58	60	66	60	69	67	69
China	10	13	17	23	30	36	43	54	66	77
Other regions	69	80	102	120	122	133	148	162	172	181
Total Autocatalyst Scrap	786	904	996	927	1,050	1,093	1,065	1,126	1,187	1,230
Old jewellery scrap										
North America	33	12	10	9	10	9	6	6	6	6
Europe	12	10	8	8	7	7	7	7	6	7
Japan	273	281	344	257	235	245	216	198	184	191
China	223	376	412	587	497	467	447	482	461	443
Other regions	1	2	3	3	3	3	3	3	3	3
Total Old Jewellery Scrap	542	681	778	864	752	731	679	695	661	650
SUPPLY	7,377	7,768	8,178	7,587	7,813	6,669	7,881	7,788	7,769	7,653
Autocatalyst demand										
North America	350	390	490	466	495	501	479	431	443	473
Europe	1,283	1,431	1,468	1,273	1,209	1,309	1,412	1,486	1,450	1,397
Japan	339	435	368	389	353	340	330	314	324	310
China	180	214	185	178	225	265	244	275	319	341
Other Regions	386	547	583	655	670	671	692	689	720	746
Total autocatalyst demand	2,539	3,017	3,094	2,960	2,952	3,086	3,157	3,196	3,255	3,268
Jewellery demand										
North America	181	212	218	224	235	243	248	246	244	246
Europe	222	219	214	212	221	217	215	213	201	214
Japan	270	262	283	320	327	318	324	317	315	309
China	1,953	1,529	1,620	1,746	1,852	1,759	1,662	1,396	1,284	1,194
Other regions	52	69	85	93	109	125	148	145	160	174
Total jewellery demand	2,678	2,291	2,420	2,595	2,744	2,662	2,597	2,318	2,204	2,136
Chemical demand										
North America	59	95	78	65	74	77	60	80	74	77
Europe	54	81	91	79	80	98	72	108	85	91
Japan	28	50	31	22	24	45	36	40	42	38
China	39	80	95	102	120	154	143	173	186	213
Other regions	101	176	191	131	136	213	128	185	187	191
Total chemical demand	283	482	487	398	435	587	439	588	573	610

APPENDIX 1 - PLATINUM SUPPLY AND DEMAND 2009-2018

(000 ounces)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018f
Electronics demand										
North America	39	34	27	15	11	7	7	6	6	5
Europe	13	9	4	4	4	3	3	3	2	2
Japan	35	35	30	25	22	21	19	18	20	20
China	33	37	36	34	31	30	27	26	30	31
Other regions	158	167	160	149	134	134	127	124	139	146
Total electronics demand	278	283	256	227	202	195	183	178	197	204
Glass demand										
North America	7	(7)	12	18	(1)	4	7	17	40	36
Europe	(16)	15	9	13	11	3	34	15	15	19
Japan	31	142	108	98	(92)	(116)	(34)	2	15	22
China	(71)	157	56	143	121	1	85	177	143	199
Other regions	141	198	154	89	(16)	37	98	63	120	161
Total glass demand	91	505	338	361	22	(71)	189	274	333	436
Petroleum demand										
North America	56	30	28	41	52	33	37	57	68	48
Europe	40	35	16	15	4	23	55	27	24	19
Japan	9	21	8	8	(12)	7	(21)	4	(7)	(3)
China	4	7	7	11	15	7	3	7	27	31
Other regions	54	75	84	51	47	52	23	41	60	85
Total petroleum demand	163	168	144	126	107	122	96	135	172	180
Retail investment										
North America	131	40	53	87	55	50	55	86	63	66
Europe	38	10	17	13	10	8	7	43	41	35
Japan	142	37	206	148	37	55	498	402	182	171
Other regions	3	8	36	34	34	28	23	19	17	20
Total retail investment	313	95	312	282	136	141	582	550	303	292
Other industrial demand										
North America	162	175	200	237	248	272	274	303	306	305
Europe	152	165	183	202	208	222	190	196	206	212
Japan	44	56	60	71	73	79	79	83	97	100
China	30	43	50	52	60	68	82	101	108	116
Other regions	42	56	65	59	59	59	56	60	69	75
Total other industrial demand	431	494	559	621	649	700	681	742	784	808
DEMAND	6,776	7,335	7,610	7,571	7,247	7,423	7,924	7,981	7,822	7,934
Physical Surplus/(Deficit)	601	434	568	16	566	(754)	(42)	(193)	(53)	(281)
Identifiable stock movements										
Industry Stocks	665	0	(100)	(300)	(1,000)	1,300	(50)	50	0	0
ETF release/(build)	(384)	(579)	(156)	(238)	(891)	(221)	192	(15)	15	(100)
Sub Total - Stock Movements	281	(579)	(256)	(538)	(1,891)	1,079	142	35	15	(100)
Net Balance	882	(146)	312	(522)	(1,325)	325	99	(158)	(38)	(381)

APPENDIX 2 - PALLADIUM SUPPLY AND DEMAND 2009-2018

(000 ounces)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018f
Mine production										
South Africa	2,481	2,646	2,686	2,391	2,432	2,008	2,653	2,467	2,529	2,417
Russia	2,677	2,722	2,704	2,624	2,527	2,582	2,575	2,526	2,728	2,680
Canada	281	352	560	557	530	578	519	512	468	508
United States	407	374	399	396	404	401	406	420	428	458
Zimbabwe	177	222	261	256	314	325	323	388	386	381
Others regions	299	296	251	272	261	243	238	227	202	208
Total mine production	6,321	6,612	6,861	6,497	6,468	6,136	6,713	6,540	6,741	6,653
Autocatalyst scrap										
North America	705	831	961	922	992	1,126	1,054	1,109	1,203	1,218
Europe	241	306	358	317	334	393	363	409	477	503
Japan	70	83	78	83	100	106	102	128	126	128
China	15	23	33	47	62	79	98	134	164	205
Other Regions	46	64	84	104	99	122	147	176	191	210
Total autocatalyst scrap	1,077	1,307	1,514	1,472	1,587	1,826	1,763	1,956	2,160	2,265
Old jewellery scrap										
North America	3	1	2	3	4	4	3	3	3	4
Europe	9	10	12	12	11	9	9	10	10	11
Japan	25	32	39	29	28	30	27	23	24	27
China	171	165	136	153	133	67	36	23	3	3
Other regions	9	7	7	7	7	8	7	6	6	7
Total old jewellery scrap	217	215	194	203	182	118	82	65	47	52
SUPPLY	7,615	8,134	8,569	8,172	8,238	8,080	8,558	8,561	8,948	8,969
Autocatalyst demand										
North America	887	1,244	1,387	1,581	1,640	1,645	1,750	1,902	1,936	1,987
Europe	1,057	1,395	1,599	1,558	1,539	1,640	1,780	1,828	1,837	1,816
Japan	700	845	769	929	904	927	863	855	887	838
China	782	1,032	1,093	1,230	1,402	1,536	1,663	1,954	2,043	2,153
Other Regions	607	808	820	861	876	997	1,002	1,074	1,177	1,297
Total autocatalyst demand	4,032	5,324	5,667	6,159	6,361	6,745	7,057	7,613	7,880	8,090
Jewellery demand										
North America	135	115	85	78	75	65	55	52	50	45
Europe	128	138	146	148	149	150	151	150	145	147
Japan	48	48	47	52	54	52	47	44	42	42
China	663	412	341	269	204	172	28	4	3	2
Other regions	135	85	55	48	42	40	43	43	44	44
Total jewellery demand	1,110	797	674	595	525	478	324	293	285	280
Dental demand										
North America	190	188	178	170	163	148	135	127	119	114
Europe	91	97	91	83	72	63	59	56	53	50
Japan	305	289	283	278	263	253	244	234	227	222
China	3	2	2	2	2	2	2	1	1	1
Other regions	13	14	13	13	11	10	9	8	8	7
Total dental demand	602	590	567	546	511	475	449	426	408	394

APPENDIX 2 - PALLADIUM SUPPLY AND DEMAND 2009-2018

(000 ounces)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018f
Chemical demand										
North America	43	53	54	54	55	55	55	68	69	65
Europe	160	161	165	161	158	152	157	183	177	170
Japan	19	21	21	21	22	21	20	22	22	22
China	31	44	66	78	101	76	54	90	131	146
Other regions	53	90	80	64	74	82	87	96	107	95
Total chemical demand	306	369	385	379	409	385	374	459	506	498
Electronics demand										
North America	262	290	275	273	238	233	208	197	187	179
Europe	171	189	187	186	170	166	139	122	116	111
Japan	288	324	315	318	284	277	248	225	214	204
China	151	185	189	206	227	222	198	197	187	179
Other regions	267	272	284	259	215	211	198	197	187	179
Total electronic demand	1,140	1,260	1,250	1,242	1,134	1,109	991	938	892	852
Retail investment										
North America	140	68	47	27	30	35	34	33	39	43
Europe	30	12	14	10	8	6	5	6	6	8
Other regions	0	0	0	0	0	5	6	6	8	9
Total retail investment	170	80	61	37	38	45	45	45	53	59
Other industrial demand including petroleum										
North America	48	65	71	74	78	77	77	73	81	74
Europe	14	17	17	15	14	15	15	16	17	17
Japan	8	8	7	7	7	6	7	7	5	5
China	2	2	2	1	3	3	3	7	3	3
Other Regions	0	0	0	0	1	1	1	1	1	1
Total other industrial demand	71	91	99	98	101	102	102	99	107	100
DEMAND	7,444	8,521	8,707	9,068	9,089	9,354	9,355	9,887	10,148	10,297
Physical Surplus/(Deficit)	171	(388)	(138)	(896)	(850)	(1,273)	(797)	(1,326)	(1,201)	(1,327)
Identifiable stock movements										
Russian	1,100	800	800	400	200	0	0	100	200	0
Stillwater	0	0	0	0	0	0	0	0	0	0
Industry Stocks	0	0	(50)	(100)	(500)	600	(150)	140	(290)	(160)
ETF release/(build)	(507)	(1,090)	532	(448)	0	(899)	727	637	384	350
Sub Total - Stock Movements	593	(290)	1,282	(148)	(300)	(299)	577	877	294	190
Net Balance	765	(677)	1,143	(1,044)	(1,150)	(1,572)	(220)	(449)	(907)	(1,137)

APPENDIX 3 - PLATINUM SUPPLY AND DEMAND 2009-2018

(tonnes)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Mine production										
South Africa	143.2	147.7	147.4	130.1	135.9	100.2	140.7	133.2	132.3	128.8
Russia	24.7	24.4	25.4	25.0	23.0	21.4	22.4	21.1	22.0	21.3
Canada	5.3	4.0	8.4	6.9	6.8	8.7	7.5	8.3	7.2	6.7
United States	3.8	3.5	3.7	3.7	3.7	3.7	3.8	4.0	4.1	4.4
Zimbabwe	7.1	8.9	10.6	10.4	12.7	12.4	12.4	15.0	14.6	14.5
Other regions	4.0	3.9	3.6	4.3	4.9	4.4	4.1	3.9	4.0	3.9
Total mine production	188.1	192.3	199.2	180.3	187.0	150.7	190.9	185.6	184.2	179.6
Autocatalyst scrap										
North America	12.2	14.0	14.8	12.8	14.4	13.2	13.5	14.0	14.2	14.7
Europe	8.0	9.3	10.8	9.7	11.7	13.5	11.9	12.1	13.2	13.4
Japan	1.8	1.9	1.7	1.8	1.9	2.1	1.9	2.2	2.1	2.1
China	0.3	0.4	0.5	0.7	0.9	1.1	1.3	1.7	2.0	2.4
Other regions	2.1	2.5	3.2	3.7	3.8	4.1	4.6	5.0	5.3	5.6
Total autocatalyst scrap	24.5	28.1	31.0	28.8	32.7	34.0	33.1	35.0	36.9	38.3
Old jewellery scrap										
North America	1.0	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2
Europe	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2
Japan	8.5	8.7	10.7	8.0	7.3	7.6	6.7	6.2	5.7	5.9
China	6.9	11.7	12.8	18.3	15.5	14.5	13.9	15.0	14.3	13.8
Other regions	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total old jewellery scrap	16.9	21.2	24.2	26.9	23.4	22.8	21.1	21.6	20.5	20.2
SUPPLY	229.4	241.6	254.4	236.0	243.0	207.4	245.1	242.2	241.6	238.0
Autocatalyst demand										
North America	10.9	12.1	15.2	14.5	15.4	15.6	14.9	13.4	13.8	14.7
Europe	39.9	44.5	45.7	39.6	37.6	40.7	43.9	46.2	45.1	43.5
Japan	10.6	13.5	11.4	12.1	11.0	10.6	10.3	9.8	10.1	9.6
China	5.6	6.7	5.8	5.5	7.0	8.3	7.6	8.6	9.9	10.6
Other regions	12.0	17.0	18.1	20.4	20.8	20.9	21.5	21.4	22.4	23.2
Total autocatalyst demand	79.0	93.8	96.2	92.1	91.8	96.0	98.2	99.4	101.2	101.6
Jewellery demand										
North America	5.6	6.6	6.8	7.0	7.3	7.6	7.7	7.7	7.6	7.6
Europe	6.9	6.8	6.7	6.6	6.9	6.7	6.7	6.6	6.3	6.6
Japan	8.4	8.1	8.8	10.0	10.2	9.9	10.1	9.9	9.8	9.6
China	60.8	47.6	50.4	54.3	57.6	54.7	51.7	43.4	39.9	37.2
Other regions	1.6	2.1	2.6	2.9	3.4	3.9	4.6	4.5	5.0	5.4
Total jewellery demand	83.3	71.2	75.3	80.7	85.4	82.8	80.8	72.1	68.6	66.4
Chemical demand										
North America	1.8	3.0	2.4	2.0	2.3	2.4	1.9	2.5	2.3	2.4
Europe	1.7	2.5	2.8	2.4	2.5	3.1	2.2	3.4	2.6	2.8
Japan	0.9	1.5	1.0	0.7	0.8	1.4	1.1	1.3	1.3	1.2
China	1.2	2.5	3.0	3.2	3.7	4.8	4.4	5.4	5.8	6.6
Other regions	3.1	5.5	6.0	4.1	4.2	6.6	4.0	5.8	5.8	5.9
Total chemical demand	8.8	15.0	15.1	12.4	13.5	18.3	13.6	18.3	17.8	19.0

APPENDIX 3 - PLATINUM SUPPLY AND DEMAND 2009-2018

(tonnes)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018f
Electronics demand										
North America	1.2	1.1	0.8	0.5	0.4	0.2	0.2	0.2	0.2	0.2
Europe	0.4	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Japan	1.1	1.1	0.9	0.8	0.7	0.6	0.6	0.6	0.6	0.6
China	1.0	1.2	1.1	1.1	1.0	0.9	0.8	0.8	0.9	1.0
Other regions	4.9	5.2	5.0	4.6	4.2	4.2	3.9	3.9	4.3	4.5
Total electronics demand	8.7	8.8	8.0	7.1	6.3	6.1	5.7	5.5	6.1	6.3
Glass demand										
North America	0.2	(0.2)	0.4	0.5	(0.0)	0.1	0.2	0.5	1.2	1.1
Europe	(0.5)	0.5	0.3	0.4	0.3	0.1	1.0	0.5	0.5	0.6
Japan	1.0	4.4	3.4	3.1	(2.9)	(3.6)	(1.1)	0.1	0.5	0.7
China	(2.2)	4.9	1.7	4.5	3.7	0.0	2.6	5.5	4.5	6.2
Other regions	4.4	6.2	4.8	2.8	(0.5)	1.2	3.0	1.9	3.7	5.0
Total glass demand	2.8	15.7	10.5	11.2	0.7	(2.2)	5.9	8.5	10.4	13.6
Petroleum demand										
North America	1.8	0.9	0.9	1.3	1.6	1.0	1.1	1.8	2.1	1.5
Europe	1.2	1.1	0.5	0.5	0.1	0.7	1.7	0.8	0.8	0.6
Japan	0.3	0.6	0.3	0.3	(0.4)	0.2	(0.6)	0.1	(0.2)	(0.1)
China	0.1	0.2	0.2	0.3	0.5	0.2	0.1	0.2	0.8	1.0
Other regions	1.7	2.3	2.6	1.6	1.5	1.6	0.7	1.3	1.9	2.7
Total petroleum demand	5.1	5.2	4.5	3.9	3.3	3.8	3.0	4.2	5.4	5.6
Retail investment										
North America	4.1	1.3	1.6	2.7	1.7	1.6	1.7	2.7	2.0	2.1
Europe	1.2	0.3	0.5	0.4	0.3	0.2	0.2	1.3	1.3	1.1
Japan	4.4	1.1	6.4	4.6	1.2	1.7	15.5	12.5	5.7	5.3
Other regions	0.1	0.2	1.1	1.1	1.1	0.9	0.7	0.6	0.5	0.6
Total retail investment	9.8	3.0	9.7	8.8	4.2	4.4	18.1	17.1	9.4	9.1
Other industrial demand										
North America	5.0	5.4	6.2	7.4	7.7	8.5	8.5	9.4	9.5	9.5
Europe	4.7	5.1	5.7	6.3	6.5	6.9	5.9	6.1	6.4	6.6
Japan	1.4	1.7	1.9	2.2	2.3	2.5	2.4	2.6	3.0	3.1
China	0.9	1.3	1.6	1.6	1.9	2.1	2.5	3.1	3.4	3.6
Other regions	1.3	1.7	2.0	1.8	1.8	1.8	1.7	1.9	2.1	2.3
Total other industrial demand	13.4	15.4	17.4	19.3	20.2	21.8	21.2	23.1	24.4	25.1
DEMAND	210.7	228.1	236.7	235.5	225.4	230.9	246.5	248.2	243.3	246.8
Physical Surplus/(Deficit)	18.7	13.5	17.7	0.5	17.6	(23.4)	(1.3)	(6.0)	(1.6)	(8.7)
Identifiable stock movements										
Industry Stocks	20.7	0.0	(3.1)	(9.3)	(31.1)	40.4	(1.6)	1.6	0.0	0.0
ETF release/(build)	(11.9)	(18.0)	(4.8)	(7.4)	(27.7)	(6.9)	6.0	(0.5)	0.5	(3.1)
Sub Total - Stock Movements	8.7	(18.0)	(8.0)	(16.7)	(58.8)	33.6	4.4	1.1	0.5	(3.1)
Net Balance	27.4	(4.5)	9.7	(16.2)	(41.2)	10.1	3.1	(4.9)	(1.2)	(11.8)

APPENDIX 4 - PALLADIUM SUPPLY AND DEMAND 2009-2018

(tonnes)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018f
Mine production										
South Africa	77.2	82.3	83.5	74.4	75.6	62.5	82.5	76.7	78.6	75.2
Russia	83.3	84.7	84.1	81.6	78.6	80.3	80.1	78.6	84.9	83.4
Canada	8.7	11.0	17.4	17.3	16.5	18.0	16.1	15.9	14.5	15.8
United States	12.7	11.6	12.4	12.3	12.6	12.5	12.6	13.1	13.3	14.3
Zimbabwe	5.5	6.9	8.1	8.0	9.8	10.1	10.0	12.1	12.0	11.9
Other regions	9.3	9.2	7.8	8.4	8.1	7.6	7.4	7.1	6.3	6.5
Total mine production	196.6	205.6	213.4	202.1	201.2	190.9	208.8	203.4	209.7	206.9
Autocatalyst scrap										
North America	21.9	25.9	29.9	28.7	30.9	35.0	32.8	34.5	37.4	37.9
Europe	7.5	9.5	11.1	9.8	10.4	12.2	11.3	12.7	14.8	15.7
Japan	2.2	2.6	2.4	2.6	3.1	3.3	3.2	4.0	3.9	4.0
China	0.5	0.7	1.0	1.5	1.9	2.5	3.0	4.2	5.1	6.4
Other regions	1.4	2.0	2.6	3.2	3.1	3.8	4.6	5.5	5.9	6.5
Total autocatalyst scrap	33.5	40.7	47.1	45.8	49.4	56.8	54.8	60.8	67.2	70.4
Old jewellery scrap										
North America	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Europe	0.3	0.3	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3
Japan	0.8	1.0	1.2	0.9	0.9	0.9	0.9	0.7	0.8	0.8
China	5.3	5.1	4.2	4.7	4.1	2.1	1.1	0.7	0.1	0.1
Other regions	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total old jewellery scrap	6.7	6.7	6.0	6.3	5.7	3.7	2.5	2.0	1.5	1.6
SUPPLY	236.9	253.0	266.5	254.2	256.2	251.3	266.2	266.3	278.3	279.0
Autocatalyst demand										
North America	27.6	38.7	43.1	49.2	51.0	51.2	54.4	59.2	60.2	61.8
Europe	32.9	43.4	49.7	48.5	47.9	51.0	55.4	56.9	57.1	56.5
Japan	21.8	26.3	23.9	28.9	28.1	28.8	26.8	26.6	27.6	26.1
China	24.3	32.1	34.0	38.2	43.6	47.8	51.7	60.8	63.6	67.0
Other regions	18.9	25.1	25.5	26.8	27.2	31.0	31.2	33.4	36.6	40.3
Total autocatalyst demand	125.4	165.6	176.3	191.6	197.8	209.8	219.5	236.8	245.1	251.6
Jewellery demand										
North America	4.2	3.6	2.6	2.4	2.3	2.0	1.7	1.6	1.6	1.4
Europe	4.0	4.3	4.5	4.6	4.6	4.7	4.7	4.7	4.5	4.6
Japan	1.5	1.5	1.5	1.6	1.7	1.6	1.5	1.4	1.3	1.3
China	20.6	12.8	10.6	8.4	6.4	5.3	0.9	0.1	0.1	0.1
Other regions	4.2	2.6	1.7	1.5	1.3	1.2	1.3	1.3	1.4	1.4
Total jewellery demand	34.5	24.8	20.9	18.5	16.3	14.9	10.1	9.1	8.9	8.7
Dental demand										
North America	5.9	5.9	5.5	5.3	5.1	4.6	4.2	3.9	3.7	3.5
Europe	2.8	3.0	2.8	2.6	2.2	2.0	1.8	1.7	1.6	1.5
Japan	9.5	9.0	8.8	8.6	8.2	7.9	7.6	7.3	7.1	6.9
China	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
Other regions	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.2	0.2
Total dental demand	18.7	18.4	17.6	17.0	15.9	14.8	14.0	13.3	12.7	12.3

APPENDIX 4 - PALLADIUM SUPPLY AND DEMAND 2009-2018

(tonnes)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018f
Chemical demand										
North America	1.3	1.6	1.7	1.7	1.7	1.7	1.7	2.1	2.2	2.0
Europe	5.0	5.0	5.1	5.0	4.9	4.7	4.9	5.7	5.5	5.3
Japan	0.6	0.7	0.6	0.7	0.7	0.6	0.6	0.7	0.7	0.7
China	1.0	1.4	2.1	2.4	3.1	2.4	1.7	2.8	4.1	4.5
Other regions	1.7	2.8	2.5	2.0	2.3	2.5	2.7	3.0	3.3	3.0
Total chemical demand	9.5	11.5	12.0	11.8	12.7	12.0	11.6	14.3	15.8	15.5
Electronics demand										
North America	8.2	9.0	8.6	8.5	7.4	7.2	6.5	6.1	5.8	5.6
Europe	5.3	5.9	5.8	5.8	5.3	5.2	4.3	3.8	3.6	3.4
Japan	9.0	10.1	9.8	9.9	8.8	8.6	7.7	7.0	6.7	6.4
China	4.7	5.8	5.9	6.4	7.1	6.9	6.2	6.1	5.8	5.6
Other regions	8.3	8.5	8.8	8.1	6.7	6.6	6.2	6.1	5.8	5.6
Total electronics demand	35.5	39.2	38.9	38.6	35.3	34.5	30.8	29.2	27.7	26.5
Retail investment										
North America	4.4	2.1	1.5	0.8	0.9	1.1	1.1	1.0	1.2	1.3
Europe	0.9	0.4	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.2
Other Regions	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.3
Total retail investment	5.3	2.5	1.9	1.2	1.2	1.4	1.4	1.4	1.7	1.8
Other industrial demand (including petroleum)										
North America	1.5	2.0	2.2	2.3	2.4	2.4	2.4	2.3	2.5	2.3
Europe	0.4	0.5	0.5	0.5	0.4	0.5	0.5	0.5	0.5	0.5
Japan	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
China	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.2	0.1	0.1
Other regions	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total other industrial demand	2.2	2.8	3.1	3.1	3.1	3.2	3.2	3.1	3.3	3.1
DEMAND	231.5	265.0	270.8	282.0	282.7	290.9	291.0	307.5	315.7	320.3
Physical Surplus/(Deficit)	5.3	(12.1)	(4.3)	(27.9)	(26.4)	(39.6)	(24.8)	(41.2)	(37.3)	(41.3)
Identifiable stock movements										
Russia	34.2	24.9	24.9	12.4	6.2	0.0	0.0	3.1	6.2	0.0
Stillwater	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Industry Stocks	0.0	0.0	(1.6)	(3.1)	(15.6)	18.7	(4.7)	4.4	(9.0)	(5.0)
ETF release/(build)	(15.8)	(33.9)	16.5	(13.9)	0.0	(28.0)	22.6	19.8	11.9	10.9
Sub Total - Stock Movements	18.5	(9.0)	39.9	(4.6)	(9.3)	(9.3)	17.9	27.3	9.1	5.9
Net Balance	23.8	(21.1)	35.6	(32.5)	(35.8)	(48.9)	(6.8)	(14.0)	(28.2)	(35.4)

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