SFA Oxford

THE PLATINUM STANDARD

May 2015

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May 2015

Edition 03

CONTENTS

FOREWORD

Due south or north?

"Things are not so rosy as they might be..."
Robert Falcon Scott, December 1911

Unlike Captain Scott, SFA has never been known to understate adversity, especially where platinum is concerned. So, if all seemed to point 'due south' for the platinum price, SFA would not hesitate to flag hostile terrain ahead. However, as with previous issues of *The Platinum Standard*, we have checked our bearings with outside experts, and we have discovered that the platinum needle may actually be shifting. Or, to complete Scott's thought, "...we keep our spirits up and say the luck must turn".

To help map the way forward, we are delighted to introduce **'The Platinum Investment Compass'** by SFA's Ralph Grimble. This new, 'hand-held' device is designed to measure platinum's value to investors. So, what is the appeal to investors of platinum's fundamentals, its 'paper' opportunities, its ETFs, and its value relative to recent history and to competing (gold, equities) investments? At the end of Q1'15 the Compass was signalling outstanding value in platinum investment.

Jewellery's journey is charted by PGI's Nicholas Graham Smith. 'Secular stagnation' may be the fashionable pessimism for the world economy, but platinum jewellery markets are in no such rut. Established markets in the West are deepening and widening, and PGI, among others, is exploring new frontiers, especially in the hinterlands of China and India. True, one platinum:gold price ratio does not fit (growth in) all (market segments and regions). But who said marketing was easy?

Diesel's apparent metamorphosis from platinum 'darling' to 'demon' is recorded by Greg Archer of Gaian Ltd. At 42% of gross demand and as the engine of demand growth in the early 2000s, platinum use in diesel vehicles is important. Disparity between laboratory tests and real-world driving performance, in particular much higher NO_x emissions than regulators bargained for, has led to something of an 'urban revolt'. The costs of bridging these gaps will mean more expensive diesel cars. However, as Al Bedwell of LMC Automotive infers, there are grounds for believing platinum is through the worst of the diesel storm. Indeed, reports of the death of diesel are exaggerated, and may even be an urban myth.

As for **the platinum market** itself, 2014 was tough sledding. Supply restraint of the most unwelcome kind – mine strikes – was offset by increased recycling, more destocking and lower demand, especially investment. All change, we forecast, for 2015, with supply and demand expanding. Mines may more than recover last year's losses, recycling will accelerate, and the two together are likely to outweigh an expected demand bounce. Against a closely balanced market, the price will do well to make much headway above $1,200/oz. And we think, as Scott put it (on finding Amundsen had beaten him to the South Pole), it is wise now to say "good-bye to most of the day-dreams". The era of 100% premia of platinum over gold is gone. *Terra Nova* may well be platinum:gold parity, and this will test the resilience of all sides of the platinum market. Like Scott, we believe, "Fortune would be in a hard mood indeed if it allowed such a combination of knowledge, experience, ability, and enthusiasm to achieve nothing".

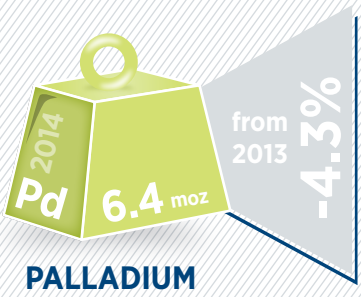
Yours sincerely, The SFA (Oxford) team

THE PGM MARKETS IN 2014

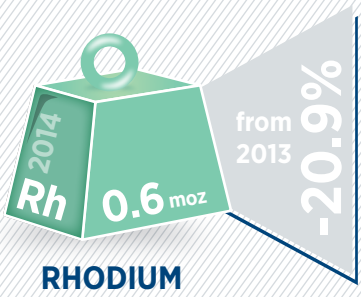
THE **PGM** MARKETS

TOTAL **PRIMARY SUPPLY**

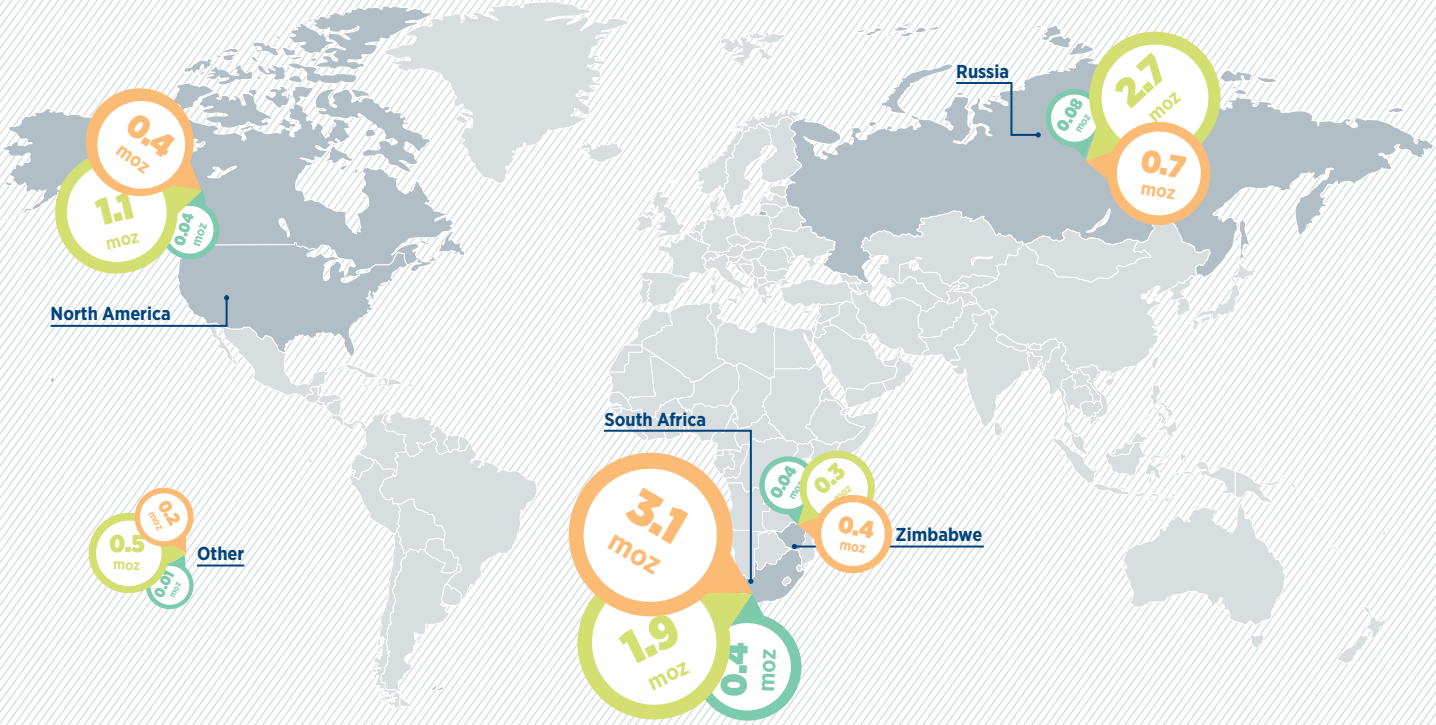
PLATINUM



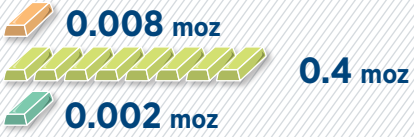
PALLADIUM

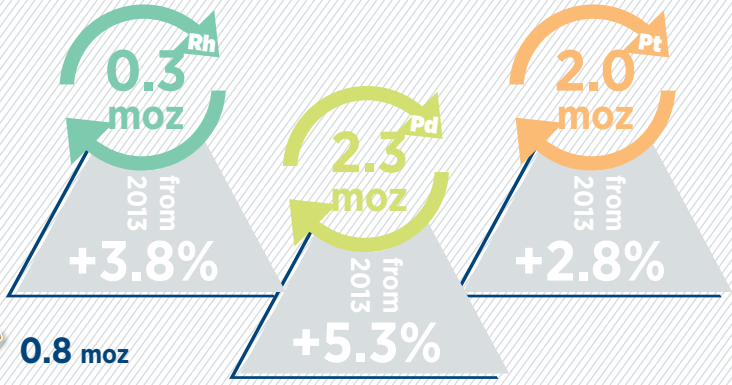


RHODIUM



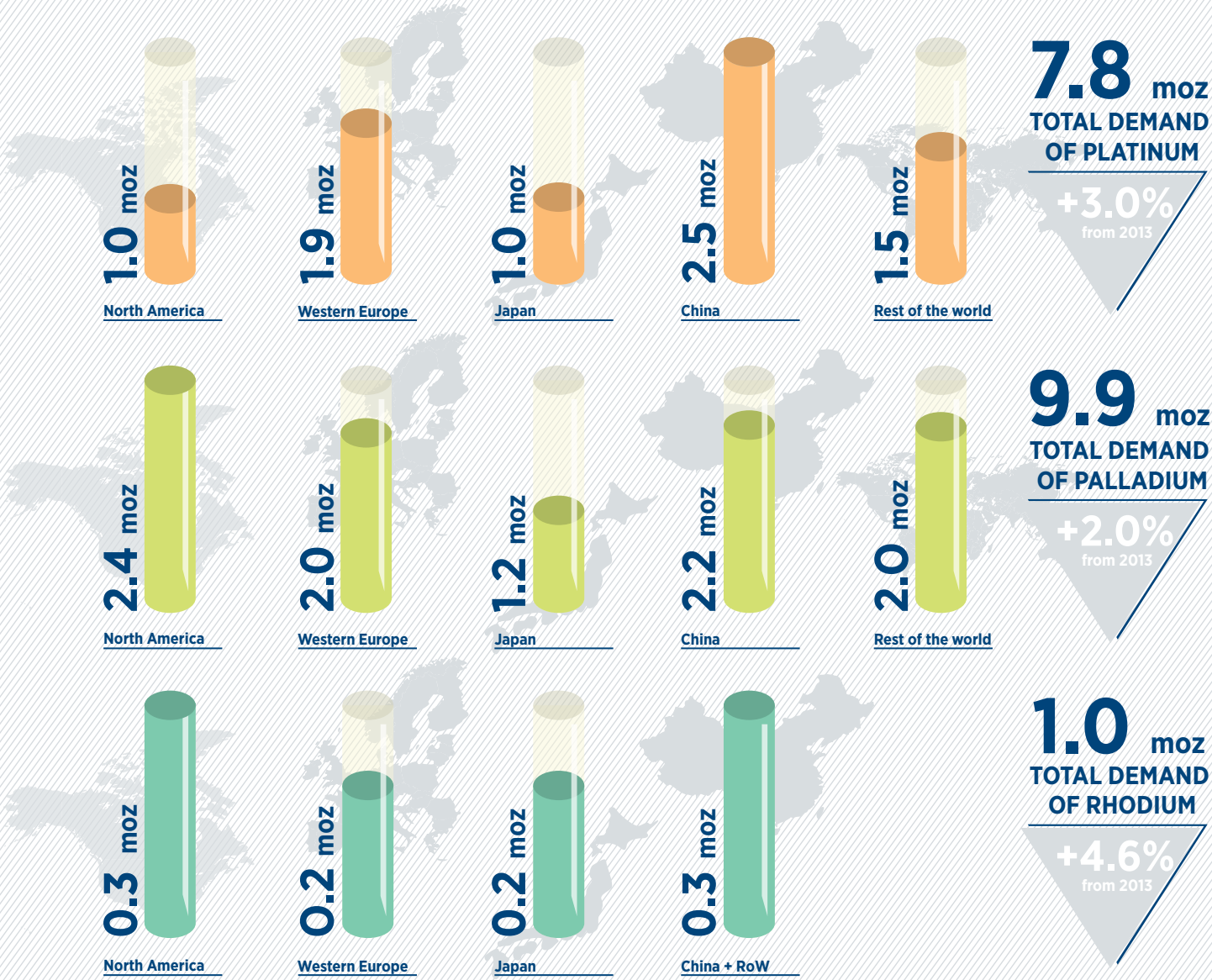
TOTAL **RECYCLING SUPPLY**



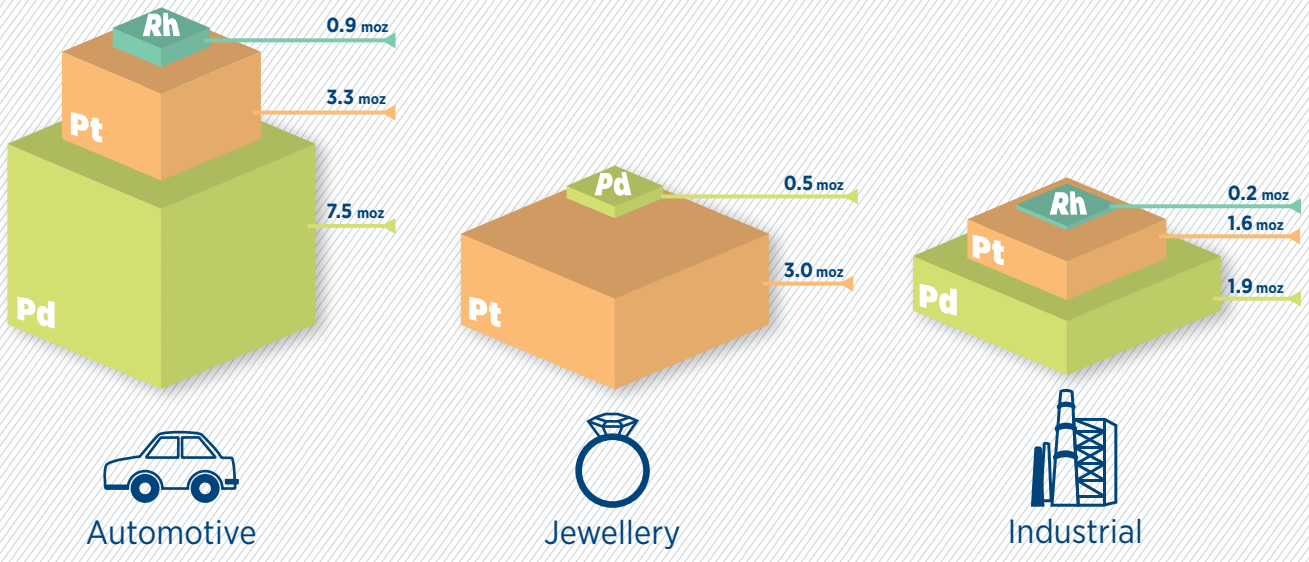


2014

REGIONAL **GROSS DEMAND**



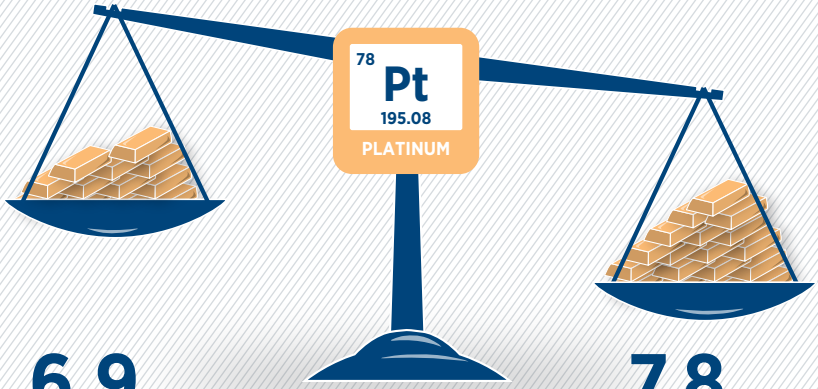
SECTOR **GROSS DEMAND**



2014

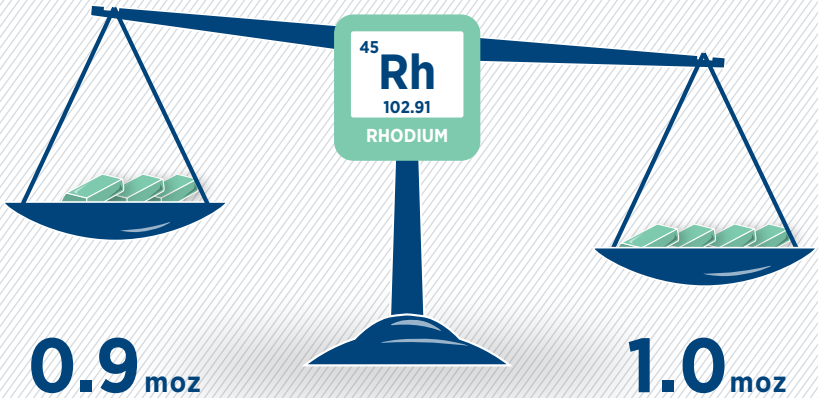
SFA Oxford

GROSS SUPPLY — GROSS DEMAND

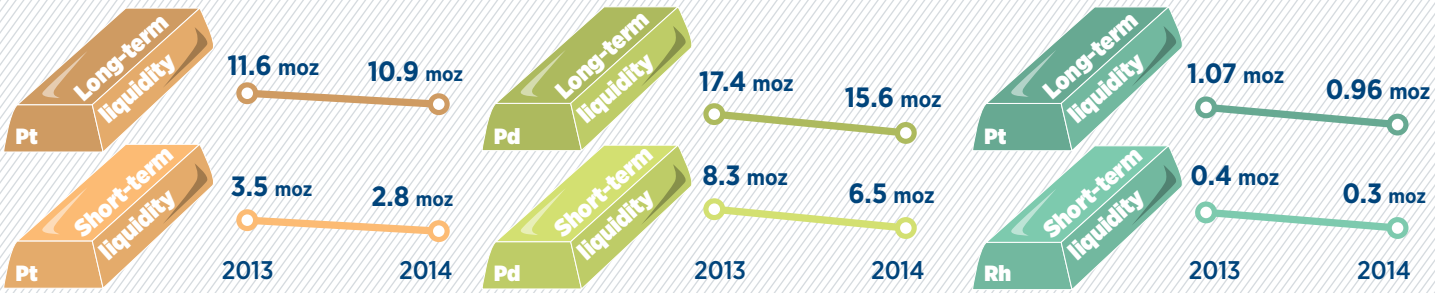


6.9 moz — 7.8 moz

8.7 moz — 9.9 moz



0.9 moz — 1.0 moz



The PGM markets in 2014

Beresford Clarke, Managing Director & Head of Research, SFA (Oxford)

The platinum market

This is the story of platinum in 2014, a story split into two separate novellas: the first on the internal struggle, industrial action and lost production in South Africa; the second on lacklustre prices and an industry obsession with above-ground stock availability.

Mine supply

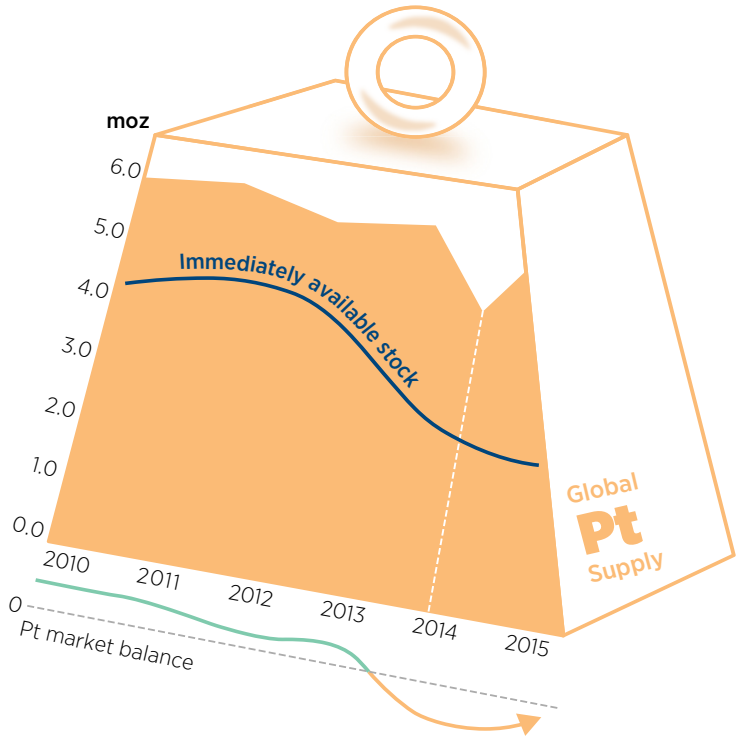
South African output falls more than a quarter

Strike-hit South Africa struggled in 2014, losing more than a quarter (1,240 koz) of its annual yield. Russia and Zimbabwe remained unchanged in their overall output, contributing 740 koz and 405 koz respectively to the global balance.

Outperforming all, however, was North America. Here production increased by 13% to 400 koz, but was partly bolstered by work-in-progress inventory processing.

The resultant calculation showed an industry in a deficit of some 885 koz of platinum on a fundamental basis (excluding producer sales and investment holdings).

Supply, liquid stocks and market balance



Source: SFA (Oxford)

Recycling

Total recycling increased by just 3% in 2014 to 2,040 koz, as a drop in jewellery returns largely offset growth in scrapped autocatalysts.

Rise in autocatalyst recycling is largely offset by lower jewellery returns

Autocatalyst recycling of platinum continues to grow, providing some offset to the loss of primary supply. Diesels were the principal cause, demand for diesel cars in Europe rising from around 30% of annual sales in 1999 to upwards of 50% in 2005, triggering an upsurge in the need for platinum-rich passenger car catalysts. These catalysts are now returning to market via scrapyards as vehicles expire and, as a result, global autocatalyst recycling grew by 12% to 1,255 koz in 2014.

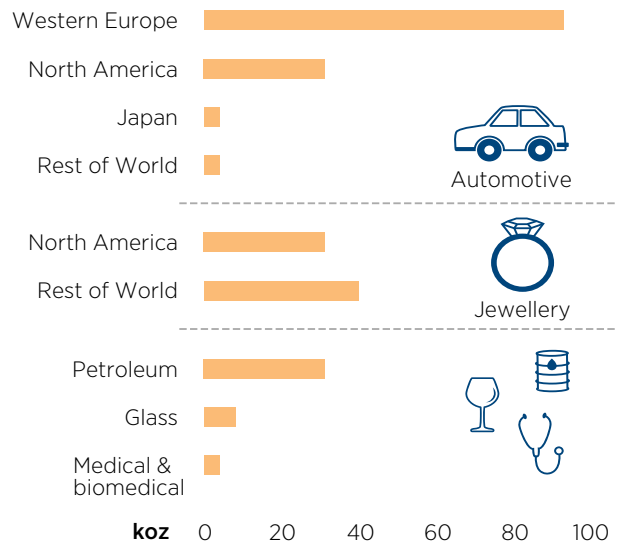
Chinese jewellery fared less well, with Q4 witnessing a fall in platinum jewellery sales, and thus a concurrent decrease in the reprocessing of old, unwanted pieces.

Demand

Upturn in Europe boosts platinum demand

Global demand increased by 2.9% to 7,805 koz last year. Autocatalyst requirements proved encouraging, with growth of 4.0% year-on-year boosted, in particular, by Western Europe where auto production accelerated by 7.1%. Furthermore, for the first time in six years, the region's car sales took an upturn. Germany and Spain made the greatest gains, the latter having been in recovery since 2012 when its auto industry bottomed out at just 2 million units produced.

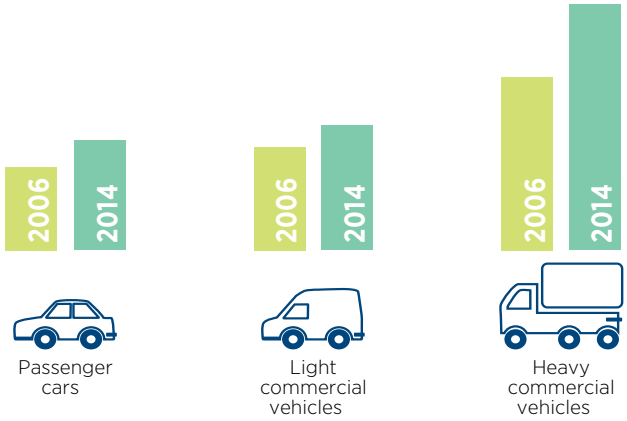
Largest Pt demand changes (2013 vs. 2014)



Source: SFA (Oxford)

It was also a year in which emissions were further legislated against with the introduction of Euro 6 leading to OEMs fitting more complex aftertreatment systems containing, on average, more platinum per car. This will, of course, take time, with emissions curtailment occurring over a number of years. The new regulations initially applying only to new models, with vehicles already in production conforming later.

Diesel autocatalyst loadings



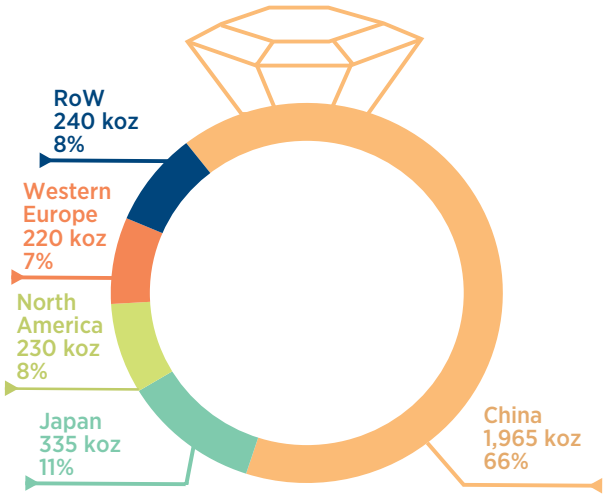
Source: SFA (Oxford)

Jewellery

China, the centrepiece of global jewellery demand, saw levels of luxury sales fall in 2014 while wedding registrations – an important precipitator of demand for platinum rings – were down by 3% year-on-year. Nonetheless, demand for platinum held up relatively well against this background, slipping just 1% year-on-year to 1,965 koz.

Jewellery demand down in China

Jewellery demand, 2014



Source: SFA (Oxford)

Japan's market has remained stable with its jewellery consumers absorbing 335 koz of platinum. This was thanks in large part to the boost to demand ahead of the tax increase on luxury goods in April. Also notable was the gold-platinum price differential which for a time narrowed, promoting higher grade platinum use.

India's demand grew by 35 koz to 175 koz in 2014 as the PGI continued to promote the market for platinum.

Industrial

Recovery in petroleum lifts industrial demand

Industrial demand's estimated increase of 3.6% year-on-year was underwritten by a recovery in petroleum demand (+30 koz), as well as growth in the medical and biomedical sectors (+5 koz) and glass (+10 koz).

Above-ground stocks

Platinum stocks took an acute hit in 2014, with mine strikes and subsequent shutdowns leading to a reduction of stored metal. The combination of the strike in 2014 and strong ETF growth in 2013 has shrunk industry reserves by 1,340 koz since 2012.

Ample stocks limit price appreciation

By year-end, immediately available platinum stocks totalled 2,800 koz, down from 3,470 koz the previous year – a considerable reduction. All-in stocks of platinum were reduced to 10,915 koz, which includes the above, plus metal held by investors and the normal working inventories held by end-users.

Platinum prices ended the year $150/oz lower than at the start at $1,208/oz. The strike in South Africa helped to lift prices to over $1,500/oz by mid-year, but the subsequent return to work, stronger dollar and metal availability hit prices in the second half of the year.

The palladium market

Wider deficit and new ETF products, but metal availability limits price rise

The market deficit for palladium widened to 1,205 koz in 2014 on a fundamental basis, i.e. excluding producer sales and the allocation of metal by investors.

The launch in April of two new ETF products from Absa and Standard Bank in South Africa rapidly accumulated 1.1 moz between them in 2014, with investors playing a strong part in driving prices to over $900/oz by September. However, palladium could not avoid the commodity-wide sell-off as the dollar strengthened, and prices ended the year at $805/oz. Arguably the rally was too early, as stocks were immediately available at an estimated 6,530 koz by the end of 2014.

Refined production from South Africa was down by half-a-million ounces last year. However, higher output elsewhere, such as +110 koz from Russia and +85 koz from Canada, partly offset the loss from the AMCU strike in South Africa. Total production therefore dropped 4.3% to 6,390 koz, a much smaller fall than for platinum or rhodium, though it was enough to increase the deficit to over 1 moz.

Automotive palladium requirements for gasoline autocatalysts continued to grow by a robust 5.3%, as demand from the US, Europe and China rose collectively by 400 koz.

Nonetheless, total demand growth was just 1.9% to 9,865 koz, as stronger autocatalyst demand was partly offset by reductions in other applications, particularly chemical, electrical and dental, which fell collectively by 125 koz. Recycling also grew by 5.3% to 2,270 koz and this limited demand on a net basis to 7,595 koz, a growth of just 1%.

The rhodium market

First drawdown in stock since the financial crisis

The rhodium market shifted to a fundamental deficit of an estimated 160 koz in 2014, the first drawdown in stock since before the financial crisis began. The impact of the AMCU strike reduced refined mine supply by 21% year-on-year to 585 koz and was principally responsible for the deficit last year.

However, the rhodium price fell to an average of $1,170/oz last year, which is around a fifth of what it was in 2007. Collectively the market has been oversupplied by 555 koz since 2008.

Automotive demand for rhodium, which accounts for 85% of total usage, is recovering steadily, assisted by Euro 6 emissions legislation requiring some rhodium-rich lean-NO_x traps. In 2014, automotive requirements increased by 4.8% to 860 koz but this is still 140 koz down on peak 2007 levels, as high and volatile metal prices forced fabricators to reduce or thrift loadings of rhodium per catalyst. Also, during this time autocatalyst recycling has grown from 190 koz to 275 koz, highlighting that net autocatalyst requirements are 225 koz lower than at peak levels.

PRICE OUTLOOK FOR 2015

Platinum: $1,200/oz

Ample stocks

The buzzword for platinum in 2015 is 'recovery', at least as far as production is concerned, with South African mine output again exceeding the 4,000 koz mark. Demand is forecast to grow by a healthy 4.5%, suggesting a prosperous year for platinum.

However, stronger growth in recycling caps some of the net demand growth. Numerous expansions in recycling capacity, weaker non-dollar currencies and the return of more highly loaded catalysts are expected to boost autocatalyst recycling by 10%, leaving net automotive demand growth flat for the year. Fortunately, a pick-up in industrial demand and steady jewellery sales will help to keep the platinum market in slight deficit in 2015. Metal availability will not be a problem, so SFA's average price forecast of $1,200/oz is predicated on a strengthening rand from current levels as forecast by Oxford Economics. If the rand remains above ZAR12/USD then, of course, SFA's price outlook will soften.

Palladium: $790/oz

Deficit narrows

SFA provided its clients with a forecast over a year ago that the platinum-palladium price ratio would drop to 1.5:1. We have reached our target and see limited further upside in the near term while stocks are easily available and lease rates remain low – hence SFA's average price forecast of $790/oz. The market is expected to remain in structural deficit throughout 2015. However, as output from South Africa recovers, recycling expands and demand growth remains steady, the deficit is likely to narrow.

Rhodium: $1,200/oz

Prices remain soft

The rhodium market looks set to remain in the doldrums in 2015 as the drawdown of 160 koz of stock in 2014 still left ample inventory. Based on our current supply-demand forecasts, rhodium prices are estimated to remain relatively soft.

THE PLATINUM INVESTMENT COMPASS

The Platinum Investment Compass

Dr Ralph Grimble, Principal Market Analyst, SFA (Oxford)

The Platinum Investment Compass – pointing out platinum's investment potential

With its price now 40% below its 2011 peak, has platinum finally become a 'value' proposition for investors? Statistical models risk data mining, causing them to lose sight of the 'wood for the trees'. SFA's new 'Platinum Investment Compass' gets to the point – actually four points – much more efficiently.

The Platinum Investment Compass introduces four key metrics that could help to answer the question, "Is platinum cheap (and hence worth investing in)?"

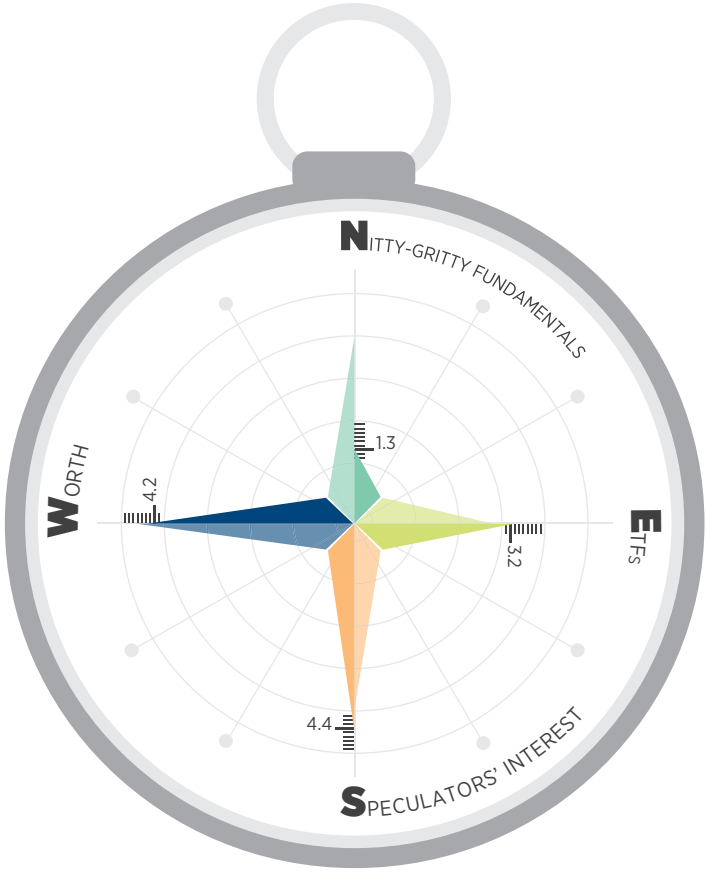
N: 'Nitty-gritty' – the 'fundamentals'. Where is platinum sponge (its industrial form) trading relative to ingot?

S: Speculators' paper positions. How crowded is the platinum trade?

E: Exchange traded funds. How excessive is the long position in the prime form of physical platinum investment, ETFs?

W: Platinum's *'Worth',* relative to its own price history, to gold and to equity prices.

Scores range from 1-5. A higher score implies greater investment potential. The pointers show the value at the end of Q1'15. The lighter shaded areas of the compass needles represent the value at the end of 2014.



Value at the end of Q1'15

Value at the end of 2014

Source: Bloomberg, Mitsubishi commentary, CFTC, SFA (Oxford)

With this simple 'hand-held' device, investors can monitor both the momentum of platinum's 'micro' (its own demand/supply) and the attraction of its 'macro' environment. This is because each pointer is on a common scale of 1 to 5, representing the number of standard deviations that the latest value lies from its four-quarter average. For example:

The Compass highlights fundamental and macro influences on investment

- '1' means the indicator ended the latest quarter at the highest level in the last four quarters, so is pointing to 'overvaluation' or excessive investor interest.

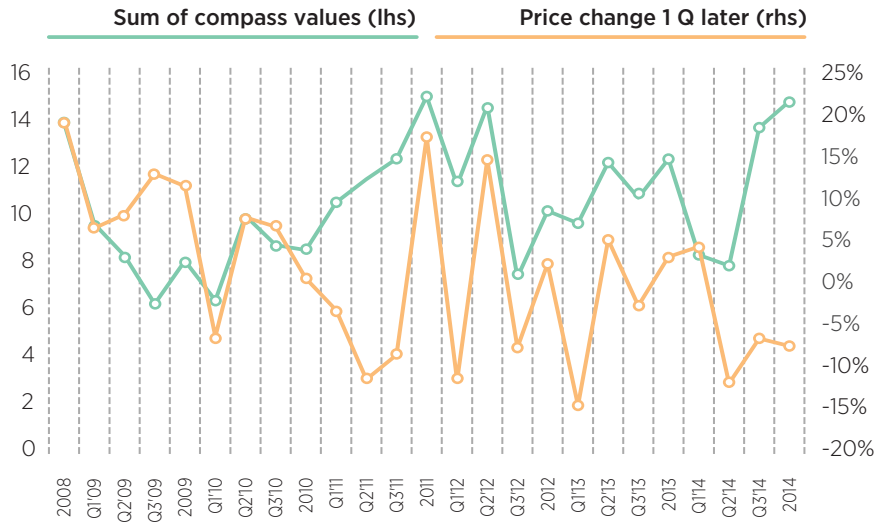
- '5' means the indicator is at its lowest in the last four quarters, pointing to 'undervaluation' and so there is scope for extra investor interest.

By overlaying pointers for the latest quarter over the previous quarter, trends in what is driving investor behaviour can be easily seen. And, of course, an investor can weight each pointer to their own taste or bias. For example, a more fundamentally driven investor might want to rank the 'Nitty-gritty' higher than, say, ETF holdings, whereas a more technically driven investor might be more interested in how 'crowded' platinum is, i.e. the length of existing speculative and physical positions, and how 'cheap' platinum is.

And the 'value' in all this? At the end of the first quarter of 2015, the Compass was pointing on balance to much better than average value in platinum investment. Looking back over the last seven turbulent years, the Compass could have helped point the way for investors.

At the end of Q1'15 the Compass pointed to very good value in platinum

Sum of compass points and platinum price change in the following quarter



Source: Bloomberg, SFA (Oxford)

The four compass points are:

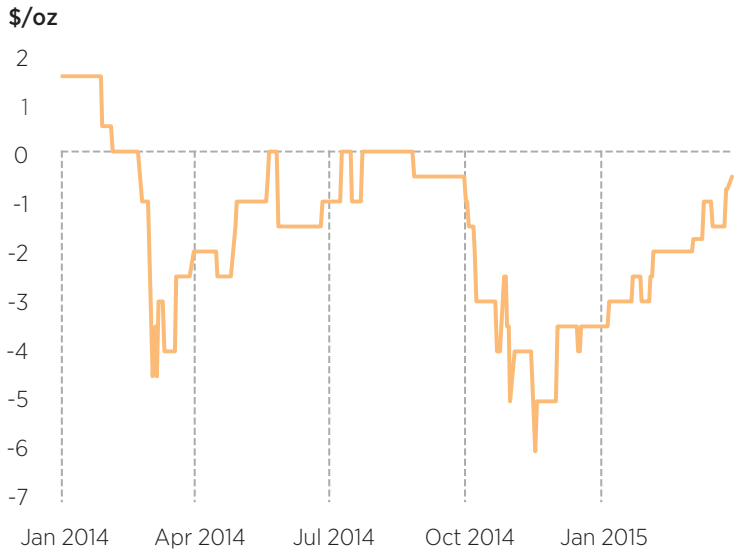
North – Nitty-gritty: our proxy for ´the fundamentals`, the ingot-sponge premium/discount

A value of 5 indicates high relative industrial demand for sponge and low investment demand, so investment is undervalued. A value of 1 indicates high relative investment demand so investors are already in the trade. To be clear, a value of 1 does not necessarily mean that ingot is trading at a premium to sponge, just that it is trading at the highest relative level (lowest discount) seen over the four quarters.

The value of 1.3 calculated for Q1'15 shows that ingot is trading at a high relative valuation compared to sponge, i.e. investment demand has improved relative to industrial demand. The value at the end of 2014 was 3.7 so this indicator has seen the largest swing over the first quarter.

Ingot–sponge discount has narrowed

Ingot–sponge premium/discount

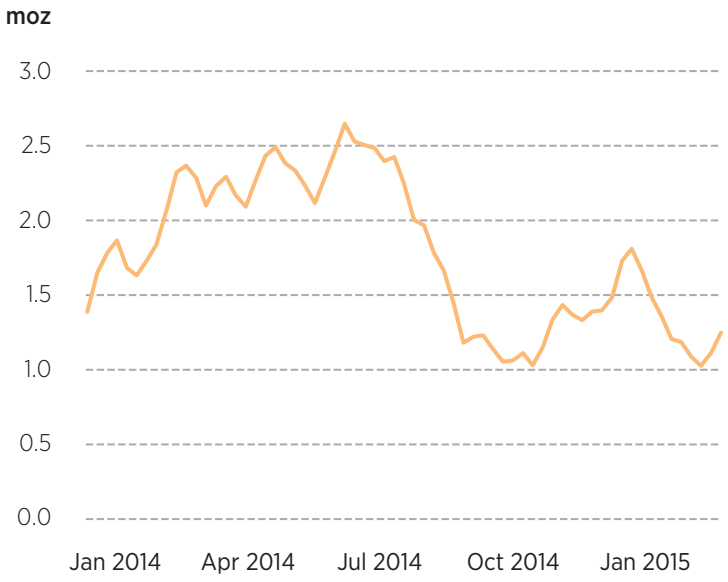


Source: Bloomberg, Mitsubishi commentary, SFA (Oxford)

South – Speculators: how net long are large NYMEX speculators; how crowded is the platinum `play´?

Here a value of 5 indicates that the speculators are at the low point of their net length for the period and hence there is plenty of room for them to increase their positions. A value of 1 indicates that the speculators are at their most net long and suggests limited potential for further positions to be added. The value of 4.4 shows that the large speculators' net long position ended Q1'15 at a low level, although not quite as low as it registered at the end of 2014 when the value was 4.6.

Large speculators' net position



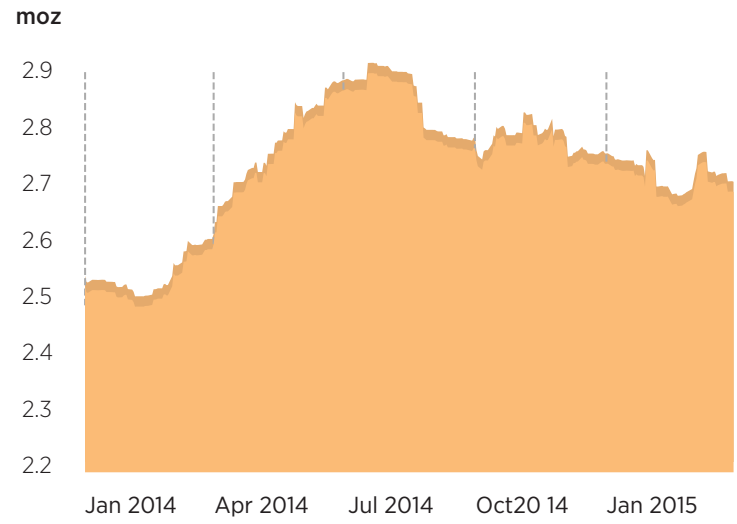
Source: Bloomberg, CFTC, SFA (Oxford)

The speculative platinum trade is far from crowded

East – ETFs: how much is invested in ETFs?

The ETF figure is based on the total ounces held in platinum ETFs globally, with a 5 indicating the level of ETFs is at its lowest relative to the four-quarter mean and therefore suggesting that there is room for ETF holdings to grow. A value of 1 would show that ETF holdings were at their highest level at the end of the four-quarter period.

Global ETF holdings



Source: Bloomberg, CFTC, SFA (Oxford)

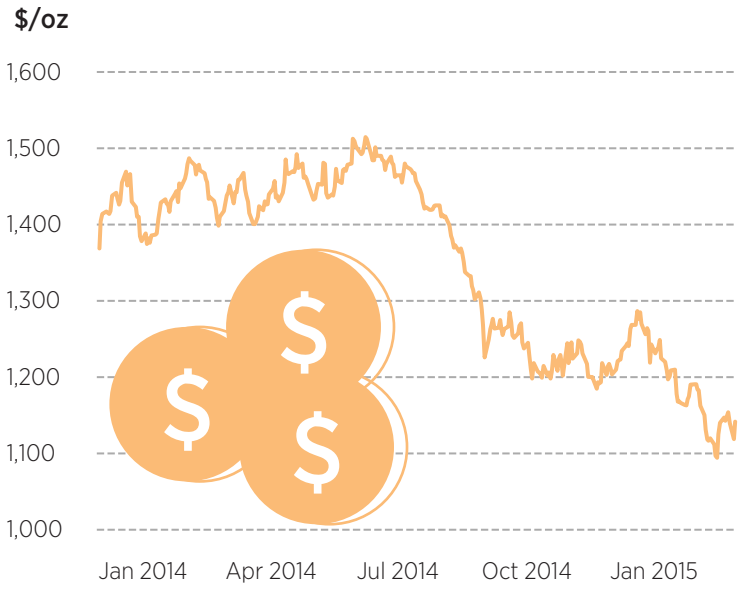
The value of 3.2 indicates that ETF holdings were slightly below average at the end of Q1'15 relative to the four-quarter period. The indicator, and so the scope for ETF buying, has improved from the 2.6 it registered at the end of 2014.

West – Worth: is platinum cheap in its own terms and relative to gold and Wall Street?

This is a composite of the figure calculated for the price, the platinum:gold ratio and the platinum:Dow ratio (50:25:25). A value of 5 would show that the price is low and the platinum:gold and the platinum:Dow ratios are at the lowest level, indicating that platinum is undervalued and therefore potentially presents a good investment opportunity. A value of 1 would indicate that the price is high and the ratios suggest that the platinum price is high relative to gold and stocks.

The composite value of 4.2 shows that all the price indicators rate platinum as relatively undervalued, although not quite as undervalued as indicated by the score of 4.5 at the end of 2014.

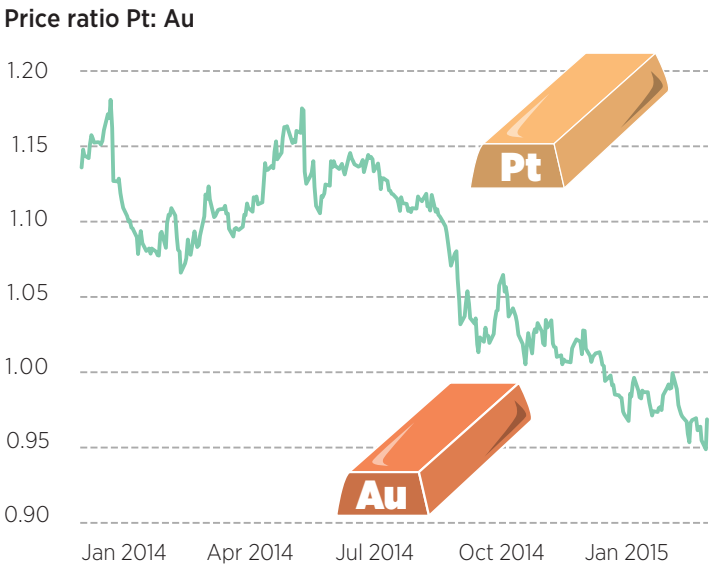
Platinum price



Source: Bloomberg, SFA (Oxford)

Platinum is cheap compared to recent history

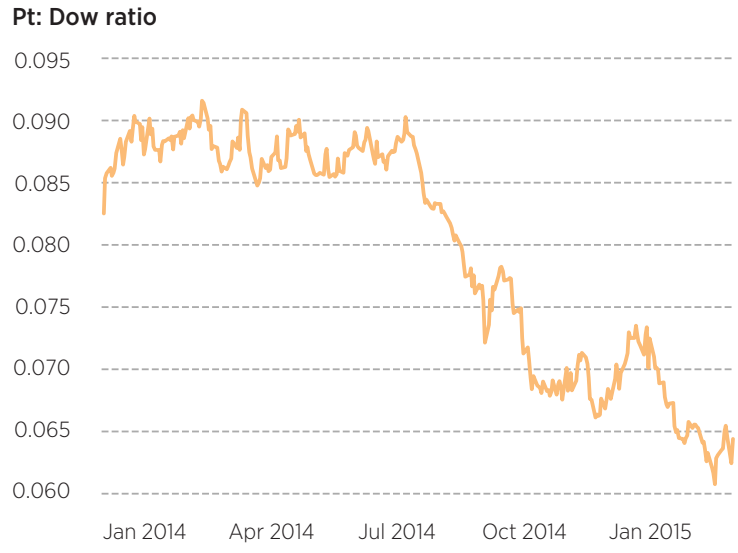
Platinum/gold ratio



Source: Bloomberg, SFA (Oxford)

Platinum is undervalued relative to gold…

Platinum/Dow ratio



Source: Bloomberg, SFA (Oxford)

…and equities

THE GLOBAL JEWELLERY MARKET

The global jewellery market

Nicholas Graham Smith, Chief Operating Officer, Platinum Guild International, London

There is significant potential to increase the size of the platinum jewellery market over the next 5-10 years. Many analysts have identified the growth opportunities in the jewellery category, and the following quote from McKinsey and Co. captures a number of elements. Highlighted are some of the key phrases which describe the potential, the competition for the consumer's pocket, and the need to be adept at marketing and business.

Poised to rise significantly in the next decade

"***The jewelry industry seems poised*** *for a glittering future. Annual global sales of €148 billion are expected* ***to grow*** *at a healthy clip of* ***5 to 6 percent each year****, totaling €250 billion by 2020.* ***Consumer appetite for jewelry****, which was dampened by the global recession,* ***now appears more voracious than ever****.*

Jewellery players must be alert and responsive to important trends and developments

But the industry is as dynamic as it is fast growing. Consequential changes are under way, both in consumer behavior as well as in the industry itself. ***Jewelry players can't simply do business as usual and expect to thrive****; they* ***must be alert*** *and responsive to* ***important trends*** *and developments* ***or else risk being left behind*** *by more agile competitors.*" *(A multifaceted future: The jewelry industry in 2020 by Linda Dauriz, Nathalie Remy and Thomas Tochtermann, 2014.)*

Euromonitor International published its global forecasts in 2014 which analysed the broader category of luxury goods, and it predicted that this will be worth $405 billion by 2019. The US will continue to be the largest market but Euromonitor also noted that:

Luxury expenditure in China is expected to increase by 52% in real terms to 2019

"Luxury expenditure in China is expected to increase by 52% in real terms in the five years to 2019, driven by gains in disposable income of 64% of the population during the same time period. China is still on course to overtake Japan as the second biggest luxury market in the world, but this shift will now be delayed until 2019 as opposed to the previous prediction of 2016".

This chapter sets out to review some of the past trends, provide some broad indications about the future and address some of the issues:

1. How important is platinum jewellery to overall demand and what has been the performance?
2. What are the future prospects and are there opportunities in China and India?
3. Is platinum jewellery price elastic?
4. How does marketing secure the growth potential?

How important is platinum jewellery to overall demand and what has been the performance?

Platinum jewellery continues to be an important component of jewellery demand. In supply/demand scenarios, platinum jewellery is one of the most effective levers the industry can pull. In the autocatalyst sector there is a 'tug of war' between legislation and thrifting, making a potential ounce gain threatened by production efficiencies. In today's environment where incremental demand is critical for the platinum price, jewellery will play a vital role.

Jewellery is one of the most effective levers the platinum industry can pull

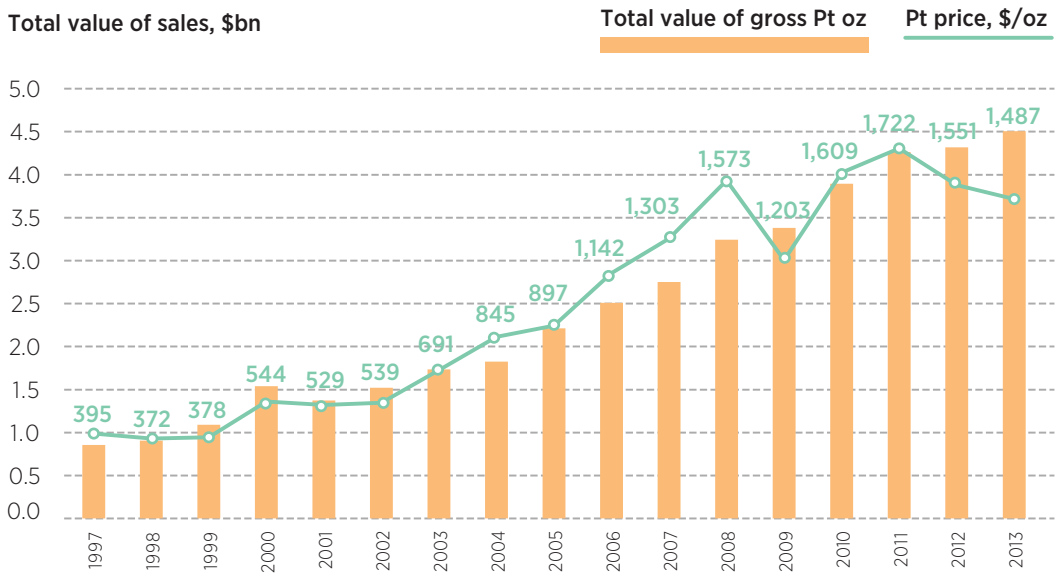
In the 1990s the jewellery and the autocatalyst markets consumed roughly the same level of ounces, but at the end of the decade jewellery took a larger percentage of platinum demand.

In the early/mid 2000s, jewellery's share declined for a few reasons. Firstly, this period saw the rise of autocatalyst demand. Secondly, the increasing price differential with gold, reaching more than double the price, had a dampening effect, and thirdly, during the mid-2000s, the palladium jewellery market grew and then declined in China. During this period the axis of influence moved East with the rise of the Chinese market.

Platinum jewellery sales have grown since 1997

However, the following chart demonstrates the consistent growth of platinum jewellery in value since 1997, reflecting consumer demand. Jewellery remained a core ounce contributor in the period when the price rose steeply.

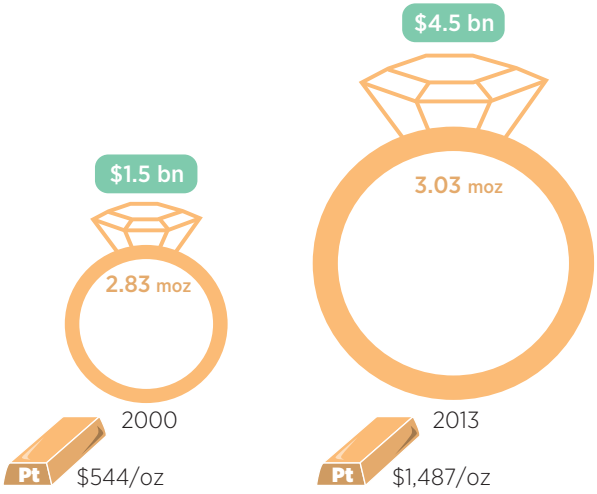
Platinum jewellery growth, 1997-2013



Source: Johnson Matthey, Kitco

To summarise the growth, the chart below shows a comparison between 2000 and 2013. In this period, despite the platinum price increasing by 173% from $544/oz to $1,487/oz, the number of total ounces grew by 7% to just over 3 million. The growth was largely due to the rise of the Chinese market which delivered the ounces despite lower figures in Japan and the US.

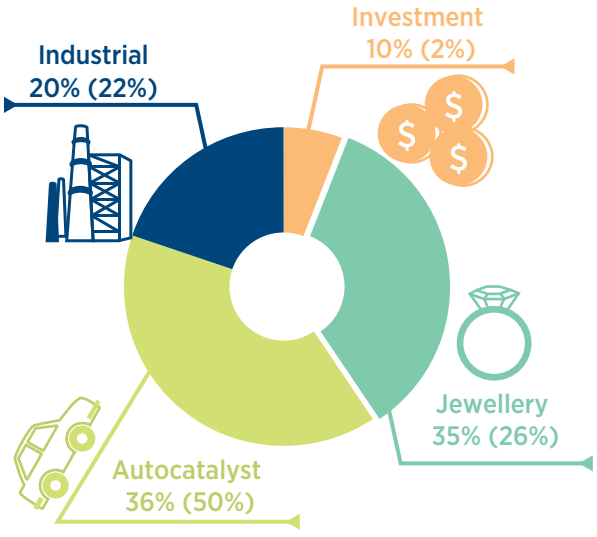
Platinum jewellery growth, 2000 vs. 2013



Source: Johnson Matthey, Kitco

Platinum jewellery's share of demand rose from 26% in 2007 to 35% in 2013, demonstrating its importance in the global 'pie'.

Platinum demand, 2007 vs. 2013

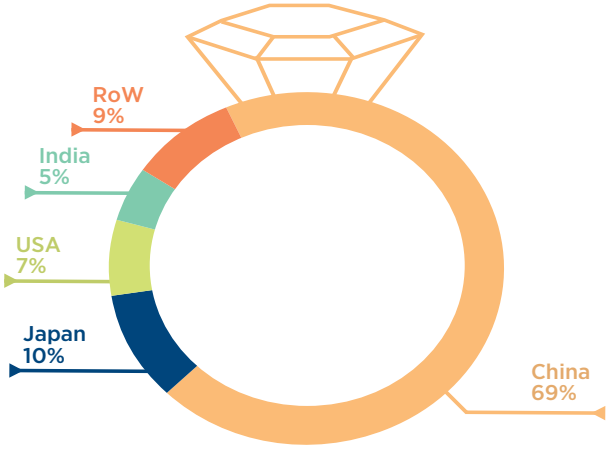


Source: Johnson Matthey (2007 percentages)

Jewellery demand is close to autocatalyst consumption in its importance to platinum

China dominates the global sector with 69% of jewellery demand. India, coming from a small base, is rapidly increasing its share which now sits at 5%.

Platinum demand by region, 2014



China dominates demand, while India is growing fast off a low base

Source: Johnson Matthey

In 2014, Platinum Guild International (PGI) launched a Retail Barometer and collected data from retailers' sales to consumers. The second annual Barometer was conducted in January/February 2015 and reported 2014 sales data from around 400 companies, representing close to 40,000 retailers across China, India, Japan and the US.

PGI's Retail Barometer reported 2014 sales data from close to 40,000 retailers

The research was robust and comprehensive, and independently executed. The findings gave a trend for 2014 retail sales versus 2013.

Platinum jewellery Retail Barometer results applied to Johnson Matthey's market estimates, 2014

	*2013/koz	% change	2014/koz
China	2,100	-3.0%	2,037
India	140	+28.0%	179
Japan	310	+3.3%	320
USA	213	+8.0%	230
Total	2,763	+0.0%	2,766
Rest of the World	264	Flat**	264
Global Total	3,027	± 0.0%	3,030

* Gross manufacturing demand (JM)
** PGI estimate

Source: Johnson Matthey, PGI. Note: Only Rest of the World % change is supplied from PGI.

After a challenging year, the Chinese market declined by 3% in 2014, set against a rise of 3% in 2013. However, the picture was mixed as some segments within the market and some retail channels showed growth. Where PGI was active, such as in the bridal sector, there were positive figures. Some retail operations reported double-digit rises in sales of pair rings, and the strategic retail partners showed growth of 11%.

Chinese market was down 3% in 2014

The positive figures in India, Japan and the US matched the decline in China, and the retail market was flat in 2014. The trade was also asked for its predictions for 2015 and, on a global basis, the expectation is for retail sales to grow by 2.3%.

Offset by growth in India, Japan and the US

Flat retail market for 2014, retailers expect 2.3% growth for 2015

Since the past does not provide an indicator for the future, it is important to build up more granular segmented market models to predict the potential for platinum jewellery. One way to look at the market is to split the countries into developing (China and India) and developed.

China delivered ounce growth of 77% between 2000 and 2012 and although the market has slowed in the last two years, the indicators are strong. India is on a fast track and platinum jewellery currently represents less than 1% of the gold jewellery market, so the opportunities are clear. Japan and the US are seen as developed markets but this does not mean there are no additional growth segments. Indeed, momentum is building in both countries.

Platinum jewellery is <1% of gold in India, suggesting high growth potential

What are the future prospects and are there opportunities in China and India?

Strong GDP growth ahead for China and India

Looking at the IMF economic forecasts for the four markets provides positive indications for the next five years.

Economic trends (2014-2019 year-on-year change)

		2014	2015	2016	2017	2018	2019
China	GDP	7.4%	6.8%	6.3%	6.0%	6.1%	6.3%
	Inflation	2.0%	1.2%	1.5%	2.0%	2.5%	3.0%
	Nominal GDP	**9.5%**	**8.0%**	**7.9%**	**8.1%**	**8.8%**	**9.5%**
India	GDP	7.2%	7.5%	7.5%	7.6%	7.7%	7.7%
	Inflation	6.0%	6.1%	5.7%	5.6%	5.2%	5.0%
	Nominal GDP	**13.6%**	**14.0%**	**13.6%**	**13.6%**	**13.3%**	**13.1%**
Japan	GDP	-0.1%	1.0%	1.2%	0.4%	0.7%	0.7%
	Inflation	2.7%	1.0%	0.9%	1.8%	1.3%	1.2%
	Nominal GDP	**2.7%**	**2.1%**	**2.1%**	**2.2%**	**1.9%**	**1.9%**
USA	GDP	2.4%	3.1%	3.1%	2.7%	2.4%	2.0%
	Inflation	1.6%	0.1%	1.5%	2.4%	2.5%	2.3%
	Nominal GDP	**4.0%**	**3.2%**	**4.6%**	**5.1%**	**5.0%**	**4.4%**

Source: IMF (April 2015)

However, it is more valuable to build up models of the existing platinum jewellery market in each country and identify the segments where growth can be delivered. Each market is at a different stage of development. In China, the focus has been on the bridal sector, but this represents only about 30% of the total market. Conversely, in India, the focus has been on post-marriage gift giving between the couple through the Platinum Day of Love programme, and the bridal segment has only recently been launched in December 2014. In Japan, there is potential in non-bridal jewellery which increased in 2014, particularly as the engagement market is likely to shrink owing to changing demographics. In the US, the focus has been on the bridal category but within that there are significant growth opportunities.

Identifying country-specific segments where platinum jewellery sales can be grown

China has focused on the bridal segment

India has focused on post-marriage gifting

Japan has potential in the non-bridal sector

The US has opportunities to grow bridal sales

PGI is currently in the middle of a global Scenario Planning project, modelling demand over the next 5-10 years and identifying and analysing the different factors that shape jewellery offtake. From a retail perspective, platinum is viewed alongside gold and this important factor is included in the work. Whilst it is expected that the platinum price should be higher than gold, it is important to focus on the relative price between the metals.

In China and India, a steadily rising platinum price would be seen as a spur to consumer demand.

Are there strong opportunities in China?

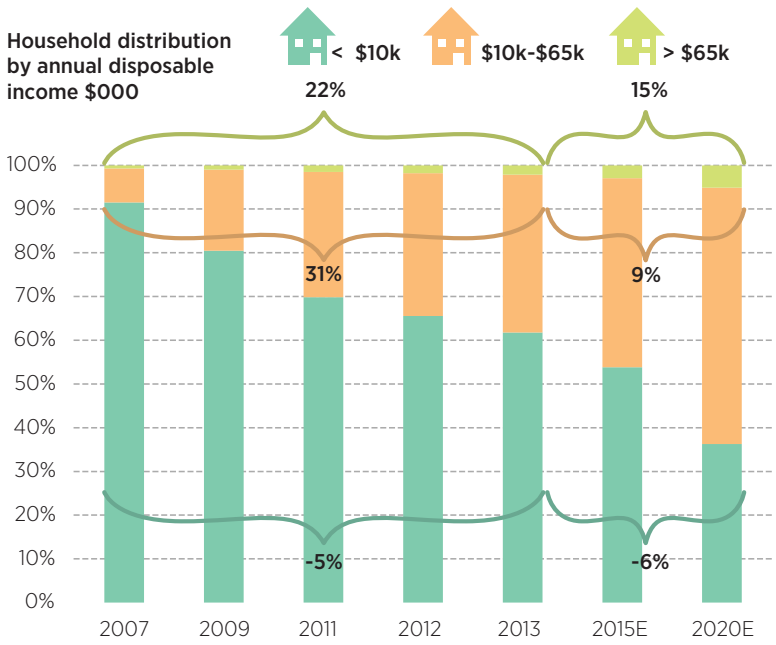
Some analysts have looked at the development of China by modelling the per capita GDP as a percentage of the US market, and taken the 50-year development of Japan (1945-1995) and Korea (1963-2013) as benchmarks. China shows a very similar trajectory but the starting point was only in 1990. According to these forecasts there is plenty of headroom for economic growth, with consequent increases in consumer spending.

Chinese growth supported by rising disposable income, expansion of Tier 3 and 4 cities and growing consumer appetite for jewellery

There are many factors that paint a picture of the future, three of which are the increase in expected disposable income, the expansion of Tier 3 and 4 cities, and the consumer's appetite for jewellery.

The first two of these points are illustrated in the following charts.

Future growth from the additional +/- 100 million middle class and affluent households by 2020



Source: Euromonitor, Bain & Company. Note: Middle class and above is defined as households with annual disposable income of >$10k.

Middle class with income to spend on jewellery is set to grow by 9% by 2020

CAGR 2007-2013

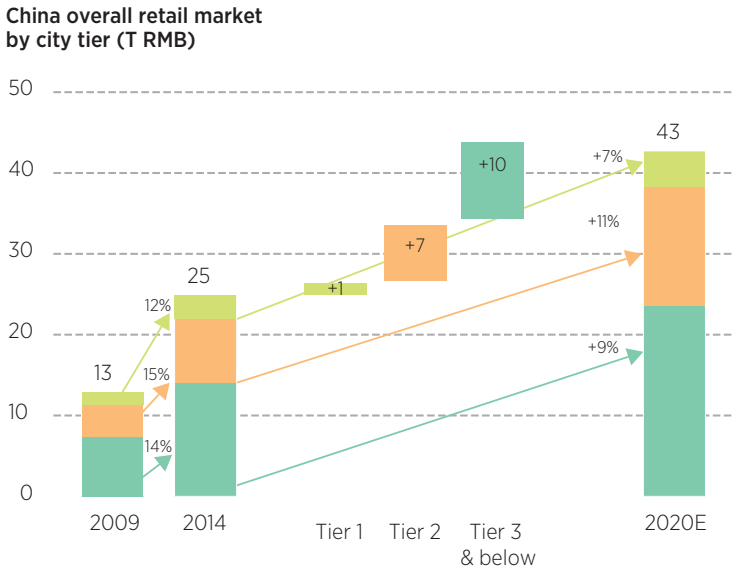
- *>$65k: 22%*
- *$10k-$65k: 31%*
- *<$10k: -5%*

CAGR 2013-2020E

- *>$65k: 15%*
- *$10k-$65k: 9%*
- *<$10k: -6%*

Currently, 67% of total retail sales come from Tier 3 and lower cities, and it is estimated that 76% of the middle classes will come from Tier 2 and 3 cities by 2022.

Incremental growth from Tier 3 and 4 cities



Source: National Bureau of Statistics, CEIC, Euromonitor, Bain & Company

Tier 3 and below cities are set to dominate overall retail sales growth

PGI has been very successful in creating desire for platinum jewellery and has focused its programmes over recent years on the bridal category through pair rings (rings for both a woman and a man) or a tri-set (pair rings plus an engagement ring). In terms of regional footprint, the emphasis has been on Tier 1 and 2 cities.

Emotion plays a significant role in China, and De Beers estimates that the drivers behind around 73% of all purchases are love or the celebration of a personal milestone.

Platinum jewellery marketing in China

Source: PGI

Market growth in bridal segment through promoting pair rings and tri-sets

Fine jewellery is a desirable product, and in a De Beers study consumers were asked to select from a list of competitive items or experiences they most coveted. The top selection was fine jewellery, with 48% choosing it as both a gift and self-purchase, followed by a laptop (36% self-purchase, 17% gift), a designer handbag (31%), a holiday abroad and a luxury watch.

Fine jewellery was the most desired luxury in a consumer survey

The most recent PGI brand-tracker research indicated that 59% of consumers would consider platinum as their first choice for jewellery.

Apart from consumer desire, the second critical element is to ensure that the trade is committed and supportive. PGI has built strong relationships with key manufacturers and retailers, but it is vitally important to introduce new segments to excite and enthuse the market.

Jewellery trade needs a steady feed of new segments to keep the market vibrant

There are two main business opportunities in China. Firstly, PGI has started to widen the promotion of bridal jewellery to Tier 3 and 4 cities, as the growth to date has been primarily focused on Tier 1 and 2 cities. Secondly, there are many segments within non-bridal jewellery where platinum can find a role and deliver additional ounces.

PGI increasing bridal campaigns to Tier 3 and 4 cities

PGI has already embarked on a comprehensive strategic review to introduce programmes that will realise the full market potential over the next decade. Once the strategic review is completed, PGI will share the targets and explain how they will be achieved.

Also targeting non-bridal jewellery segments

What can India deliver?

India is also experiencing a period of increasing wealth which is percolating through to the middle classes, who are growing rapidly in number and consuming goods ranging from high-end cars to designer clothing. It is estimated that in two decades the country will surpass Germany as the world's fifth-largest consumer market. The culture is changing but gold will maintain its central role within the traditional fabric of Indian society, even if fashions are changing. Today's young Indians see jewellery as a reflection of themselves rather than as a savings plan. Platinum, with its positioning as a gift of love, chimes with the values and aspirations of young Indians and also influences their parents.

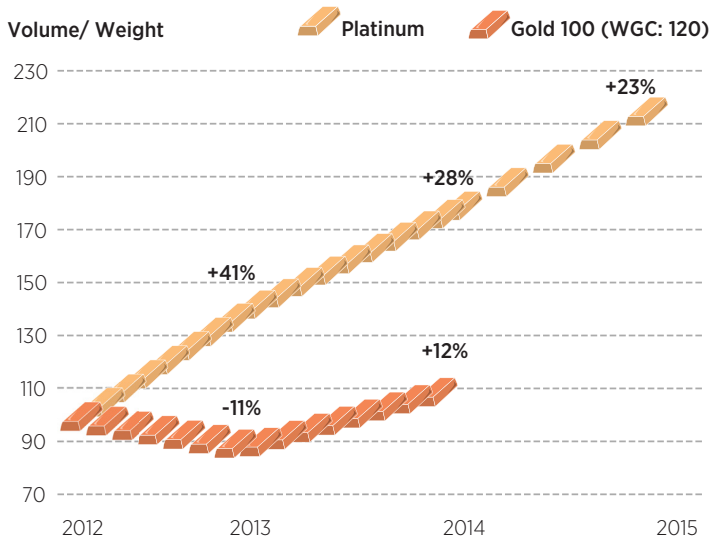
India is expected to surpass Germany as the world's fifth-largest consumer market in two decades

Young Indians see jewellery as an expression of self, and no longer as just a savings plan

PGI's success in the Indian market has been based on the Platinum Day of Love (PDOL) programme and men's jewellery. The PDOL captures the emotions expressed by a married couple after their wedding where they exchange rings as a demonstration of their love. Launched in 2009, it has shown very strong growth and has been the key driver in the market. In addition, the men's segment has increased the jewellers' offering and been very successful; this is significant in ounce terms as it is primarily heavy (30-45 grams) platinum neck-chains and wristwear. The sales growth in ounces in 2013 and 2014, and the trade's estimate for retail sales in 2015 would result in the market more than doubling in three years.

Heavyweight jewellery for men is an important growth segment

Platinum jewellery sales in India



Source: StratWon

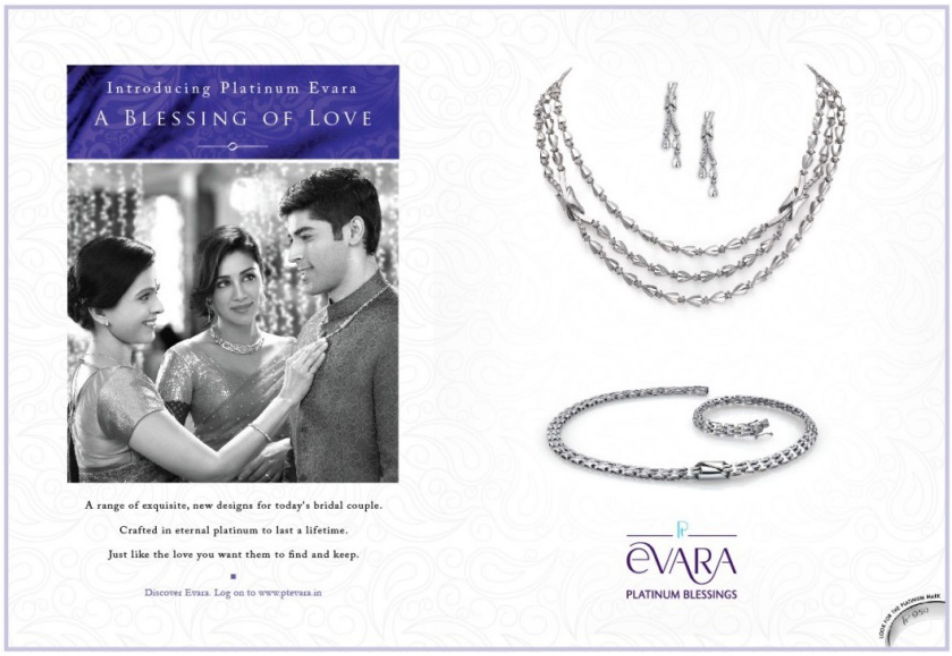
A new brand was launched in December 2014 called Platinum Evara, targeting weddings in India which constitute 60% of the total jewellery business. The advertising depicts the presentation of gifts of separate pieces of Platinum Evara jewellery from the bride's parents to both the bride and groom. The consumer and trade response has been positive and although it is too early to assess its impact, the first results are very promising.

Platinum Evara, a new campaign targeting weddings, was launched in December 2014 and has had a very promising start

PGI marketing in India

Source: PGI

PGI's Platinum Evara marketing campaign



Source: PGI

The focus for India will be the continued expansion of the PDOL programme which now has Platinum Evara as a complementary segment, establishing platinum's role as a gift of love at the wedding. Platinum Evara will be the main driver of ounces over the next 10 years, and there will also be support from the fast-growing men's platinum jewellery programme, which consumes many ounces through a relatively low number of pieces.

Platinum Evara expected to drive growth

With the launch of Platinum Evara, PGI estimates that the Indian market, starting from a base of 140 koz in 2013, should consume more than 500 koz annually by 2019.

India estimated to be a >500 koz platinum jewellery market by 2019

Are Japan and the US areas of focus?

There have been positive results in both the US and Japan in recent years and, assuming an acceptable difference between the platinum and the gold price, PGI expects these markets to show steady growth during the next five years.

Sales success in the US and Japan depends on platinum's price relationship with gold

In Japan, platinum is entrenched in the bridal sector which, owing to an ageing population, is becoming less important. Non-bridal jewellery has been showing growth which has been helped by the parity in price between platinum and gold.

In the US, the major retail chains cut back their platinum support in the mid-2000s when platinum carried a significant premium to gold, but they have re-entered the market and are bullish about the future.

Consequently, the prospects are good for the US, but clearly they will not deliver the ounce growth anticipated in China and India.

The following chart shows the relative price of platinum and gold since 2000. It is important to remember that, at retail, the price will be significantly more because a platinum piece has a purity of 950 whilst gold might be 750. In addition, the manufacturing costs would be higher.

It is not just about the metal price – platinum jewellery is frequently higher purity than gold and manufacturing costs are higher

Relative price of platinum and gold, 2000-2014

Av price $/oz	Pt	Au	Pt to Au Premium
2000	545	279	95%
2001	530	271	95%
2002	540	310	74%
2003	692	364	90%
2004	846	410	106%
2005	897	445	102%
2006	1,142	604	89%
2007	1,305	697	87%
2008	1,573	872	80%
2009	1,203	973	24%
2010	1,609	1,226	31%
2011	1,720	1,572	9%
2012	1,550	1,667	-7%
2013	1,486	1,409	5%
2014	1,384	1,265	9%

Source: SFA (Oxford), Bloomberg

Is platinum jewellery price elastic?

If all the growth seems positive, what will happen to the jewellery market when the platinum price rises? PGI looked at the precedent from the 2000s when this did not prove to be the case.

There have been a number of theories about the elasticity of platinum jewellery, and some have expressed a view that platinum jewellery has a price ceiling above which demand would fall away. Although trade feedback and anecdotal information did not prove this to be the case, PGI felt it important to conduct independent research amongst the jewellery trade.

Over 130 companies across the world were interviewed and the results aggregated for each market. The responses reflect the trade's view of likely consumer behaviour, as it is very challenging to ask consumers how they might, hypothetically, behave in various pricing scenarios.

The findings were reasonably consistent across the markets and the key conclusions were:

Platinum jewellery pricing is inextricably linked with gold pricing

1. Changes in the platinum spot price alone do not threaten demand for platinum jewellery.

2. The price of platinum must be compared and measured against the price of gold, which dominates the sector. Should the platinum premium over gold increase significantly between the metals, there would be more of a challenge for the platinum market.

3. Platinum jewellery demand was found to be largely inelastic in the event of gradual and steady changes to the price of platinum, assuming a constant with gold.

4. A platinum price increase of 10% per annum would not affect the platinum market and, indeed, in China and India would act as a spur.

Battling the impact of a price rise on demand

In terms of mitigating the risk of the impact that price increases would have on the platinum market, the research demonstrated:

- The importance of building a platinum tradition (e.g. Japanese engagement ring) which would be more secure with rising prices.

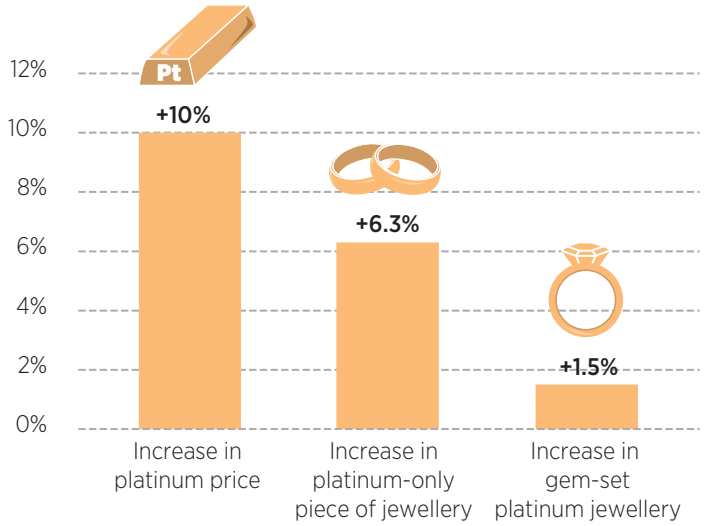
- Consistent and effective PGI marketing is seen as the most important driver in China.

- Strengthening trade relationships and building continuity establishes trust in the trade which, in time, turns into commitment to platinum.

It is important to understand that an increase in the platinum price does not correlate to an immediate increase in the retail price. As platinum makes up only a small part of the retail price of a piece of platinum jewellery, the research from China demonstrated the impact of a change in the platinum price on retail jewellery.

Platinum price movements do not immediately or directly affect the jewellery retail price

Impact of a change in platinum price vs. retail jewellery in China



Source: StratWon

How does marketing secure the growth potential?

Even if the economic indicators seem positive, there is obviously a considerable difference between identifying the opportunity and realising a return.

PGI's marketing teams focus on understanding consumer needs, identifying business opportunities, developing a strategic plan including core insights, and then a first-class execution. Consumers are changing rapidly and PGI monitors some of the emerging trends to see how platinum can take full advantage of them.

1. Brands – Jewellery branding is still relatively nascent and it is estimated that only about 20% of all jewellery is branded. Undoubtedly, this will be an area of growth which helps the retailer command a premium and establish differentiation.

2. Consumer segmentation – The traditional marketing approach of 'push and pull' has become outdated as the emerging markets have changed the landscape. Consumers who have acquired 'new money' are looking for 'badges' to demonstrate their newly acquired wealth. There is also a need for brands to inspire trust and confidence, and that can be a crucial factor when deciding which purchase should be made.

Branding will be increasingly important:

- *For consumers as 'badges' of wealth*
- *For retailers to command a premium*
- *To inspire trust and confidence*

3. On-line – There has been a rapid increase in on-line searching and shopping. Last year in China 69% of consumers purchased products or services using their smartphones compared to 46% in the US. It is now the first destination in terms of research for products and it is vital that the consumer platinum jewellery offer is at the same standard as other luxury competitors.

   In addition, the shift from bricks and mortar retailers to on-line purchasing has meant there is a need to reconfigure the channel landscape; this does not mean that the role of physical stores will decline but that all businesses must take a multi-channel approach to their customers.

4. Supply chain – A number of industries have dramatically shortened the time to market and there is consumer expectation that a concept can be moved into a physical product very quickly. The jewellery market is aware of this concept and the importance of balancing customised delivery with maintaining high-quality production.

Summary

All the numbers are just a starting point. PGI's success, which has driven the growth of platinum jewellery, has been achieved by its focus on meeting the consumer's needs and ensuring the trade is aligned behind marketing programmes. At the forefront is the importance of creativity, innovation and imagination in the platinum business. The global opportunities are numerous but it takes a professional, systematic and consistent approach to turn these into incremental platinum ounces.

Professional + systematic + consistent approach = platinum ounces

About Platinum Guild International

PGI was established in 1975 and its primary role is to develop and build demand for platinum jewellery. PGI focuses on the four key markets of China, Japan, USA and India and is sponsored by Anglo American Platinum, Impala Platinum and Lonmin.

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THE DIESEL DEBATE: ARGUMENTS FOR AND AGAINST

The diesel debate: Arguments for and against

Part 1: A policy perspective – Impacts of technology and policy on the market for diesel cars

Greg Archer, Managing Consultant, Gaian Ltd

The automotive sector uses 40% of global platinum supply, virtually all in the exhaust aftertreatment systems required to meet air pollution emissions limits. Platinum is predominantly used in diesel catalysts, while a cheaper and equally/more effective alternative (palladium) has largely replaced platinum in gasoline three-way catalytic converters. Clearly, the effects of emerging technologies and environmental policies on the market for diesel cars and exhaust aftertreatment systems have a direct impact upon platinum demand.

In Europe, diesel cars have long been promoted as a low-carbon transport solution, growing to over half of the new car market. This 'dieselisation' has been driven by generous tax breaks on diesel fuel and car taxation schemes that reward lower CO_2 diesel tailpipe exhaust emissions. The cost of diesel cars has been kept artificially low by weak air pollution limits and tests that have enabled simpler exhaust aftertreatment systems to be deployed in Europe – but not in the US where NO_x controls are more stringent so larger diesel cars need more complex aftertreatment.

Diesel cars made up 53% of the 11.8 million cars produced in Europe in 2014

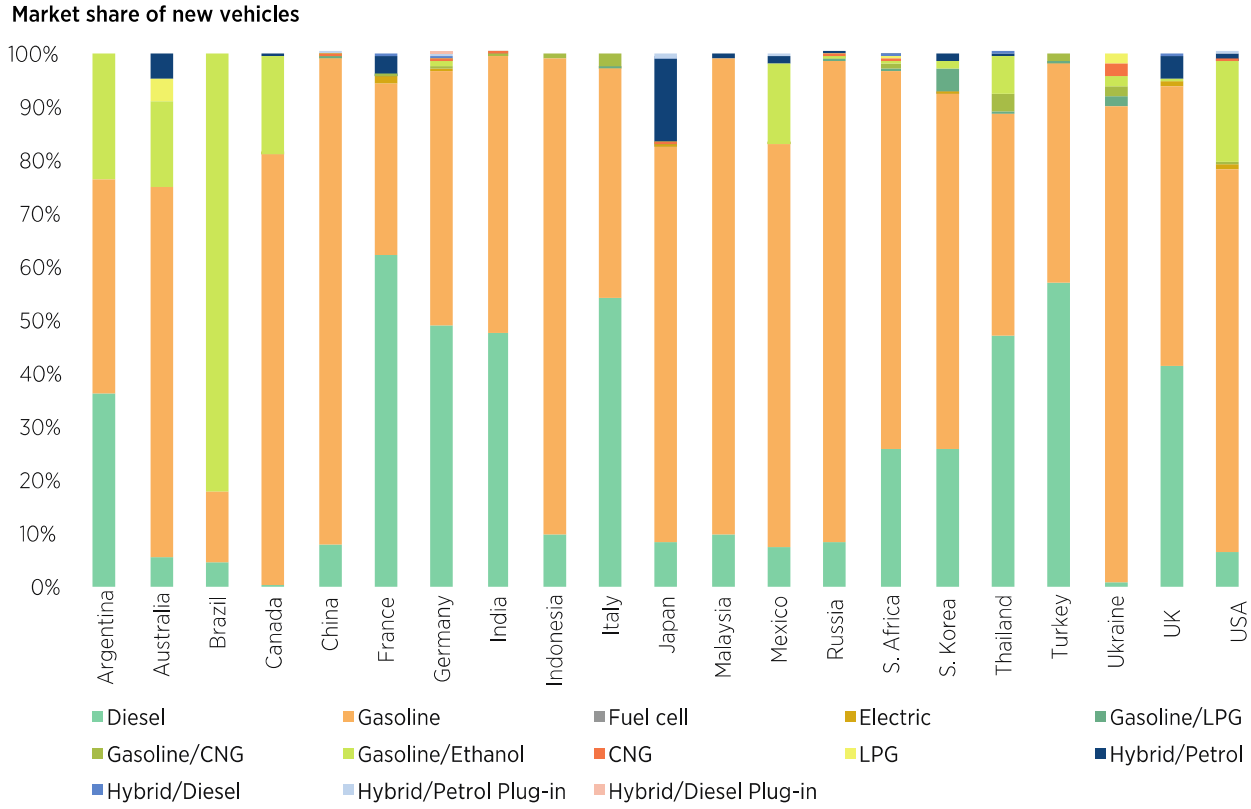
The global diesel car market

Globally, the automotive market continues to grow strongly, up by 50% since 2000 (source: International Organization of Motor Vehicle Manufacturers' (OICA) production statistics 2014). In 2014, 89 million vehicles were manufactured, of which 68 million were passenger cars and the remainder commercial vehicles that were predominantly diesels. Around 10 million diesel cars were sold worldwide, including *c.*7 million in Western Europe, *c.*1.5 million in India and *c.*250,000 in each of South Korea and Turkey (source: derived from data from the Global Fuel Economy Initiative and OICA).

Current forecasts point to Western European diesel car autocatalysts contributing 10% of total platinum demand in 2020

In the other significant global car markets of China, North America, Brazil, Russia and Japan, diesel sales are very low or absent. Diesel cars in Western Europe account for 30% of the total global autocatalyst market for platinum and 12% of total global demand.

The market for diesel cars in selected countries

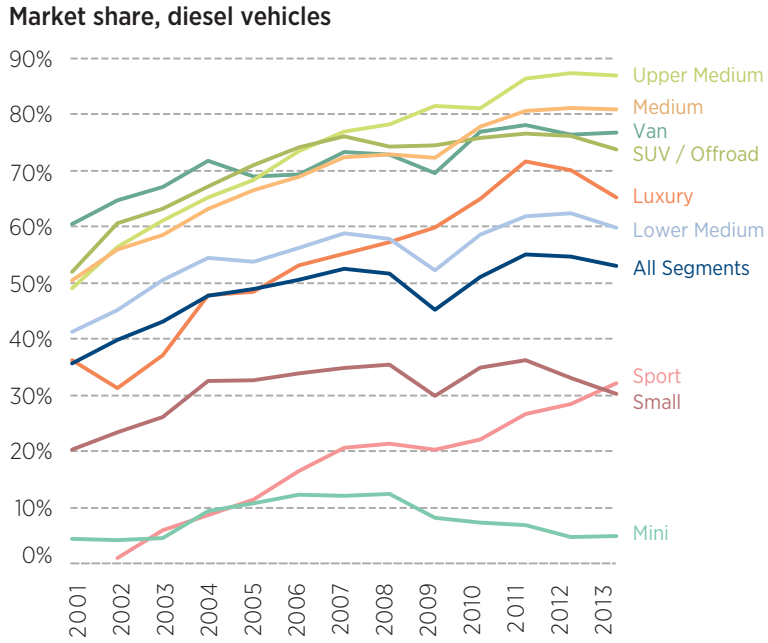


Source: LMC Automotive and SFA (Oxford)

Sales of diesels in Western Europe have grown steadily since 1990, reaching a peak of 55% of new car sales in 2012, but have since fallen back modestly to 53% in 2013 and 2014. Trends are consistent across almost all EU Member States. Diesel cars dominate in the larger, heavier car segments and tend to have much higher power output than petrol equivalents.

Diesel car sales in Western Europe have stabilised at just over 50%

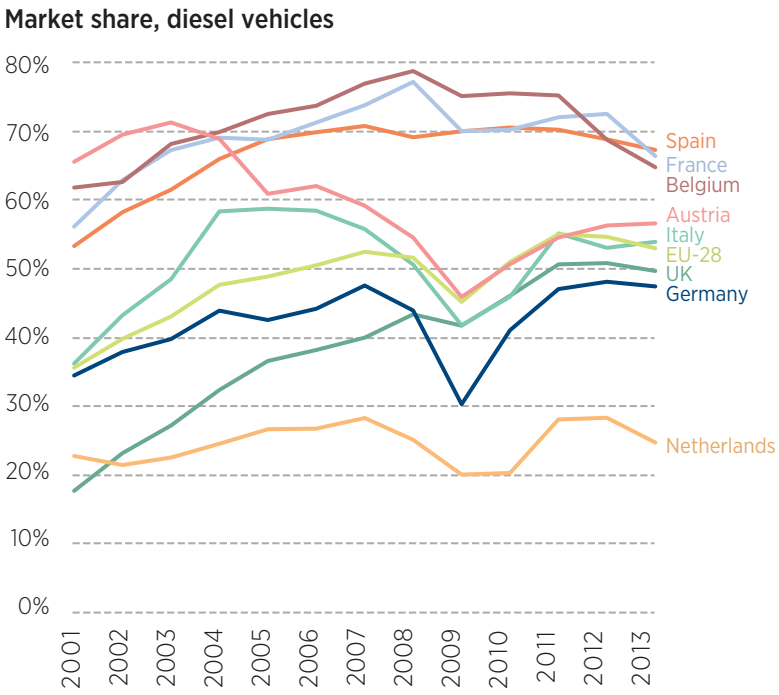
Diesel car sales by vehicle type in Europe



Diesels dominate the larger categories of light vehicles

Source: International Council for Clean Transportation, European Vehicle Market Statistics 2014

Diesel car sales by country in Europe



Diesel's share varies according to national fuel taxation policies and, to some extent, national preferences

Source: International Council for Clean Transportation European Vehicle Market Statistics 2014

Why has Europe 'dieselised'?

The 'dieselisation' of cars in Europe has not happened by chance, but has been driven by three specific policy choices, outlined below:

Policy has supported the widespread adoption of diesel cars in Europe

Policy 1
High levels of excise duties on transport fuels

Europe has traditionally taxed transport fuels at much higher levels than markets such as the US, leading to high fuel prices and a greater focus on vehicle fuel economy. Most European countries also apply higher excise duties on gasoline, leading to diesel prices being lower at the pump. Diesel taxes are currently 15-50% per litre lower than gasoline taxes; the UK and Switzerland are the only European countries with no diesel bonus. This disparity in diesel taxes is even more notable given that diesel has a 12% higher energy content per litre than petrol. This diesel bonus is even written into EU legislation, the Energy Tax Directive, setting a lower minimum fuel tax rate for diesel than for gasoline. The diesel tax bonus decreased from the mid-1990s to the mid-2000s but overall has remained largely constant for the last decade. However, recently diesel excise duty has increased in Italy, Poland, Belgium, Hungary and Finland. Some of these countries were obliged under the terms of their IMF/EU bail-out programmes to review fuel taxes.

Policy 2
CO_2-based vehicle taxes

To encourage sales of lower-carbon, more fuel-efficient cars, many countries have linked their systems of vehicle taxation to the tailpipe CO_2 emissions of the car. This includes sales, circulation and company car taxes, and has encouraged sales of diesel cars that have *c*.20% lower tailpipe CO_2 emissions than the equivalent gasoline model. The Netherlands imposes heavier taxes on diesel vehicles to take account of higher air pollution emissions, and is notable in having significantly lower sales of diesels (29% market share) and higher sales of hybrid cars.

Policy 3
Weaker air pollution standards

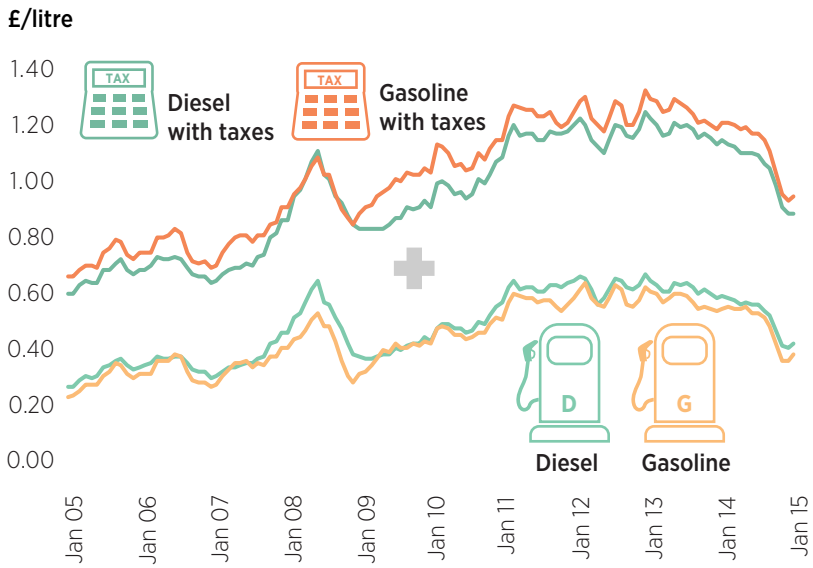
Since 1996 (Euro 2), the EU has set different air pollution exhaust limits for diesel and gasoline vehicles to control emissions. Notably, diesels in Europe have been permitted to emit more oxides of nitrogen (NO_x). This continues for Euro 6 limits introduced in 2014 with a gasoline limit some 20 mg/km lower than that for diesels. The approach contrasts with the US where emissions limits are technology-neutral and diesel sales are niche.

Loopholes in the testing procedures have also given diesel cars a significant advantage. The obsolete, unrepresentative testing system has permitted diesel cars to emit significantly more emissions on the road than during tests. Cycle beating by diesels means on-the-road emissions are much higher than both test and gasoline cars, with NO_x emissions typically 7-10 times higher on the road than in tests, for Euro 6-compliant vehicles.

In contrast, three-way catalytic converters used for exhaust aftertreatment on gasoline cars reduce most pollutants to very low levels in both tests and on the road. The failed test system has enabled manufacturers to use simpler emissions control technologies than would be required if tests effectively reduced emissions. A new real-world testing procedure is expected to remove this benefit and hence markedly reduce diesel cars' advantage.

Source: Transport & Environment

Average fuel prices in Western Europe with and without taxes



Taxes remain a large part of the pump prices of diesel and petrol

Source: UK Department of Energy & Climate Change

EU countries with CO_2-related car taxes

Rank	Country	CO_2 g/km	Registration Tax	Circulation Tax	Company Car Tax
1	**Netherlands**	109	√ √		√ √
2	**Greece**	112		√	
3	**Portugal**	112	√ √	√	
4	**Denmark**	112	√ √	√ √	
5	**France**	117	√ √	√	√ √
6	**Italy**	121			
7	**Spain**	122		√	
8	**Belgium**	124	√		√
9	**UK**	128		√	√ √
10	**Austria**	131	√ √		
11	**Finland**	132	√	√	
12	**Sweden**	133		√	
13	**Czech Rep**	135			
14	**Germany**	136		√	
15	**Poland**	138			

√ Tax relates to CO_2, but only to a limited extent.
√ √ Tax strongly graduated according to CO_2.

Source: Transport & Environment, CO_2 emissions from new cars in Europe: Country ranking in 2013

CO_2- related car taxes can influence vehicle and fuel choices

The environmental impacts of 'dieselisation'

Diesels have historically contributed more than gasoline to particulates and NO_x air pollution

The growth in diesel cars combined with lax air pollution limits and tests have contributed to high levels of air pollution in urban and other heavily trafficked areas. Diesels emit significant amounts of nitrogen dioxide (NO_2) and disproportionately contribute to fine particulate matter and ozone formation. In Europe, over 400,000 people are estimated to die prematurely as a result of air pollution – ten times the number killed in road accidents (source: European Commission Air Quality Package Impact Assessment, 2013). Emerging evidence on the mortality effects of NO_2 will significantly increase estimates of early deaths.

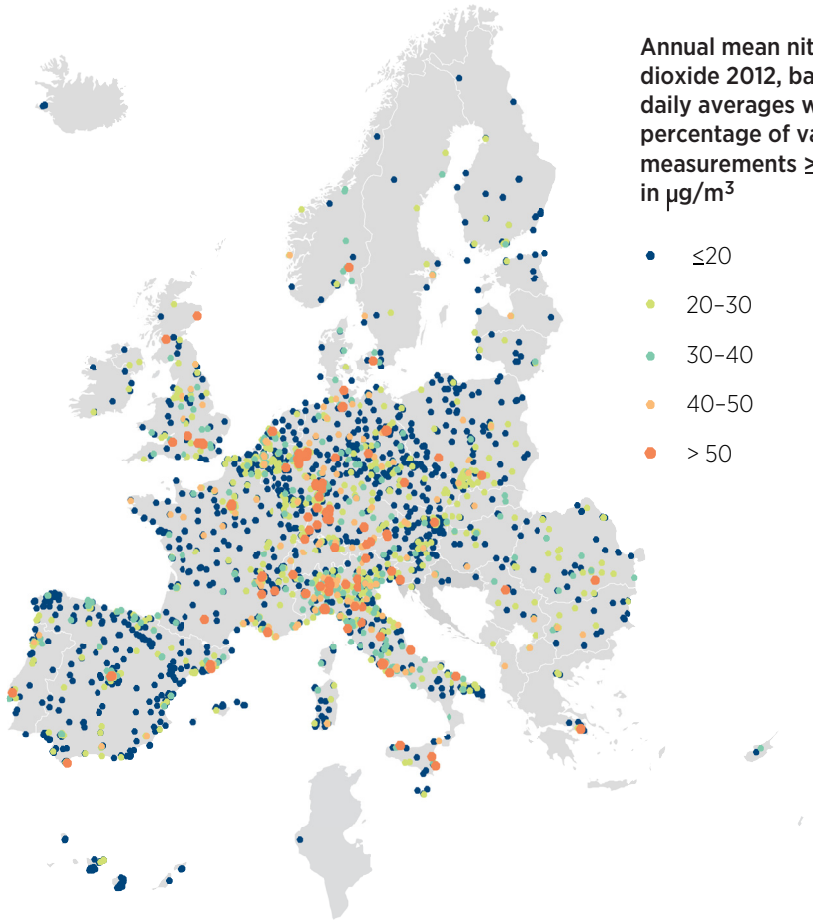
Air pollution also causes over 500 million days of restricted activity and over 100 million lost working days, imposing societal costs of €1,000-€2,000 a year for every EU citizen. Air pollution is now the environmental issue of greatest concern amongst Europeans, with over half highlighting this as their key worry (source: Special Eurobarometer 416, 2014). The health implications and costs, and growing public concern are creating new momentum to tackle air pollution that for the last decade has taken a backseat to tackling global warming.

Autocatalysts and engine improvements have cut diesel emissions greatly but they still remain somewhat higher than gasoline emissions

A modern Euro 6 diesel car produces around ten times more NO_x than an equivalent gasoline model on the road. A much greater share of the emissions is harmful NO_2. Concentrations of NO_2 are above World Health Organization (WHO) guidelines across Europe and 5-13% of EU citizens live in areas where air pollution exceeds limits considered damaging to health (source: European Environment Agency).

Severe episodes in Europe still occur, most recently in spring 2015 when pollution levels reached hazardous concentrations in cities including Brussels and London. The European Commission is now taking action against EU Member States that have failed to meet ambient air pollution limits for NO_2 and fine particulates with the threat of multi-billion euro fines.

Exceedances of NO_2 limits in the EU (2012)



Source: European Environment Agency 2014, Air Quality in Europe 2014 Report

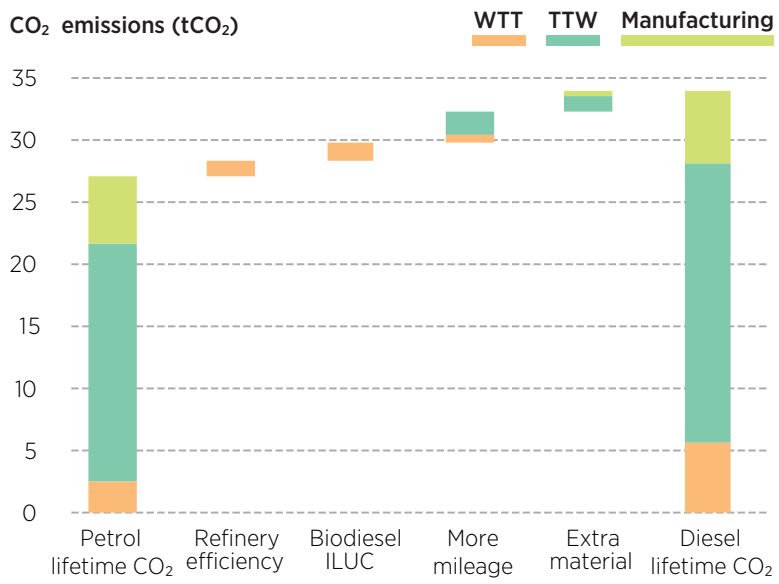
Air quality limit breaches are very widespread

The high emissions of NO_x and demand for diesel have other environmental impacts. NO_x emissions impact on the biosphere, from the eutrophication of rivers and lakes when excessive nutrient build-up leads to damaging algal blooms. Biodiesels added to diesel fuel are derived from oil seeds, creating additional demand for palm oil and driving deforestation. The high demand for diesel in Europe also creates a market for (Canadian) tar sands (source: National Resources Defense Council (NRDC), 2014) and requires more energy to be expended to refine crude oil, increasing CO_2 emissions.

Although passenger diesel engines deliver about 25% more km per litre than a gasoline engine, the life-cycle impacts of a diesel car are greater – over its lifetime, a diesel car will emit more than 5 extra tonnes of CO_2, 17% more than its gasoline-powered equivalent (Transport & Environment, 2015 (in press)).

Need to weigh the fuel efficiency of diesel over gasoline against life-cycle impacts

Lifetime CO_2 emissions for typical mid-size petrol & diesel cars in the EU



Additional manufacturing tank-to-wheel and well-to-tank costs for diesel cars over petrol cars

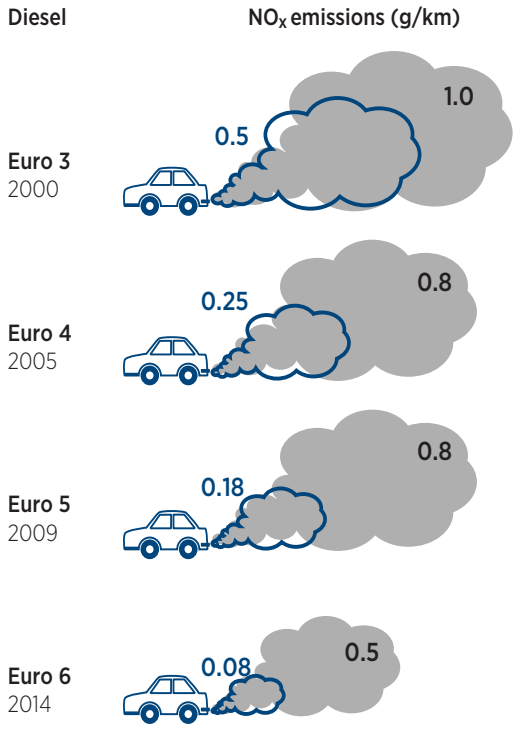
Source: Transport & Environment, 2015. Note: Well-to-tank is abbreviated to WTT, and tank-to-wheel to TTW.

Diesel exhaust aftertreatment systems

Diesel exhaust emissions are being progressively reduced through Euro standard emissions limits, yet improvements on the road are only a fraction of those delivered under test conditions. The chart below illustrates this, with limits in blue and actual emissions on the road in grey. It is clear that the disparity between test and real-world emissions is growing; Euro 3 target emissions of 0.5 g/km have only been met under real-world driving conditions under Euro 6.

Significant disparity exists between legislated emissions standards and real-world driving emissions

Comparison of test and real-world diesel NO_x emissions



Source: International Council for Clean Transportation, European Vehicle Market Statistics 2014

Euro 6 standards are, progressively, driving improvements to exhaust aftertreatment systems. Historically, diesels were fitted with oxidation catalysts to treat emissions of carbon monoxide and hydrocarbons. The introduction of Euro 5 standards in 2009 necessitated new controls on emissions of particulate matter, leading to the use of a diesel particulate filter (DPF). Tighter NO_x limits also required the use of exhaust gas recirculation (EGR) to lower the oxygen content and temperature in the cylinder and reduce NO_x formation.

Euro 6 standards introduced in 2014 and 2015 impose tougher NO_x limits

Euro 6 limits introduced in 2014 imposed even tougher NO_x limits. To achieve these limits, lean NO_x traps (LNT) are used. They bind the NO_x during lean engine operation, then under rich conditions the NO_x is reduced to nitrogen over the catalyst. An alternative system is selective catalytic reduction (SCR). SCR uses a diesel exhaust fluid (DEF), usually urea, which is injected into the exhaust. The DEF reduces NO_x to nitrogen, water and CO_2, achieving NO_x reductions of up to 90% and simultaneously reducing hydrocarbon and carbon monoxide emissions by 50-90%.

Options to cut NO_x limits are divided between LNT and SCR

The DEF requires replenishing, adding to operating costs and causing some inconvenience for motorists. For this reason, car manufacturers have been accused of under-dosing of the DEF, thereby reducing the effectiveness of the SCR system when the vehicle is driven on the road compared to during a test. This is to ensure the DEF cannot run out, leaving the car to "limp home" until it is refilled.

The impact of real-world driving emissions tests

The incremental addition of diesel catalytic systems to meet tighter NO_x limits significantly increases the complexity and costs of aftertreatment.

Aftertreatment to curb diesel emissions adds costs to diesel cars

The introduction of new real-world driving emissions (RDE) tests is likely to require aftertreatment systems to be upgraded on all diesel vehicles. With the introduction of gasoline direct injection (GDI) engines, the fuel economy benefit of a diesel is eroded whilst hybrids are more efficient on standard drive cycles, but not if substantial highway driving is involved.

The precise requirements of the RDE test are still being negotiated. The test procedure is expected to be agreed by EU Member States and the European Commission in 2015, along with what and when limits shall become legally binding. The legislation is likely to include conformity factors (CFs) that apply to RDE tests. These factors multiply the Euro 6 diesel NO_x limit (80 mg/km) to give a maximum level that will apply during an RDE test. The RDE test is expected to come into force from 2017 but will not apply to all new vehicles until the end of 2019.

Real-world driving emissions testing is likely to be even more stringent – applied from 2019

The automotive industry and supportive Member States (such as Romania and the Czech Republic) are arguing for a high CF to apply initially, with a lower CF to apply at some future date. Other Member States, particularly those exceeding ambient air pollution NO_2 limits (such as the UK and Netherlands), want a strict CF from 2017 as NO_2 limits are still not expected to be met in London and other major cities until after 2030 – some 25 years late! The battle is finely poised and the date for implementation of strict CFs (close to 1) is uncertain but is likely to be after 2020.

Impacts on the market for diesel cars

RDE compliance is likely to increase the purchase price of diesel cars

The strictness of the RDE test procedures and the limits which apply will have a significant effect on the cost and attractiveness of diesel cars. Whilst the premium car sector is relatively price insensitive, the mainstream segments are not. With thin margins in these markets already, manufacturers will have little choice but to pass on the additional costs of SCR aftertreatment systems when RDE test limits become sufficiently stringent. This will impact on the relative levels of sales of diesel, gasoline and hybrid vehicles.

Diesels represent one in three cars in the Small segment (e.g. VW Polo), two in three cars in the Lower-Medium segment (e.g. VW Golf), and over four in five sales in the Medium (e.g. VW Passat) and Upper-Medium markets. These segments represent about 4.5 million sales of diesel cars, which is two-thirds of the diesel car market in Europe and approaching half of the world market.

Downsized GDI engines, many fitted with turbochargers, will also replace conventional gasoline engines and deliver a substantial fuel economy improvement, further eroding the fuel economy benefit of diesel and making an increasing number of diesel car buyers switch to alternatives.

Threats to the premium diesel market

Improving hybrid and battery technology also poses a threat to diesel cars

The RDE tests are not the only threat to the diesel car market. In the premium sector the challenge comes from alternative technologies, especially hybridisation and electrification, driven by both CO_2 regulations and the enhanced performance of vehicles using electric motors. To counter the success of Tesla electric cars and the BMW i8, premium manufacturers will launch a range of plug-in hybrid vehicles from 2015 onwards. These earn additional credits in the car CO_2 regulation, making them especially appealing to manufacturers. Within five to ten years, the cost of battery technology is expected to fall to such a level that the total costs of ownership of battery electric cars will be highly competitive, further eroding the diesel market.

A vicious circle for diesel cars – a risk to platinum markets

The policy bias in favour of diesel is coming to an end, driven by the urban air pollution crisis to which diesel cars disproportionately contribute as a result of real-world driving falling short of emissions standards. This will be accelerated by the European Commission bringing infraction proceedings against 17 EU Member States for failing to enforce air pollution limits, with the threat of future fines unless limits are met. At an EU level, the new RDE tests will require advanced SCR systems to be widely used (although the timing is not yet agreed) which will increase the price of diesel cars.

Further car CO_2 regulations planned for 2025 will also encourage a shift to hybrid and electric cars, as emission limits are tightened and the costs of meeting the limits through improvements in the efficiency of diesels become prohibitive.

Rising costs of compliance with all forms of emissions legislation are likely to make diesel cars less attractive

At a national level, many Member States are beginning to increase diesel excise duties, reducing the bonus of filling up with diesel. Some are revising vehicle tax policies so they take account of the higher air pollution emissions from diesel cars. France has announced a scheme in which scrapping a dirty diesel car and buying an electric car will be supported by a €10,000 incentive. The Mayor of Paris has announced plans to ban diesels from the city and the Mayor of London intends to charge diesel car drivers an additional £10 for each trip into the city, as part of plans for an ultra-low emission zone (although Euro 6 diesels will be exempted). There are also plans to switch the iconic black cab from diesel to electric power. Some London local authorities, including Islington, are now even charging residents more to park their diesel cars.

However, the threat to diesel is not only from policy shifts. There is a growing realisation that the long-forecast shift to electric cars is underway. Recharging infrastructure is being installed along highway corridors to enable cars to recharge quickly and become practical for longer journeys. New customers are discovering that recharging at home or work is adequate for most daily needs and satisfaction rates for users are very high.

Electric and hybrid powertrains increasingly offer lower carbon transport

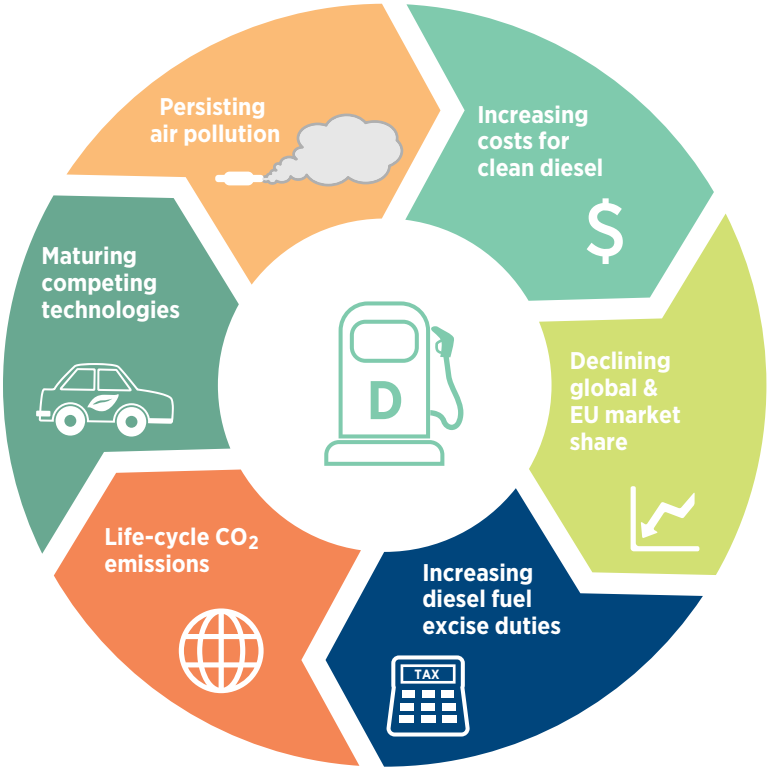
Many countries are building attractive packages of support to encourage the purchase of electric cars, including tax breaks, preferential charging and access to cities and lanes dedicated for buses. Such policy tools have been highly effective, notably in Norway where a quarter of new car sales are now electric. In the premium car sector, plug-in hybrid models offer high-performance, low-carbon motoring that is increasingly appealing to car buyers.

Car companies may not continue to invest in diesel technology if lower sales prevent them from recouping their investment

Diesel sales have already peaked in Europe and show no sign of attracting a significant market share in other major car markets. In India, where diesel car ownership has been encouraged by cheap fuel, there is growing concern about the air pollution impacts. Older diesels are being impounded in Delhi in response to the city's air pollution problem. The benefits of public transport using compressed natural gas (CNG) are being offset by rising sales of private diesel cars. However, the car market in India remains small in global terms (*c.*2.5 million car sales in 2014), over half of which were diesels. Any growth in sales in India is unlikely to offset the decline in the EU, making diesel an increasingly marginal powertrain globally. It is therefore unlikely that many car companies will choose to continue to invest heavily in developing diesel technology with so many other demands on research budgets, notably from hybridisation, electrification, and autonomous and connected cars.

A vicious circle of policy shifts, rising costs of diesel exhaust aftertreatment and increasingly favourable competing technologies is eroding the global market share of diesel. The question is not whether the diesel car becomes a progressively niche global powertrain – but how quickly.

The vicious circle for diesel cars



Source: Transport & Environment (in press)

About Gaian Ltd

Gaian Ltd is a consultancy providing expert advice on the environmental impacts of vehicles; policy development; advocacy and communication.

The author and managing consultant, Greg Archer, also works as the Vehicles Programme Manager for Transport and Environment (T&E) an independent environmental charity promoting sustainable transport. The author leads campaigns for less polluting vehicles supported by around 50 member organizations. The views expressed are those of the author.

The diesel debate: Arguments for and against

Part 2: An industrial perspective – The outlook for diesel cars in Europe

Al Bedwell, Director, Global Powertrain, LMC Automotive

Diesel car market summary

- Several technical drivers of vehicle fuel type are moving against diesel, particularly small diesel cars, and this is resulting in the decline of diesel car share. The decline will continue throughout this decade.
- Those markets which have traditionally provided an unusually diesel-friendly market, such as France, Spain and Belgium, are moving towards a more diesel-neutral stance, with falling diesel share as a result.
- Elsewhere, recent diesel sales data are robust, with no discernible impact yet in any market that could be definitively attributed to growing anti-diesel sentiment.

Diesel car sales robust

- Although some reports suggest that some Euro 6 diesel emissions are far higher on the road than under test conditions, these are disputed, and LMCA does not expect any significant measures that penalise diesel cars in this decade to include Euro 6 diesels.
- The adoption of the WLTP test procedure in Europe later this decade is expected to erode the diesel case further for small diesel cars, but the core diesel segments will be less impacted, and premium carmakers, in particular, are developing diesel strategies for WLTP.

Tighter legislation threatens mainly small, lighter platinum-loaded cars

- Given the essential nature of diesel in achieving mandated CO_2 targets and the investment that has been made in meeting Euro 6 requirements for diesel, LMCA expects that the European car industry will work hard to promote the benefits of new diesel cars. There is currently a considerable lack of knowledge in this area among car buyers.
- Diesel technology has not yet reached the pinnacle; there will be further improvements in fuel efficiency as well as power and torque density. However, despite the growing complexity of gasoline engines, diesel engines will continue to cost significantly more to produce.
- Diesel car owners generally have a high satisfaction rate. As long as diesel continues to retain its core virtues and new diesel cars are not legislated against, LMCA expects a significant number of new car buyers to continue to choose diesel despite a gradual erosion of the fiscal case for it.

Consumers like their diesel cars!

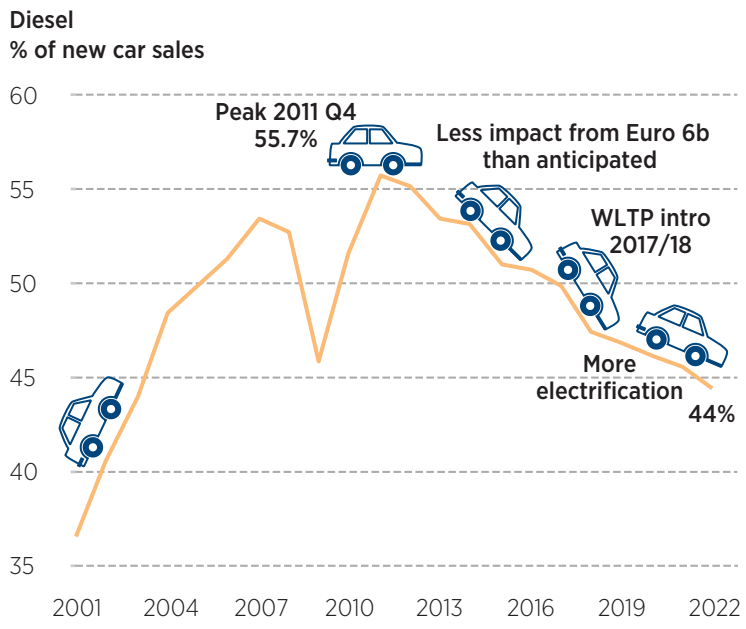
- Despite being conscious that diesel could be further negatively impacted by adverse media reports, LMCA remains faithful to its current rigorous forecast methodology which indicates that the diesel market will shrink through this decade but that diesel car sales will remain above 40% of the Western European market even into the early part of the next decade.

Diesel car market forecasting

LMC Automotive (LMCA) has been forecasting the European diesel car market for more than 15 years. The company believes that the share of diesel within all car sales in Europe has peaked and that it will see further contraction, so the key question now is how fast and to what extent will it contract.

LMCA's current forecast of diesel as a share of Western European new car sales is shown below.

Base case diesel forecast – Western Europe car sales



Source: LMC Automotive European LV diesel forecast. Note: Diesel share includes diesel hybrid.

Diesel is facing many challenges, some of which are listed in the side bar on the right. LMCA has been forecasting a decline in European diesel share for many years, and so far it is change in the cost-competitiveness of diesel versus alternatives that has driven this decline. The severe downswing in 2009 was a result of widespread car scrappage schemes which caused a temporary distortion of the market, as those schemes boosted sales of small, mostly non-diesel, cars.

Diesel sales in Western Europe expected to fall to 44% by 2022

Short/medium term diesel problems include the diesel fuel price, new technologies, anti-diesel sentiment (UK, France etc.) and electrification in some markets

Long-term diesel problems include:

- *Euro 6c/RDE*
- *Gasoline hybrid (especially PHEVs)*
- *Other electrification*
- *Diesel refinery capacity*
- *Urbanisation*

More recently, there has been widespread media coverage of the role that diesel cars play in contributing to poor urban air quality, highlighted by instances of noxious emissions exceeding the European Commission's Air Quality Directive's maximum levels in several major cities.

Spotlight on removal of older, highly polluting diesel cars from cities

The spotlight on these issues is likely to accelerate the imposition of measures that will encourage or require the removal of older, highly polluting diesel cars from city environments. Generally, this can be seen as a positive move, although it may be problematic for those drivers who are forced to scrap their old diesel car but are not in an economic position to purchase a newer, low-emission car.

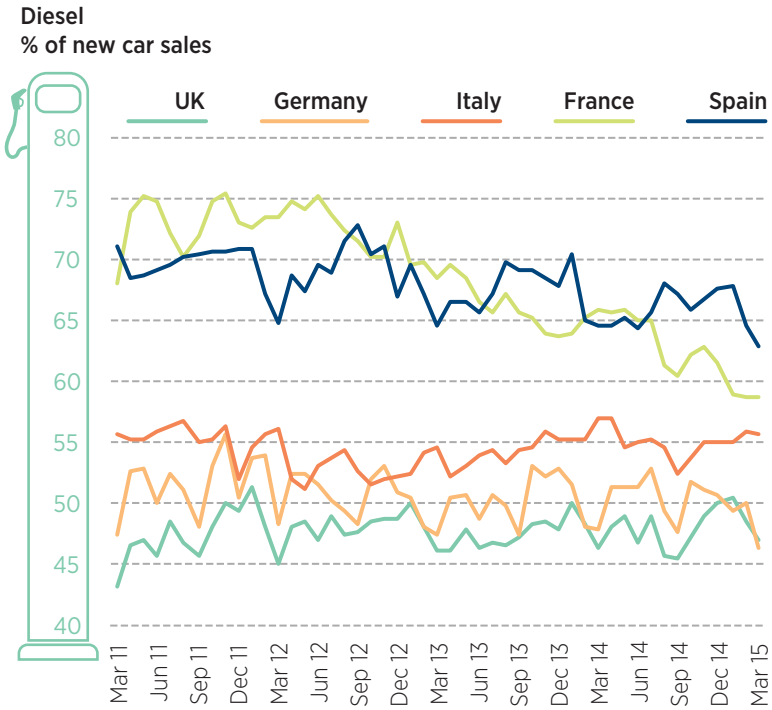
Diesel fuel is likely to lose tax advantages at the pump

At the same time, it is likely that those markets in which diesel has so far been awarded an 'unfair' fiscal advantage will see this as an opportunity to create a 'more level playing field' between competing fuel types. France, for instance, falls squarely into this category and will realign diesel and gasoline pump prices such that diesel loses the advantage that it has enjoyed for many years. Taking into account other measures including restrictions for older diesel vehicles in Paris and possibly elsewhere, LMCA expects diesel share in France to move quite rapidly towards a figure more typically seen in the UK or in Germany where diesel cars are not favoured so blatantly by fiscal measures.

Big 5 diesel trends

The chart on the following page shows the diesel car trend in the Big 5 European markets (which accounted for more than 90% of diesel car sales in Western Europe in 2014). Despite media reports on the poor emissions performance of diesel cars, public thirst for them has only marginally diminished in recent times. In the first quarter of 2015, Western European diesel share was just one percentage point down on the same period in 2014.

Four-year monthly diesel share trend, Europe Big 5 cars



Source: LMC Automotive

Average diesel share in Italy, the UK and Germany in March 2011 was 49.0% compared to 49.7% in March 2015

For Spain and France the diesel share figures are 69.4% and 61.0% respectively

France and Spain, markets which have traditionally offered a very benign climate for diesel car buyers, have seen a cumulative decline in the diesel share over the last four years, while Italy, Germany and the UK have not. With what could be termed an artificially high diesel share, France and Spain are more vulnerable to subtle shifts in the cost-benefit of diesel cars that have already taken place. LMCA anticipates further notable falls in the diesel share in those markets as they further dismantle diesel-promoting policy.

Diesel's pricing advantage over gasoline will narrow

Fuel pricing

An area in which this policy shift will occur is the pump price of diesel fuel versus gasoline. While cost-benefit models indicate that (surprisingly) diesel share is not especially sensitive to this (as long as the differential is not too great), it does have a fiscal and psychological effect. If policymakers have CO_2 emissions as a prime motive, diesel fuel should cost more than gasoline since it contains more carbon per litre. Few European countries actually impose such a policy in fuel pricing, but the pricing advantage for diesel has narrowed and will narrow further. In the long term, price parity may be a reasonable assumption; the haulage sector in some countries will strongly resist moves beyond this point.

Consequently, in the medium term, some markets will see an appreciable shrinking of diesel share while others will experience slower erosion driven by a reduction in the cost-competitiveness of diesel versus other fuels, rather than by distinct policy changes that specifically impact on Euro 6 diesels (although there are likely to be numerous schemes aimed at removing older diesel cars). The result will be a steady, but not dramatic, decline in European diesel share out to 2017 or 2018, at which point LMCA expects to see the imposition of the new Worldwide harmonized Light vehicles Test Procedure (WLTP).

Diesel car sales may shrink slowly owing to weakening competitiveness against other powertrains, rather than from distinct policy instruments

WLTP

The impact on diesel from this new test procedure is not yet clear but LMCA's best estimate is that it will further increase the cost burden, particularly on small, non-premium diesel cars, and hence that segment of the market will see further contraction. Larger, mostly premium, vehicles will be better able to absorb added costs and will face fewer headwinds from the test procedure itself, which (simulations indicate) will produce different outcomes for gasoline and diesel based on vehicle weight, with diesel generally performing more favourably in the heavier car classes.

New real-world driving test procedure is likely to make diesel cars less competitive

Electrification

Beyond 2018, LMCA anticipates that electrification will start to play a more significant part in vehicle-buying decisions. While battery electric vehicles are expected to grow only slowly, LMCA perceives greater potential this decade for the plug-in hybrid sector, particularly in the diesel-rich large car and SUV segments. As carmakers seek global markets for this technology, LMCA sees a weighting towards gasoline plug-in hybrids rather than diesel ones. Cost is also a factor here. Diesel plug-in hybrids are in the pipeline (one mainstream model is available) but gasoline models will be more numerous.

Electrification is most likely to be seen as plug-in hybrids, rather than full battery electric vehicles

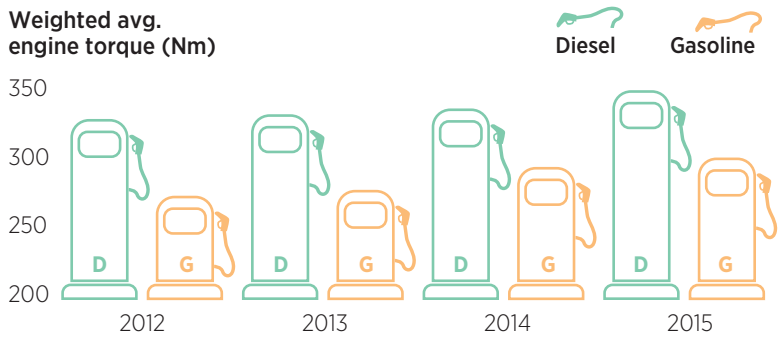
Diesel faces erosion from the bottom as it becomes a less attractive fuel in the small car segments for cost reasons. In the longer term, diesel faces potential attack in its heartland, the larger premium car segment, from gasoline plug-in hybrids that will attract incentives, helping to offset their high sticker prices, as well as qualifying for CO_2 super-credits for the carmakers.

The customer

Diesel retains a clear torque advantage

Although supported fiscally to one degree or another, growth in diesel car demand in Europe is also testament to a high satisfaction level from diesel car owners. They may or may not benefit from lower running costs than a gasoline equivalent (depending on usage, fiscal environment and car segment), but they will almost certainly benefit from increased range, higher torque and hence better driveability and towing ability. While gasoline engine torque has been increasing owing to the widespread application of boosting (turbocharging), a significant advantage for diesel remains, as the chart below indicates.

European light vehicle 2.0L engine fitment by fuel type and torque



Source: LMC Automotive European engine & transmission forecast

Despite advances in gasoline technology, LMCA estimates that conventional diesel cars will retain their core consumer advantages over conventional gasoline cars. The same can be said for their disadvantages, primarily in the area of noise vibration and harshness.

Electrification will alter the relative merits of one fuel type over another, but is not expected to become significant (by which is meant at least 10% of the car market) until well into the next decade.

A significant number of buyers will continue to choose diesel cars

LMCA's experience of car market forecasting shows that, in the vast majority of cases, car buyers make logical decisions based on a variety of factors. Unless new diesel cars lose some of their utility (for instance, they are excluded from some city centres) or become fiscally unattractive versus alternatives, LMCA expects a significant number of buyers to continue to choose diesel.

As the current level of sales would indicate, negative headlines about diesel have had a minimal impact on car buyers' choice of fuel type so far. This is backed up by recent surveys which indicate that most motorists would not support penalties against Euro 6 diesels. A 2015 survey reported by the Society of Motor Manufacturers and Traders (SMMT) indicates that 72% of motorists would not support anti-Euro 6 diesel measures.

The SMMT also reports that 42 million Euro 6 diesel cars produce the same amount of NO_x as a single coal-burning power station, and that despite popular belief, power stations, not vehicles, are the UK's biggest producer of NO_x emissions.

Power stations, not cars, are the largest source of NO_x emissions in the UK

Additionally, the pan-European investment in diesel engine production runs into many billions of euros and supports many thousands of jobs. According to LMCA figures, 10.4 million light-vehicle diesel engines were produced in the region in 2014. Investment in the sector has not cooled in recent times, with at least three major diesel engine plant investments being undertaken over the last few years.

The CO_2 imperative

While the European car industry is currently undergoing unprecedented technical change, it will rely heavily on conventional engine technology, including diesel technology, to achieve legally binding, medium-term CO_2 emission targets. A radical move away from the planned diesel car sales mix would make achieving the 95 g/km CO_2 2021 target impossible for most OEMs. The production base, fiscal support and model pipeline are not in place to facilitate a mass move to electrification, the only alternative to diesel in the medium term if CO_2 targets are to be attained.

Diesel remains key to meeting medium-term CO_2 emission targets

The proposed long-term CO_2 target for the middle of the next decade, although not yet formalised, will require a significant shift to electrification, and roadmaps to achieve this target are being formulated by carmakers.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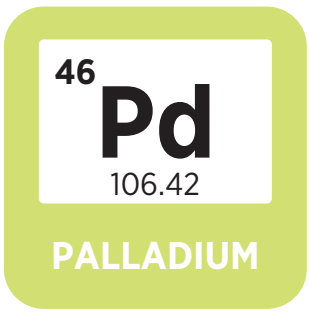
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PALLADIUM


45
Rh
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APPENDIX

Platinum supply-demand balance

Market balance, koz

	2008	2009	2010	2011	2012	2013	2014	2015e
Primary supply								
Regional								
South Africa	4,555	4,550	4,725	4,595	4,205	4,355	3,115	4,060
Russia	805	775	790	800	780	740	740	705
Zimbabwe	180	230	280	340	365	405	405	405
North America	370	275	200	375	345	355	400	385
Other	0	0	120	145	180	215	220	210
Total	5,910	5,830	6,115	6,255	5,875	6,070	4,880	5,765
Demand & recycling								
Autocatalyst								
Gross demand	3,730	2,520	2,915	3,115	3,140	3,125	3,250	3,375
Recycling	1,055	835	955	1,210	1,175	1,120	1,255	1,380
Net demand	2,675	1,685	1,960	1,905	1,965	2,005	1,995	1,995
Jewellery								
Gross demand	1,935	2,680	2,170	2,450	2,760	2,945	2,990	3,085
Recycling	390	415	475	630	840	855	775	725
Net demand	1,545	2,265	1,695	1,820	1,920	2,090	2,215	2,360
Industrial demand	1,660	1,295	1,655	1,745	1,570	1,510	1,565	1,645
Other recycling	15	15	10	10	5	10	10	5
Gross demand	7,325	6,495	6,740	7,310	7,470	7,580	7,805	8,105
Recycling	1,465	1,260	1,440	1,855	2,030	1,985	2,040	2,110
Net demand	5,860	5,235	5,300	5,455	5,440	5,595	5,765	5,995
Market balance								
Balance (before ETFs)	50	595	815	800	435	475	-885	-230
ETFs (stock allocation)	100	365	570	175	195	905	215	
Balance after ETFs	-50	230	245	625	240	-430	-1,100	-230

Source: SFA (Oxford). Notes: Numbers have been rounded. Primary supply refers to refined metal production and excludes producer sales.

Demand & recycling summary, koz

	2008	2009	2010	2011	2012	2013	2014	2015e
Gross demand								
Autocatalyst								
North America	570	335	390	385	415	420	450	485
Western Europe	1,920	1,290	1,335	1,495	1,330	1,335	1,430	1,475
Japan	540	315	480	500	595	575	580	570
China	150	95	135	120	115	125	115	115
India	90	100	145	180	210	160	160	180
RoW	460	385	430	435	475	510	515	550
	3,730	2,520	2,915	3,115	3,140	3,125	3,250	3,375
Jewellery								
North America	195	140	160	160	185	200	230	265
Western Europe	200	185	180	175	175	220	220	225
Japan	450	430	370	315	325	335	335	335
China	1,020	1,860	1,370	1,670	1,915	1,990	1,965	1,985
RoW	70	65	90	130	160	200	240	275
	1,935	2,680	2,170	2,450	2,760	2,945	2,990	3,085
Industrial								
North America	330	235	285	275	335	330	320	375
Western Europe	305	230	205	185	205	140	200	180
Japan	165	130	235	240	120	70	100	105
China	200	130	295	250	330	470	380	400
RoW	660	570	635	795	580	500	565	585
	1,660	1,295	1,655	1,745	1,570	1,510	1,565	1,645
Total gross demand								
North America	1,095	710	835	820	935	950	1,000	1,125
Western Europe	2,425	1,705	1,720	1,855	1,710	1,695	1,850	1,880
Japan	1,155	875	1,085	1,055	1,040	980	1,015	1,010
China	1,370	2,085	1,800	2,040	2,360	2,585	2,460	2,500
RoW	1,280	1,120	1,300	1,540	1,425	1,370	1,480	1,590
	7,325	6,495	6,740	7,310	7,470	7,580	7,805	8,105
Recycling								
Autocatalyst								
North America	580	550	580	600	575	560	560	595
Western Europe	310	135	195	420	405	365	470	550
Japan	115	110	145	115	115	95	105	110
China	0	0	0	5	10	20	30	30
RoW	50	40	35	70	70	80	90	95
	1,055	835	955	1,210	1,175	1,120	1,255	1,380
Jewellery								
Japan	220	130	150	285	285	250	235	215
China	170	285	325	345	555	600	530	500
RoW	0	0	0	0	0	5	10	10
	390	415	475	630	840	855	775	725
WEEE	15	15	10	10	5	10	10	5
Total recycling								
North America	585	555	585	605	575	560	565	595
Western Europe	315	135	195	425	410	365	475	555
Japan	340	245	295	400	400	345	340	325
China	170	285	325	355	570	625	565	535
RoW	55	40	40	70	75	90	95	100
	1,465	1,260	1,440	1,855	2,030	1,985	2,040	2,110

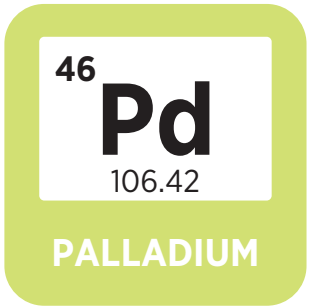
Source: SFA (Oxford). Note: Numbers have been rounded.

Palladium supply-demand balance

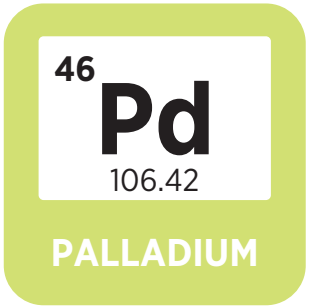
Market balance, koz

	2008	2009	2010	2011	2012	2013	2014	2015e
Primary supply								
Regional								
South Africa	2,345	2,425	2,590	2,550	2,355	2,360	1,860	2,290
Russia	2,700	2,675	2,720	2,705	2,630	2,580	2,690	2,610
Zimbabwe	140	180	225	265	280	315	330	310
North America	880	610	580	865	895	975	1,055	1,055
Other	0	0	300	390	445	450	455	445
Total	6,065	5,890	6,415	6,775	6,605	6,680	6,390	6,710
Demand & recycling								
Autocatalyst								
Gross demand	4,790	4,095	5,625	6,190	6,700	7,145	7,525	7,810
Recycling	1,215	1,155	1,395	1,525	1,485	1,645	1,780	1,955
Net demand	3,575	2,940	4,230	4,665	5,215	5,500	5,745	5,855
Jewellery								
Gross demand	350	325	370	440	530	505	480	490
Recycling	0	0	100	135	130	145	120	165
Net demand	350	325	270	305	400	360	360	325
Industrial demand	2,910	2,780	2,690	2,495	2,250	2,025	1,860	1,815
Other recycling	315	340	400	350	345	365	370	360
Gross demand	8,050	7,200	8,685	9,125	9,480	9,675	9,865	10,115
Recycling	1,530	1,495	1,895	2,010	1,960	2,155	2,270	2,480
Net demand	6,520	5,705	6,790	7,115	7,520	7,520	7,595	7,635
Market balance								
Balance (before ETFs)	-455	185	-375	-340	-915	-840	-1,205	-925
ETFs (stock allocation)	380	480	1,110	-535	285	0	940	
Balance after ETFs	-835	-295	-1,485	195	-1,200	-840	-2,145	-925

Source: SFA (Oxford). Notes: Numbers have been rounded. Primary supply refers to refined metal production and excludes producer sales.



Demand & recycling summary, koz



	2008	2009	2010	2011	2012	2013	2014	2015e
Gross demand								
Autocatalyst								
North America	1,545	1,005	1,310	1,495	1,730	1,825	1,955	2,080
Western Europe	965	920	1,280	1,490	1,415	1,520	1,635	1,665
Japan	925	605	810	670	735	745	740	725
China	395	705	1,010	1,130	1,300	1,515	1,670	1,770
India	90	105	150	160	165	160	170	185
RoW	870	755	1,065	1,245	1,355	1,380	1,355	1,385
	4,790	4,095	5,625	6,190	6,700	7,145	7,525	7,810
Jewellery								
North America	55	50	65	80	85	80	80	80
Western Europe	100	85	105	80	85	80	70	70
Japan	20	20	20	20	15	15	15	15
China	55	75	65	145	215	205	195	200
RoW	120	95	115	115	130	125	120	125
	350	325	370	440	530	505	480	490
Industrial								
North America	520	505	495	460	445	440	415	415
Western Europe	320	325	365	360	370	330	335	335
Japan	675	635	625	600	615	500	445	430
China	905	855	740	540	375	360	285	270
RoW	490	460	465	535	445	395	380	365
	2,910	2,780	2,690	2,495	2,250	2,025	1,860	1,815
Total gross demand								
North America	2,120	1,560	1,870	2,035	2,260	2,345	2,450	2,575
Western Europe	1,385	1,330	1,750	1,930	1,870	1,930	2,040	2,070
Japan	1,620	1,260	1,455	1,290	1,365	1,260	1,200	1,170
China	1,355	1,635	1,815	1,815	1,890	2,080	2,150	2,240
RoW	1,570	1,415	1,795	2,055	2,095	2,060	2,025	2,060
	8,050	7,200	8,685	9,125	9,480	9,675	9,865	10,115
Recycling								
Autocatalyst								
North America	850	890	975	975	930	1,005	950	1,025
Western Europe	250	135	205	335	325	345	410	425
Japan	95	100	175	130	125	125	130	140
China	0	0	0	15	20	50	145	165
RoW	20	30	40	70	85	120	145	200
	1,215	1,155	1,395	1,525	1,485	1,645	1,780	1,955
Jewellery								
Japan	0	0	10	15	20	20	20	20
China	0	0	90	120	110	125	100	145
	0	0	100	135	130	145	120	165
WEEE								
North America	85	85	80	70	75	70	65	65
Western Europe	70	75	115	80	80	85	85	85
Japan	115	115	130	125	110	130	135	140
China	15	15	20	15	20	20	15	10
RoW	30	50	55	60	60	60	70	60
	315	340	400	350	345	365	370	360
Total recycling								
North America	935	975	1,055	1,045	1,005	1,075	1,015	1,090
Western Europe	320	210	320	415	405	430	495	510
Japan	210	215	315	270	255	275	285	300
China	15	15	110	150	150	195	260	320
RoW	50	80	95	130	145	180	215	260
	1,530	1,495	1,895	2,010	1,960	2,155	2,270	2,480

Source: SFA (Oxford). Note: Numbers have been rounded.

Rhodium supply-demand balance

Market balance, koz

	2008	2009	2010	2011	2012	2013	2014	2015e
Primary supply								
Regional								
South Africa	610	660	650	645	600	590	425	560
Russia	80	75	75	75	75	70	75	70
Zimbabwe	15	20	25	30	30	35	35	35
North America	30	20	15	30	30	35	40	40
Other	0	0	10	10	10	10	10	10
Total	735	775	775	790	745	740	585	715
Demand & recycling								
Autocatalyst								
Gross demand	915	585	730	740	770	820	860	890
Recycling	190	170	220	235	235	260	275	310
Net demand	725	415	510	505	535	560	585	580
Industrial demand	140	110	170	170	150	155	160	160
Other recycling	3	2	1	1	1	1	2	2
Gross demand	1,055	695	900	910	920	975	1,020	1,050
Recycling	195	170	220	235	240	265	275	315
Net demand	860	525	680	675	680	710	745	735
Market balance								
Balance (before ETFs)	-125	250	95	115	65	30	-160	-20
ETFs (stock allocation)				15	35	50	10	
Balance after ETFs				100	30	-20	-170	-20

Source: SFA (Oxford). Notes: Numbers have been rounded. Primary supply refers to refined metal production and excludes producer sales.

Demand & recycling summary, koz

	2008	2009	2010	2011	2012	2013	2014	2015e
Gross demand								
Autocatalyst								
North America	275	150	180	180	200	230	240	255
Western Europe	265	190	200	215	190	205	225	230
Japan	240	115	165	135	150	145	145	140
China	30	45	70	75	90	100	110	115
India	10	10	15	20	20	15	15	20
RoW	95	75	100	115	120	125	125	130
	915	585	730	740	770	820	860	890
Industrial								
North America	15	10	15	20	15	15	15	15
Western Europe	15	15	25	20	20	10	15	15
Japan	45	35	45	45	45	40	40	40
China + RoW	65	50	85	85	70	90	90	90
	140	110	170	170	150	155	160	160
Total gross demand								
North America	290	160	195	200	215	245	255	270
Western Europe	280	205	225	235	210	215	240	245
Japan	285	150	210	180	195	185	185	180
China + RoW	200	180	270	295	300	330	340	355
	1,055	695	900	910	920	975	1,020	1,050
Recycling								
Autocatalyst								
North America	115	125	160	140	145	165	155	170
Western Europe	50	20	30	60	60	55	70	75
Japan	20	20	25	25	25	25	30	35
China	0	0	0	0	0	5	5	5
RoW	5	5	5	10	5	10	15	25
	190	170	220	235	235	260	275	310

Source: SFA (Oxford). Note: Numbers have been rounded.

GLOSSARY OF TERMS

Base metals
Copper and nickel

Basket price
Collective revenue of metals divided by 4E oz

By-products
Copper, nickel, iridium and ruthenium

CAPEX
Capital expenditure

Dow
Dow Jones Industrial Average

Emissions legislation
Tailpipe regulations affecting particulate matter, hydrocarbons and oxides of nitrogen (NO_x)

ETF
Exchange traded fund

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

Exhaust gas recirculation (EGR)
A strategy to control NO_x emissions from diesel engines

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

Gross demand
A measure of intensity of use

HDV
Heavy-duty vehicle

Head grade
Grams of 4E PGMs per tonne of ore milled

Ingot
Platinum bullion bars

koz
A thousand ounces

Large speculators
Non-commercial traders on NYMEX

LCV
Light commercial vehicle

Lean NO_x trap (LNT)
Platinum and rhodium-based, catalyses the chemical reduction of NO_x in diesel engine exhaust to harmless nitrogen

Lease rates
Fees payable for the rental of an asset

Long-term liquidity
Includes all estimated inventories available in both the short term (unassigned vaulted metal) and the long term (investment products and the industrial and jewellery working inventory)

Low temperature polymer electrolyte membrane (PEM)
A semi-permeable membrane generally made from ionomers and designed to conduct protons while being impermeable to gases such as oxygen or hydrogen

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

Metal cocktail
The make-up of polymetallic orebodies

Mine lease area
Area defined by farm boundaries

moz
Million ounces

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

Net supply
Proxy supply of metal surplus to requirements

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

NYMEX
An exchange on which platinum futures and options contracts are traded

OEMs
Original equipment manufacturers

OPMs
Other platinum-group metals

oz
Ounce

Particulate filter (DPF, GPF)
Platinum-rich catalyst on ceramic filter, removes harmful fine particles from diesel and gasoline exhausts

PGMs
Platinum-group metals

Price elastic
Susceptible to changes in price

Primary supply
Mine production

Producer sales
Mine output plus inventory sold to market

Real-world driving emissions (RDE)
Real-world driving emissions from vehicles are often higher than those measured under laboratory conditions; it is proposed that Euro 6c legislation (expected around 2017) will begin to enforce these real-world limits

Secondary supply
Recycling output

Selective catalytic reduction (SCR)
PGM-free, converts harmful NO_x in diesel exhausts to harmless nitrogen, via a tank of urea solution; used in heavy-duty diesel vehicles, increasingly competes with LNT in light-duty diesel vehicles

Short-term liquidity
A term used by SFA to describe estimated immediately available metal stock, i.e. vaulted metal that is not tied up in investment products and the necessary working inventory of industrial and jewellery end-uses

Sponge
A form of platinum used in autocatalyst and industrial manufacturing

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

Tonnes milled
Concentrator throughput of ore

UG2 Reef
Also found in South Africa, this chromite-rich layer of rock contains fewer by-products than the Merensky Reef

WLTP
Worldwide harmonized Light vehicles Test Procedure determines levels of emissions and fuel consumption; expected to differ somewhat from the previous testing procedure

4E
Platinum, palladium, rhodium and gold

Currency symbols

ZAR	South African rand
$	US dollar
£	UK pound

METHODOLOGY NOTES

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

Gross demand is a measure of intensity of use.

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

Automotive demand is based on vehicle production data not sales.

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