The Automotive Sector: A Driver of Demand and Supply

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Introductory Comments

Thank you for the introduction. When I saw the title in the programme I thought maybe the title was a little bit misleading, because what you will not see me doing here is giving exact projections in terms of demand from the whole sector, and nor will I do the same for the supply generated by our industry. What I rather would like to do is take you through the technological trends that we see and also the legislation roadmap, which is important and which drives our industry. At the beginning I cannot not address some basics of catalysts. I do not know whether we have engineers in the room? Show of hands? I thought so.

Automotive Catalysts

So, this is what an automotive catalyst actually looks like. Here we see some of the ingredients on the bottom of the slide. You see the substrates, which are actually not catalytically active. They provide a stable matrix that holds the catalyst and you see on the left side a cut through a catalyst. The curved material is actually the catalyst and the material that has the catalytic activity. Most of it does not consist of the precious metal. In fact, it is only a small part that contains the precious metal. The vast amount of it is made up of oxide components like aluminium oxides and others. Obviously, what a catalyst does is what the name suggests that it does, which is it makes chemical reactions go faster, reactions that would not otherwise be sufficiently fast at the temperatures that we need them to proceed. Those chemical reactions take toxins like nitrogen oxides, carbon monoxide, hydrocarbons and particulate matter and turn them into non-harmful components.

Megatrends

(a) Increased Focus on CO\(_2\)

So, what are the megatrends in automotive catalysts? Number one, it is certainly the increased focus on CO\(_2\), which means energy efficiency. This is a big focus now, especially in Europe, and everything that the car manufacturers and the engine manufacturers do is basically directed towards that single goal, to make the engines consume less and produce less CO\(_2\). In non-OECD economies and the BRIC countries, what we see there is they are fast catching up with the emission legislation that we have in Europe and North America, which is ultimately what drives the implementation of the catalyst and ultimately therefore also drives the demand for the precious metals that go into those catalysts.

(b) New Markets

Another megatrend is that we have whole new markets that are being created as we speak, basically, and those are mainly in diesel, in heavy duty applications that are the trucks that you see on the road, but also in heavy machinery, like in excavators, in farming equipment, and even the marine sector, and they will create a huge market in the future.

(c) Electrification

I have seen one of the questions on the screen here that addresses electrification, which is obviously a megatrend. There is no question about this, but we do not see electrification making any dent in the precious metal demand from our sector in a 10-year time frame, because simply the volumes and the number of cars with electric propulsion will be too low.

Factors Influencing PGM Demand

Here is a slide that gives you a little idea of which factors can influence the PGM demand from the catalyst sector. Obviously, one is growth in the global car market: the more cars you have, the more
catalysts you also have and the more precious metal you need. Another is tightening of emission legislation for cars. Obviously, that drives up demand. There is also what I just talked about, which are the new markets that we are seeing being created in heavy duty, non-road and on-road applications. On the other side, there is the increasing recycling rate. Obviously, that will reduce the demand for new PGM. By improving PGM efficiency, I mean doing more with less, and obviously this is the goal of my industry, to be ever more efficient and to formulate ever better catalysts that need less and less precious metal and can still meet the required performances. In terms of the increasing share of electric vehicles, obviously if all the cars on the road have a battery and do not have an internal combustion engine any more, obviously we would not need after treatment, but this is a very long way off. Especially in the last year, there has been some pessimism, I would say, to where electrification can go within the next 10 years or so, especially in China, I should add, which had very ambitious goals. I think they had a stated goal like 5 million electric cars on the road in 2020.

Catalyst Glossary

(d) Overview

This is a little catalyst glossary. The reason why I added this is because different types of cars – diesel versus gasoline versus heavy duty, light duty – require different types of catalyst. Different types of catalyst have different mixes of precious metals going into them, and I will just take you quickly through them. The SCR, for example, is a technology that we are seeing being applied to diesel applications, both light duty as well as heavy duty, and it does not have any precious metal, so that is important to notice. Then there is DOC, the diesel oxidation catalyst, which is applied, as the name would suggest, to diesel applications. It uses platinum and palladium, and no rhodium. The particulate filter is also technology for diesel applications. It uses both platinum and palladium. The TWC has been the workhorse of after-treatment for many years and it is the technology that has been used in petrol applications, and it can use all three PGMs, that is platinum, rhodium and palladium, and in fact, nowadays it almost has no platinum at all, and this is simply because of pricing. Platinum and palladium are mutually exchangeable in a TWC and adjustments are being done on pricing grounds, and as of the price being at the moment low for palladium, the platinum is almost not used at all.

(e) Lean NOx Trap

This is a technology that will be used in Europe in the coming years. It is called the lean NOx trap. It is also a diesel application and it uses all three precious metals. In some degrees, they can be interchanged for others. Here I have a nice little slide that gives you a colour code for this. What you see here in red are diesel technologies. As I said, the CDPF has platinum and palladium. There is the DOC, which is platinum and palladium as well. The SCR is PGM-free, and the blue ones are applied for petrol application. The L&T[?] can strictly be used for both, but I will not go into those details.

(f) PGM Flexibility

PGM flexibility is a very important question and a very important challenge, and obviously we as catalyst producers need to be able to react when the price differentials between two or three different precious metals change rapidly. In fact, flexibility is there but it is not unlimited. For example, in the case of platinum and palladium, in TWC I just told you they are completely interchangeable. That is true and in fact that is what happened in 2001, when the price differential suddenly changed. I will have a chart of the prices in the next slide here.

For diesel, this is very important, because the big new markets that will be created in the coming years will be created in diesel heavy duty and those technologies will mostly be using platinum. There are some options there to change the one for the other, but it is also limited by the fuel quality. The fuel quality in China and India, in those big markets, is not on par with what we have in Europe, because they have higher sulphur. That means that you cannot change all the platinum for palladium, so that basically means that in those new markets that we will see emerging, a lot of the after-treatment systems will be much heavier in platinum than what we have seen so far in Europe.
(g) Petrol and Diesel

This is what I was referring to in 2001. You can see the black curve and the red curve intersecting. That was the time when for a brief period of time they changed from palladium to platinum because platinum was at that time for a brief period of time cheaper than the palladium. What is important to note regarding the global car market is that it is basically a petrol market. We believe in Western Europe that a large portion of the passenger market is in fact diesel, and in Western Europe that is the case, obviously, but it is an exception in most parts of the world. As you see here in this diagram, the big portion of the car park in the world is gasoline, and the reason why I am saying this is because I just went through the precious metals that go into those different catalysts, and a gasoline application would be the one that would be equipped with a TWC, with a three-way catalyst, and they would normally be rich in palladium. They would also require rhodium.

On light duty applications and the mix going forward, what I want to say here is that from the standpoint of energy efficiency, the diesel is very attractive, obviously. It has the best fuel efficiency of all the internal combustion engines, but the thing is that the growth in the diesel segment in a way is also limited, because after-treatments are relatively expensive and also because some countries might find it hard to provide all the diesel necessary. For example, if in China, suddenly the passenger car diesel segment were to explode, then it would be difficult to provide all the diesel, so there are some limits to where the light duty diesel segment can go.

Legislation Trends

First, in OECD countries we see some further tightening of pollutant emissions, and this is mostly what we call the so-called off-cycle emissions. That means basically emissions under conditions which so far have not received a lot of attention. That is basically under higher speed conditions and so forth, and this will be more of a focus going forward and maybe that also will require more performing catalysts. Mostly what is on the minds of our customers in Europe is CO₂, to make the cars more energy efficient. This is clearly the main focus in Europe. The last point that I want to make is since I am not talking about total demand from our industry but I am rather focusing on precious metal per vehicle, this is a number that we do not see change much in Europe going forward, especially in the petrols segment and in the gasoline powered cars. We do not believe that even though there might be further tightening in the emission legislation, we do not see any further growth in PGM per vehicle.

In the non-OECD countries the big news here and in fact where the money is, as I have said, before, in heavy duty, in on-road but also in the off-road sector. That is where markets that so far have not existed will be created, in fact huge markets. What we see here is this is mainly a diesel market, so those diesel trucks will mainly need platinum as a PGM input. In the gasoline sector, for example, in countries like India and China, they already have after-treatment there, and they will be further tightening there as well, but this tightening will not lead to a further increase or substantial increase of PGM per vehicle, so this is a similar situation that we have in Europe as well.

What you see here is basically that throughout the world we have different legislation systems. The blue ones all follow the European legislation and those different systems they are different because they have different criteria to test cars. They have different driving cycles. The blue ones all follow Europe’s lead and they go through the same emission steps that we went through, but only a few years later. Then you have the red ones. They are following the American legislation. Then I guess the Japanese have their own system there, but basically the world falls into those two categories. The key message really is that these emissions keep on being tightened.

This is heavy duty. I do not want to go through all the numbers here. I think maybe you will have the presentation on the stick later and you can have a close look if you want. The message is only that for diesel, heavy duty, on-road and off-road, there is either emission already place or it will be introduced shortly, and that is the reason why this market is so interesting and so lucrative because it has not existed before and it is something that many people want to position right now into that market. Those are the after-treatment systems that will be needed for the heavy-duty segment.

They will all combine a diesel oxidation catalyst. The red filter is what we call a partial flow filter. This is a device that I will not talk about and it does not contain precious metal. Or, it could be what I call CDPF, which is the flow-through filter with a very high trapping efficiency and it contains
precious metal. Again, the message here is that those systems, prepared with the TWC, are relatively rich in platinum.

The new markets being created mainly in Asia that have not existed so far in India and China in the heavy duty segment will all require systems that are relatively heavy. In platinum, they will use only a little palladium, and the mean reason is because of the fuel quality in those countries. You have a relatively high amount of sulphur and palladium is very sensitive to sulphur and therefore we believe that this new demand will mainly be from platinum and not so much from palladium.

**PGM Recycling**

A quick word on PGM recycling. I think tomorrow we have a presentation for that topic. As you have noticed, in my presentation I have not talked so much about it. It is a huge area for itself and a lot can be said about. Obviously, it makes a lot of sense to produce more and more precious metal from products, because I do not know what the percentage of the precious metal is in your ores. I am sure it is much lower than what you find in a catalyst in the product, so I believe I have heard something like at the moment, the recycling rates for the catalyst that are being bought today will be order of some 60%. It is a large number and it makes perfect sense. One of the key pre-conditions for this to work obviously is a network for collecting the scrap catalyst and this is something that is in place in some of the countries of the world. In some countries it is under development, including in China.

**PMG Efficiency**

I think I mentioned at the beginning that is obviously what we all want to do. We want to achieve more with less, and that is something that we do. On the other hand, I think it is not realistic if people say or if people assume that there will be in a few years something that will completely replace the precious metal for use in catalysts. There is no such thing that we see on the horizon, this is clear. We do not see a quantum leap in PGM reduction per catalyst. So, we believe the amounts of precious metal might go somewhat further down per catalyst, but there is certainly no quantum leap or no magic new formula. There is no new magic element that will achieve this. Complete substitution of PGM with base metals is also something that we do not see on the horizon and we do not believe is a realistic prospect at the time.

Last but not least, one of the reasons why I guess it is so difficult to make prognoses about future absolute demands from our sector is because there is so much uncertainty in growth, obviously. I have talked a lot about precious metal per catalyst and per vehicle and I think we have a good idea where this will be, but obviously it is very difficult to say anything about future growth in the car market. I always like to look at this one, for example. This is McKinsey. I am sure they have been paid well for this report, where they actually predicted out the Chinese car market out to 2030. They did this in 2006. It looks to me that they just took a ruler, put it over two of the three bars, and we will see. I hope I am still around at that time. I expect to be. This is the big unknown, I guess, in our market.

**Conclusion**

So, this is the summary. The main message that I want to leave here is that we believe the new markets in diesel and heavy duty, on-road and off-road, will basically require catalysts that are relatively heavy or highly loaded. I should not say highly loaded, but the ratio of platinum will be rather high in those catalysts, higher than what you find in what is the current precious metal mix in North America or Europe. We do not believe that there will be any further substantial increase of PGM loadings per car in gasoline applications, even though India and China have not caught up to where we are in Europe, but those future tightening will not require substantially higher amounts of PGM. There is no substitute for PGM on the horizon. Again, the big unknown about growth in China and in fact economic growth in the entire world is unknown and it is difficult to say, but surely it will have a big impact on the demand from our industry. With this, I hope I am still within your time budget, and I am happy to answer questions later. Thank you.