Future Trends in Off-Road Engine Demand – Platinum Saviour?

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Introduction
Thank you, Tom. I do appreciate the invitation. Having focused on the off-road world in the last six years, I get to go to fun places like Detroit, Waterloo, Iowa, Peoria, Illinois, so Montreal is a nice change and I have to say it is the best-looking audience I have ever seen at a conference. In the off-road marketplace, the only dress code requirement typically is that you are clothed, so it is interesting to see a different crowd.

What I am going to try to do today is give you a brief overview of the off-road market. I will briefly touch on the technology component to it, delve into some of the regulations that are driving the market which, from an off-road perspective, started this year, and then some of the marketing factors that are driving it after the regulatory reasons. The regulatory market drivers and issues of forecasting off-road engines is the key point I want to get across.

The Controlled Pollutants
First I would like to paint a picture to give this industry a little bit of public relations in terms of what we are trying to do here. Hopefully you can take away that the end product of platinum and palladium is being used to make the world a better place. We have gotten there in the on-road world starting in 2007, and we are starting this year in the off-road world.

I do not know how many of you remember when you used to have a bus pull away from a bus stop and that huge black cloud that would go spurting out in front of you? We have pretty much taken that away from the on-road world and we are now working on the off-road side.

What we are trying to get rid of is carbon monoxide, hydrocarbons, oxides and nitrogen (what the industry refers to as NOx) and particulate matter. Now we are starting to clean up the off-road world.

Review of Technology
Off-Road Typical Layout
This is the one place where the off-road world mimics the on-road world with just a lag in timing. The first phase of off-road implementation is what I will get into later. Tier 4 Interim and Stage IIIB in Europe is what the on-road world did in 2007. We basically take a diesel engine; we put a diesel oxidation catalyst in the back-end, platinum- and palladium-loaded catalyst, and follow that out with a diesel particulate filter, also a platinum and palladium catalyst.

Review of Technology
The difference that is going to happen in 2014-2016 in the off-road world, which has happened this year in the on-road world, when we go to Tier 4 final, is we will take that same technology and add an SCR system on the back-end to it and an ammonia oxidation catalyst. The SCR catalyst at this point is typically a base metal catalyst, so I do not know if that is really going to get this world jazzed up, but the ammonia slip catalyst is a platinum-based catalyst, so that will add a little bit more to platinum offtake.

What are you putting on the back of these trucks? These oxidation catalysts remove carbon monoxide and hydrocarbons. To put some scale to it, they are three to sixteen litre bricks. An automotive brick is somewhere from one to three litres. You are putting a diesel particulate filter on there obviously to remove particulates, selective catalytic reduction to remove the NOx and ammonia oxidation catalysts to remove any excess ammonia still in the system.

Regulatory Drivers
What Drives Off Road Heavy Duty Need for Catalysts?

Government regulations
I certainly got the tone today that most of this industry is not in love with regulations. On the other side of the coin, I love regulations. Nobody would buy anything from me without it so we are
pro-regulation on our side. This is where the on-road world started in 2007. The on-road regulations started mandating the use of DOCs and CSFs or DPFs – diesel particulate filters to remove particulate matter.

On-road in 2010 moved to needing higher NOx removal, so they went to DOC, DPF and an SCR system. The off-road regulations will be phased in and they started this year requiring DOCs and DPFs. The way the off-road world is phasing this in over a three-year period is by engine size, so this year any engine over 130kWs needed to be regulated. Next year you will bring in the 56-130kW engines, and in the final year, 2013, the less than 56kW engines and above 19kW engines will need DOCs and DPFs.

What does this mean in terms of forecasting? Right now you have the bigger engines, which obviously need more catalysts but there are fewer of them. As we roll the smaller engines in next year and the year after, the catalysts will be smaller but the market of total number of engines will be much larger. When you look at your platinum and palladium offtake, you are going to have to factor this in as the engine size rolls into the market. In 2014 and 2016, they are going to do the same thing with final Tier 4 and once again phase it in by engine size.

**The state of the economy (and customers)**

The other thing that drives the use of catalysts is the economy and our customers. The industry itself is very diverse in off-road as opposed to on-road. In on-road it is very easy to get a J. D. Power report that will say there are 157,000 class A trucks that are going to be sold in the US this year and 180,000 next year, and you can do the same thing in Europe and the rest of the world. It is also very easy to get that number for class 4-7, but in the off-road world it becomes a little trickier because you are not talking about just one industry. You have a bunch of different industries that might be moving in different directions and where they are in the economy at the moment. That is the tricky part.

**Off-road regulations**

Sometimes a picture is worth a thousand words.

**Off-Road Regulations**

![Diagram](image)

This one shows particulates on the vertical and NOx on the horizontal axis. I have been in this industry for 18 years and I still don’t know what a gram per brake horsepower hour is. To give you a relative term, Tier 1 engines and Tier 2 engines were mostly done by engine control within the engine itself. Once we moved to Tier 3 and Tier 4, you started needing after-treatment devices and thus increased the need for platinum and palladium.
Just from a scale perspective, the first wave of Tier 4 regulations focused on particulate matter. After they got the particulate down, they started cranking down on the NOx regulations themselves.

Global regulations
Global regulations seem to have come together a little bit more, at least in the off-road world, and they are somewhat aligned in that Stage IIIb in Europe is aligned with US interim Tier 4 and then final Tier 4 in the US is Stage IV in Europe, so at least the European union and the US and Japan have come somewhat in line in how they are doing this. This makes the engine manufacturers much happier from the production side. The phasing is also the same in Europe as in the US.

Let me quickly touch on possible future global regulations.

Fuel economy/CO$_2$-based legislation
The off-road world follows the on-road world, which follows the light-duty and automotive world. CO$_2$ regulations and the global move toward better fuel economy could increase needs. Where the off-road demand is going to increase is pretty easy to figure out because it will follow on from the on-road side.

Market Drivers
What are the market drivers? Off-road is obviously not like on-road. Complexity not only comes in the number of engine producers but the number of applications. You are now looking at somewhere around 24 major engine OEs. That is six major ones, 24 total ones. They now go in about 600 machine manufacturers, or machine OEs, so if you think about that to go find a report on what the on-road side is doing, I would give DDC, Volvo and Cummins a buzz. The other people I might worry about; they are 5% or 10% or whatever the number is. But if I go to the off-road world, I now have to call up 600 companies and say, ‘How does your cherry-picker forecast look? How does your mining equipment look? How does the road grader equipment look?’

We all tend to think about the agricultural harvester and the road grader because they are the two things we see as we drive around this world, but if you stand back and think about all the thousands of different small applications there are that use a diesel engine, it is quite immense. On the positive side that means we are going to sell a lot more platinum, catalysts and applications. The difficult side is figuring out what that number will be.

Markets
You are looking at a couple of major markets: construction, material handling, lawn and garden, agricultural, small marine applications, mining applications and utility applications. The other part I did not delve into, and this is the locomotive, marine, aircraft and stationary applications that will also kick in. That is a whole other level of complexity in terms of regulations and where in the world you are.

General economic trends
Some markets are going up and some are going down. The construction industry, which takes a lot of diesel engines, has hit hard times. I guess the saying is, ‘They dropped their shovels, and after they dropped their shovels they turned the diesel engine off, and then they stopped ordering wood from the companies that have nice diesel equipment out in the forest.’ You would not believe these things can take a tree, cut it, flip it sideways and skin it and throw it in a pile. It is an impressive piece of speciality equipment, but that market is in the toilet, for lack of a better way to put it.

The road construction industry seems to have come back a little bit. On the US side, some of the funds that were sprung out by our current government to stimulate the economy helped that industry a little bit, but now the money has dried up so they are flat.

The agricultural market is doing great. The agricultural commodity prices are up and the agricultural industries are selling a ton of equipment so that is a positive.

Some port expansions and port regulations are driving some need for port equipment for vehicles that service the ports.

I could go on in a lot of different industries for this, but I wanted to point out that you have one going down and one going up, so it is difficult to say how that affects the total number of engines in the off-road world.

What are the future market drivers for off-road engines?
Its legislation. I guess the real estate market is location, location, location, and in my world it is regulation, regulation, regulation.

**Maximise fuel economy/Minimise CO2**

They will certainly look to maximise fuel economy and minimise CO$_2$, fuel economy being the obvious one. If they could figure out a way to make the emissions cost less money from a fuel penalty standpoint, they will move in that direction. In the automotive side you typically think about cutting precious metals to reduce the cost. In the diesel side, sometimes fuel economy is more important so it might not necessarily mean cutting platinum. It might actually mean putting more platinum in it if you can get a better fuel-efficient vehicle, since these vehicles tend to be on the road or in the field longer than when you are buying a car. They are also a lot more expensive to begin with, so the fuel cost trade-off is a little bit different.

As I say, a picture is worth a thousand words;

![Picture of catalysts](image)

the small, white brick shown on the left here is an uncoated automotive catalyst. It is uncoated so you can see the contrast. The black catalyst on the right is a diesel oxidation catalyst, and the big brick on the left is a diesel particulate filter, so that just gives you some scale of what we are talking about from the automotive industries moving to a diesel industry.

**Conclusion**

I do not know if I have answered your questions or confused you even more, but in any case thank you for your attention.