Institute of Transport Economics
Norwegian Centre for Transport Research

Summary:

Emissions from new vehicles - trustworthy?

Euro 6/VI – status 2015

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Our measurements show that modern heavy vehicles with Euro VI engines have low emissions of nitrogen oxides (NO_x) and exhaust particles (PM) for all types of test cycles. The reductions are more than 90% compared to the emissions from previous Euro V generations. New Euro 6 cars with diesel engines, however, are still struggling with too high NO_x emissions.

Since 2011, TØI in collaboration with VTT in Finland have conducted emission measurements of 12 heavy vehicles with Euro VI engines, and seven Euro 6 diesel cars. In addition, several petrol vehicles (Euro 5 and 6) and diesel vehicles (Euro 5) are measured. The study is funded by the Norwegian Public Roads Administration, as part of the "EMIROAD" program. All vehicles are tested in laboratory under conditions that as far as possible should correspond to the actual use of the vehicles.

Big reduction in NO_x emissions from heavy vehicles – still high emissions from light diesel vehicles

Based on our testing of vehicles in 2013-14 the main conclusion is that the NO_x emission in real traffic and in cold weather (-7 °C) from new light vehicles with Euro 6 diesel is still high. Heavy vehicles with Euro VI engines including city buses now have effective technology for purification of NO_x, and emit only small amounts of all types of exhaust components, see Figure S1.

Figure S1: New heavy vehicles with Euro VI approved diesel engines have very low emission of all types of local emissions. NO_x emission from new passenger cars with Euro 6 diesel engines under demanding city-driving conditions is still a challenge for urban air quality. The emissions shown are typical for demanding city-driving for passenger cars and city-buses, respectively.

Based on measurements of 12 heavy vehicles with new Euro VI approved engines and seven Euro 6 approved cars with diesel engines, it is possible to draw two clear conclusions when it comes to exhaust emissions:

- **All the tested heavy vehicles with Euro VI engines have very low emissions of NO_x and PM in real traffic. The tested NO_x and PM emissions were less than 1/10 of that from previous generations of city buses and other heavy vehicles with Euro VI engines, more or less regardless of the driving cycle used when testing.**
- **Euro 6 type approved private cars with diesel engines have 4-20 times higher emission of NO_x in city traffic and during cold weather than the type approval limit value (0,08 g/km), see Figure S2. The average emission of NO_x from the tested Euro 6 private cars with diesel engines was also about four times higher than the average emission from the tested city buses and heavy vehicles with Euro VI engines.**

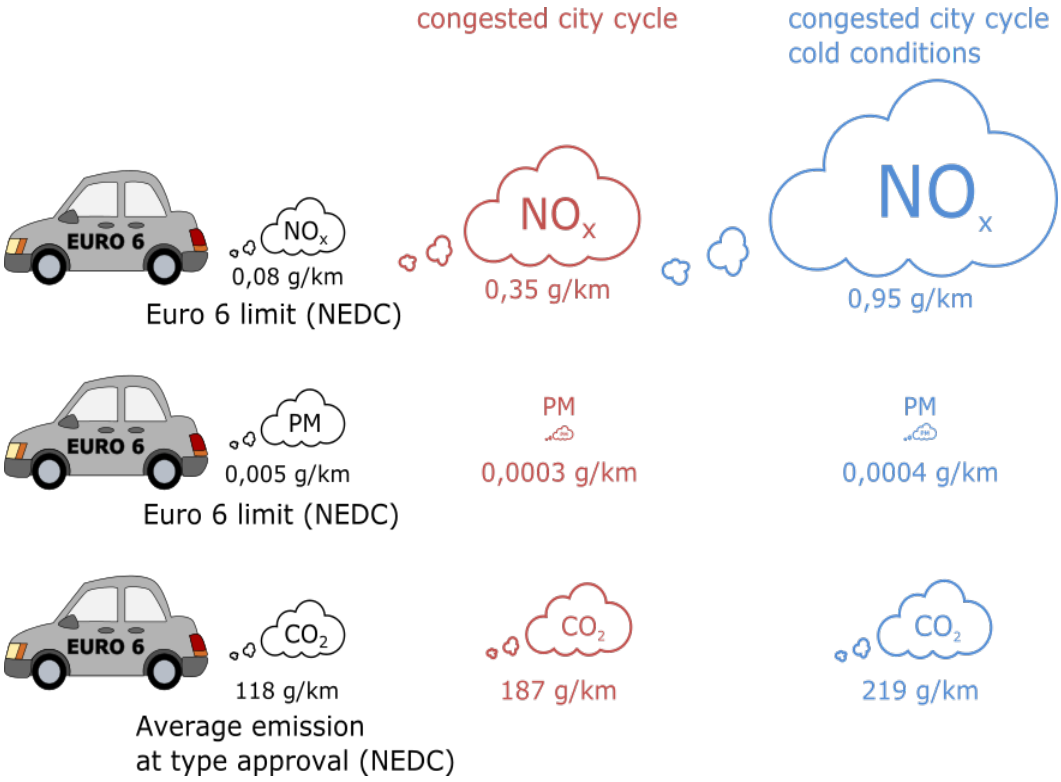

Figure S2: Comparison between limit values from EUs type approval regulations (black clouds) to emissions in "real life" city traffic from the average Euro 6 diesel passenger car. NO_x, PM and CO_2 emission when using the Helsinki city cycle. Measured at +23 °C (red clouds) and -7 °C (blue clouds). The size of the red and blue clouds indicate the difference in emission from the emission in the type approval test (NEDC).

Currently, no heavy vehicles have been tested in cold weather conditions. Our assessment is that heavy vehicles with Euro VI engine will have low emissions of NO_x even in cold test conditions, but this will be tested during the winter 2015/2016. We will then perform emission tests aboard three buses with Euro VI engines.

We notice that new private cars with diesel engines generally have trouble complying with the limit values for NO_x from the type approval, when used in real life city

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traffic. The type approval of light vehicles is conducted by driving the NEDC driving cycle (New European Driving Cycle). The NEDC driving cycle has low acceleration levels and provide emission values of NO_x and NO_2 which is lower than emissions when driving in real city traffic, and often significantly lower than emissions when starting and driving in cold weather conditions (-7 °C).

In real traffic, Euro 5 diesel cars and the seven tested Euro 6 passenger cars with diesel engines generally have low emissions of PM. The limit value for Euro 6 approval is significantly higher than what we measure from new Euro 6- approved diesel vehicles under all driving conditions. New diesel cars have, in other words efficient and well-functioning particle filters.

For fuel consumption and exhaust emissions of CO_2, the values from all kinds of new light vehicles are higher than what is measured in the type approval cycle NEDC. Type approval values for CO_2 emissions from cars are, despite the fact that they are low, in proportion to the size of CO_2 emissions in real traffic. A car that has low CO_2 emissions in type approval have as a rule somewhat higher emissions (20-95 %) in real traffic. A car that has high CO_2 emissions in type approval will have even higher emissions in real traffic. The low emission values from the type approval may give the impression that the cars are more environmentally friendly than they actually are.

Technically possible to reduce the emission from light duty diesel vehicles

TØI and VTT have initiated emission measurements at VVT's laboratory in Helsinki. These measurements have made it possible to quantify local pollutant emissions from new Euro 6 cars and heavy vehicles with engines that meet the Euro VI requirements. The vehicles are tested in demanding, but realistic driving cycles.

Diesel cars in general, and heavy vehicles with Euro V diesel engine have high emissions of NO_x in real traffic. Starting with the implementation of oxidizing catalysts and particulate filters for diesel cars we can register a significant increase in the proportion of NO_2 in the total emissions of NO_x. This has resulted in increased emissions of NO_2 in cities, as well as violations of the limit value for NO_2 emission in several Norwegian cities.

Diesel (specification EN590) and petrol (specification EN228) produce emissions of various harmful gases, by combustion in engines. In 2015, it is, mainly the type and tuning of the exhaust treatment systems in vehicles with combustion engines that are crucial for the emissions of NO_x and PM.

For petrol cars the emissions of locally harmful exhaust gases has been gradually reduced to a very low level since the introduction of three-way catalysts in 1990.

For heavy vehicles with Euro VI diesel engine, it is the SCR technology (Selective Catalytic Reduction) with the reducing agent urea and advanced management and control systems, which is the main reason for the low NO_x emissions in real traffic.

Test results have shown that it is possible with effective removal of NO_x from the exhaust gases of the heavy vehicles with Euro VI engines. This means that it is technically possible to achieve the same positive results for new generations of cars with diesel engines.

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Important to base measures on new knowledge on emissions from different types of vehicles

The problem of harmful local emissions has more aspects than the discussion about fuel consumption, and petrol versus diesel. The real challenge is the emission of PM and NO_x from older vehicles, as well as NO_x and NO_2 emissions from new Euro 6 diesel cars in real traffic and during cold weather conditions.

If emission levels in the city exceed limit values, and if government wants to reduce the emission of NO_x and PM from vehicles in major Norwegian cities, our test results and other published information support the following conclusions:

- Older heavy vehicles and buses with diesel engines (older than Euro VI, 2014) provide a significant contribution to high emissions of NO_x, NO_2 and partly also PM.
- Light vehicles with diesel engines (currently including Euro 6 cars) provide in congested city driving conditions, a significant contribution to high emissions of NO_x, NO_2 and for older cars also PM.
- Petrol cars older than approximately 15 years (Euro 2) will contribute to relatively high emissions of NO_x and PM.
- Common petrol cars that are younger than approximately 15 years (Euro 3) will to a very small extent contribute to high emissions of NO_x, NO_2 and PM.
- New heavy vehicles and buses with diesel engines (Euro VI, 2014) will give low emissions of all types locally polluting emissions.

Diesel (EN590) as a fuel is in itself no obstacle to clean exhaust gases from cars. If a manufacturer is able to prove that a new car model with Euro 6 diesel engine, when driving in city traffic and in cold weather, has low emissions of harmful gases, there is no reason to introduce restrictive measures against that car model. To prove that the current model of a vehicle has low emissions of NO_x in real traffic, the car can be tested in an independent exhaust laboratory if the car manufacturer is willing to do so.

Use of alternative fuels such as ethanol, methane, biodiesel or others is a method to reduce the climate impact from the combustion of carbonaceous fuels in a lifecycle perspective. Reduced emissions of NO_x and PM has also been an argument for implementation of alternative fuels to diesel and petrol. With the new and efficient cleaning systems for the locally harmful exhaust components, it is doubtful whether reduced local pollution will be an argument for alternative fuels in the future. In 2015, we see currently a greater interest in electrification and hybridization of vehicles, than in using alternative fuels from the manufacturers and distributors of vehicles.

When introducing new measures to improve air quality in Norwegian cities, it is important to take into account the results of vehicle testing in real traffic. If measures are implemented based only on the vehicle's performance in the type approval tests, the measures will be less accurate and planned/expected emission reductions by introducing new vehicles in the vehicle fleet will be absent or less than expected.

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