FACT SHEET: EUROPE

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THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

NO_X CONTROL TECHNOLOGIES FOR EURO 6 DIESEL PASSENGER CARS

Controlling nitrogen oxide (NO_x) emissions from Euro 6 diesel passenger cars is one of the biggest technical challenges facing auto makers. The new Euro 6 diesel passenger cars have to meet an emission limit of 80 mg of NO_x per kilometer, down from 180 mg/km for Euro 5 vehicles. But this limit value is not as stringent as it appears on paper, because it applies to an outdated emissions certification driving cycle (NEDC) that should be replaced by a more realistic one (WLTC) from 2017 on.

The biggest challenge for diesel passenger car manufacturers will not arise from the certification cycle (be it the NEDC or the WLTC), but from the impending real-driving emissions (RDE) test, which is scheduled to become a mandatory step for the type approval of passenger cars in the EU in January 2016. Under this new testing framework, diesel passenger cars will have to prove that they can keep NO_x emissions at reasonably low levels during a test that more closely represents real-world driving situations.

CONTEXT

- Three main technologies are available for controlling NO_x emissions from modern diesel passenger cars: inner-engine modifications coupled with exhaust gas recirculation (EGR), lean-burn NO_x adsorbers (also called lean NO_x traps, or LNTs), and selective catalytic reduction (SCR). In this study, we combined two automotive databases from reputable sources to report on the evolution of the market share of Euro 6 diesel passenger cars and on the **relative shares of NO_x control technologies by car manufacturer in the EU during the phase-in of the Euro 6 standard.** We also did a side-by-side comparison of the EU and US diesel car markets.
- In order to provide some insights into the **relative performance of manufacturers and NO_x control technologies**, we analyzed the results of chassis dynamometer laboratory emissions tests performed by Europe's largest car club *Allgemeiner Deutscher Automobil-Club* (ADAC) as part of their EcoTest program. These covered 32 Euro 6 diesel passenger cars (11 SCR-, 16 LNT- and 5 EGR-equipped). These vehicles were tested over both the NEDC and the WLTC 2.0 driving cycles (which is more representative of real-driving conditions than NEDC).

HIGHLIGHTS OF THE RESULTS

- This study introduces the main technologies available for the control of NO_x emissions from diesel passenger cars, and shows the different strategies that vehicle manufacturers have used for their deployment in the EU and US markets.
- In the US market, where the NO_x emission limit is even lower than 80 mg/km and the certification cycle (Federal Test Procedure, FTP) has somewhat higher loads, **combined aftertreatment systems are featured in some models that otherwise use a single NO_x control technology in their European market versions**.
- The emissions laboratory results *by NO_x control technology* indicate that most EGR- and SCR-equipped vehicles performed relatively well over the WLTC, but their average conformity factor[1] (1.6 for SCR and 1.9 for EGR) is still higher than the average conformity factor over the NEDC (0.6 for SCR and 0.8 for EGR). The differences could have been even higher, because some of the **cold-start emissions over WLTC were avoided by running the hot-start version of this cycle.**
- LNT-equipped vehicles had the best performance over NEDC (0.4) but the worst over WLTC (2.9). Also, **three vehicles equipped with LNTs had extreme NO_x emission levels** (1167 mg/km, 708 mg/km and 553 mg/km of NO_x, respectively). This is a clear indication that there are significant differences between the performance of individual vehicle manufacturers and that, *in some cases*, LNT technology is tuned to deliver good performance on the certification test, but not necessarily under the more transient, real-world conditions represented by the WLTC. On the other hand, some LNT vehicles managed to perform well over both cycles.

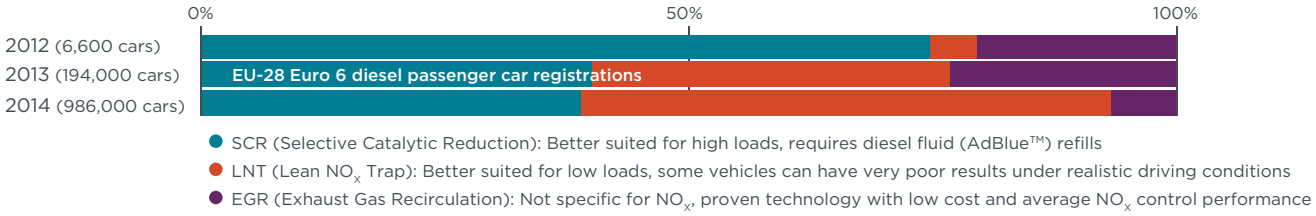
In the short run, RDE should lead to **more robust implementations of existing NO_x control technologies**, especially in terms of engine/aftertreatment calibration but, in some cases, it could also have a significant impact upon the way that manufacturers design the hardware used to control pollutant emissions. In the long-term, RDE should also deliver

1 The conformity factor (CF) is the ratio of measured emissions to the regulated emission limit. A CF>1 indicates an exceedance of the limit.

substantial improvements in urban air quality in Europe as fleet turnover makes pre-RDE diesel cars less prevalent.

In the coming months, the European Commission will work with the stakeholders to determine the conformity factors that will apply to on-road RDE tests. Since RDE cannot apply retroactively to existing Euro 6 type approval certificates, it is essential to act fast and **ensure that high emitters of NO_x are prevented from entering the market**.

Market share of NO_x control technologies for diesel passenger cars during Euro 6 phase-in (Section 3)

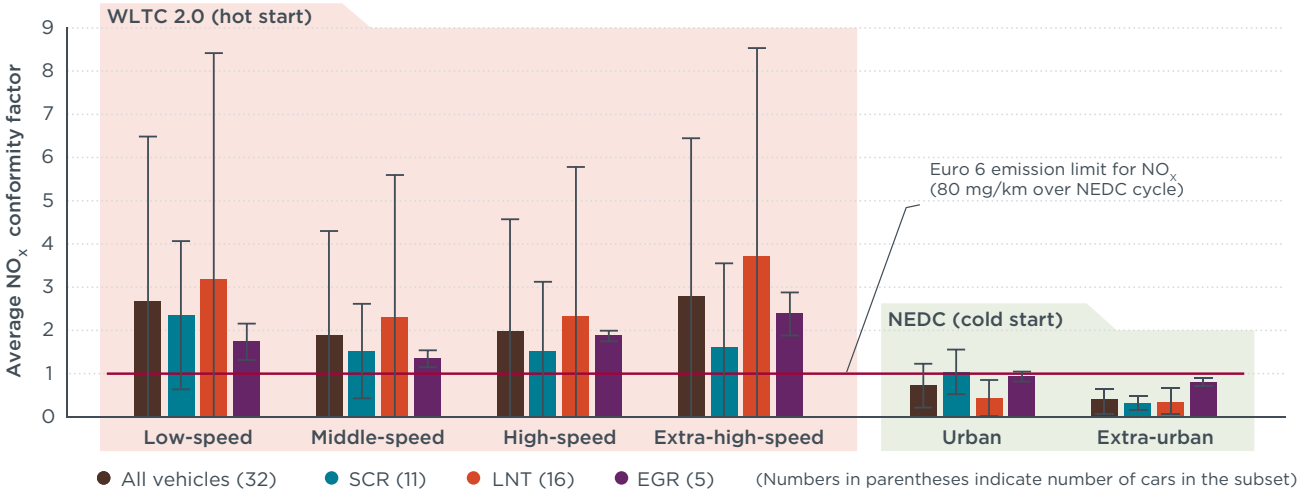


NO_x emissions from diesel passenger cars during real-world driving are a major threat to urban air quality in Europe. A substantial part of the problem is related to a weak testing framework and insufficient monitoring and enforcement. An recent amendment to Euro 6 regulations (Real-Driving Emissions, RDE) could drive diesel cars with poor on-road performance out of the market.

The US diesel passenger vehicle market is much smaller than EU's (0.8% vs 53% of sales in 2014), and it is dominated by German manufacturers. We found striking differences between the aftertreatment systems featured in US and EU vehicles, likely due to differences in the emissions testing procedures (US cycle is more demanding, nominal emission limit is lower), enforcement programs (more robust in the US) and market composition.

NO_x emissions of 32 Euro 6 diesel passenger cars tested by ADAC on a chassis dynamometer cycle (Section 3)

NEDC: current EU emissions type-approval cycle (unrealistic low load, quasi-steady velocity profile)
WLTC: future (2017) EU emissions type-approval cycle (somewhat more realistic than NEDC)
Conformity factor (CF): ratio of measured emissions to the regulated emission limit (CF>1 indicates an exceedance)



FURTHER INFORMATION

NO_x control technologies for Euro 6 Diesel passenger cars
Market penetration and experimental performance assessment.

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