Emission reduction versus NO_2 air quality concentrations, a trade-off?

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NO_2 and PM10 are the two pollutants with the highest number of violations of air quality standards in urban areas. As the PM10 burden is a result of many different sources, this is different for NO_2. Especially in urban areas pollution from road traffic can be considered as the main contributor to the NO_2 concentration. The world health organisation (WHO) set a value of 40 µg/m³ as threshold for the annual mean value. This value has been taken over in the EU Directive for clean air for Europe [1]. Some countries like Austria or Switzerland even reduced this value to 30 µg/m³.

Many urban areas are far away from achieving the air quality standards. Violations of the NO_2 annual threshold value as well as of the accepted numbers of days with a daily mean value > 50 µg/m³ for PM10 happen regularly not only within trafficked areas but also in urban background regions.

Hence abatement measures have to be set in order to improve urban air quality. Euro standards for road vehicles intend to reduce the emission quantity for new vehicles. Focus of emission reductions is the reduction of NO_x as well as of particle emissions. This concerns all type of vehicles, passenger cars as well as LDV an HDV. However, the potential to reduce tailpipe emissions only due to internal measures during the combustion process are limited. For gasoline engines three way catalytic converters are state of the art. Modern diesel vehicles are equipped with oxidation catalyst, PM filters and/or with DeNOx measures (SCR).

Despite the fact that more stringent emission standards have been applied to new vehicles, NO_2 concentrations near major roads keep stable or even tend to rise instead of going down, while NO_x concentrations tend do decline. Figure 1 shows the trend of NO_2 concentrations at some major road sections in Austria. The concentration levels are far above the EU threshold value of 40 µg/m³ and twice as high as the Austrian threshold level for the annual mean value. A similar trend can be found in Germany (Figure 2).

The main reason for this negative NO_2 trend can be found mainly in the emission behaviour of diesel cars. NOx emission levels of diesel cars in real world driving situations are decreasing from EURO 3 to EURO 5 while the share of NO_2 in the NO_x emissions at the tailpipe is increasing. The reasons for increasing NO_2 shares are mainly a catalytic exhaust gas aftertreatment such as DOC and coated DPF and the increasing EGR rates for modern vehicles. High NO_2 levels at the raw exhaust gas are desired for the passive regeneration of the DPF at lower exhaust gas temperatures. Thus the exhaust gas after treatment to reduce PM emissions is at least partly responsible for the actual NO_2 situation.

Figure 3 shows the increase of the share of primary emitted NO2 for passenger car diesel vehicles. The combination of the increase in traffic in general and the increase in the usage of diesel cars in special resulted in this unwanted situation. Thus a better control of the NO/NO_2 conversion is an important task for future diesel cars. In order to bring the NO_2 concentrations in urban areas down to acceptable levels within the next few years, a very quick renewal of cars towards EURO 6 or towards gasoline driven vehicles would be necessary.

References:

[1] EU (2008) Directive 2008/50/EC from 21.5.2008

[2] Scholz W. (2010): NO2-Immissionsbelastungen in Deutschland und Baden-Württemberg. Fachtagung: Herausforderung NO2-Immissionen – Gesetzgebung, Luftbelastung, Lösungen, 3./4. März 2010 Heidelberg

[3] Hausberger S., Rexeis M., Zallinger M. (2010): NOx und NO2 Emissionen von aktuellen und zukünftigen Kraftfahrzeugen. Fachtagung: Herausforderung NO2-Immissionen – Gesetzgebung, Luftbelastung, Lösungen, 3./4. März 2010 Heidelberg

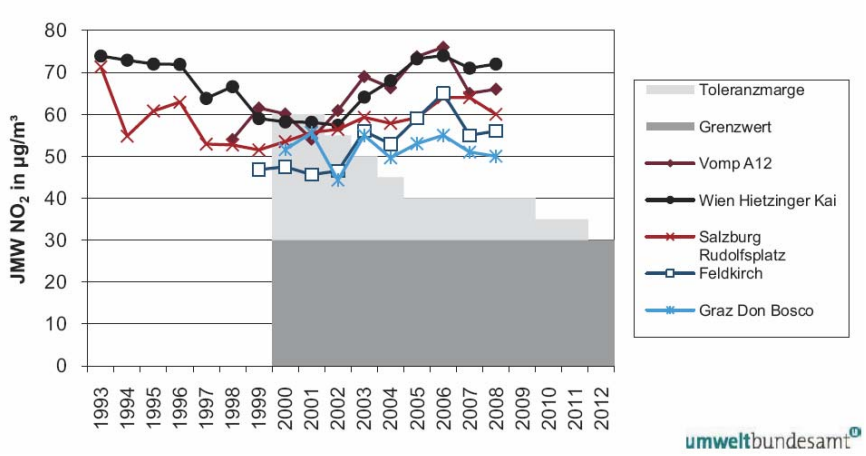

Figure 1: NO2 concentrations at curb side monitoring stations in Austria (source: Umweltbundesamt Wien)

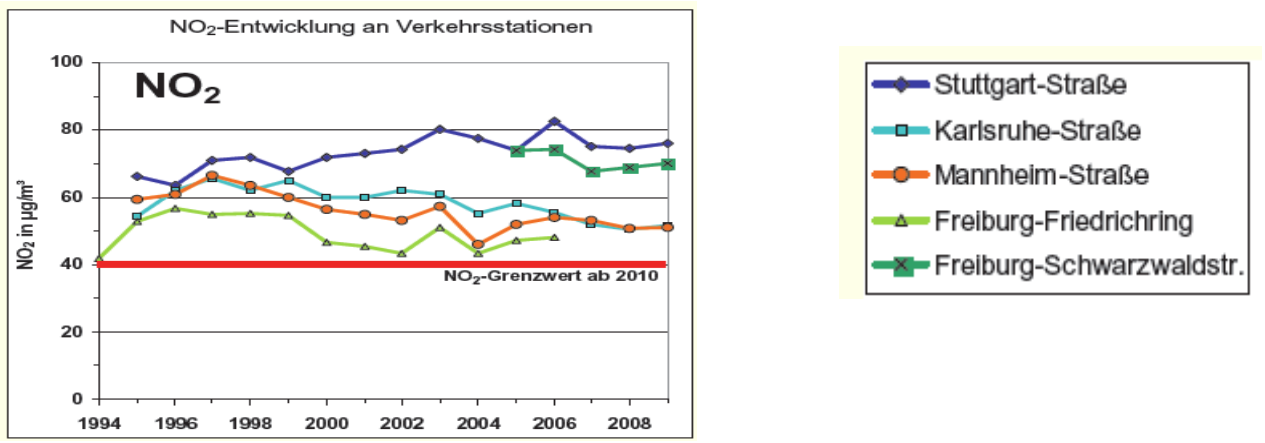

Figure 2: NO2 trend Baden-Württemberg, traffic related monitoring sites [2]

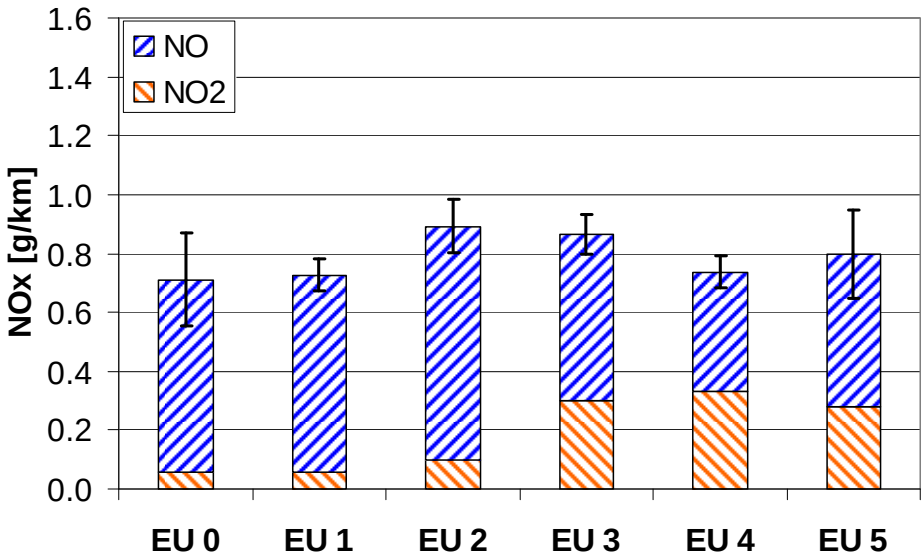

Figure 3: Share of primary NO2 emissions for diesel passenger cars [3], only four EURO 5 cars measured yet