

# Impact of EURO norms for particulate matter vehicle emissions on global air quality

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The impacts of atmospheric aerosols span from local to global scale, affecting air quality, visibility, human health, climate and ecosystems. Therefore, several actions at national, regional and global scale have been adopted to reduce particulate matter (PM) emission levels, especially abating anthropogenic emissions in densely populated areas. In our work we make use of the EDGAR\_v4.3 emission database (Emission Database for Global Atmospheric Research) to compare today's PM levels with ex-post scenarios developed to assess the impact and effectiveness of legislation over the last 4 decades on air quality and climate. Differently from most of literature works addressing future air quality, here we look at historical global anthropogenic emissions of particulate matter and retrospective emission scenarios to demonstrate the role played and remaining potential of EU policies improving air quality in Europe and beyond. In our work, a special focus is dedicated to road transport PM<sub>2.5</sub> emissions, representing a significant source of aerosols and having this sectorial activity strongly increased over the last 40 years, not only in industrialized countries but also in the emerging and developing ones.

Here we investigate the impact of European emission standards for motor vehicles coupled with the technological advancement adopted to reduce PM<sub>2.5</sub> road transport emissions at European and global level over the last 40 years (from 1970 when the first European air quality directive was introduced till 2010). However, a special focus is dedicated to the years 1990-2010 to quantify the impact of EURO standards on road transport emissions.

We firstly demonstrate the effect of the introduction of European standards on vehicle construction on the one side and fuel quality on the other; then we evaluate what would be the emissions in Europe if the technological improvement would have remained at the pre-legislation levels or fuels would have not improved over the years. Secondly, after having analyzed the impact of legislation on vehicle emissions in Europe we look at how the global market of EURO compliant vehicles has impacted on the emissions and consequently on the air quality of other countries thus resulting in an export of good practices and positive air quality effect of global market of vehicle manufacturers.

We mainly developed two retrospective scenarios in order to analyze separately the impact of concurrent factors on today's emission levels, such as i) the change in fuel consumption and mix from 1970 to 2010 (shift to

cleaner fuels) and ii) the implementation of abatement measures as well as the change in technologies.

EURO standards, from EURO1/I to EURO5/V, for vehicle emissions (passenger cars (1-5), heavy duty (I-V), etc.) significantly affected particulate emissions, reducing them by a factor of 2 globally and 4 in Europe in 2010 compared to the scenario without abatement measures applied. However, it is possible to observe an impact of European standards all over the world, due to the deployment of vehicles with European Standards in many worldwide regions. Figure 1 reports road transport PM<sub>2.5</sub> emissions for the year 2010 comparing the real situation with the no abatements applied scenario for world regions. A decrease of ca 50% of PM<sub>2.5</sub> road transport emissions (0.91 Tg) is observed globally due to the implementation of EURO standards on vehicles. This reduction is almost equally attributed to the impact of the EURO standards in Europe (0.47 Tg) as well as outside Europe (0.44 Tg). Major impact of EU regulations on vehicle emissions outside Europe is found in China, Southeastern Asia, India, Middle East, Indonesia, Japan, Oceania, etc. while smaller impact is seen in USA due to the deployment of American vehicle standards not affected by the considered scenario (UT1, UT2, UT3, PH1 and PH2). The hypothesis that we support here is that, since Europe has been one of the most important automotive markets globally for the decades after the second world war and the one for which the most stringent regulations were imposed to vehicle manufactures on emission quality standards, it has boosted the technology and end-of-pipe implementation for all car/ heavy duty vehicle manufacturers from Europe and from their non-European competitors. Standards were not changed for manufacturing simplicity, allowing to cover a global car/ heavy duty vehicle market and thus producing benefits even in regions and countries where those standards were not required.

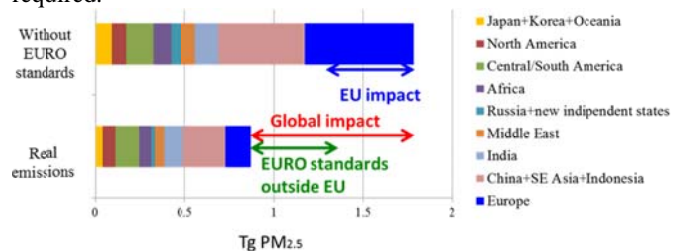


Figure 1. Impact of European legislation (“without EURO standards” scenario) on PM<sub>2.5</sub> road transport emissions at global scale.