FACT SHEET: EUROPE

**FEBRUARY 2019**

communications@theicct.org WWW.THEICCT.ORG

THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

# HEALTH IMPACTS OF AIR POLLUTION FROM TRANSPORTATION SOURCES IN GERMANY

A new study provides the most detailed picture available to date of the health impacts attributable to emissions from four transportation subsectors: on-road diesel vehicles, on-road non-diesel vehicles, shipping, and non-road mobile sources such as agricultural and construction equipment. It links state-of-the-art vehicle emissions, air pollution, and epidemiological models to estimate transportation $PM_{2.5}$ and ozone-related premature deaths at the global, regional, national, and local levels in 2010 and 2015.

## KEY FINDINGS FOR GERMANY

In 2015, approximately 13,000 premature deaths in Germany were attributable to ambient $PM_{2.5}$ and ozone from transportation tailpipe emissions. Deaths attributable to ambient $PM_{2.5}$ and ozone from all sources totaled 43,000, meaning that transportation accounted for just under one-third (31.4%) of all deaths from $PM_{2.5}$ and ozone pollution that year.

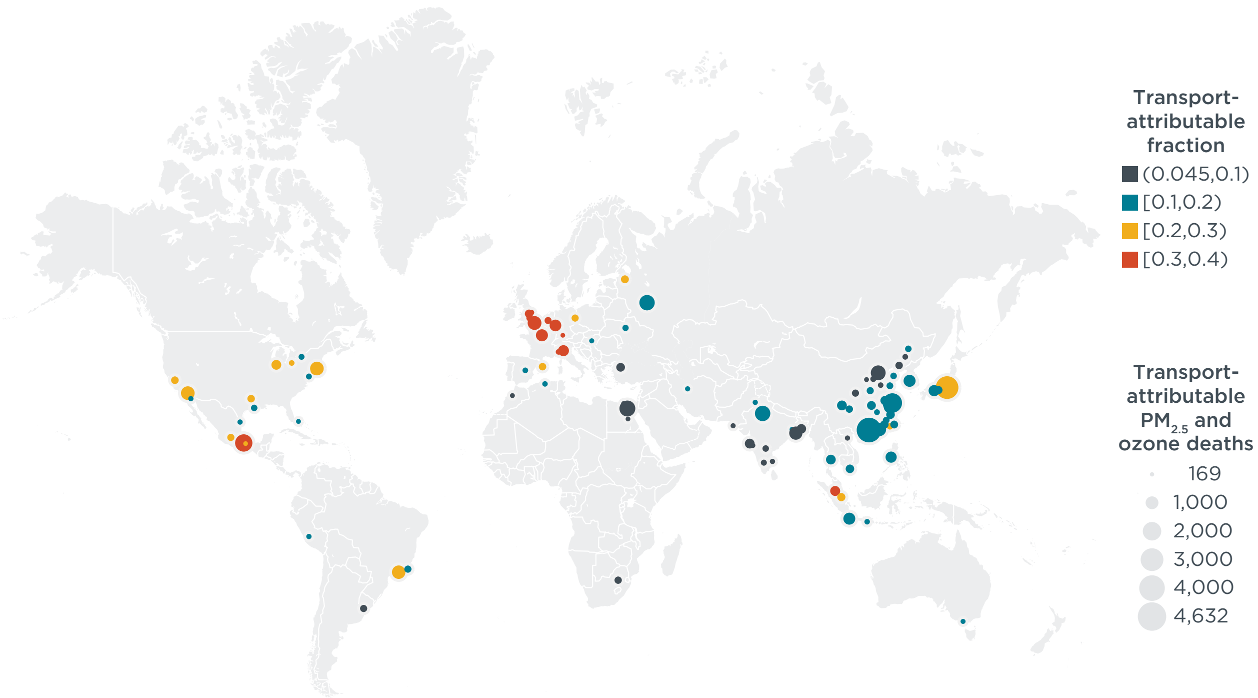
Germany had the 4th highest number of transportation-attributable premature deaths from $PM_{2.5}$ and ozone pollution among all countries in 2015, behind China, India, and the United States. Controlling for population size, Germany had the highest mortality rate attributable to transportation tailpipe emissions of any major economy, at 17 premature deaths per 100,000 population—more than three times the global average and nearly 50% above the EU average.

On-road diesel vehicles contributed two-thirds of the transportation health burden in Germany, followed by international shipping (14%); non-road mobile sources, including agricultural and construction equipment and rail (13%); and on-road non-diesel vehicles (8%). The high contribution of on-road diesel vehicles reflects both tailpipe $PM_{2.5}$ and $NO_x$ emissions, the latter of which contribute to secondary $PM_{2.5}$ (in the form of nitrate aerosols) and ozone.

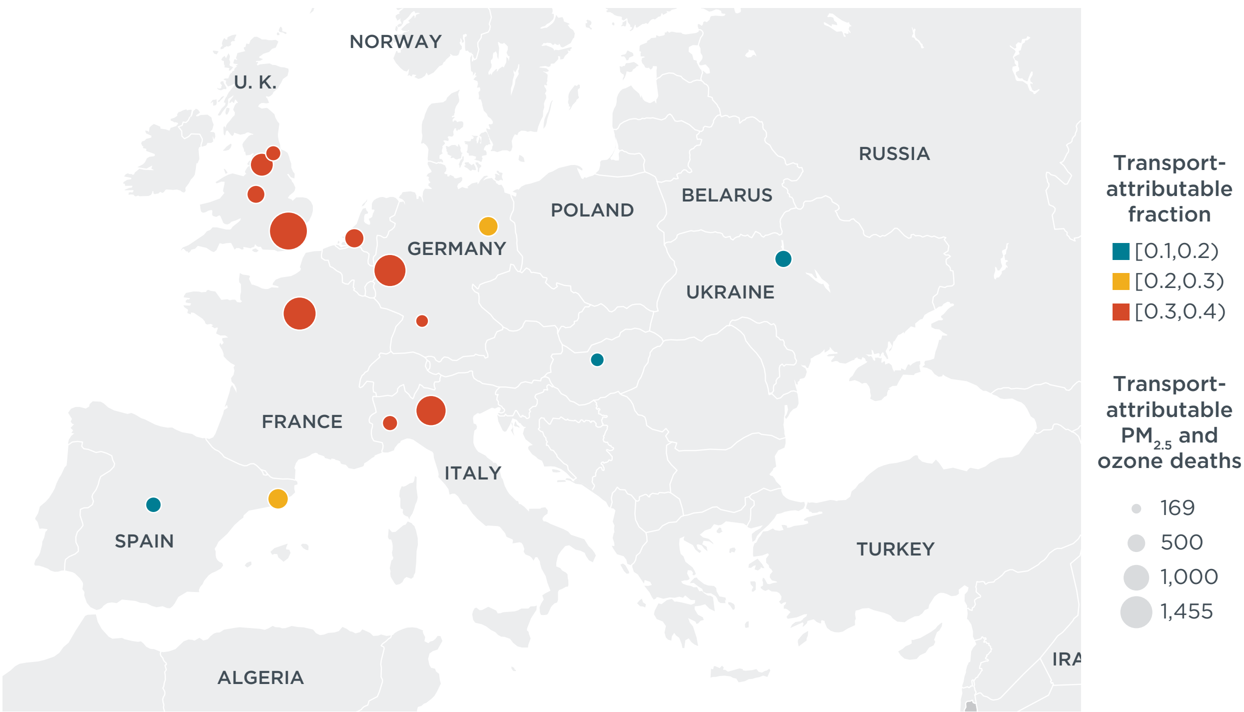
Among 100 major urban areas worldwide that the study evaluated, 3 of the 6 cities with the highest mortality rate attributable to transportation tailpipe emissions in 2015 were in Germany: those 6 cities were Milan, Turin, Stuttgart, Kiev, Cologne, and Berlin.

In Stuttgart, the home of Mercedes-Benz and Porsche, on-road diesel vehicles contributed 78% of the health burden from transportation emissions in 2015—the highest of any major urban area in the world—and transportation sources were responsible for approximately 36% of premature deaths from ambient $PM_{2.5}$ and ozone pollution.

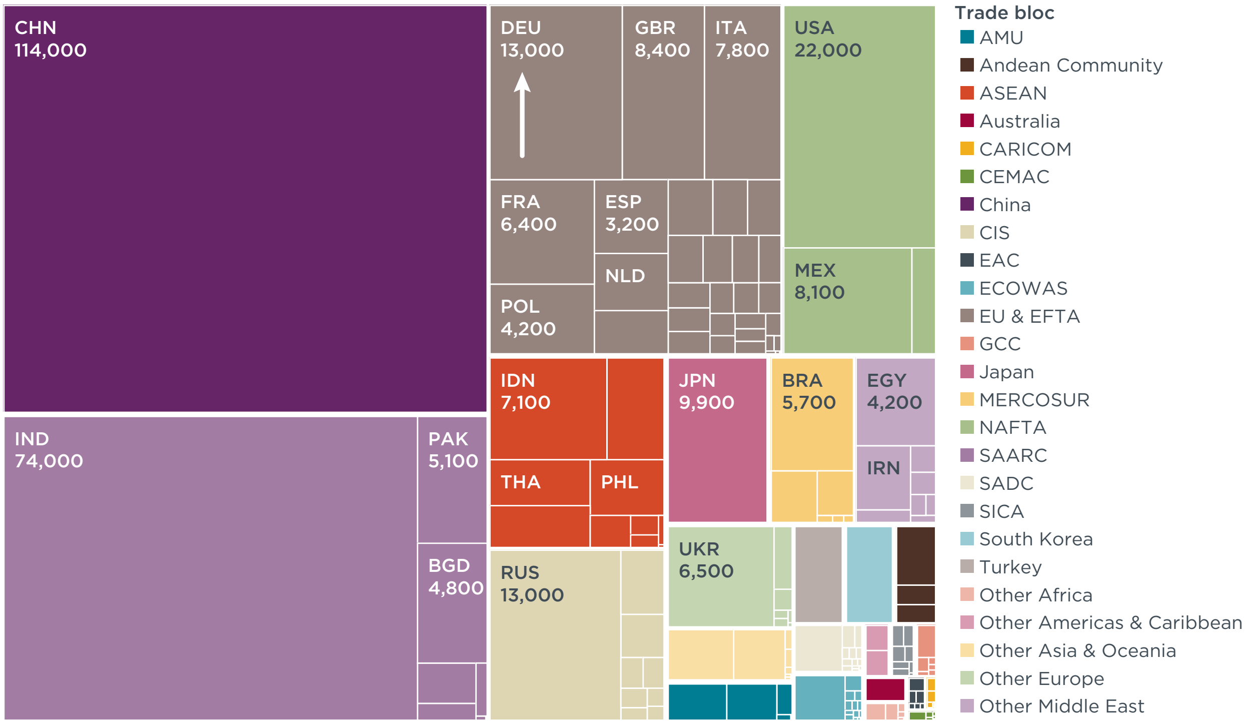
The societal welfare loss associated with transportation health damages in Germany amounted to 110 billion (2015 US$) (approximately 97 billion EUR) in 2015, about 3% of Germany's gross national income.




Total number of transportation-attributable $PM_{2.5}$ and ozone deaths in 2015 by urban area. Bubble size indicates total number of transportation-attributable $PM_{2.5}$ and ozone deaths using central relative risk estimates. Bubble color indicates transportation attributable fraction (TAF) of total $PM_{2.5}$ and ozone premature deaths.




Total number of transportation-attributable $PM_{2.5}$ and ozone deaths in 2015 for select urban areas in Europe. Bubble size indicates total number of transportation-attributable $PM_{2.5}$ and ozone deaths using central relative risk estimates. Bubble color indicates transportation attributable fraction (TAF) of total $PM_{2.5}$ and ozone deaths.




National total $PM_{2.5}$ and ozone mortality that is attributable to transportation emissions in 2015 in major trade blocs globally, using central relative risk estimates. The size of each box corresponds to each country's share of global transportation-attributable $PM_{2.5}$ and ozone mortality in 2015.[1]

## POLICY IMPLICATIONS

Like many other EU member states, Germany suffers a high public-health burden from transportation emissions, particularly from on-road diesel vehicles. The disproportionate contribution of on-road diesel vehicles is attributable both to high tailpipe $PM_{2.5}$ emissions from pre-Euro 5b cars and vans and pre-Euro VI trucks and buses (i.e. without diesel particulate filters) and persistent elevated NOx emissions particularly from pre-Euro 6d cars and vans and Euro IV and V trucks and buses. The health damages associated with outdated or non-compliant vehicle and engine technologies are likely to persist until such equipment is retrofitted or scrapped. The immense societal cost of transportation tailpipe emissions—estimated at approximately 97 billion EUR per year in Germany in 2015—could support the rationale for large-scale investments or programs aimed at accelerating the retrofit or replacement of such vehicles in Germany.

The high fraction of total deaths from air pollution that is attributable to transportation emissions in Germany underscores the central importance to national and local air-quality management plans of controlling transportation emissions. In particular, the high concentration of transportation emissions in urban areas could justify more ambitious policy actions. Such policies could include low-emission zones, other restrictions on high-emitting vehicles, accelerated fleet renewal programs (e.g. for municipal fleets and urban delivery vehicles), and policies that facilitate the transition to zero-emissions transportation.

## OVERALL SUMMARY AND METHODS

The study estimates impacts of transportation sector emissions globally on $PM_{2.5}$ and ozone and their health impacts in 2010 and 2015. The analysis is restricted to the air pollution-related health impacts of transportation tailpipe emissions because a clear set of well-understood policies is available to reduce emissions, and global inventories of transportation tailpipe emissions exist.

1 Acronyms of countries identified in the figure: CHN = China; IND = India; PAK = Pakistan; BGD = Bangladesh; DEU = Germany; FRA = France; POL = Poland; GBR = United Kingdom; ESP = Spain; NLD = Netherlands; ITA = Italy; IDN = Indonesia; THA = Thailand; PHL = Philippines; RUS = Russia; JPN = Japan; UKR = Ukraine; USA = United States; MEX = Mexico; BRA = Brazil; EGY = Egypt; IRN = Iran.

The analysis used the GEOS-Chem global chemical transport model to simulate the fractions (TAF) of $PM_{2.5}$ and ozone concentrations that are attributable to transportation emissions. Gridded year-specific concentration estimates for ambient $PM_{2.5}$ and ozone pollution were obtained from the Global Burden of Disease (GBD) 2017 study, which integrated satellite measurements with data from thousands of ground monitoring stations in over one hundred countries. The analysis combined the GEOS-Chem results with the epidemiological health impact assessment methods of the GBD 2017 to estimate the burden of disease attributable to transportation tailpipe emissions.

To evaluate the health burden attributable to specific subsectors (on-road diesel vehicles, on-road non-diesel vehicles, international shipping, and non-road mobile sources), the analysis summed the gridded $PM_{2.5}$ and ozone deaths attributable to each transportation subsector according to national boundaries and urban areas. Urban area definitions are taken from the Global Human Settlement grid for 2015 at 1km resolution, and regridded to 0.1° resolution. The study used the "urban centers or high density clusters" definition, which treats areas with dense contiguous urbanicity as one large city. The number of transportation-attributable mortalities in a subset of one of these areas could be estimated by multiplying the appropriate population estimate by the estimated transportation-attributable mortality rate (i.e., deaths per 100,000 population).

## APPLICABILITY TO AIR QUALITY LIMIT VALUES

According to the World Health Organization, ambient $PM_{2.5}$ pollution is harmful to human health even at concentrations below the 2005 guideline limit of 10 micrograms per cubic meter (µg/m3); therefore the aim is to achieve the lowest possible levels of ambient $PM_{2.5}$. Since 2015, the GBD methods assess $PM_{2.5}$ health impacts relative to a theoretical minimum-risk exposure level, defined as a uniform distribution between 2.4 and 5.9 µg/m3 based on the minimum and 5$^{th}$ percentile exposure level of outdoor air pollution cohort studies conducted in North America. Germany had an estimated national population-weighted mean $PM_{2.5}$ exposure of 13.5 µg/m3 in 2015 (95% confidence interval: 13.3 to 13.6)—roughly 2 to 6 times the theoretical minimum-risk exposure level for ambient $PM_{2.5}$. For this reason, even though Germany met the EU air quality standards for annual average $PM_{2.5}$ in 2015 (set at 25 µg/m3), there is still a need from a public health perspective to further reduce $PM_{2.5}$ levels in Germany. Additionally, although the GBD methods do not evaluate the direct health impacts of exposure to nitrogen dioxide ($NO_2$), $NO_2$ is a precursor to both $PM_{2.5}$ (in the form of nitrate aerosols) and ozone. Therefore, policies that target reductions in $NO_2$—for which many urban traffic air quality monitoring stations in Germany measure exceedance of EU air quality standards—would reduce the incidence of premature deaths from ambient $PM_{2.5}$ and ozone, the health endpoints that were quantified for 2010 and 2015 in this study.

**PUBLICATION DETAILS**

**Title:** *A global snapshot of the air pollution-related health impacts of transportation sector emissions in 2010 and 2015*

**Download:** www.theicct.org/publications/health-impacts-transport-emissions-2010-2015

**Authors:** Susan Anenberg, George Washington University Milken Institute School of Public Health; Joshua Miller, International Council on Clean Transportation; Daven Henze, University of Colorado, Boulder; Ray Minjares, International Council on Clean Transportation

**Contact:** Joshua Miller (josh@theicct.org)