

# Science for Environment Policy

## Emissions from 2008–2015 VW diesel vehicles fitted with 'defeat devices' linked to 59 premature deaths

**In September 2015, the United States Environmental Protection Agency (EPA) alleged that Volkswagen (VW) violated the US Clean Air Act by fitting 'defeat devices' in their light-duty diesel vehicles to falsify the results of emissions tests. According to a study assessing the potential impact of this decision, an extra 59 early deaths in the US are likely to be caused by exposure to PM<sub>2.5</sub> and ozone.**

**Defeat software is designed to detect when emissions tests are being run and turn on pollution controls so that a vehicle can meet air quality standards.** During normal road use, the pollution controls are disabled to enhance engine performance and fuel economy, but these changes also increase emissions, of nitrogen oxides (NO<sub>x</sub>) for example.

In this study, researchers evaluated the impact on the health of the American public by assessing the real-world emissions from 482 000 VW light duty diesel vehicles. All had been fitted with defeat devices and sold during 2008 to 2015. Diesel vehicles are a major source of NO<sub>x</sub>, substances which react chemically in the atmosphere to form harmful air pollutants including ozone (in the presence of sunlight) and fine particulate matter (PM<sub>2.5</sub>).

The researchers calculated the excess vehicle emissions based on the estimated average distance a vehicle would travel before it was retired, and on research that showed real-world NO<sub>x</sub> emissions were 10 to 40 times higher than the U.S. EPA standard and that emissions of PM<sub>2.5</sub> were on average 40% higher than those predicted by an atmospheric model.

They then used a chemical transport model to estimate the U.S. public's exposure to PM<sub>2.5</sub> and ozone formed from the excess NO<sub>x</sub> emissions. Using previously established relationships between the concentration of each pollutant and health outcomes, such as stroke or lung cancer, the researchers calculated the risk of early death and non-fatal outcomes for the U.S. public. In their analysis, the researchers also addressed the uncertainties associated with modelling the health impacts of emissions. They developed probability distributions to derive the best estimates for emissions and their effect on air quality and changes in the public's exposure to the emissions and related the resultant exposure to health outcomes.

As a result, the researchers estimated that an additional 59 premature deaths in the U.S. will be caused by excess emissions from non-compliant vehicles sold from 2008 to 2015. Eighty-seven per cent of these deaths are expected to be as a result of exposure to PM<sub>2.5</sub> and 13% from exposure to ozone. These death rates are likely an underestimation, as the study did not consider the direct effects of exposure to high levels of NO<sub>2</sub>.

In addition, the researchers estimated there would be an additional 31 cases of chronic bronchitis and 34 hospital admissions from respiratory and heart problems. Individuals would also suffer around 120 000 'minor restricted activity days', including work loss days; around 210 000 lower respiratory symptom days; and around 33 000 days where they have to use additional bronchodilator medicine.

*Continued on next page.*



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**Source:** Barrett, S.R.H., Speth, R.L., Eastham, S.D., Dedoussi, I.C., Ashok, A., Malina, R. & Keith, D.W. (2015) Impact of the Volkswagen emissions control defeat device on US public health. *Environmental Research Letters*. 10: 114005. DOI:10.1088/1748-9326/10/11/114005. This study is free to view at: <http://iopscience.iop.org/article/10.1088/1748-9326/10/11/114005>

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From 2008 to 2015, the researchers estimated that the diesel vehicles fitted with the defeat devices emitted 36.7 million kg of excess NO<sub>x</sub>. If the vehicles are not fixed so that they meet US air quality standards, the researchers estimate that there will be an extra 140 early deaths from 2016 until the vehicles retire. If, however, all the affected the vehicles are fixed by the end of 2016, 130 of the 140 forecast early deaths could be avoided.

The researchers also calculated that the social costs, such as hospital visits, due to exposure to NO<sub>x</sub> emissions during the sales period 2008 to 2015, would be US\$450 million (in 2015 US\$ terms), equivalent to €414 million. Failure to recall all faulty vehicles and fix the vehicles would result in around 140 premature deaths and extra overall social costs of US\$910 (€837) million from 2016 into the future (up to 2040). If all vehicles were fixed during 2016, US\$840 (€773) million of the future costs could be avoided.

This study has shown that retrofitting the 2008 to 2015 fleet of affected diesel vehicles in 2016 so that they meet air quality standards will substantially reduce the impact of excess emissions on public health in the U.S. If all affected vehicles are recalled and brought into compliance by 2016, the researchers calculate that 93% of deaths and 92% of costs could be avoided.

