

Particulate emissions from light-duty vehicles in Brussels

Particulates are present in the exhaust of combustion engine vehicles. Exposure to these pollutants can increase the risk of a range of health problems, such as lung and cardiovascular diseases. Particulate emissions can be characterized in multiple ways including particulate matter (PM), which is reported as mass, and particle number (PN) emissions, which is measured as the number of solid particles. As part of a real-world vehicle emission study, the TRUE Initiative used a portable instrument to measure the tailpipe PN emissions of close to 600 light-duty vehicles. Analyses of these measurements, along with complimentary roadside remote-sensing PM measurements, provide insights into the PM and PN emissions of the Brussels light-duty fleet.

BACKGROUND

Diesel particulate filters (DPF) are a highly efficient technology for controlling tailpipe PM and PN emissions. These filters have been universally applied to new diesel passenger vehicles since 2012 and, when operating as designed, can reduce PM emissions by over 95% and PN

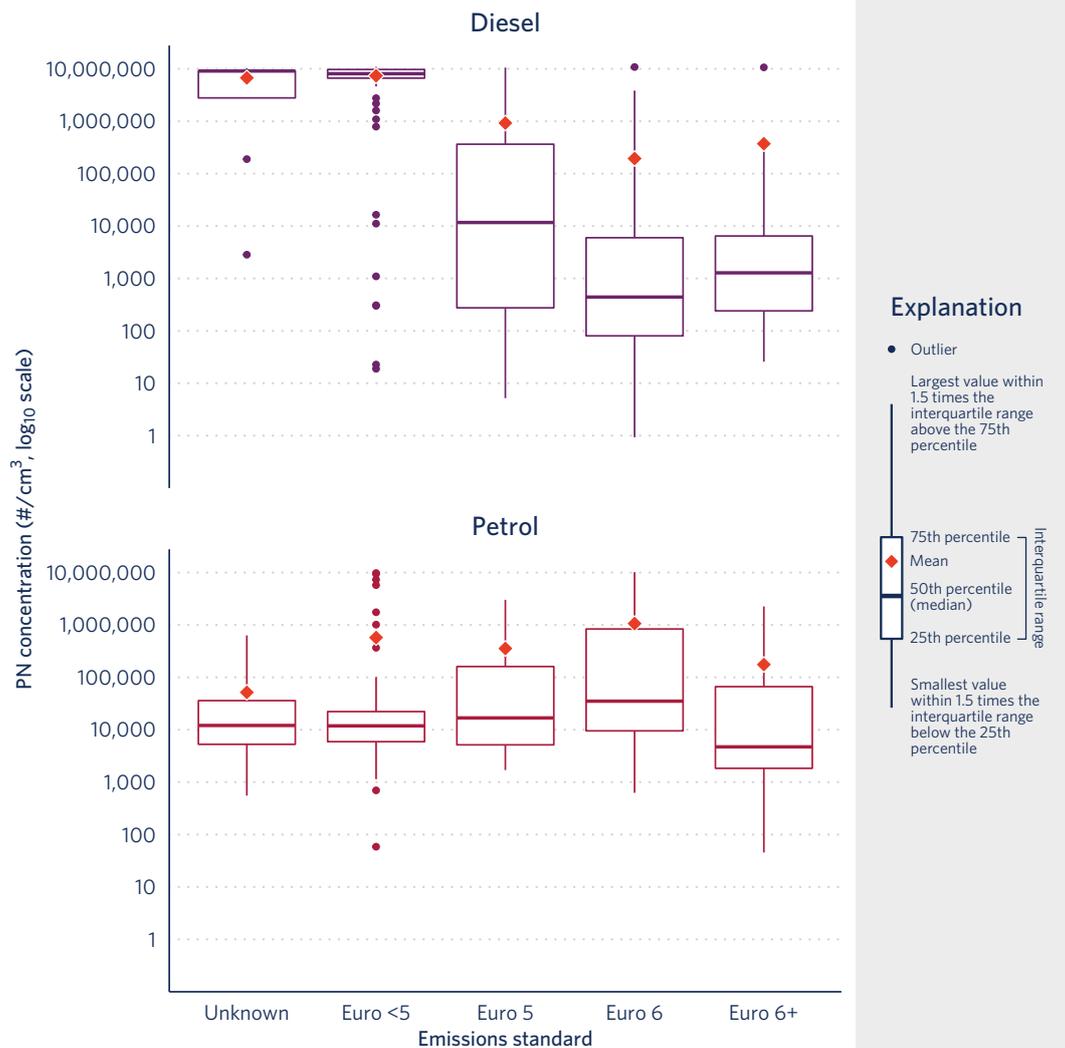
emissions by over 99%. However, if a DPF malfunctions or is intentionally removed, PM and PN emissions can increase significantly—by 15–50 times for PM mass and orders of magnitude for PN emissions. It is important that in-use vehicle emissions control programs are able to identify and address instances where DPFs are not performing effectively in the real-world due to malfunctions or intentional tampering. Belgium, along with other European countries (Netherlands and Germany) have taken steps to incorporate particle number testing into periodic technical inspection (PTI) programs to target high-emitting (i.e. tampered) vehicles more effectively. The TRUE initiative study provides new information about the PM and PN emissions of the Brussels fleet and the prevalence of DPF malfunctions or tampering.

KEY FINDINGS

- Roadside remote-sensing measurements of the vehicle fleet found that, conservatively, approximately 2% of the diesel light-duty vehicles in Brussels equipped with a DPF showed high PM emissions indicative of



Roadside remote-sensing emission testing including PM measurement (left) and particle number inspections using a portable emission tester (right) on Rue du Lieutenant Lotin, Brussels



Boxplot of PN tailpipe emission concentration of light-duty vehicles by Euro standard and fuel type. Diamonds represent the mean emissions. “Euro 6+” refers to Euro 6d-TEMP and Euro 6d. The proposed particle number limit for periodic technical inspection programs in Belgium currently applies to Euro 5b and higher DPF-equipped vehicles. A limit for diesel Euro 5a vehicles is still under discussion.

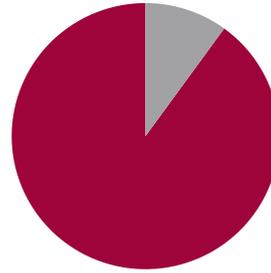
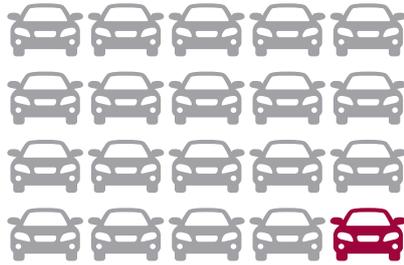
a failure of the emission control system. Due to the conservative threshold used in the study, the real percentage of vehicles with DPF performance issues is likely even greater.

- Tailpipe PN measurements show that a small number of high-emitting vehicles, 5% of the tested DPF-equipped fleet for which a type-approval limit for PN applies (Euro 5b and higher), had concentrations exceeding 1 million #/cm³, a level indicative of DPF malfunctioning or tampering. These gross-emitting vehicles were estimated to be responsible for more than 90% of total particle number emissions from that test group. A similar PN threshold of 1 million #/cm³ will be used to identify high-emitting vehicles for follow-up actions under the new Belgian PTI program.
- Tailpipe PN concentrations were highest for pre-Euro 5 diesel vehicles, which are not equipped with DPFs. These findings also provide further evidence

that the next implementation stage of the Brussels low-emission zone (LEZ), which bans Euro 4 diesel vehicles beginning in 2022, will provide important PN emissions benefits.

- PN testing results for petrol vehicles show the highest tailpipe concentration levels for pre-RDE Euro 6 vehicles. This is attributed to the increasing market share of direct injection engines, as well as a phase-in period for PN emission limits for these vehicles. The tightening of the PN emission limits for vehicles equipped with petrol direct injection engines and introduction of on-road type-approval PN testing requirements has driven the introduction of particulate filters for these vehicles and improvements in PN emission performance. In 2030, the Brussels low-emission zone will require petrol cars and vans to be certified to at least Euro 6d, which is expected to drive a substantial reduction in PN emissions from traffic.

Particle number emissions



PN concentrations exceeded 1 million #/ cm³ for 5% of Euro 5b and higher DPF-equipped vehicles.

These high-emitting vehicles are responsible for 90% of total PN emissions from the test group.

Illustration of the contribution of the 5% highest emitters to total PN emissions from DPF-equipped Euro5b and higher light-duty vehicles.

- As average PM emissions from diesel and direct injection petrol vehicles are reduced through the application of particulate filters, indirect injection petrol vehicles may become an increasingly important source of traffic-related PM emission in Brussels. The TRUE study identified one Euro 6 petrol light commercial vehicle model with real-world PM emissions at a level comparable to those of Euro 4 diesel vehicles, which are not equipped with DPFs. The real-world emissions of indirect injection petrol light commercial vehicles warrant further scrutiny, especially because these vehicles are not subject to any PN or PM limits under the most up-to-date Euro standard.
- The recent addition of particle number testing requirements to the Belgian PTI program is an important step towards detecting and addressing high-emitting vehicles. Further benefits could be realized by tightening high-emitting vehicle thresholds and extending requirements to a broader set of vehicles, such as diesel cars and vans certified to Euro 5a standards, petrol vehicles, and other vehicle types such as heavy trucks and buses.



FIA Foundation and the International Council on Clean Transportation (ICCT) have established The Real Urban Emissions (TRUE) Initiative. The TRUE initiative seeks to supply cities with data regarding the real-world emissions of their vehicle fleets and equip them with technical information that can be used for strategic decision making.

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TO FIND OUT MORE:

For details on the Brussels remote-sensing project and related questions, contact Yoann Bernard, y.bernard@theicct.org. For more information on TRUE, visit www.trueinitiative.org.

Download the paper "Evaluation of real-world vehicle emissions in Brussels" <https://theicct.org/publications/true-brussels-emissions-nov21>