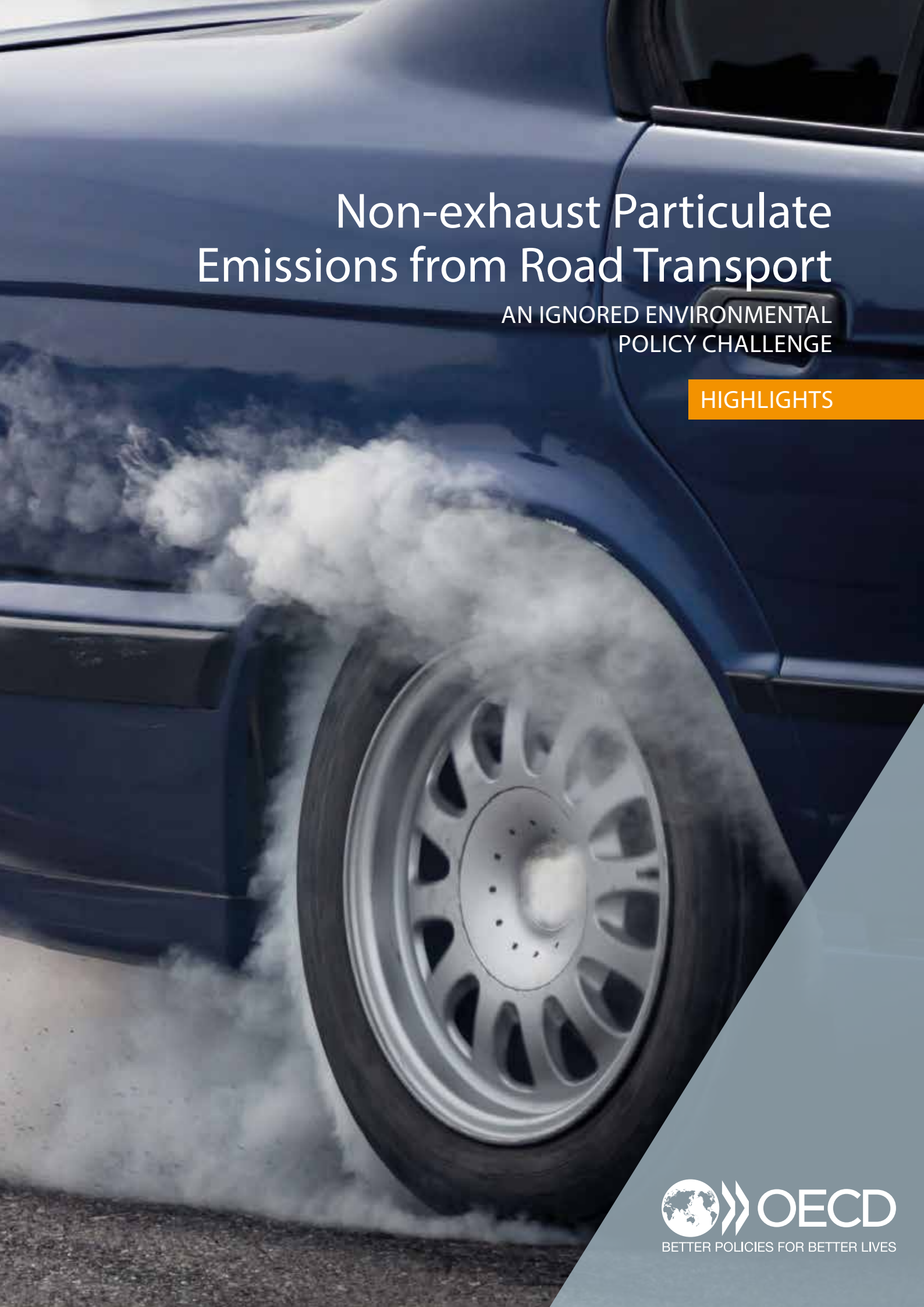

# Non-exhaust Particulate Emissions from Road Transport

## AN IGNORED ENVIRONMENTAL POLICY CHALLENGE

HIGHLIGHTS

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**Non-exhaust emissions of particulate matter constitute a little-known but rising share of emissions from road traffic and have significant negative impacts on public health. In the first comprehensive policy-oriented treatment of non-exhaust emissions to date, this report synthesises the current state of knowledge about the nature, causes, and consequences of non-exhaust emissions. It also finds that switching to electric vehicles will not be an effective way to reduce these emissions and reflects on policy instrument mixes that can address this largely ignored environmental issue.**


# Key Messages

- Non-exhaust emissions are produced from the wearing down of brakes, tyres, and road surfaces, and from the resuspension of road dust. Exposure to these emissions is associated with a variety of adverse health outcomes, such as increased risks of cardiovascular, respiratory, and developmental conditions, as well as an increased risk of overall mortality.

- With stringent controls on tailpipe emissions and increased penetration of electric vehicles, non-exhaust emissions are quickly becoming the dominant source of particulate matter from road transport and are expected to comprise the vast majority of particulate matter pollution from road transport as early as 2035.

- Despite the significant burden of non-exhaust emissions on public health and their rising share as a source of particulate matter from road traffic, few public policies target them explicitly. Targeted policy action is therefore needed to mitigate their consequences for public health.

- The uptake of electric vehicles will not address this policy challenge. While electric vehicles are estimated to emit slightly less PM10 from non-exhaust sources than conventional vehicles, heavier-weight EVs are estimated to emit more PM2.5 than conventional vehicles.

- Under a modest assumption of electric vehicle uptake in which 4% of vehicles are electric by 2030, total non-exhaust emissions from passenger traffic are expected to rise by 53.5%. Assuming a doubling of electric vehicle uptake still leads to a 52.4% increase in non-exhaust emissions over this period.

- Policies can target non-exhaust emissions by reducing the amount of emissions that vehicles emit per kilometre and the total number of kilometres driven by vehicles.

- Developing effective mitigation policies for non-exhaust emissions will require a robust evidence base regarding the factors that influence the magnitude of their negative impacts. To this end, policy makers should prioritise advancing the state of knowledge on non-exhaust emissions and establishing standardised approaches to measuring them.

- Promising mitigation measures include vehicle light-weighting, regulations on tyre composition, urban vehicle access regulations and the promotion of public transport, walking and cycling.

# What does this report cover?

This report makes four main contributions:

- **First**, the report reviews existing scientific literature regarding the processes underpinning the generation of non-exhaust particulate emissions, including how vehicle, road and driving characteristics influence their magnitude. It also reviews the body of evidence regarding the consequences of non-exhaust emissions for public health.
- **Second**, it estimates the amount of non-exhaust particulate matter emitted by battery electric vehicles and their conventional counterparts. Estimations are based on data from the scientific literature, emission inventories and other sources, and distinguish between passenger cars, sport utility vehicles and light commercial vehicles.
- **Third**, it surveys the scientific literature and industry reports to identify currently available solutions to reduce non-exhaust particulate emissions from wear and road dust resuspension. The report builds on this review by proposing a framework for the design of a pricing instrument to address non-exhaust emissions.
- **Fourth**, it provides an overview of the main uncertainties and data gaps on non-exhaust emissions, and proposes next steps for moving forward in developing effective mitigation measures.

# What are the causes and consequences of non-exhaust emissions?

**Non-exhaust particulate matter emissions are comprised of brake wear, tyre wear, road wear and road dust resuspension.**

- Brake wear emissions can be influenced by vehicle and driving characteristics, including vehicle weight, brake disc and pad composition, rate of deceleration, rotor temperatures, sliding speed, and contact pressure.
- Tyre and road wear are affected by the composition of tyres and road surfaces in addition to vehicle and driving characteristics.
- Road dust resuspension is affected by a vehicle's speed, size and shape, the porosity and amount of dust on road surfaces, as well as weather conditions.
- Uncertainty remains surrounding the magnitude of non-exhaust emissions estimates in real-world driving conditions and how this amount varies with changes in the factors identified above.

**Exposure to non-exhaust emissions is associated with a variety of adverse health impacts, including an increased risk of cardiovascular, respiratory, and developmental conditions, as well as an increased risk of overall mortality.**

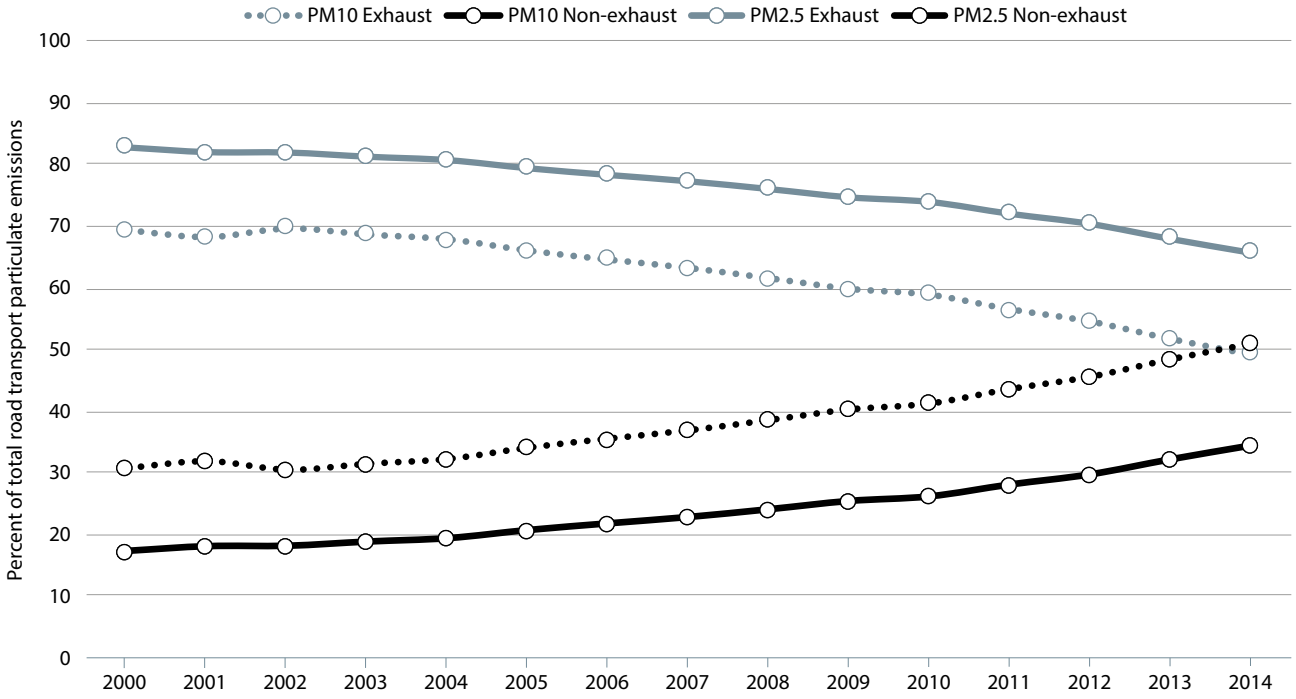
- Epidemiological studies have demonstrated, for example, that particulate matter exposure is associated with acute respiratory infections, lung cancer, and chronic respiratory and cardiovascular diseases. The effects of PM2.5 are considered to be particularly damaging.
- Oxidative stress and inflammation are the main physiological mechanisms responsible for the negative health effects of airborne particulate matter.
- Research has also found significant correlations between exposure to PM2.5 and fatality rates in previous respiratory disease epidemics, increasing the relevance of air quality for public health and the resilience of social systems more generally.

# How will non-exhaust emissions develop in future years?

## Particulate matter from non-exhaust sources comprises a growing share of particulate matter emissions from road transport.

- Road traffic is responsible for an average of 25% of ambient PM2.5 in urban areas worldwide.
- As the global fleet of vehicles becomes newer and the amount of particulate matter from exhaust sources continues to fall, the vast majority of particulate matter from road transport is expected to come from non-exhaust sources in future years.

Figure 1: **EXHAUST VS. NON-EXHAUST WEAR PARTICULATE EMISSIONS: PERCENTAGE OF TOTAL PARTICULATE EMISSIONS FROM ROAD TRANSPORT**



## Electric vehicles do not necessarily emit less non-exhaust particulate matter than conventional vehicles.

- Lightweight electric vehicles with a driving range of about 100 miles emit an estimated 18-19% less PM10 from non-exhaust sources than conventional vehicles and 11-13% less PM2.5.
- Heavier electric vehicles with a driving range of 300 miles or more are estimated to emit only 4-7% less PM10 than conventional vehicles and 3-8% more PM2.5.

Table 1: **NET CHANGE IN TOTAL NON-EXHAUST EMISSION FACTORS OF BEVS RELATIVE TO GASOLINE ICEVS (percentage points)**

| | Assumed electric vehicle weight | Passenger cars | Sport utility vehicles | Light commercial vehicles |
|---|---|---|---|---|
| PM2.5 | Lighter weight | -12.8 | -11.2 | -13.3 |
| | Heavier weight | +2.6 | +7.5 | +7.8 |
| PM10 | Lighter weight | -17.8 | -18.0 | -19.3 |
| | Heavier weight | -6.5 | -4.5 | -5.5 |

## Projections show that the uptake of electric vehicles will not lead to significant decreases in non-exhaust emissions from road traffic.

- Assuming modest electric vehicle uptake by 2030, the total amount of non-exhaust particulate matter emitted by passenger vehicles worldwide is projected to rise by 53.5%.
- Doubling the uptake of electric vehicles relative to the modest uptake scenario has a negligible impact on projected non-exhaust emissions, leading to a 52.4% increase by 2030.

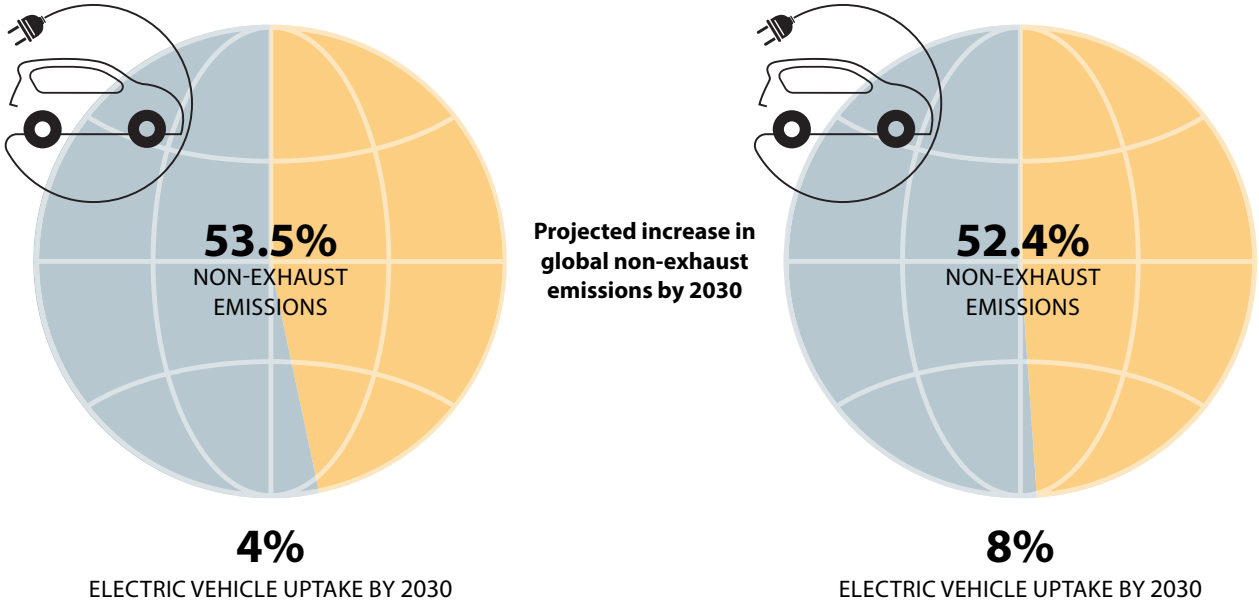
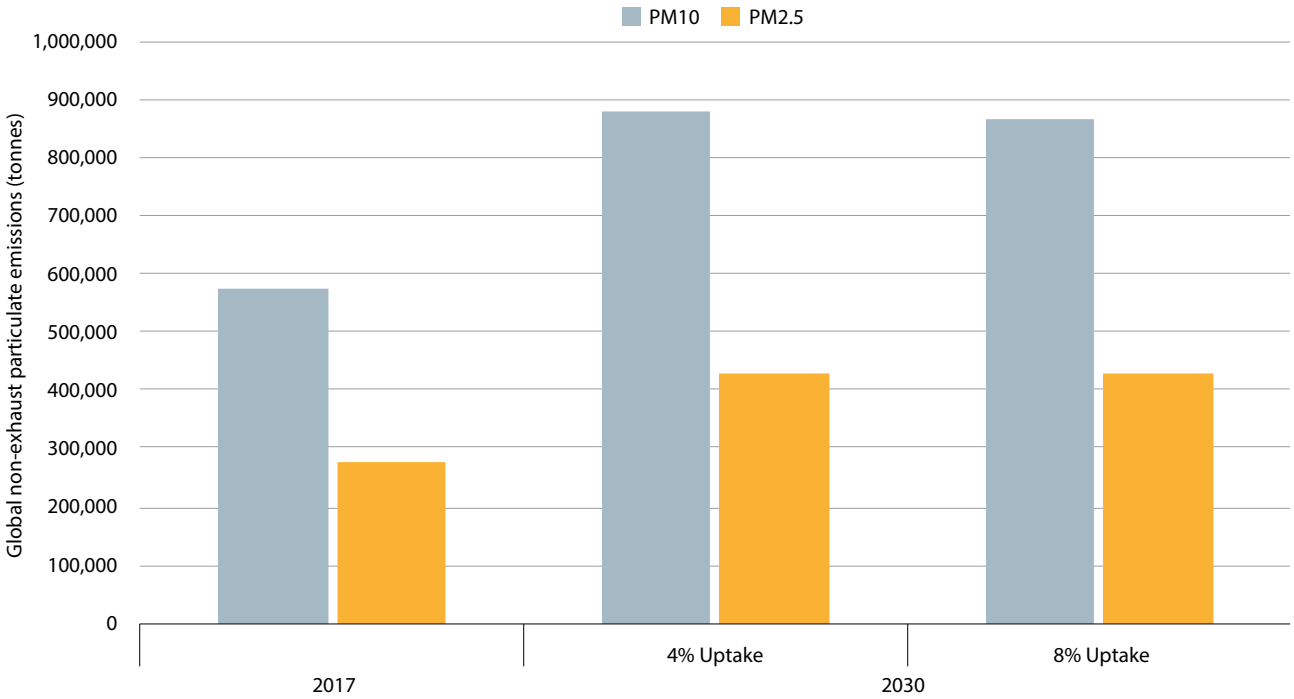



Figure 2: **EMISSION RATE ESTIMATES FOR THE YEAR 2017 AND PROJECTED 2030 UNDER ALTERNATIVE ELECTRIC VEHICLE UPTAKE SCENARIOS**



# How can policy makers address non-exhaust emissions from road transport?

**Policies can reduce non-exhaust emissions by reducing the amount of emissions that vehicles emit per kilometre and by decreasing the total number of kilometres that vehicles are driven.**

- Evidence suggests that technology-oriented policies such as vehicle light-weighting and regulations on the composition of tyres can reduce the amount of non-exhaust emissions emitted per kilometre.
- The amount that vehicles are driven in urban areas can be reduced by policies that disincentivise the ownership and use of private vehicles and by policies that incentivise the use of alternative modes such as public transport, cycling, and walking.
- A distance-based charge designed to internalise the social costs of non-exhaust emissions would incentivise both a reduction in vehicle-kilometres travelled as well as a reduction in emission factors.

**A robust understanding of emission factors, their drivers, and the effectiveness of potential mitigation measures will be necessary in order to assess the costs and benefits of policy alternatives.**

- Standardised methodologies to measure brake, tyre and road wear emissions will need to be developed in order to design, implement, and enforce measures to mitigate non-exhaust emissions.
- Priority should be given to quantifying the impact of vehicle, road, driver and environmental characteristics on the generation of non-exhaust particulate emissions.
- Priority should be given to measuring and valuing the damages caused by non-exhaust emissions and to evaluating the effectiveness of potential mitigation measures to reduce vehicle emissions factors and the number of kilometres driven.

# Conclusions

**This report synthesises the current state of knowledge on the nature, causes and consequences of particulate matter from non-exhaust emissions and simulates how these emissions will evolve in future years. It identifies existing technological and policy measures to mitigate non-exhaust emissions and proposes a policy framework designed to internalise the social costs associated with these emissions.**

Addressing non-exhaust emissions will involve immediate mitigation measures as well as strengthening our understanding of non-exhaust emissions and how to reduce them:

- Resources should be invested in better understanding the impacts of non-exhaust emissions and the effectiveness of mitigation measures to address them, as well as in developing a commonly accepted methodology for emissions measurement.
- A combination of policies, including those that reduce emissions intensity per kilometre travelled and those that reduce total distances travelled can be used to reduce non-exhaust emissions from road transport.
- Findings regarding the amount of non-exhaust emitted by electric vehicles invite a reappraisal of the net environmental benefits that can be expected from their use and a reconsideration of policy approaches that provide blanket support for electric vehicles.

**The development and implementation of targeted policy action depends on a robust understanding of the processes that generate non-exhaust emissions, the relationship between exposure to these emissions and health impacts, and the effectiveness of various mitigation measures in reducing emission rates and exposure.**

This Policy Highlights is based on the OECD publication
***Non-exhaust Particulate Emissions from Road Transport: An Ignored Environmental Policy Challenge***

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This report analyses the nature, drivers and health consequences of particulate matter from non-exhaust emissions and reports estimates of total non-exhaust factors for electric and conventional vehicles. Based on these estimates, the report explores the implications of anticipated electric vehicle uptake for non-exhaust particulate matter emissions. The report also provides an overview of existing policies that contribute to the reduction of non-exhaust particulate matter emissions and proposes a framework for the design of a pricing instrument to address the negative externalities associated with these emissions. The report emphasises that the development and implementation of targeted policy action depends on a robust understanding of the processes that generate non-exhaust emissions, the relationship between exposure to these emissions and health impacts, and the effectiveness of various mitigation measures in reducing emission rates and exposure.

This report is an output of the OECD Environmental Policy Committee and its Working Party on Integrating Environmental and Economic Policies (WPIEEP). The report was carried out under the overall responsibility of Shardul Agrawala, Head of the Environment and Economy Integration Division in the OECD Environment Directorate. All chapters of the report were authored by Fulvio Amato of the Institute of Environmental Assessment and Water Research (IDÆA) and the Spanish National Research Council (CSIC), Alexandros Dimitropoulos of PBL Netherlands Environmental Assessment Agency, and Katherine Farrow and Walid Oueslati of the OECD Environment Directorate.

To access the full report, visit: oe.cd/non-exhaust



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