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Monitoring vehicle emissions with the on-road chasing method over a decade

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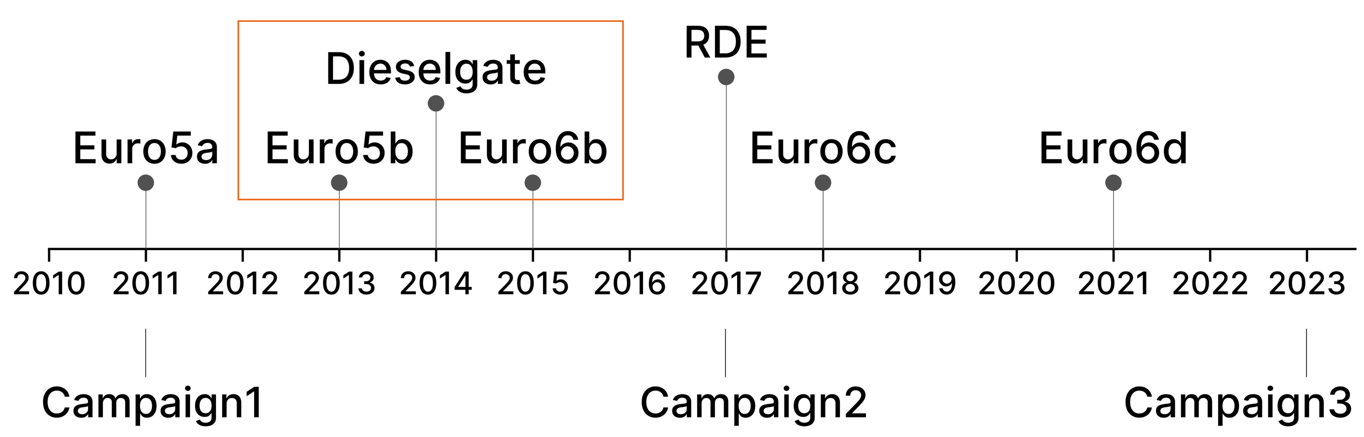
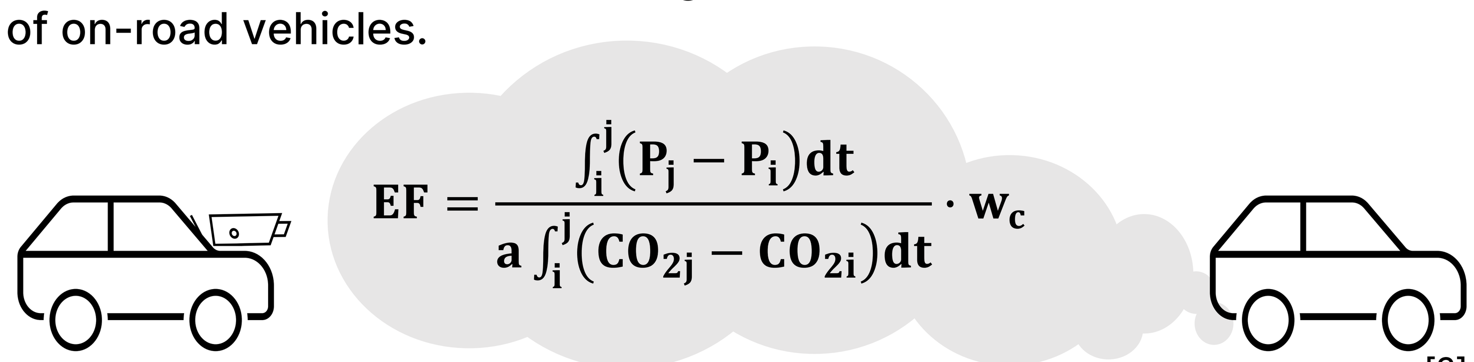
Motivation and method

National regulators turning a blind eye to vehicle test cheating is the main culprit for the 29 million 'dirty' diesel cars sold in Europe by 2016.[1] 77% of Euro 6 diesel cars and 85% of the Euro 5 vehicles have "suspicious" test results, showing excessive emissions.[2] EU introduced testing in real-world conditions called Real Driving Emissions (RDE) in addition to laboratory tests in 2017.



The on-road chasing method is an independent real-world vehicle emission testing method, where emissions of random, in-use vehicles are measured by chasing them on the road. We analyzed EF distributions from 3 on-road chasing measurement campaigns to evaluate the effectives of the legislation aimed to reduce emissions of on-road vehicles.

$$\mathrm{EF} = \frac{\int_i^j (P_j - P_i)\,dt}{a\int_i^j (CO_{2j} - CO_{2i})\,dt} \cdot w_c$$

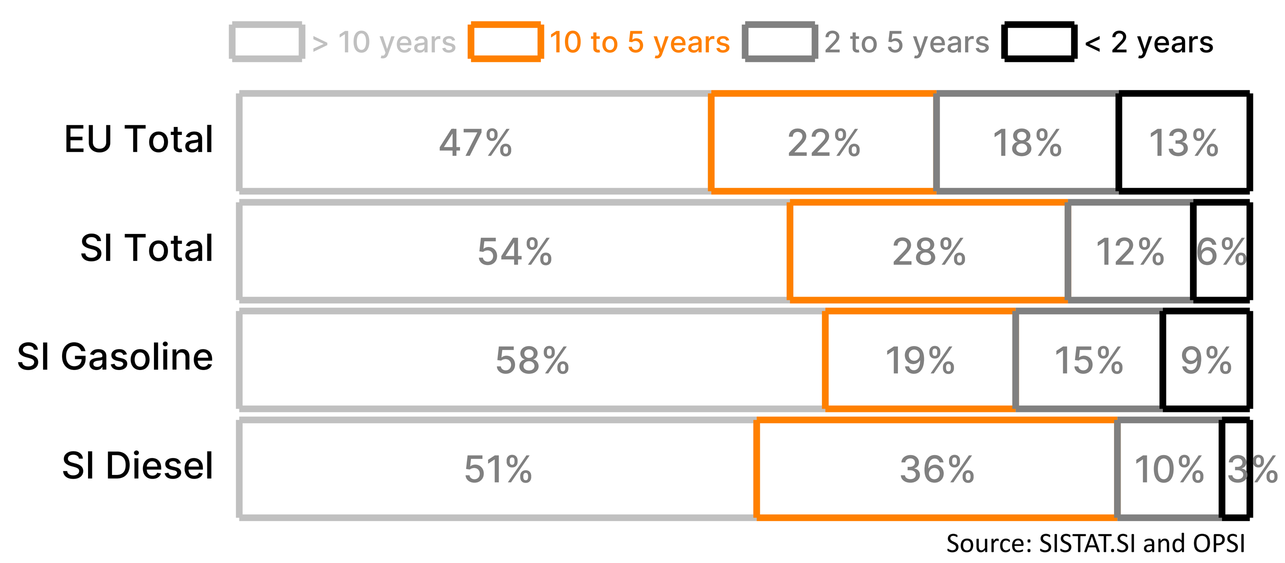


[3]

P = BC, PN or Nox, a = 0.2727, w_c is 0.86.
Instruments: CO2 – Carbocap GMP 343, BC – Aethalometer AE33, NOx - 2B Technologies 410 and 401 (2011), EcoPhysics, CLD86 (2017),and AL2 (2023); PN - TSI, FMPS (2011 & 2017) and CPC (2023).

Sampled vehicle fleet is representative of EU average

Average age of European (Slovenian) car in 2021 was 12 years (11 years) [4].
36% of SI diesel cars are the problematic 10- to 5-year-old Euro 5 and Euro6.



Sample size

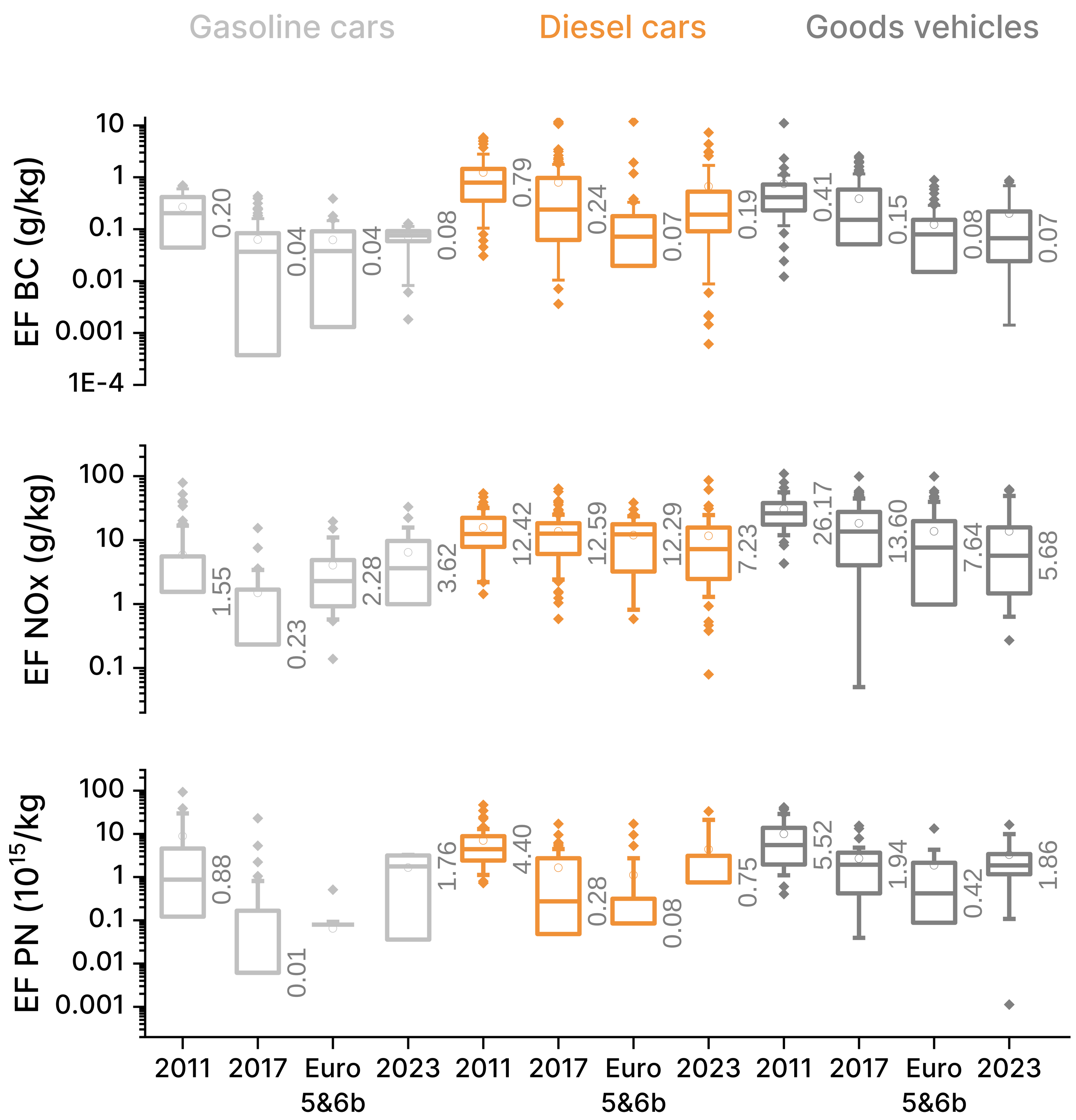
Campaign	Total	GC	DC	GV
2011 [3]	139	24	68	47
2017	380	113	160	107
2023 preliminary	96	20	54	22

We checked against open-source national data (OPSI) that the age and the engine size distribution of the measured vehicle sample in 2017 (and 2011) was representative of the Slovenian national vehicle fleet which is representative for the European average.

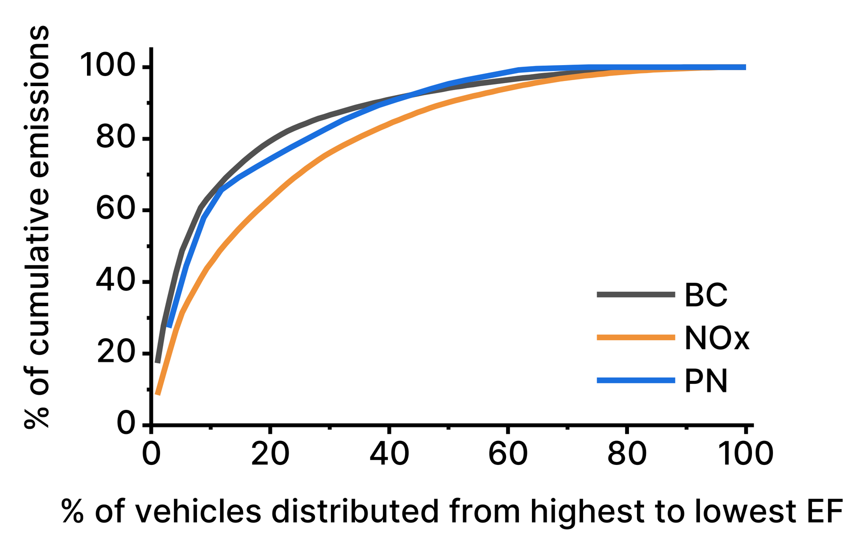
RESULTS

BC EF of diesel cars and goods vehicles are continuously decreasing over the decade.

Median NO_x EF of diesel cars and goods vehicles in 2023 has almost halved since 2017 campaign.



High emitters contribute disproportionally to vehicle fleet emissions.



10% of vehicles with highest EF in 2023 sample contribute 65% of BC and PN emissions, and 46% of NO_x emissions.

Conclusions

Introduction of the new vehicle emission standards resulted in reduction of BC and PN emission factors.
NO_x emissions were insufficiently reduced by 2017 (Euro5 and Euro 6b), however reductions were shown with the 2023 campaign.
Excluding high emitters would be an effective approach to reduce total vehicle fleet emissions.

References

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[3] Ježek, I., et al. (2015). Atmos. Chem. Phys., 15, 11011–11026
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