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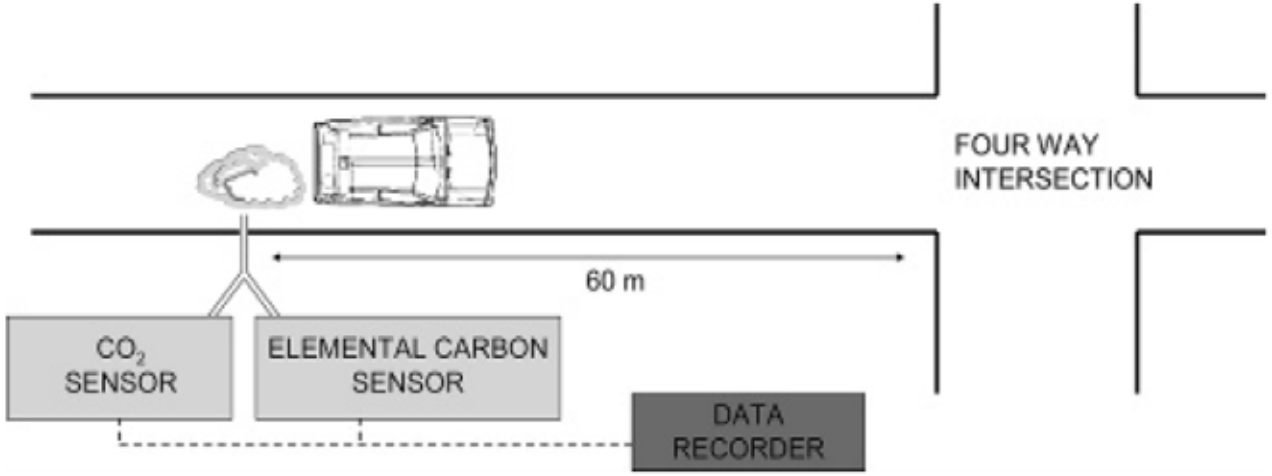
Hochschule für Technik

Reducing fleet emissions by periodical technical inspection

H. Burtscher, A. Mayer

Indication that few high-polluters dominate fleet emissions exists long time

Ø **Kurinawan and Schmidt-Ott (2006):** A small percentage of “superpolluters” (here 5%) account for a high percentage (here 43%) of the pollution

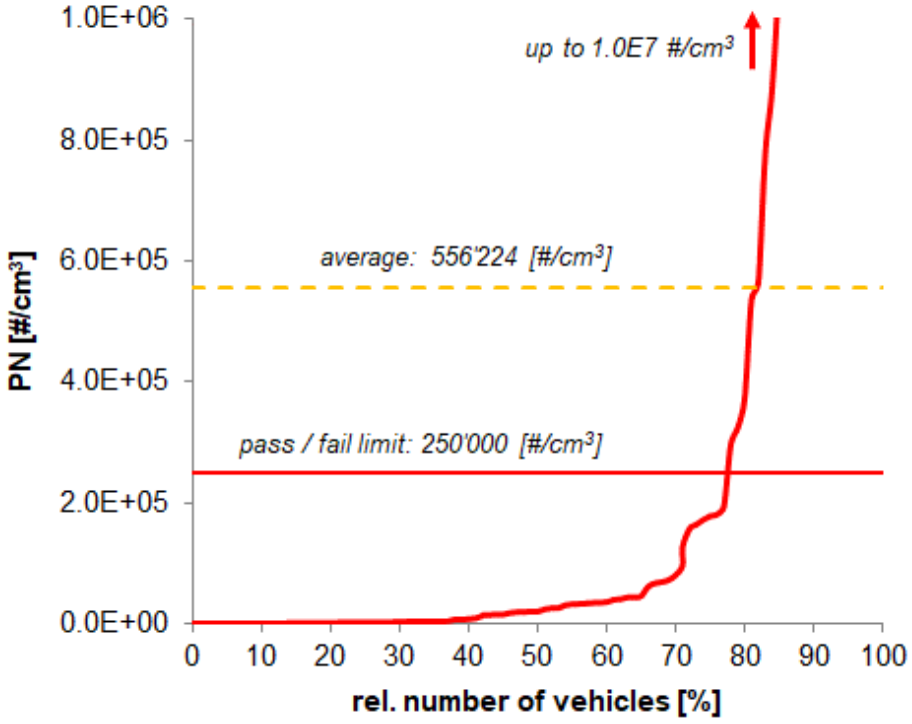


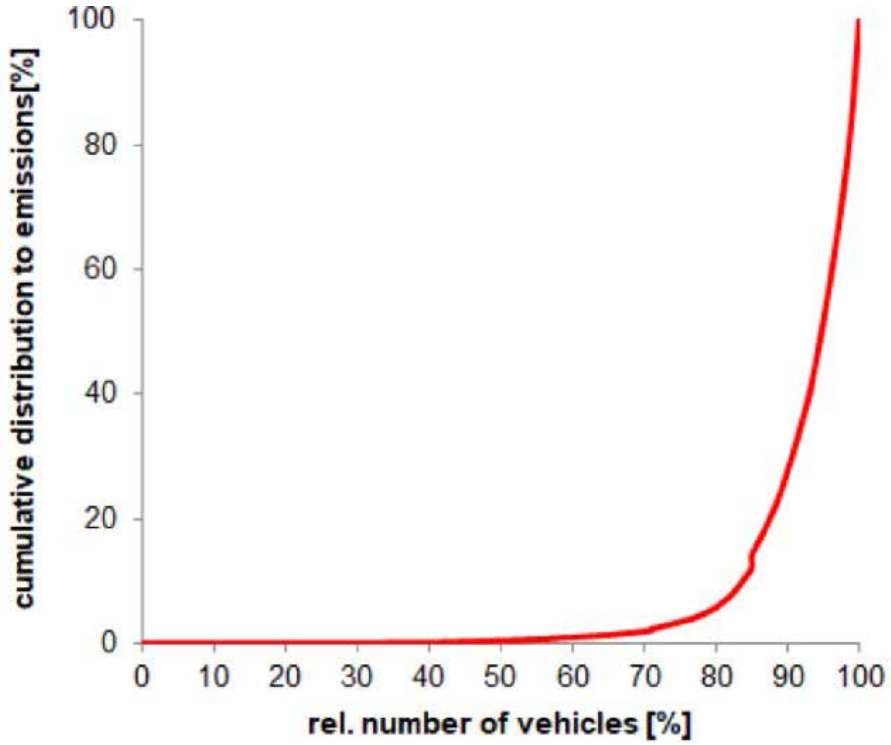
1250 cars measured on road

Beaton et al., 1995: The emission distribution is highly skewed; the half of the fleet with the lowest emissions contributed less than 10% of the CO and HC, while a few high-emission vehicles dominated the mean values. In this instance, 7% of the vehicles accounted for '50% of the on-road CO emissions, and 10% of the vehicles accounted for 50% of the on-road HC emissions.

Meanwhile corroborated by a large number of studies

Emissions from construction machinery

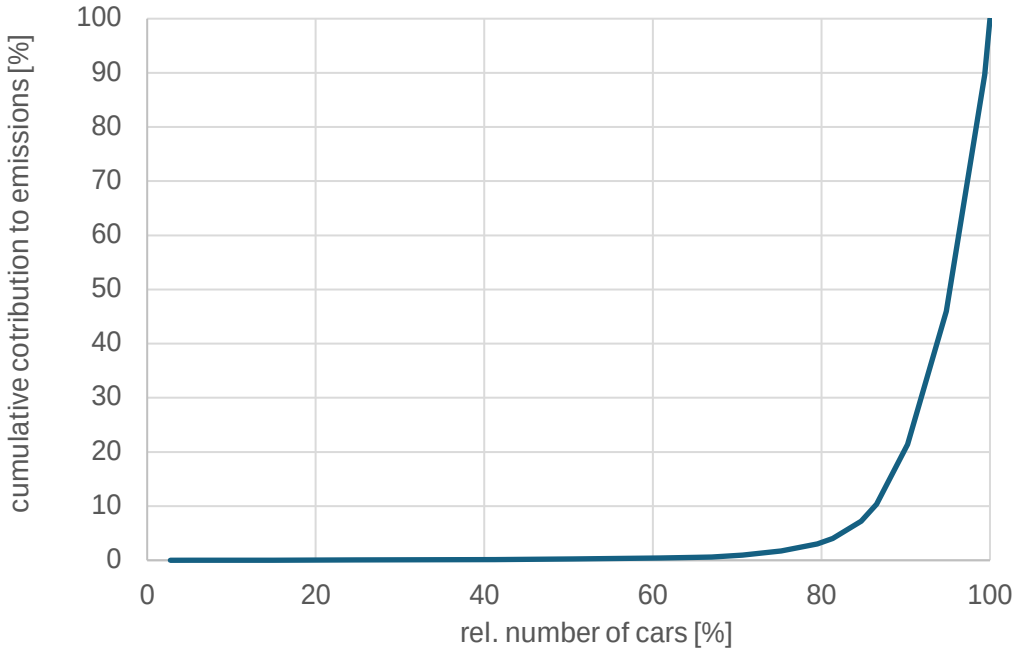


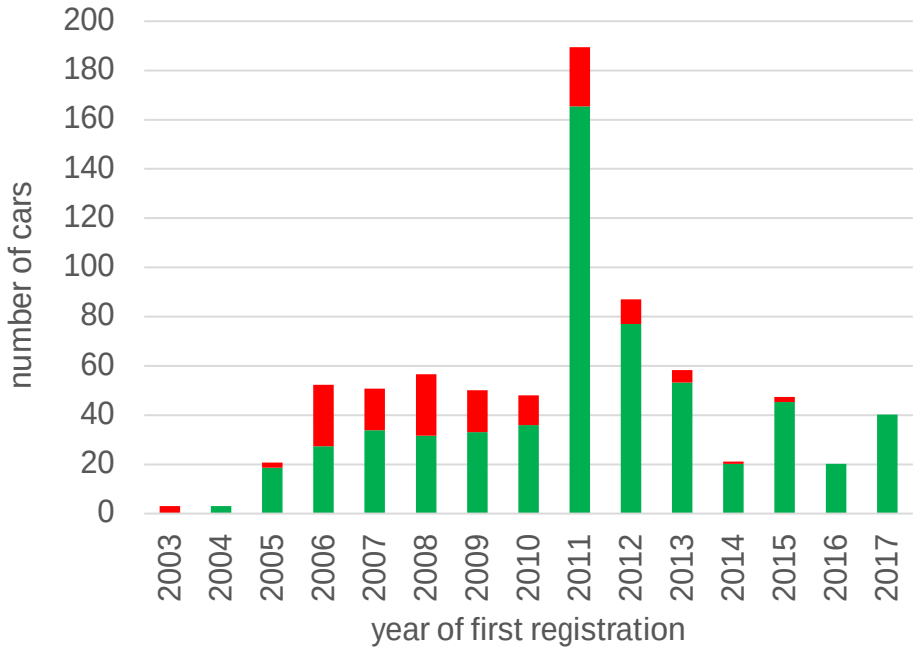


Cumulative impact on the emissions of the entire fleet

Nauroy, H., Compte, P., Czerwinski, J., Willi, P.: Field Particle Number and Opacity Measurements on Construction Machinery. Report Berner Fachhochschule, Labor für Verbrennungsmotoren und Abgastechnik (2017)

PN emissions from diesel vehicles with DPF

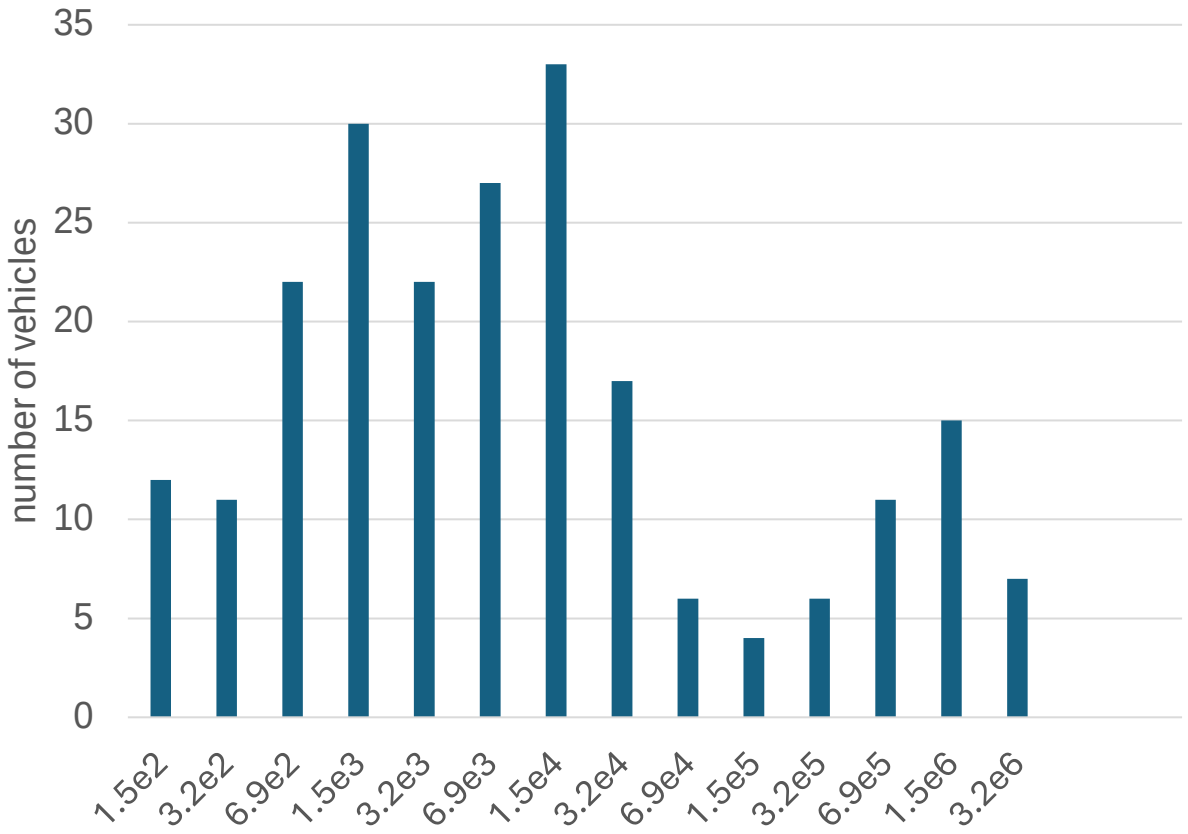


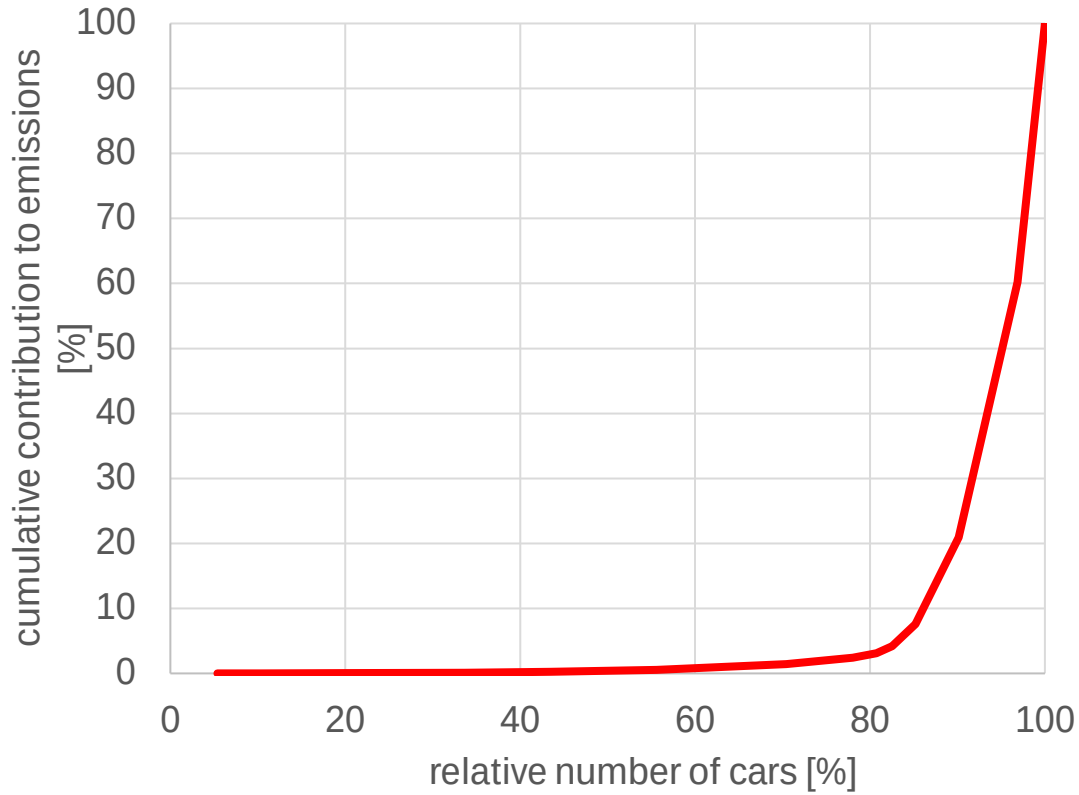


Distribution of the filter failure rate as a function of vehicle operating time (green: <250,000 cm^{-3} red: > 250,000 cm^{-3})

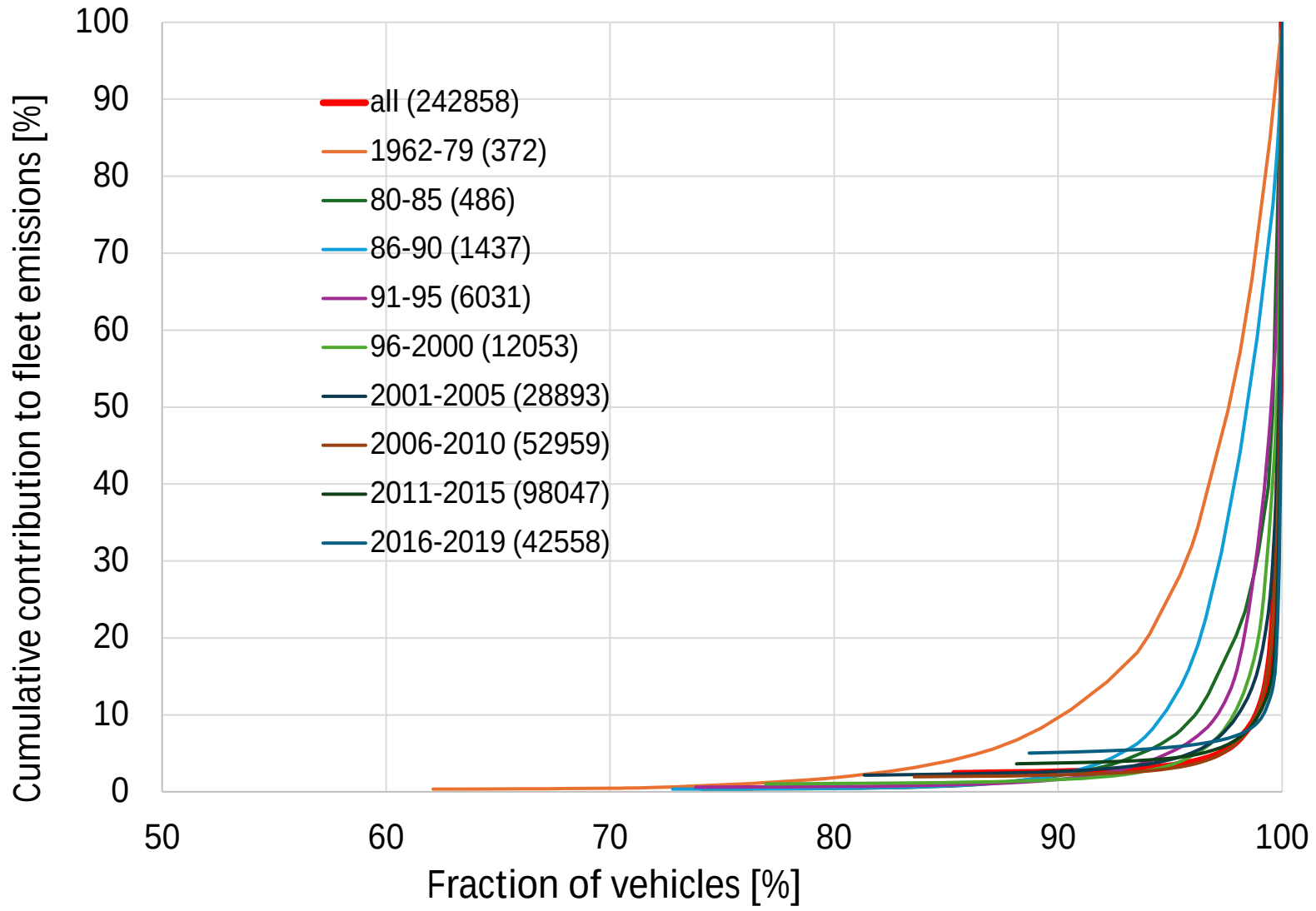
Data from B. Gloor, AWEL

400 buses (Santiago, Chile)

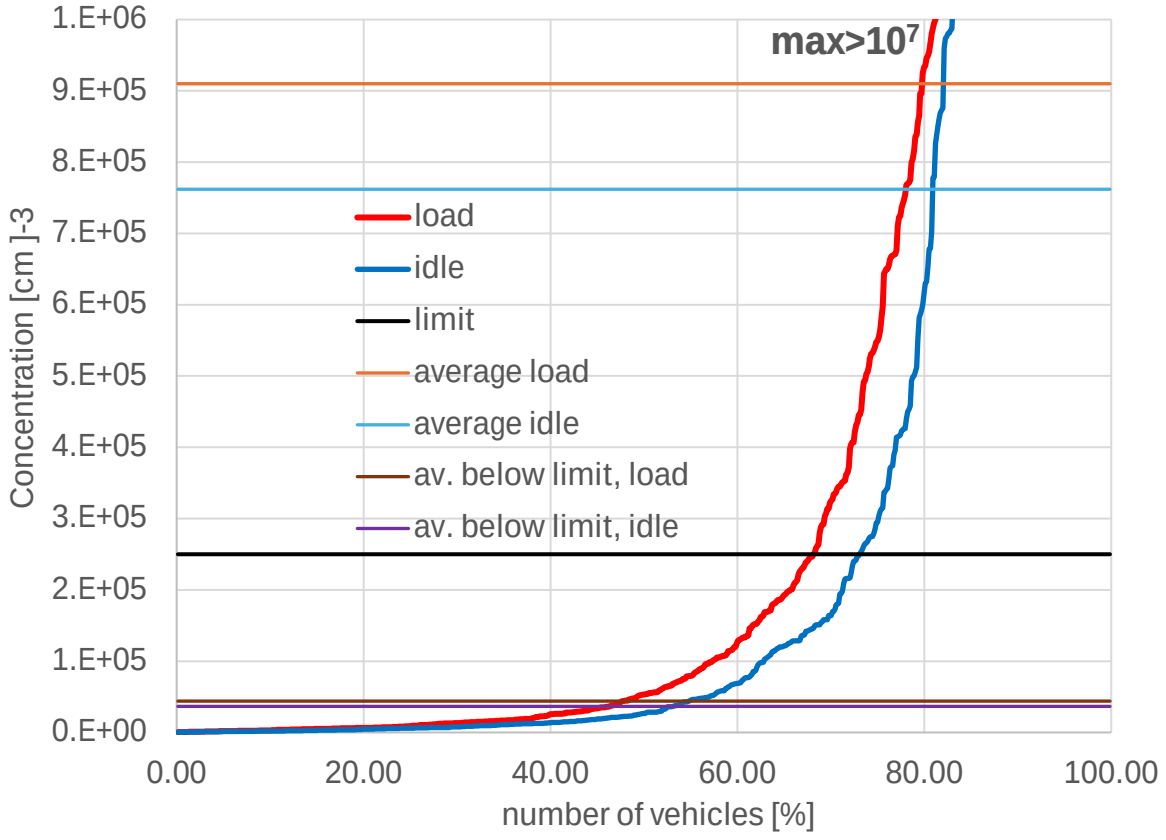


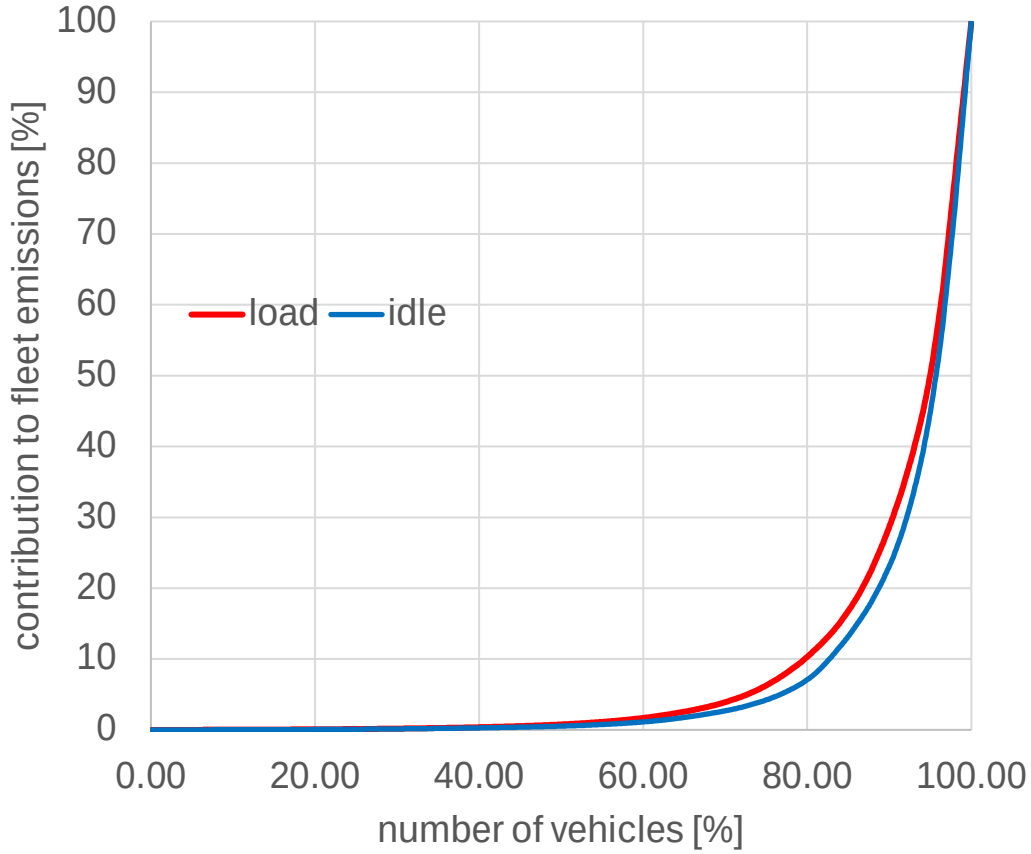


Emissions from >400’000 vehicles in Mexiko



Emissions from modern gasoline engines



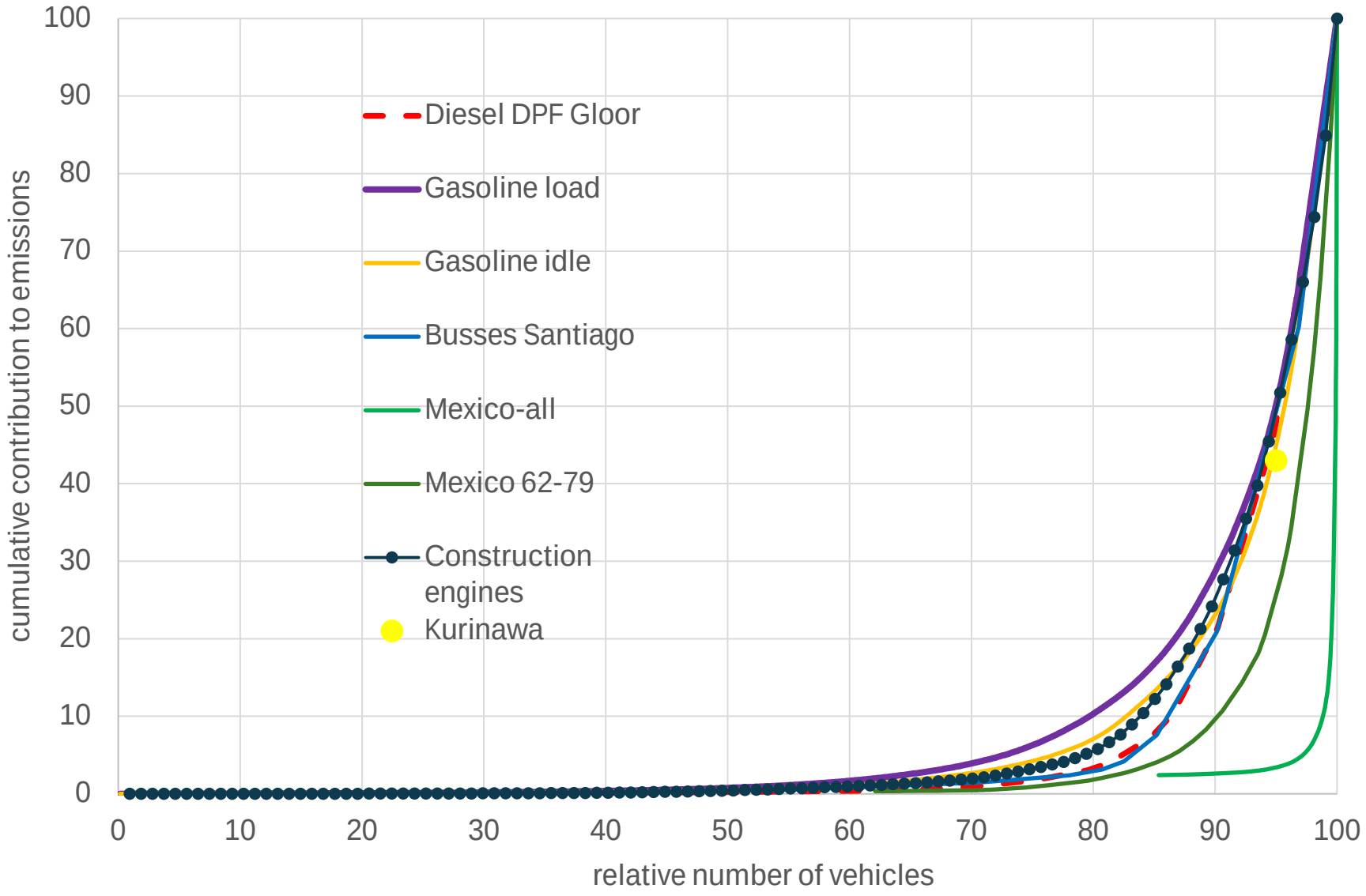


From Mayer et al., 2025

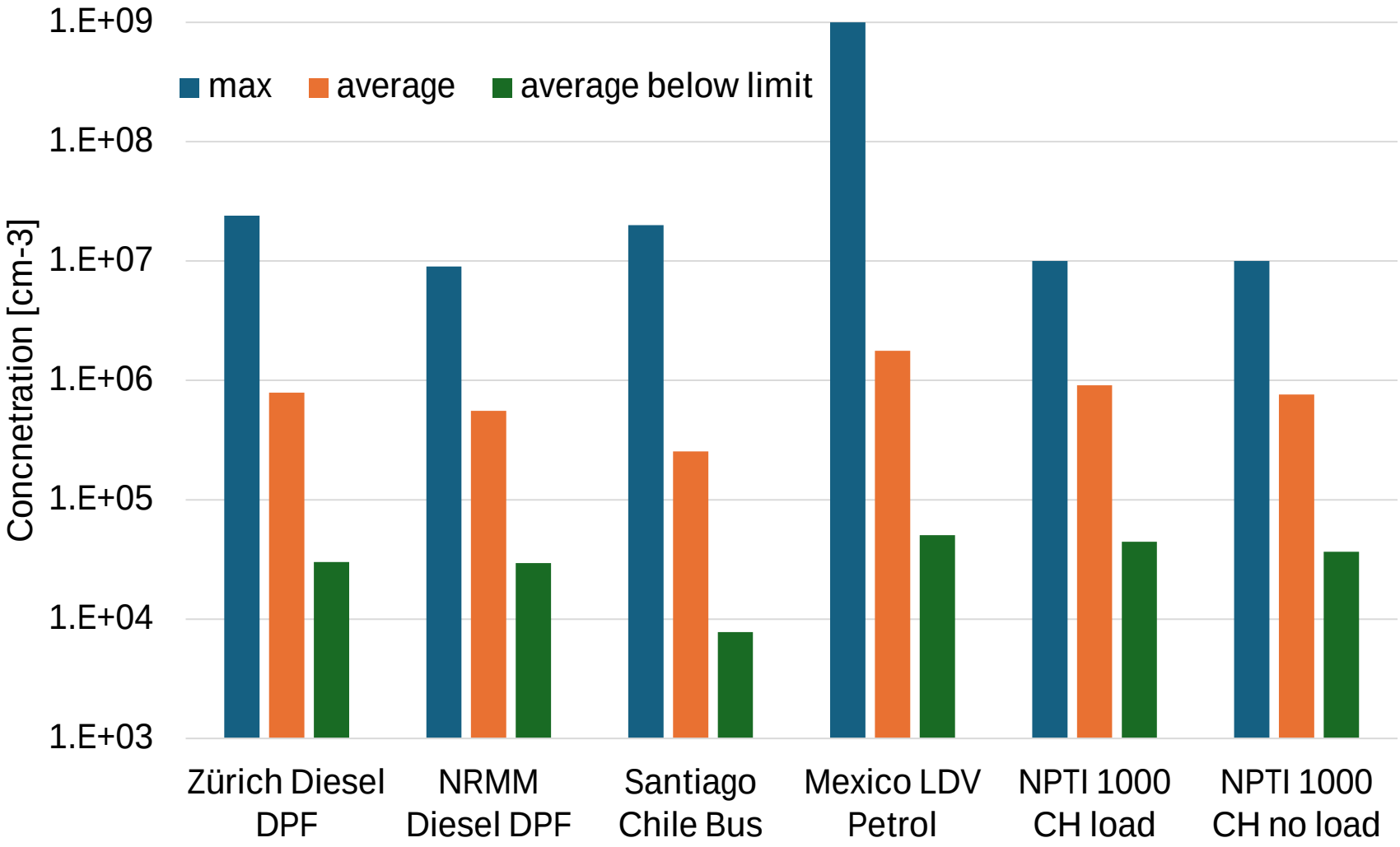
2.943.068 diesel vehicles with euro norm 5 or higher were tested in the Flemish Regio (fromJuly 1th 2022 until March 21th 2024).

Emission standard	Number of tests	Above 1.000.000 cm^{-3}	Between 250.000 cm^{-3} and 1.000.000 cm^{-3}
Euro 5a	580.057	16,79%	6,90%
Euro 5b	668.685	9,52%	4,13%
Euro 6	1.694.326	2,72 %	2,37 %
ALL	**2.943.068**	**7,03 %**	**3,66 %**

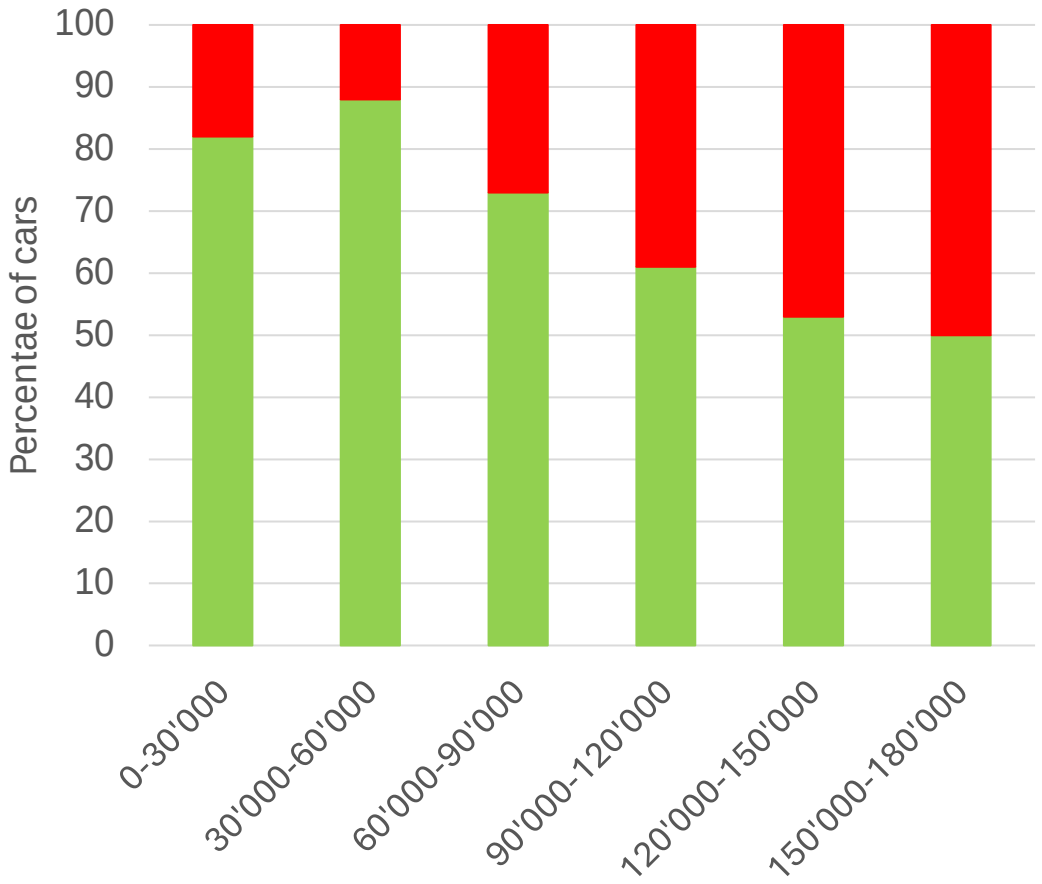
Sumary of results

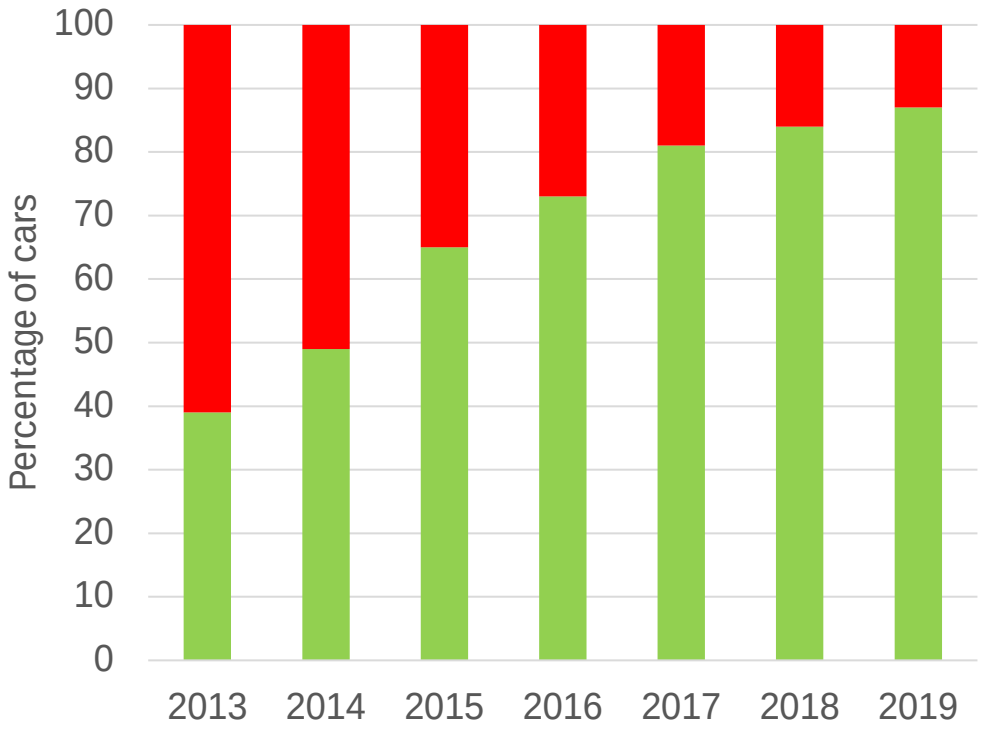


Max. and average emissions of all vehicles and those compliant with the limit of 250’000 cm^{-3}



Influence of age and milage





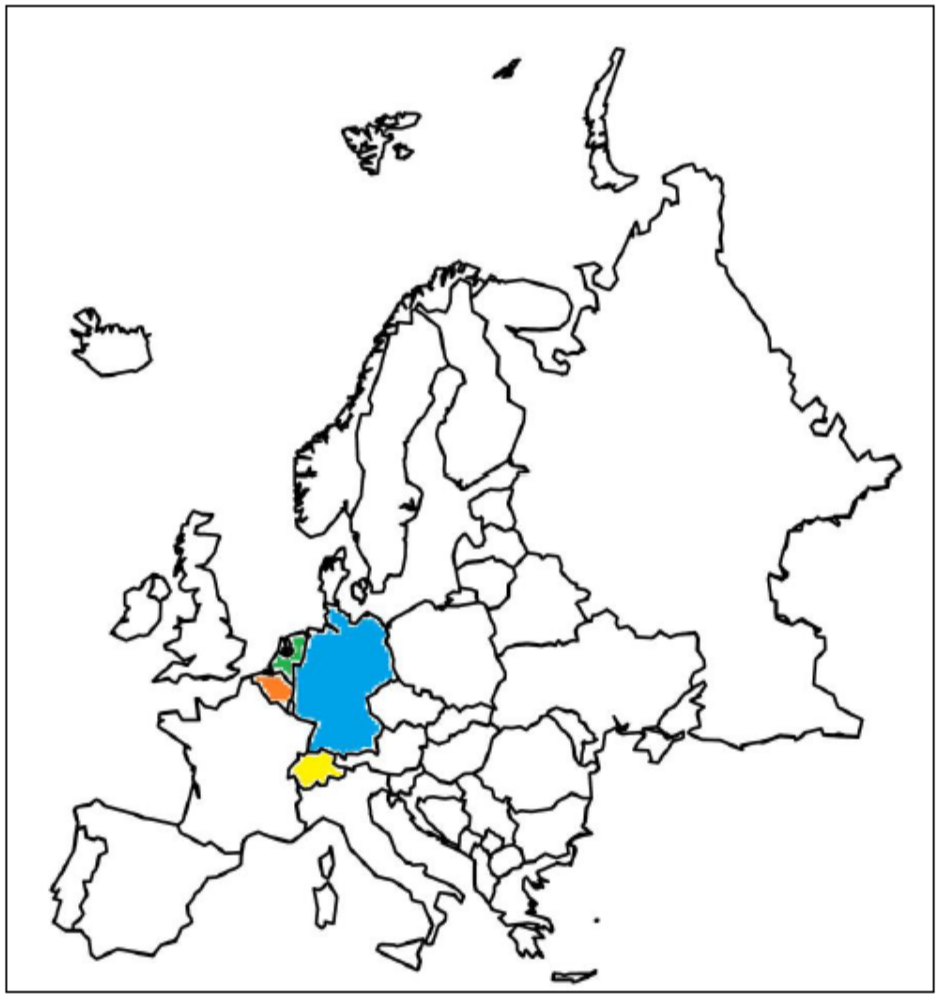
Green: <250’000cm^{-3}
Red: > 250’000cm^{-3}

Data from Fracer

Particle Number measurement already implemented in PTI in Europe:

Gross poluters indentified*

+ 13.2%



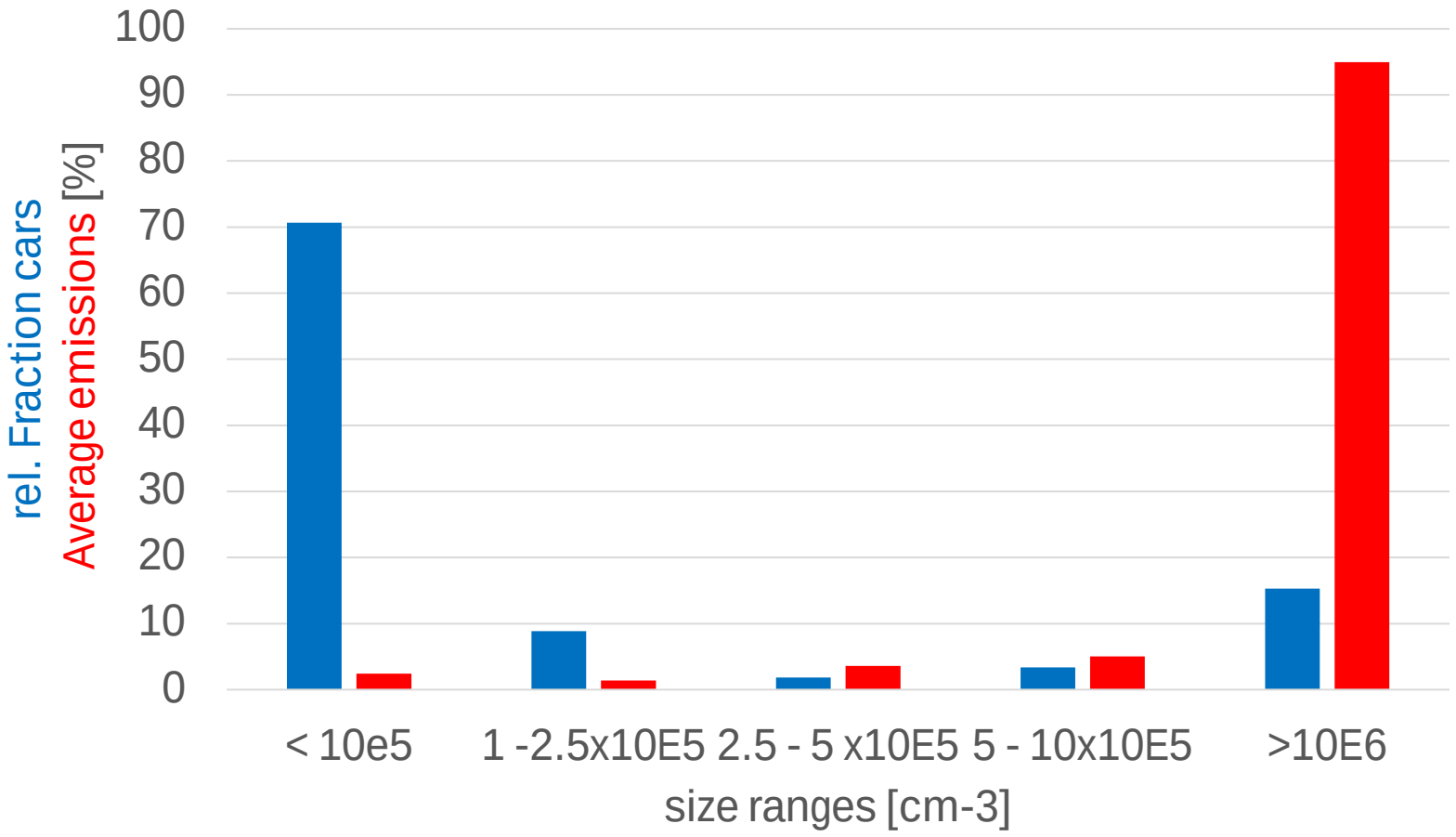
OBD detected

0.14%

*After more than 880.000 of inspections with PN counting technologies in Flanders (north of Belgium)

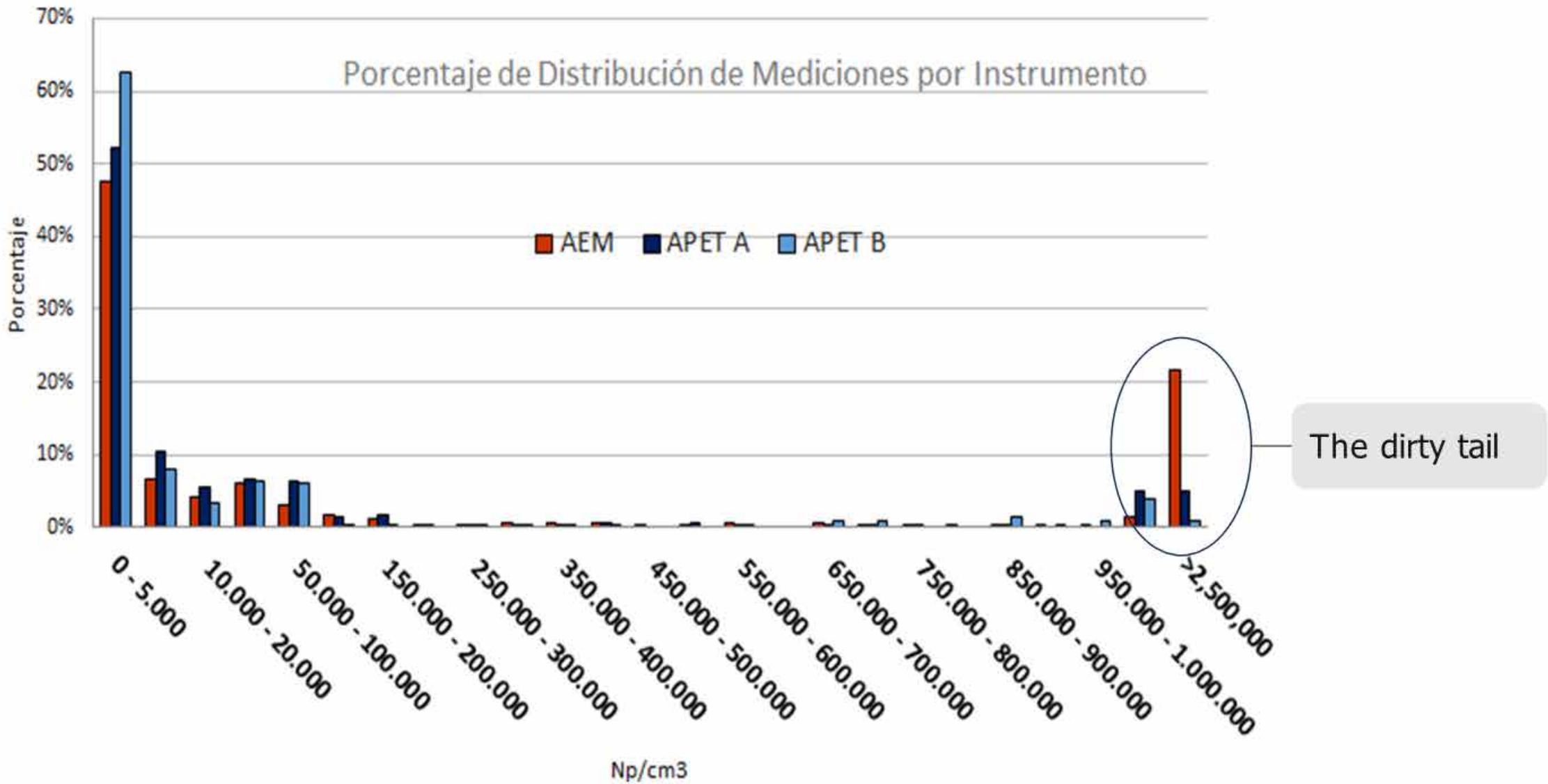
From A. Checa

Number of cars and contribution to emissions in size classes



Data from Gloor, AWEL

Measurement of particle number in 1,000 light and medium duty vehicles equipped with diesel particulate filter (DPF) in Periodic Test Inspection Stations in Santiago de Chile, 2021



Fraser, VERT

PN measurement in Europe

PN

EU

Scope	Belgium		The Netherlands	Germany	Switzerland	European guidelines
	Flanders & Brussels	Wallonia				
Vehicle category	M1, N1	M1, N1	All	All	All	M, N
Start Date	1.7.2022	1.7.2022	1.1.2023	1.7.2023	1.1.2023	/
Fuel type	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel
Euro Norm	Euro 5a and higher	Euro 5b and higher	All vehicles with DPF	Euro 6	Euro 5b and higher, Euro VI and higher, Stage V, retrofitted Buses, retrofitted NRMM	Euro 5b (or Euro VI for HDV) and higher
Threshold [cm^{-3}]	(250.000) 1.000.000	(250.000) 1.000.000	1.000.000	250.000	250.000	250.000 but also 1.000.000 possible
Equipment specifications	NMi Part 1 & 2 (NPTI)	NMi Part 1 & 2 (NPTI)	NMi Part 1 & 2 (NPTI)	PTB	METAS SR 941.242 (admin.ch) List of type approved instruments METAS - legnet2	Described in the guidelines

Technologiestraat 21-25 I 1082 Brussel I Tel 02 469 09 00 I Fax 02 469 05 70 I www.gocavlaanderen.be I info@gocavlaanderen.be

GOCA VLAANDEREN

from Pascal Buekenhoudt,GOCA

Overview specifications PN-emission test device

	The Netherlands & Belgium	Germany	Switzerland	European guidelines
Technology	Neutral	Neutral	Neutral	Neutral
Particle size	23 – 80 nm	23 – 200 nm	23 – 200 nm	23 – 80 nm but possible up to 200 nm
Counting efficiency	0,2 – 1,3	20% - 200%	40 – 300%	0,2 – 1,3 (or 2)
Max permissible error	2,50E+04 cm^{-3} or ± 25%	± 25% Minimum 5,00E+03 cm^{-3}	± 30% @ 80 nm	± 25% or absolute MPE ≤2,50E+04 cm^{-3}
Display range [cm^{-3}]	5,00E+03 cm^{-3} 5,00E+06 cm^{-3}	5,00E+03 cm^{-3} 5,00E+05 cm^{-3}	Min. requirement: 5,00E+04 cm^{-3} 5,00E+06 cm^{-3}	5,00E+03 cm^{-3} At least 2 x limit
Type Approval	NMi	PTB	METAS SR 941.242 (admin.ch)	Open

from Pascal Buekenhoudt,GOCA

Conclusions

- Fleet emissions are dominated by high polluters
- OBD cannot detect most of them, alternatives are required
- Tighter limits in type approval only make sense if high polluters are eliminated
- As there is large gap between clean vehicles and high polluters, the setting of the limit is not critical
- large uncertainties can be tolerated, making the test simple and cheap
- Test can be implemented as:
  - PTI
  - on road tests (by police)
  - Ristovski suggested for public busses tests when a bus leaves a stop
  - Remote sensing, as done by Kurinawan and Schmidt-Ott

Thank you for your attention?

Questions ?