New knowledge on high-emitters and on-road emissions from the H2020 CARES project

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CARES

H2020
GA No 814966

H2020 Call: InCo flagship on reduction of transport impact on air quality

C) Sensing and monitoring emission in urban road transportation system. This area intends to urgently provide a means to monitor fleet-wide on-road emissions, to detect and repress any emission-affecting modifications of individual vehicles (tampering) or bad maintenance/poor after-treatment system durability/OBD ineffectiveness, to support local air quality plans, and to help national and local enforcement authorities in identifying and prosecuting infringing vehicles.

- Remote sensing of road vehicle emissions (contactless measurements from the roadside, portals or from chasing vehicles); further technological development of available techniques is needed to improve performance, reduce costs, facilitate use by unskilled personnel and achieve a broader deployment potential;
- Establishment of a proper data infrastructure built around vehicle registration databases, traffic management measures and air quality monitoring systems;
- Demonstration of the system in several cities;

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CARES – a H2020 InCo flagship project bringing together worldwide RES and RDE expertise

Partners:

AGENZIA MOBILITÀ AMBIENTE TERRITORIO

Airyx

CRAES

Czech Technical University in Prague Faculty of Mechanical Engineering

CZU CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Empa Materials Science and Technology

TU Graz

香港科技大學 THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

icct THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

IIASA

INNOVHUB STAZIONI SPERIMENTALI PER L'INDUSTRIA innovation and research

ivl Swedish Environmental Research Institute

KRAKOW SMOG ALERT

LAT LABORATORY OF APPLIED THERMODYNAMICS ARISTOTLE UNIVERSITY THESSALONIKI

TNO

TECHNISCHE UNIVERSITÄT DRESDEN

UNIVERSITY of York

UNIVERSITY OF LEEDS

UNIVERSITÄT HEIDELBERG ZUKUNFT SEIT 1386

Commercial remote sensing service providers:

OPUS RSE

heat

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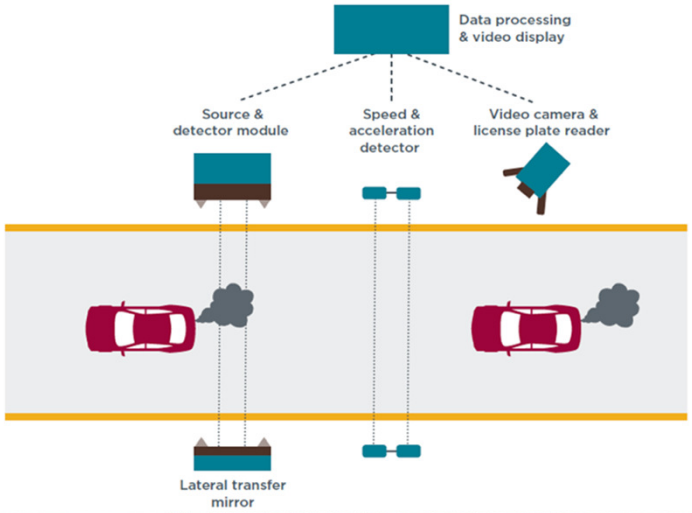
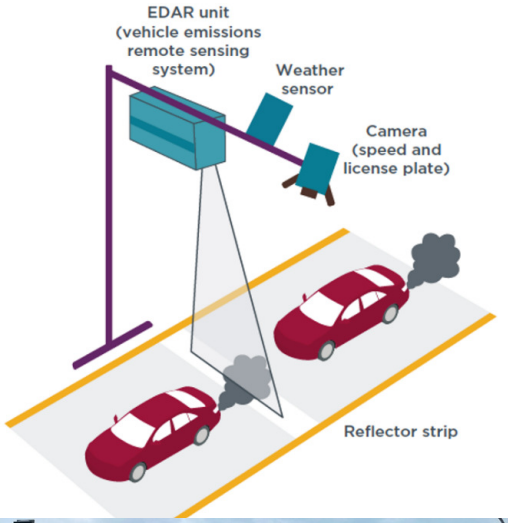
Conventional/commercial RES



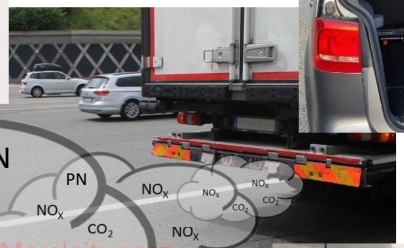
Capable of measuring:

- CO_2
- CO
- HC
- NO
- NO_2
- NH_3
- CH_4
- PM/PN???

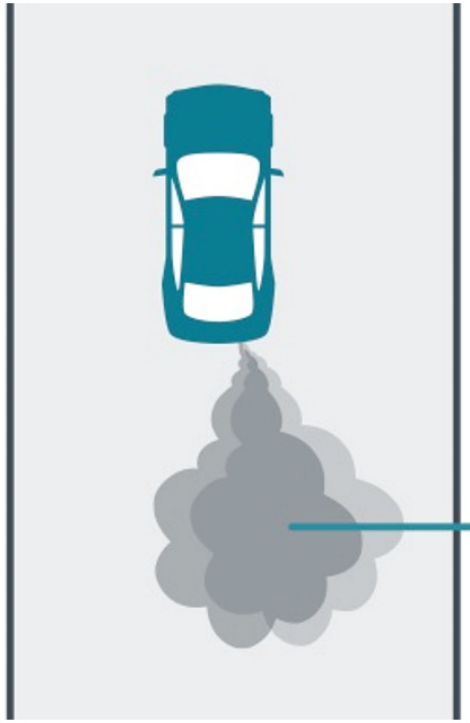


CARES is further developing RES techniques

Plume chasing – NO_X, PN and BC



Point sampling – PN, BC and NO_X



Analyzer

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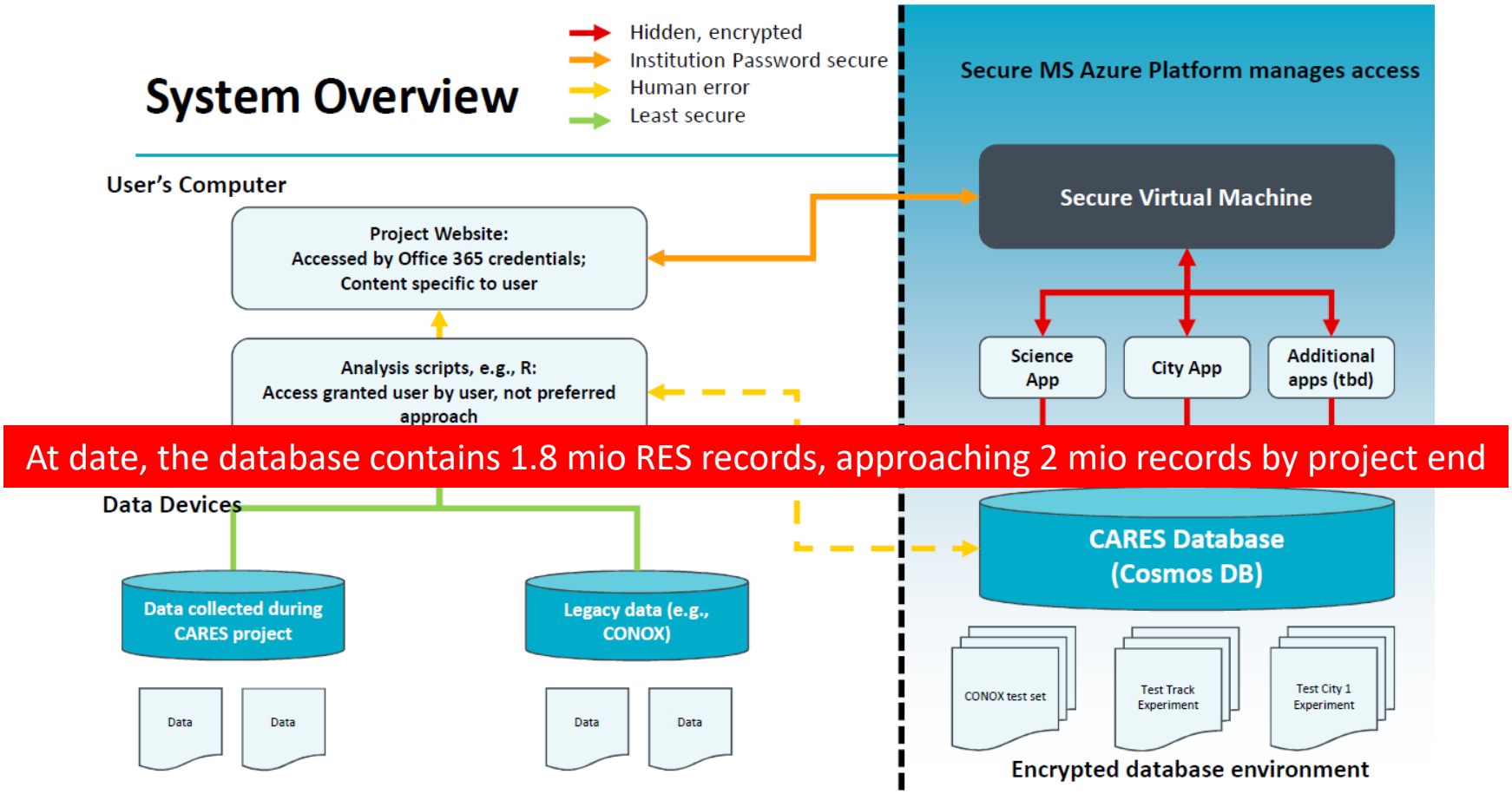
CARES database platform



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Some results

- On-road emissions from passenger cars by Euro standard (NO_X and particulate matter)
- On-road emissions from heavy-duty trucks by Euro standard (NO_X and particulate matter)
- Identification of NO_X high-emitting HD trucks by means of plume chasing
- Identification of PN high-emitting diesel passenger cars by means of point sampling

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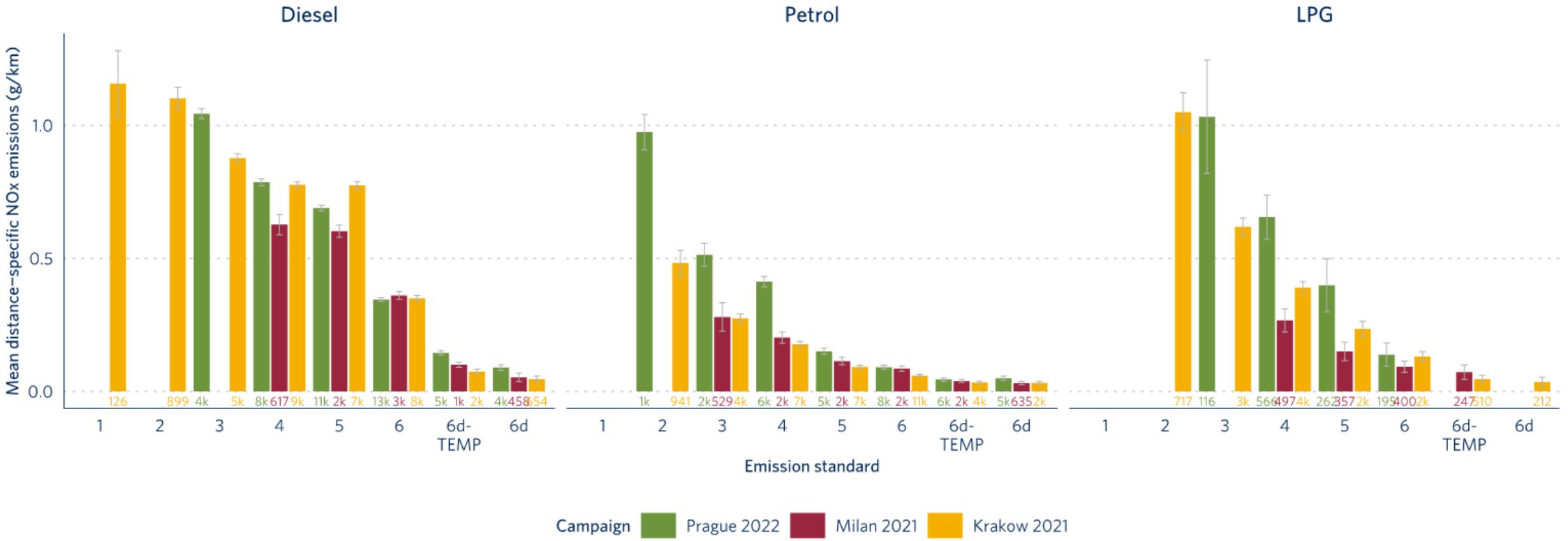
Average NO_X emissions from passenger cars by Euro standard in all three demo cities



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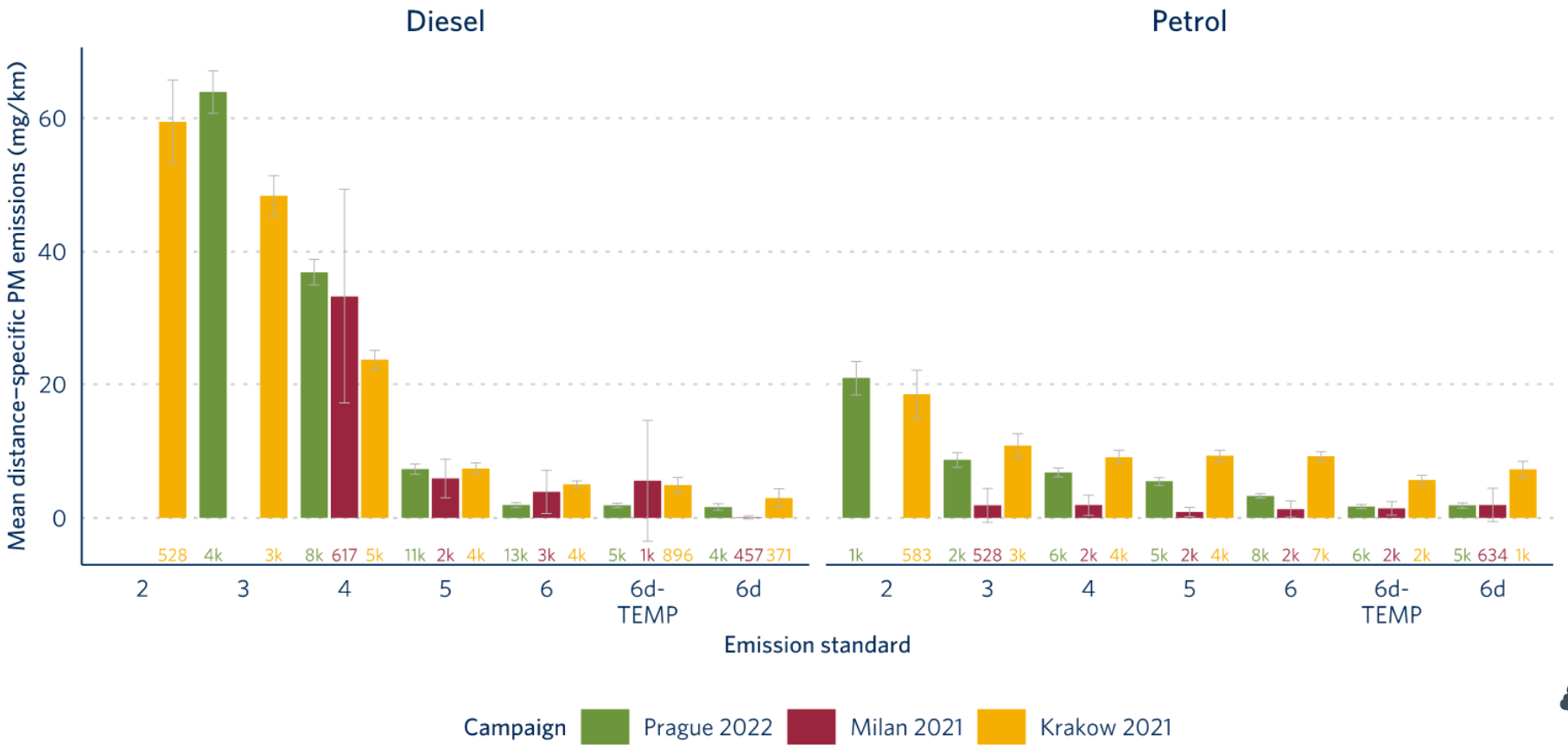
Average PM emissions from passenger cars by Euro standard in all three demo cities



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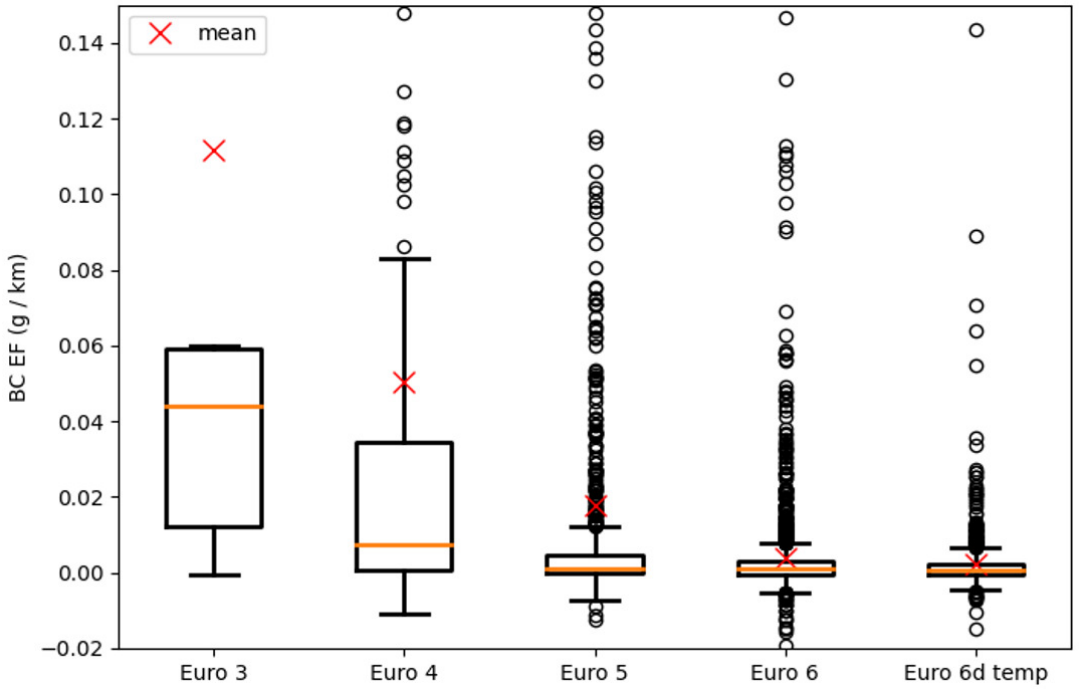
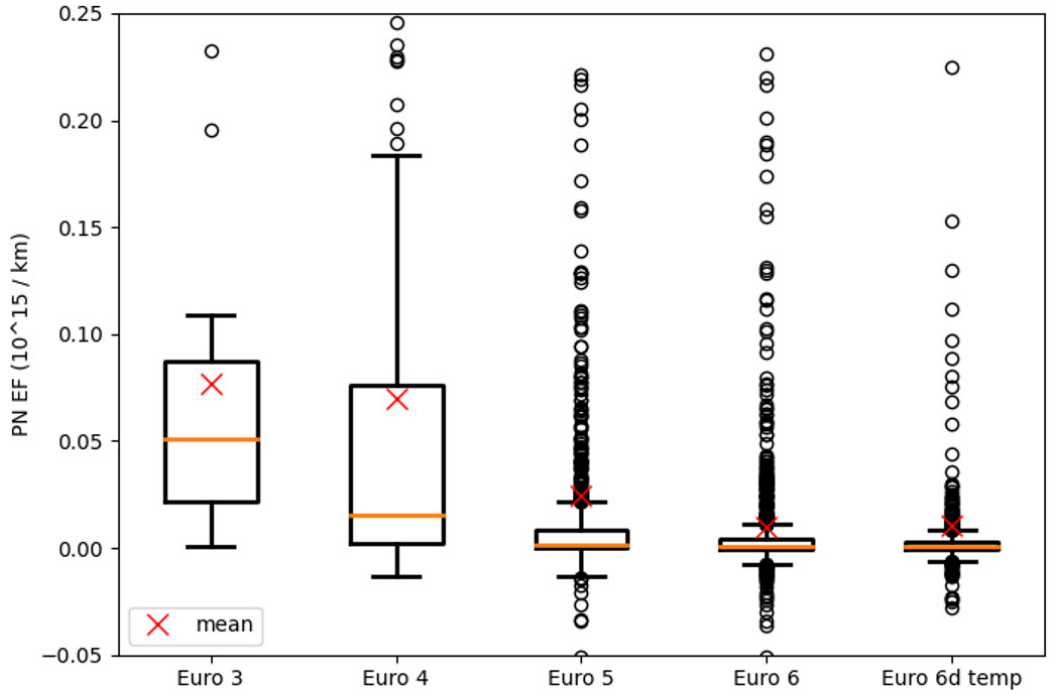
Average BC and PN emissions from diesel cars by Euro standard (Milan 2021)

Black Carbon (BC)



Particle Number (PN)



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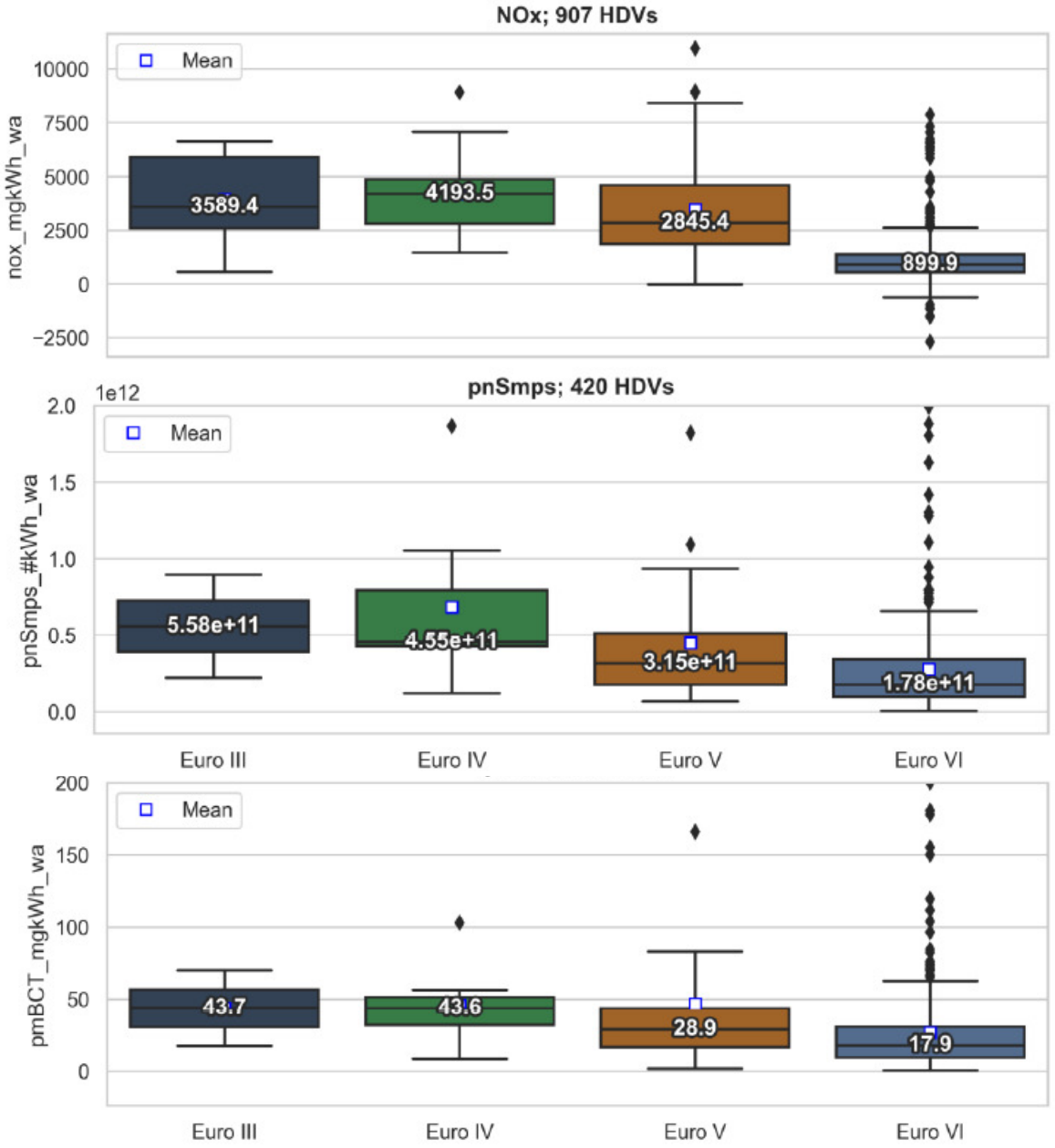
Average emissions by Euro standard from HDVs as measured by plume chasing



NO_X

PN

BC

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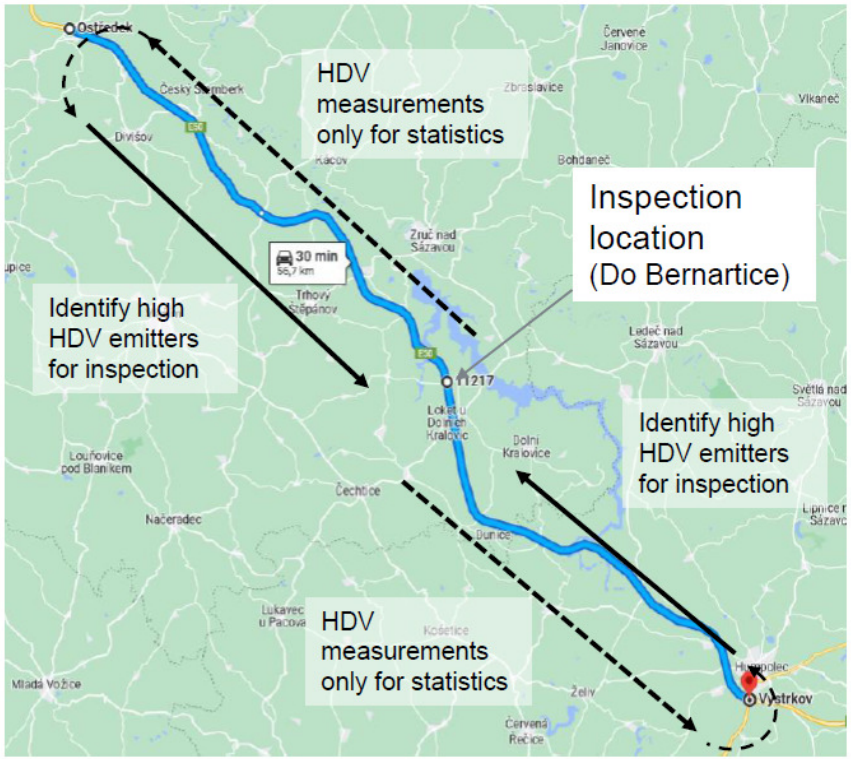
HDV high-emitter detection (Brno, CZ, 2022)



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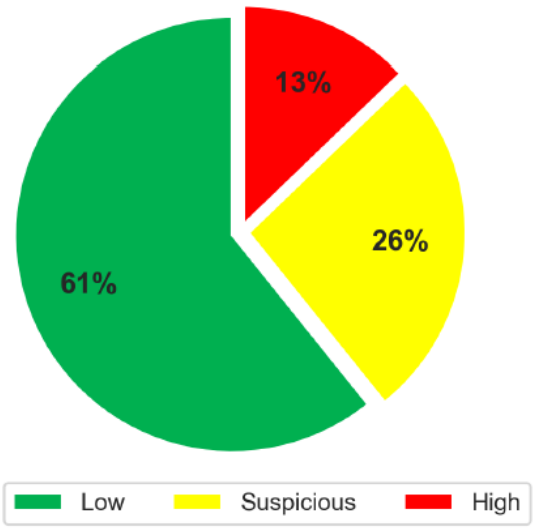
HDV on-road NO_x emission statistics

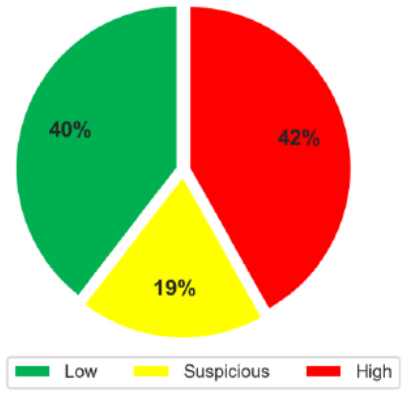
- ~39% high and suspicious emitters for all Euro classes
- 61% high and suspicious emitters for Euro V

  → Euro V has a higher share of high emitters compared to Euro VI

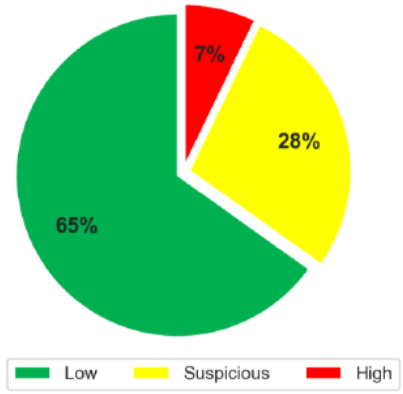
All EURO classes



EURO V



EURO VI



	EURO IV	EURO V	EURO VI
Classification	mg/kWh	mg/kWh	mg/kWh
low (up to)	<4000	<2500	<1200
suspicious (up to)	<5000	<3500	<2200
high (above)	>5000	>3500	>2200
EURO emission limit	<3500	<2000	<460
RDE conformity factor			1,5

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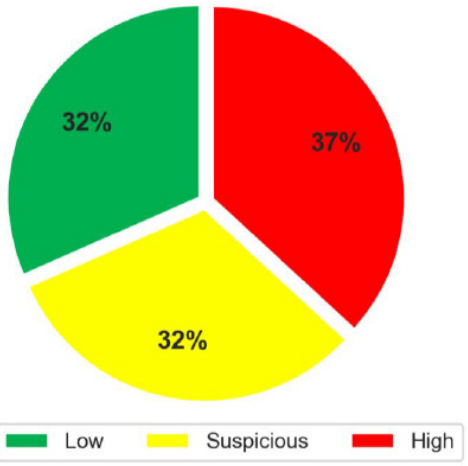
HDV on-road NO_X emission statistics – at nighttime!

- ~39% high and suspicious emitters for all Euro classes
- 61% high and suspicious emitters for Euro V
  - → Euro V has a higher share of high emitters compared to Euro VI
- 52% high and suspicious emitters for RO BG BIH SRB SLO TR (198 HDVs)
  - → Higher share of suspicious and high emitters for HDVs from some countries (south-east)
- 70% high and suspicious emitters at night (after 18 o'clock, 19 HDVs (1 Euro IV, 3 Euro V, 15 Euro VI))
  - → Higher share of suspicious and high emitters during the night?

All EURO classes - night time



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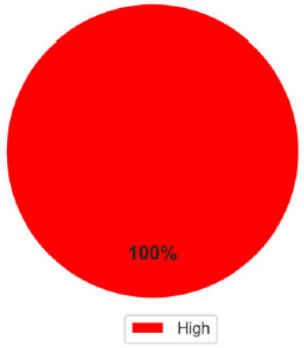
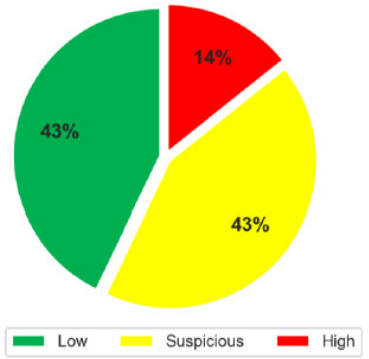
high (above)	>5000	>3500	>2200
EURO emission limit	<3500	<2000	<460
RDE conformity factor			1,5

EURO V - night time



EURO VI - night time



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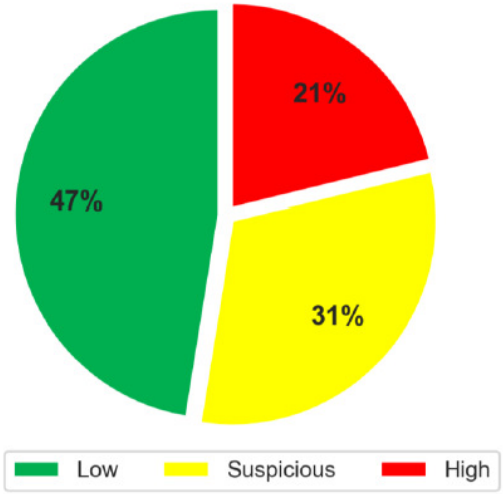
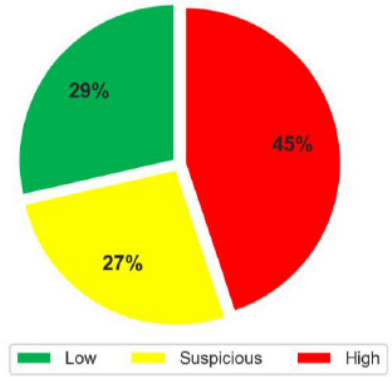
HDV on-road NO_X emission statistics – selected countries (East Europe)

- ~39% high and suspicious emitters for all Euro classes
- 61% high and suspicious emitters for Euro V
  - → Euro V has a higher share of high emitters compared to Euro VI
- 52% high and suspicious emitters for RO BG BIH SRB SLO TR (198 HDVs)
  - → Higher share of suspicious and high emitters for HDVs from some countries (south-east)

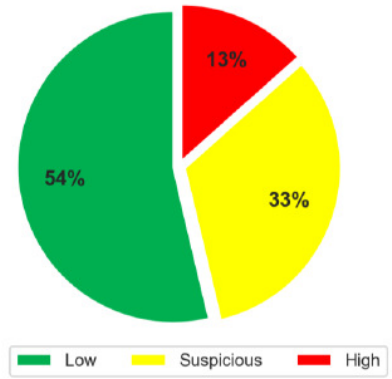
All EURO classes
- RO BG BIH SRB SLO TR



EURO V
- RO BG BIH SRB SLO TR



EURO VI
- RO BG BIH SRB SLO TR



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Inspections of suspected HDV NO_X high-emitters

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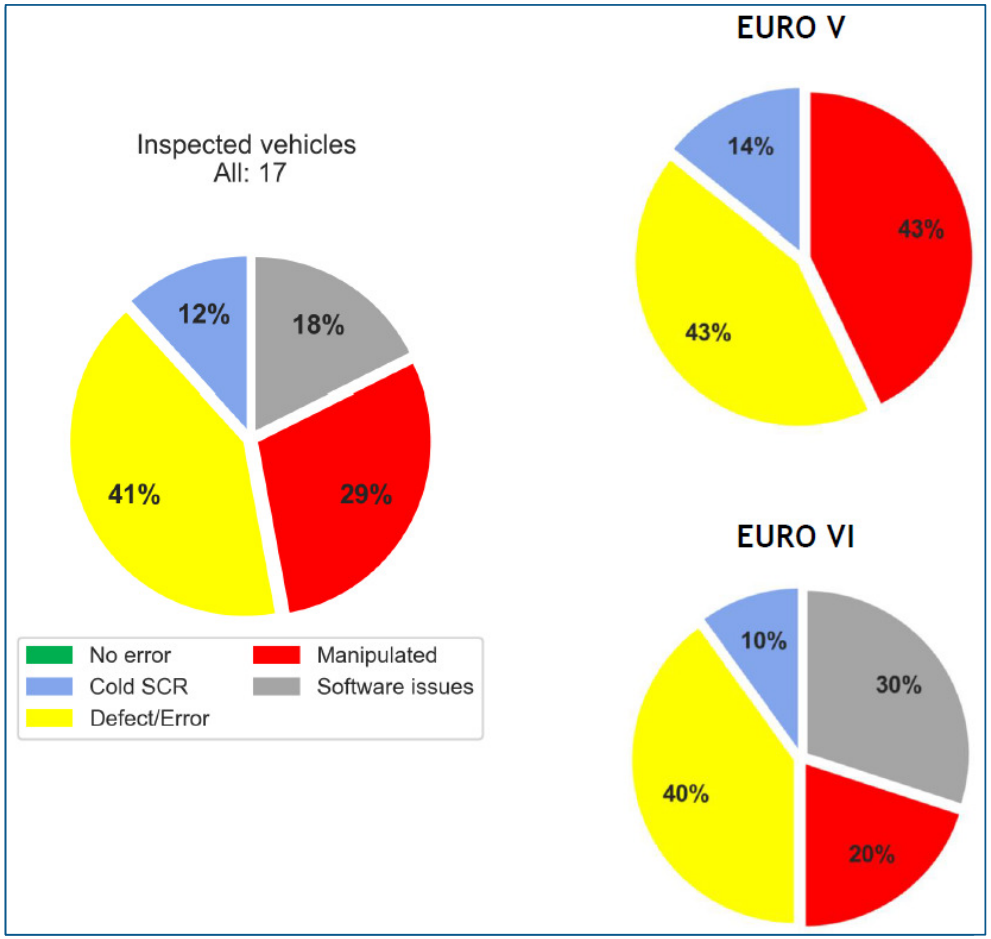
Inspections of suspected HDV NO_X high-emitters

- Vehicles inspected by authorities: 2% (17)
  - → 24% suspicious emitters
  - → 76% high emitters
  - → 41% Euro V
  - → 59% Euro VI
- A reason for the high emissions could be found for all inspected vehicles
  - → Vehicles with very high emissions more often manipulated
  - → Software issue: Manufacturer issue due to missing mandatory update of OE software (Volvo) → it seems that there is a lack in legislation that mandatory updates are not done if trucks are not maintained at a manufacturer workshop!
- Higher share of manipulations for Euro V
- More Defects/Errors and software issues for Euro VI



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Inspections of suspected LDV PN high-emitters

- Point sampling (PS) measurements → High emitter identification
- ~ 1 km? up the road → Police and technical inspections of the suspicious vehicles
- PS identified potential high emitter and forwarded number plate to inspectors per phone
  - Used BCT live data
- 17 inspected vehicles
  - → 13 proved as high emitter
- Problems:
  - Live identification (only by visually looking at the live graphs) → Can be enhanced!
  - Looking parallel at data and license plates and forwarding the information

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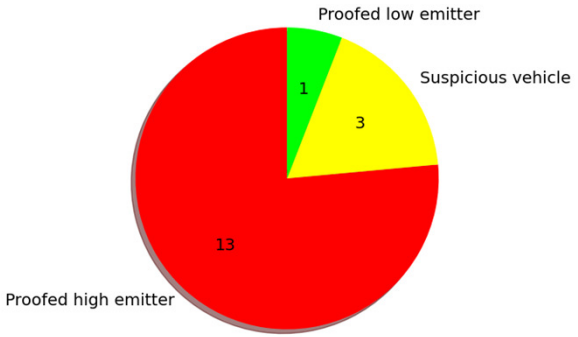
Inspections of suspected LDV PN high-emitters

Index	Vehicle	Registration Year	Fuel type	PS BC EF (g / kg fuel)	PS PN EF (10^15 / kg fuel)	PN inspection (#/cm³)	Comment
1	FIAT	2007	Diesel	3.49	11.95	5.00E+07	
2	FORD Transit	2008	Diesel	-	-	3.00E+06	Missing ANPR detection
3	MAN TGL 12.250	2011	Diesel	-	-	9.00E+07	Missing license plate information
4	DACIA Logan	2015	Petrol	0.37	0.49	-	No PN inspection measurement
5	FIAT Dobolo	2014	Diesel	0.43	7.75	9.00E+06	Expired technical inspection
6	FORD Transit	tbd	Diesel	0.65	6.16	3.00E+07	
7	SKODA Octavia	2007	Diesel	0.17	1.24	-	No PN inspection measurement
8	FORD Galaxy	2012	Diesel	2.99	3.65	-	393k mileage, no working DPF according to inspection, no PN inspection measurement
9	FORD S-Max	2006	Diesel	2.78	6.32	-	No PN inspection measurement
10	SKODA Octavia	tbd	Diesel	-	-	3.00E+06	Missing ANPR detection
11	PEUGEOT 407	2008	Diesel	1.8	3.86	2.00E+06	
12	SKODA Superb	tbd	Diesel	-	-	2.30E+06	Vehicles too close for proper plume separation
13	IVECO Daily	2011	Diesel	-	-	5.00E+06	Missing ANPR detection
14	VW Transporter	2009	Diesel	1.38	10.88	1.35E+07	
15	HYUNDAI i30	tbd	Petrol	-	-	4.50E+04	No high emitter, vehicles too close for proper plume separation
16	AUDI A3	tbd	Diesel	-	-	1.40E+07	Missing ANPR detection
17	MERCEDES BENZ	2001	Diesel	19.51	38.64	-	Visible smoke during acceleration, no PN inspection measurement



Red: Proofed high emitter
Yellow: Suspicous vehicle
Green: Proofed low emitter

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Thank you for your attention!
Questions?

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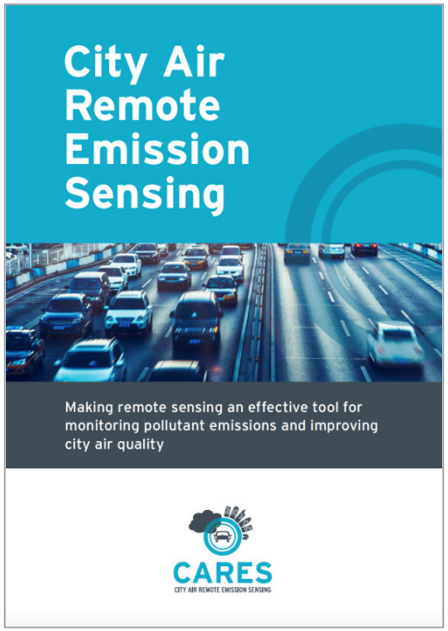
For further information about CARES

- **Check the website:** https://cares-project.eu
- **Download the project brochure**
- **E-mail contact:** ake.sjodin@ivl.se
- **Follow us on social media:**
  - https://twitter.com/cares_project
  - https://www.linkedin.com/company/city-air-remote-emission-sensing-cares/



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CITY AIR REMOTE EMISSION SENSING

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