VERT-NPTI Focus 7.July 2021 – Web-conference

Technical Inspection of Public Transport Buses with DPF in Santiago de Chile

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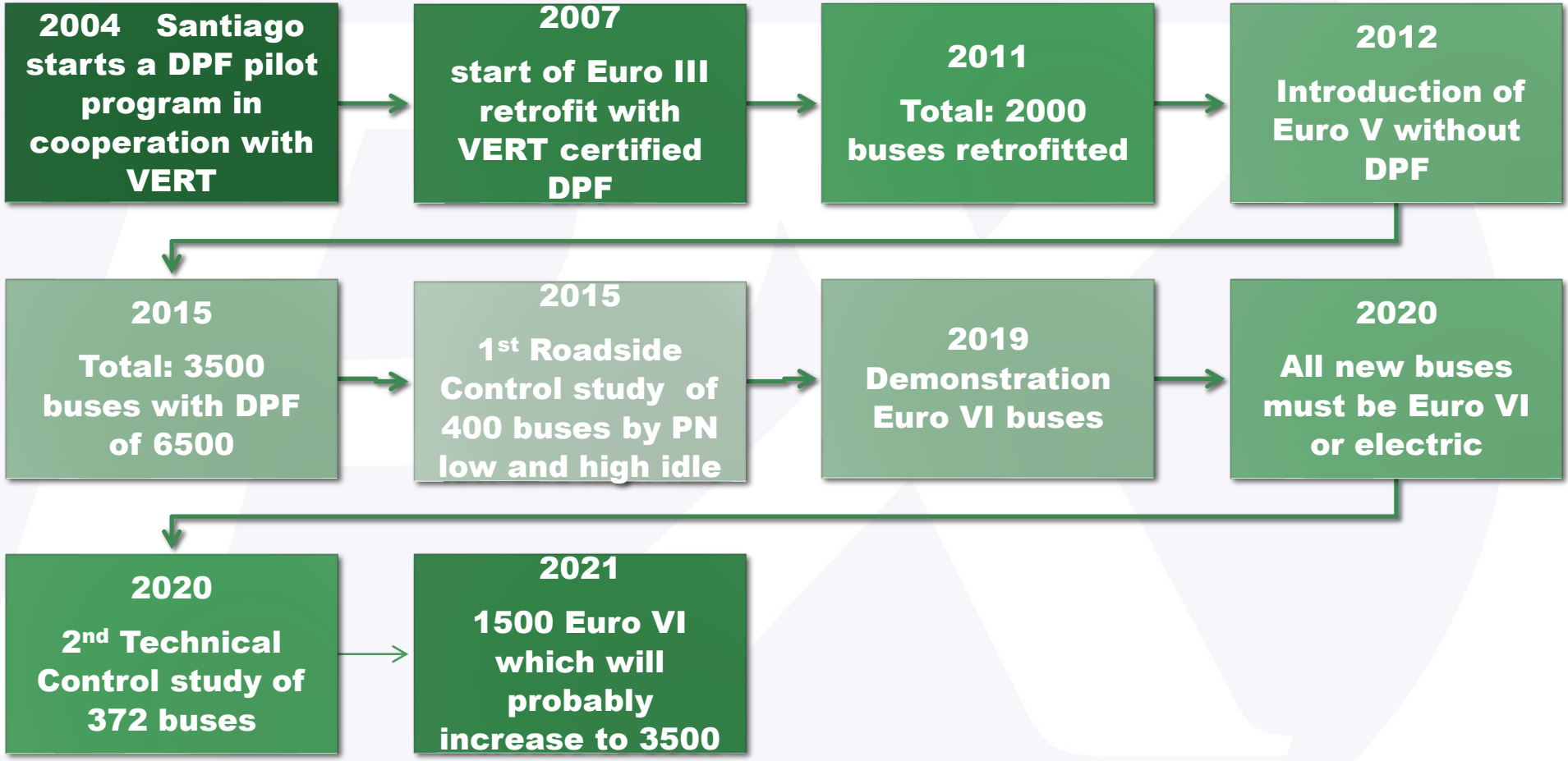
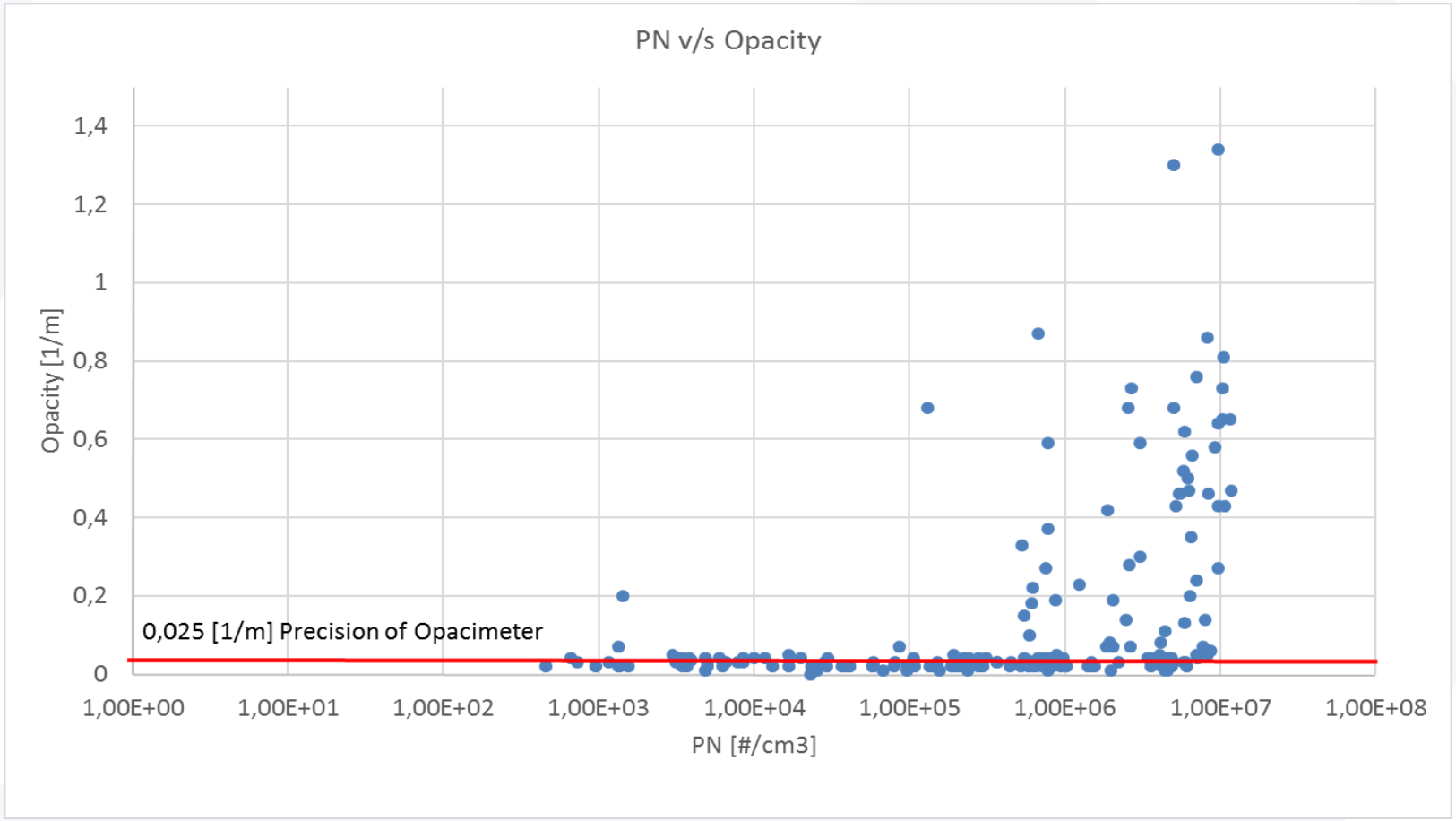
DPFs in Santiago de Chile



1st Roadside Technical Control

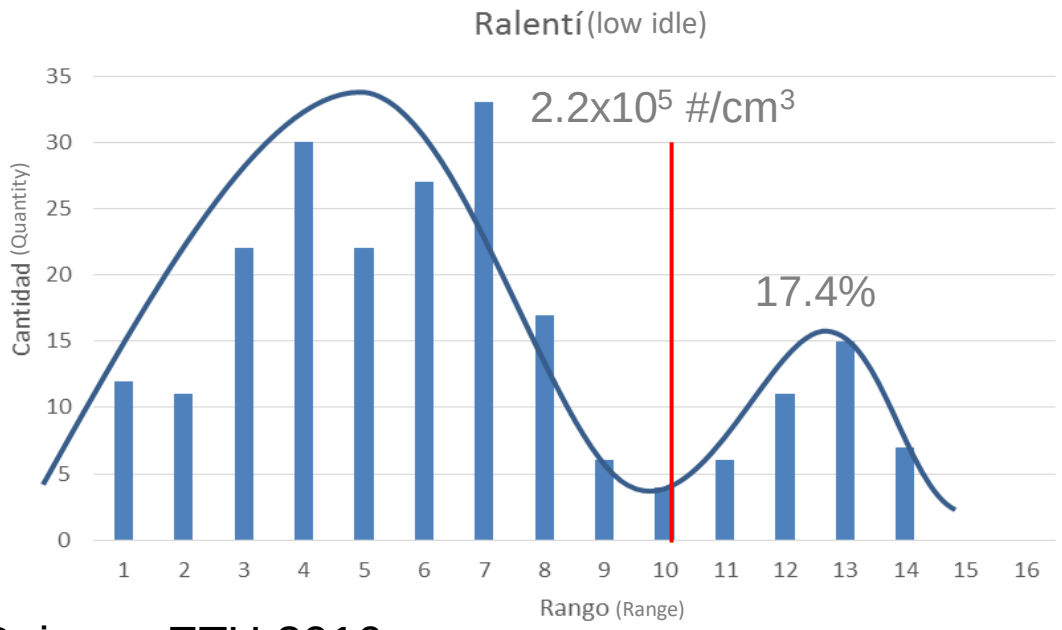
- PN random roadside measurements of 400 buses, at end of pipe.
- Using NPET-TSI
- Goal: implement solid PN measurement for inspection.

1st Roadside Technical Control: PN v/s Opacity at Free acceleration



1st Roadside Technical Control:
End of pipe PN Limit to detect Abnormal Emissions

- Separation in bimodal structure (normal and abnormal), clearest for low idle.
- Low Idle speed is easier to implement in road side control (no driver or RPM electronic control interferences)
- Bimodal structure determines limit of 2.2x10E+5 [#/cm^3] as threshold.



Range	≥	<	N	Condition
1	1,00E+02	2,20E+02	12	Normal
2	2,20E+02	4,70E+02	11	Normal
3	4,70E+02	1,00E+03	22	Normal
4	1,00E+03	2,20E+03	30	Normal
5	2,20E+03	4,70E+03	22	Normal
6	4,70E+03	1,00E+04	27	Normal
7	1,00E+04	2,20E+04	33	Normal
8	2,20E+04	4,70E+04	17	Normal
9	4,70E+04	1,00E+05	6	Normal
10	1,00E+05	2,20E+05	4	Indifferent
11	2,20E+05	4,70E+05	6	Abnormal
12	4,70E+05	1,00E+06	11	Abnormal
13	1,00E+06	2,20E+06	15	Abnormal
14	2,20E+06	4,70E+06	7	Abnormal
15	4,70E+06	1,00E+07	0	Abnormal
16	1,00E+07	2,20E+07	0	Abnormal
		TOTAL	223	

Reinoso ETH 2016

2nd Campaign to Measure Nanoparticles in 372 buses - 2020:

Objetive: Obtain data on DPF condition on buses in the Transantiago System

- Criteria and methodologies used in:
  - Switzerland
  - Netherlands
  - Chile
- Support of :
  - Ministerio del Medio Ambiente
  - Ministerio de Transportes y Telecomunicaciones
- Used NPET provided by TSI

Ministerio del Medio Ambiente
Gobierno de Chile

Ministerio de Transportes y Telecomunicaciones
Gobierno de Chile

Methodology

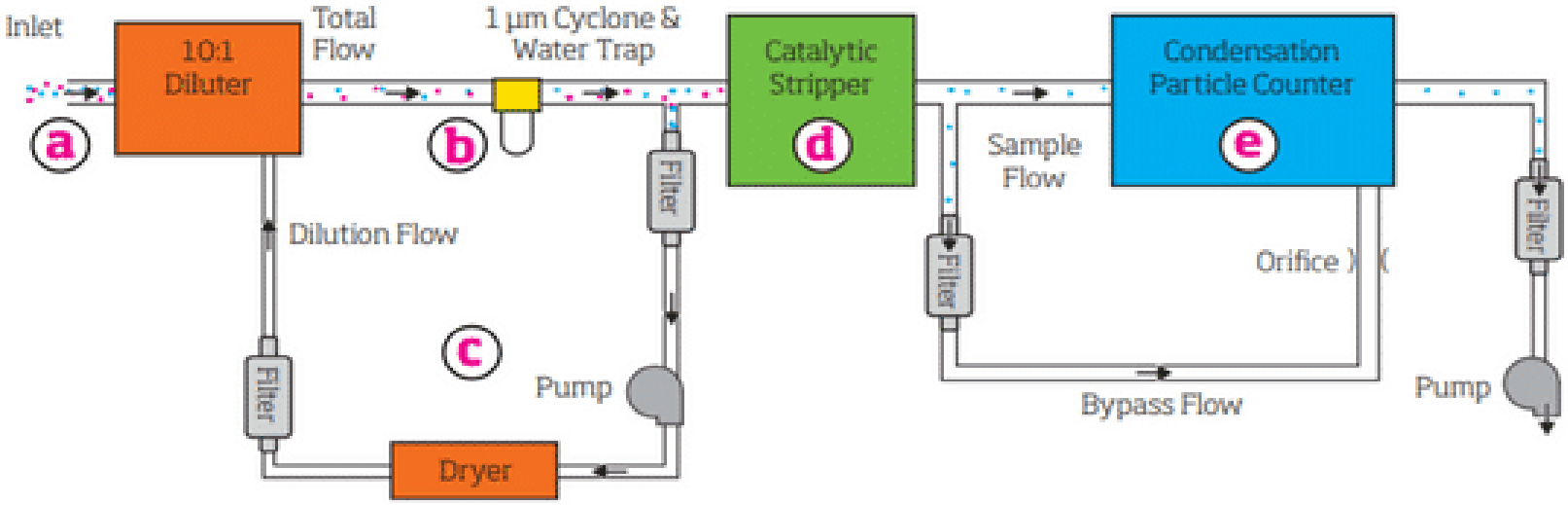
- Protocol recommended by Federal Office for the Environment Switzerland (FOEN)
- PN measurement at low-idle
- 15+ cm into the exhaust line.
- 55 seconds

Methodology

15 s	• 15 s Warm-up
10 s	• Measurement
5 s	• Pause
10s	• Measurement
5 s	• Pause
10 s	• Measurement

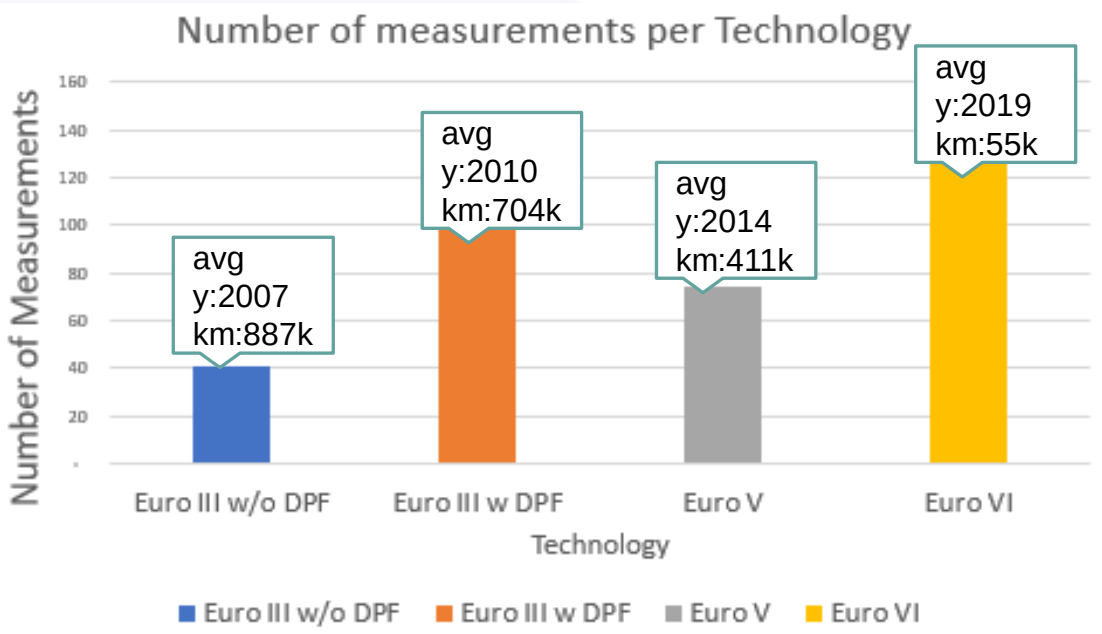
Measurement method

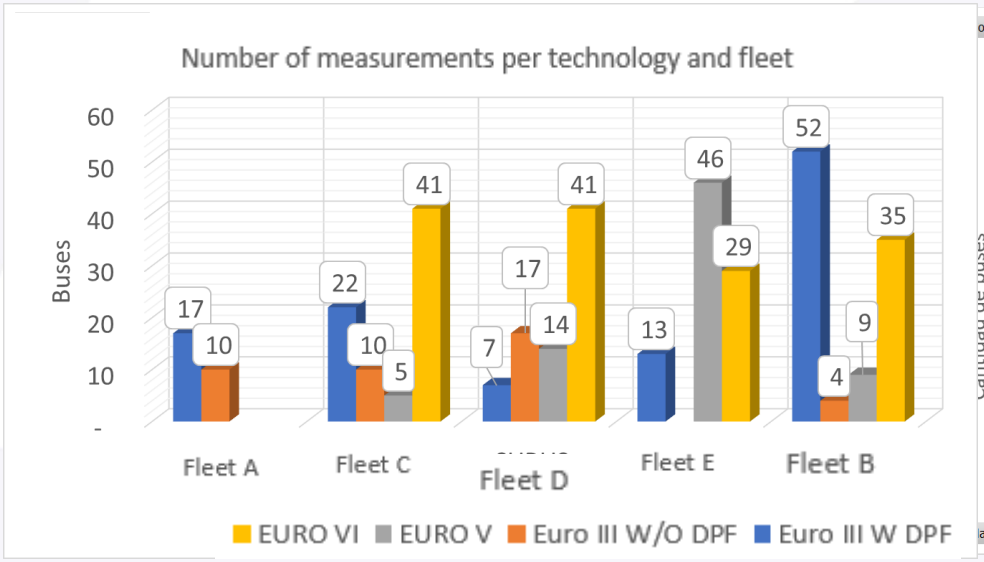
- Measurements were made with the TSI NPET HC instrument
- METAS 2014 certification
- Solid-particle number concentration measurement range to 100,000,000 particles/cm^3

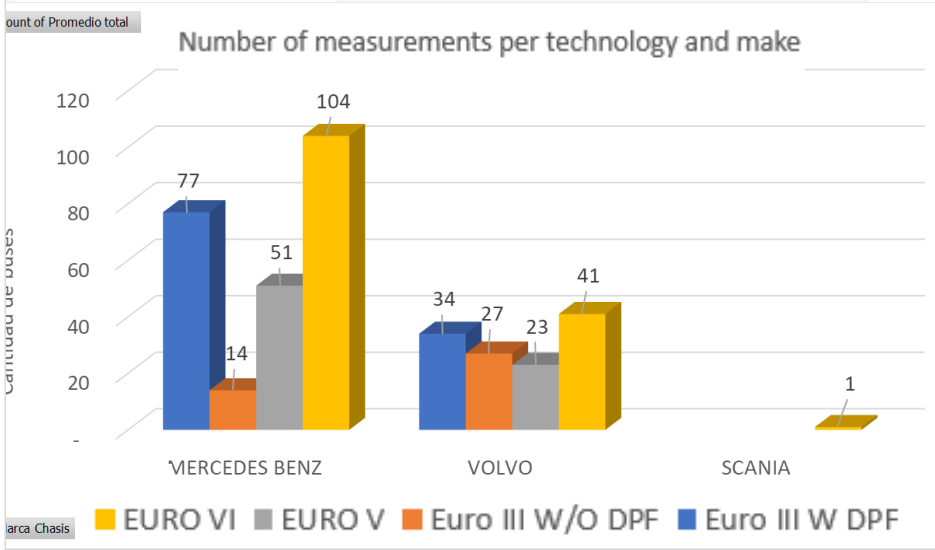


Measurements

- 372 buses
  - 5 fleet companies.
  - Euro III with DPF
  - Euro III without DPF
  - Euro V (without DPF)
  - Euro VI

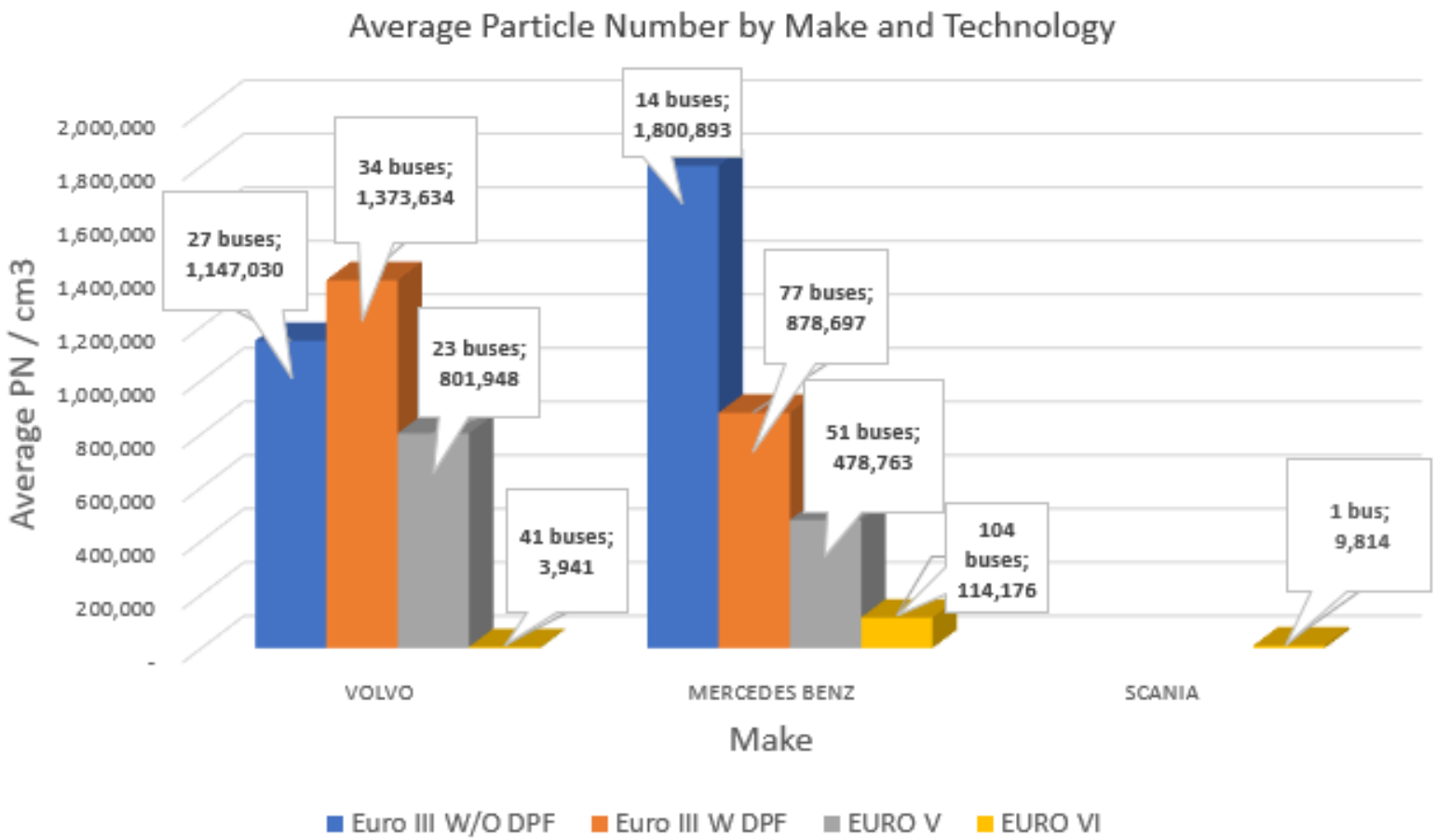






Results

Results by Make: Emission technologies

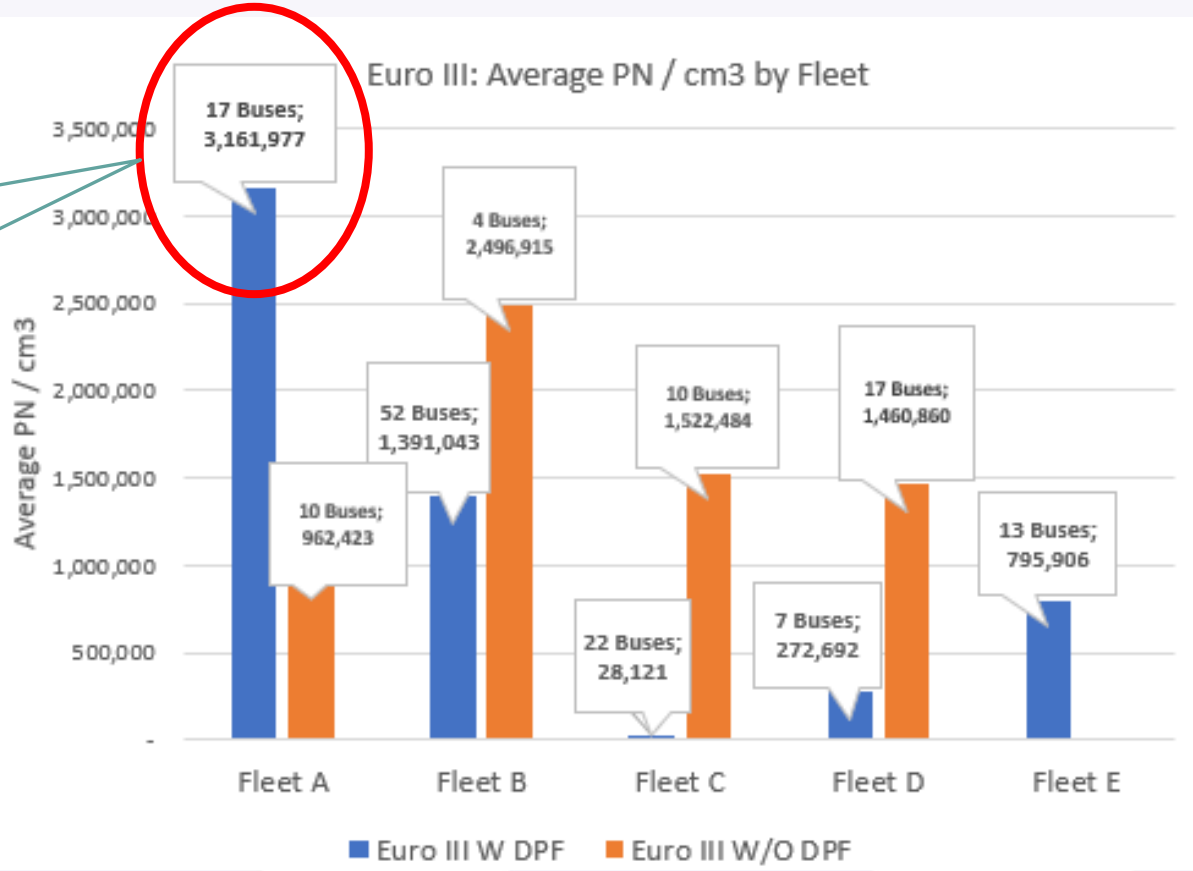


High degree of DPF deterioration, failure or removal

Results

Results by fleet: Euro III with DPF and without DPF

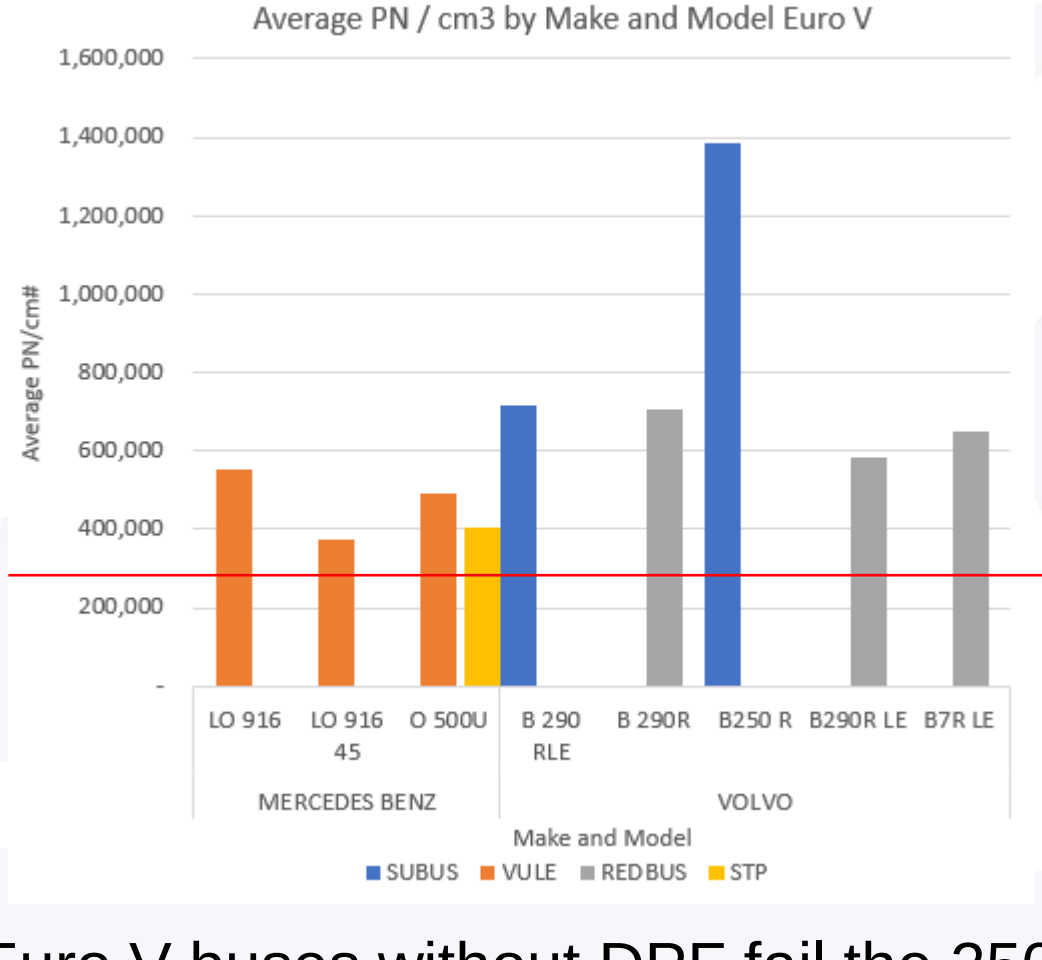
100% DPF failure and/or removal



DPFs reduce significantly the particle numbers but maintenance is required to ensure optimal performance. The fleets with best maintenance have the lowest emissions

Results

Results by fleet: Euro V (without DPF)

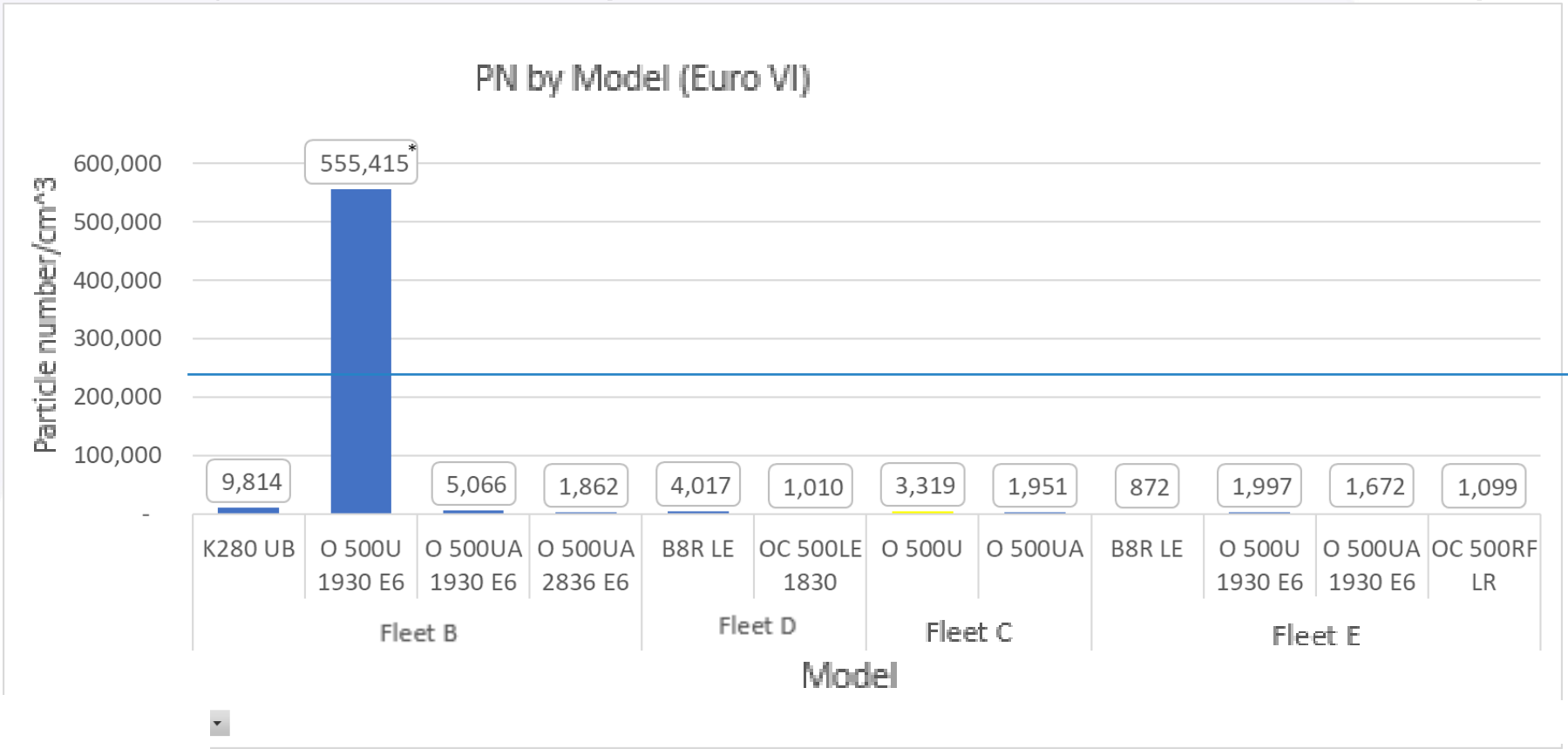


Pass/fail for Euro III with DPF

100% of Euro V buses without DPF fail the 250.000 PN/cm^3 criteria

Results

Results by fleet: Euro VI (143 2019-buses and 3 2017-buses)

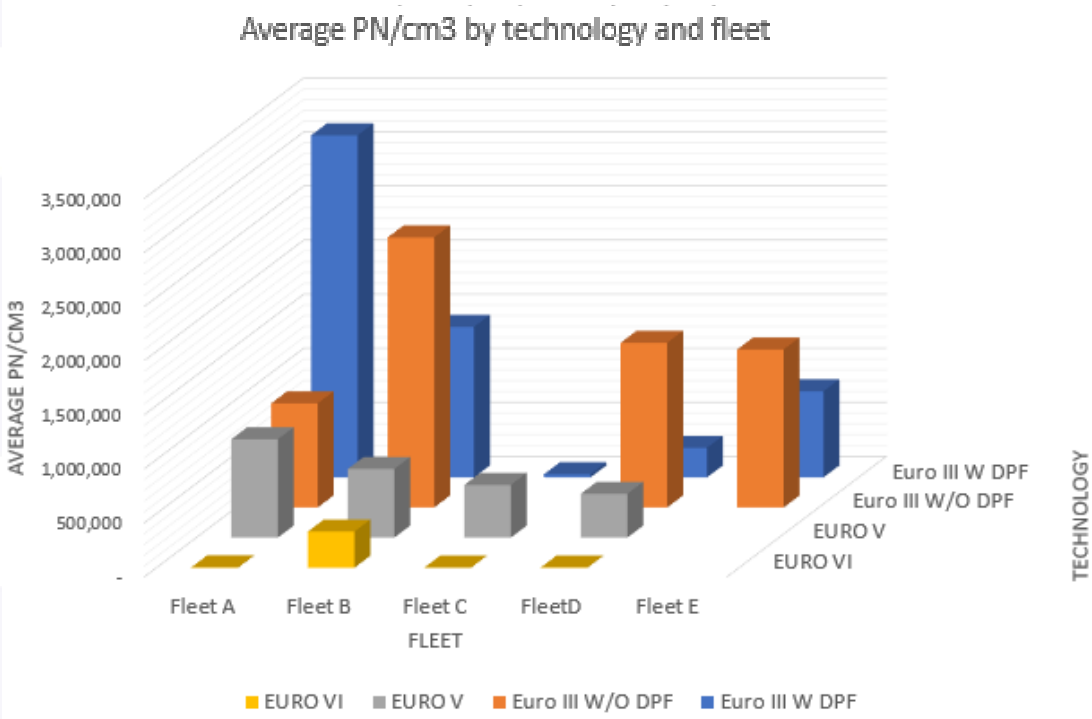


A single O-500U 1930 marked over 10.000.000 PN/cm^3. This value is associated to poor maintenance and increased average

99+% of new Euro VI buses approve pass/fail criteria

Results

Results overview: Fleet and PN by technology



Well mantained Euro III buses with a DPF have lower PN emissions than Euro V.

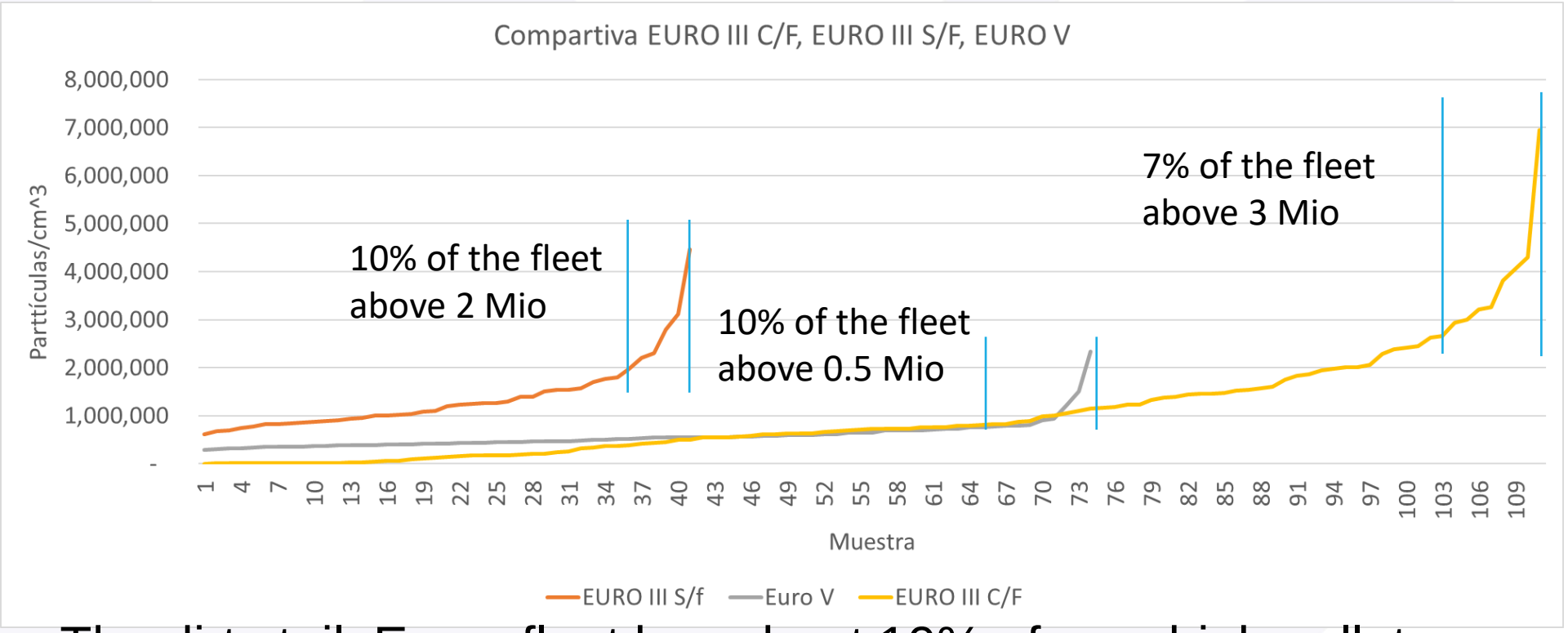
The new Euro VI buses have the lowest emissions.

Maintenance is very important. The higher emitters have poor maintenance

Results

General comparison of EURO III with DPF, EURO III without DPF and EURO V technologies from lowest to highest for each technology

Euro VI not because all but one were <15000 PN/cm^3



The dirty tail: Every fleet has about 10% of very high polluters

30% of Euro III with DPF would fail PN Criteria

Conclusions

- EURO VI is the most efficient technology currently used to reduce particulate matter emissions
- In 4 out of 5 fleets analysed, the particulate filter in Euro III technology helps to reduce the amount of PN.
- Importance of roadside emission control: Enforcement authorities should be equiped with instruments to test vehicles that are high polluting.
- The new instruments presented at this conference seem perfectly suited for this purpose.

Conclusions

- On the basis of the pass/fail level set by Switzerland of 250,000 PN/cm^3 for
  - EURO VI, **99%** of the fleet would **pass.**
  - EURO V, **100%** of the buses would **not pass.**
  - EURO III w/o DPF, **100%** of the fleet **would not pass.**
  - EURO III w DPF, **30%** of the fleet would still **pass after 10+ years of operation.**

- Taking into account DPFs and buses in good codition, EURO III with a DPF is 77% more efficient than EURO V (Without a DPF)

Conclusions

- Maintenance is very important
  - Maintenance includes periodic technical control by number count

- To improve overall emissions, the priority should be to eliminate “the dirty tail.
  - Maintenance becomes more important than technology

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Thank you

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