Real Driving Emissions of a GPF-equipped production car

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Real Driving Emissions
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Association for Emissions Control by Catalyst AISBL

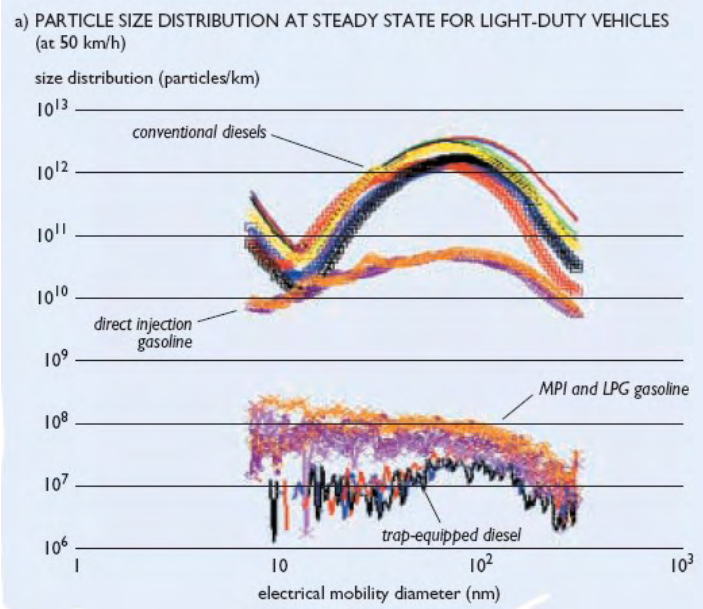
Association for Emissions Control by Catalyst (AECC) AISBL

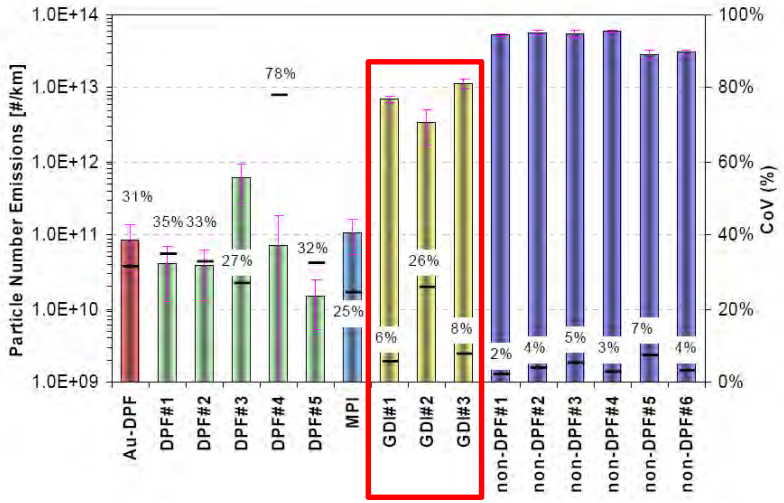
AECC members: European Emissions Control companies

Exhaust emissions control technologies for cars, commercial vehicles, motorcycles and non-road mobile machineries for original equipment, aftermarket and retrofit.

GDI particle emissions background

- 2001: Joint UK programme[1] indicated potential for significant particle emissions from GDI cars.
- 2007: UN PMP exercise[2] showed GDI particle number (PN) emissions in the range of 3×10^{12} to 1×10^{13} #/km compared to $<2\times10^{11}$ #/km for DPF-equipped diesels.





1. DETR/SMMT/CONCAWE Particulate Research Programme
2. Particle Measurement Programme (PMP) Light-duty Inter-Laboratory Correlation Exercise (ILCE_LD) Final Report

Recent GDI particle emissions measurements

- Other tests show higher PN from GDI than on the regulatory test cycle.
- Several papers and reports showed the potential of Gasoline Particulate Filter.

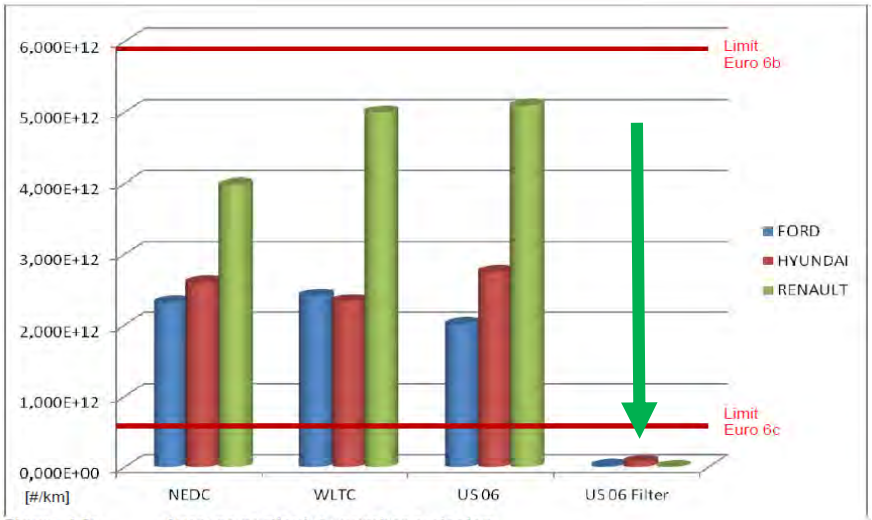
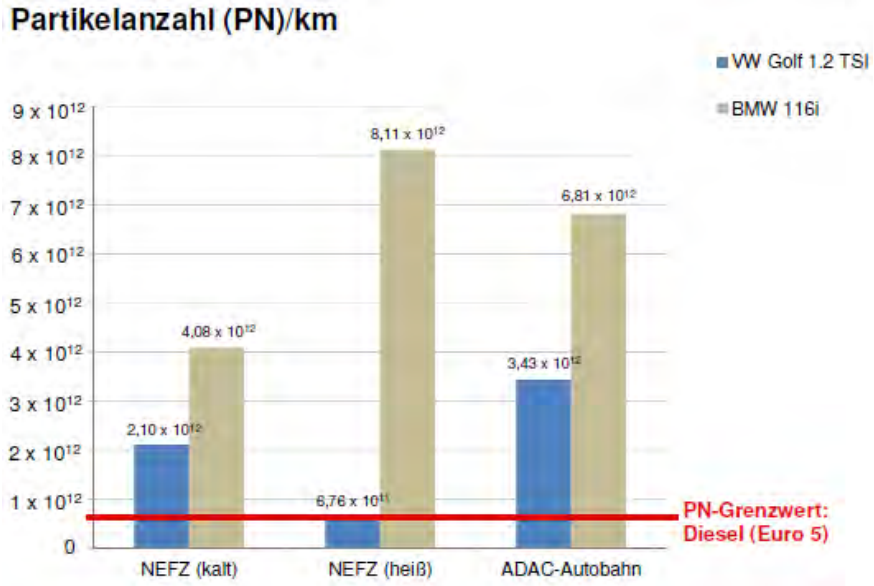


Figure 4.2: Average particulate number emission

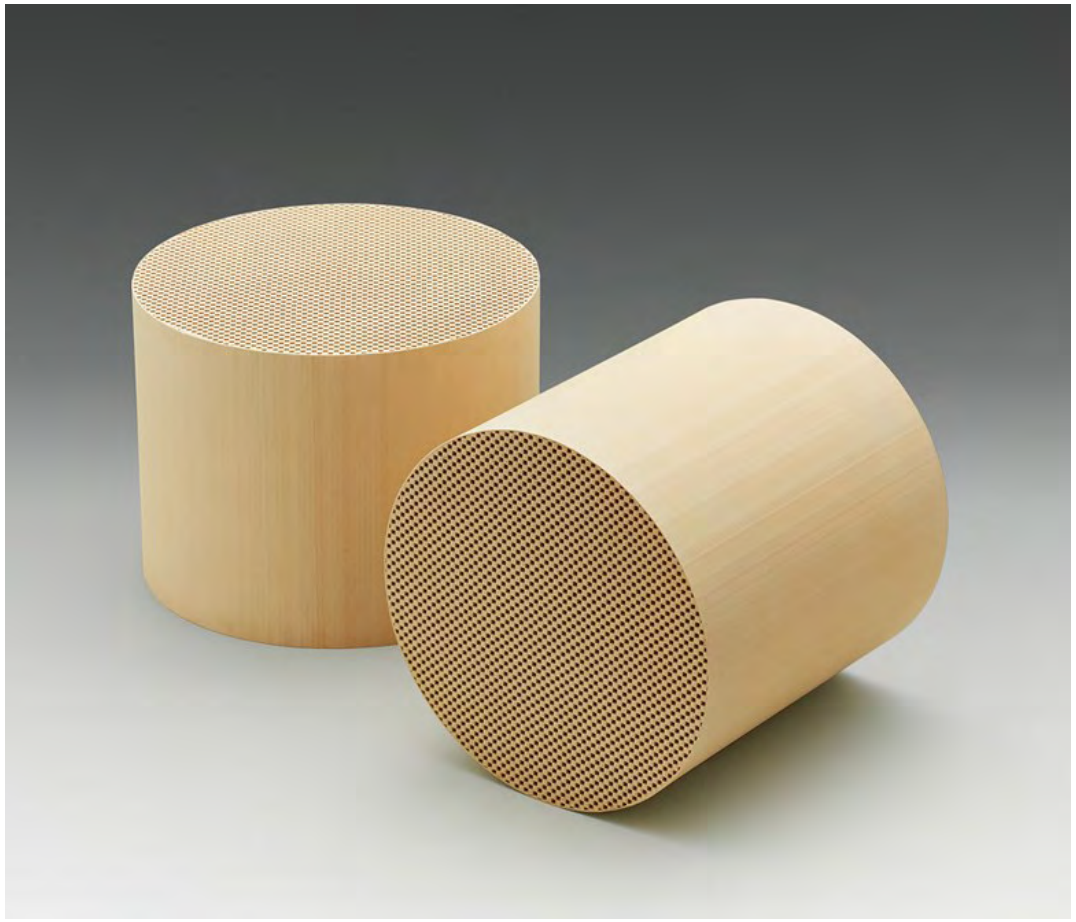
Source: T&E Briefing Particle emissions from petrol cars, November 2013.

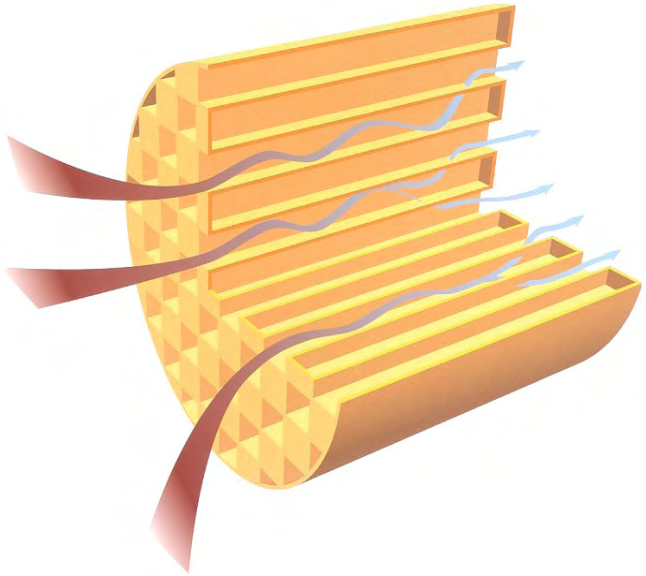


Source: DUH, July 2011.

- The legislative PN limit for GDIs will be the same as diesels at Euro 6c.
- PN will be included in the RDE test procedure.

Gasoline Particulate Filter (GPF)





AECC-Concawe test programme

- **Objective**: evaluate the emissions performance of the first commercially available GDI passenger car equiped with GPF.

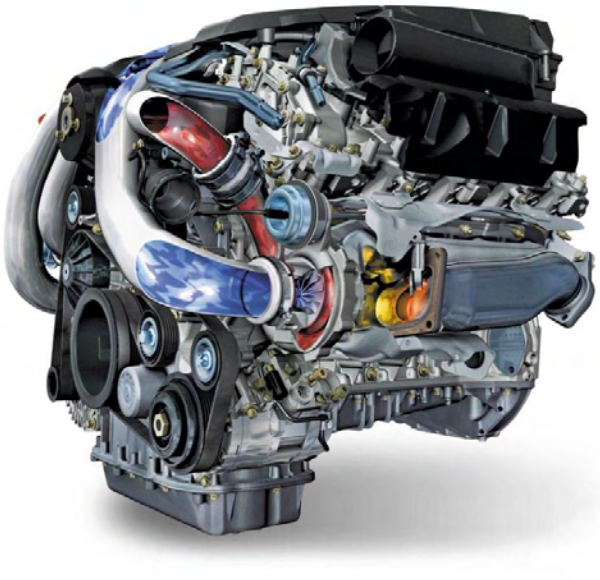
- Test car: F class 2-wheel drive 7-speed automatic.
- Mileage of 10600 km on receipt.

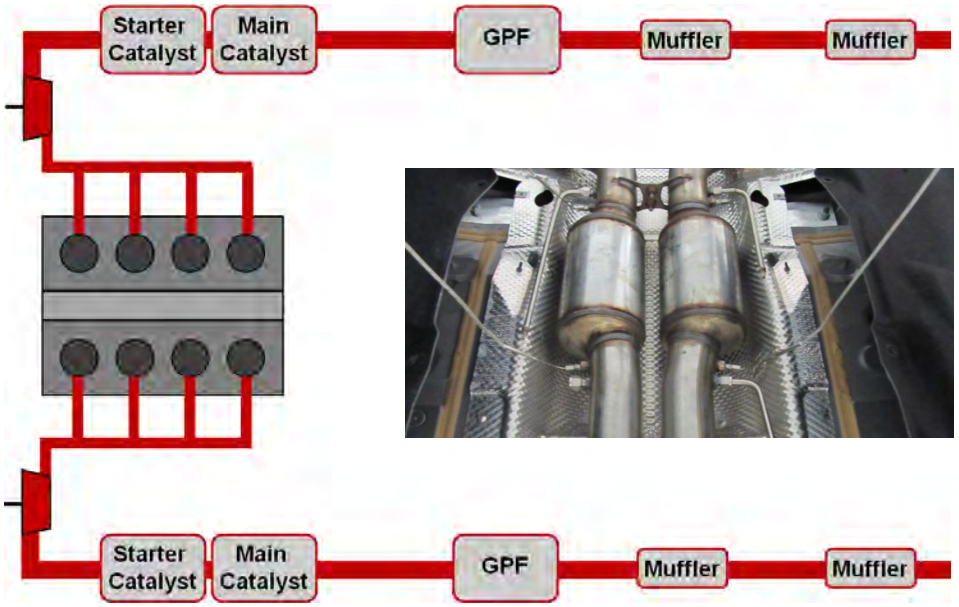
AECC-Concawe test programme

- New OEM exhaust system procured to allow fitment of instrumentation; run in for 1500 km.
- Actual coast-down determined (without PEMS).
- Measurements over the NEDC and WLTC test cycles + Real Driving Emissions using PEMS.
  - Ecostar LDV PEMS for CO/CO_2/NOx, Pegasor Mi3 for PN.
- Market fuel used for all testing – 95.1 RON, 85.5 MON, 5.2 mass % ethanol, 2.8 mass % MTBE, C:H 84.43:13.22.

Engine and exhaust system

Engine Type		Capacity	Power	Emissions control
V8 Turbocharged	Direct Injection (Central Injector)	4.7 litres	335kW	2×TWC+GPF in each of 2 branches

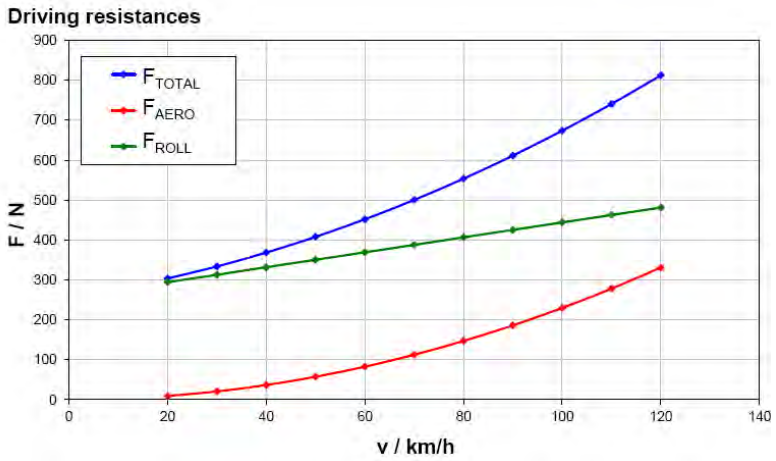




Preparatory test work

Coastdown:

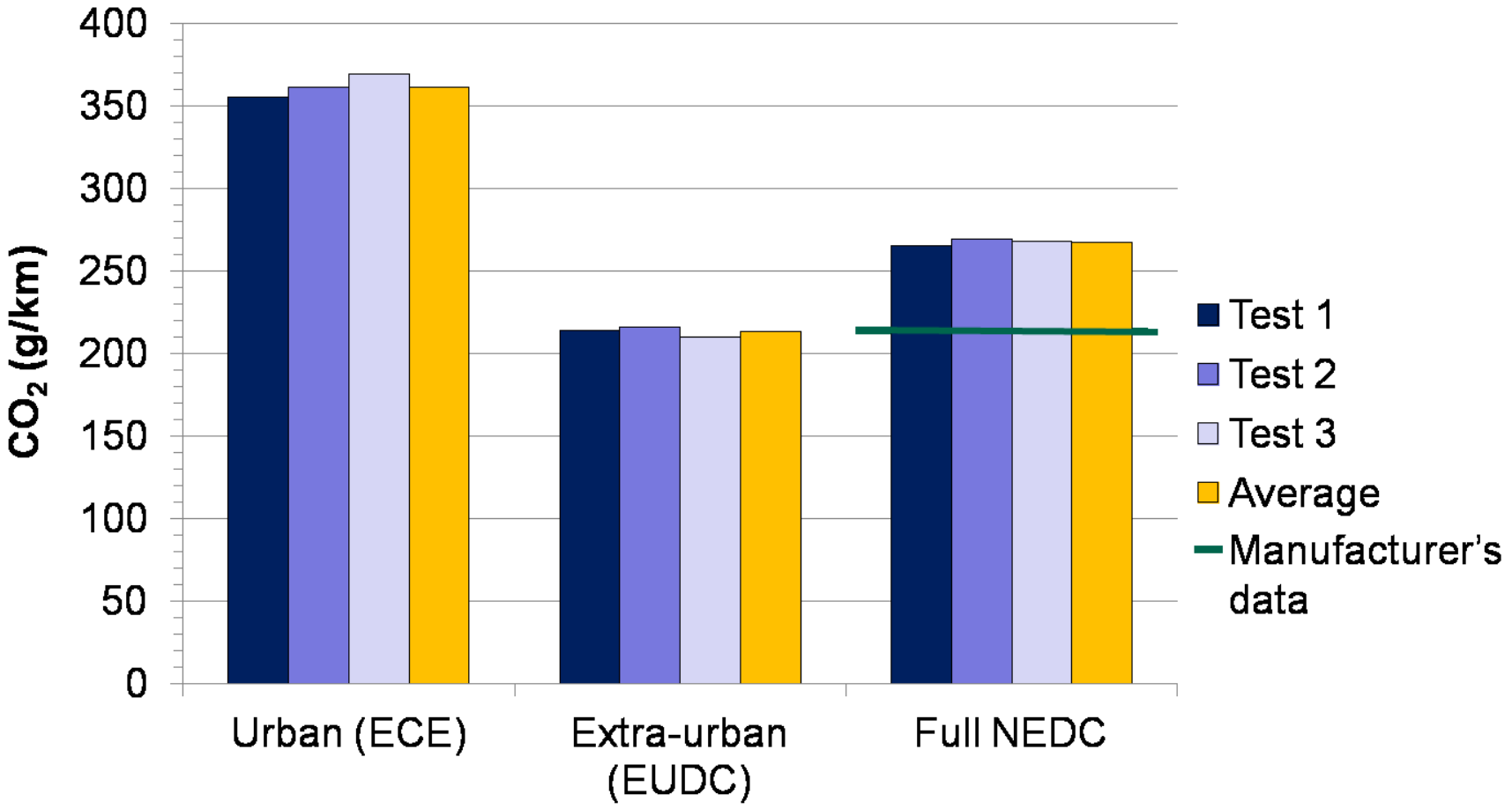
- Vehicle found to have high rolling resistance due to high weight from optional equipment and large tyres.



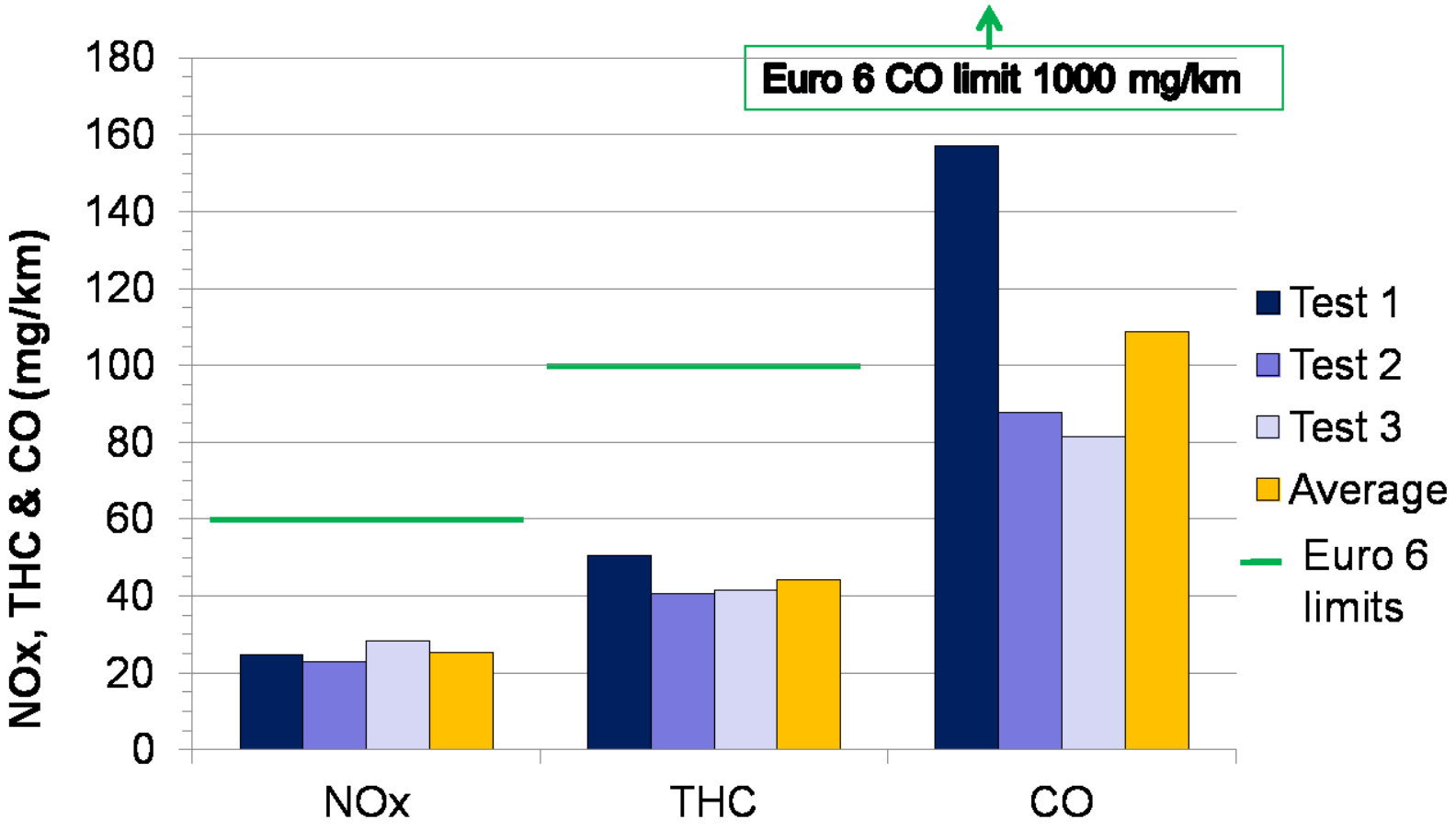
- PEMS-chassis dyno correlation tests run with PEMS positioned behind the vehicle to avoid any influence of additional weight.
- Correlation meets RDE requirements.

Measurement method	CO_2 (g/km)	NOx (mg/km)	CO (mg/km)	PN (#/km)
NEDC				
Test bench	265	24.79	157.06	1.37e11
PEMS	282	29.28	140.98	1.19e11
WLTP				
Test bench	265	16.25	111.33	2.38e11
PEMS	278	14.59	174.01	1.43e11

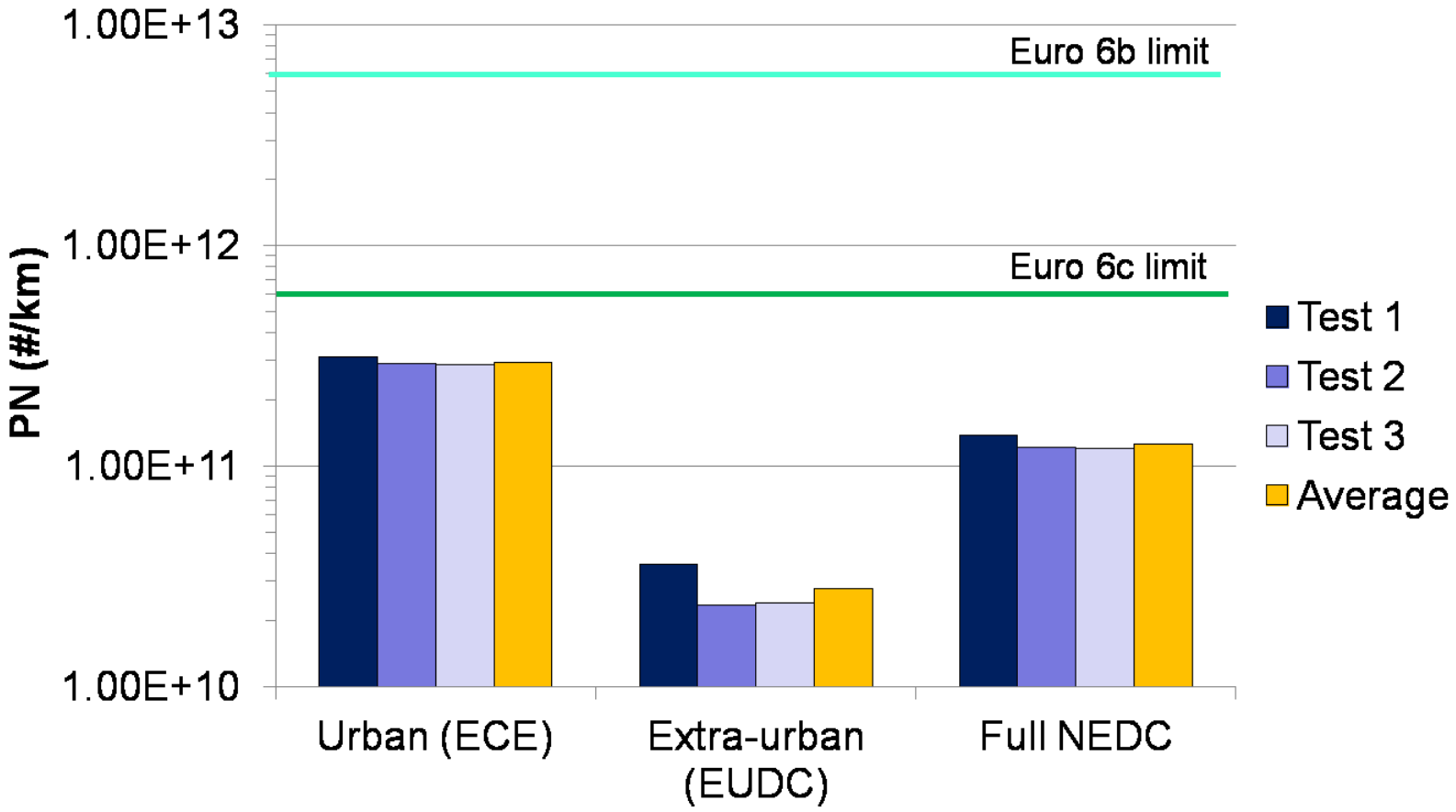
NEDC urban and extra-urban CO_2 emissions



NEDC NOx, THC & CO emissions readily meet Euro 6 limits

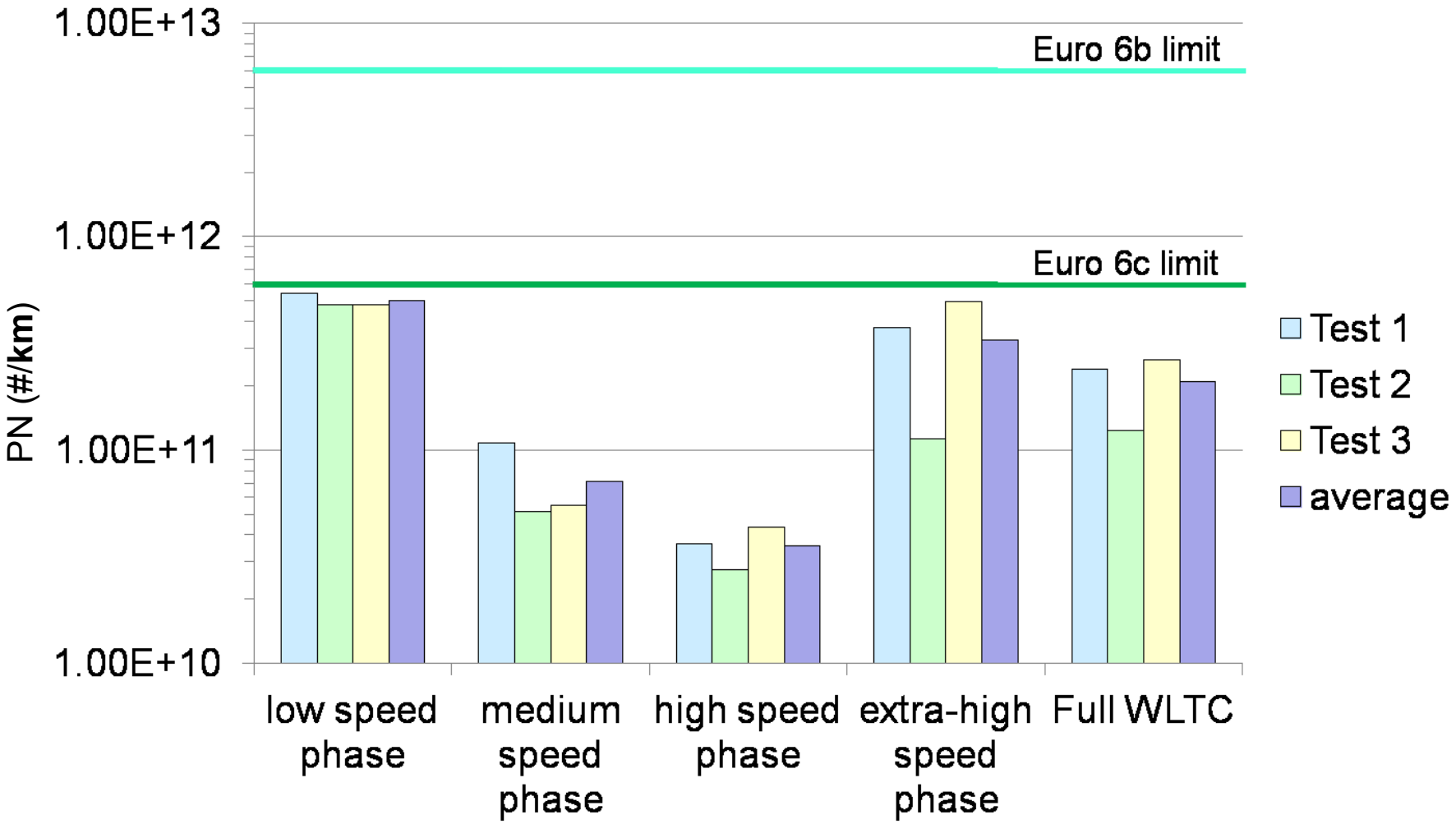


NEDC PN emissions meet Euro 6c limit



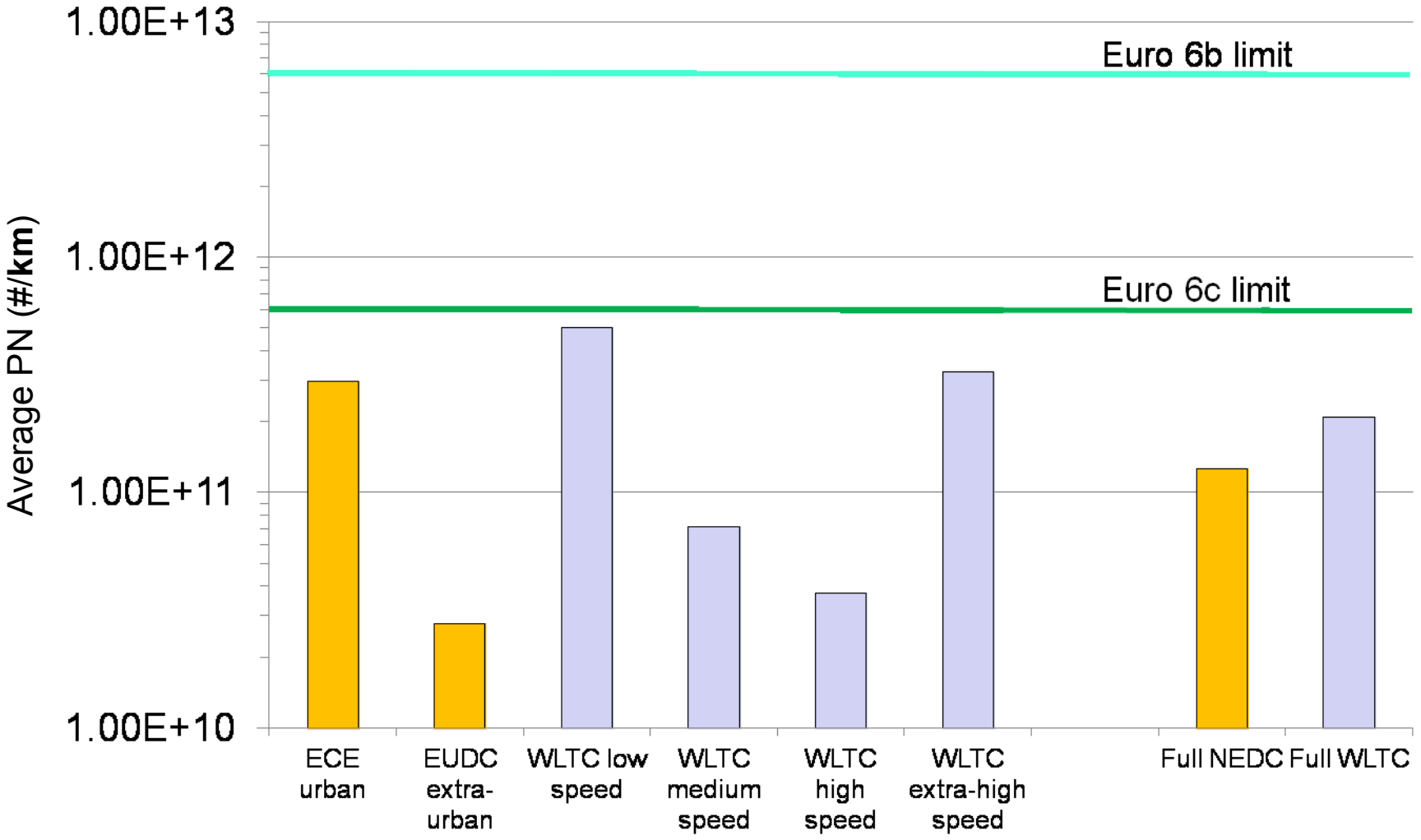
Average PM emissions 0.37 mg/km (full NEDC)

WLTC PN emissions all meet Euro 6c



Average PM emissions 0.25 mg/km (full WLTC)

WLTC vs NEDC particle number emissions



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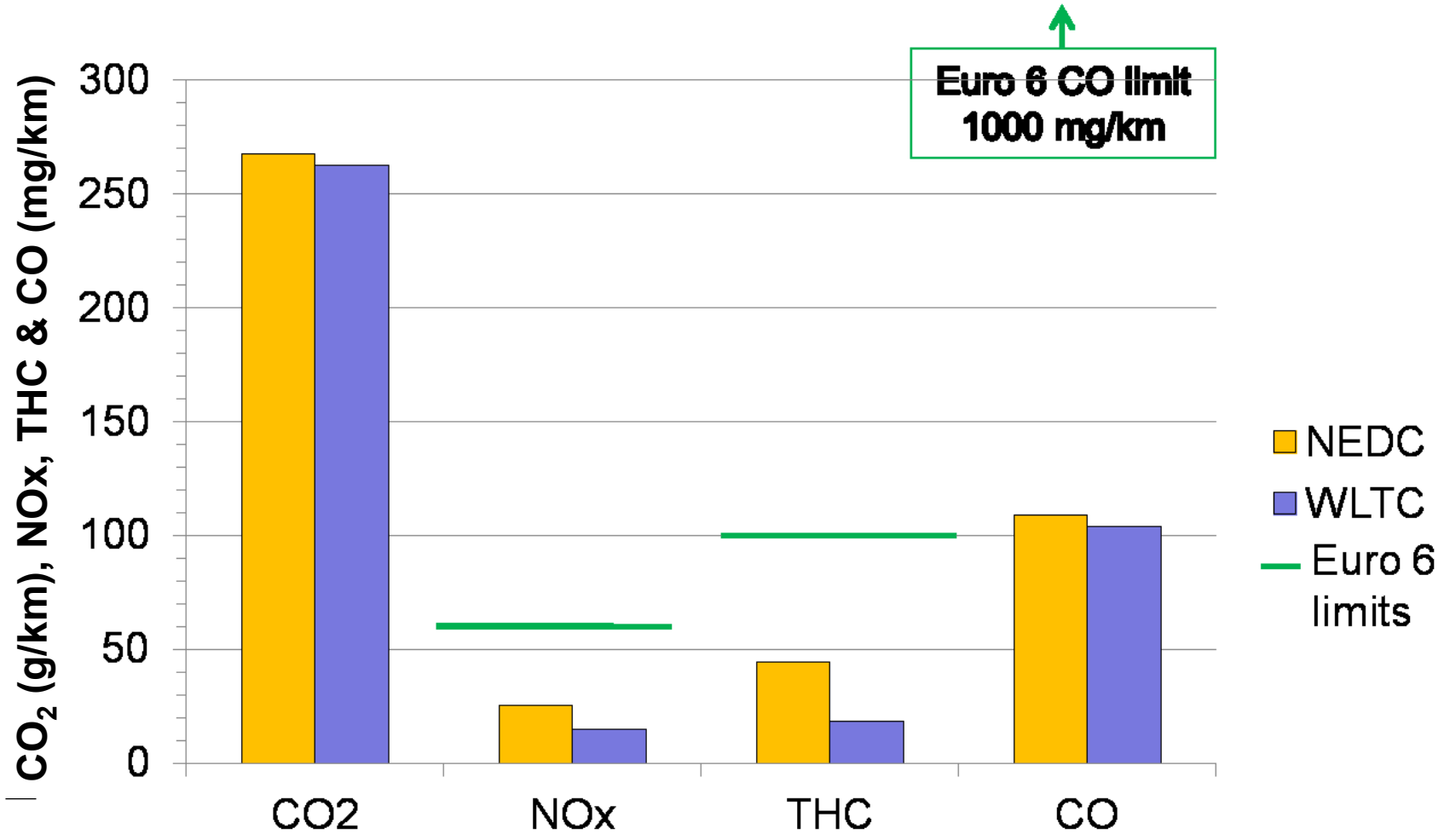
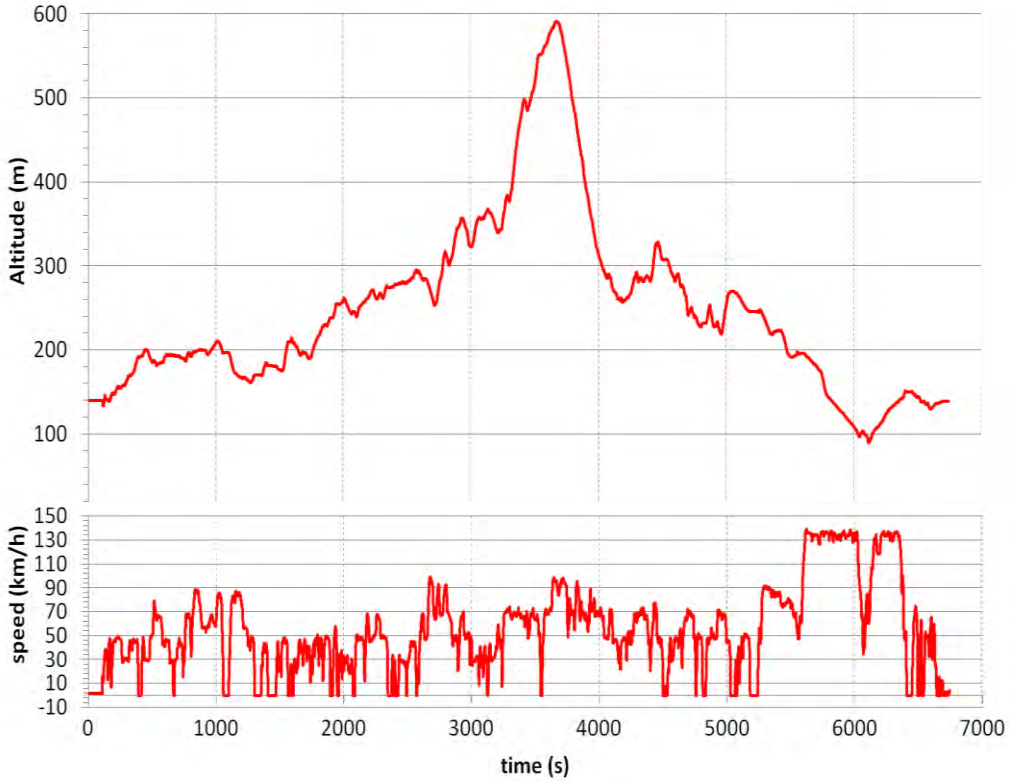
Average WLTC vs NEDC gaseous emissions

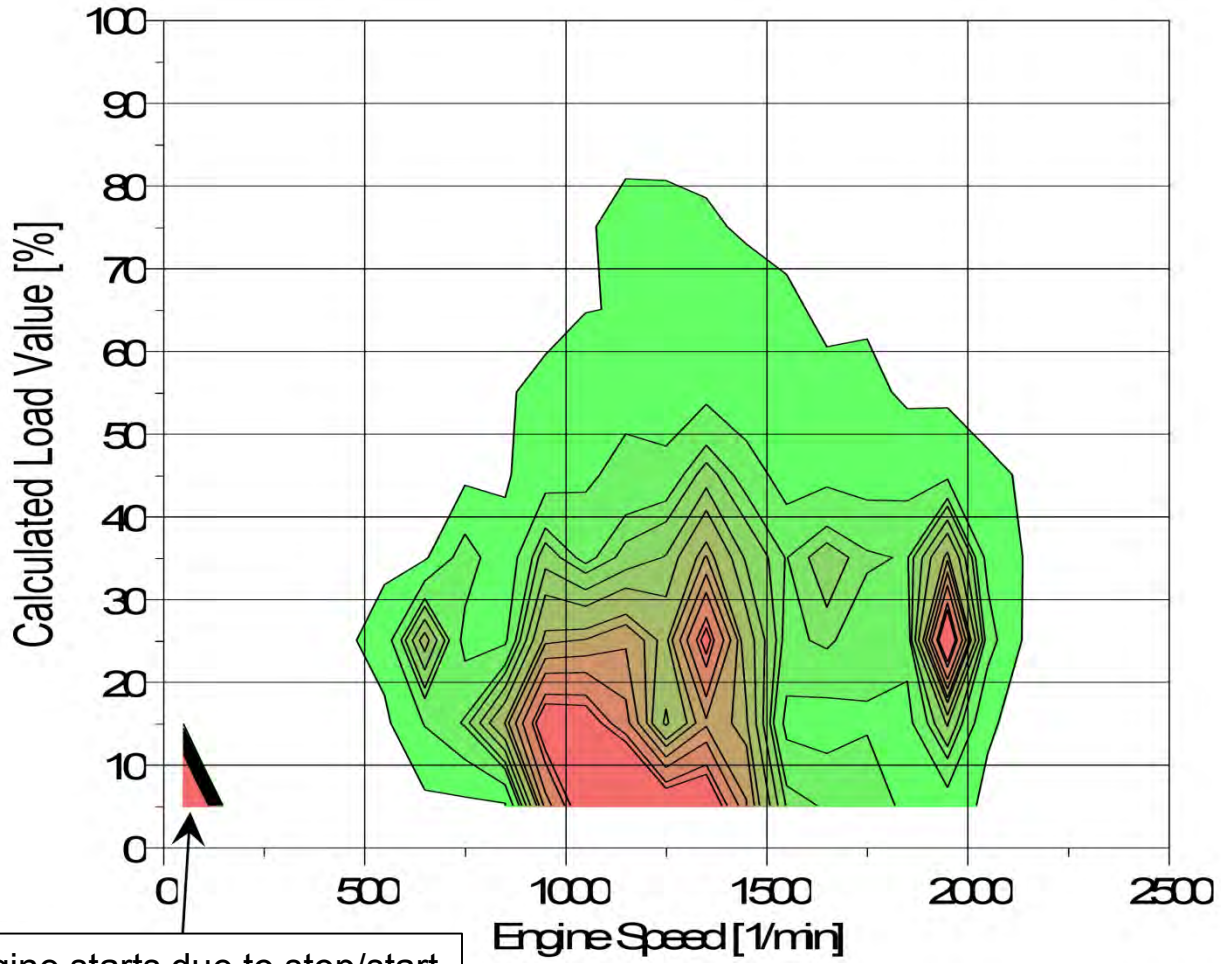


RDE route

- Approx 100 km; 1/3 each urban, rural and motorway



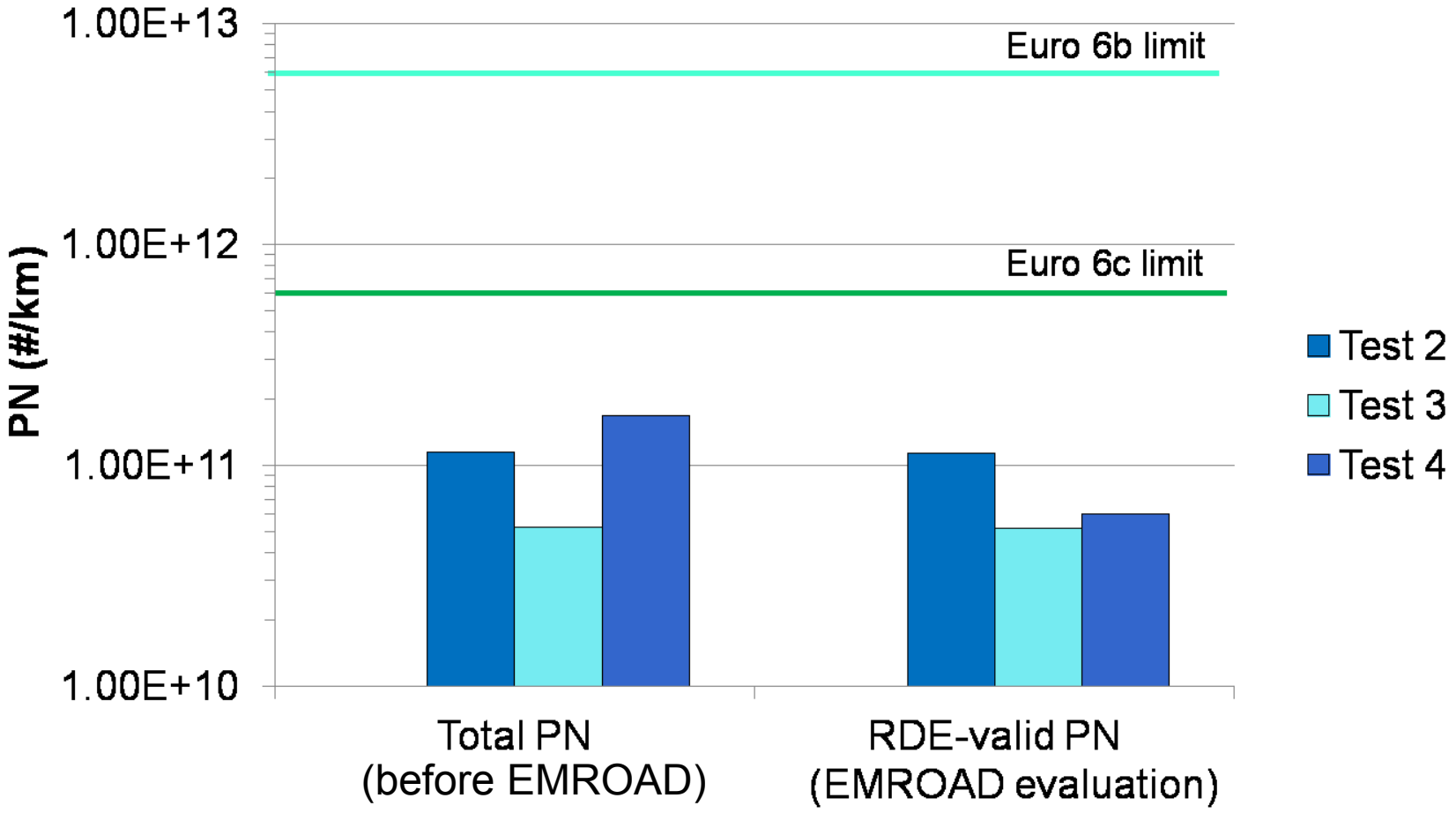
RDE test: engine speed-load map



Engine starts due to stop/start

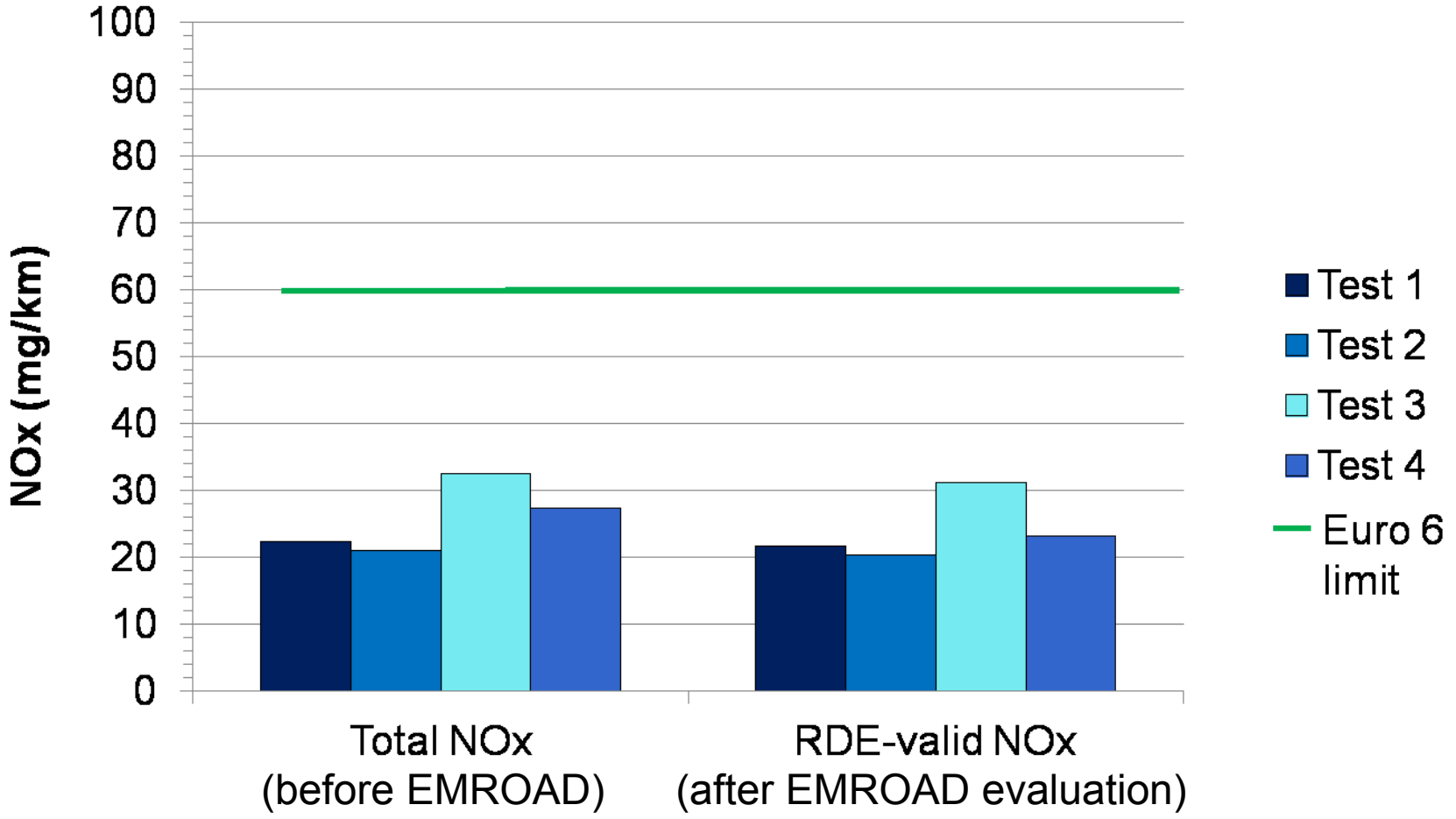
Colours represent amount of time at that engine speed/load point:
Green = lower
Red = higher

RDE PN emissions meet Euro 6c limit

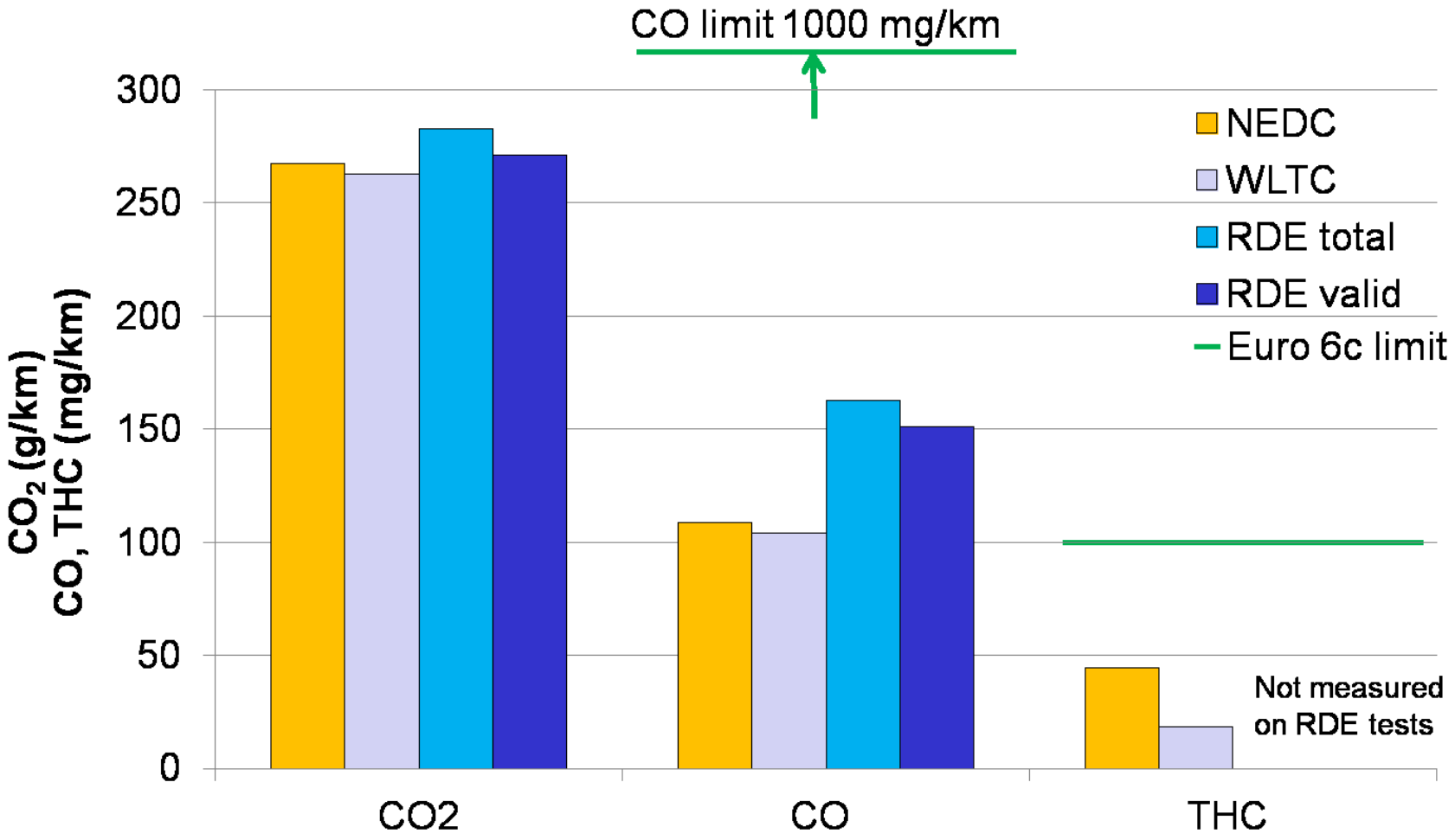


(Instrument failure on Test 1)

RDE NOx emissions well within Euro 6c limit

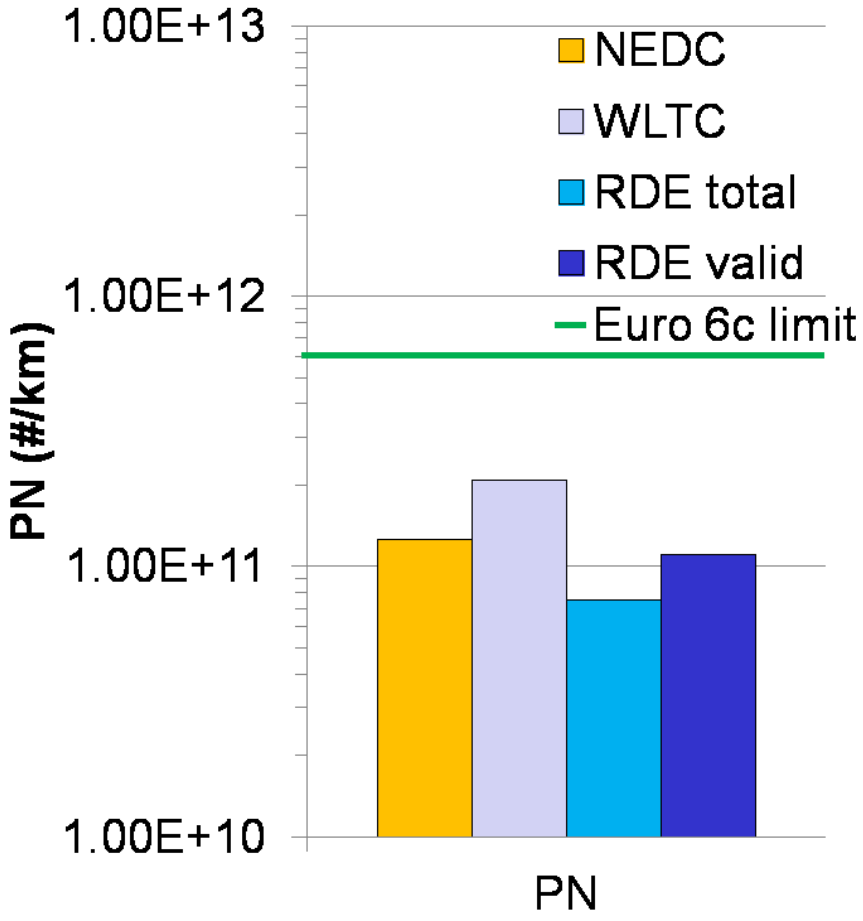


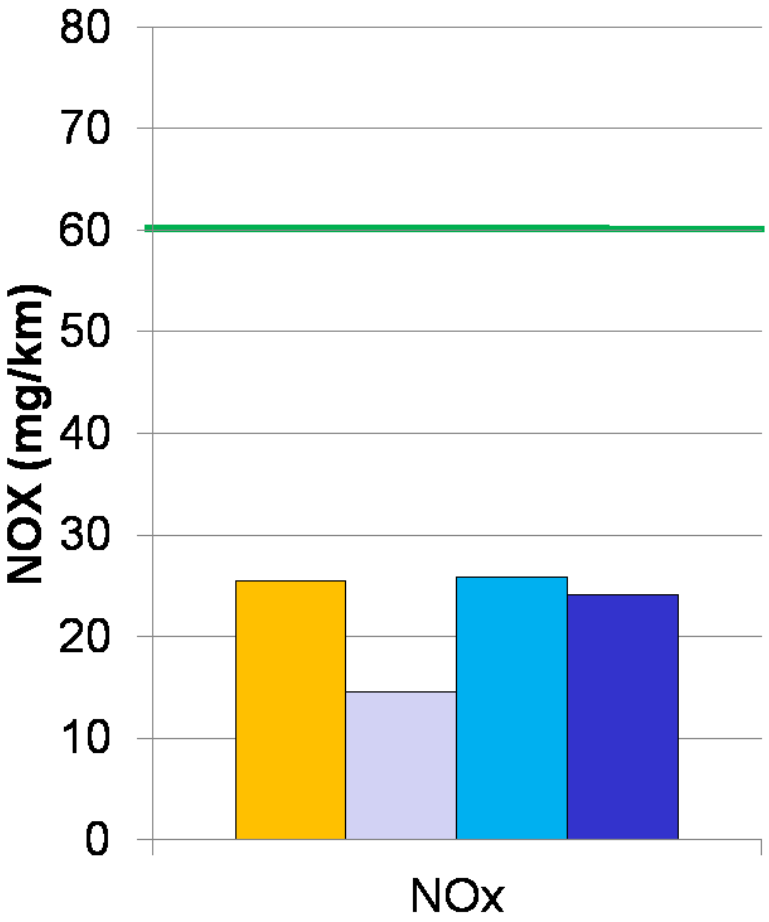
Comparisons of CO_2, CO and THC on NEDC, WLTC and RDE



RDE total = before EMROAD; RDE valid = after EMROAD

Comparison of NOx and PN emissions on NEDC, WLTC and RDE

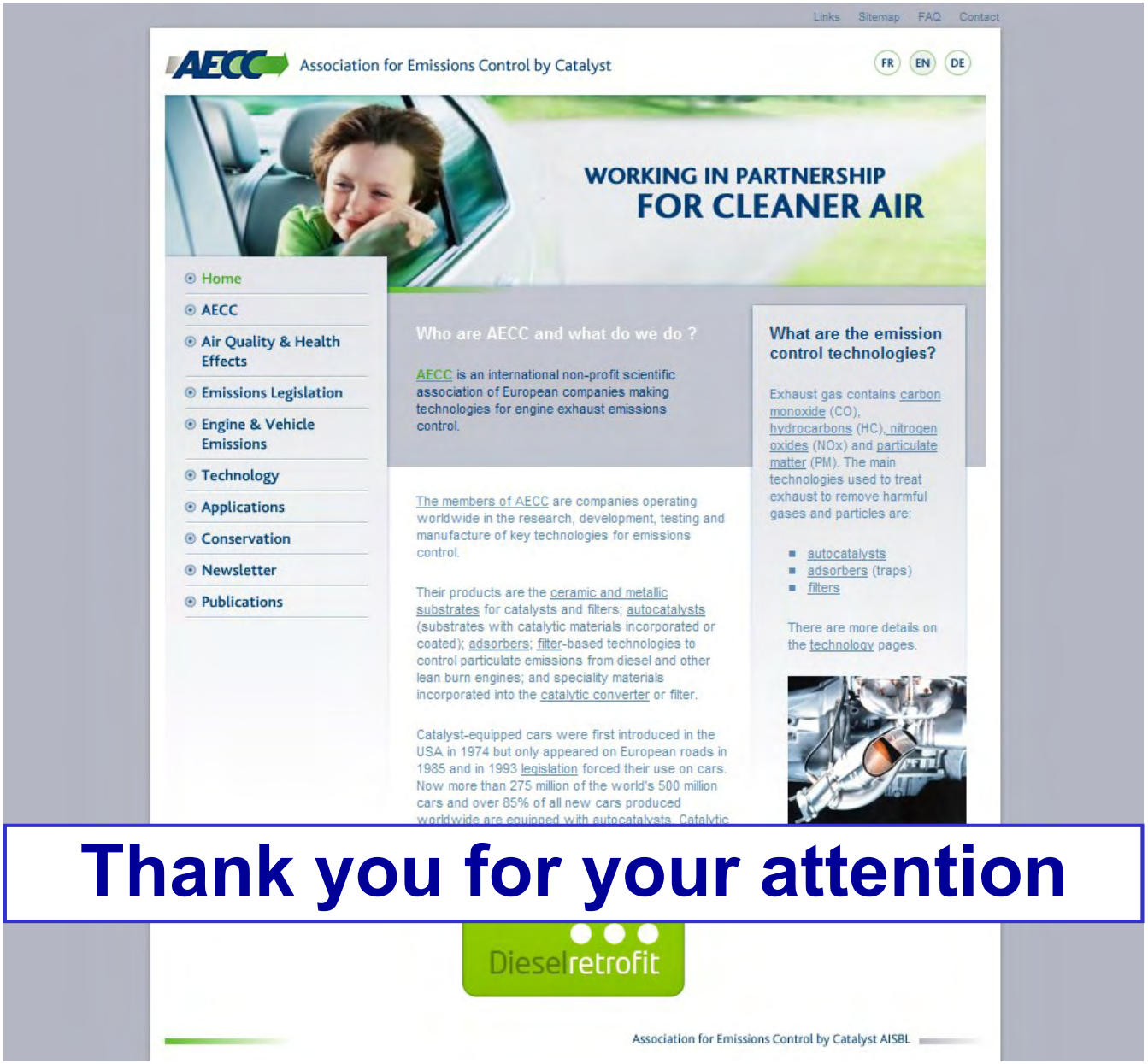




RDE total = before EMROAD; RDE valid = after EMROAD

Summary

- AECC and Concawe jointly commissioned tests at an independent laboratory on a production Euro 6 GDI vehicle equipped with Gasoline Particulate Filters.
- NEDC, WLTC and RDE tests were conducted.
- NOx emissions on all cycles were less than half the Euro 6 limit.
- PN emissions on all cycles were well below half of the Euro 6c limit.
- PN in RDE conditions was also well below the Euro 6c limit for all tests, on the basis of both total test data and EMROAD evaluation.



Thank you for your attention