

RDE PN emissions from a GDI vehicle without and with a GPF

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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



Johnson Matthey

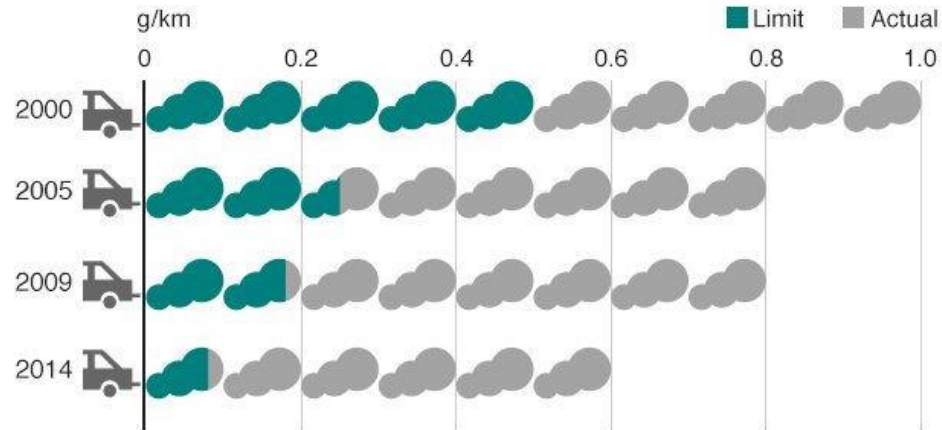


Exhaust emissions control technologies for original equipment, retrofit and aftermarket for all new cars, commercial vehicles, motorcycles and non-road mobile machinery.

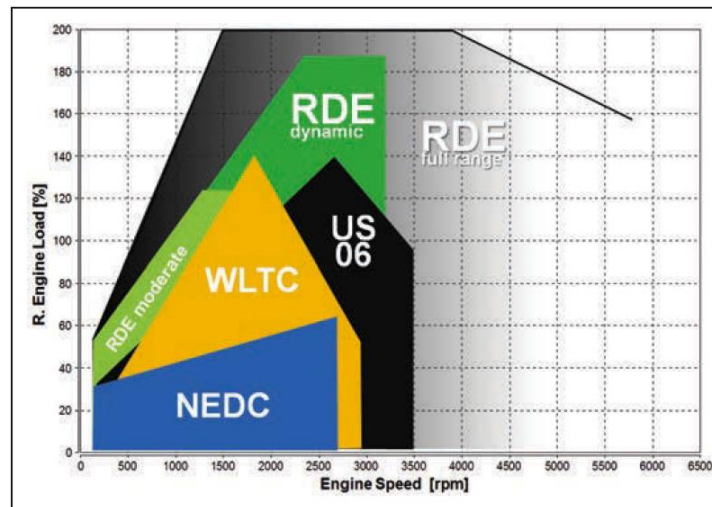


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RDE legislation to close the gap between lab and real world emissions



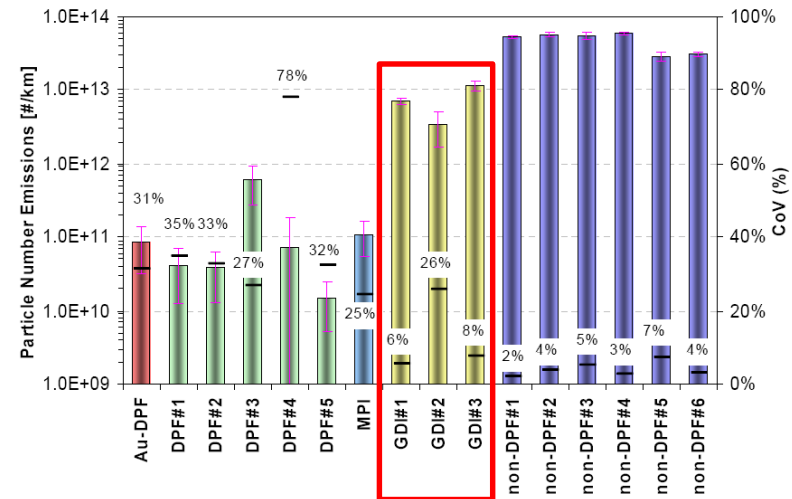
Source: the ICCT



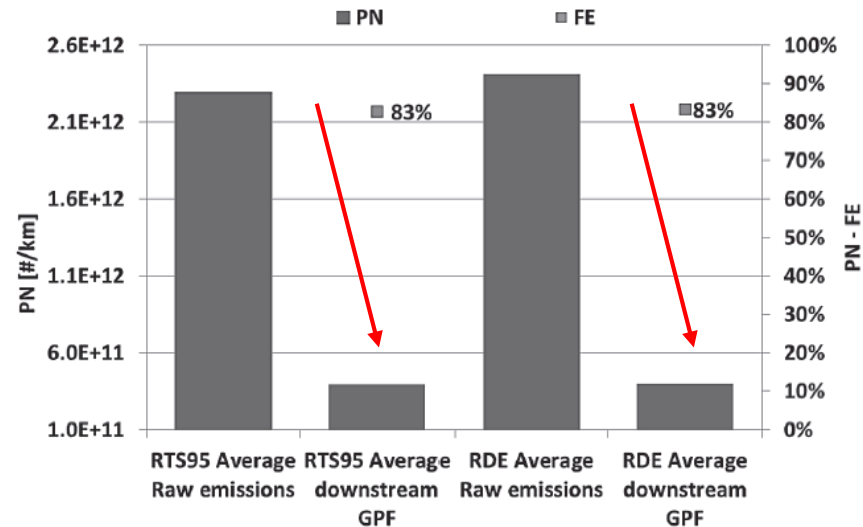
Source: AVL

The GDI particle RDE issue

- CO₂ legislation promotes fuel-efficient Gasoline Direct Injection (GDI) in the EU
- Particles emitted by DI gasoline vehicles reported higher than Euro 6c limit of 6×10^{11} #/km, especially under real driving conditions
- Gasoline Particulate Filters (GPF) are an effective route to reduce the number of ultrafine particles under a range of driving conditions

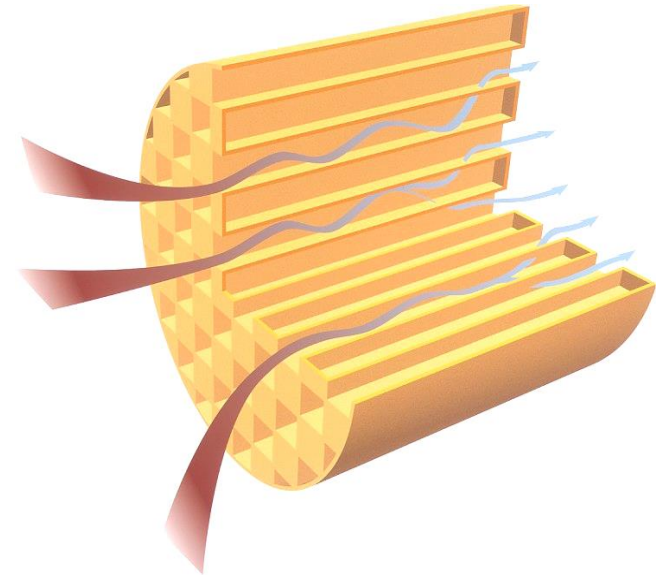


Source: PMP Inter-Laboratory Correlation Exercise Final Report



Source: AECC member

Gasoline Particulate Filter (GPF)

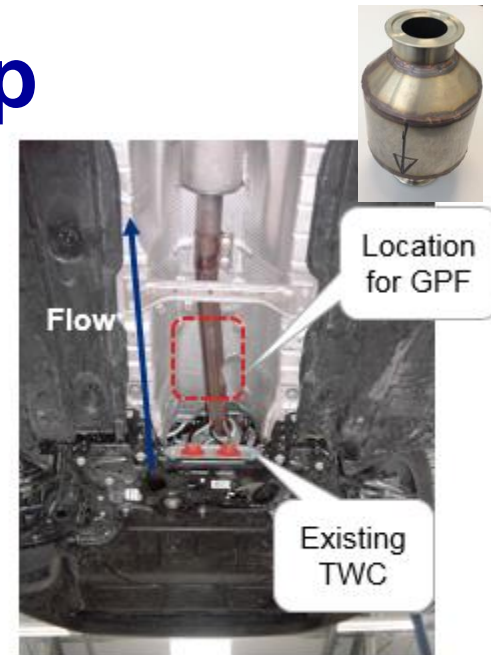


Content

- Test programme set-up
- Emissions on regulatory test cycles (NEDC and WLTC)
- Real-Driving Emissions (RDE)
 - On the road
 - On the dyno: impact of boundary conditions
- Conclusion

Test programme set-up

- Objective: investigate NOx & PN RDE without and with GPF
- At Ricardo in cooperation with Concawe
- Vehicle
 - C-segment, 1.4l engine
 - Market representative GDI technology targeting Euro 6c → only Euro 6b available
 - Original configuration w/o GPF
 - Add coated GPF demonstrator underfloor
- HORIBA PEMS equipment
 - Gaseous PEMS (CO₂, CO, NOx)
 - PEMS-PN demo unit



Underfloor view



Test programme set-up

- Identified parameters to evaluate
 - fuel type & quality
 - cold-start PN
 - driving dynamics (RDE on dyno)
 - cold ambient temperature
 - <23nm PN

- Test matrix

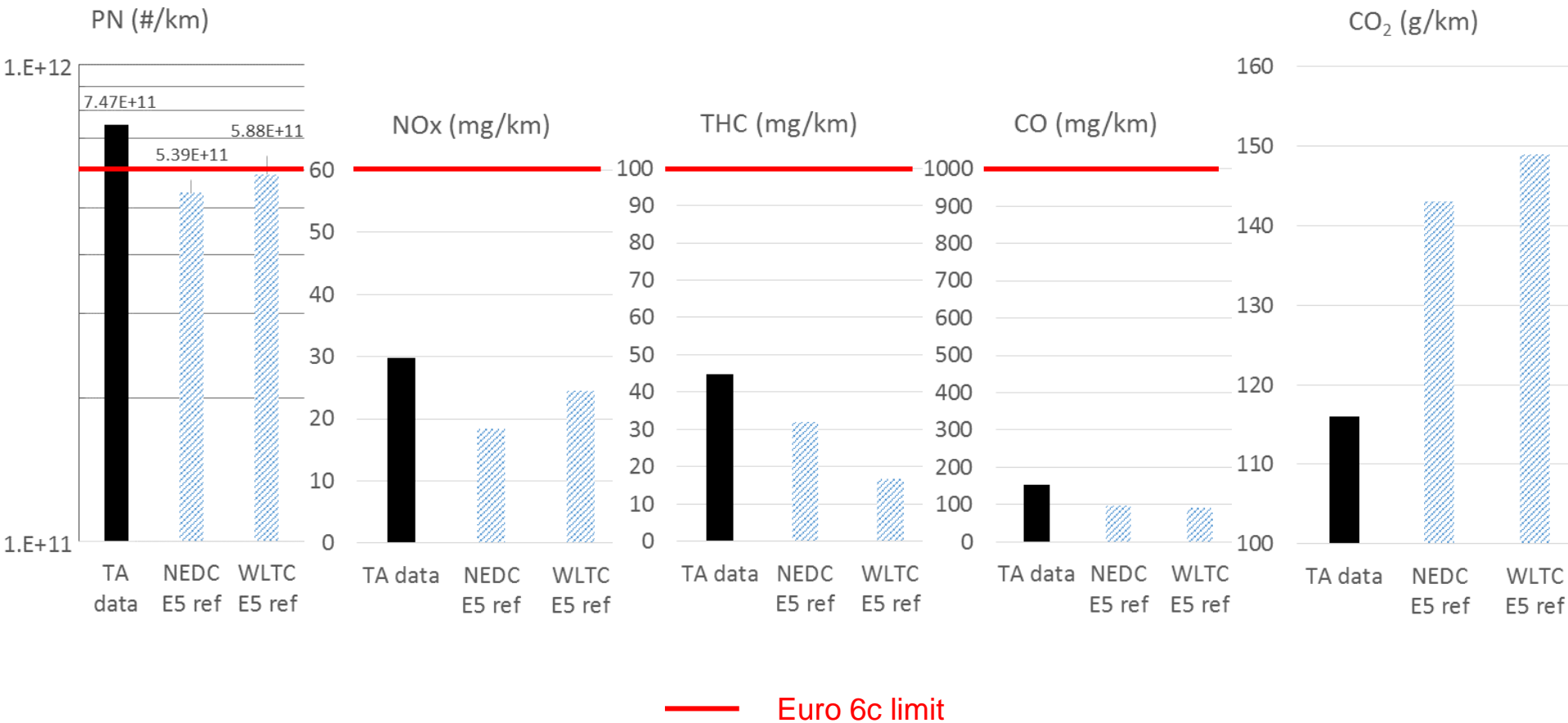
Exhaust	Fuel	NEDC + WLTC	RDE on road	RDE on dyno
Original (without GPF)	Ref E5	1x	-	-
	Ref E10	1x	3x	-
	Market E5	1x	3x	6x
With coated GPF	Ref E10	1x	3x	-
	Market E5	1x	3x	6x

Content

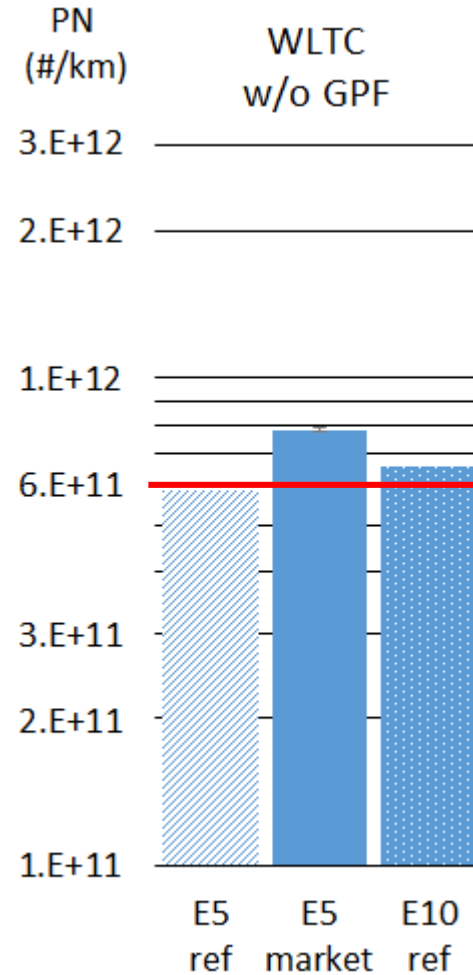
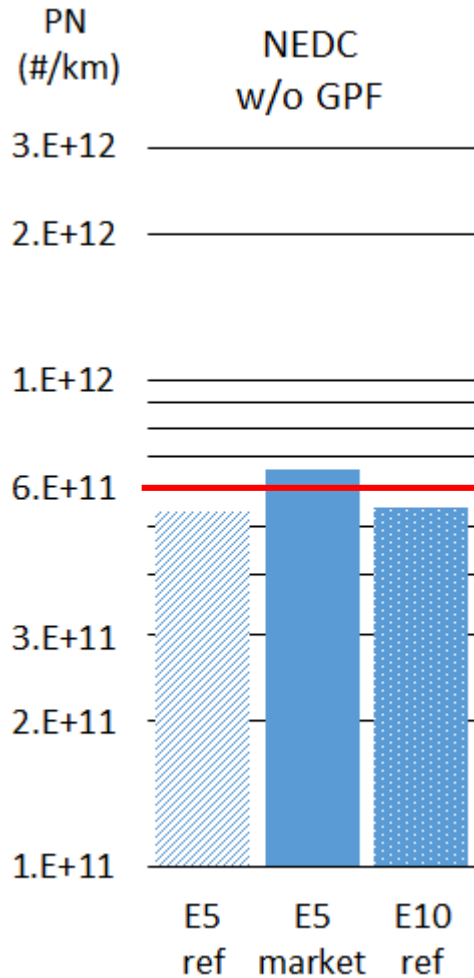
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NEDC + WLTC results w/o GPF on E5 ref fuel are below Euro 6c limit

- Data demonstrates that the vehicle is a state-of-the-art GDI



PN results w/o GPF go above Euro 6c limit on other dyno tests



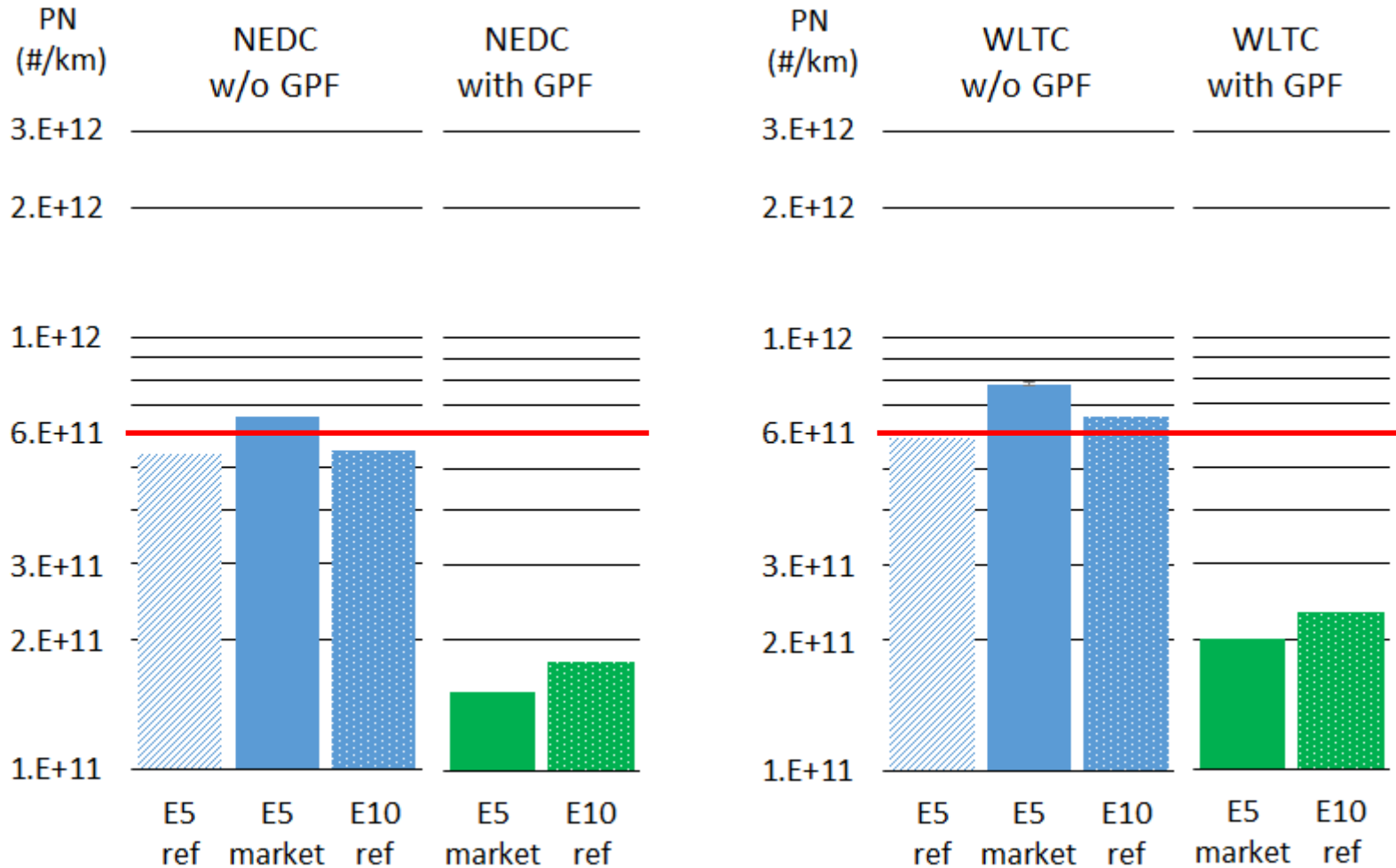
— Euro 6c limit

I Measurement range if repeated



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PN results with GPF are below Euro 6c limit on all dyno tests

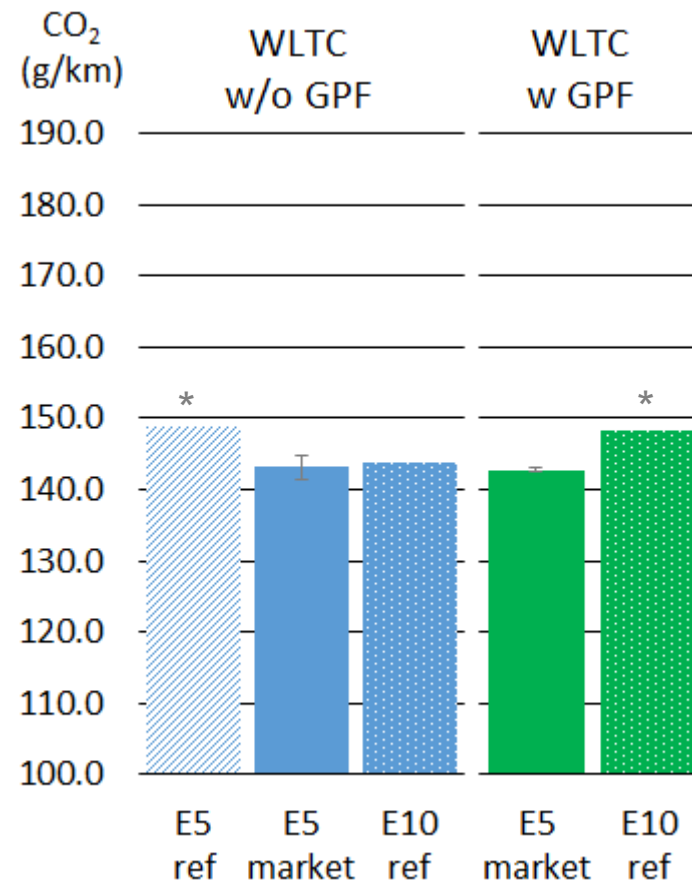
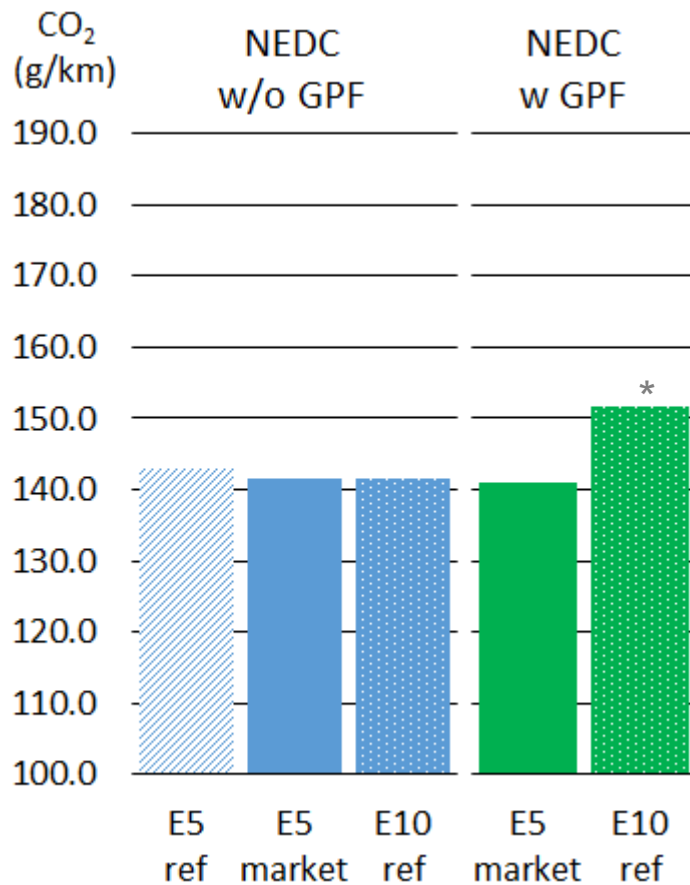


— Euro 6c limit

I Measurement range if repeated



No CO₂ penalty was measured for the GPF on NEDC and WLTC



* Start & Stop impact

I Measurement range if repeated

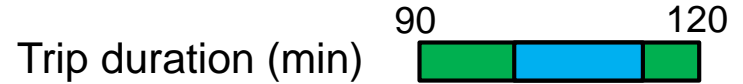
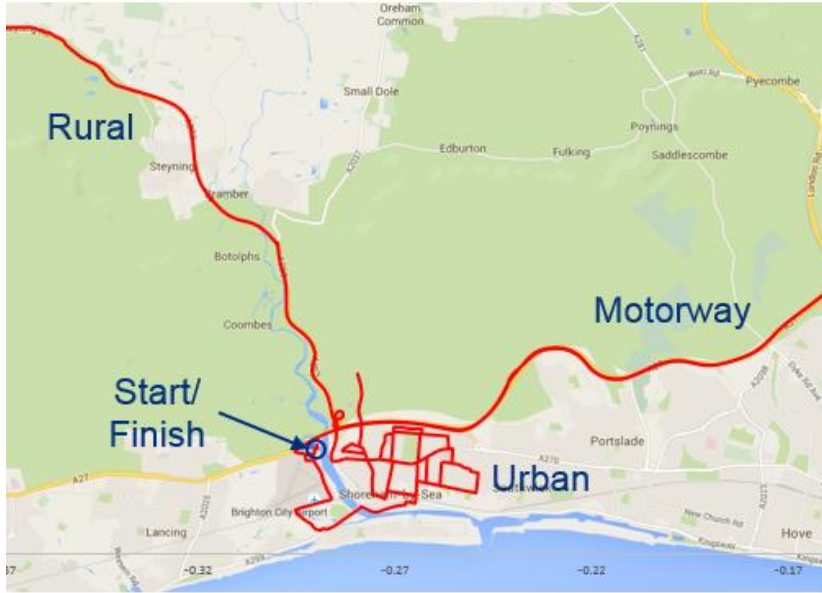


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RDE route is within the requirements

RDE Cycle Route from GPS



Distance share (%)
(>16 km)

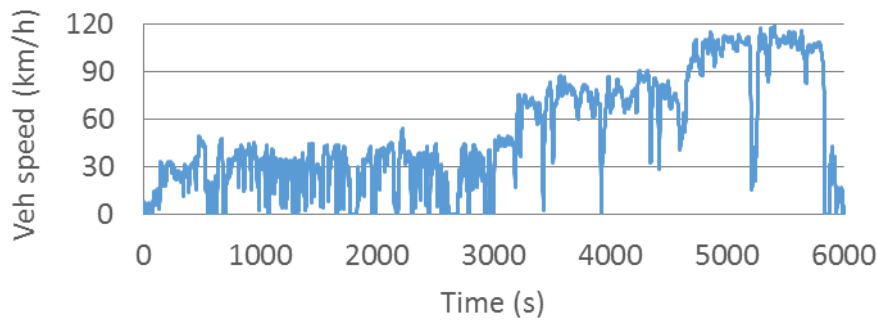
urban (<60km/h)



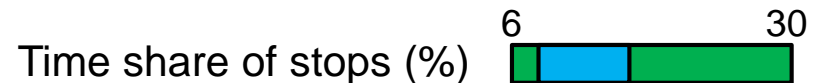
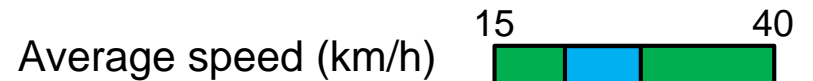
rural (>60 & <90km/h)



motorway (>90km/h)



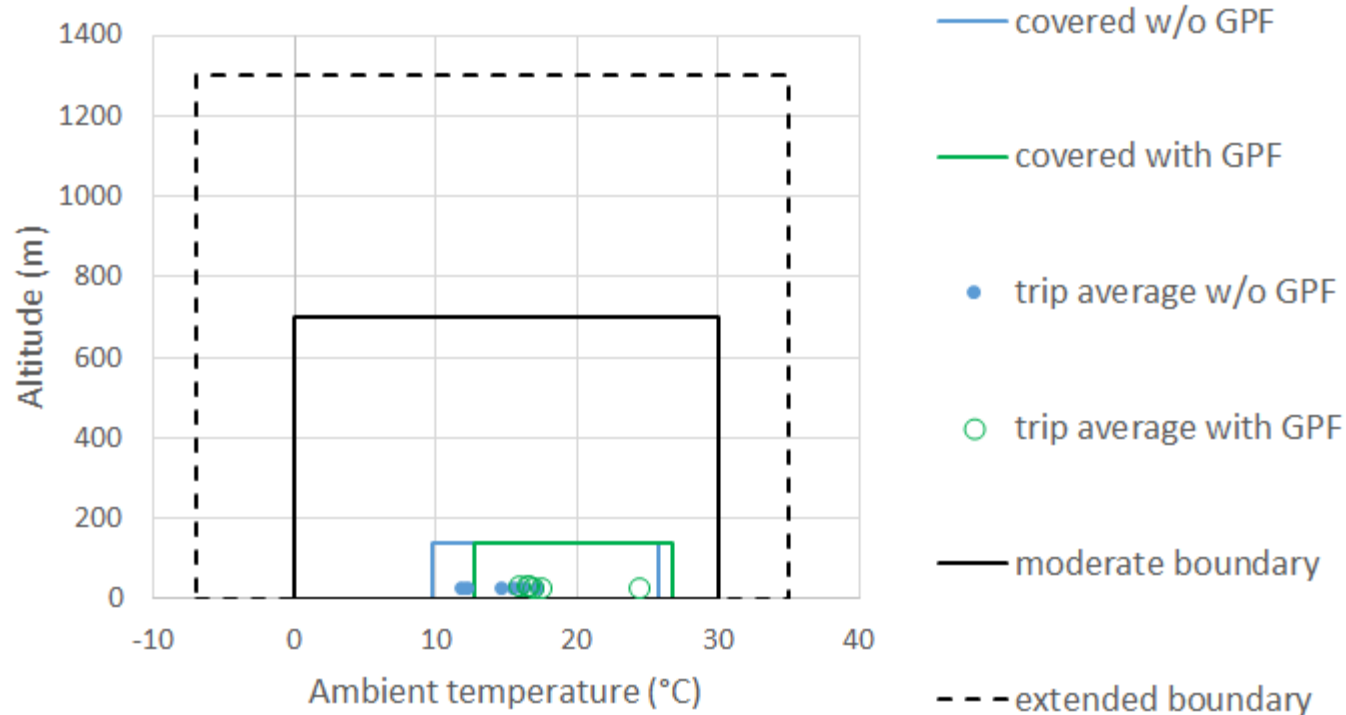
Urban requirements



■ Allowable tolerance ■ AECC tests

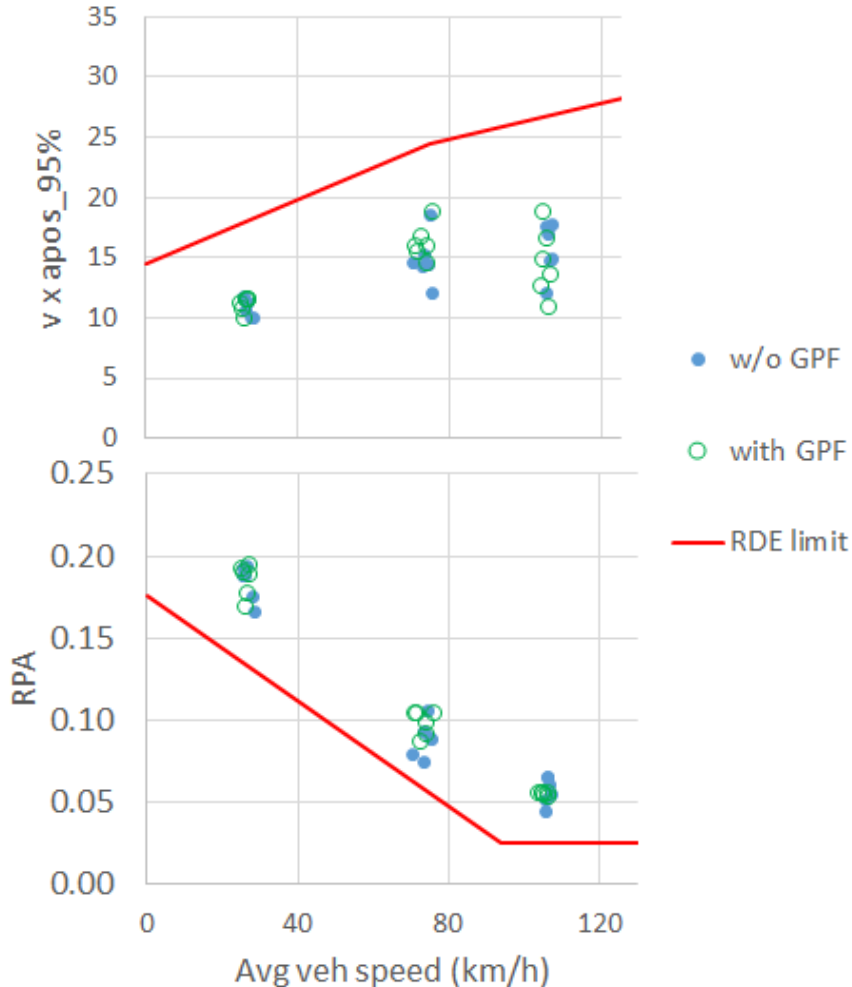


Measured data are within moderate environmental boundary conditions

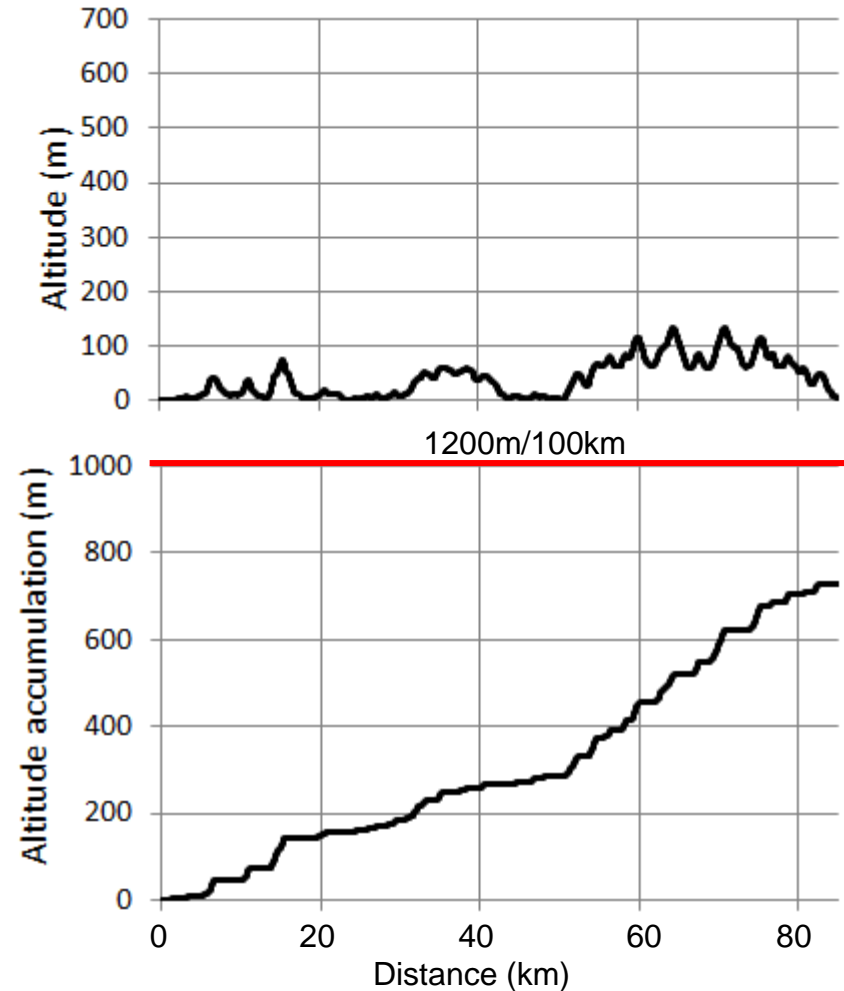


Measured data are within the dynamic boundary conditions

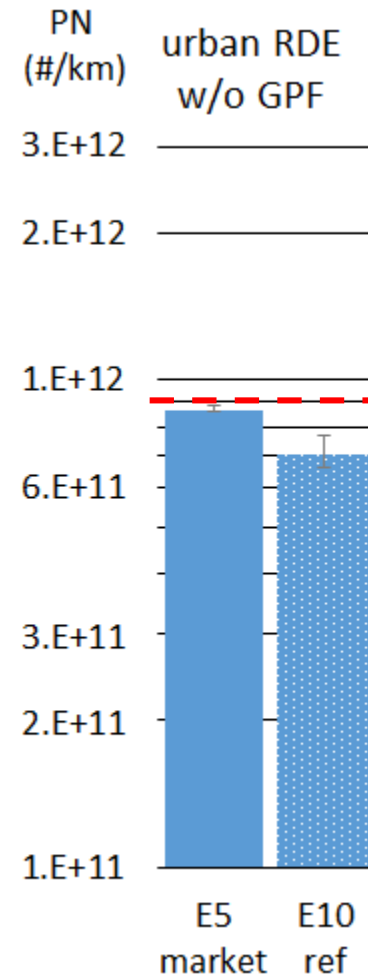
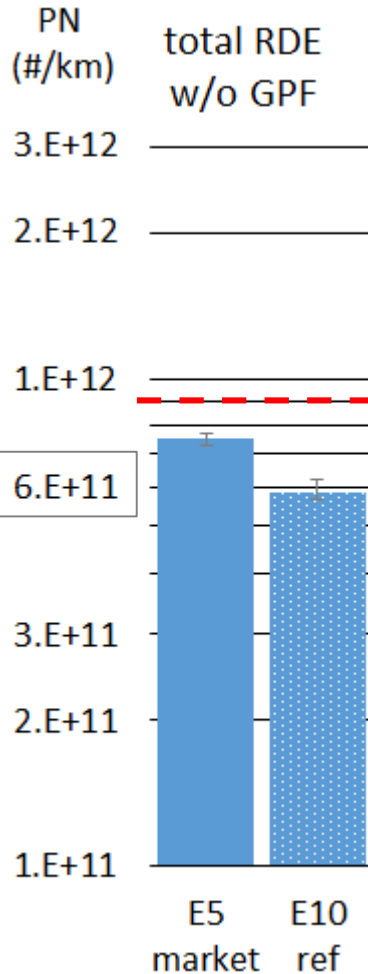
Excess or absence of driving dynamics



Altitude accumulation



PN results w/o GPF increase towards Euro 6d NTE limit on the road



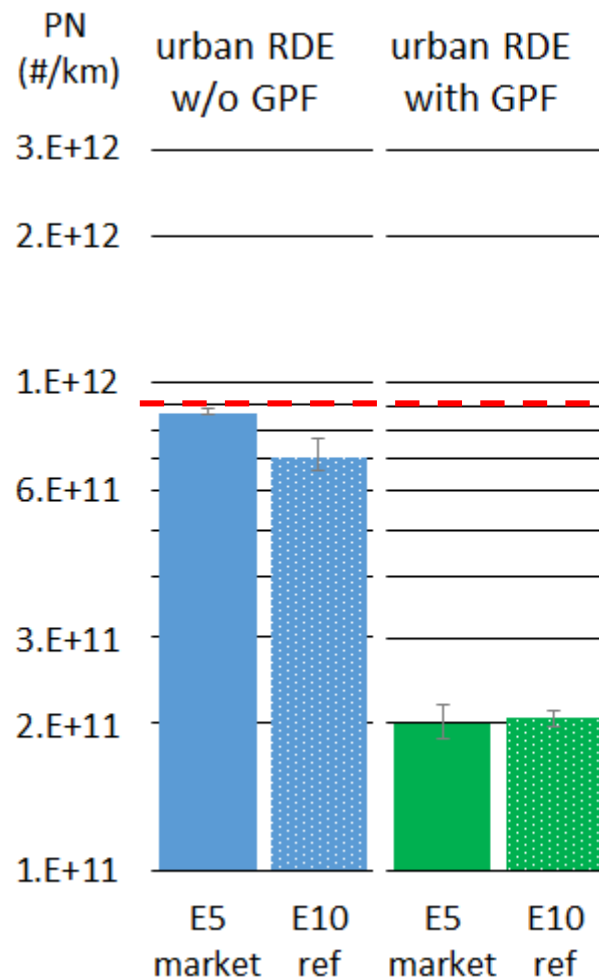
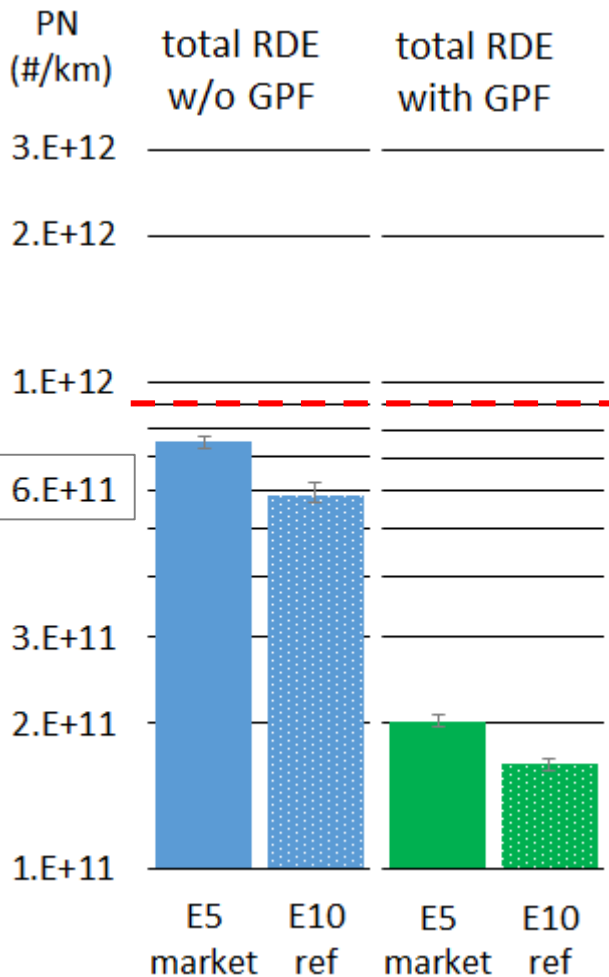
* Raw data, no exclusion/normalisation

— — — Euro 6d NTE limit (EC proposal Sept 16)

┆ Measurement range 3x RDE



PN results with GPF are well below Euro 6d NTE limit on the road



* Raw data, no exclusion/normalisation

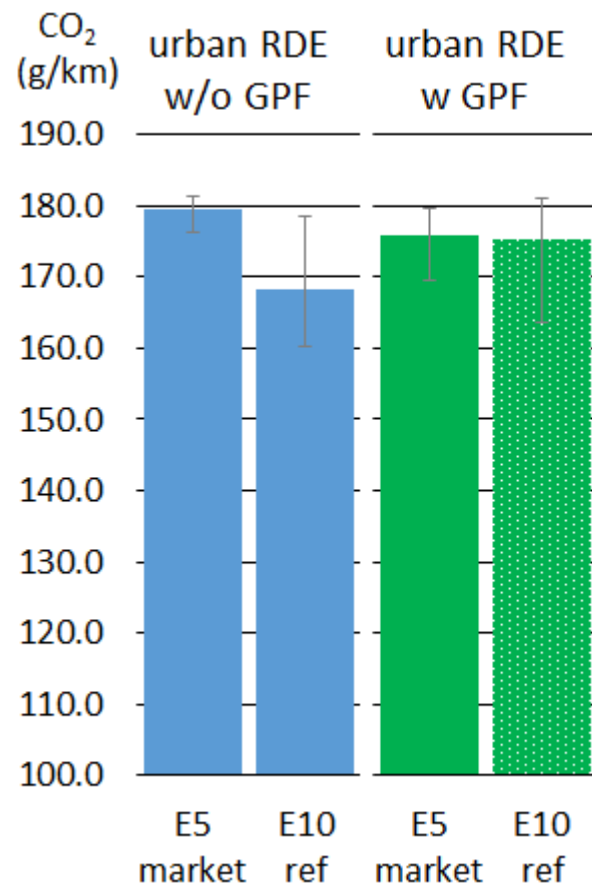
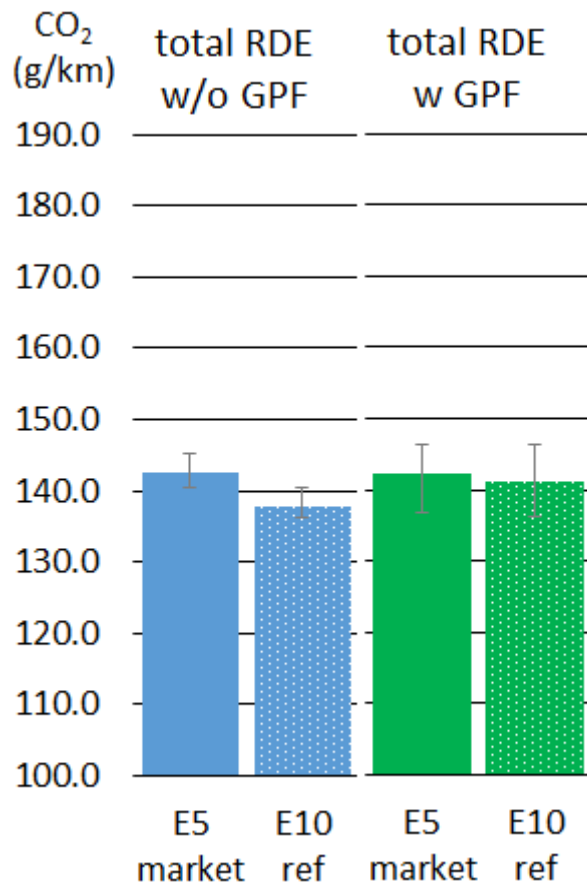
Euro 6d NTE limit
(EC proposal Sept 16)

┃ Measurement range 3x RDE



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No CO₂ penalty was measured for the GPF on the road



I Measurement range 3x RDE

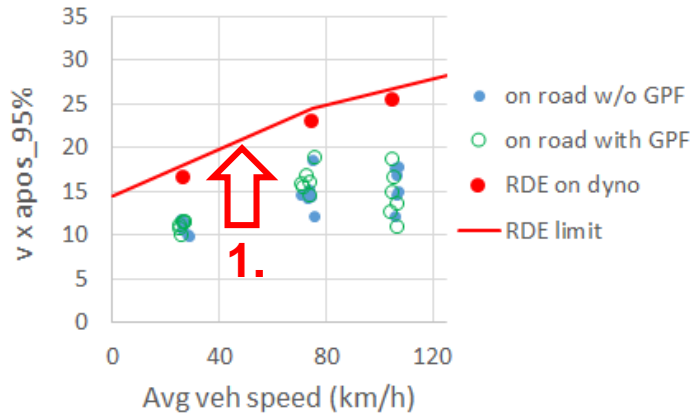


Content

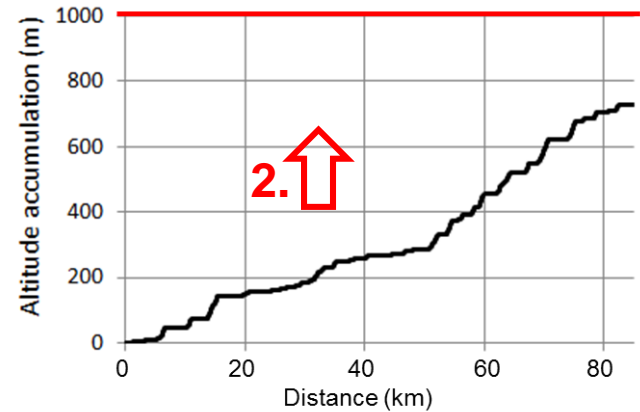
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RDE on dyno to investigate impact of going towards RDE boundary

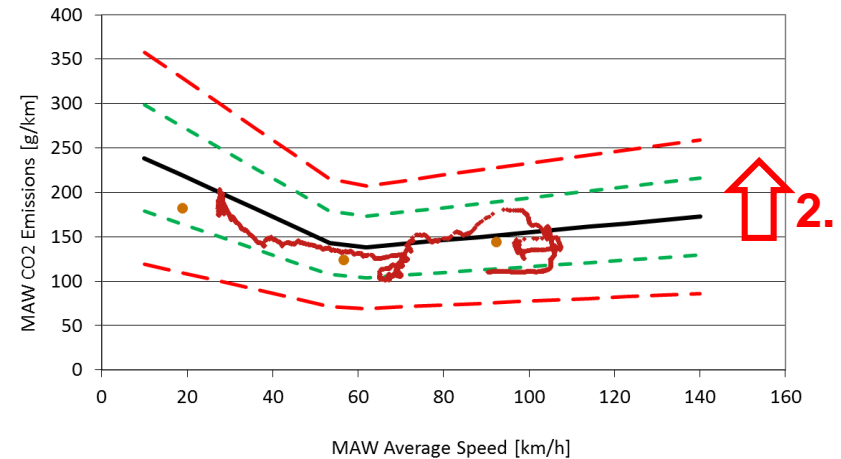
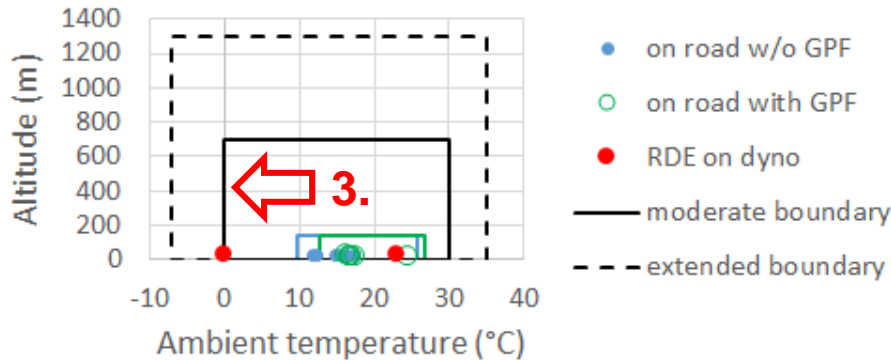
1. Change accelerations



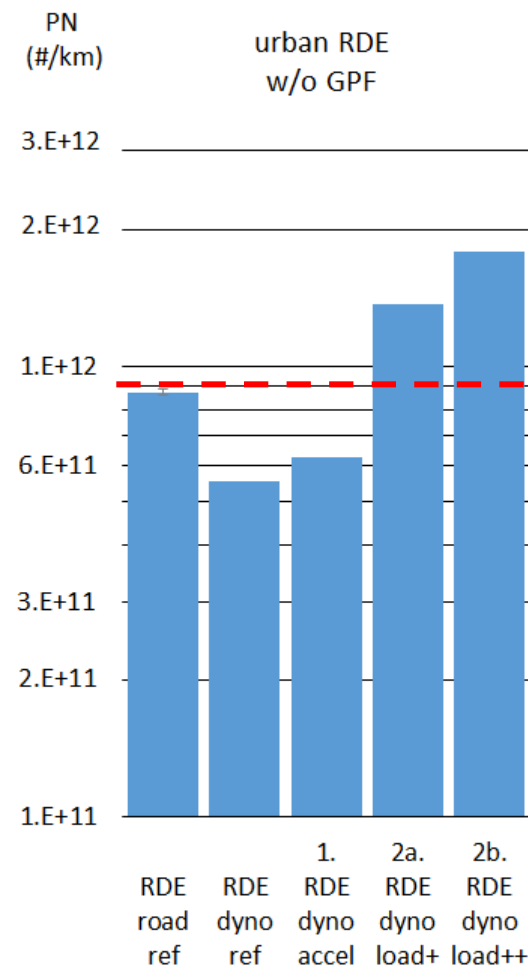
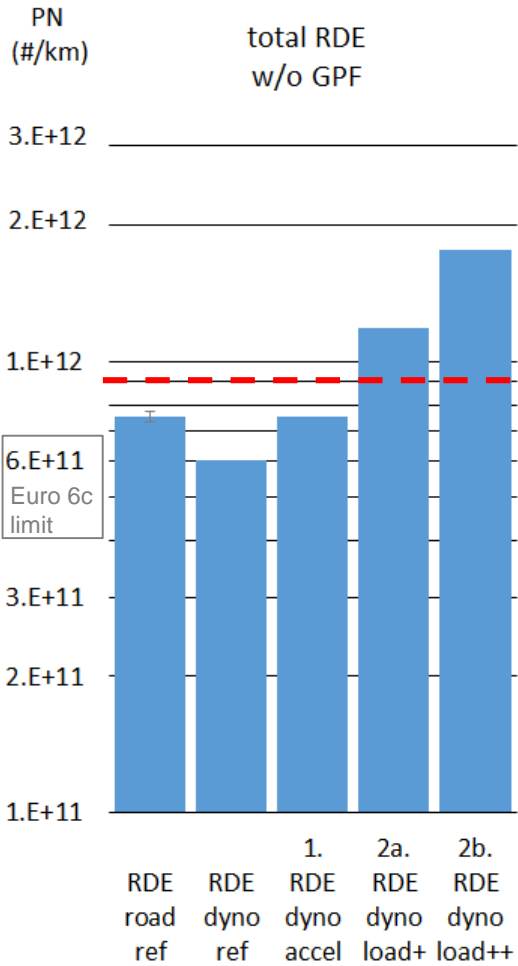
2. Change dyno load



3. Change ambient temperature



PN results w/o GPF increase above Euro 6d NTE limit towards RDE boundary

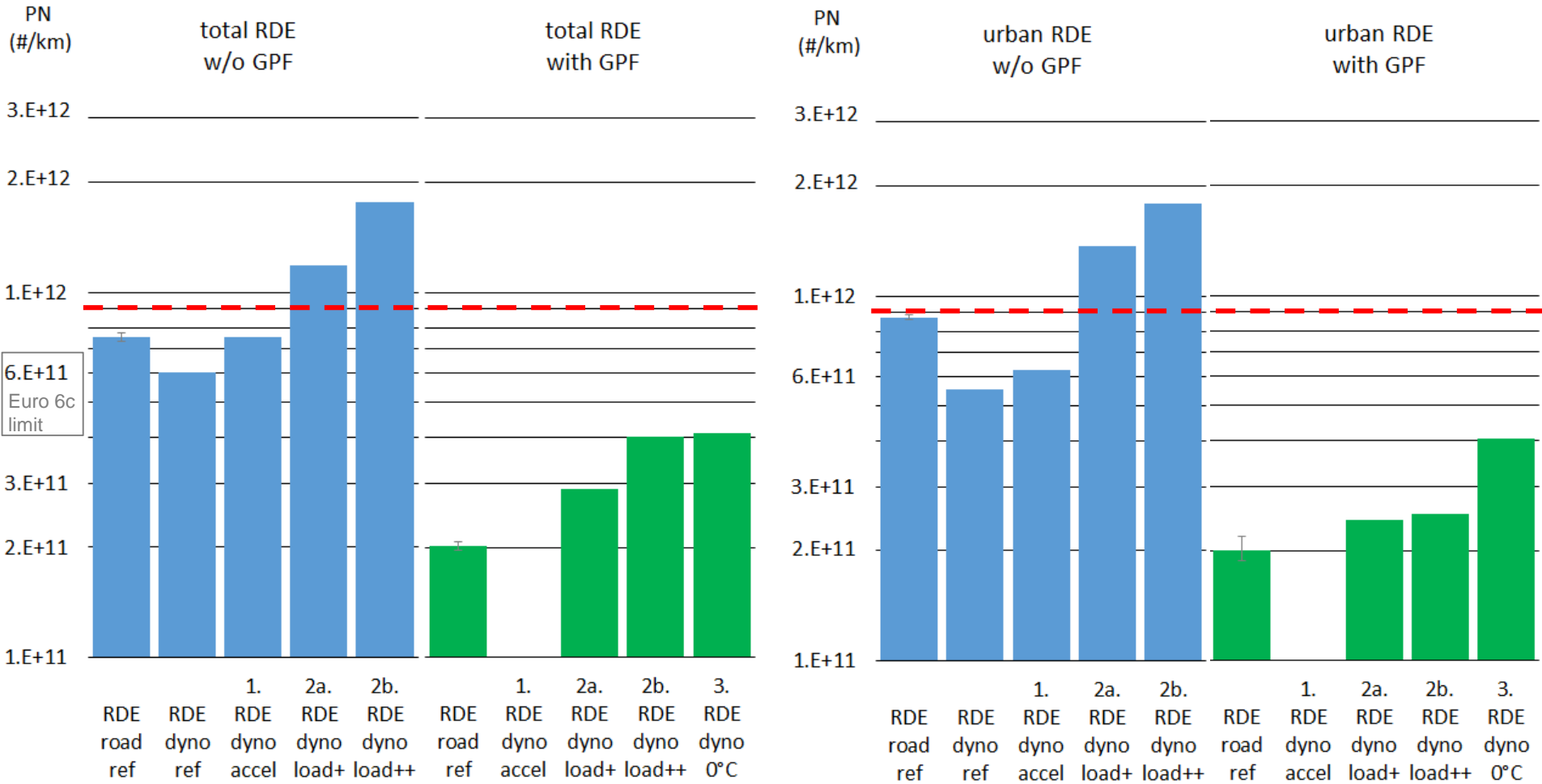


I Measurement range 3x RDE

Euro 6d NTE limit (EC proposal Sept 16)
 Association for Emissions Control by Catalyst AISBL



PN results with GPF remain below Euro 6d NTE limit



Euro 6d NTE limit
(EC proposal Sept 16)

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Measurement range 3x RDE



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Conclusion

The programme demonstrated that a GPF gives real-world PN emissions below the currently proposed Euro 6d NTE limit under the conditions tested

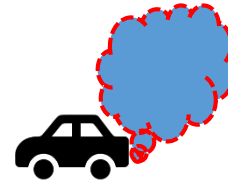
— NEDC + WLTC

w/o GPF

with GPF



— RDE on road



— towards RDE boundary
(on chassis dyno)



— Euro 6c limit

- - - Euro 6d NTE limit
(EC proposal Sept 16)



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- ⊙ AECC
- ⊙ Air Quality & Health Effects
- ⊙ Emissions Legislation
- ⊙ Engine & Vehicle Emissions
- ⊙ Technology
- ⊙ Applications
- ⊙ Conservation
- ⊙ Newsletter
- ⊙ Publications

Who are AECC and what do we do ?

AECC is an international non-profit scientific association of European companies making technologies for engine exhaust emissions control.

The members of AECC are companies operating worldwide in the research, development, testing and manufacture of key technologies for emissions control.

Their products are the ceramic and metallic substrates for catalysts and filters; autocatalysts (substrates with catalytic materials incorporated or coated); adsorbers; filter-based technologies to control particulate emissions from diesel and other lean burn engines; and speciality materials incorporated into the catalytic converter or filter.

Catalyst-equipped cars were first introduced in the USA in 1974 but only appeared on European roads in 1985 and in 1993 legislation forced their use on cars. Now more than 275 million of the world's 500 million cars and over 85% of all new cars produced worldwide are equipped with autocatalysts. Catalytic

What are the emission control technologies?

Exhaust gas contains carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx) and particulate matter (PM). The main technologies used to treat exhaust to remove harmful gases and particles are:

- autocatalysts
- adsorbers (traps)
- filters

There are more details on the technology pages.



Thank you for your attention

Dieselretrofit