DIESEL VEHICLE WITH ULTRA-LOW NOx EMISSIONS ON THE ROAD

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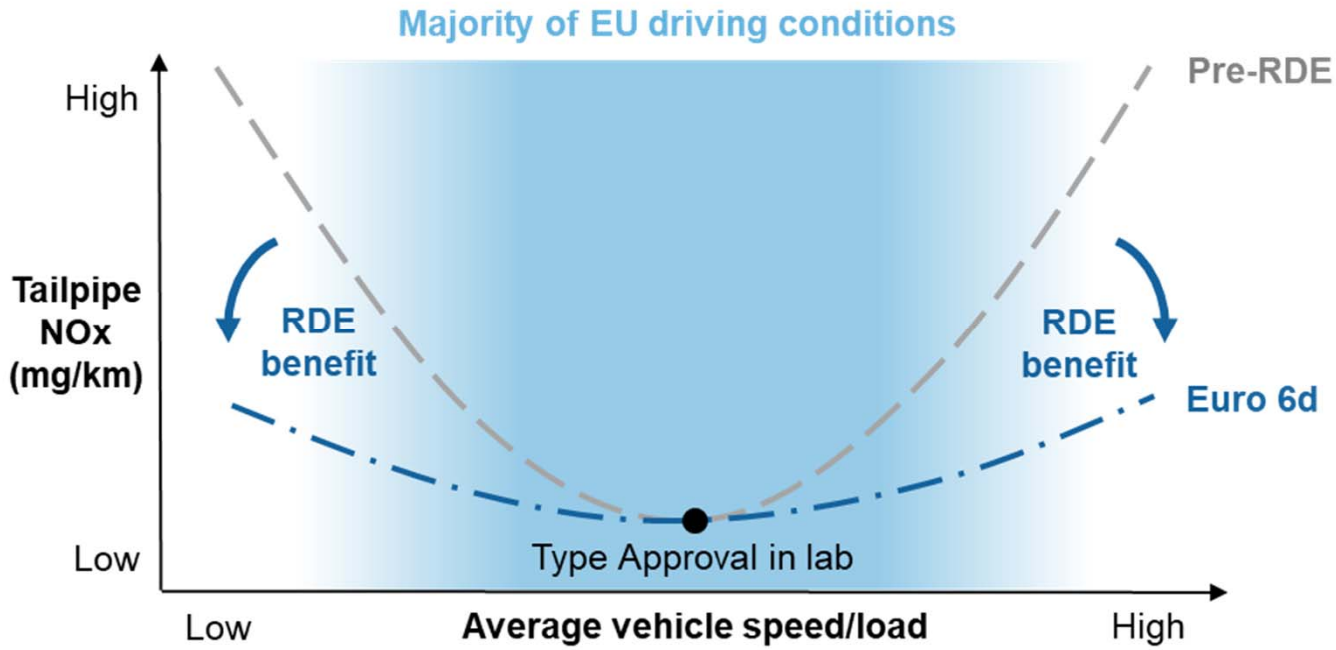
RDE legislation has significantly improved real-world NOx emissions

RDE requirements ensure that emissions are controlled over wider range of conditions



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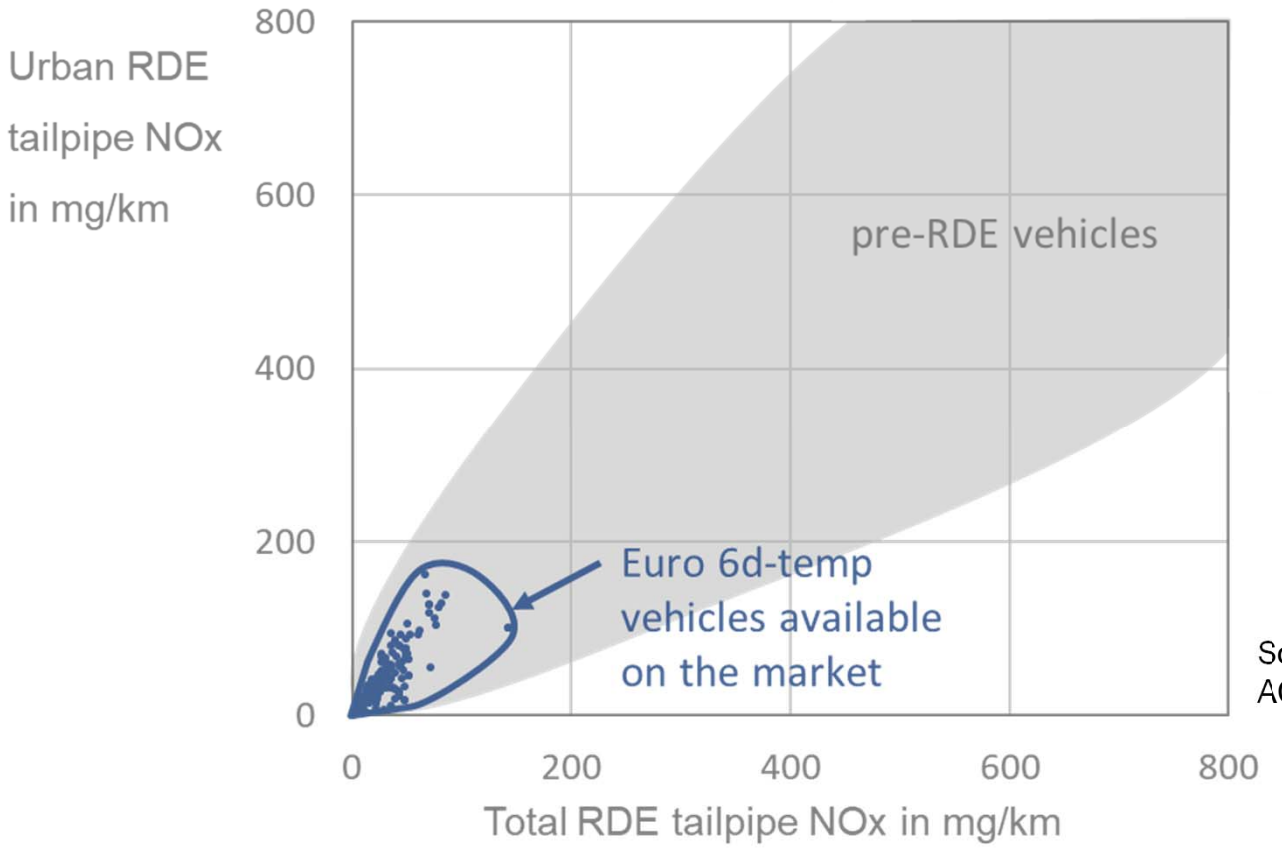
On-road emissions of Euro 6d-Temp cars are well within standards

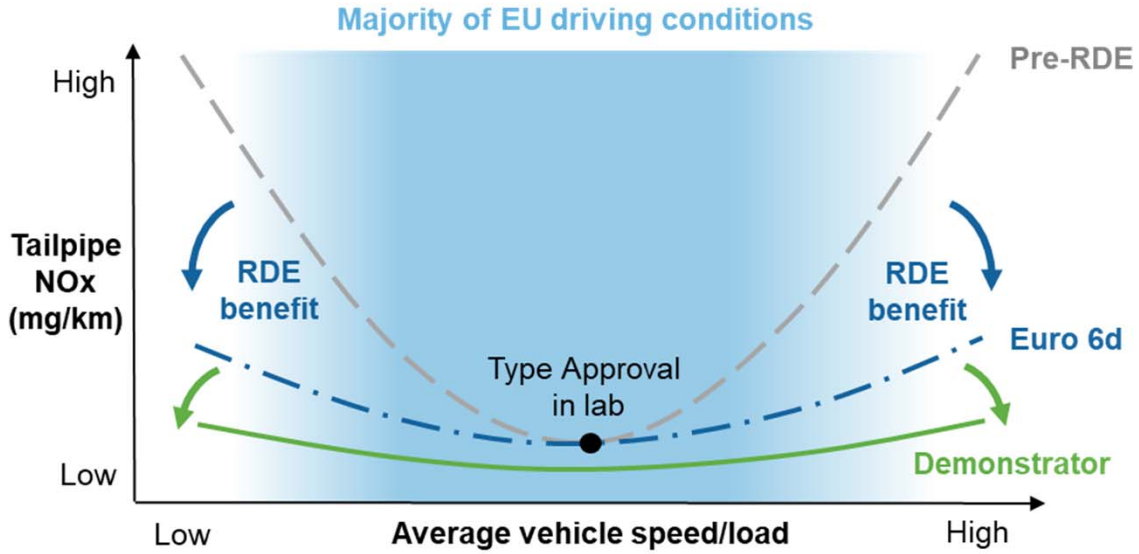


Source: PEMS results from ACEA and JAMA RDE database

Objective: demonstrate consistent low NOx emissions

Challenging driving conditions

- Low speed/load
  e.g. city driving
- High speed/load
  e.g. motorway driving
- Transients
  e.g. overtaking



Content

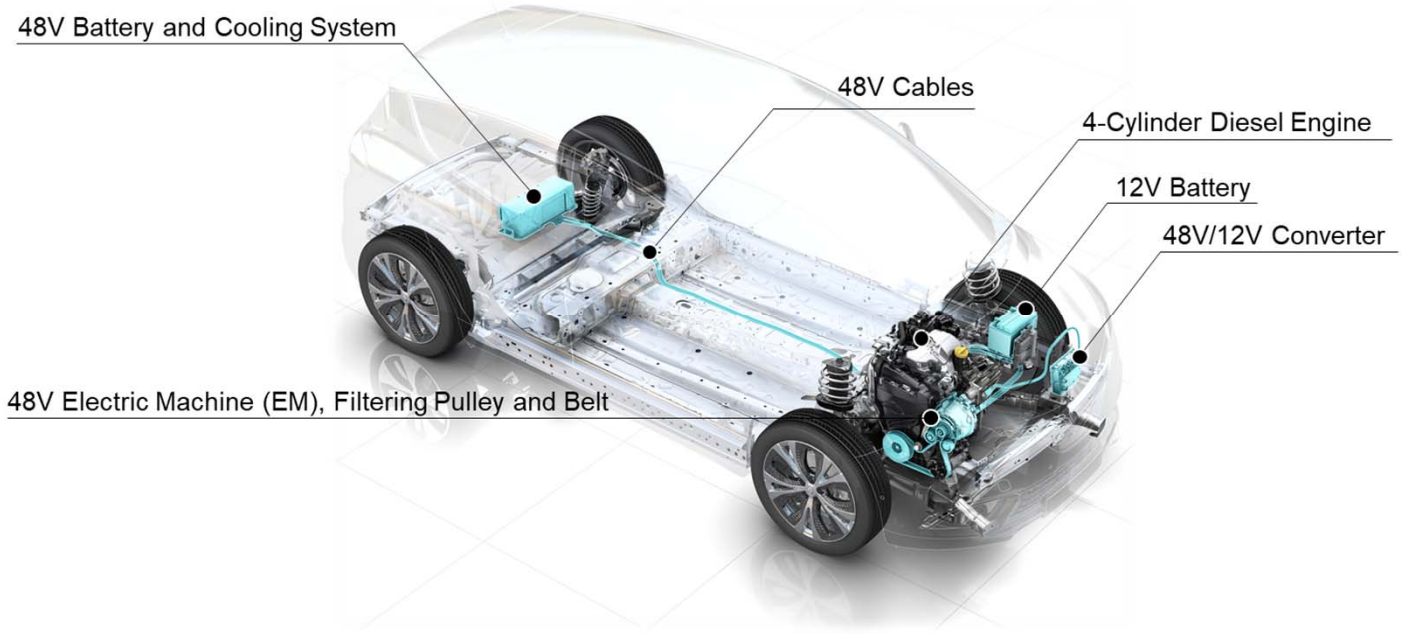
- Concept: Emissions control technologies combined in integrated system approach

- Tailpipe emissions measured
  - NOx
  - PM & PN
  - THC & CO
  - NH_3

- Conclusions

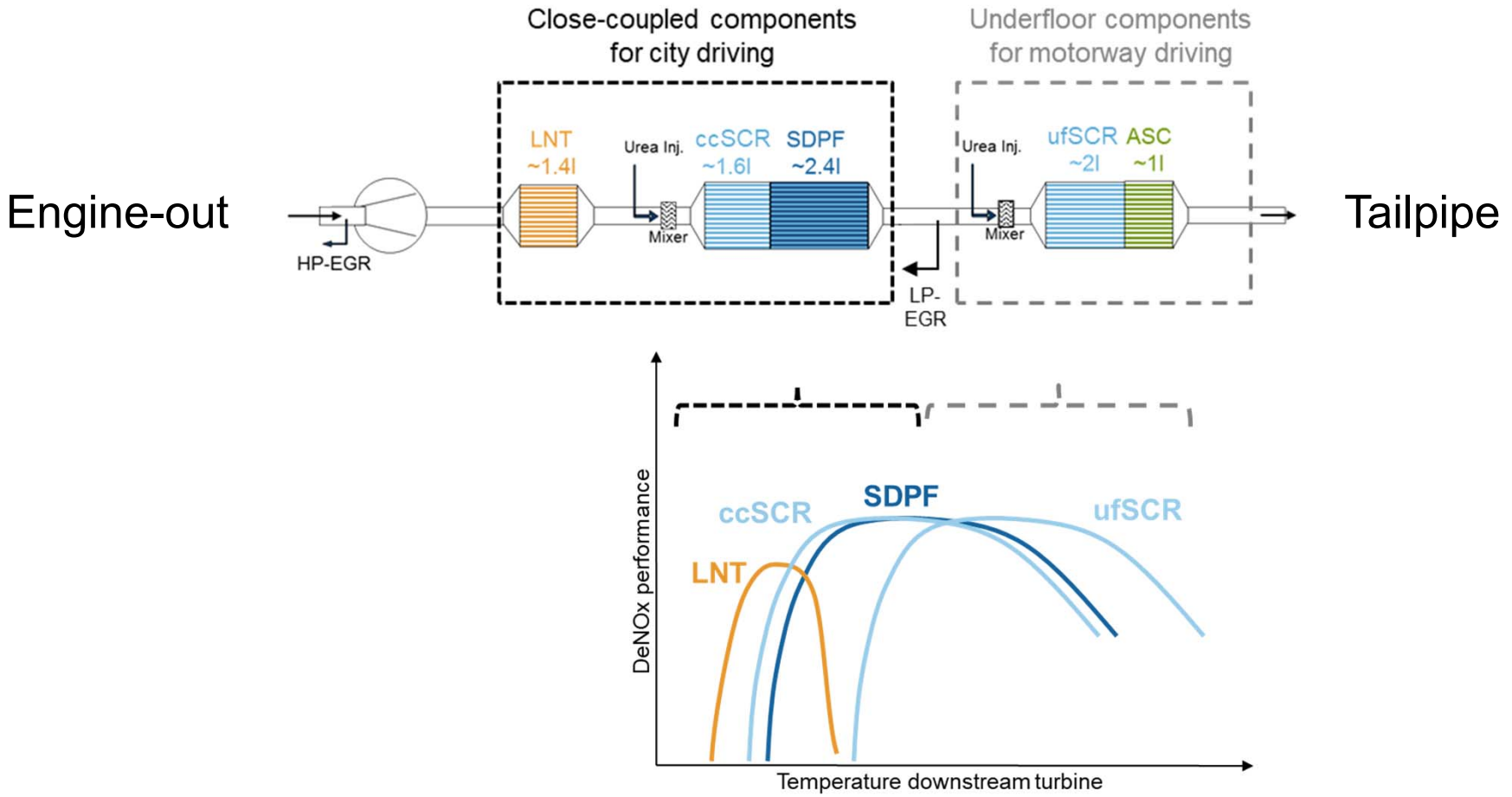
Base vehicle and powertrain characteristics

- Vehicle
  - C-segment
  - 1700 kg
- Drivetrain
  - Manual gearbox, 6-speed
  - 48 Volt mild-hybrid (belt-driven, P0)
- Engine
  - 1.5l, 4-cylinder, 2-valve
  - EGR: uncooled HP and cooled LP
- Euro 6b type approval (LNT + DPF)



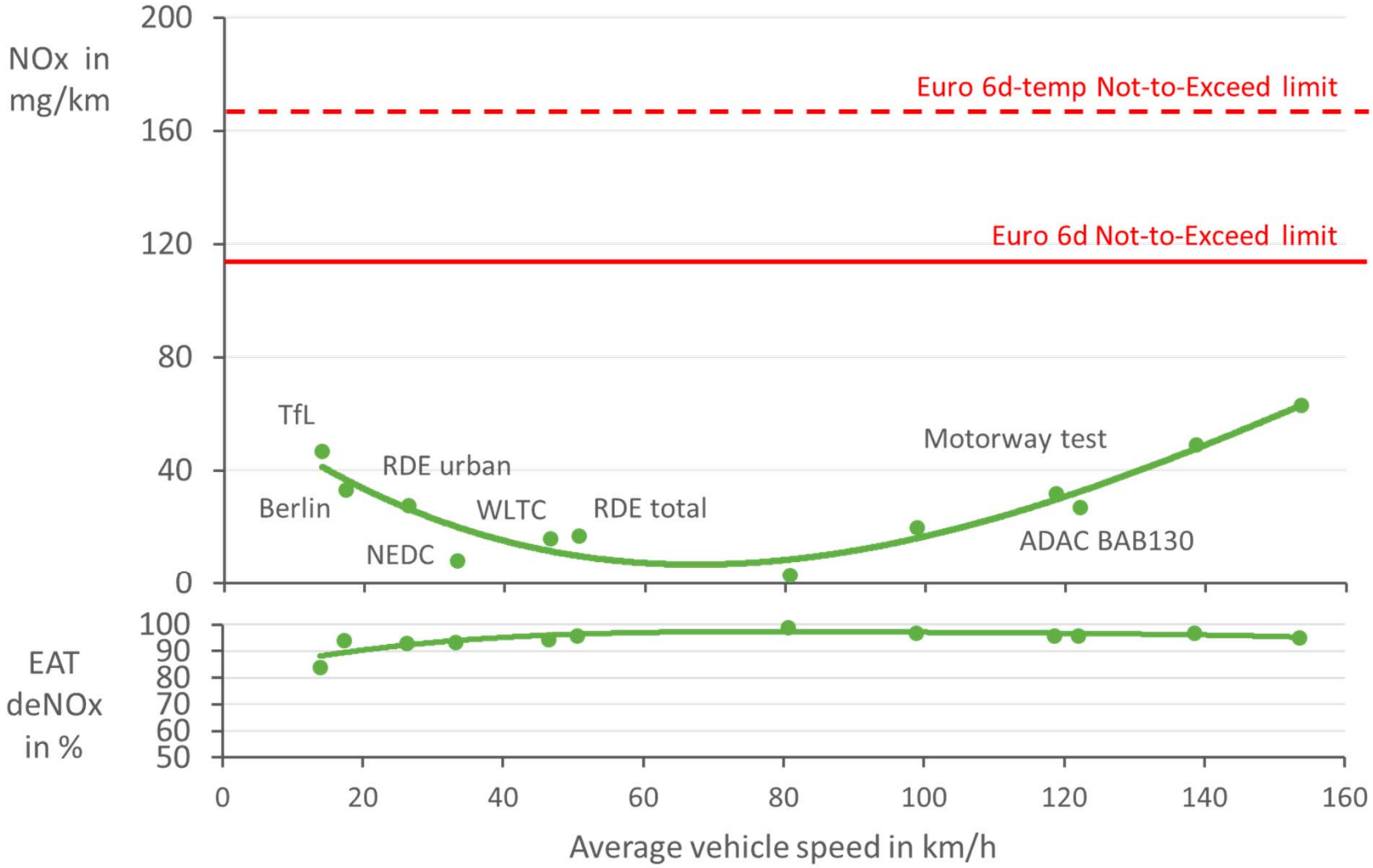
Emissions control technologies and system architecture

- LNT + dual-SCR to cover wide range of driving conditions
- Model-based SCR control



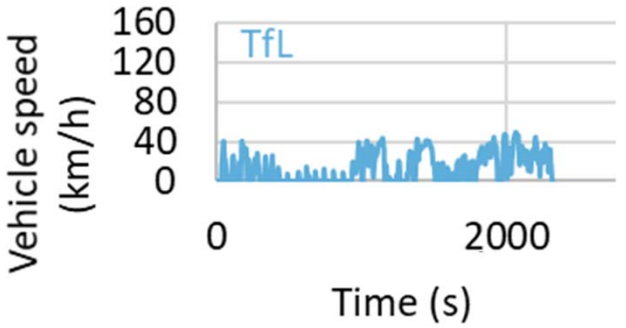
EGR: Exhaust Gas Recirculation
HP/LP: High/Low pressure
cc: close-coupled
LNT: Lean NOx trap
SCR: Selective Catalytic Reduction
DPF: Diesel Particulate Filter
SDPF: SCR on DPF
uf: underfloor
ASC: Ammonia Slip Catalyst

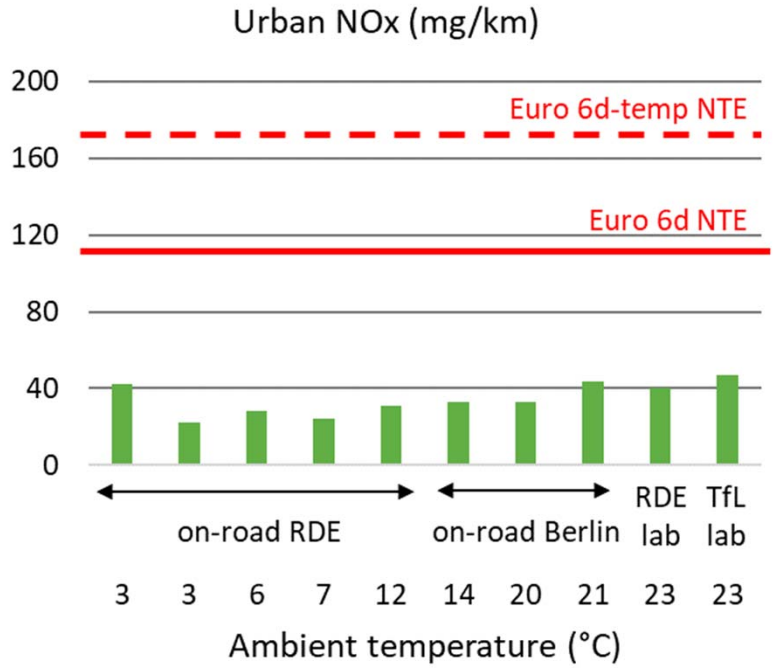
Robust NOx control across wide range of driving conditions

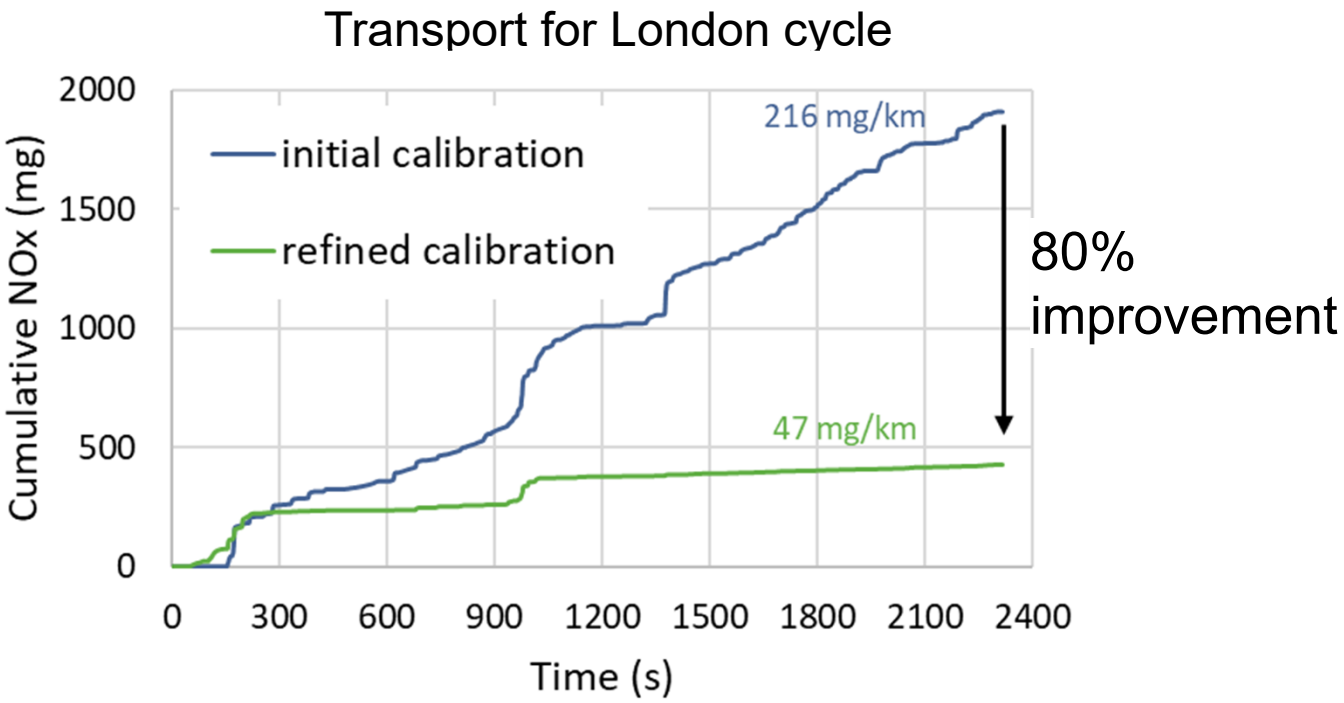


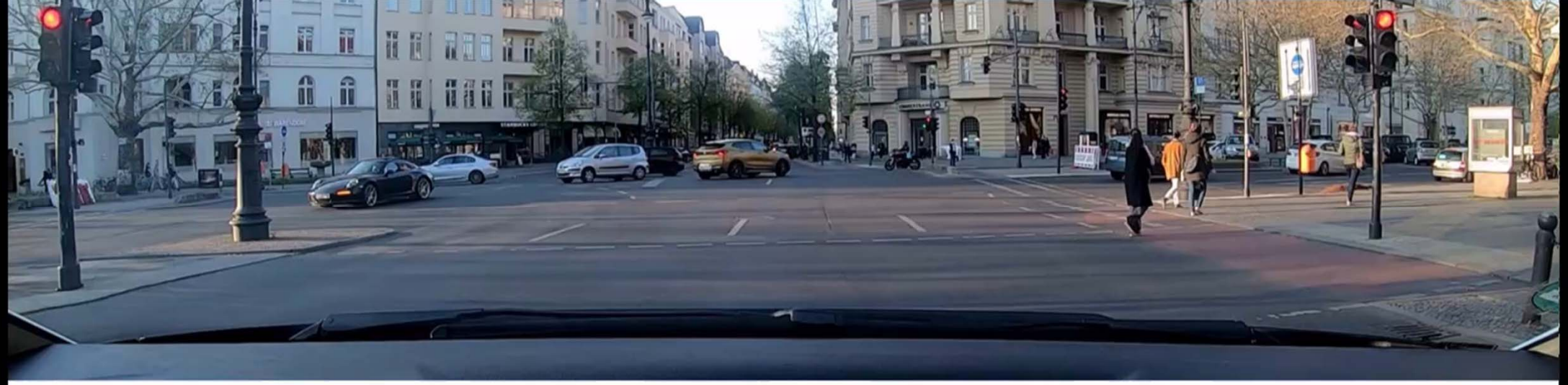
Robust NOx control in the city

- Consistent low NOx achieved, including on challenging Berlin and Transport for London (TfL) tests
- 80% improvement due to refined calibration
  - LNT regeneration stabilisation
  - Active thermal management









Engine load: 11 % Vehicle speed: 0 km/h

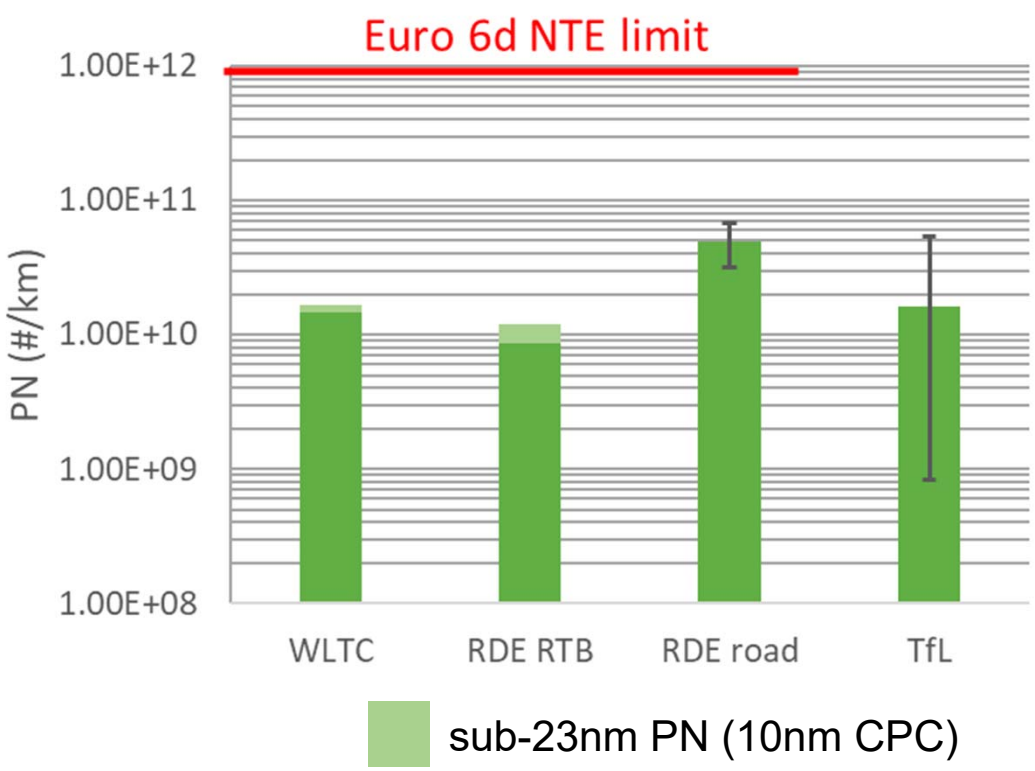
NOx	Temp	NOx	Temp	NOx	Temp	NOx
500 / 0	500 / 0	500 / 0	500 / 0	500 / 0	500 / 0	500 / 0
35 ppm	252 °C	1 ppm	275 °C	0 ppm	221 °C	0 ppm

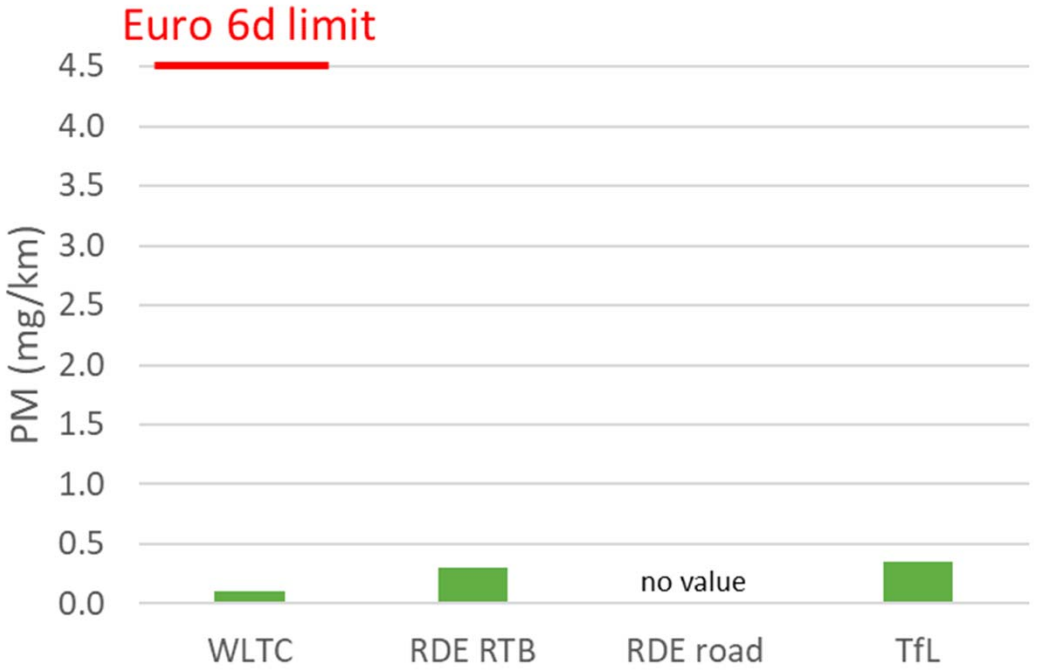
Engine heat-up

LNT regeneration

https://youtu.be/uvmR56L9uT4

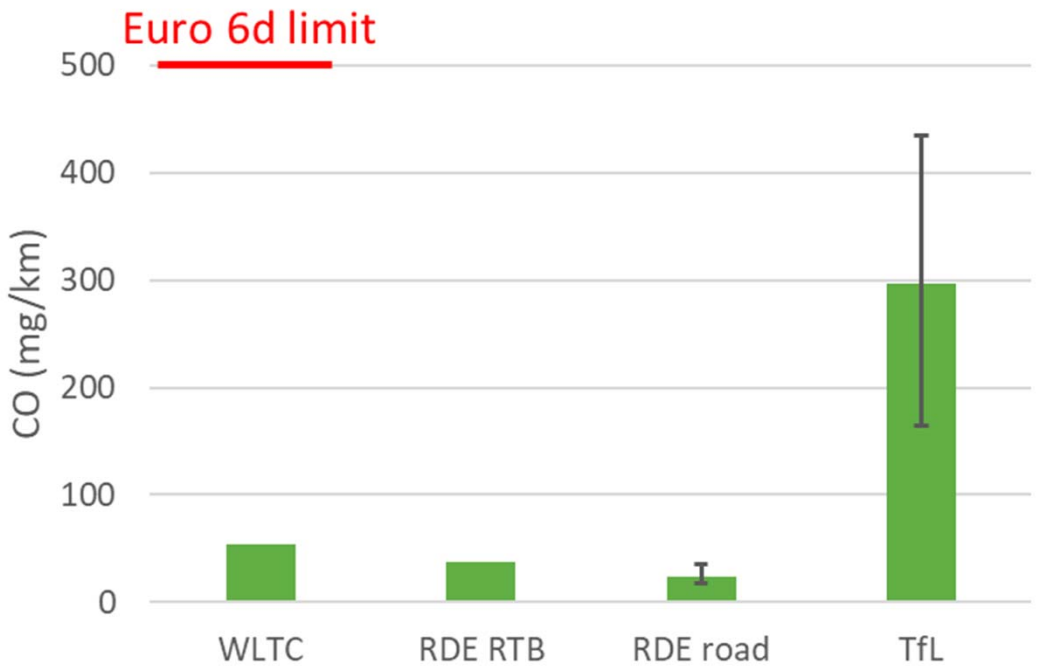
Particulate emissions controlled by SDPF under all driving conditions

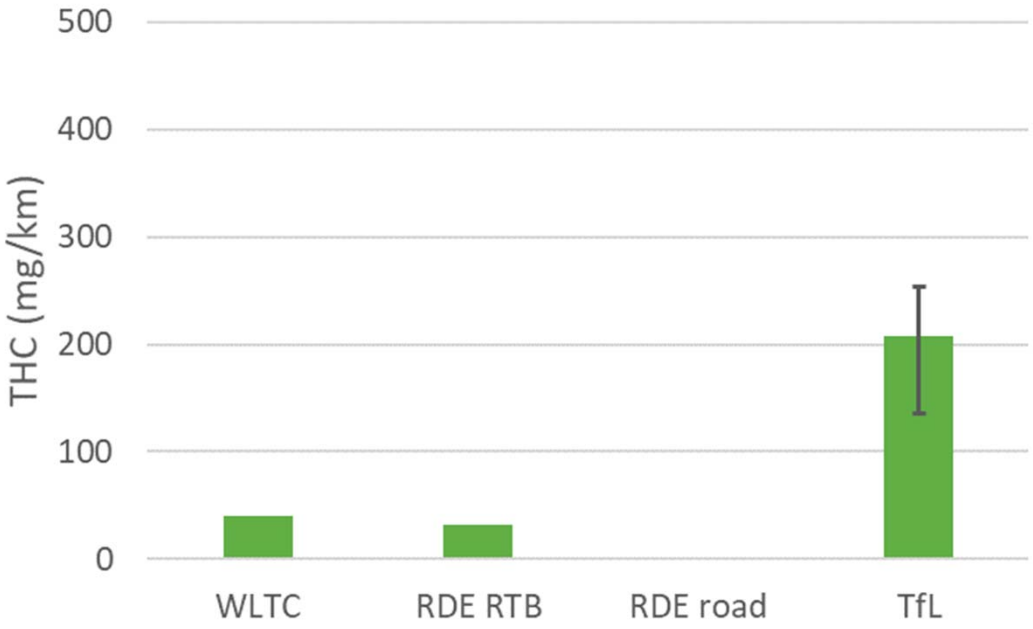




THC & CO emission well within standards on WLTC and RDE

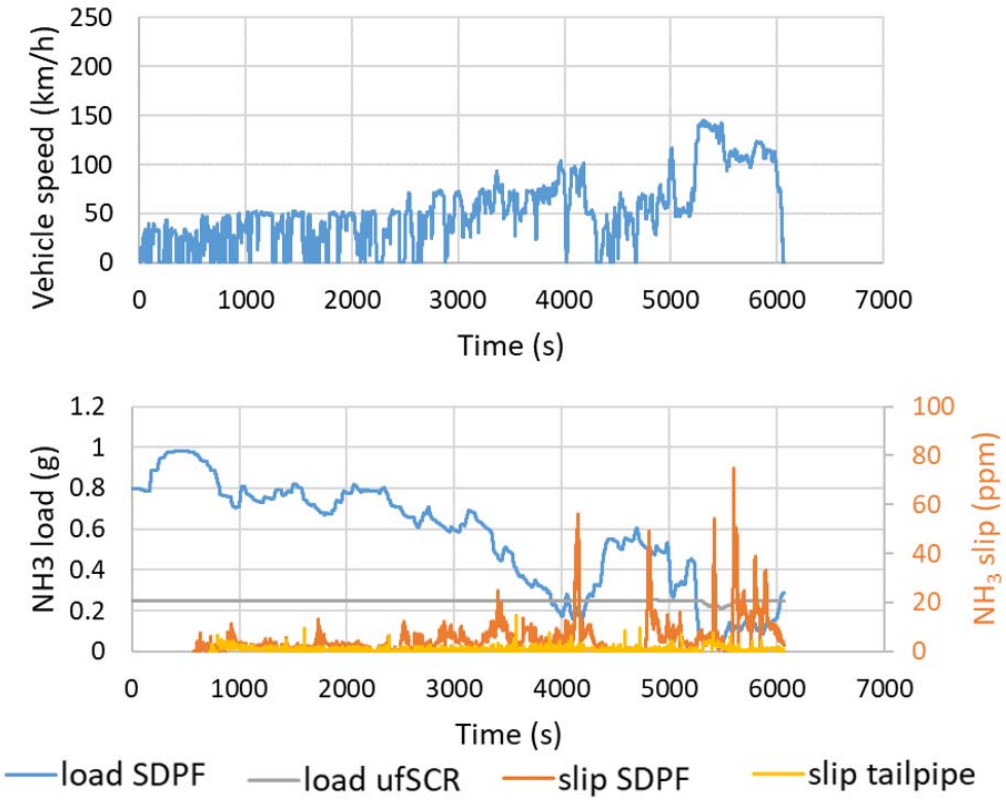
- Remain below 50 mg/km on WLTC and RDE
- Increase on TfL due to impact of thermal management (optimisation was outside programme scope)





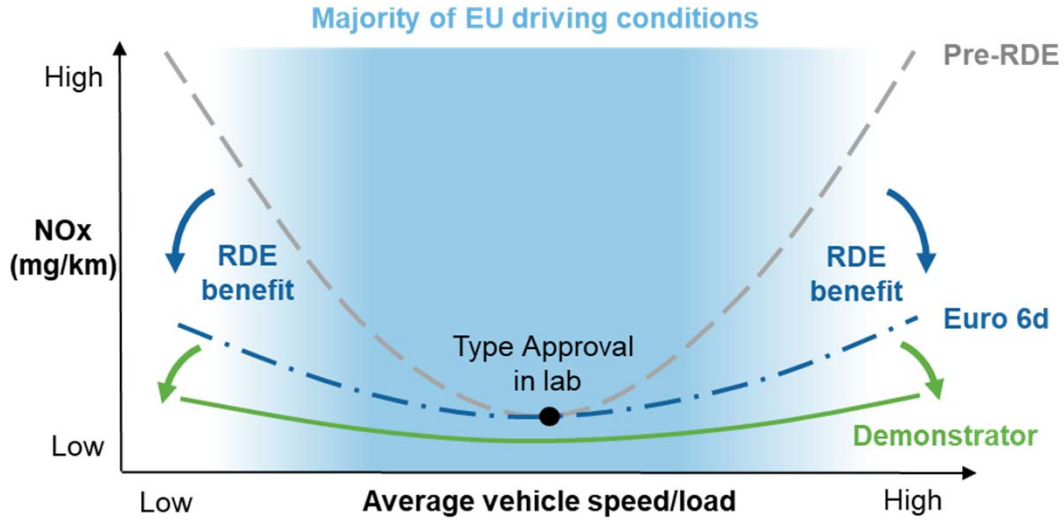
Tailpipe NH_3 slip controlled below 10 ppm on RDE

- NH_3 slip control implemented
  - Model-based calculation of NH_3 load
  - Benefit of dual-SCR with twin-urea injection
    - Separate control of NH_3 load for each SCR
    - Presence of underfloor SCR allows higher target NH_3 load for cc SCR+SDPF
  - Ammonia slip catalyst converts remaining NH_3
- Illustration for RDE test
  - Higher target NH_3 load for SDPF compared to underfloor SCR
  - NH_3 slip from SDPF is used on underfloor SCR



Conclusions

- RDE requirements have ensured better control of NOx emissions under real-world driving conditions
- This demo car shows that diesel NOx emissions can be kept at a very low level in a consistent way, over a wide range of driving conditions.
- This is achieved by combining existing catalyst technologies with improved emissions control functions supported by hybrid technology.



Thank you

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