Low NOx emissions with modern diesel cars

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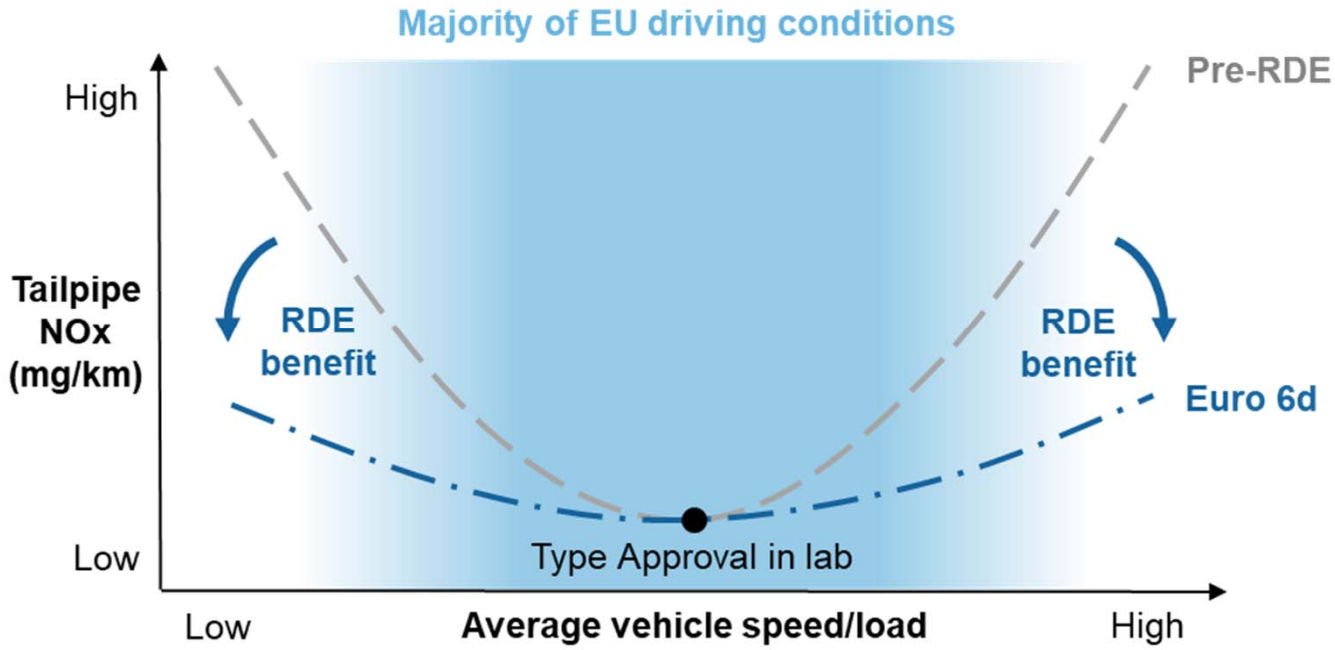
AECC
ASSOCIATION FOR EMISSIONS CONTROL BY CATALYST

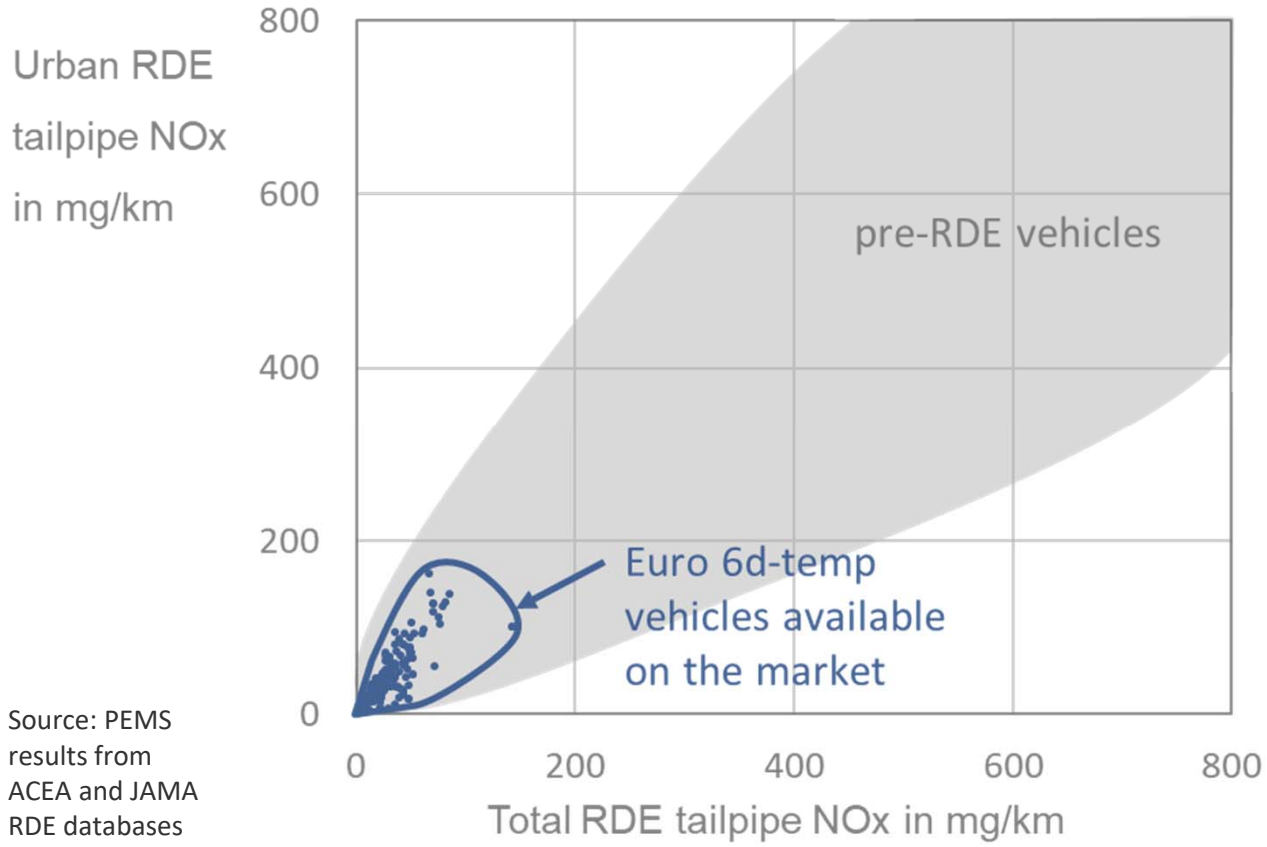
RDE legislation has improved real-world NOx emissions

- RDE entered into force on 1 September 2017 with Euro 6d-temp type-approval
- RDE requirements ensure that emissions are controlled over wider range of driving conditions



RDE legislation has improved real-world NOx emissions

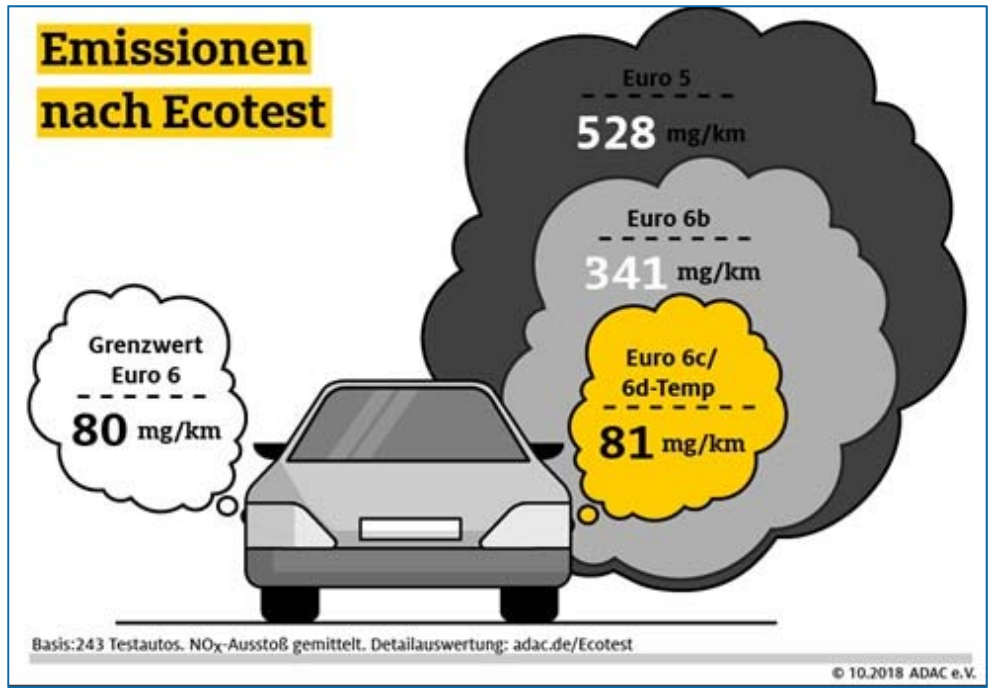
- On-road emissions of Euro 6d-Temp diesel vehicles are well within standards



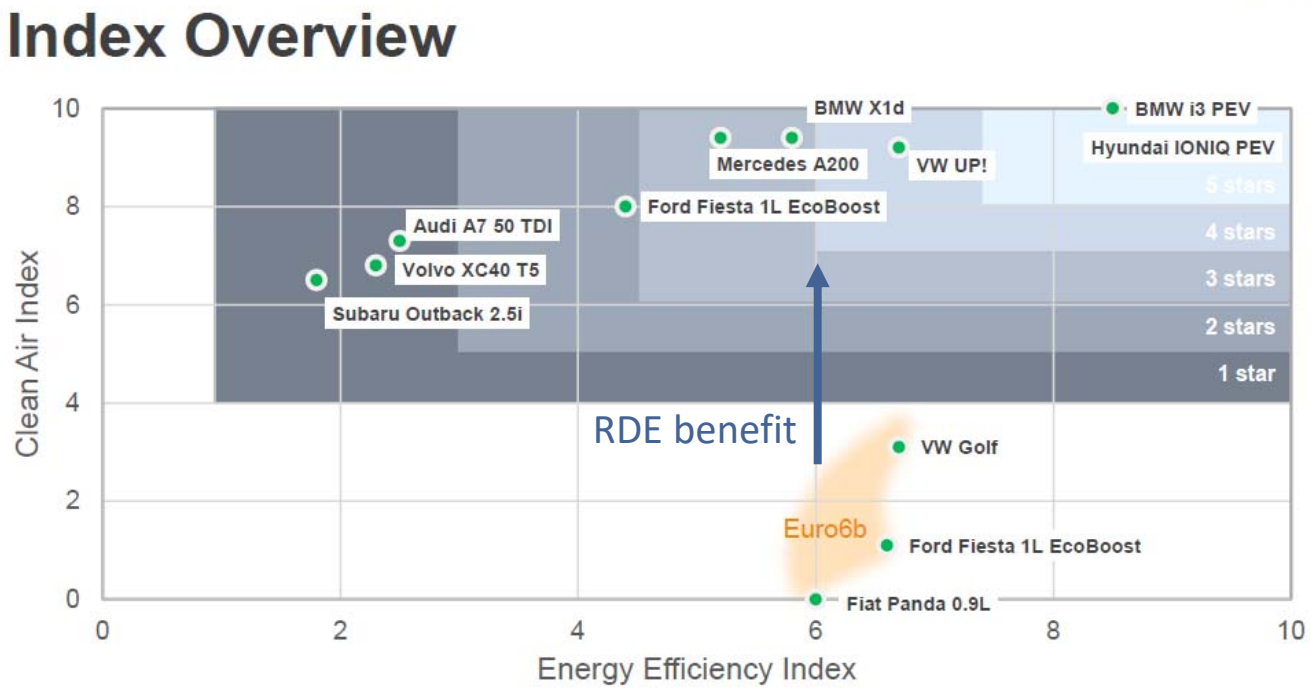
Source: PEMS results from ACEA and JAMA RDE databases

RDE legislation has improved real-world NOx emissions

- Reduction confirmed by independent testing



Source: ADAC Ecotest

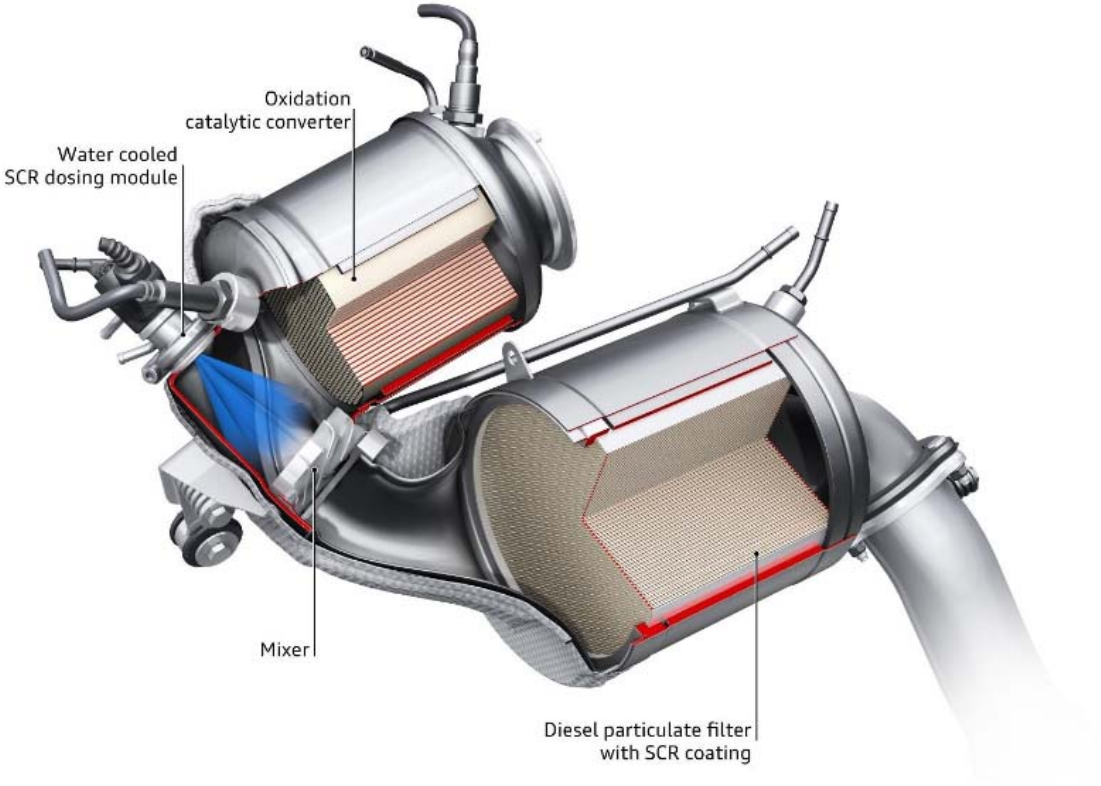


Source: Green NCAP

Light-duty diesel emissions control technology evolution

Towards combination of technologies in a compact design for RDE compliance

Source: Hyundai – Vienna Motor Symposium 2019



Source: Audi – Vienna Motor Symposium 2019

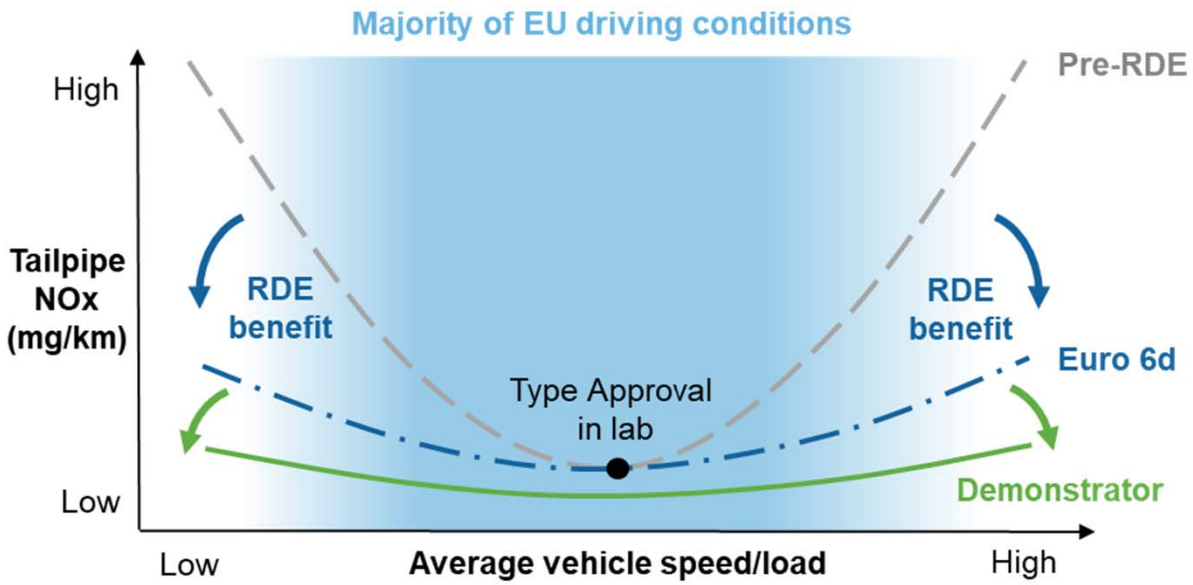
AECC-IPA-IAV ultra-low NOx emissions diesel demonstrator

- Objective: demonstrate consistent low NOx emissions

- Low speed/load
  e.g. city driving

- High speed/load
  e.g. motorway driving

- Transients



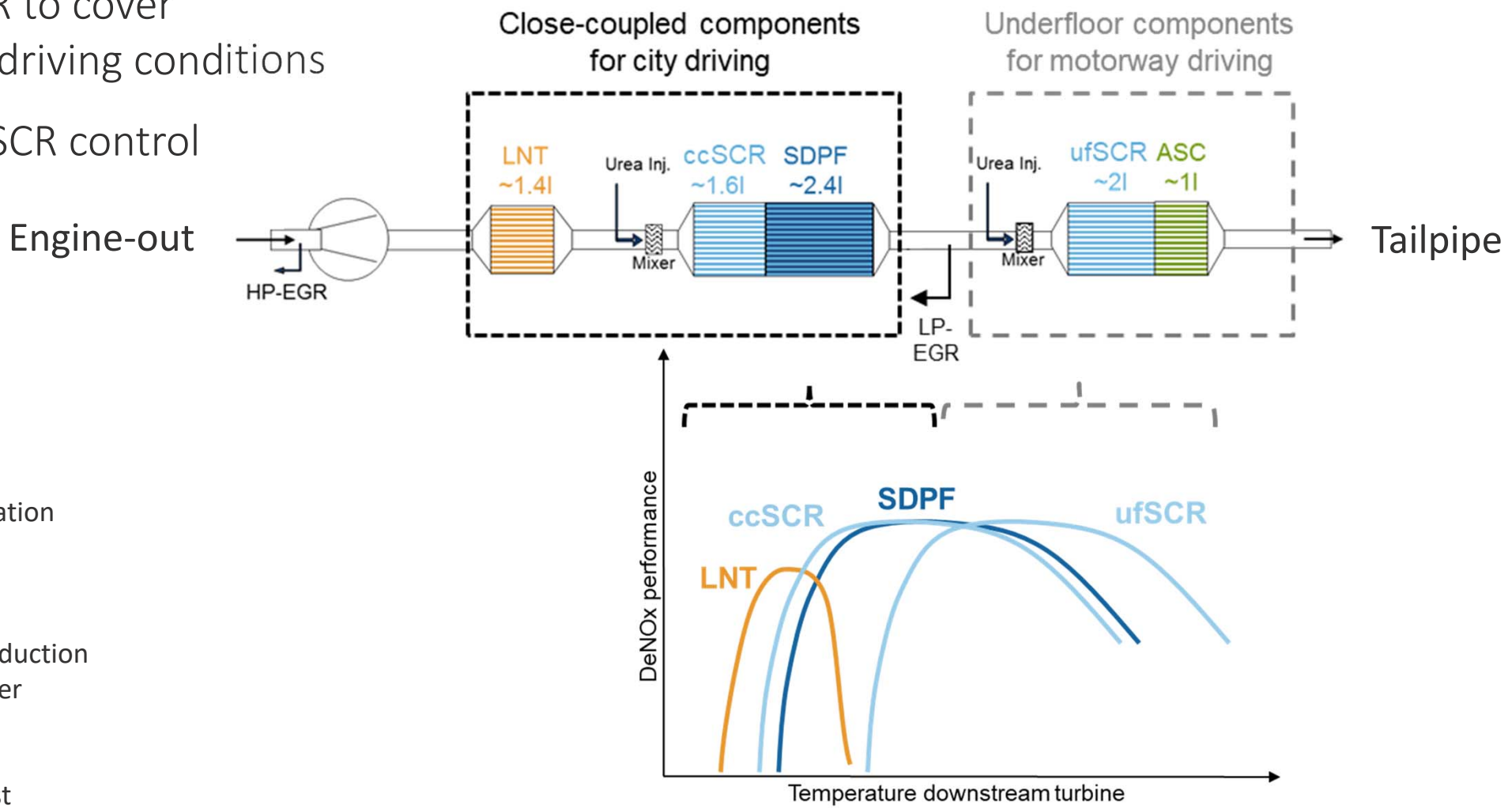
More details: *J. Demuynck, et al.; "Integrated Diesel System Achieving Ultra-Low Urban and Motorway NOx Emissions on the Road", 40th International Vienna Motor Symposium, 15-17 May 2019*

Vehicle and powertrain characteristics

- Vehicle
  - C-segment
  - 1700 kg
- Drivetrain
  - Manual gearbox, 6-speed
  - 48 Volt mild-hybrid
- Engine
  - 1.5l, 4-cylinder, 2-valve
  - Exhaust Gas Recirculation (EGR)
- Euro 6b type-approval (LNT + DPF)

Emissions control technologies

- 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

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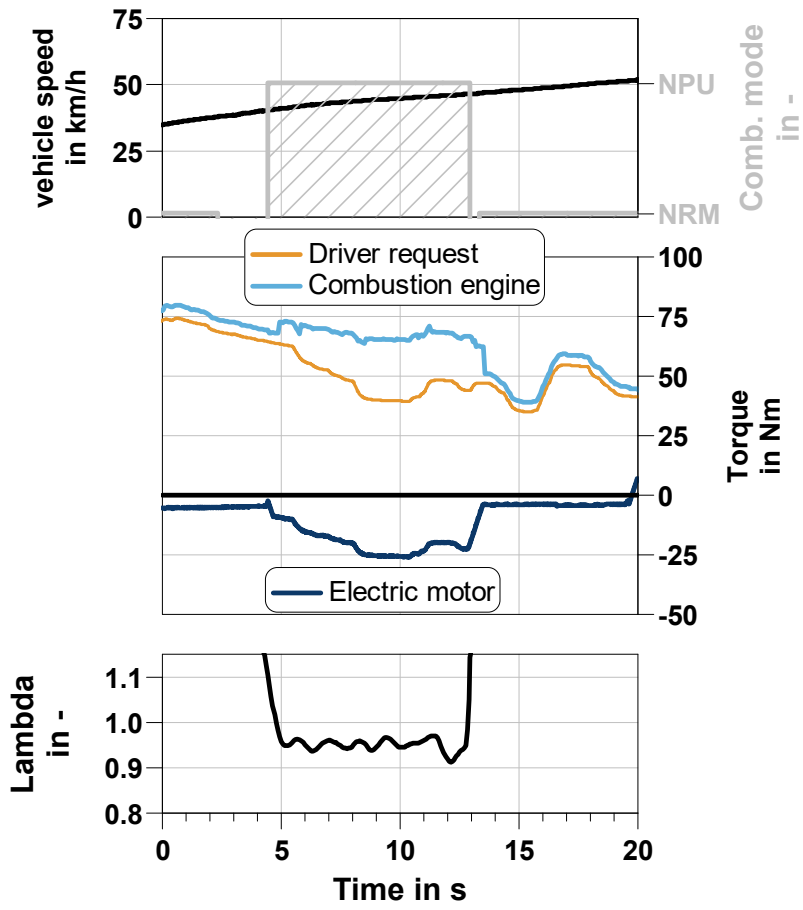
48V mild-hybrid support to emissions control

- To stabilise LNT regeneration during city driving
  - e.g. transient load compensation in case of unstable driver request



- To cut transient engine-out NOx peaks
- To support active thermal management
  - In addition to late post-injection in ICE when LNT>170°C & ccSCR<220°C
  - Throttle valve used when LNT<170°C

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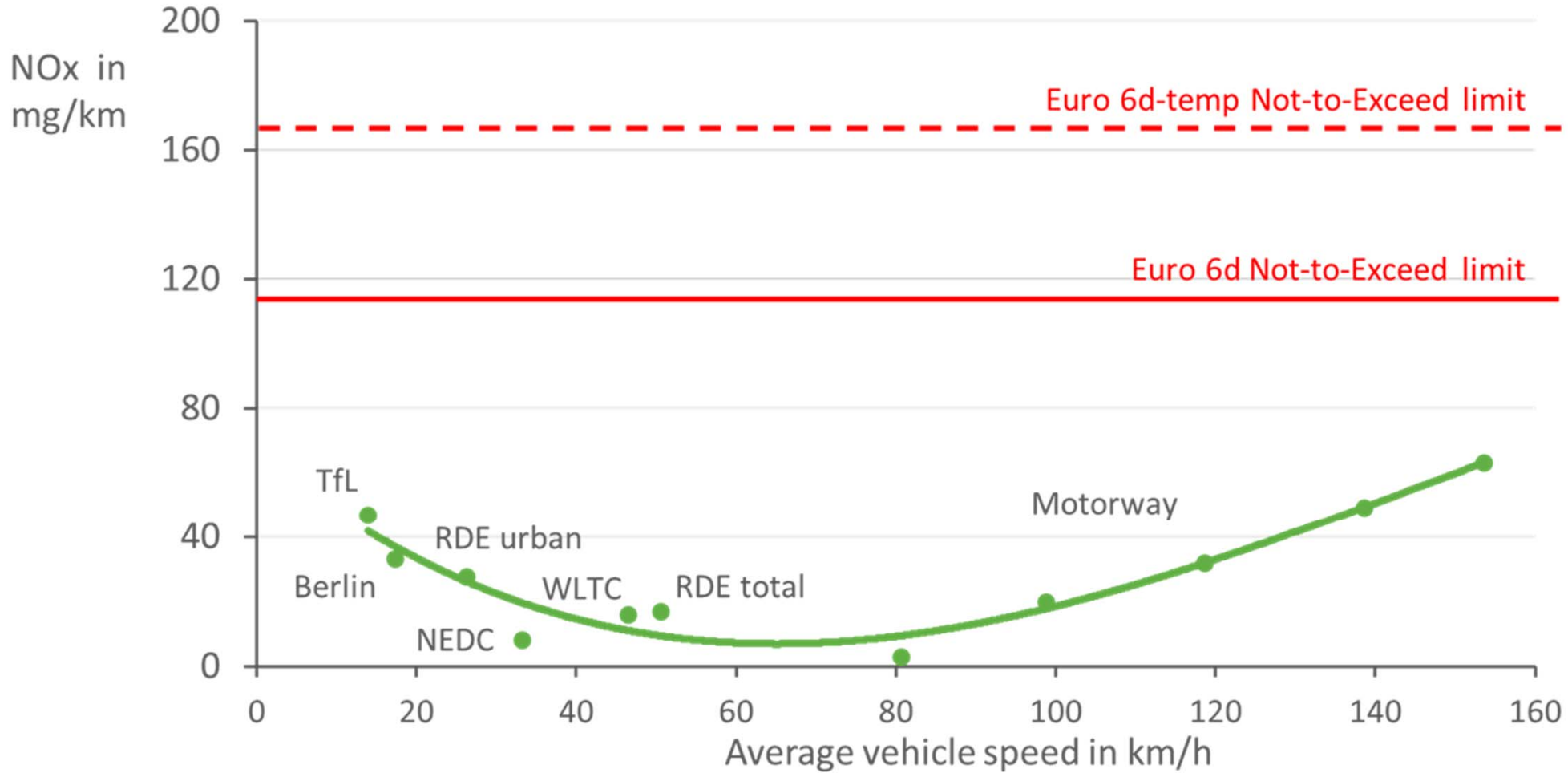
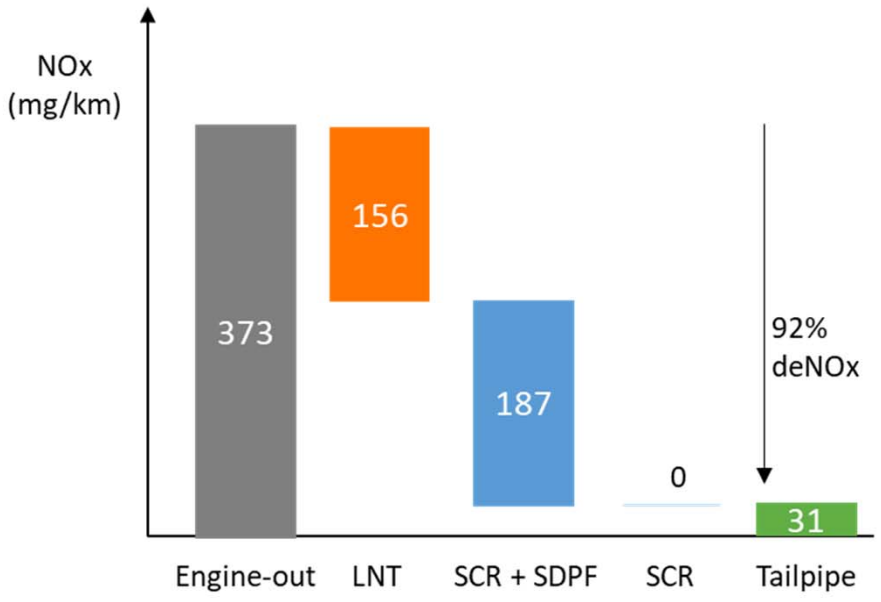
Consistent low NOx emissions were achieved



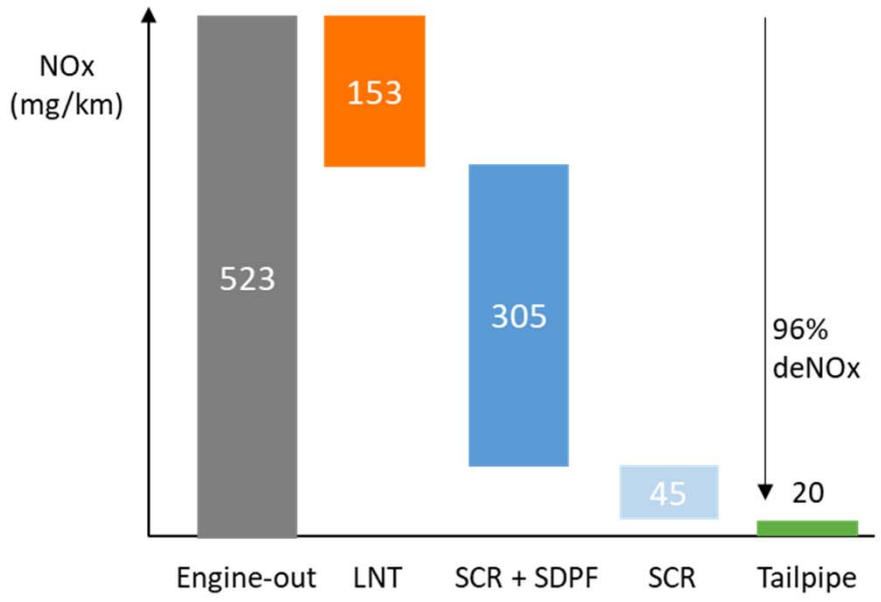
All aftertreatment components contribute to NOx control

- City driving: LNT and close coupled SCR+SDPF
- Motorway driving: underfloor SCR required to secure robust emissions control

City driving

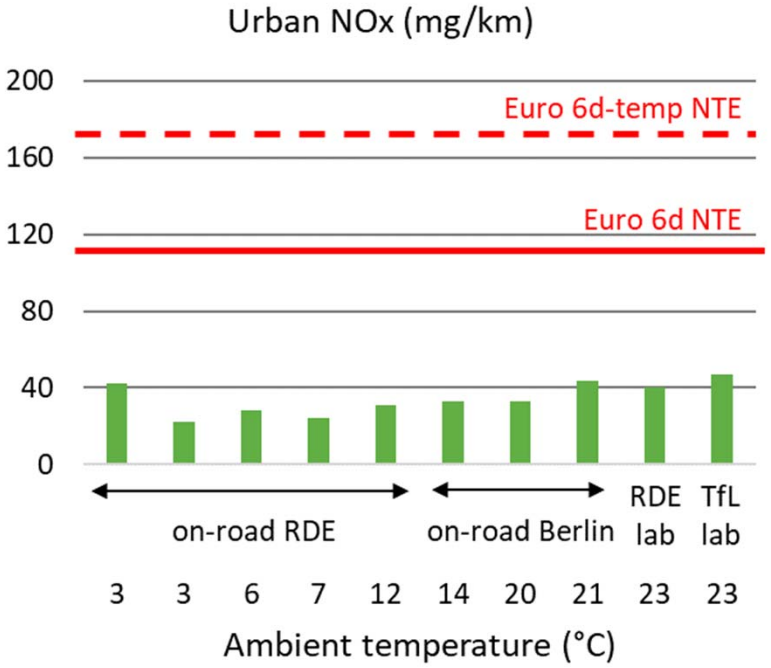


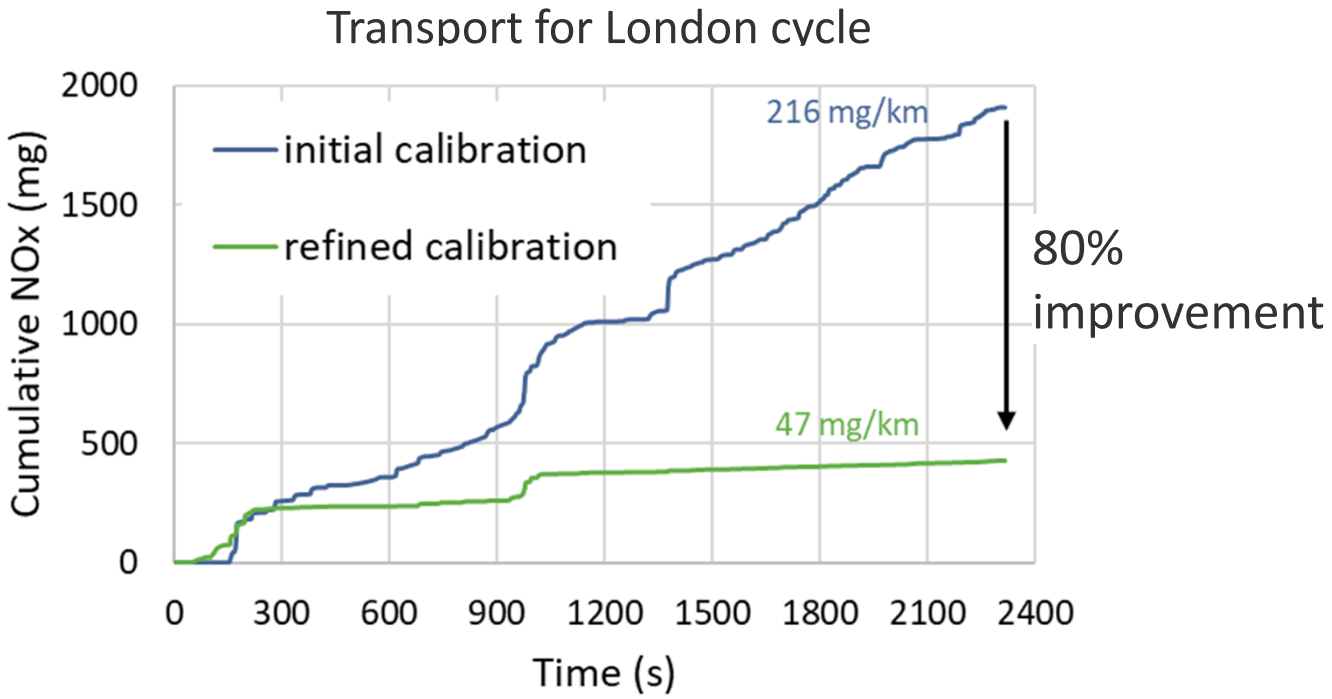
Motorway driving

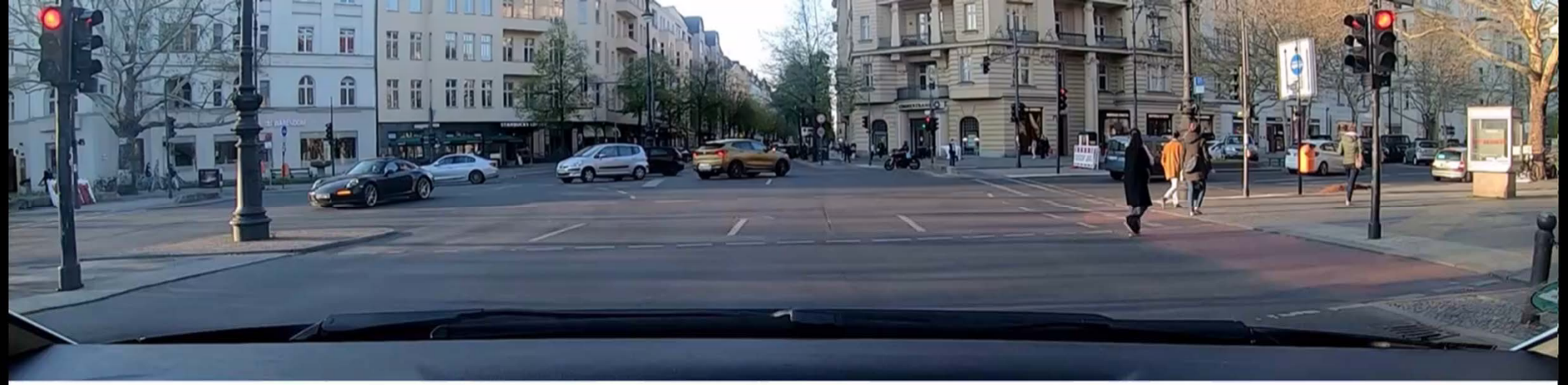


24-47 mg/km NOx in the city

- Including challenging Berlin and Transport for London (TfL) tests
- TfL NOx: 80% improvement due to LNT regeneration stabilisation and active thermal management
- Impact of calibration measures on CO_2 was below 3% on WLTC and RDE







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

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

Engine heat-up

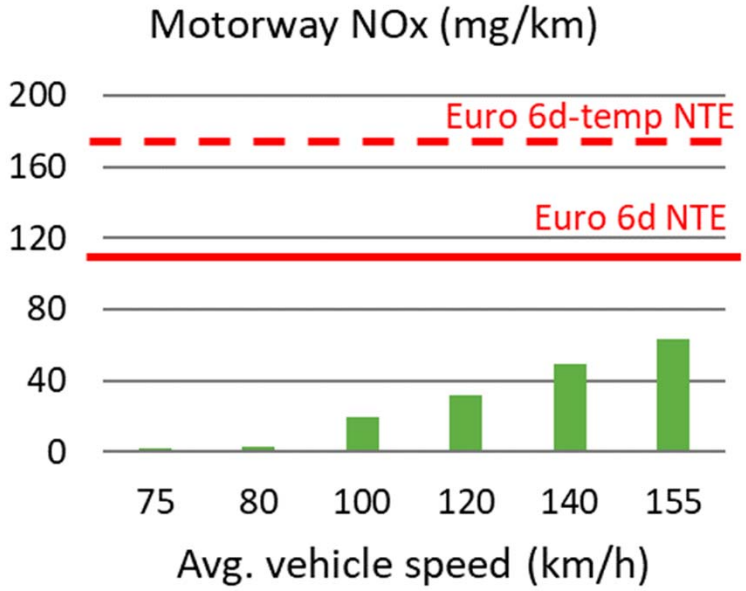
LNT regeneration

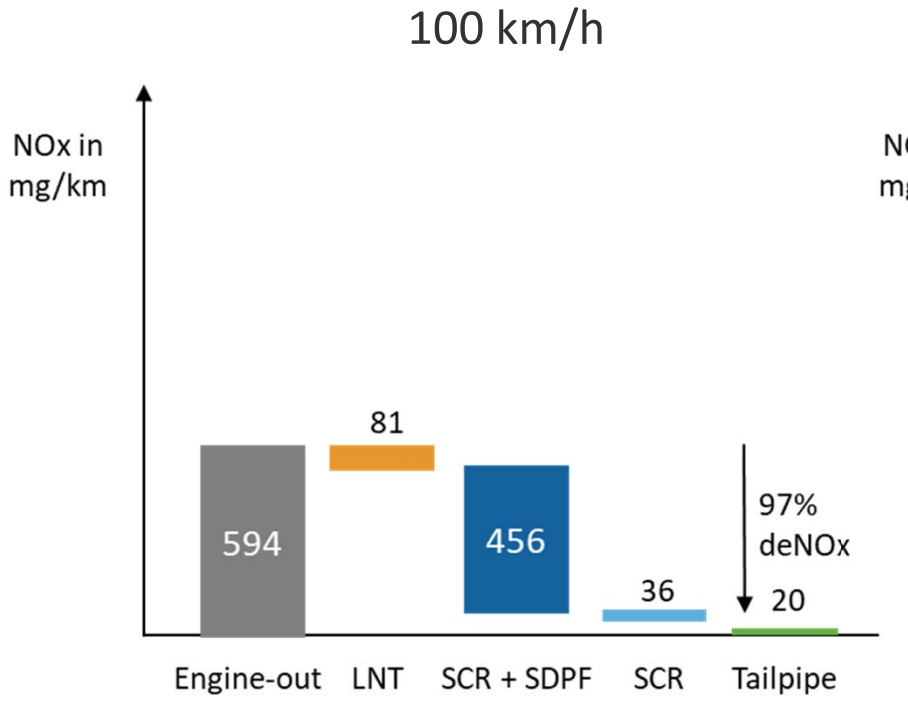
Urea doser 1

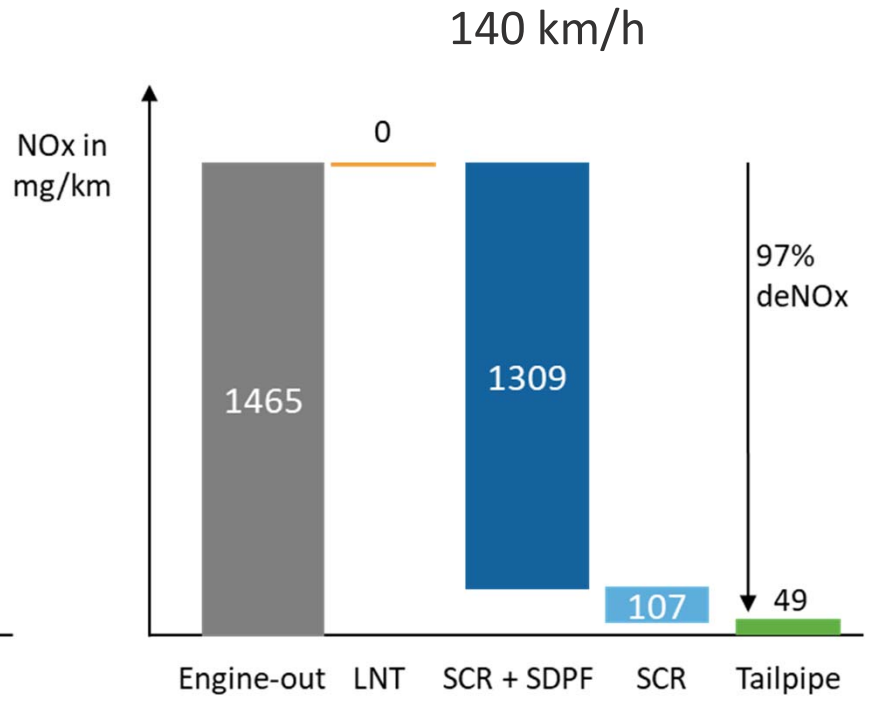
Urea doser 2

3-63 mg/km on the motorway

- 95-99% deNOx efficiency
- Main deNOx by dual-SCR
- Challenge is increase in engine-out emissions







Engine load: 67 % Vehicle speed: 118 km/h

	NOx	Temp
	442 ppm	393 °C
	96 ppm	368 °C
	5 ppm	321 °C
	0 ppm	

Engine heat-up

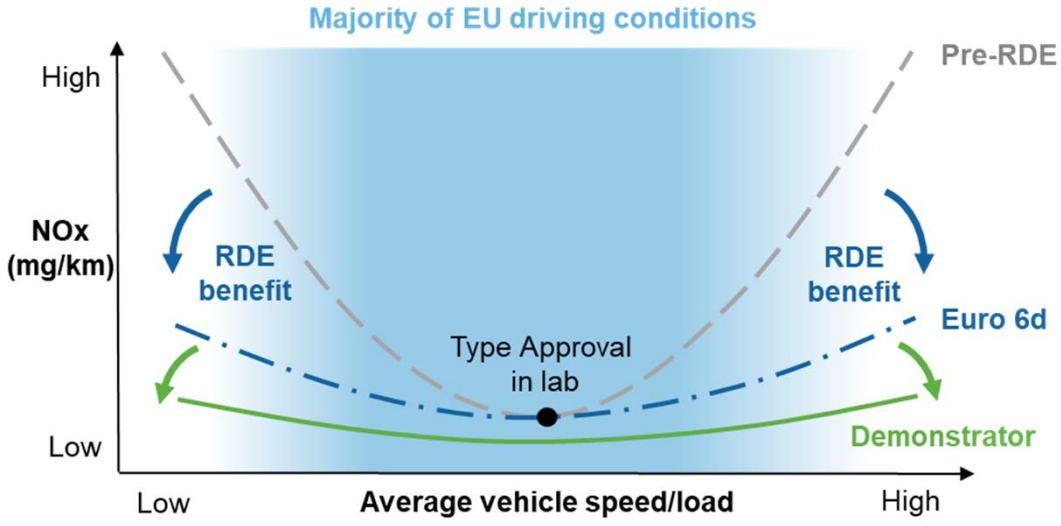
LNT regeneration

Urea doser 1

Urea doser 2

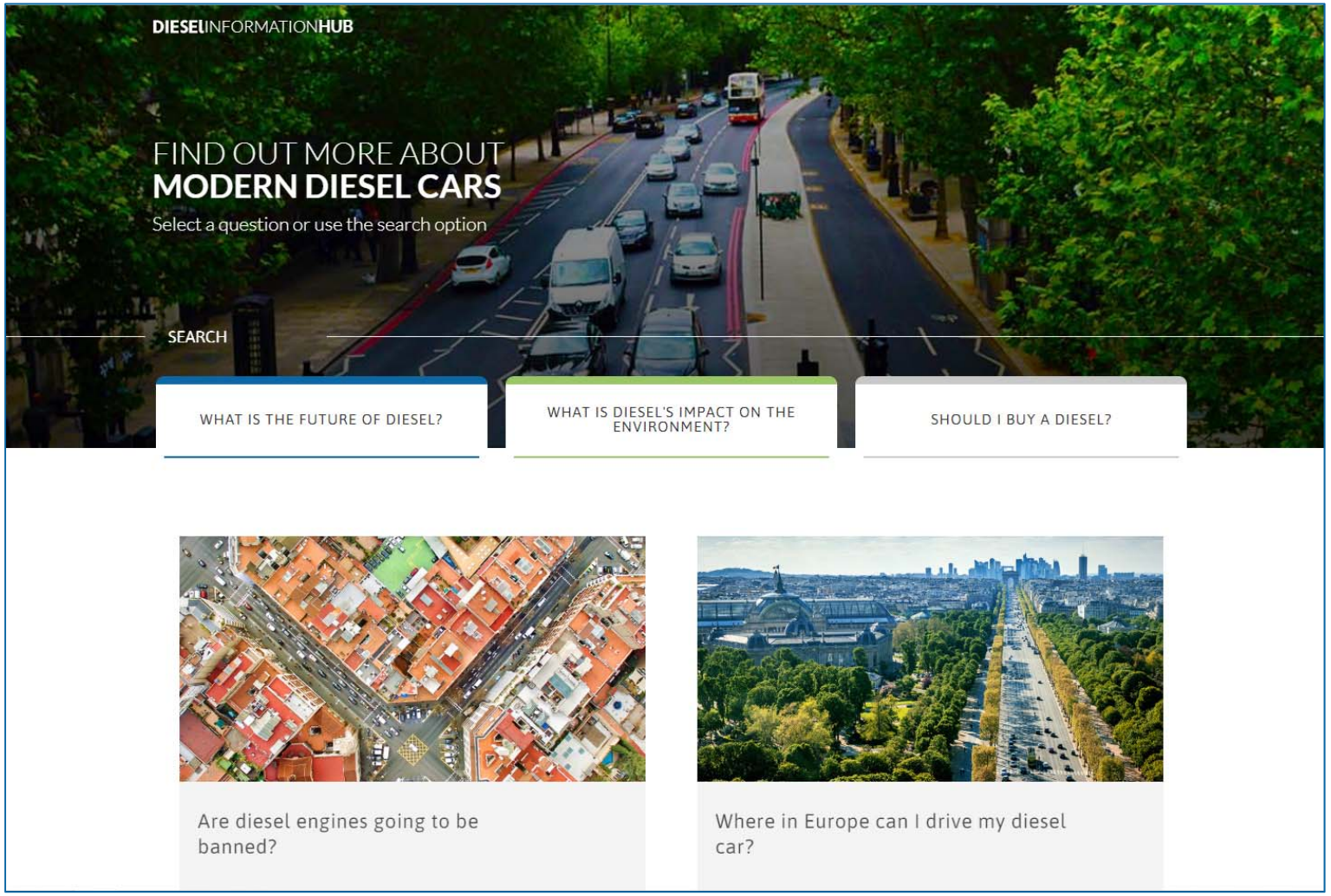
Conclusions

- RDE requirements have ensured better control of NOx emissions under most EU driving conditions – these Euro 6d-temp cars are on the road today.
- Independent testing confirms low emissions of RDE compliant vehicles.
- AECC-IPA-IAV demonstrator 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.



Diesel Information Hub

https://dieselinformation.aecc.eu (now available in EN, FR, ES, IT; DE expected)



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