Light-duty Euro 7 update and AECC demonstration programmes

Int. Symposium of Low Emissions and Fuel Efficient Technologies to Meet China 7 Requirements • 27 March 2024 • Chengdu

AECC represents European Emissions Control Companies

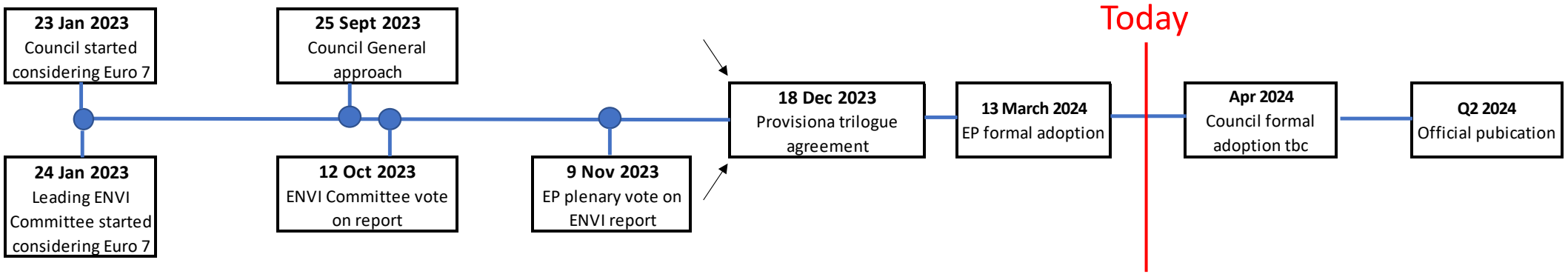
- Exhaust emissions control technologies for original equipment, retrofit and aftermarket for all new cars, commercial vehicles, motorcycles, and non-road mobile machinery
  - AECC is listed in EU Transparency Register (# 78711786419-61) and has consultative status with the UN Economic and Social Council (ECOSOC)

Agenda

- Light-duty Euro 7 update
- AECC light-duty gasoline and diesel demonstration programmes
  - Criteria pollutants with state-of-the-art emission control systems
  - GHG emissions with sustainable renewable fuels
  - Conclusions
- Outlook
  - LD CO_2 review and CO_2 neutral fuels
  - Life Cycle Assessment

Overview of ongoing Euro 7 process

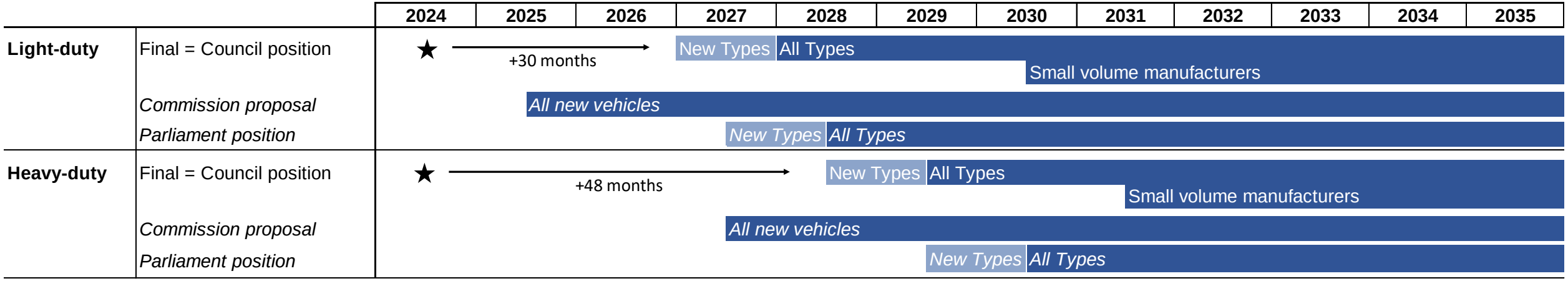
- Euro 7 proposal is in ordinary legislative procedure by EU Council and European Parliament
  - Provisional trilogue agreement reached on 18 December 2023 (Council and EP press release)
  - Final draft text is available on the Council website here
  - Formal adoption ongoing before EU elections (June 2024)



- Implementing legislation development by European Commission reconvened in Q1/2024
  - Drafting by European Commission DG GROW and DG JRC
  - Consulting stakeholders in AGVES (Advisory Group on Vehicle Emissions Standards) meetings
  - Little development needed for exhaust because Euro 6/VI test procedures are nearly kept

Euro 7 implementation timeline

- Reference to entry into force of main act
- Entry into force is 20 days following publication in Official Journal



* Assuming entry into force in July 2024

** Implementation timing for new systems, components or separate technical units is same as New Types

Euro 7 for light-duty vehicles

- Limit values kept from Euro 6e
  - Not fuel-neutral
  - Higher limits kept for LCVs (N1 class II and III)
- Changes for Particulate Number
  - PN10 measurement procedure instead of PN23
  - PN10 limits apply to all vehicles, footnote for direct injection gasoline is deleted
- Test procedures kept from Euro 6e
  - Reference to UN Regulation no. 168, includes the PEMS error margins for NOx and PN in Annex 11
- Durability is extended
  - Main lifetime up to 160 000 km or 8 years
  - Additional lifetime up to 200 000 km or 10 years
    - With 1.2 durability multiplier for gaseous pollutant emissions

Table A11/2

Pollutant	*Mass of oxides of nitrogen (NO_X)*	*Number of particles (PN)*	*Mass of carbon monoxide (CO)*	*Mass of total hydrocarbons (THC)*	*Combined mass of total hydrocarbons and oxides of nitrogen (THC + NO_X)*
$Margin_{pollutant}$	0.10	0.34	*Not yet specified*	*Not yet specified*	*Not yet specified*

Reflection on Euro 7 discussion for light-duty vehicles

- Influenced by CO_2 emissions standards
  - Setting -100% tailpipe target by 2035
  - But even then, ICE will be on the road until 2050
  - All powertrains to fulfill future air quality requirements
- Too much focus on worst case conditions
  - Due to wording ‘any’ for test conditions in Euro 7 proposal
- AECC fact sheet on myths and truths

  https://www.aecc.eu/wp-content/uploads/2023/09/2023-08-31-AECC-Factsheet.pdf

Myths and truths about
Euro 7 pollutants limits for new vehicles in the EU

Every new vehicle sold in the next decades should play its part in reducing air pollution. The robust Euro 7 rules proposed by the European Commission put EU citizens’ health first and will keep the automotive sector competitive globally.

Euro 7 is ~~un~~necessary

All EU citizens will benefit: an upgrade to Euro 7 reduces health risks caused by vehicle traffic. Each € invested in Euro 7 results in a reduction of 5€ on healthcare and environment costs.

Keeping Euro 6/VI is not sufficient.
20% of distance driven in Europe is outside current test boundaries. Wider Euro 7 test methods will better capture emissions resulting from driving in different conditions.

Euro 7 will ~~not~~ make Europe competitive

China and the United States are moving ahead with more stringent standards than Euro 6/VI. Europe cannot stay behind if it wants to remain competitive.

Investing in Euro 7 comes at incremental cost of 0.6-5.7 billion euro compared to the 59 billion euro each manufacturer is expected to invest in electrification, connectivity and automation by 2050.

Euro 7 limits are ~~not~~ feasible

The necessary emission control technology is already available and has been tested successfully with vehicles on the road.

Fitting the latest emission control technology can reduce truck NOx emissions by 75-96% compared to Euro VI-C and NOx from a gasoline car by 40-64% from Euro 6d.
Vehicle manufacturers are already developing new vehicles with more stringent limits than Euro 6/VI in mind.

Euro 7 is ~~not~~ affordable

Cars and trucks will remain affordable as equipping them with new emission control technologies comes at a very small proportion of the cost of a new vehicle.

Studies on the impact of Euro 7 estimate the additional cost of new cars to be between 104-251€ compared to Euro 6d.
Contrary to some claims, Euro 7 vehicles will not need to comply with all possible driving situations, hence automatic gearboxes and hybridisation technologies should not be counted among the cost to adapt to the new standards.

AECC ASSOCIATION FOR EMISSIONS CONTROL BY CATALYST
IPA

www.aecc.eu www.ipa-news.com

Discover the full Euro 7 fact list and what technology can deliver.

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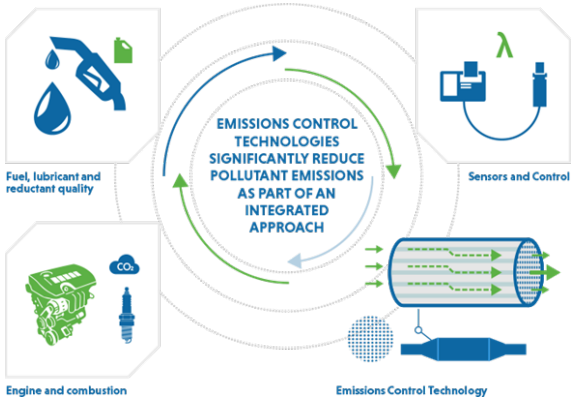
AECC demo data on criteria pollutants and GHG emissions

- Demonstrators show ultra-low pollutant emissions with emission control technologies in an integrated approach
- Tests show compatibility with drop-in sustainable renewable fuels, with substantial reduction in WtW CO_2 emissions
- Acknowledgement of external project partners

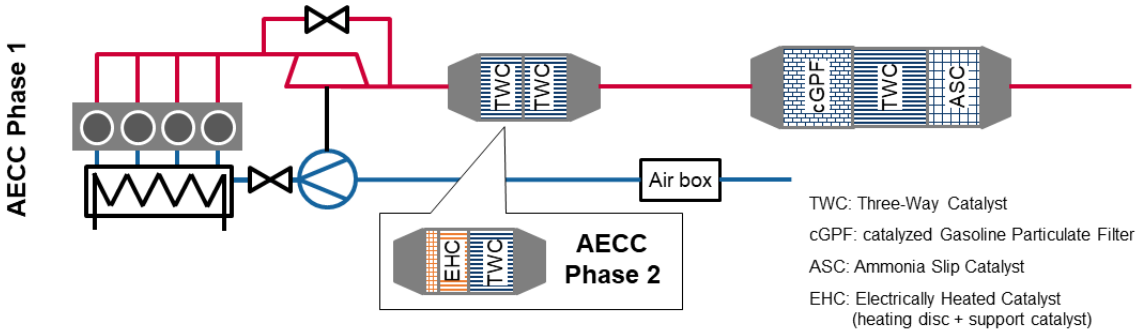


AGU Sector Group

LD gasoline demonstrator concept

- Base vehicle
  - C-segment vehicle
  - 1.5l engine with 4 cylinders
  - Variable valve train and cylinder deactivation
  - 48V mild-hybrid
  - Euro 6d type-approval baseline: cc cGPF + uf TWC

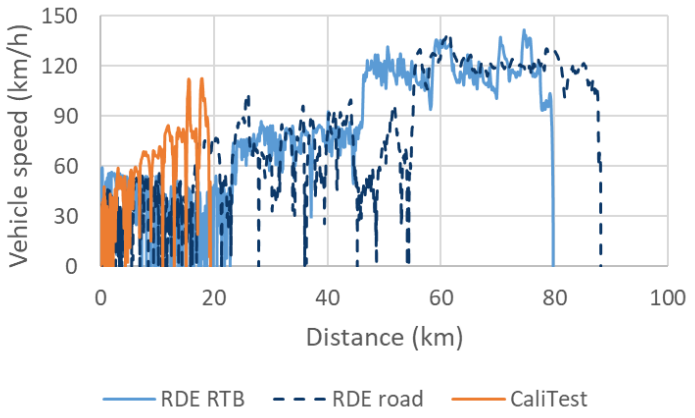
- AECC emission control system
  - Phase 1: cc TWC, uf cGPF+TWC+ASC
  - Phase 2: cc EHC|TWC, uf cGPF+TWC+ASC
  - Bench aged components targeting 160k km

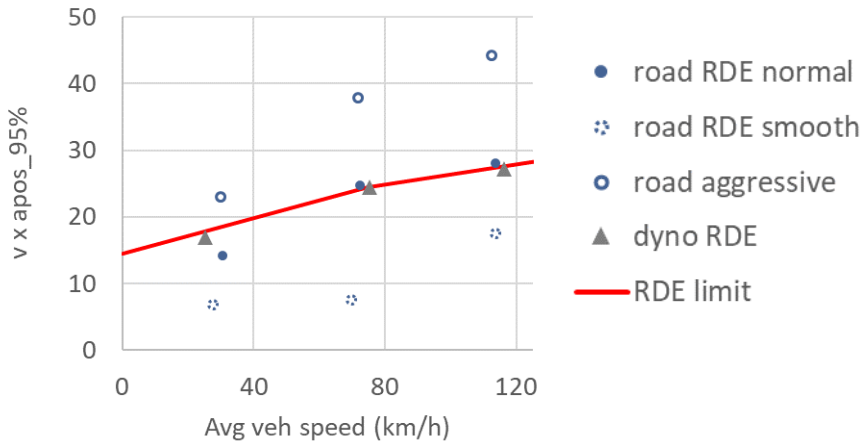


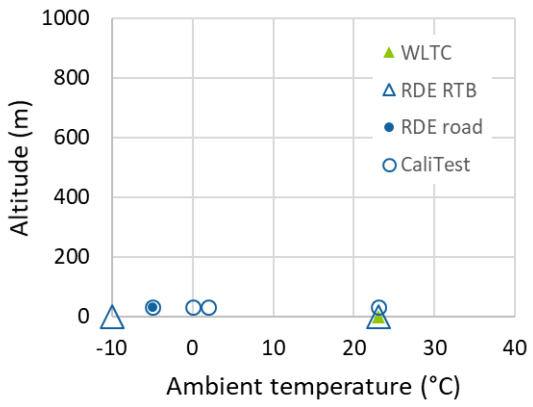
J. Demuynck, et al.; "Ultra-low Emissions of a 48V Mild-Hybrid Gasoline Vehicle with Advanced Emission Control Technologies", 15th International Conference on Engines and Vehicles, 2021
J. Demuynck, et al.; "Zero-Impact Emissions from a Gasoline Car with Advanced Emission Controls and E-Fuels" 43rd International Vienna Motor Symposium, 2022

LD gasoline demonstrator testing

- Tests conducted to characterise the emission performance
  - Road
    - RDE ~90 km
    - Calibration test (CaliTest) ~20 km
  - Chassis dyno
    - WLTC
    - RDE aggressive
- Exploring beyond Euro 6 RDE boundary conditions for
  - Ambient temperature
  - Driving style

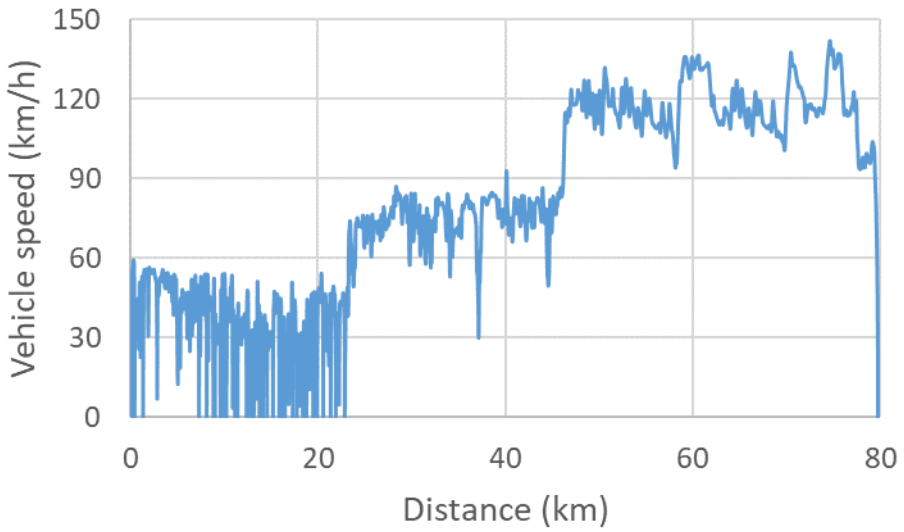


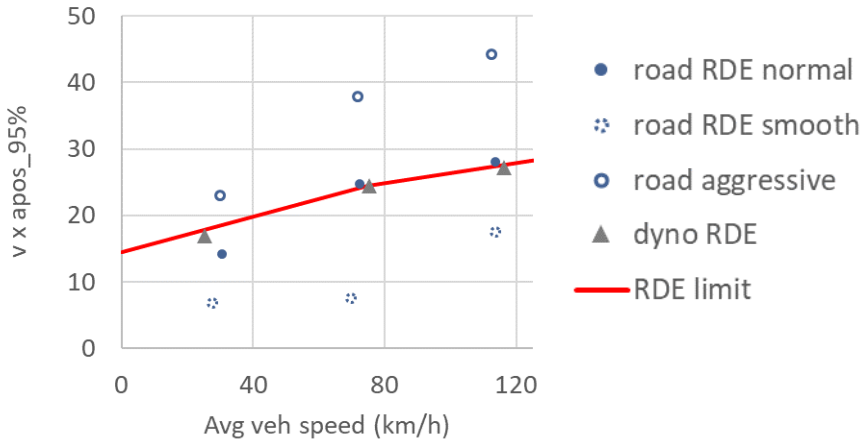




Phase 2 with ccEHC focused on RDE aggressive test

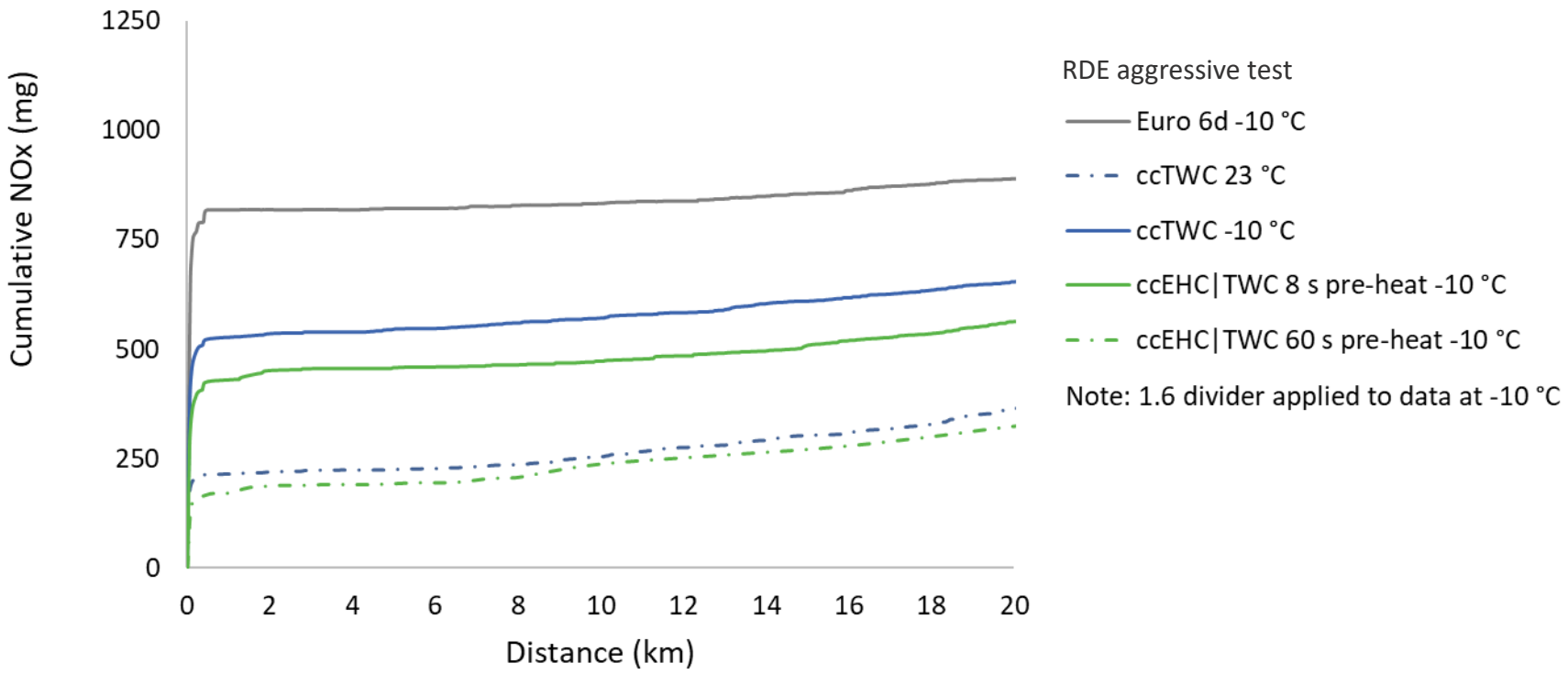
- RDE aggressive test is conducted on the chassis dyno
  - At Euro 6 RDE boundary for vxa_{pos}
  - 3s of idling between key-on and drive-off
  - First acceleration immediately to 60 km/h
  - Maximum average wheel power during first 2 kilometers after the initial cold-start is ~15%





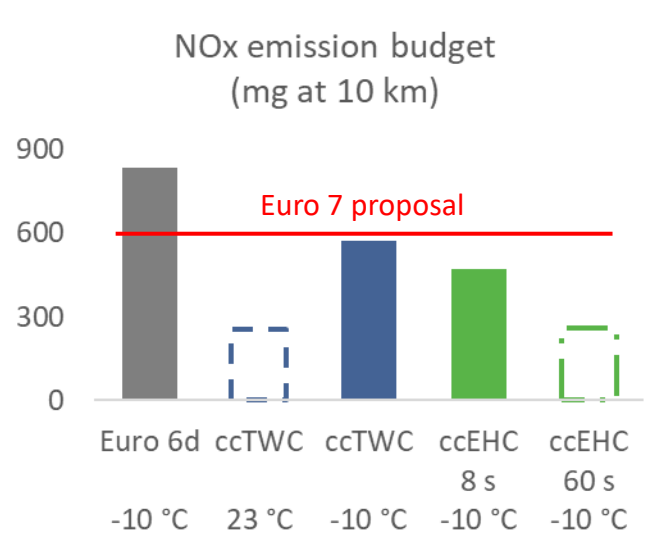
Gaseous emissions are mainly from initial cold-start

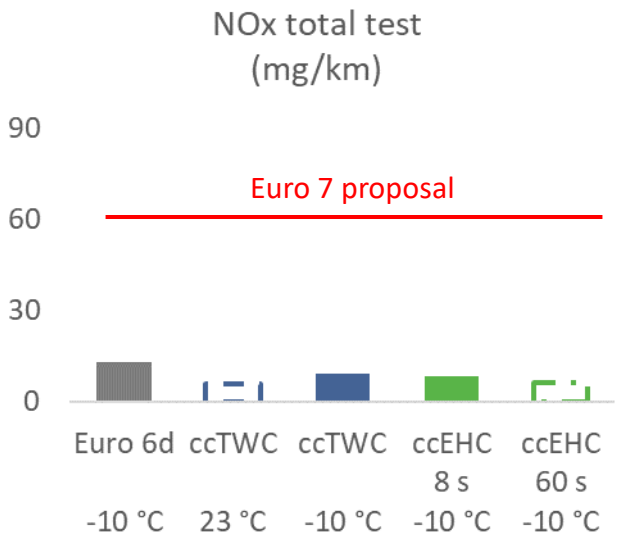
- Cold-start NOx peak influenced by test condition and emission control system
- Near-zero emissions under warm operation on all tests



Gaseous emissions are mainly from initial cold-start

- Highest cold-start NOx peak remains below original Euro 7 proposal
- Near-zero emissions under warm operation on all tests
- Further potential is possible for initial cold-start NOx due to demonstrator constraints

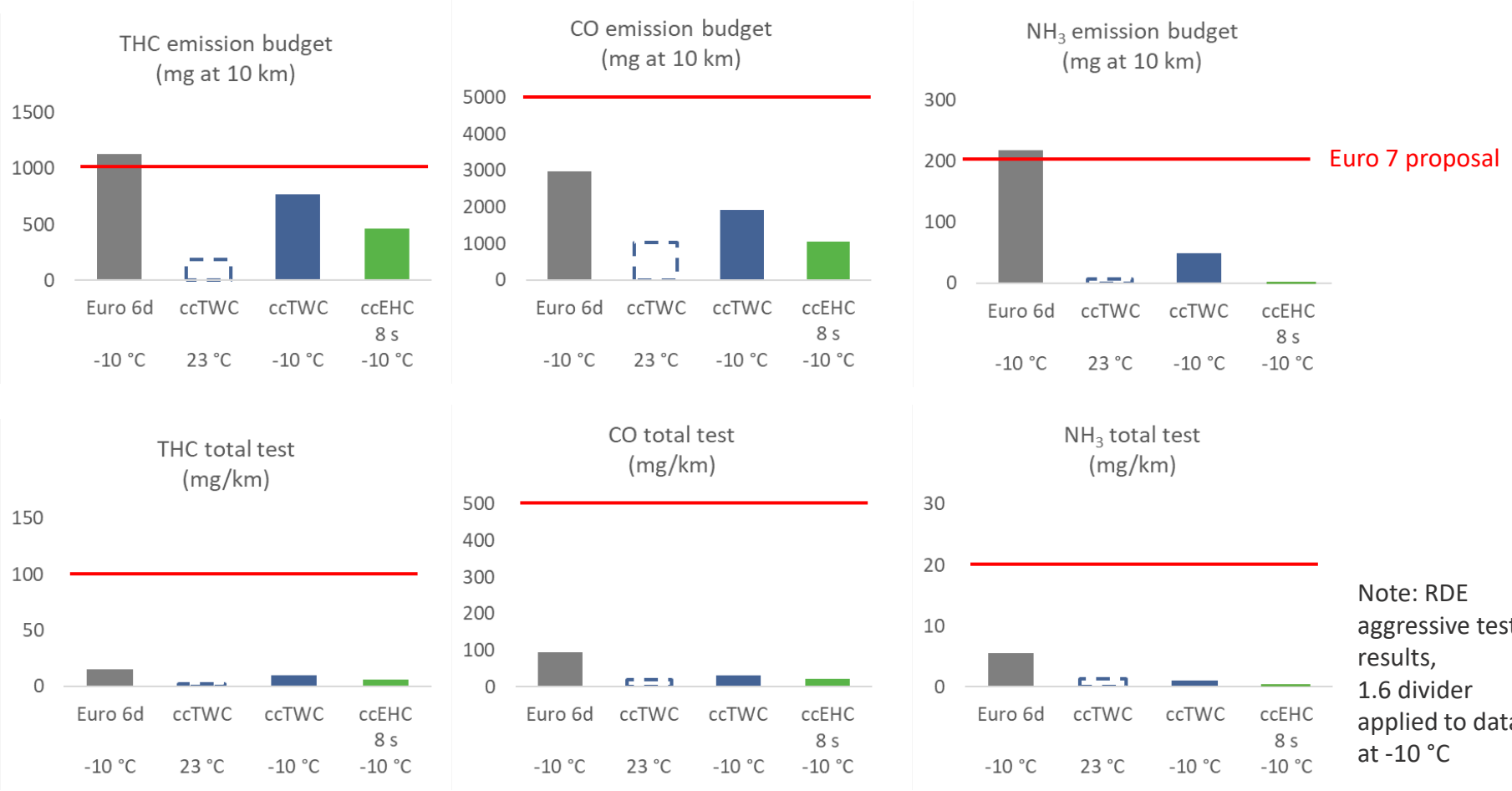




Note: RDE aggressive test results, 1.6 divider applied to data at -10 °C

Gaseous emissions are mainly from initial cold-start

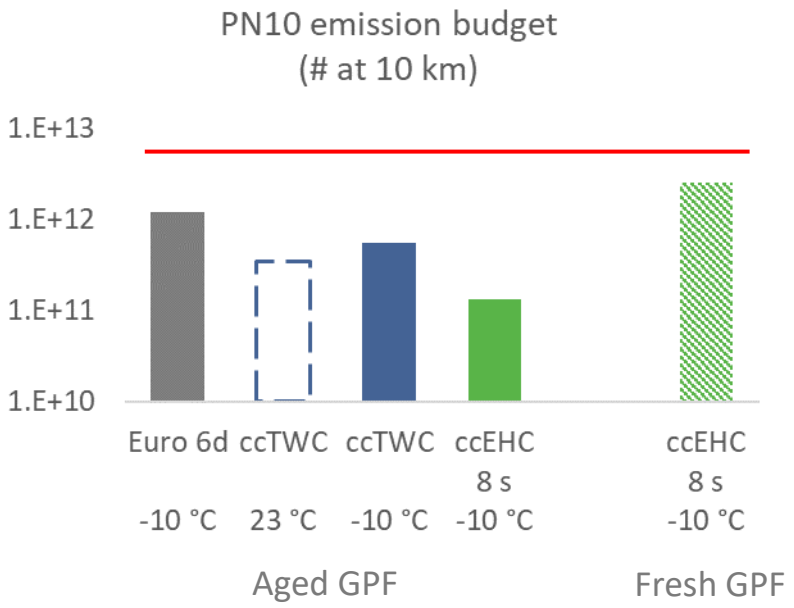
- Tests are significantly below the original Euro 7 proposal limits for THC, CO and NH_3
  - Emission budget
  - Total test result

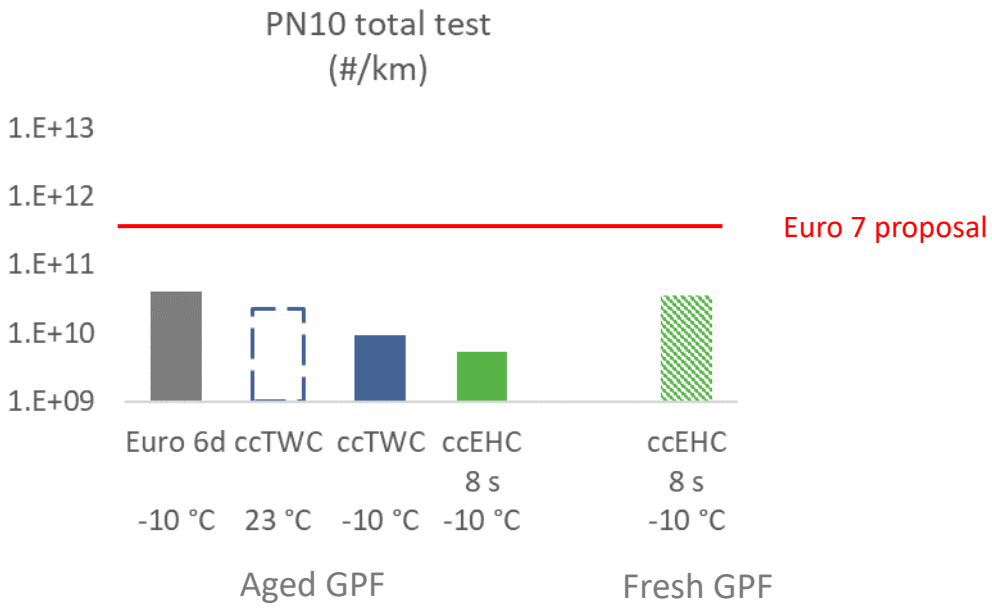


Note: RDE aggressive test results, 1.6 divider applied to data at -10 °C

Particulate emissions are mainly from initial cold-start

- Most data is measured with aged GPF
  - Ash and soot accumulation supports filtration efficiency
  - Test with ccEHC at -10 °C repeated with fresh GPF
- All PN10 data remains below the original Euro 7 proposal limit



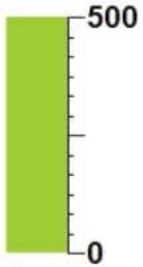


Note: RDE aggressive test results, 1.6 divider applied to data at -10 °C; the fresh GPF test is not a valid test according to the Euro 7 proposal

Ignition

Engine load: 23 %

Vehicle speed: 26 km/h



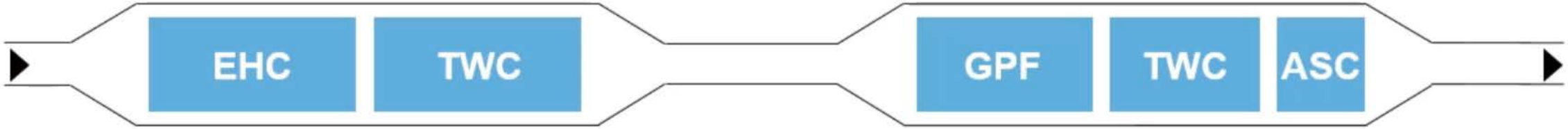
NOx
1550 ppm

30 s or 150 m to near-zero emissions

NOx
0 ppm

Video available at https://youtu.be/qoG0GxF8X-k

More videos available on YouTube (AECC eu): https://www.youtube.com/channel/UCbPS9op5ztLqrv6zlMH_IcQ



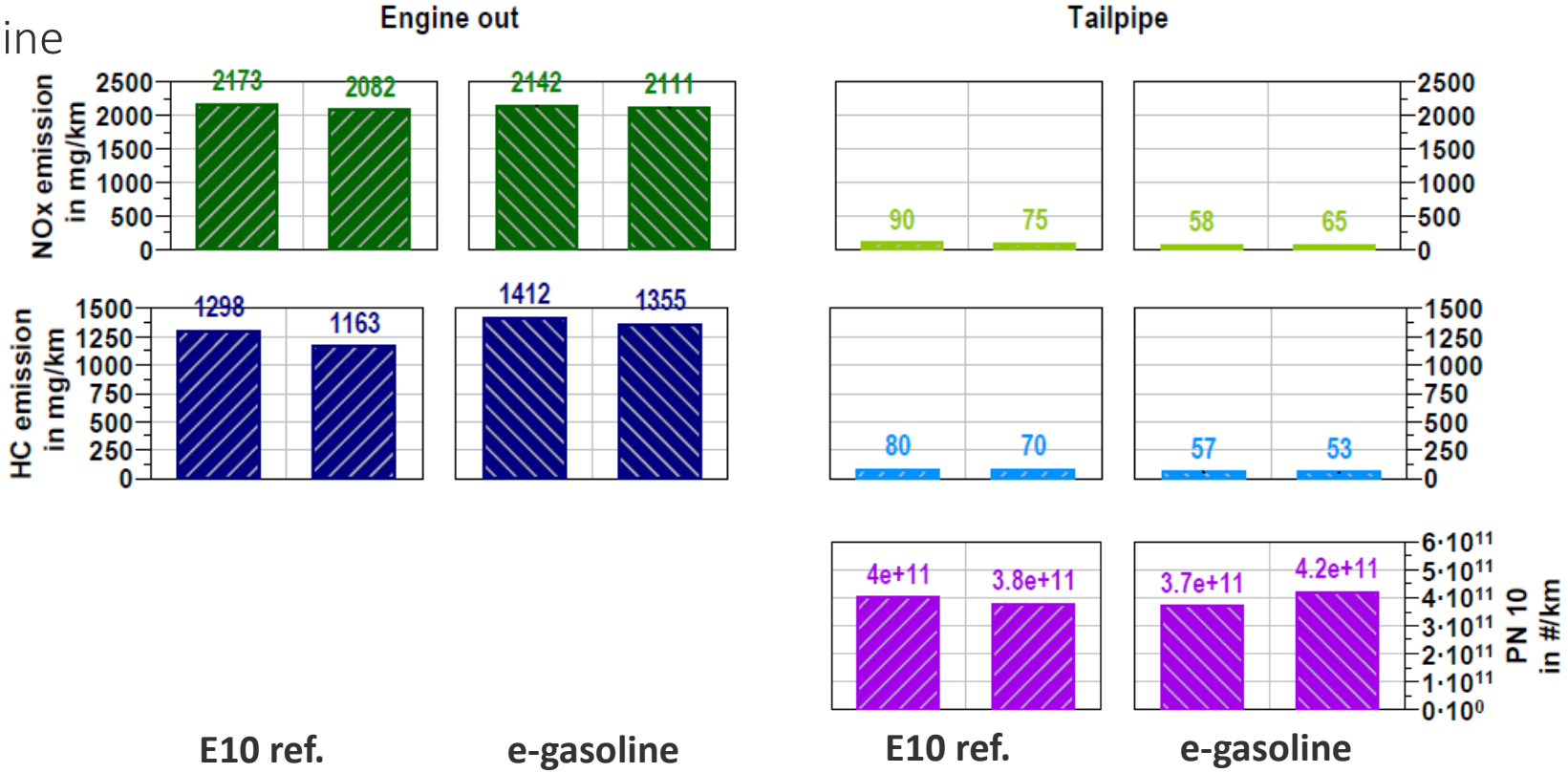
Engine catalyst heating

EHC heating

Closed-loop lambda control

LD gasoline demonstrator with sustainable renewable fuels

- Ultra-low pollutant emissions confirmed
  - Emissions on E10 and e-gasoline plotted after 10 km including the initial cold-start
  - Blue Gasoline results available in publication

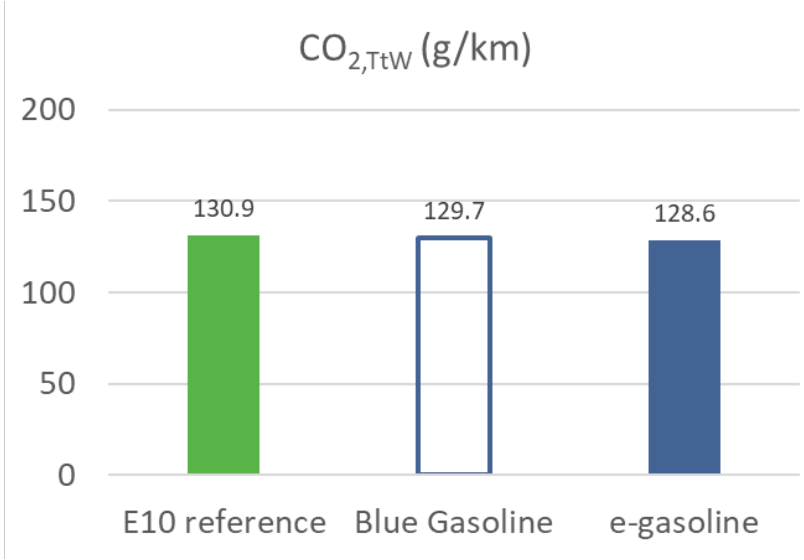


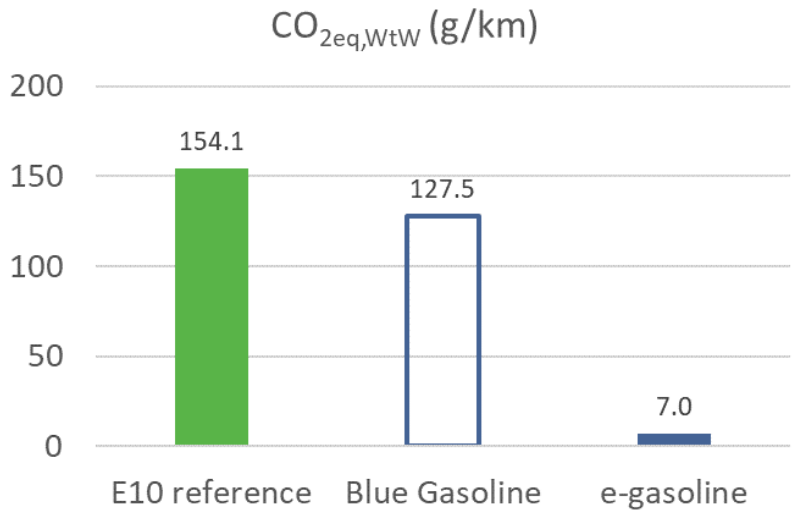
Note: RDE aggressive test results at -10 °C after 10 km (1.6 divider not applied), 2 test repeats on E10 reference fuel and e-gasoline

J. Demuynck, et al.; "Zero-Impact Emissions from a Gasoline Car with Advanced Emission Controls and E-Fuels" 43rd International Vienna Motor Symposium, 2022
J. Demuynck, et al.; "Advanced Emission Controls and E-fuels on a Gasoline Car for Zero-Impact Emissions", SAE paper 2022-01-1014, 2022

LD gasoline demonstrator with sustainable renewable fuels

- Blue Gasoline already offers today significant reduction of -17% WtW CO_2 emissions
- E-gasoline has the potential to nearly eliminate WtW CO_2 emissions





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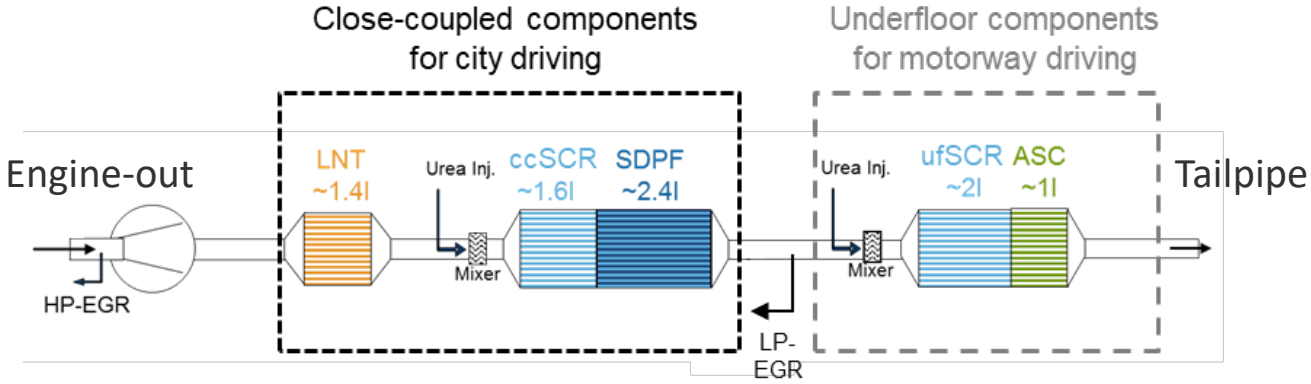
J. Demuynck, et al.; "Advanced Emission Controls and E-fuels on a Gasoline Car for Zero-Impact Emissions", SAE paper 2022-01-1014, 2022

LD diesel demonstrator concept

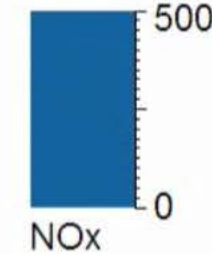
- Base vehicle
  - C-segment vehicle
  - 1.5l engine with 4 cylinders
  - 48V mild-hybrid system
  - Euro 6b type-approval

- Emission control system
  - LNT + dual-SCR
  - Hydrothermally aged components targeting 160k km



J. Demuynck, et al.; "Integrated Diesel System Achieving Ultra-Low Urban and Motorway NOx Emissions on the Road", 40th Vienna Motor Symposium, 2019
https://www.aecc.eu/wp-content/uploads/2020/07/190516-AECC-IAV-IPA-Integrated-Diesel-System-achieving-Ultra-Low-NOx-on-the-road-Vienna-Symposium.pdf
Joint MTZ publication with Bosch, Vitesco, FEV and IAV https://www.aecc.eu/wp-content/uploads/2020/09/200901-modern-diesel-MTZ.pdf
Videos of instantaneous conversion performance available at www.youtube.com/channel/UCbPS9op5ztLqrv6zlMH_IcQ

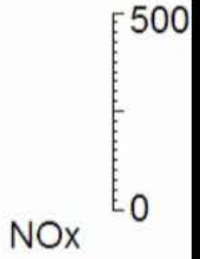
Engine load: 61 % Vehicle speed: 28 km/h



673 ppm

Near-zero emissions in city driving

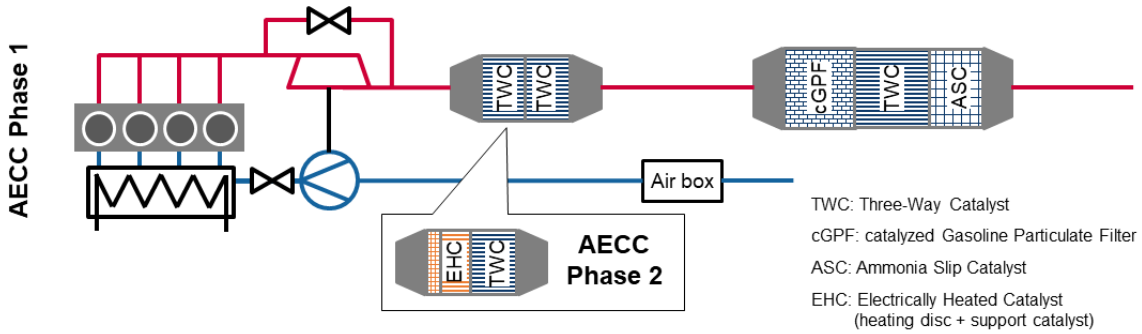
More videos available on YouTube (AECC eu):
https://www.youtube.com/channel/UCbPS9op5ztLqrv6zlMH_IcQ



0 ppm

Conclusions

- Available emission control technologies used
  - Active thermal management
  - TWC, close-coupled and underfloor
  - Catalysed GPF
  - ASC



- Ultra-low gaseous and particulate emissions are technically feasible under real-world driving conditions
  - Significant reduction of initial cold-start peak
  - Near-zero emissions after initial cold-start peak

- In combination with near-zero Well-to-Wheel CO_2 emissions using sustainable renewable fuels

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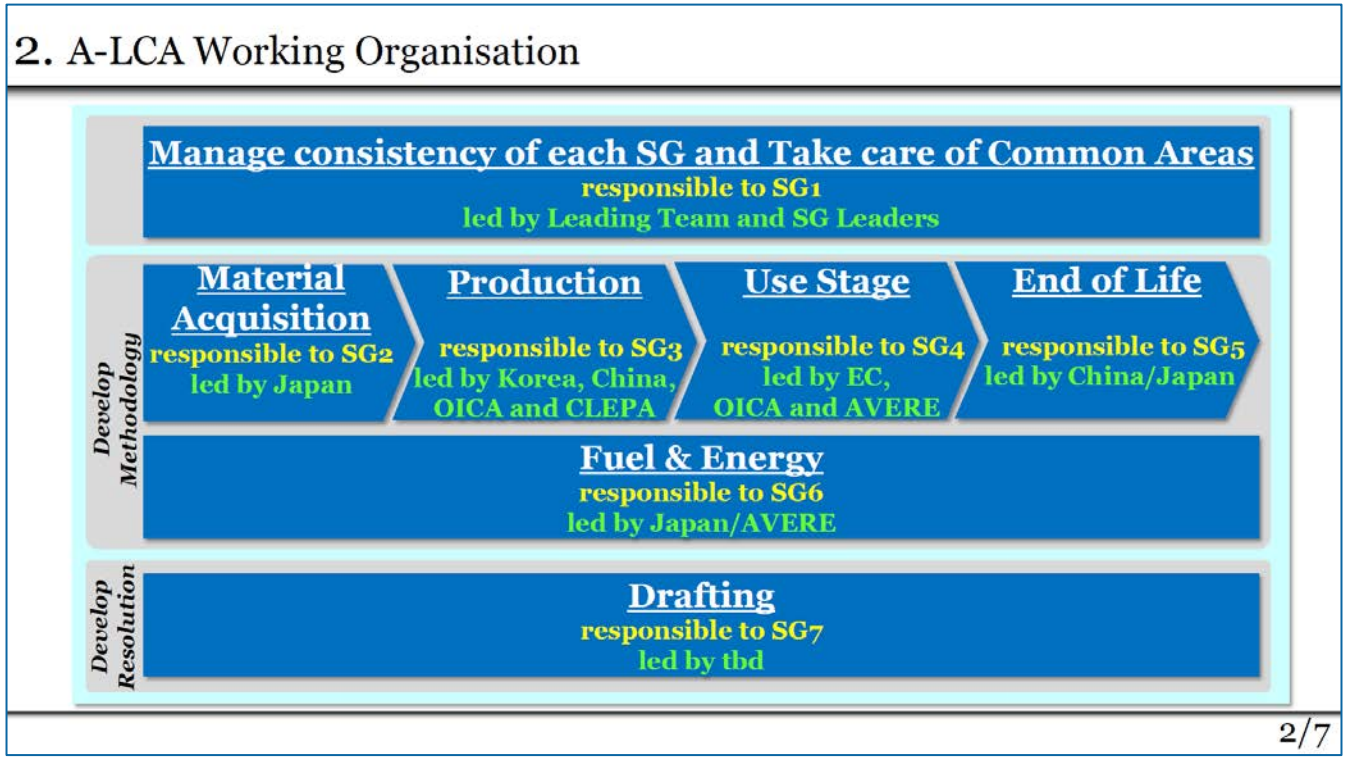
Light-duty CO_2 review and CO_2 neutral fuels

- European Commission will publish progress report in 2025 and review legislation in 2026
- Development of procedures ongoing for vehicles running exclusively on CO_2 neutral fuels
  - Draft Commission proposal is being discussed at Technical Committee on Motor Vehicles (TCMV)
  - Definitions
    - Type of fuel: current draft only covers Renewable Fuels of Non-Biological Origin (RFNBO, i.e. e-fuel)
    - Minimum GHG reduction threshold: current draft requires -100% according to Renewable Energy Directive
  - Relying on OEM to ensure
    - Vehicles are equipped with a fueling monitoring and inducement system
    - Protection from tampering for the whole lifetime of the vehicle
  - Draft text also defines CO_2 emission of H_2 ICE is not to be measured

Automotive Life-Cycle Assessment (A-LCA)

- AECC is part of the Informal Working Group on A-LCA at UNECE



- AECC will extend its Well-to-Wheel studies to LCA (LDV and HDV)

THANK YOU

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Additional references

- AECC fact sheet on myths and truths about Euro 7
- Implementation of available and affordable emission control systems
  - Cost assessment of engineering houses
    - LD demo vehicles
    - HD demo vehicle
  - Provided as input to European Commission impact assessment
- Emission control systems are designed for minimised impact on backpressure
  - See Q&A document of AECC-IPA Technical Seminar on Euro 7