

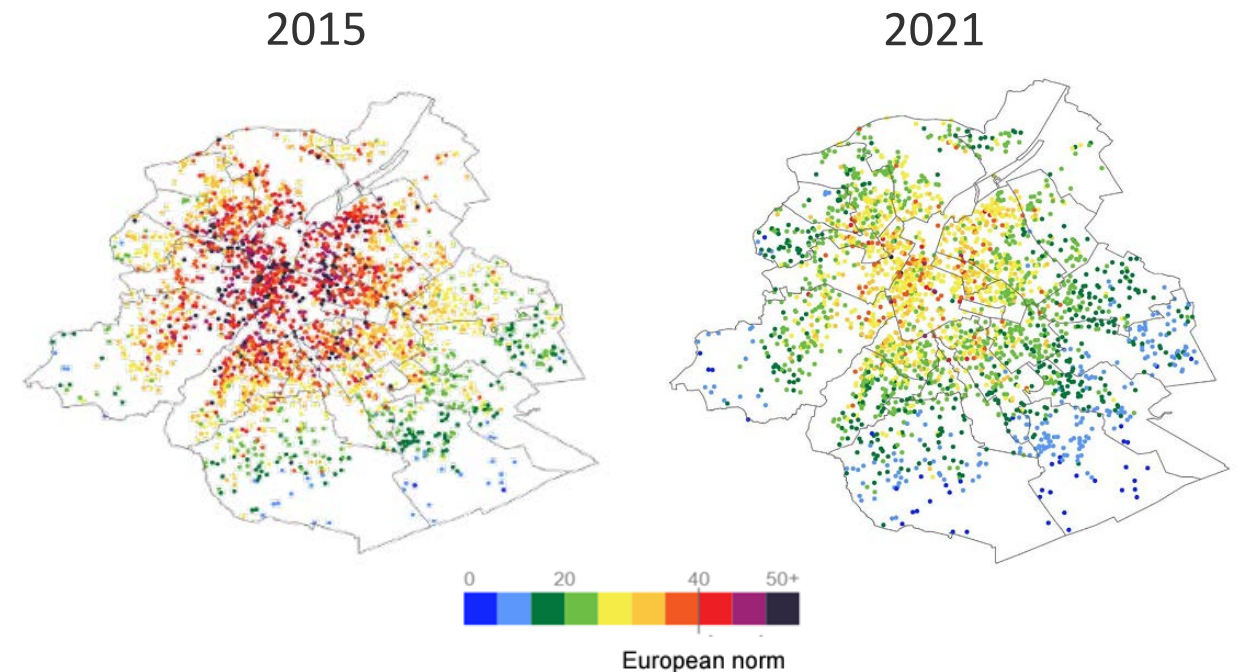
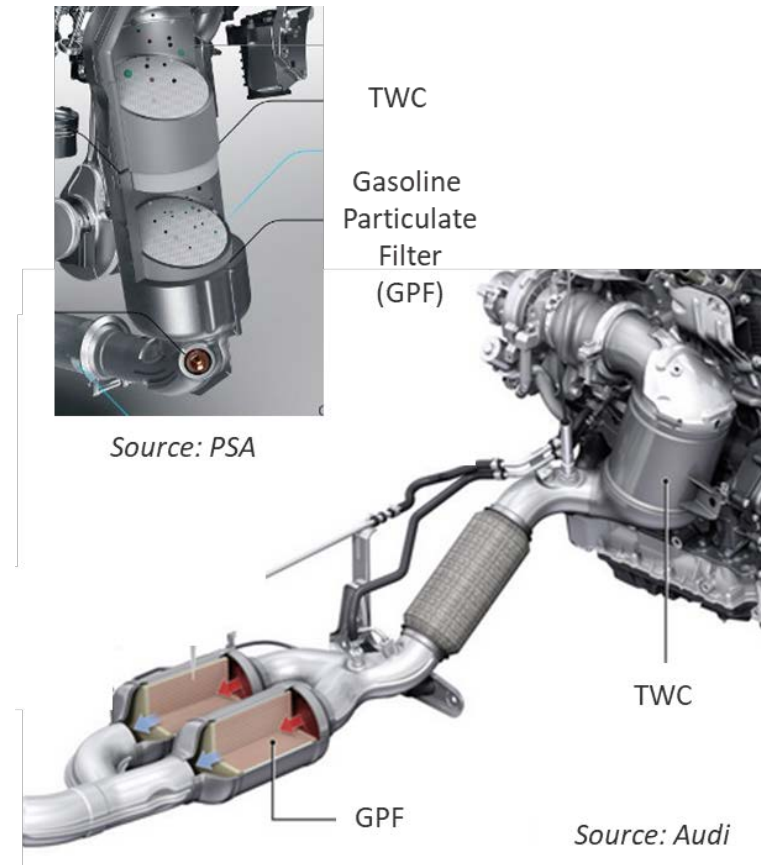
Zero-impact emissions from a gasoline car with advanced emission controls and e-fuels

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Euro 6d significantly reduced impact on air quality

- RDE procedure with PEMS for NO_x and PN
- LD Gasoline - introduction of particulate filter
- Several reports about improved air quality
- Example of NO₂ in Brussels



Source: CurieuzenAir report air quality in Brussels, 2022

Emission legislation evolution expected towards Euro 7

- Further contribute to air quality improvement with advanced emission control systems
 - New WHO guidelines, published in September 2021
 - Review of EU Ambient Air Quality Directive ongoing
- European Commission proposal for Euro 7 is expected by July 2022
- Assumptions for light-duty vehicles based on April 2021 scenarios from the CLOVE consortium
 - Pollutant emission limits
 - Tightening for regulated pollutants
 - Introduction of limit for currently non-regulated pollutants
 - Widening of RDE testing conditions, with definition of normal and extended area
 - Ambient conditions
 - Driving dynamics
 - Reduction of minimum trip length for averaging of initial cold-start emissions
 - Extension of durability requirements

Reduction of ICE CO₂ emissions to mitigate climate change

- Increase in efficiency and level of electrification for new vehicles
- Wider usage of sustainable renewable fuels to reduce Well-to-Wheel and lifecycle emissions
 - Immediate reductions for the existing fleet in addition to new vehicles
 - Production is a reality, further investments depending on the policy framework
 - Usage for road transport is not fully recognised in 'Fit for 55' proposal under discussion

03.05.2021 | Image | #Powertrain systems

Source: Bosch (2021)

Blue Gasoline with 20 percent lower CO₂ emissions



BOSCH



AECT
ASSOCIATION FOR EMISSIONS CONTROL BY CATALYST

Synthetic diesel and gasoline

Source: Aramco (2021)

Two 50 BPD fuel pilot plants
80% CO₂ abatement compared to fossil



aramco



Haru Oni pilot plant: wind power to e-fuel

Source: Siemens Energy (2020)



SIEMENS
energy



PORSCHE



aramco



Agenda

- LD gasoline demonstrator concept
- Ultra-low pollutant emissions on market E10 fuel
 - NO_x and THC
 - PN₁₀
 - NH₃
- Ultra-low pollutant emissions and Well-to-Wheel CO₂ emissions on sustainable renewable fuels
- Summary and conclusion

LD gasoline demonstrator concept

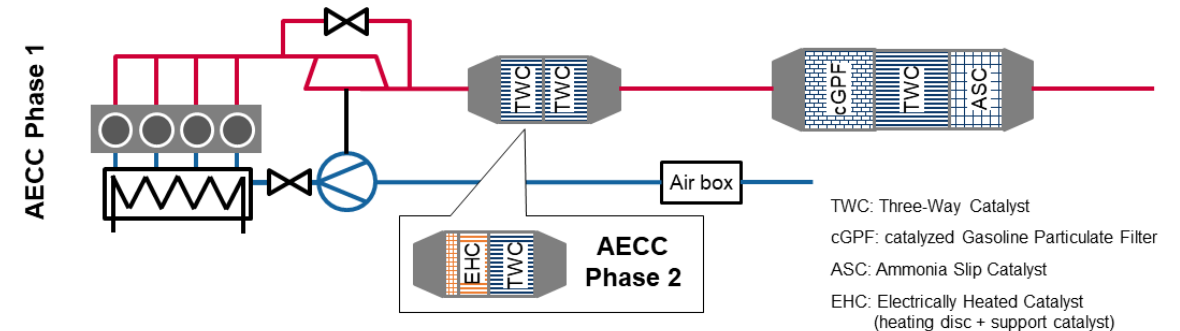
➤ Base vehicle

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



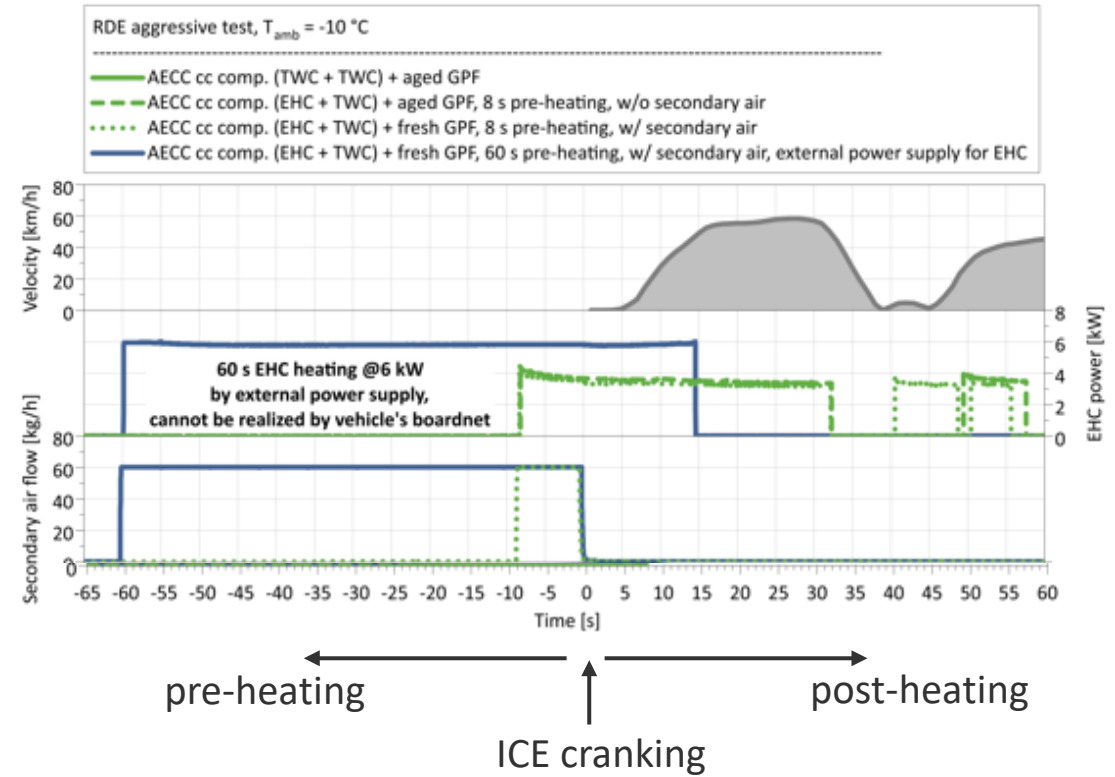
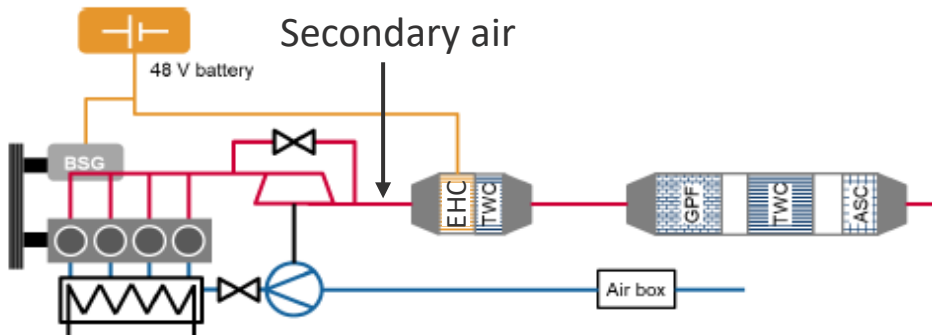
➤ AECC emission control system

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



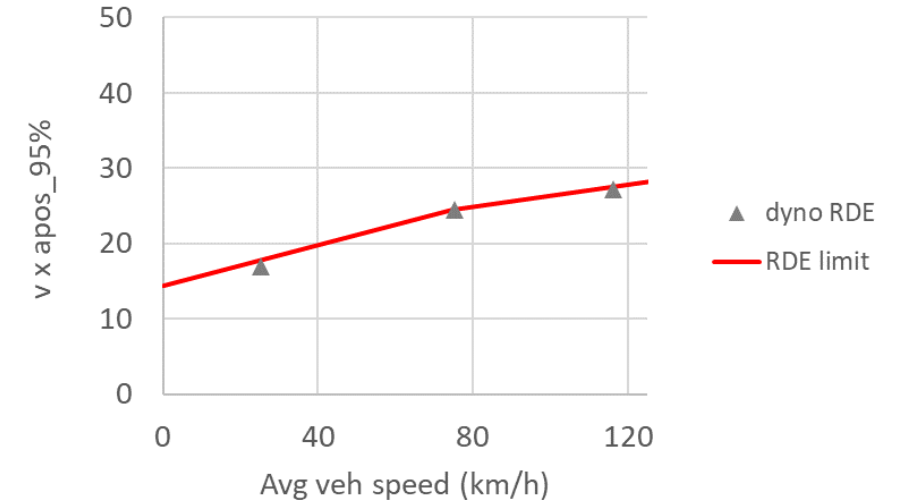
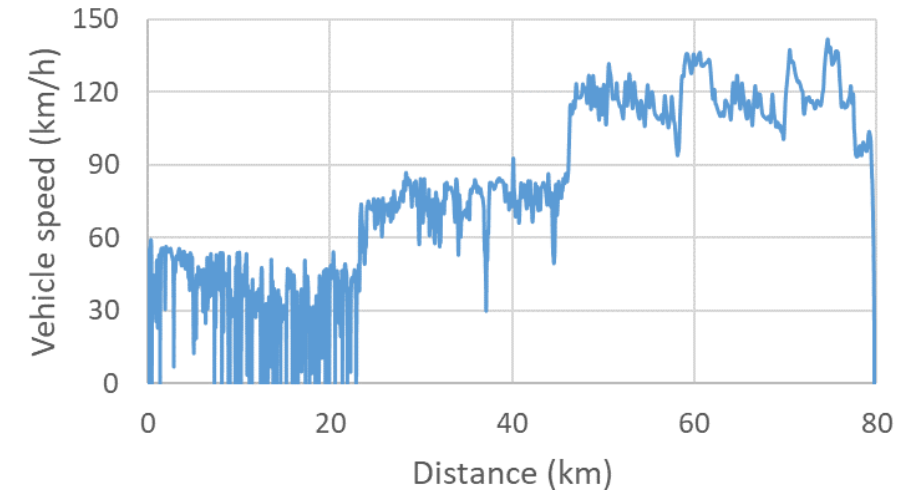
EHC control strategy

- Pre- and post-heating
 - 8 s pre-heating
 - 60 s pre-heating as outlook to advanced hybrids
- Secondary air in exhaust manifold to enhance heat transfer within catalyst during pre-heating phase in some tests



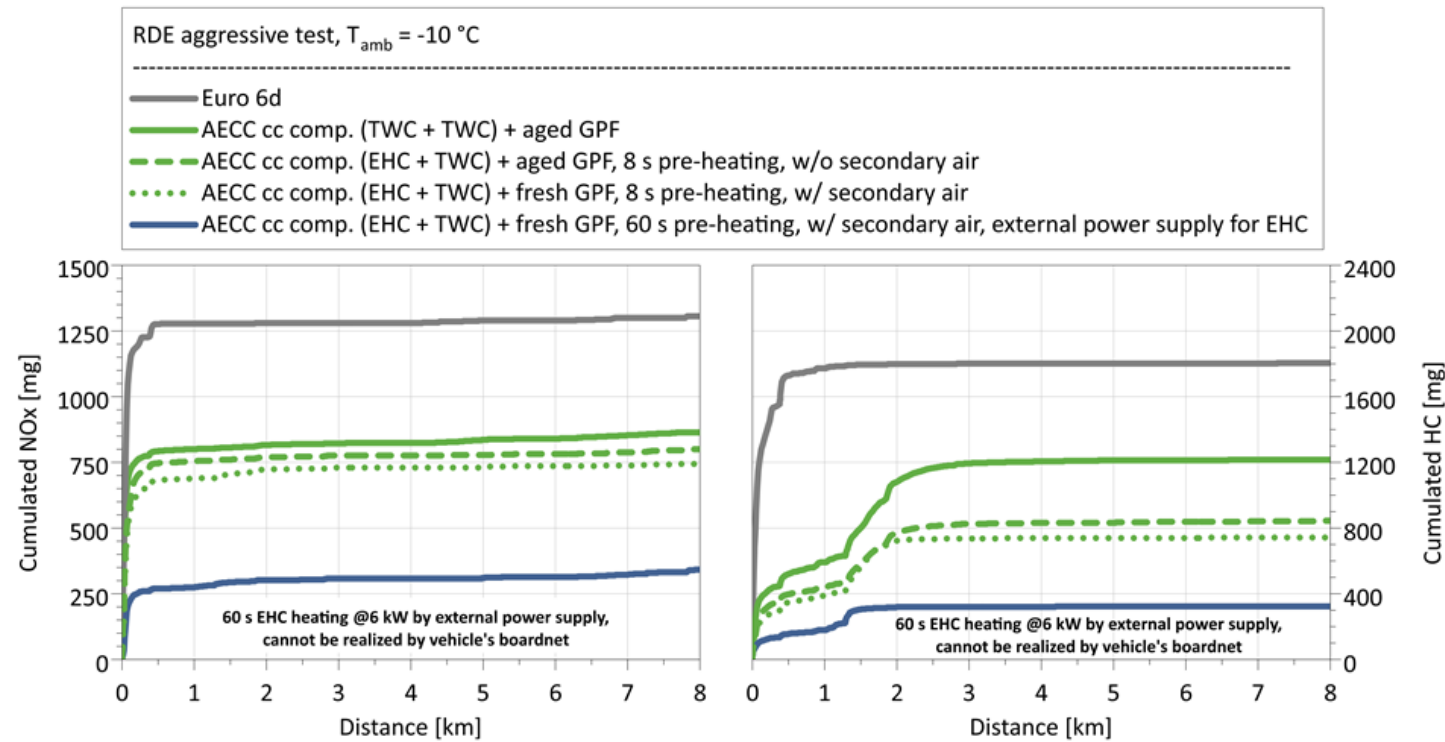
LD gasoline demonstrator testing

- Work presented focuses on RDE test on the chassis dyno
 - At ambient temperature of 23 °C and -10 °C
 - Challenging drive-off
 - 4s initial idle
 - 1st acceleration immediately to 60 km/h
 - $V_{x_{pos}}$ at Euro 6 RDE boundary condition
- Repeated on different fuels
 - E10 reference
 - Blue Gasoline
 - Methanol-to-Gasoline e-gasoline



Ultra-low initial cold-start emissions

- 8 s pre-heating: similar NO_x emissions compared to cc(TWC+TWC), some reduction for THC
- 60 s pre-heating as outlook to advanced hybrid: significant reduction for NO_x and THC
- Near-zero emissions after initial cold-start peak over range of conditions tested





Ignition

Engine load: 0%

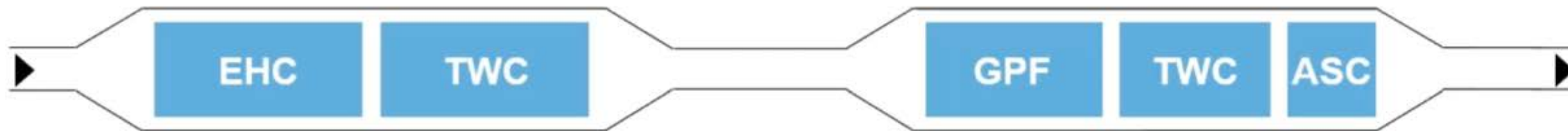
Vehicle speed: 0 km/h



30 s or 150 m to near-zero emissions



More videos available on YouTube (AECC eu): https://www.youtube.com/channel/UCbPS9op5ztLqrv6zIMH_IcQ



Engine catalyst heating



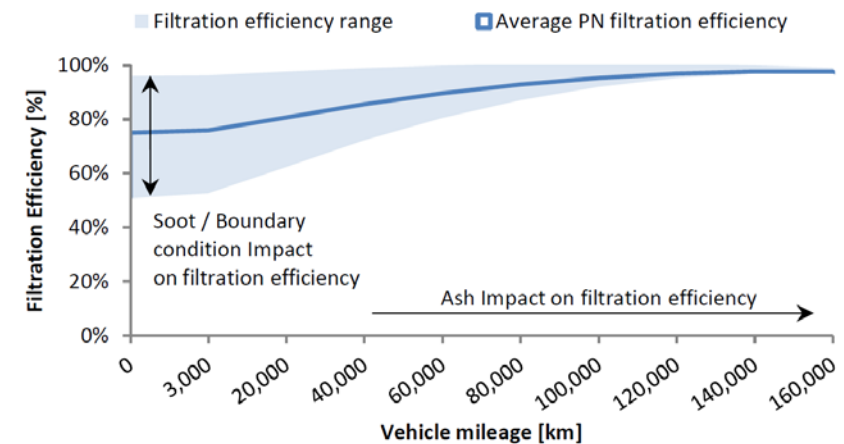
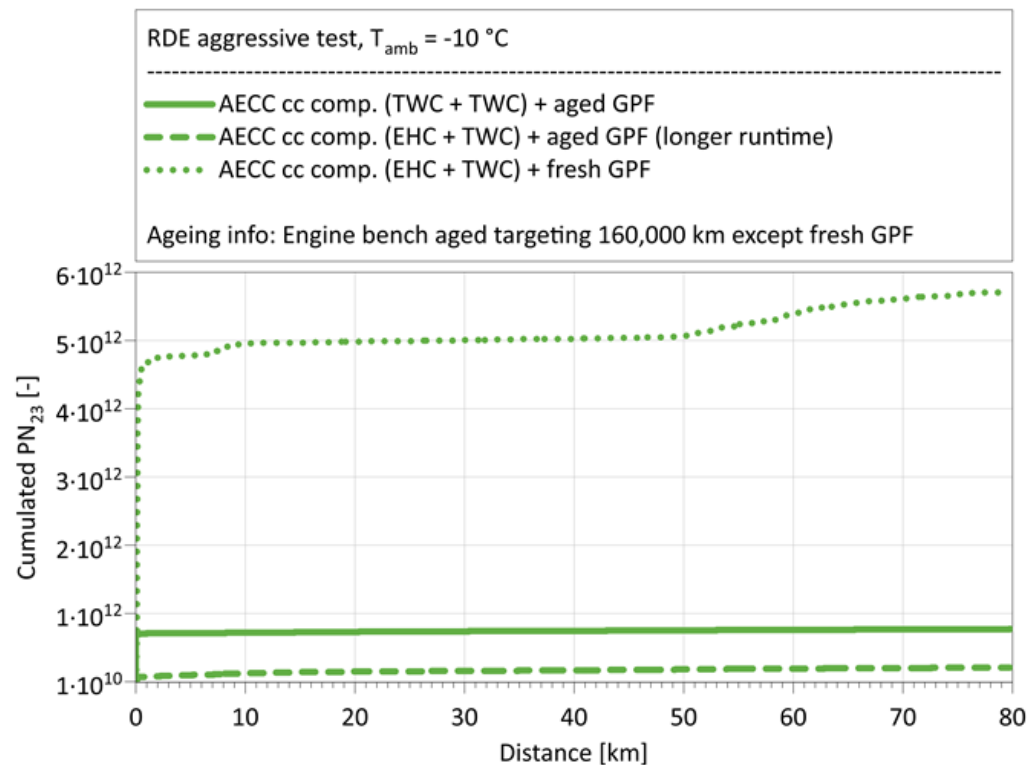
EHC heating



Closed-loop lambda control

Ultra-low PN10 emissions

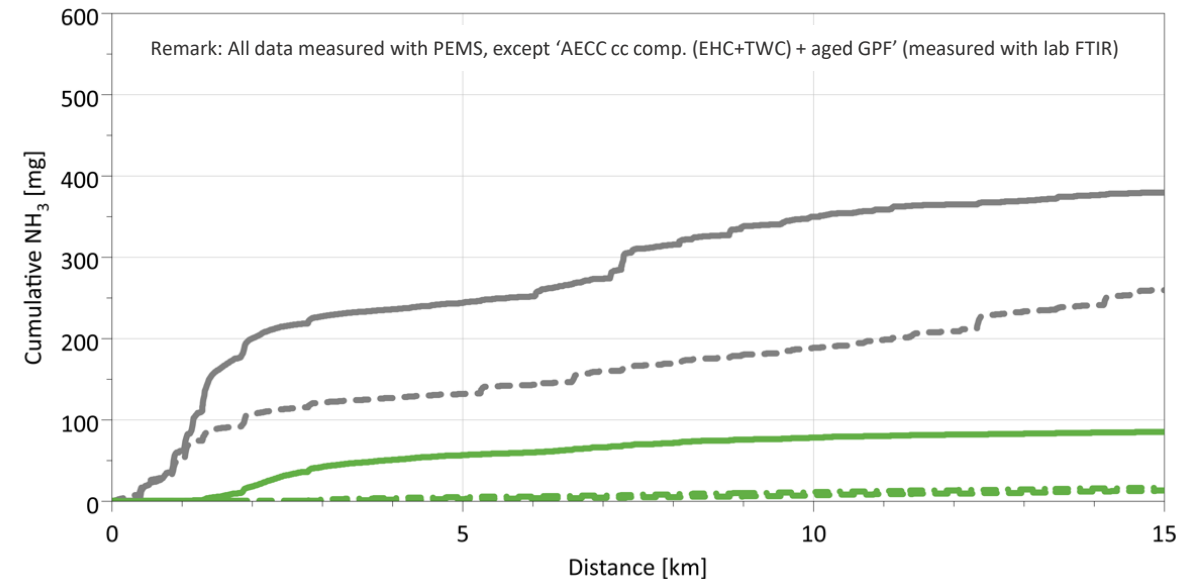
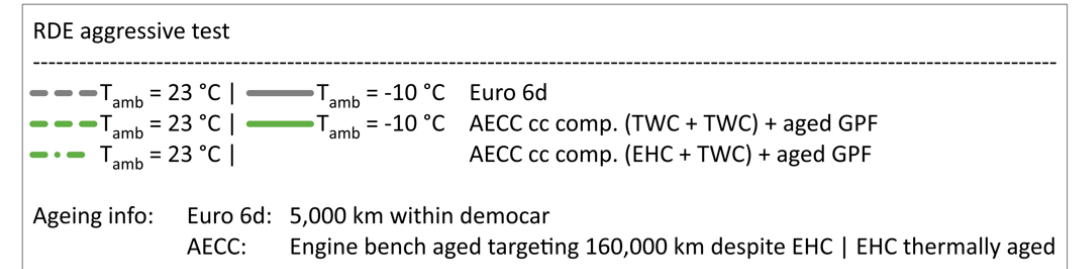
- Variation in cold-start peak for aged parts depends on exact soot/ash level
- Initial cold-start peak increases with fresh GPF



Source: D. Waters, et al.; 8th Int. Engine Congress Baden-Baden, 2021

Ultra-low NH₃ emissions

- Euro 6d level within 10-40 mg/km range reported by JRC¹⁻²
- ASC operation strategy for gasoline investigated in addition to improved lambda control
 - Emissions increase under aggressive driving style and at low ambient temperature
 - Significant reduction compared to Euro 6d



¹ R. Suarez-Bertoa, et al.; Transp. Res. Part D Transp. Environ. 49 (2016) 259-270

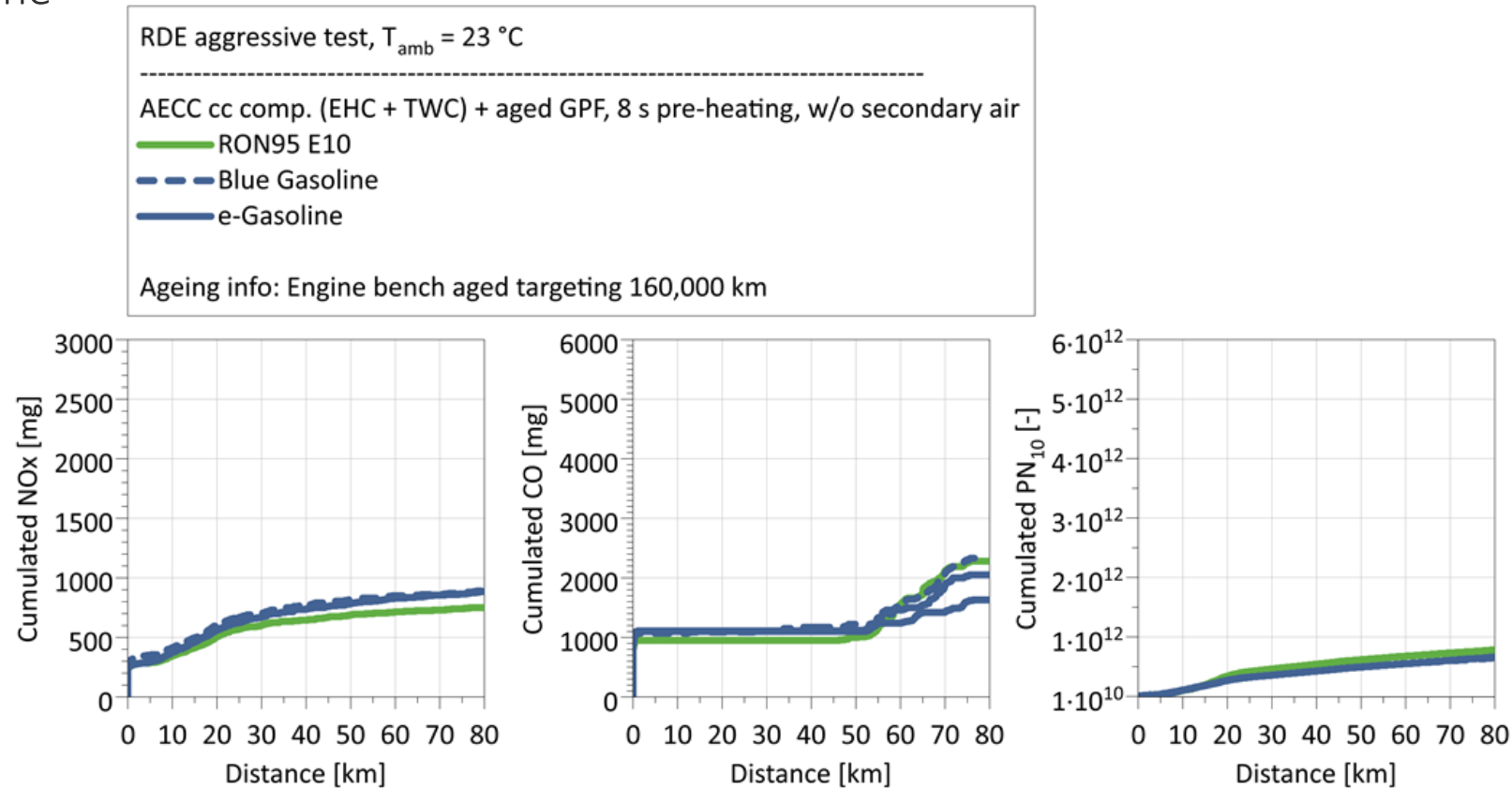
² R. Suarez-Bertoa, et al.; Atmospheric Environment 166 (2017) 488-497

Ultra-low emissions on sustainable renewable fuels

➤ Similar gaseous and particulate emissions

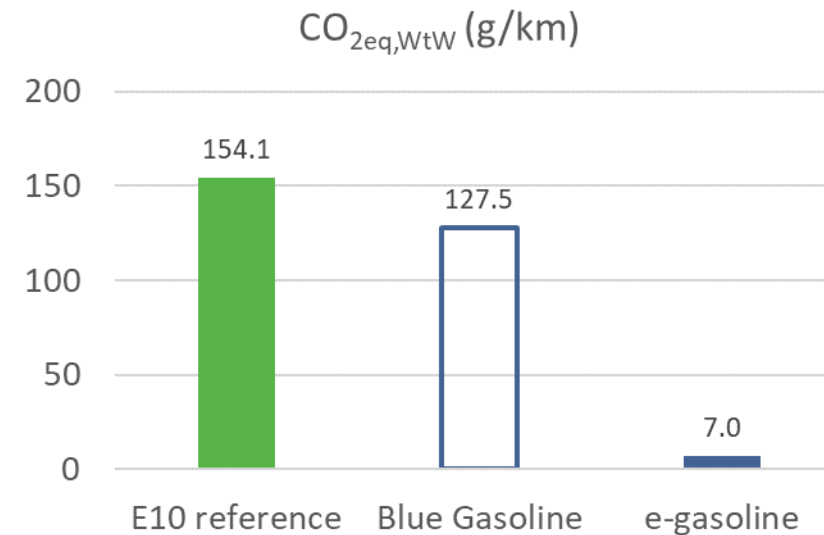
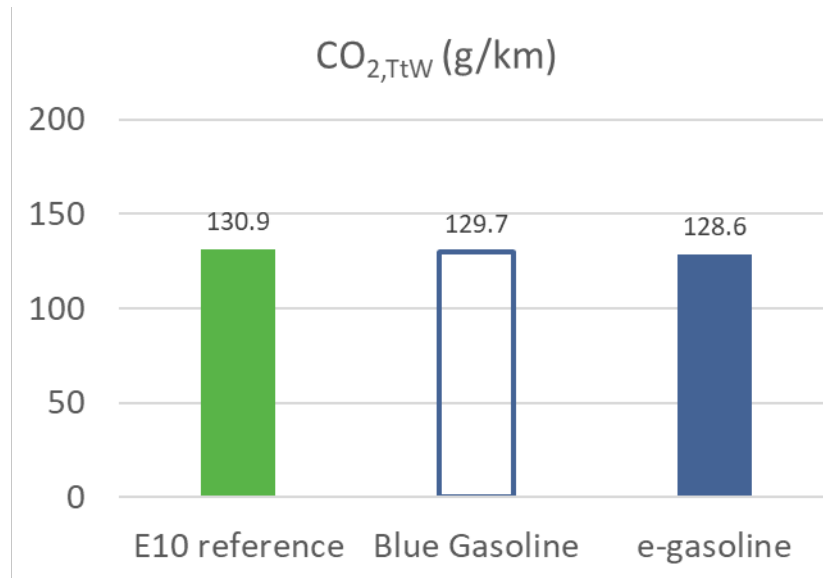
➤ Blue Gasoline

➤ e-gasoline



Well-to-Wheel CO₂ emission reduction

- Similar tailpipe CO₂ emissions
- Blue Gasoline already offers today significant reduction of 17% (20% compared to E0)
- E-gasoline has the potential to nearly eliminate Well-to-Wheel CO₂ emissions



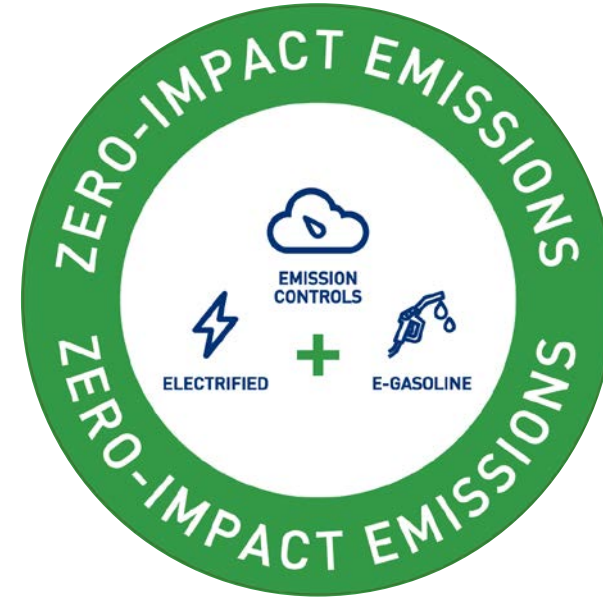
Calculated according to methodology of JEC WtW report v5

Summary and conclusions

- Advanced emission control system was implemented on a gasoline demonstrator vehicle with a 48 V mild-hybrid powertrain, including among other items
 - Close-coupled TWC substrate with 900 cpsi
 - Active thermal management with EHC
 - Ammonia Slip Catalyst operation in addition to improved lambda control
- Ultra-low pollutant emissions measured
 - Significant reduction of initial cold-start peak compared to already low Euro 6d level
 - Near-zero emissions after initial cold-start peak
- Same ultra-low pollutant emissions measured on sustainable renewable fuels, which enable to significantly reduce the Well-to-Wheel CO₂ emissions

Summary and conclusions

- Demonstration of zero-impact emissions through an integrated approach



- Meet us at the car display in front of The Hofburg to experience this while driving

THANK YOU !



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