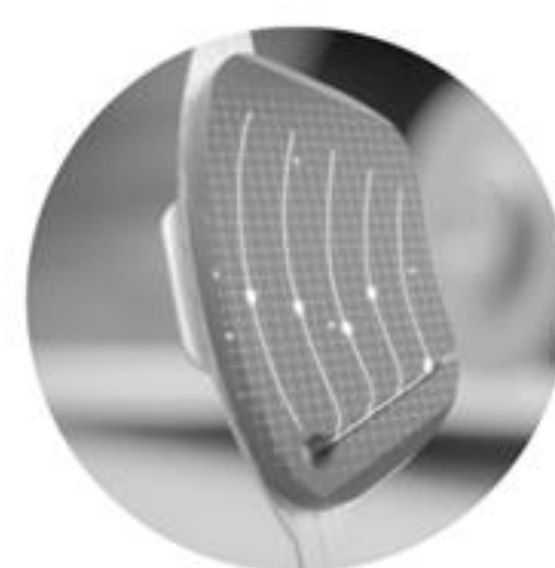
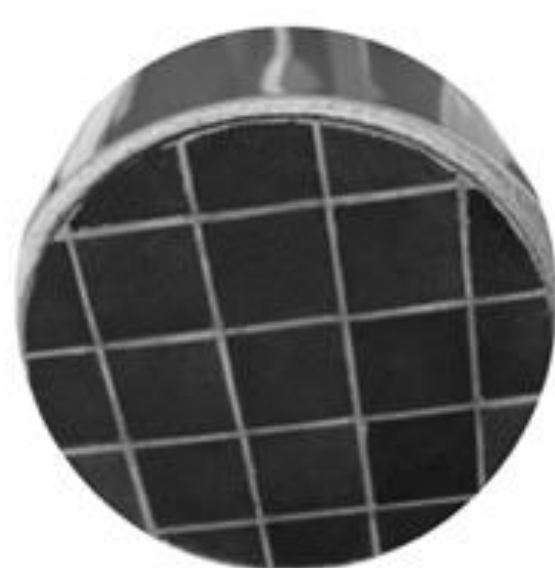




The VERA Project: Tailpipe Retrofit Solutions

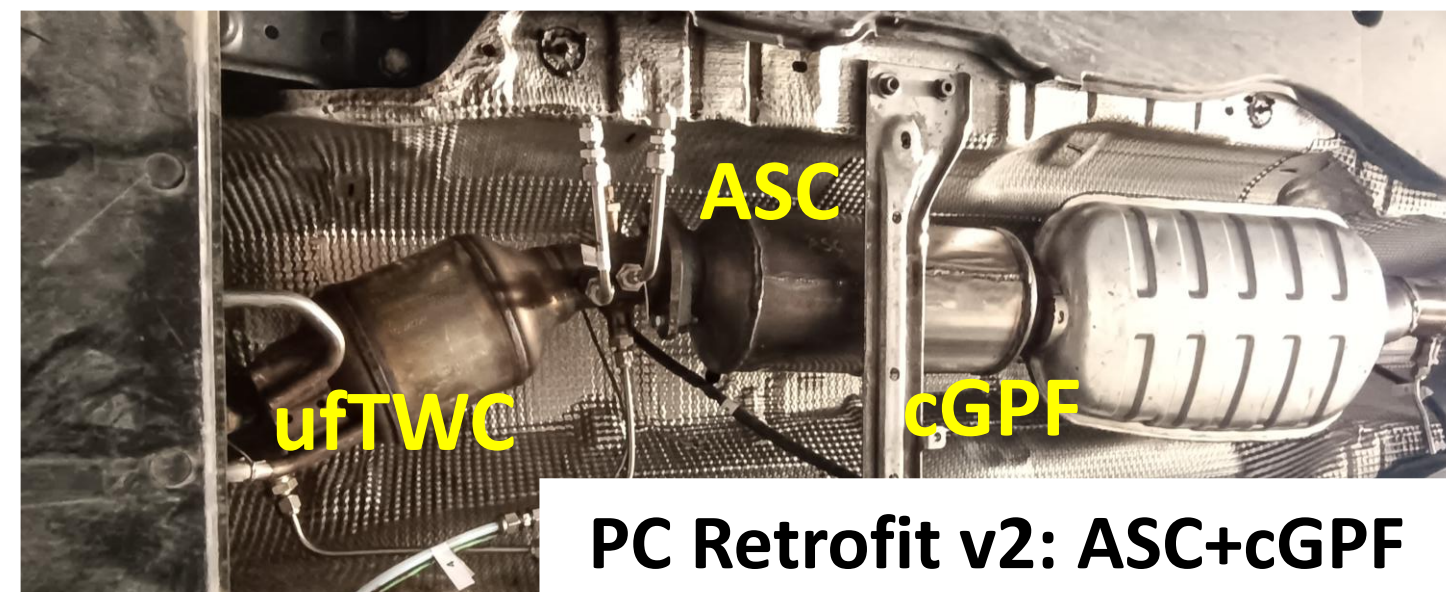
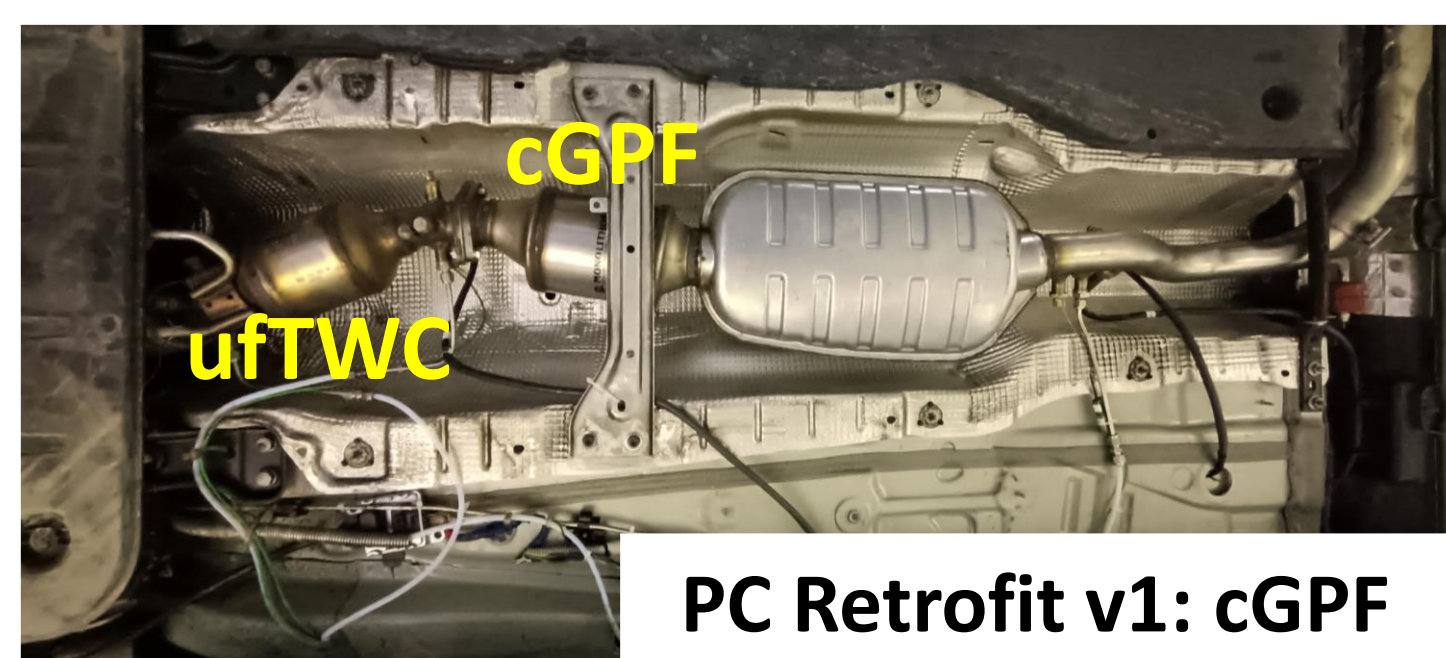
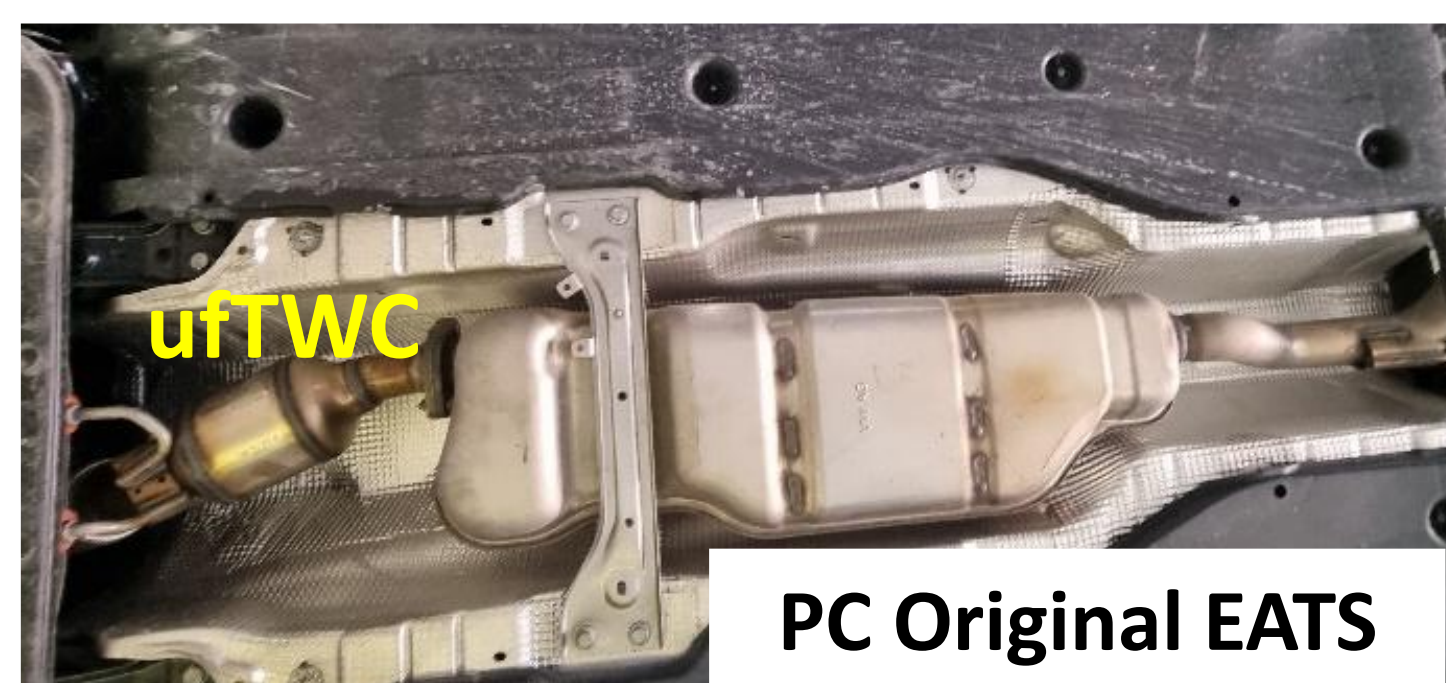
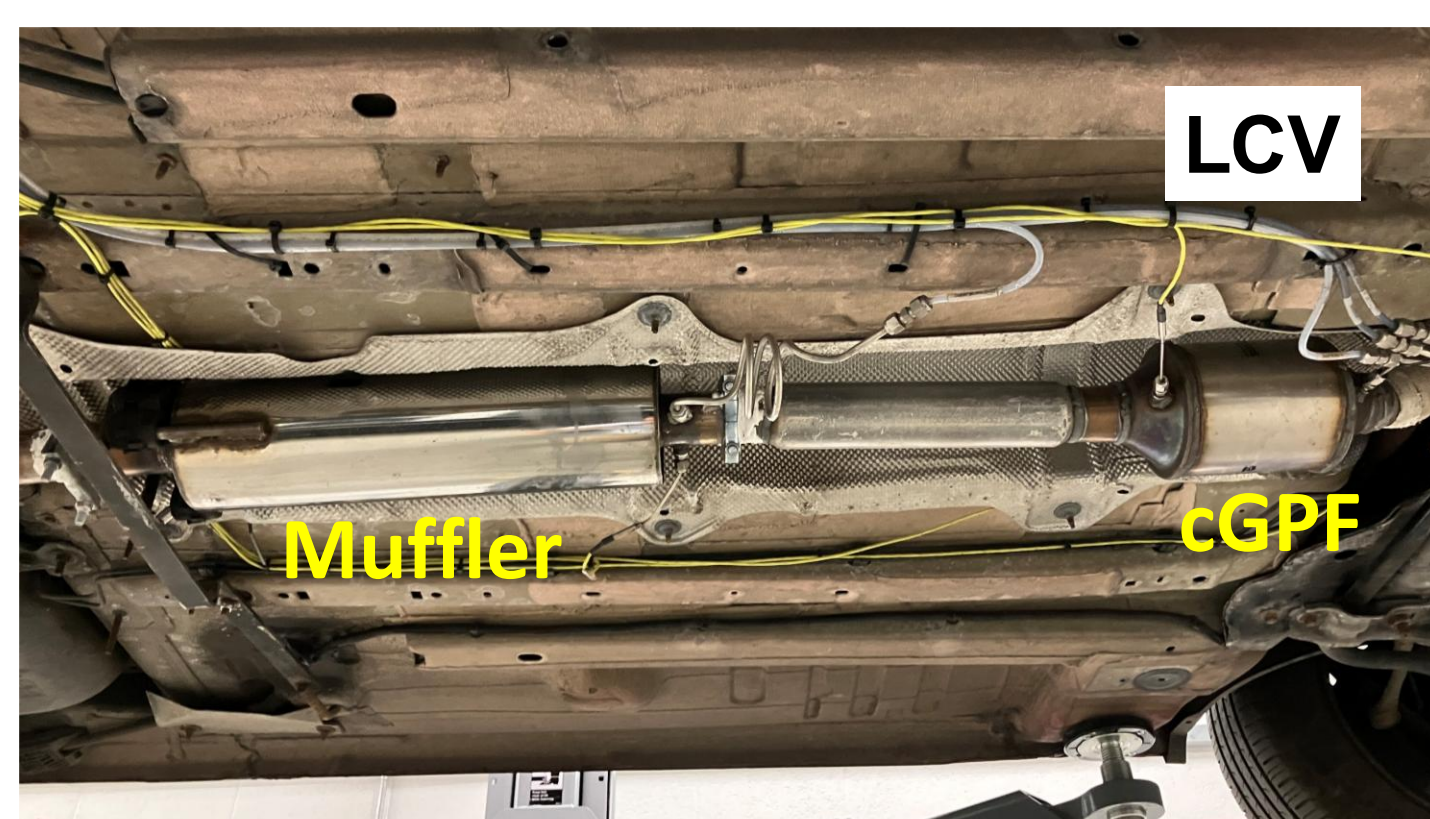
Problem, Objectives & Methodology

- **Exhaust emissions from road vehicles in the EU**
 - 280M+ vehicles in EU fleet
 - 15+ year average vehicle age
 - Vehicle & powertrain types not equipped with particulate filter: early Euro 6 GDI, PFI gasoline, bi-fuel CNG/gasoline
 - Uncontrolled pollutants, e.g., NH_3 from LDVs
 - Severe environmental & health impacts
- **Objective:** Develop, validate and optimize retrofit systems to improve emissions performance of existing vehicles and contribute to better air quality
- **Methodology**
 - Small-scale testing: SGB, ETB
 - Modelling: filtration efficiency, pressure drop, catalytic activity
 - Full-scale testing: Chassis dyno, test track, on-road

VERA Solutions and Technologies

LDV

- ✓ Cu-based coating on GPF
- ✓ ASC integration



HDV

- ✓ Low PGM coating on GPF
- ✓ LNT integration

Vehicles and Testing



Vehicle type	Fuel & Powertrain	Emission std	Application
Passenger Car (PC)	Bi-fuel CNG/Gasoline (GDI) – SI	Euro 6d	Taxi
Light Commercial Vehicle (LCV)	Gasoline PFI – SI	Euro 6b	Delivery van
Heavy-Duty Vehicle (HDV)	CNG – SI	Euro VIb	City bus

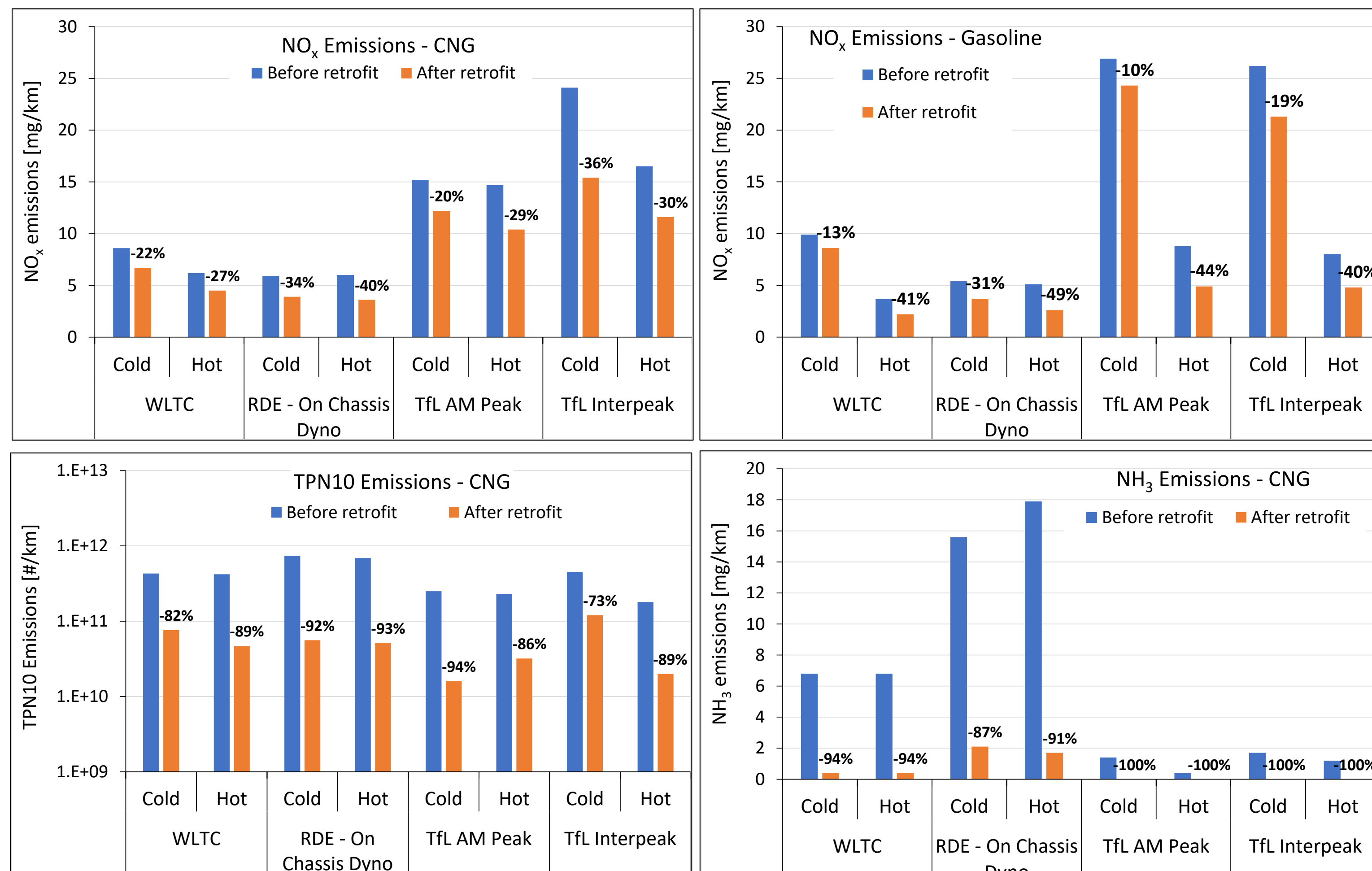
Emissions covered

- All Euro 7 regulated species
- NO_x , CO, THC/ CH_4 , PN, PM
- SPN/TPN 23/10/2.5 nm
- NH_3 considerations for LDV
- N_2O , HC speciation, dioxin

Testing

- Lab: legislated cycles, real-world profiles
- On-road: RDE, outside boundaries
- Test track for NVH analysis
- Chemical analysis of exhaust gas
- Toxicological analysis, ALI with A549 cells

Achievements



Results

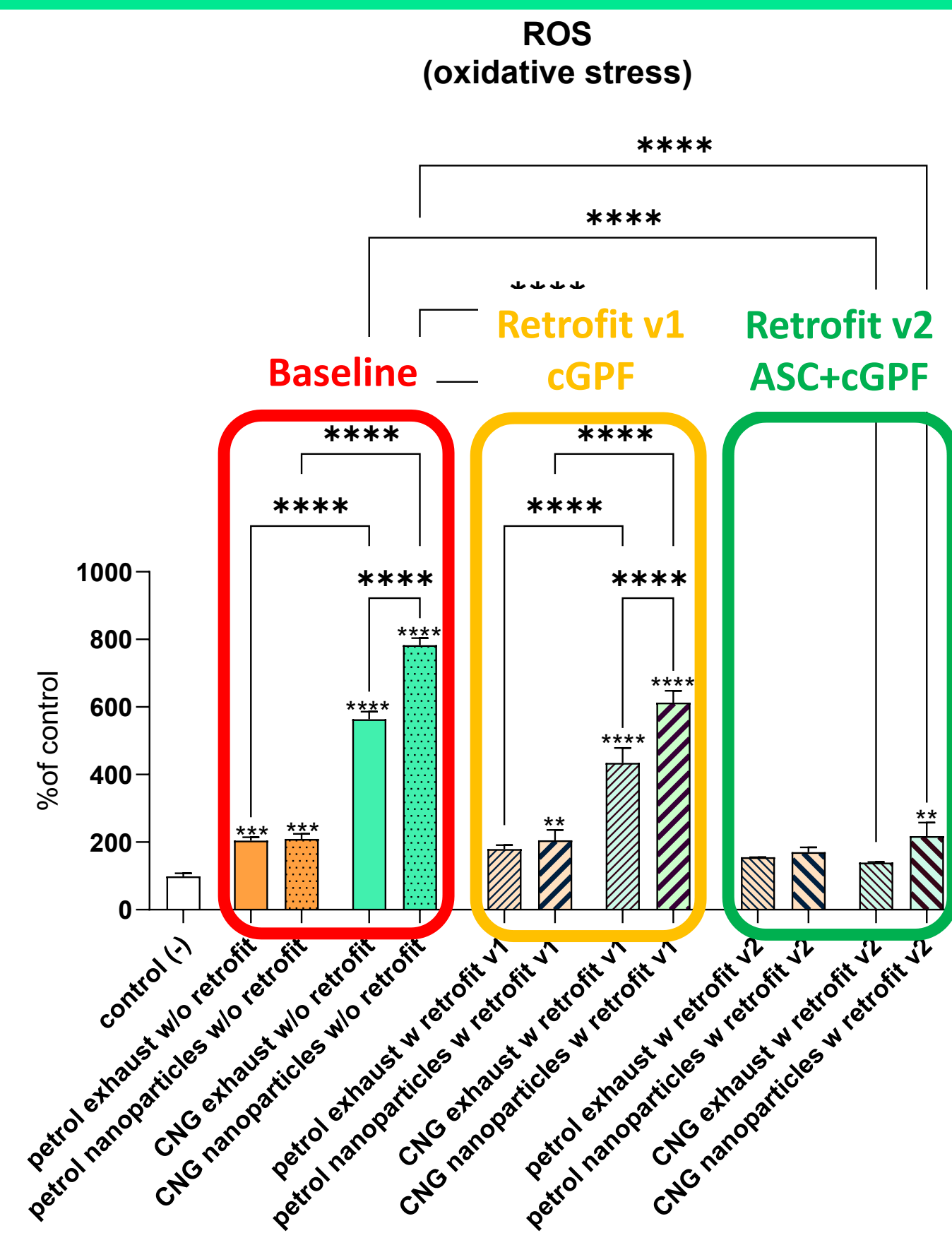
- ✓ >90% PN reduction
- ✓ 20-50% NO_x reduction
- ✓ 95-100% NH_3 removal

Key Advantages for Real-World Application

- ✓ **Adaptability:** Systems easily scalable across vehicle & powertrain types
- ✓ **Low cost:** Total system cost <10% of in-use vehicle market value
- ✓ **No performance compromise:** Solutions validated to maintain vehicle drivability, safety and comfort, without any deterioration of NVH behavior
- ✓ **Zero fuel impact:** No increase in CO_2 emissions or fuel consumption
- ✓ **No other side effects:** Confirmation of no dioxin formation

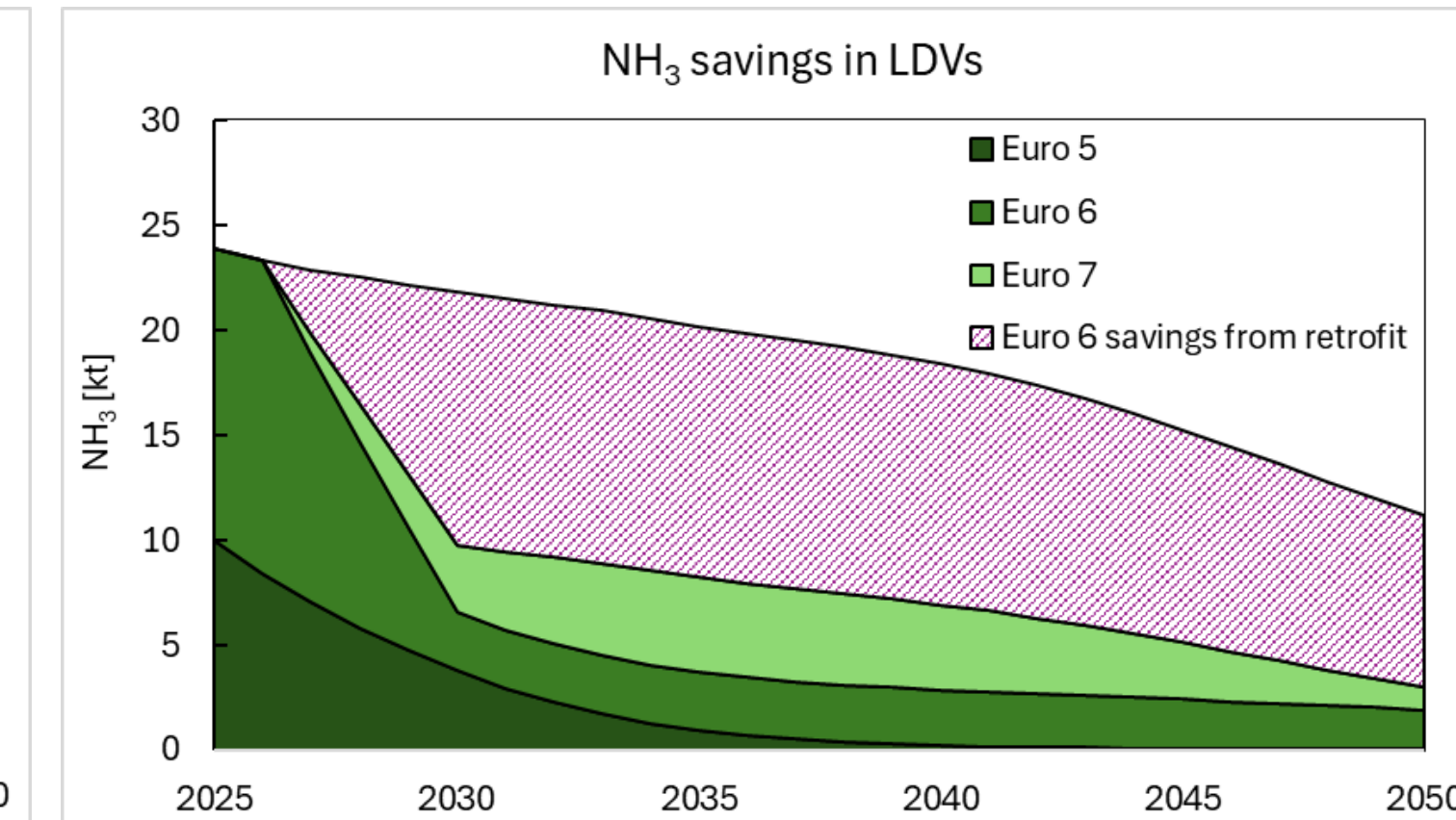
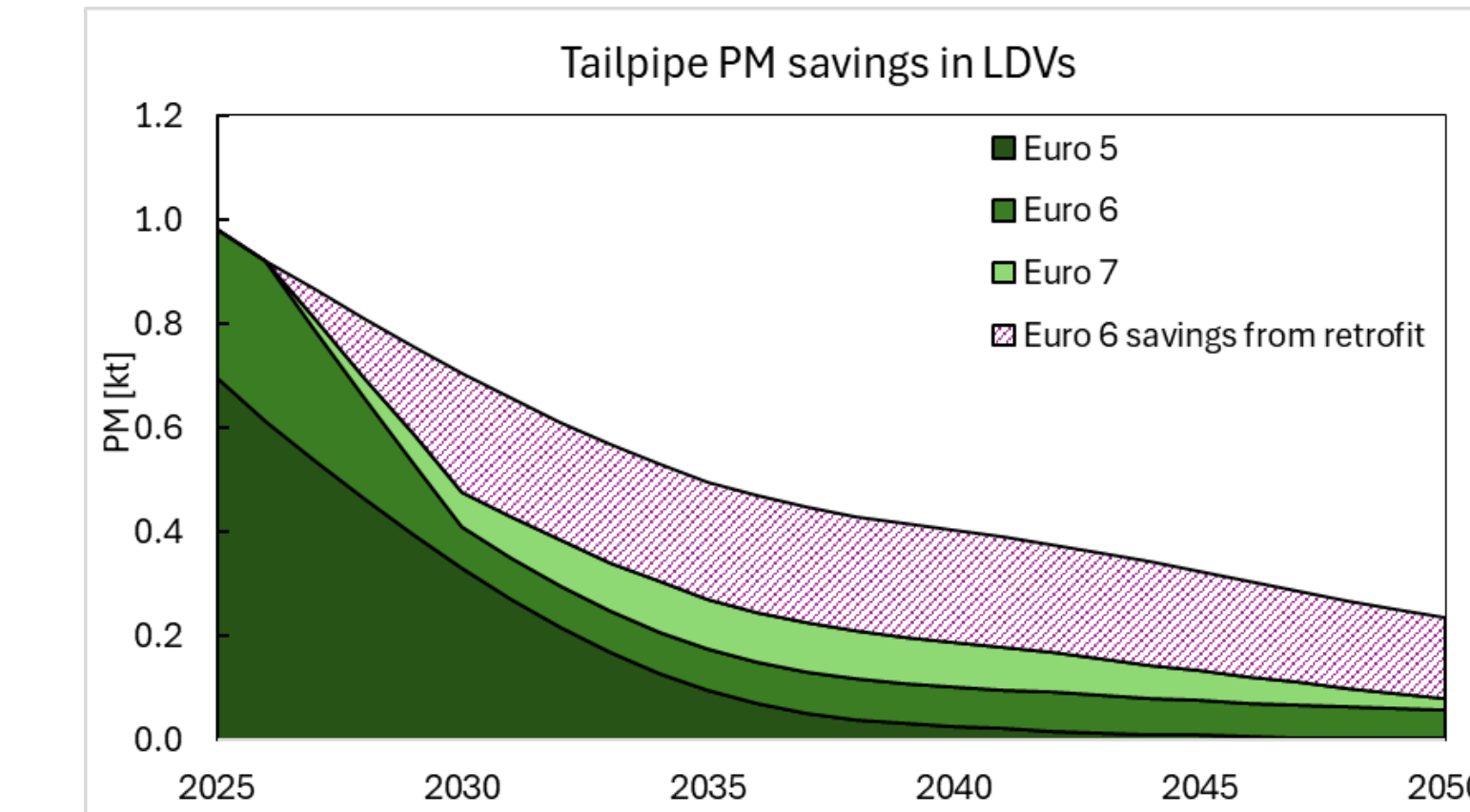
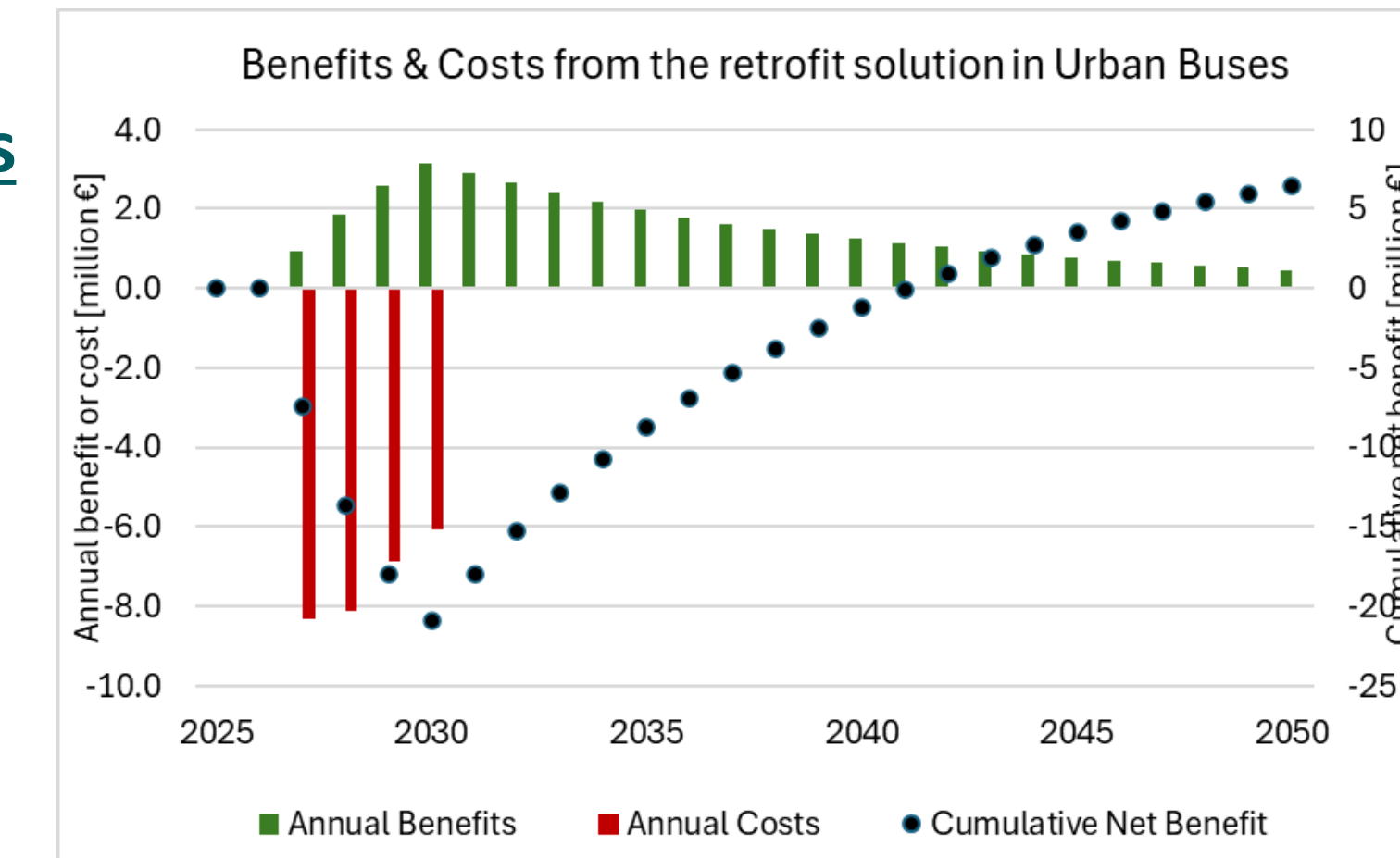
Benefits

- **Positive health impacts, confirmed by toxicological analysis**
- ✓ **Removal of nanoparticles and NH_3 has strong health benefits**
- **Cost-Benefit Analysis (CBA)**
- ✓ Retrofitting LDVs with **ASC+cGPF** provides **€4B net benefit**, driven mainly by reductions in NH_3 and particles, with co-benefits in NO_x , CO, THC
- ✓ Retrofitting LDVs only with cGPF does not prove beneficial, due to trade-offs with increased NH_3 emissions, highlighting their significance
- ✓ CNG buses retrofit with **LNT+cGPF** yields **over €10M net benefit**



Policy recommendations & implications

- Consider the inclusion of **NH_3 emission limits for LDVs**
- Prioritize **deployment of retrofit solutions** in existing fleet where rapid air-quality gains are needed
- Support uptake through **regulatory and incentives schemes**



This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101056893

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