

Guidebook and COPERT updates

Chapters 1.A.3.b.i-iv / Road Transport



Overview

- Revision of CO, EC, SPN23, NOx of Euro 6 HEV/PHEV
- Introduction of Euro VI CNG & LNG HDVs
- Revision of VOCs speciation of Euro 5/6 petrol & diesel LDVs
- Revision of EC of BEVs
- Revision of cold PM & BC of Euro 5/6 petrol, diesel & CNG LDVs
- Revision of EC of Euro 6 LPG cars
- Introduction of Euro 7 vehicles
- Revision of Euro 5 motorcycles
- Bug corrections
- Planned updates for next year

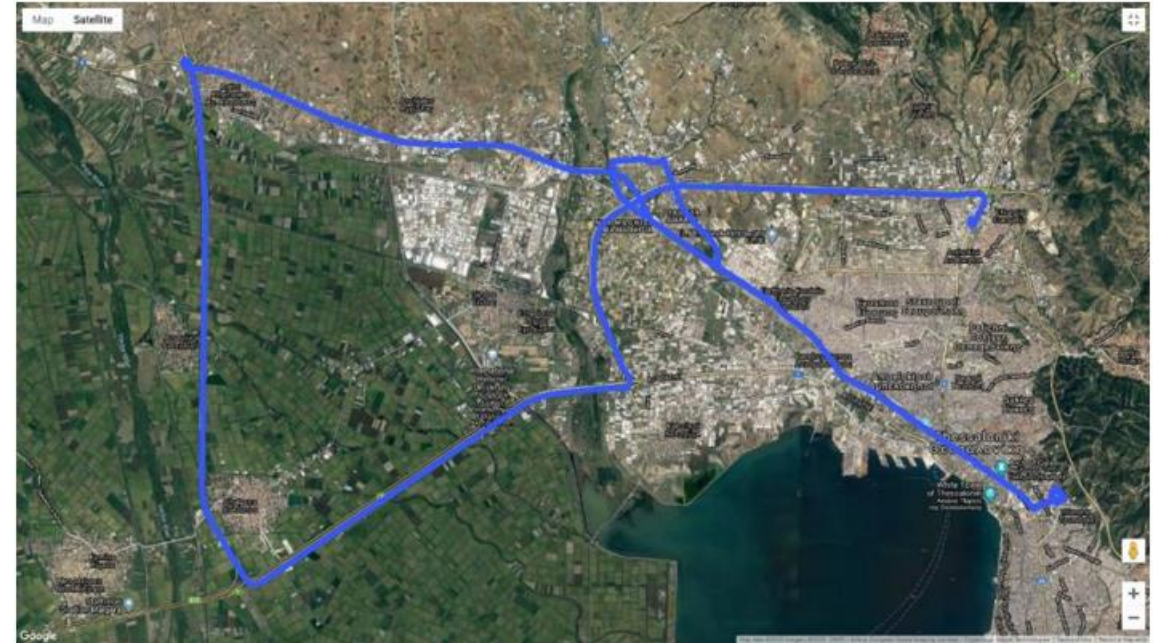


Revision of Euro 6 HEV/PHEV cars



Revision of Euro 6 HEV/PHEV cars (1/2)

- Vehicles updated
 - *Categories:* Passenger Cars
 - *Powertrains:* Petrol HEV/PHEV (CS mode)
 - *Segments:* Small/Medium/Large
 - *Euro standards:* Euro 6a/b/c, d-temp, d/e
- Measurements*
 - RDE Compliant & non-Compliant
 - 6 HEV/PHEV
 - Period 2020-2022
- Pollutants measured
CO, EC, SPN23, NOx

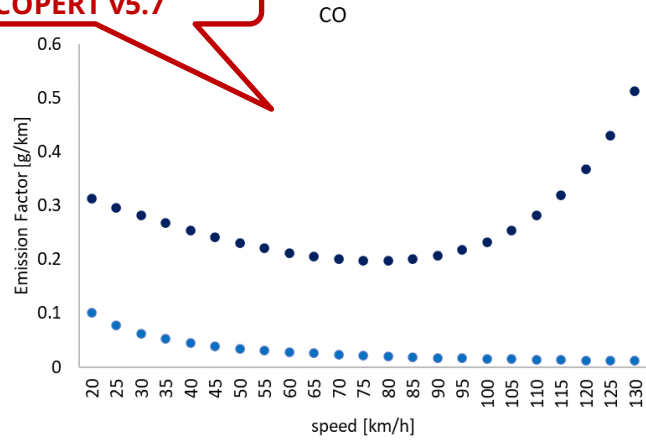


Regular RDE routes in Thessaloniki

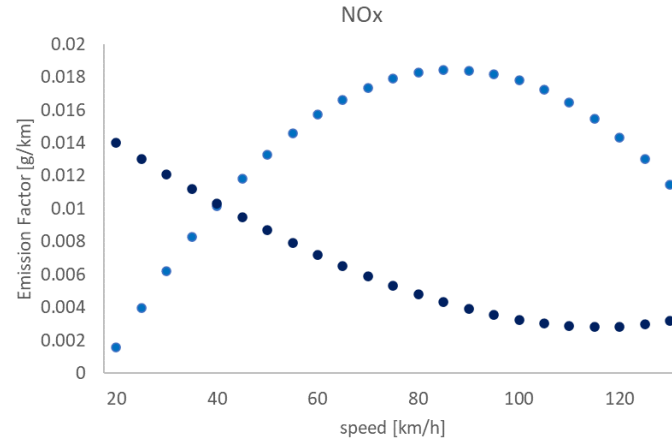
*Reference: Laboratory of Applied Thermodynamics (LAT), Aristotle University of Thessaloniki

Revision of Euro 6 HEV/PHEV cars (2/2)

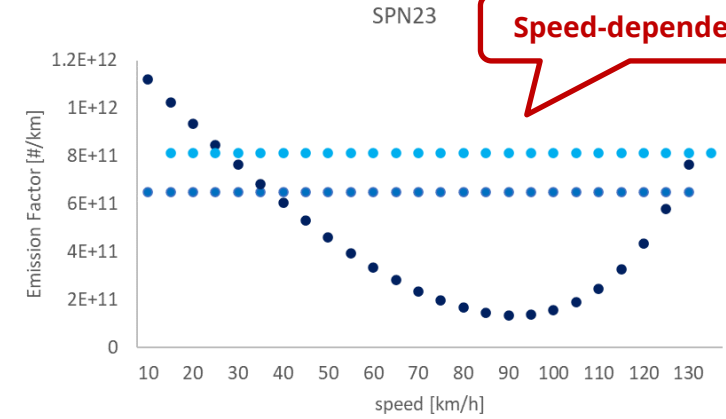
CO was underestimated in COPERT v5.7



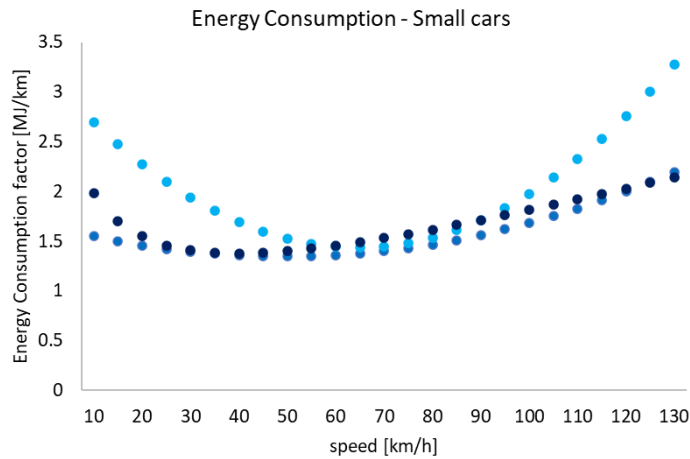
● COPERTv5.7 petrol Hybrid / PHEV (CS mode) ● COPERTv5.8 petrol Hybrid / PHEV (CS mode)



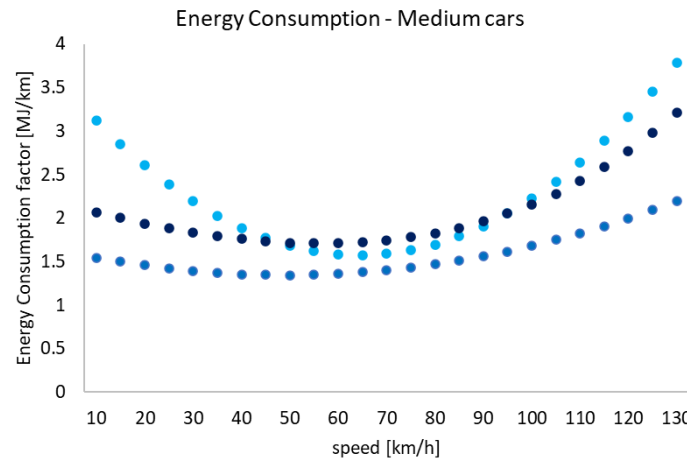
● COPERTv5.7 Petrol Hybrid / PHEV (CS mode) ● COPERTv5.8 petrol Hybrid / PHEV (CS mode)



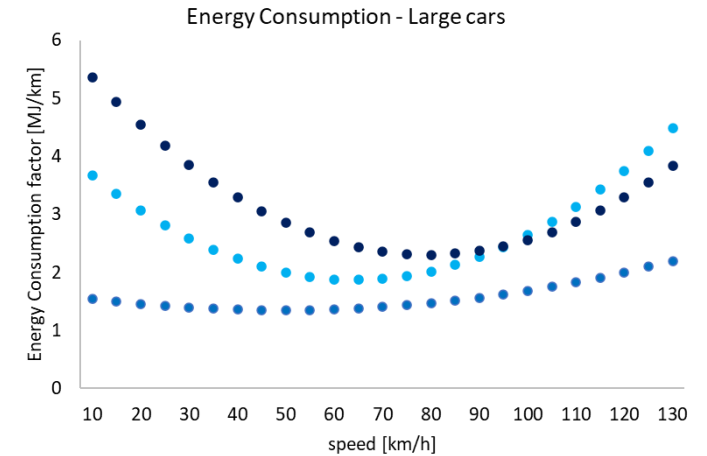
● COPERTv5.7 Petrol Hybrid / PHEV (CS mode) PFI
● COPERTv5.8 petrol Hybrid / PHEV (CS mode)
● COPERTv5.7 Petrol Hybrid / PHEV (CS mode) GDI



● COPERTv5.7 Petrol Hybrid
● COPERTv5.7 Small Petrol PHEV (CS mode)
● COPERTv5.8 Small petrol Hybrid / PHEV (CS mode)



● COPERTv5.7 Petrol Hybrid
● COPERTv5.7 Medium Petrol PHEV (CS mode)
● COPERTv5.8 Medium petrol Hybrid / PHEV (CS mode)



● COPERTv5.7 Petrol Hybrid
● COPERTv5.7 Large Petrol PHEV (CS mode)
● COPERTv5.8 Large petrol Hybrid / PHEV (CS mode)



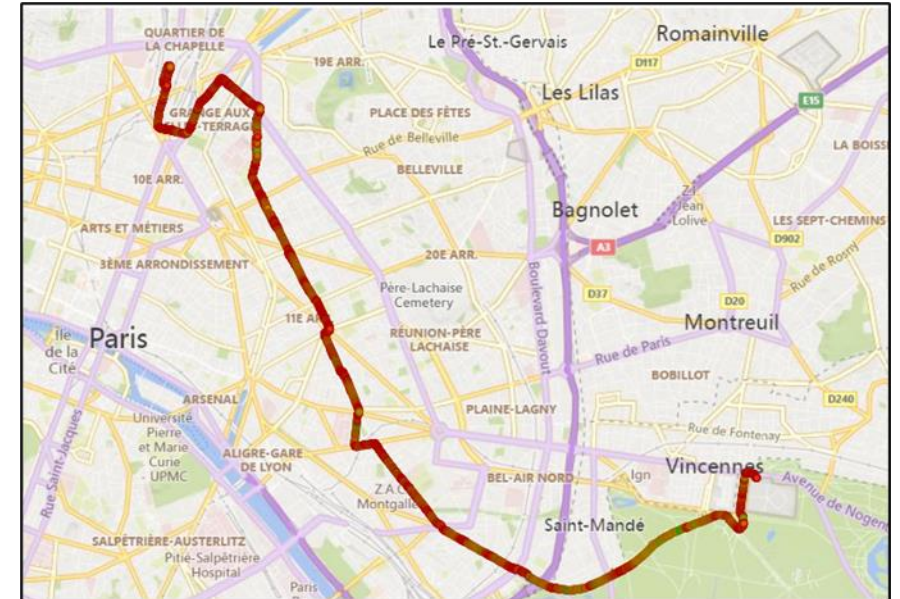
Introduction of Euro VI CNG & LNG HDVs



Introduction of Euro VI CNG & LNG HDVs (1/4)

- Vehicles introduced
 - *Categories:* Heavy-Duty Trucks & Buses
 - *Powertrains:* CNG & LNG (only for HDTs)
 - *Segments:*
 - HDTs: Rigid <7.5t, 7.5-12t, > 12t (only for CNG) & Articulated < 40t
 - Buses: Urban Buses <15t, 15-18t, > 18t (only for CNG)
 - *Euro standards:* Euro VI D/E
 - 7 gradients (-6% to +6%) & 3 loads (0%, 50%, 100%)
- Measurements
 - Simulated PEMS & chassis dyno data¹ for 5 HDTs & 6 Buses
 - Real operational conditions using PEMS² for 6 Buses
- Pollutants updated

CO, EC, NO_x, PM, PN, CH₄, VOC, N₂O, NH₃



CNG urban buses routes in Paris²

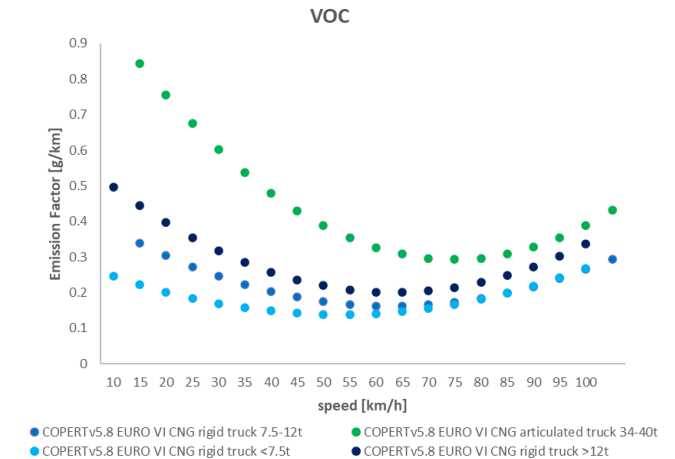
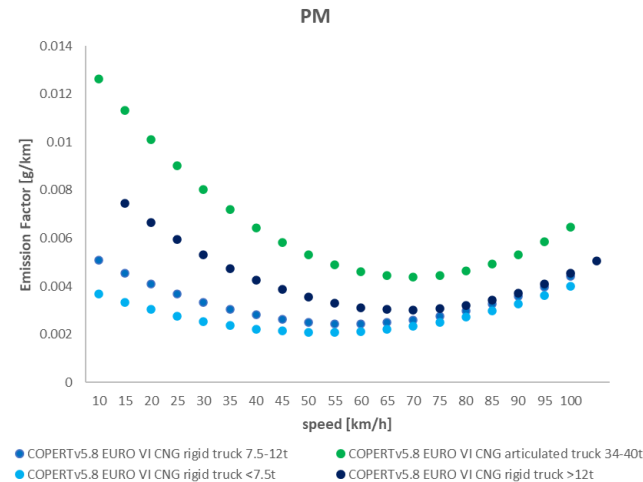
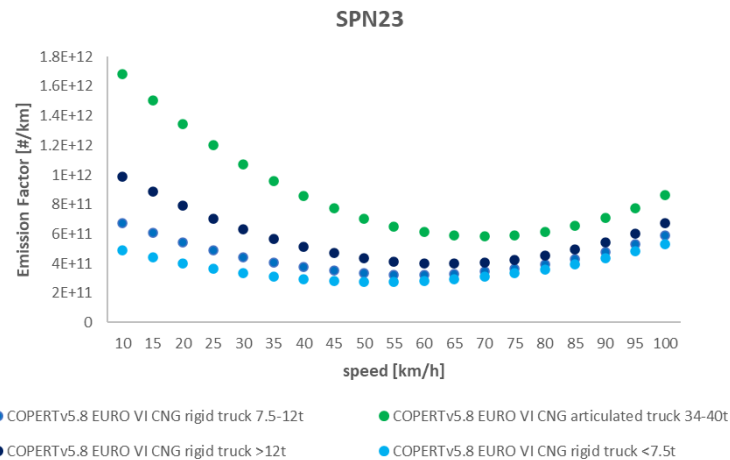
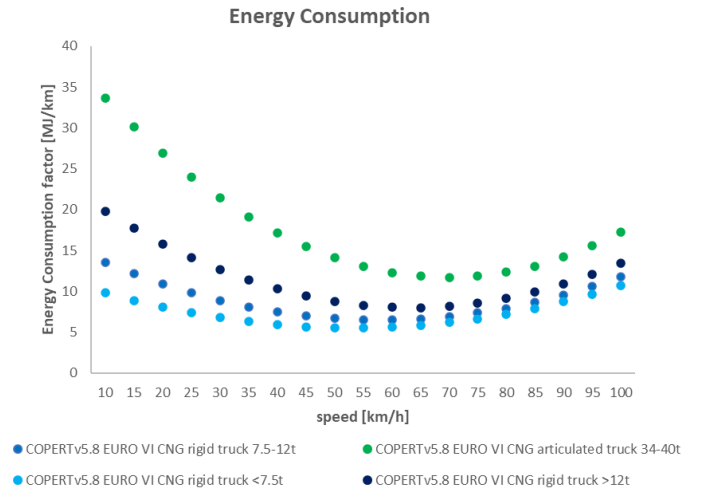
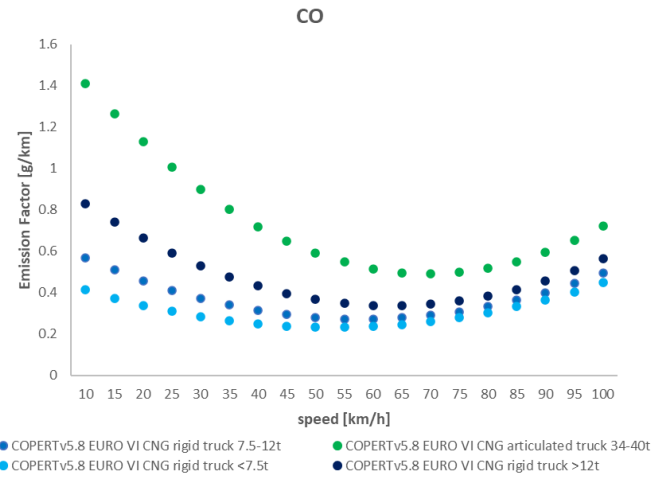
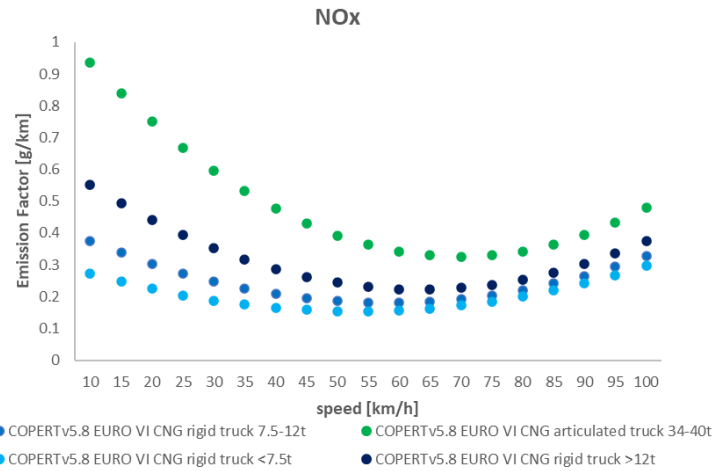
References:

¹ [HBEFA - Handbook Emission Factors for Road Transport](#)

² [AIRPARIF](#)

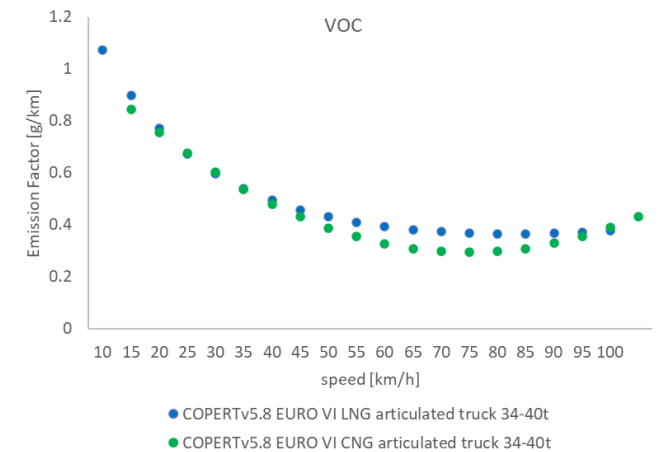
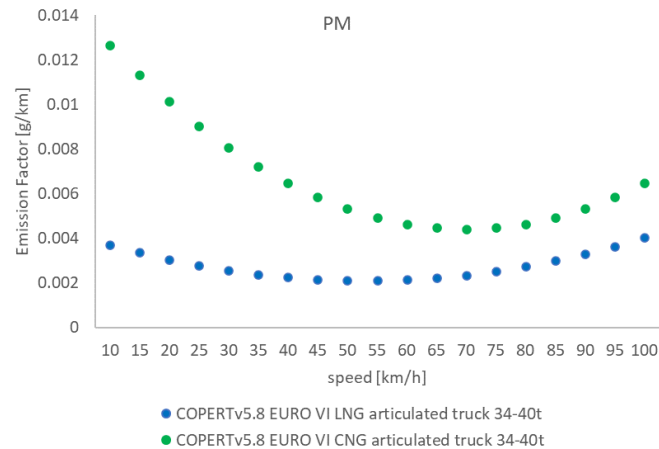
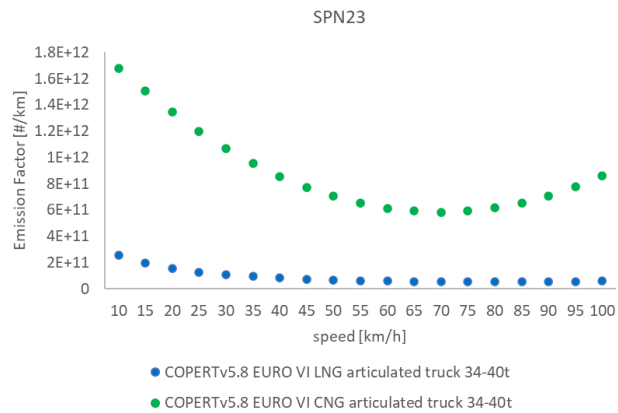
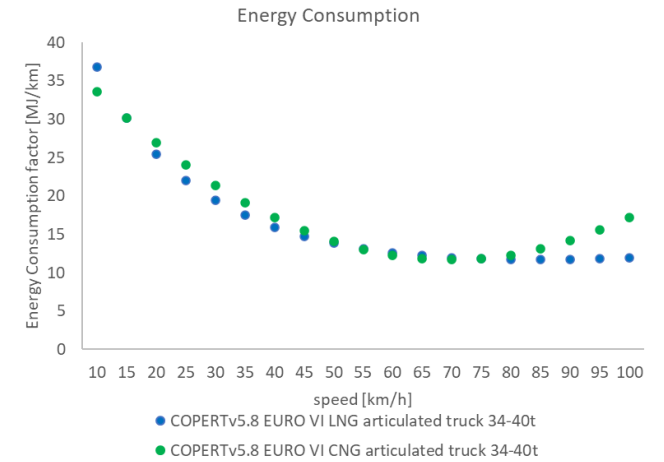
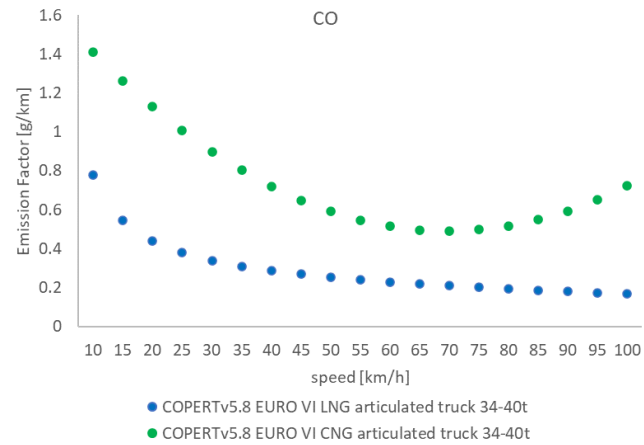
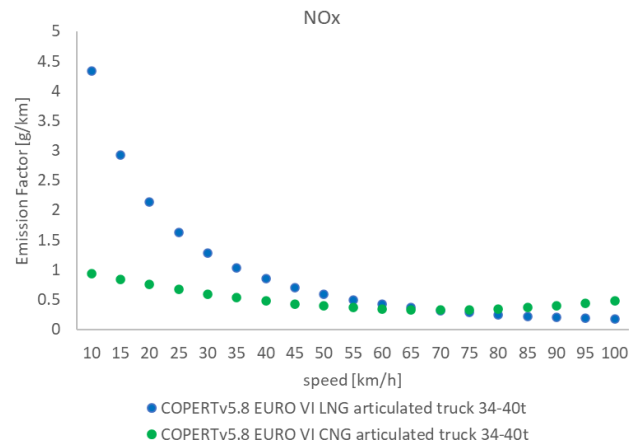
Introduction of Euro VI CNG & LNG HDVs (2/4)

CNG HDTs were not in COPERT v5.7 so comparison is done only among segments



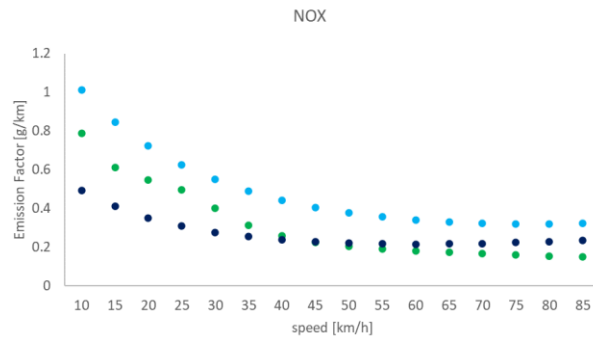
Introduction of Euro VI CNG & LNG HDVs (3/4)

LNG HDTs were not in COPERT v5.7 so comparison is done against CNG HDTs

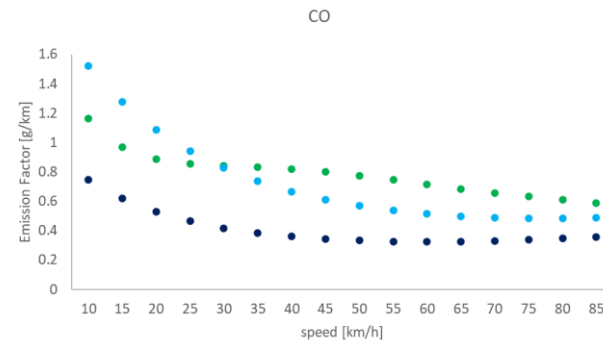


Introduction of Euro VI CNG & LNG HDVs (4/4)

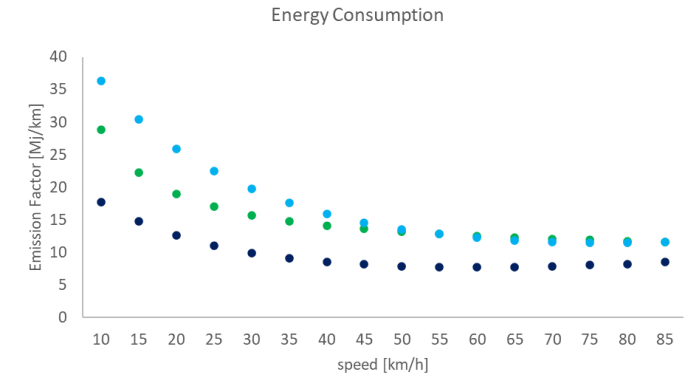
Euro VI CNG urban Buses were not in COPERT v5.7 so comparison is done only among segments



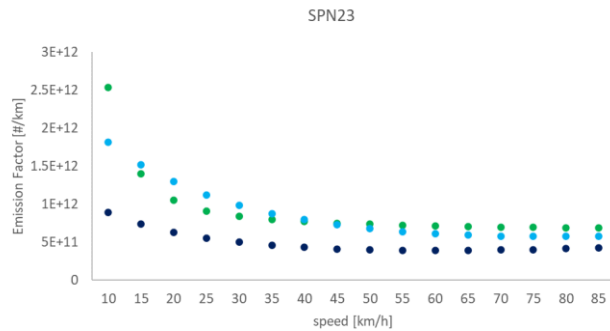
● COPERTv5.8 EURO VI CNG bus 15-18t ● COPERTv5.8 EURO VI CNG bus <15t ● COPERTv5.8 EURO VI CNG bus >18t



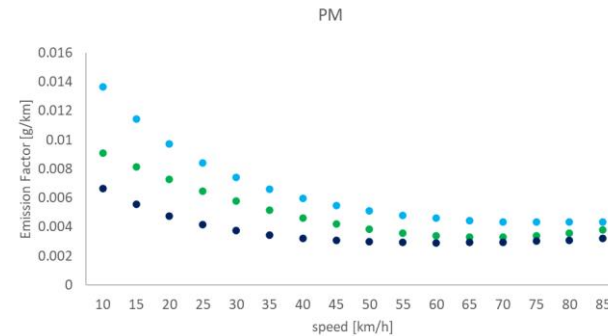
● COPERTv5.8 EURO VI CNG bus 15-18t ● COPERTv5.8 EURO VI CNG bus <15t ● COPERTv5.8 EURO VI CNG bus >18t



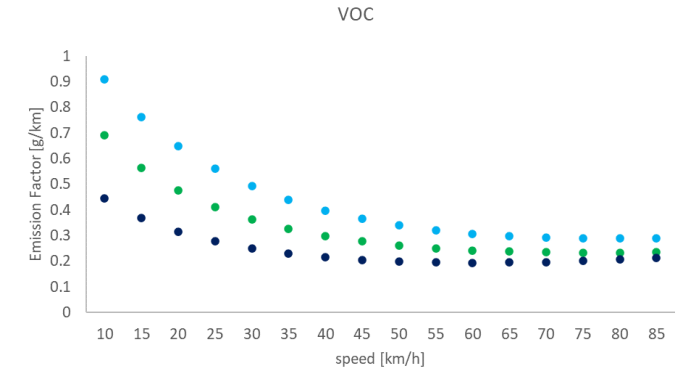
● COPERTv5.8 EURO VI CNG bus 15-18t ● COPERTv5.8 EURO VI CNG bus <15t ● COPERTv5.8 EURO VI CNG bus >18t



● COPERTv5.8 EURO VI CNG bus 15-18t ● COPERTv5.8 EURO VI CNG bus <15t ● COPERTv5.8 EURO VI CNG bus >18t



● COPERTv5.8 EURO VI CNG bus 15-18t ● COPERTv5.8 EURO VI CNG bus <15t ● COPERTv5.8 EURO VI CNG bus >18t



● COPERTv5.8 EURO VI CNG bus 15-18t ● COPERTv5.8 EURO VI CNG bus <15t ● COPERTv5.8 EURO VI CNG bus >18t



Revision of VOCs speciation of Euro 5/6 LDVs



VOCs Speciation of Euro 5/6 LDVs (1/2)

- Vehicles updated
 - *Categories:* Passenger Cars & Light Commercial Vehicles
 - *Powertrains:* Petrol/Diesel
 - *Segments:* Small/Medium/Large & N1-I/II/III
 - *Euro standards:* Euro 5 & 6
- Measurements*
 - Artemis Driving cycle (Urban cold - Motorway)
 - Three Euro 5 vehicles (1 diesel - 2 petrol PFI/GDI)
- Pollutants updated
NMVOCs speciation

Groups	Species
Alkanes	ethane, propane, butane, isobutane, pentane, isopentane, hexane, heptane, octane, 2-methylhexane, nonane, 2-methylheptane, 3-methylhexane, decane, 3-methylheptane, alkanes C10-C12, alkanes C>13
Cycloalkanes	All
Alkenes	ethylene, propylene, propadiene, 1-butene, isobutene, 2-butene, 1,3-butadiene, 1-pentene, 2-pentene, 1-hexene, dimethylhexene
Alkynes	1-butine, propine, acetylene
Aldehydes	formaldehyde, acetaldehyde, acrolein, benzaldehyde, crotonaldehyde, methacrolein, butyraldehyde, isobutanaldehyde, propionaldehyde, hexanal, i-valeraldehyde, valeraldehyde, o-tolualdehyde, m-tolualdehyde, p-tolualdehyde
Ketones	acetone, methylethylketone
Aromatics	toluene, ethylbenzene, m,p-xylene, o-xylene, 1,2,3 trimethylbenzene, 1,2,4 trimethylbenzene, 1,3,5 trimethylbenzene, styrene, benzene, C9, C10, C>13
Others	Others

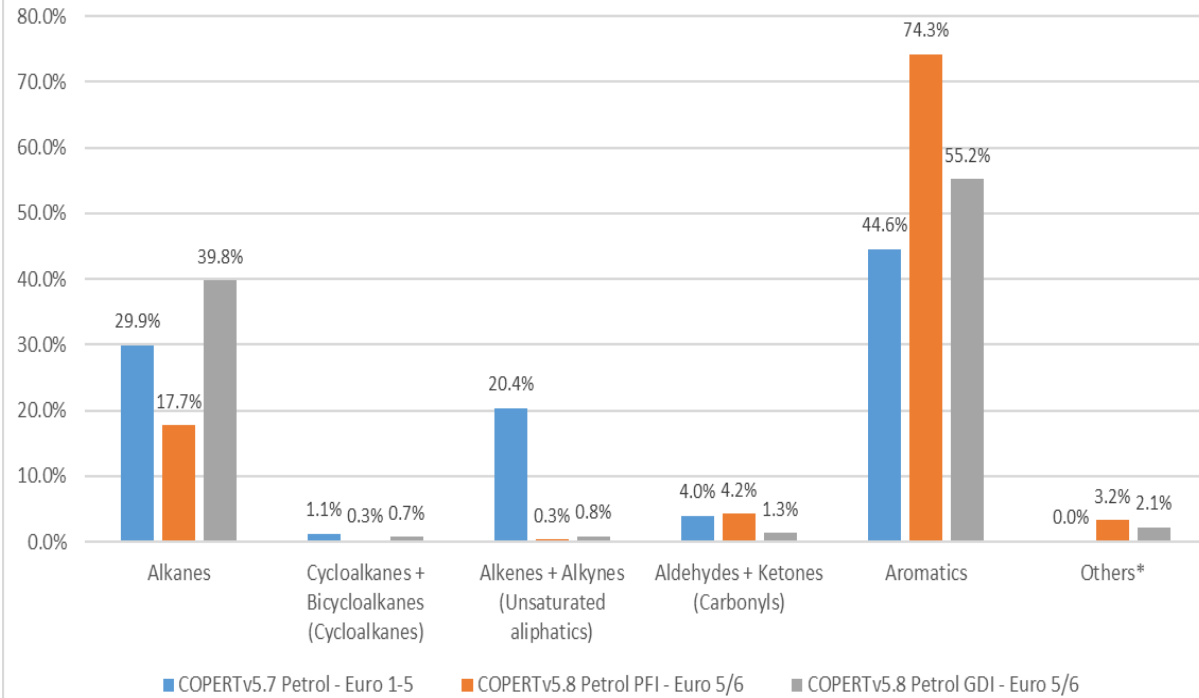
*Reference: [Baptiste et al. \(2022\)](#)



VOCs Speciation of Euro 5/6 LDVs (2/2)

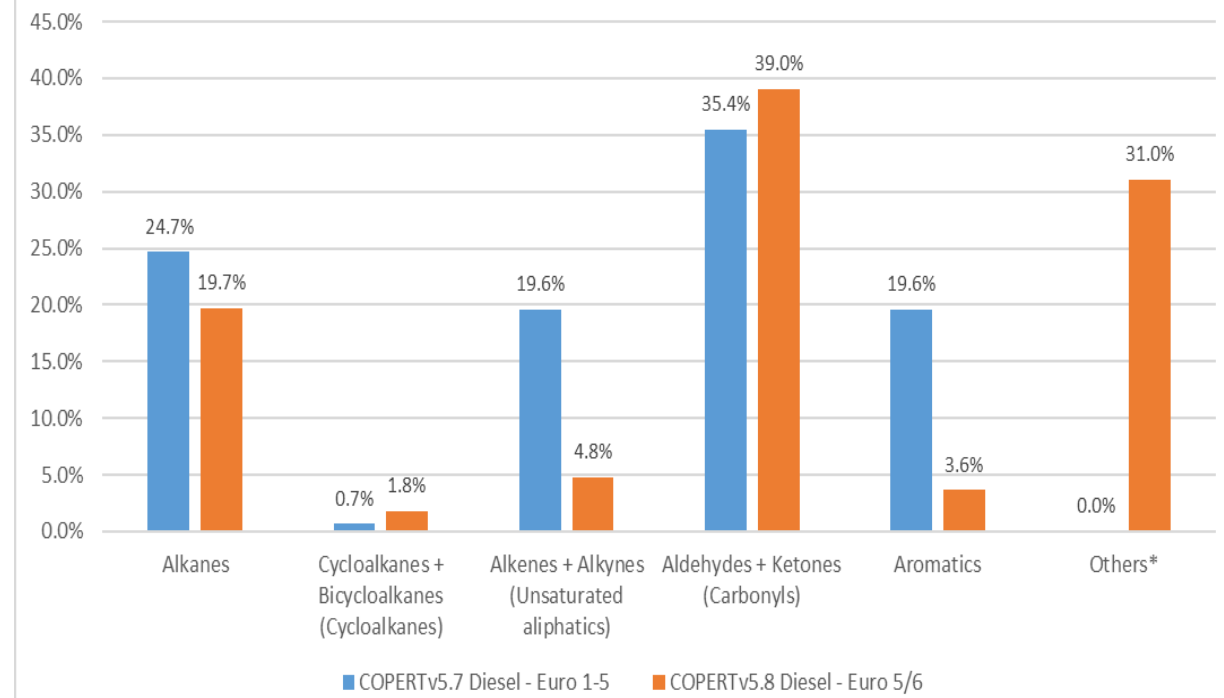
Larger differences for alkanes, alkenes, alkynes & aromatics

VOC speciation petrol PCs



Larger differences for alkenes, alkynes & aromatics

VOC speciation diesel PCs



*Others: Alcohols, Acids, Nitrogen

Revision of Energy Consumption of BEVs



Revision of Energy Consumption of BEVs (1/2)

- Vehicles introduced/updated
 - *Categories:* Passenger cars, Light-Commercial Vehicles, Urban Buses
 - *Powertrains:* Battery Electric
 - *Segments:* All
 - *Euro standards:* Euro 6/VI
 - w/wo A/C
- Measurements of energy consumption
 - Simulation data^{1,2} for >100 popular standardized driving cycles validated by real data for calculating EC over speed
 - Several databases^{3,4,5} for differentiation among S/M/L
 - Data from WLTC⁶ for consumption of A/C

References:

¹ [Mamarikas et al. \(2022\)](#)

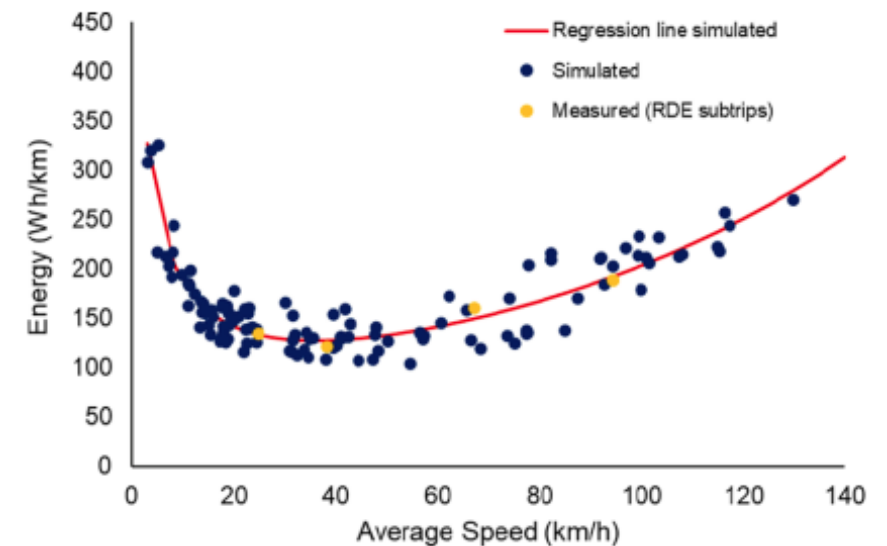
² [Mamarikas \(2024\)](#)

³ [EEA](#)

⁴ [Spritmonitor.de](#)

⁵ [EV Database](#)

⁶ [S Gil-Sayas et al. \(2023\)](#)



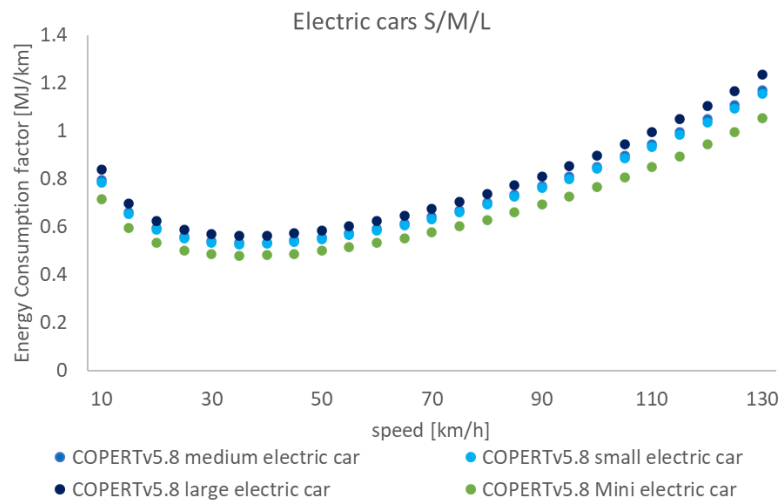
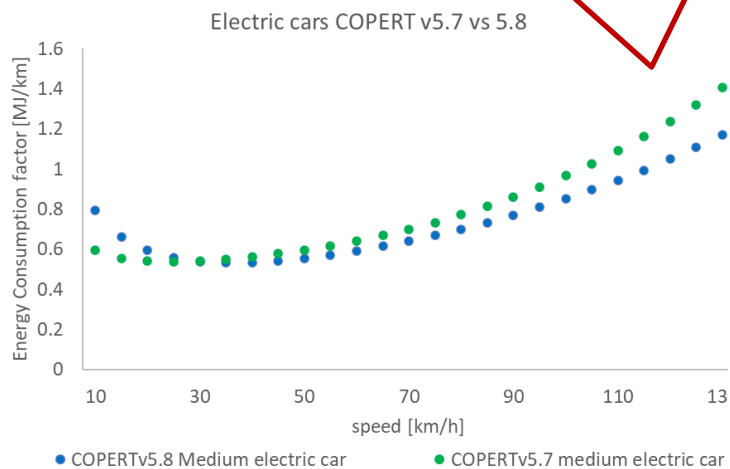
BEV simulated energy consumption over speed¹

	Average Mass [kg]	Motor Power [kW]	Avg. Energy Consumption [Wh/km]
Mini	1250	< 50	174
Small	1650	50 - 80	192
Medium	1800	80 - 145	194
Large	2100	> 145	204

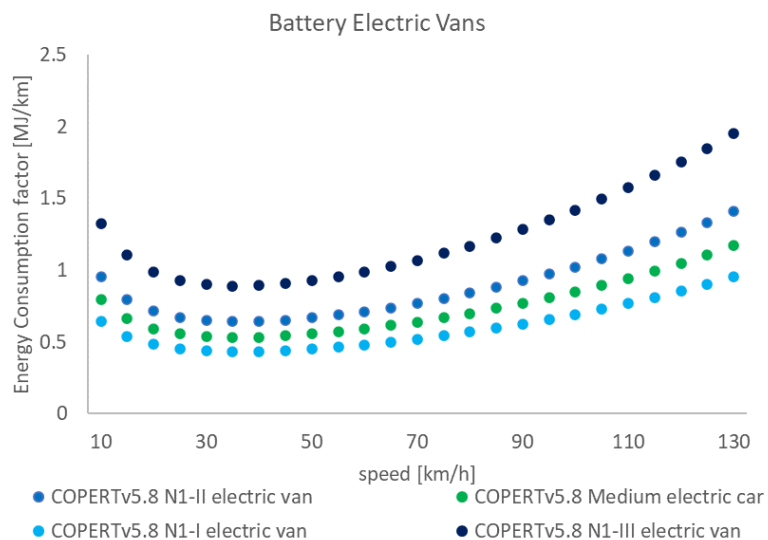
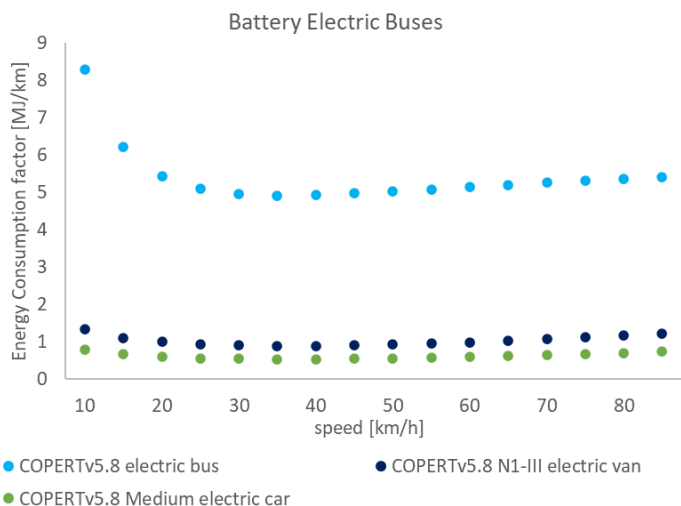
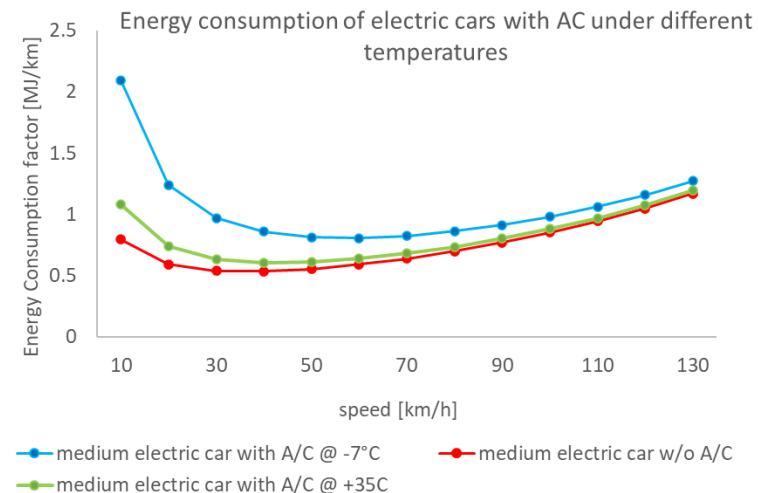
Classification of battery electric cars based on motor power

Revision of Energy Consumption of BEVs (2/2)

Higher energy demand on high speeds than v5.7



Higher energy consumed for heating in low temperatures and in low speeds



Vehicle	Average Mass [kg]	Avg. Energy Consumption [Wh/km]
N1-I	< 1305	158
N1-II	1305-1760	233
N1-III	> 1760	324

Classification of battery electric vans based on mass

Revision of cold PM & BC of Euro 5/6 LDVs



Revision of cold PM & BC of Euro 5/6 LDVs (1/2)

- Vehicles

- *Categories:* Passenger cars, Light-Commercial Vehicles
- *Powertrains:* Petrol, Diesel, CNG
- *Segments:* All
- *Euro standards:* Euro 5/6

- Measurements*

- 21 vehicles (13 of them Euro 5/6)
- NEDC cycle
- Several tests @ -7 °C and selectively @ +23 °C

- Pollutants updated

Cold PM & BC

Emission standard	Car/Fuel	No of cars	Temperature (°C)	No of tests per car/fuel
Euro 2/3	Diesel/ Diesel fuel	3	+23, +5, -7	2-8
Euro 2	NGV/CNG	1	+23, +5, -7	2
Euro 3	MPI, DISI/ Gasoline	2	+23, +5, -7	2
Euro 3/4	FFV-MPI/ E85	2	+23, +5, -7	2
Euro 5	Diesel/ Diesel fuel	3	+23, -7	2
Euro 5	MPI, DISI/ Gasoline	4	+23, -7	2
Euro 5	FFV/E85, Gasoline	2	+23, -7	2
Euro 6	DISI/ Gasoline	1	-7	7
Euro 6	FFV/E85	1	-7	7
Euro 6	Diesel/ Diesel fuel	1	-7	4
Euro 6	NGV/CNG	1	-7	4

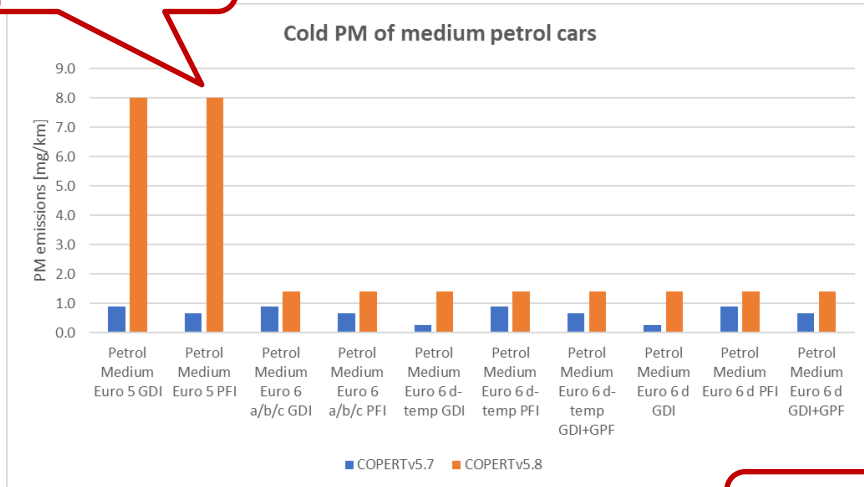
*Cars tested by VTT**

*Reference: [VTT Technical Research Centre of Finland](#)

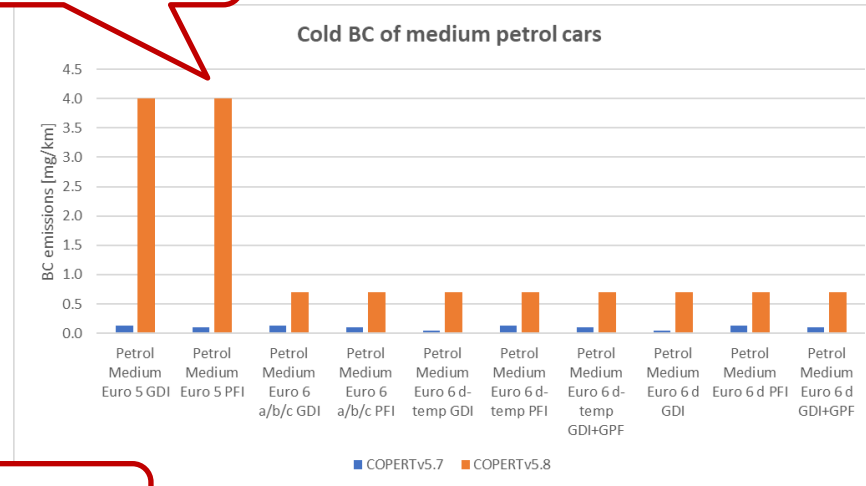


Revision of cold PM & BC of Euro 5/6 LDVs (2/2)

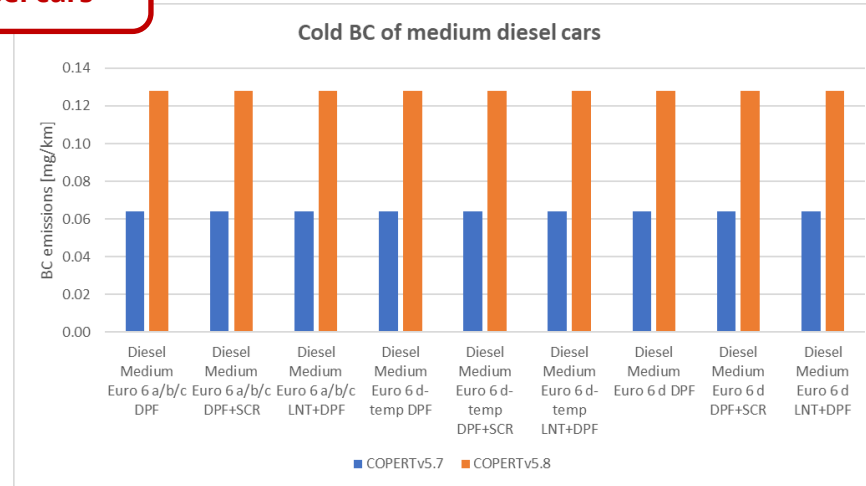
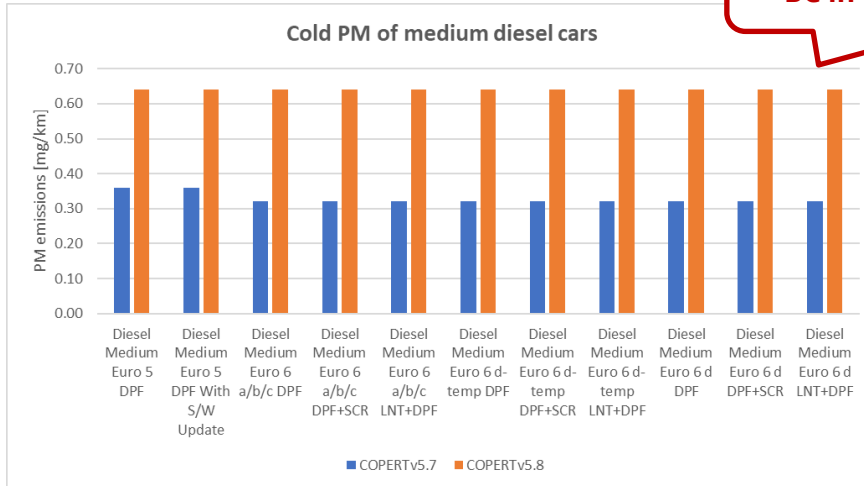
Much higher PM emissions in cold-start especially for Euro 5 petrol cars



Much higher BC emissions in cold-start for both Euro 5 and 6 petrol cars



Underestimations of cold PM & BC in v5.7 also for diesel cars



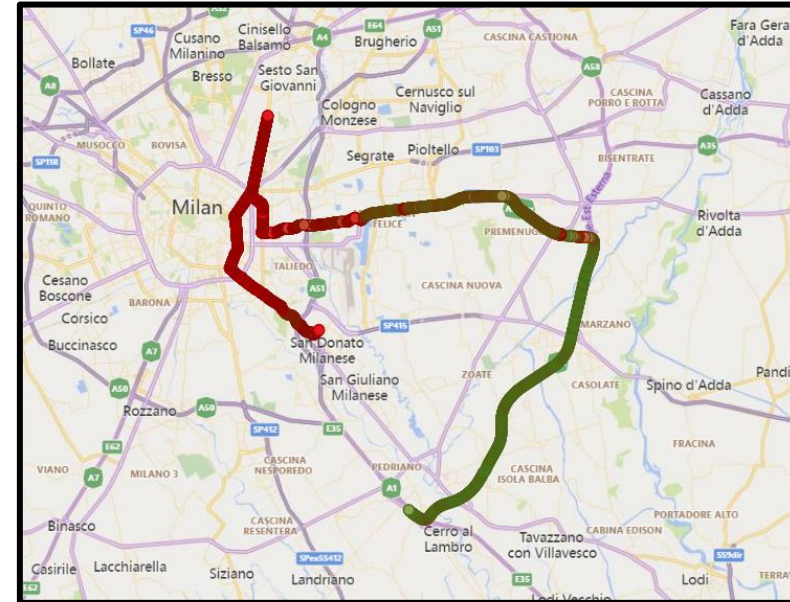
Revision of EC of Euro 6 LPG passenger cars



Revision of EC of Euro 6 LPG passenger cars (1/2)

- Vehicles updated
 - *Categories:* Passenger Cars
 - *Powertrains:* LPG
 - *Segments:* Mini/Small/Medium/Large
 - *Euro standards:* Euro 6 a/b/c, d/e, d-temp
- Measurements*
 - Chassis cycles (WLTC, NEDC, ECE...)
 - RDE (on road measurements)
- Pollutants updated

Energy Consumption only
(NO_x, CO, VOC, SPN23, CH₄ updated in v5.6)



RDE cycle in Milan

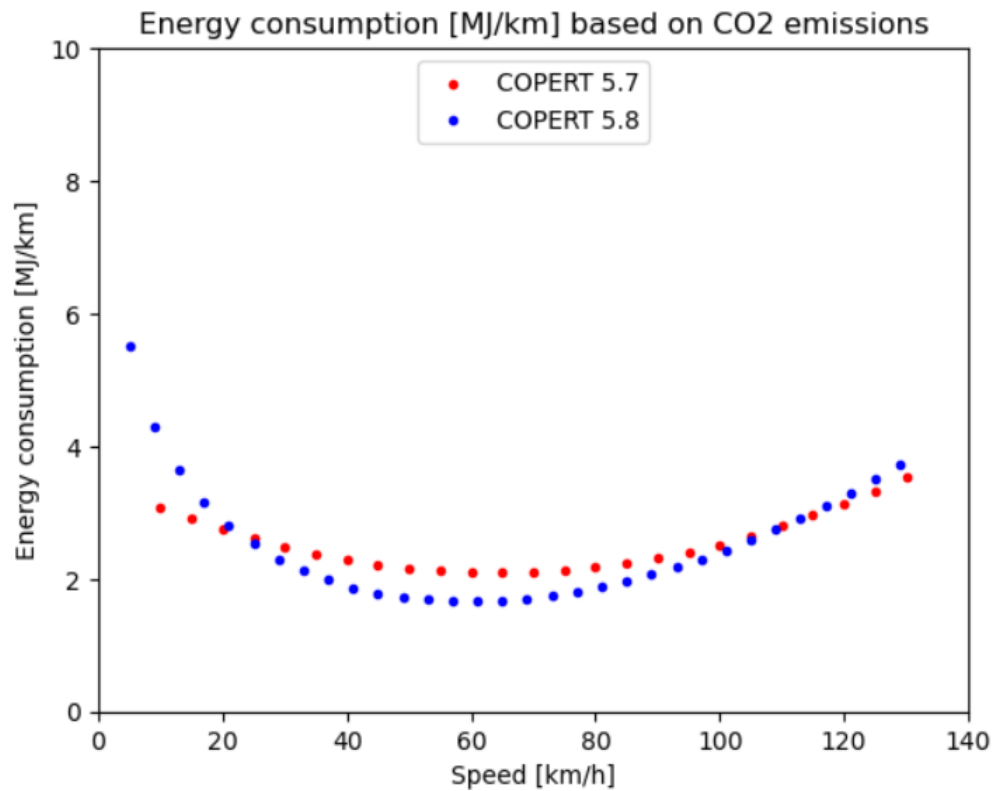
*Reference: Laboratory and On-road cycles (conducted by Innovhub in Italy)



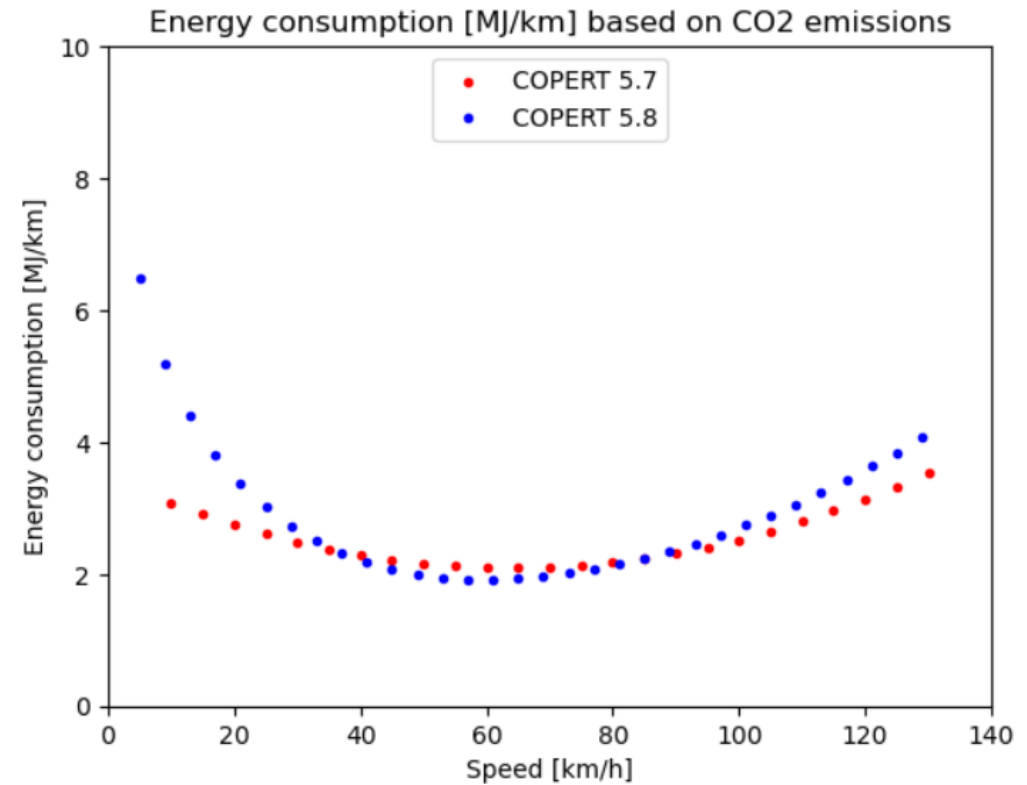
Revision of EC of Euro 6 LPG passenger cars (2/2)

Small differences between COPERT v5.7 & v5.8 – Larger differences for low speeds

Mini/Small



Medium/Large



Introduction of Euro 7 vehicles



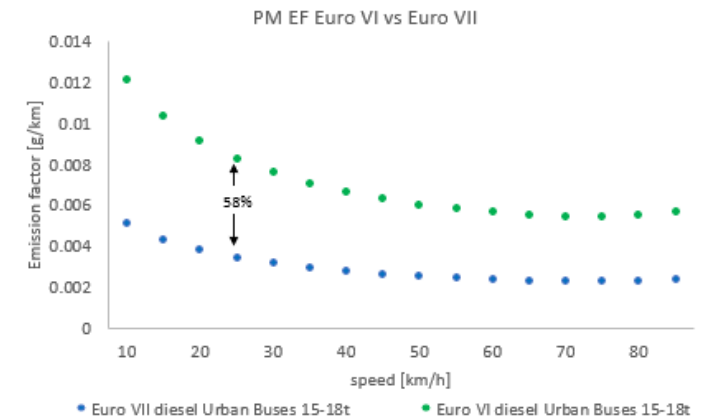
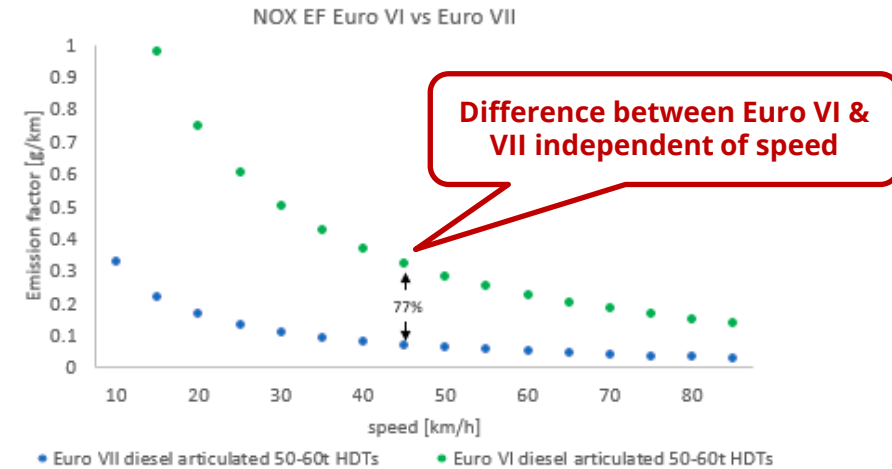
Introduction of Euro 7 vehicles

- Euro 7 LDVs & HDVs introduced in COPERT v5.8
- Numbers based on:
 - Euro 7 Impact Assessment Study¹ of CLOVE
 - Euro 7 agreed emission limits
 - Our expertise
- Euro 7 emission factors (compared to Euro 6/VI)
 - LDVs: Euro 6 exhaust emission factors with no degradation factors due to OBM & reduced (compared to Euro 6) non-exhaust emission factors
 - HDVs: Reduced (compared to Euro VI) emission factors for various pollutants by a % factor



¹ [Euro 7 impact assessment study](#)

² [Regulation \(EU\) 2024/1257](#)



Examples of Euro VII emission factors in COPERTv5.8



Revision of Euro 5 motorcycles



Revision of Euro 5 motorcycles (1/2)

- Vehicles updated
 - *Categories:* L-Category (Motorcycles)
 - *Powertrains:* Petrol
 - *Segments:* <250 cm³, 250-750 cm³, >750 cm³
 - *Euro standards:* Euro 5
- Measurements*
 - 10 Euro 5 L-category vehicles
 - Chassis dynamometer tests using WMTC & RDC
 - On-road RDE tests
 - Locations: Thessaloniki & Gratz
- Pollutants measured

EC, CO, NO_x, PM, PN, VOC, CH₄

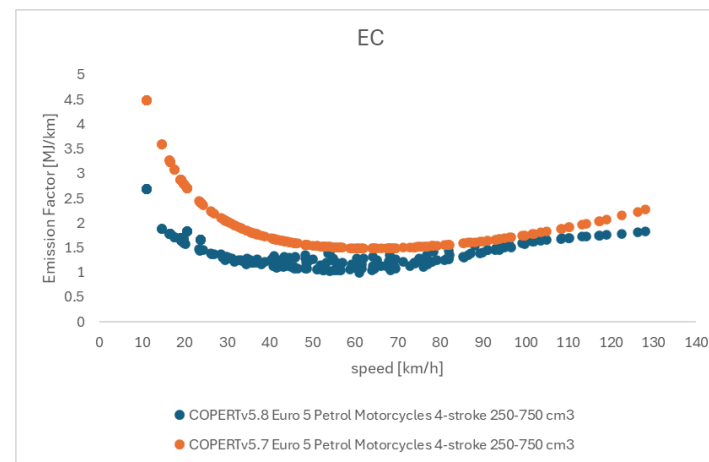
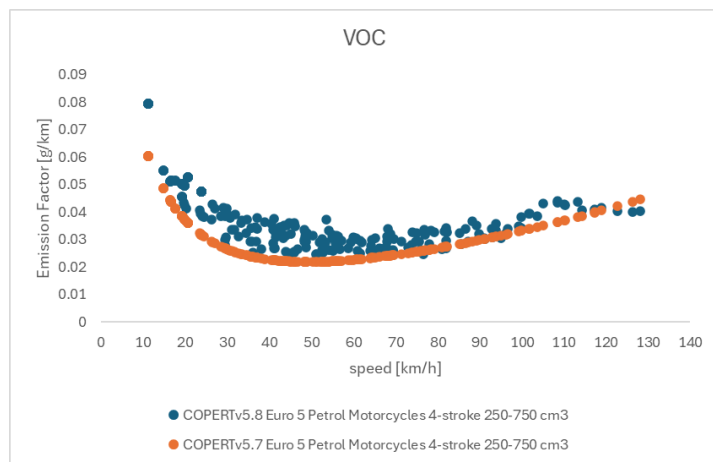
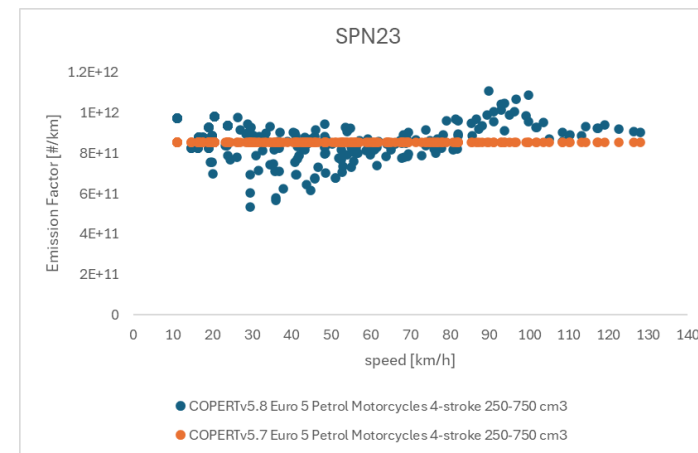
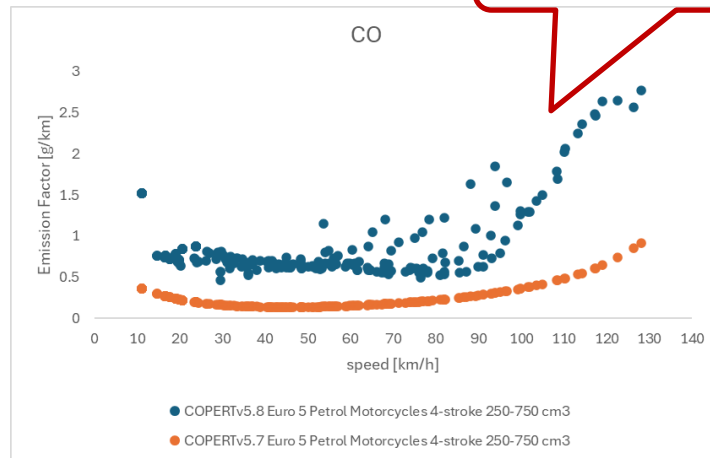
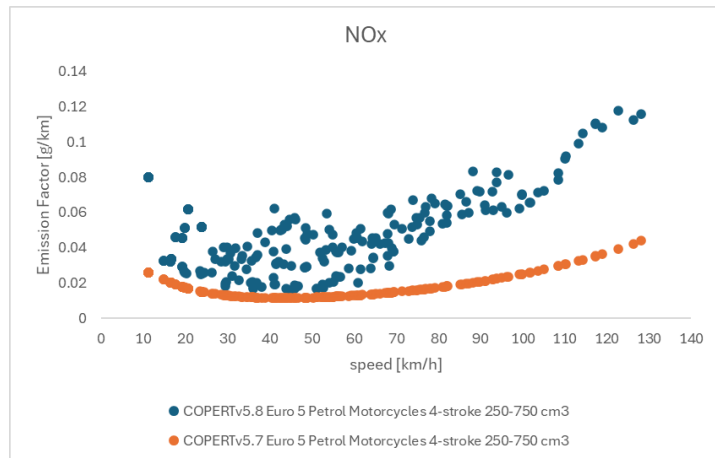


In-lab emissions testing by EMISIA in LAT

*Reference: EMISIA, TUG

Revision of Euro 5 motorcycles (2/2)

Great difference in high speeds due to rich combustion



Bug corrections in COPERT v5.8



Bug corrections in COPERT v5.8

- Cold PM & PN emissions for Euro 4 and older Petrol/LPG/CNG vehicles
- PM, PN emission factor of CNG/LPG Euro 5 & 6 vehicles
- CH4 emission factor of LPG cars
- Minor issues



Planned updates for next year



Planned updates for next year

- Revision of non-exhaust emission factors from brake wear
 - PM & PN
 - LDV & HDV
- Potential updates on tyre wear emissions
- Revision of emission factors from L-category vehicles
- VOC speciation of Euro 6 vehicles
- Revision of energy consumption factors of LDVs based on OBFCM data
- Regular updates



Thank you for your attention!

