Traianos Karageorgiou| 2023-04-18| TFEIP meeting

Guidebook and COPERT updates
Chapters 1.A.3.b/ Road Transport

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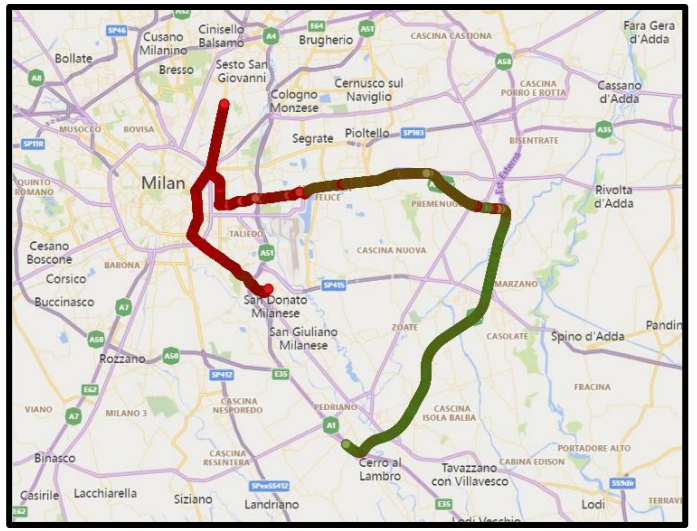
New elements in 2023

- Revision of Euro 6 CNG passenger cars
- Revision of Euro VI diesel & diesel hybrid buses
- Revision of non-exhaust emission factors
- Bug corrections in COPERTv5.6.5 for NOx, CO, VOC cold emissions
- HDVs classification based on REG EU 2017/2400
- Planned updates for next year

Revision of Euro 6 CNG passenger cars

Vehicle measurements

- Vehicles
  - Categories: 2 passenger cars (Euro 6d-temp)
  - Euro Standards: Euro 6d-temp
  - Engine size: 1.0 & 1.5 l
- Measurements
  - Laboratory and On-road cycles (conducted by Innovhub in Italy)
- Pollutants measured
  - NOx, CO, VOC, SPN23, CH4 & EC



RDE cycle in Milan (Low speed – High Speed)

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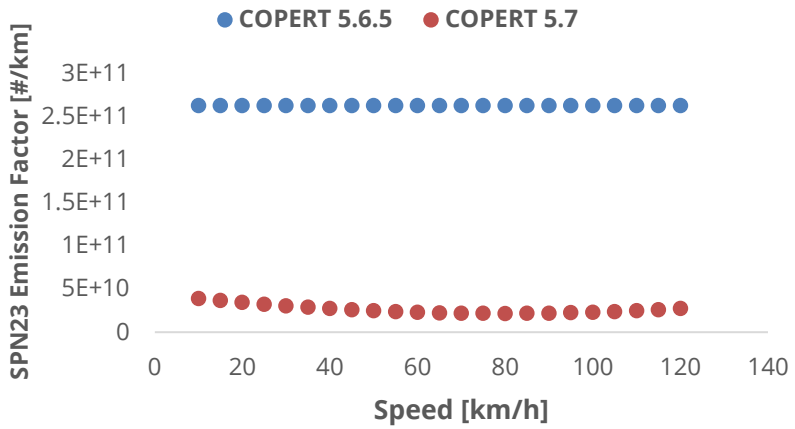
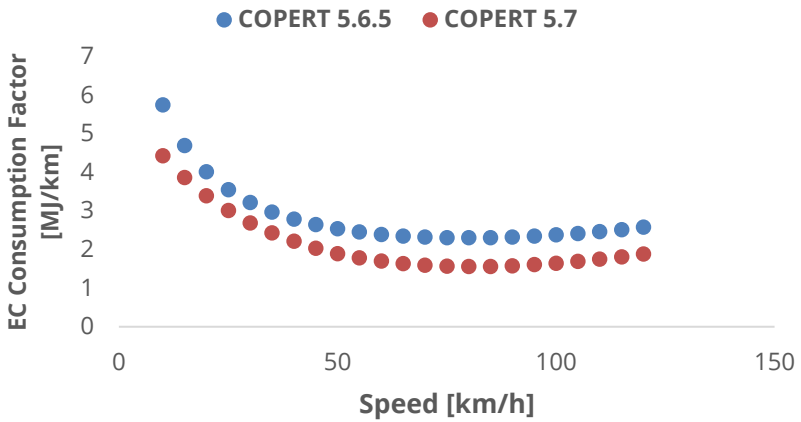
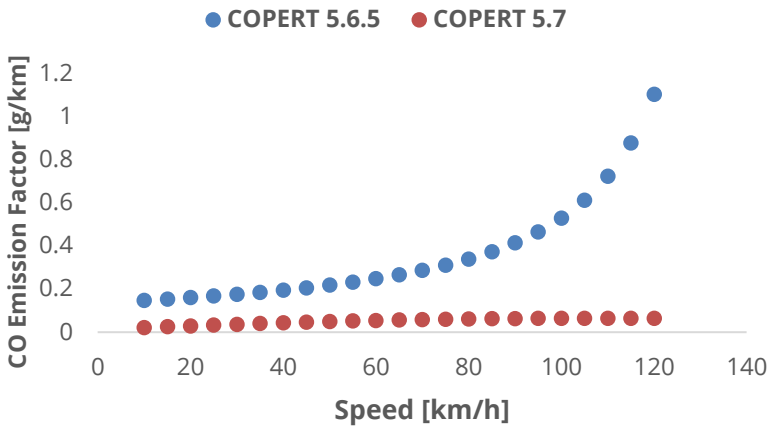
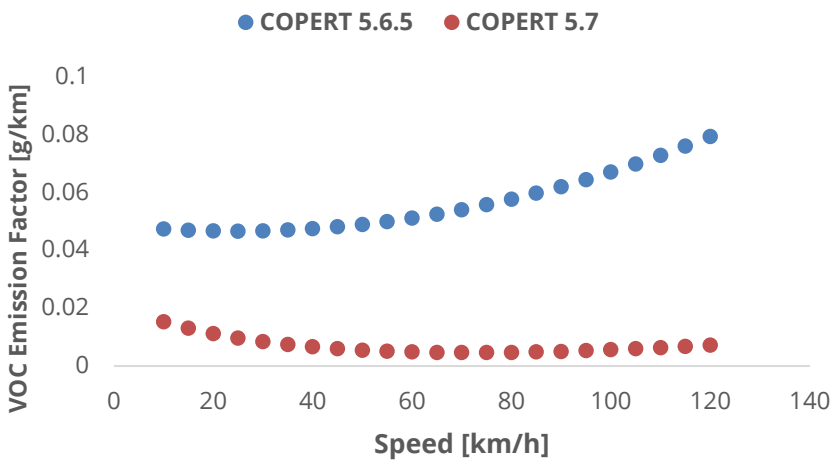
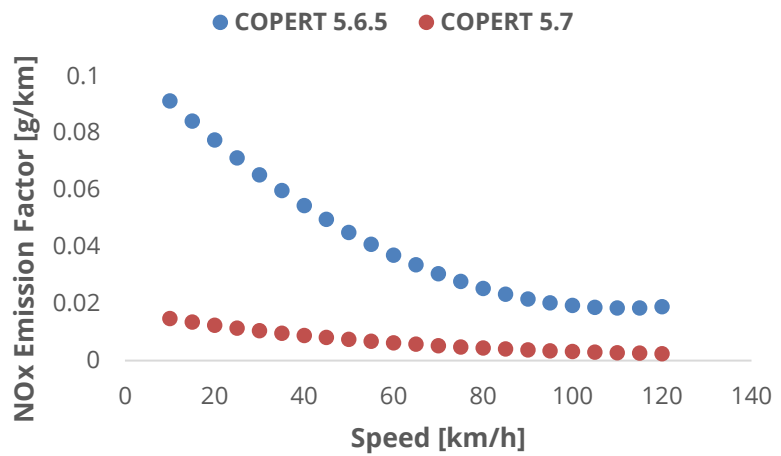
Revised equations

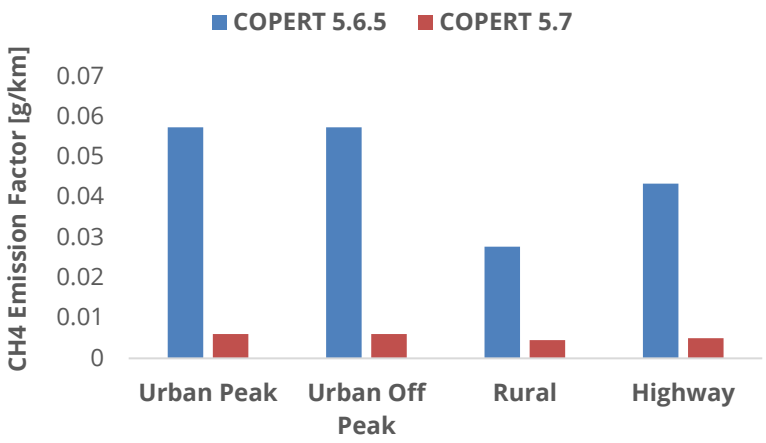












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Conclusions

Euro 6d-temp CNG Passenger Cars

- Energy consumption shows the same trend, but with lower values for the entire speed range.
- CO, HC, NOX & SPN23 emissions are lower than COPERTv5.6 for all speeds.
- CH4 emissions are lower than COPERTv5.6, in every mode. Highest change is noticed in urban mode.

Vehicles affected by the last update

Category	Fuel	Technology	Segment
Passenger Car	CNG	Euro 6d-temp	Mini/ Small/ Medium/ Large-SUV
Passenger Car	CNG	Euro 6d	Mini/ Small/ Medium/ Large-SUV

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Revision of Euro VI diesel & diesel hybrid buses

Vehicle measurements

- Vehicles

Category	Buses	Buses
Fuel	Diesel	Diesel hybrid
Euro Standard	Euro VI A/B	Euro VI A/B
Number of vehicles	6	5
Segment	Urban Buses Standard 15 – 18 t	Urban Buses Diesel Hybrid

- Measurements

  On-road measurements in Paris (conducted by AirParif)

- Pollutants measured:

  NOx, CO, SPN23 & EC

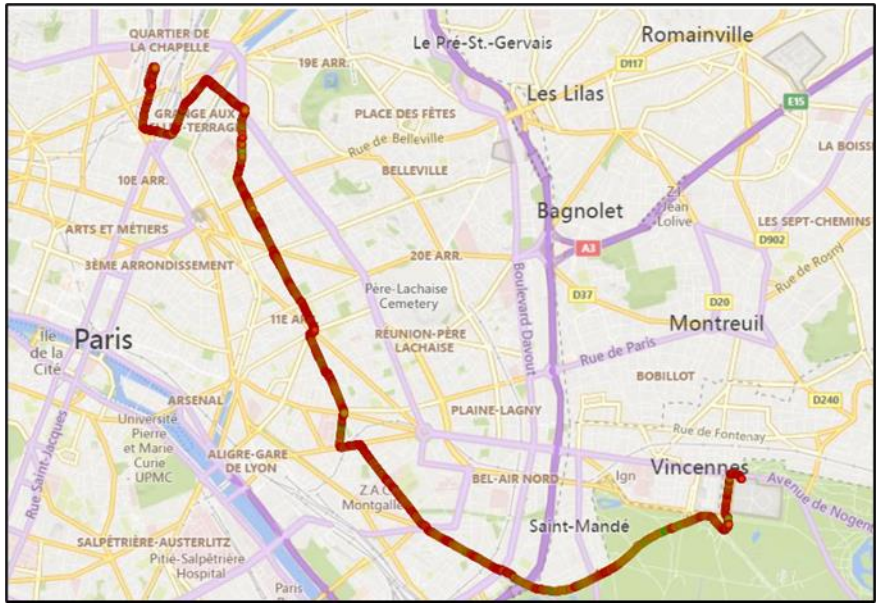

Figure x: Road trip example

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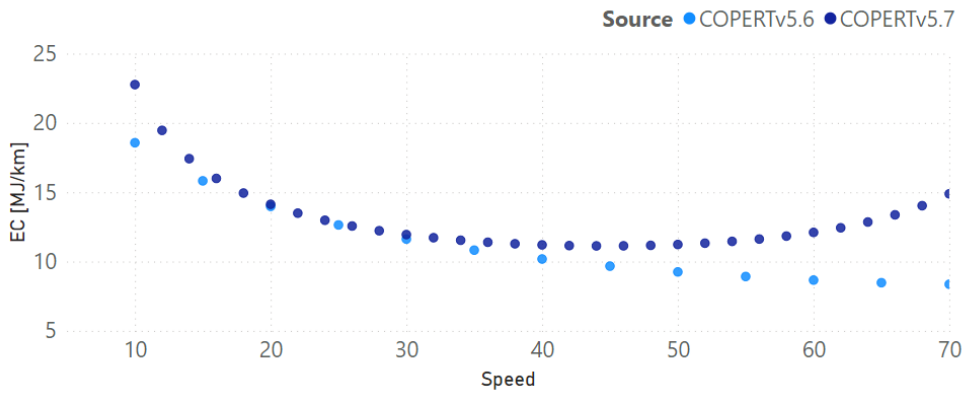
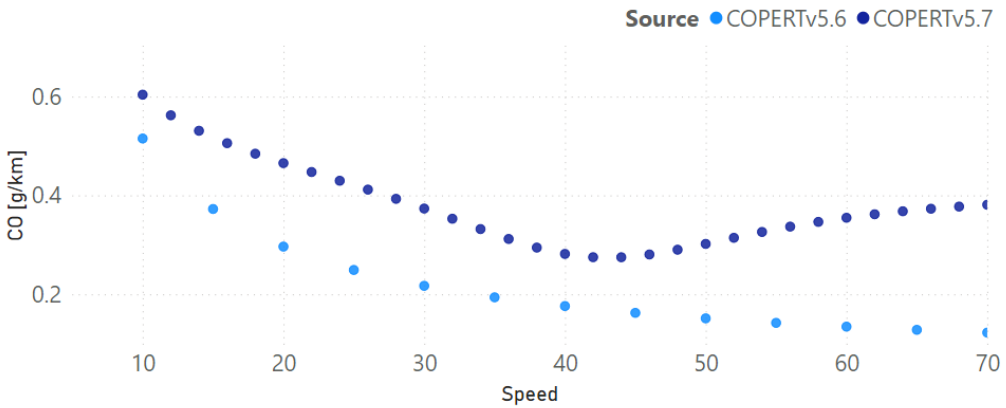
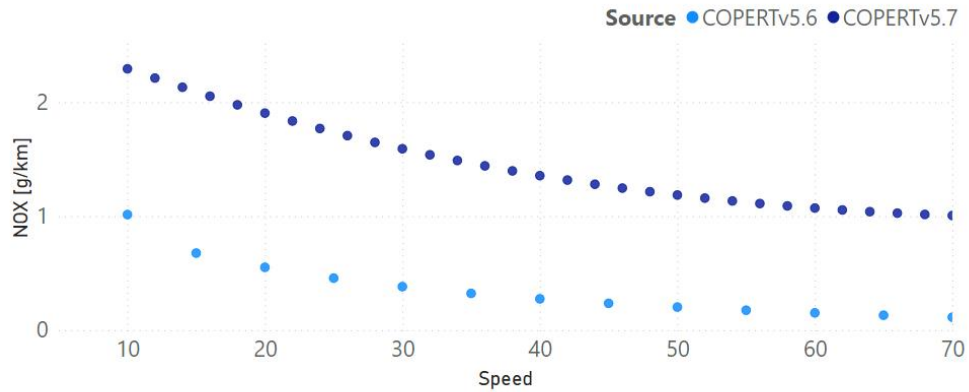
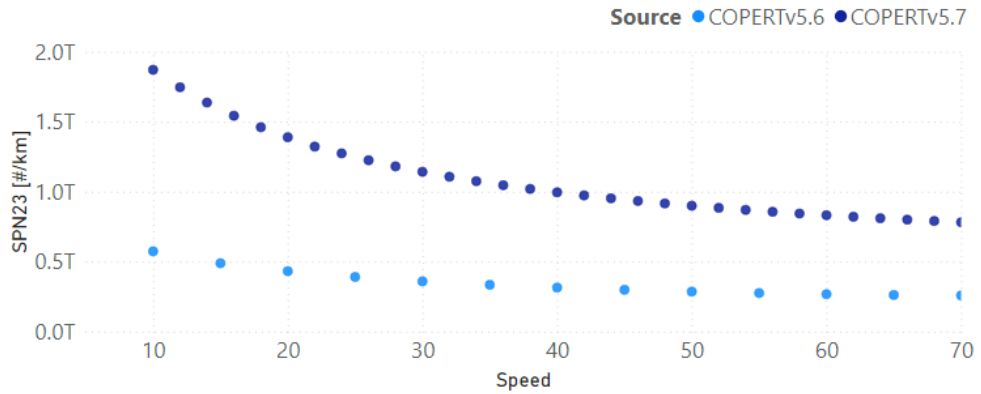
Euro VI diesel buses









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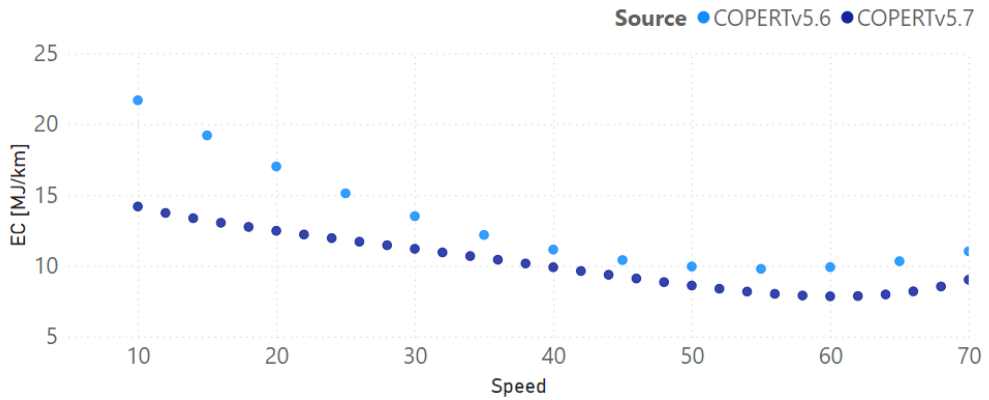
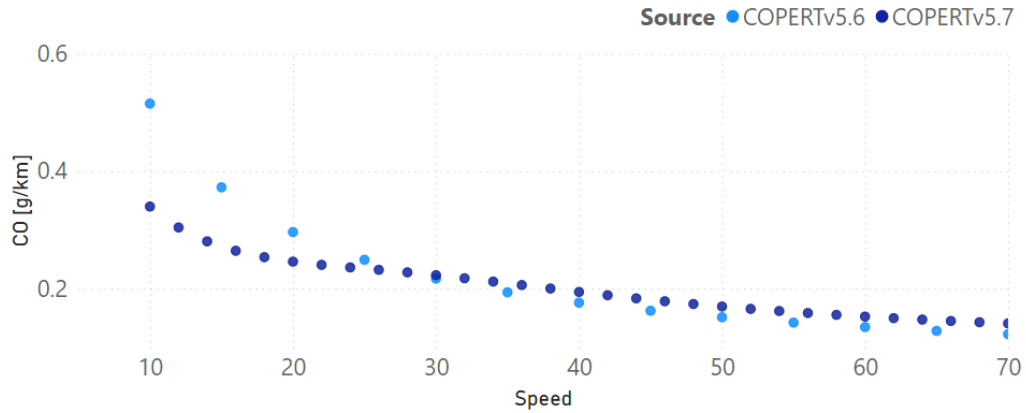
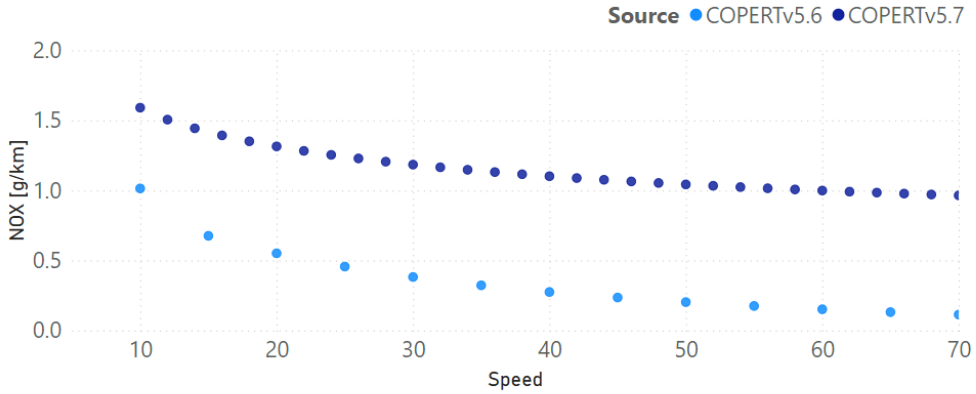
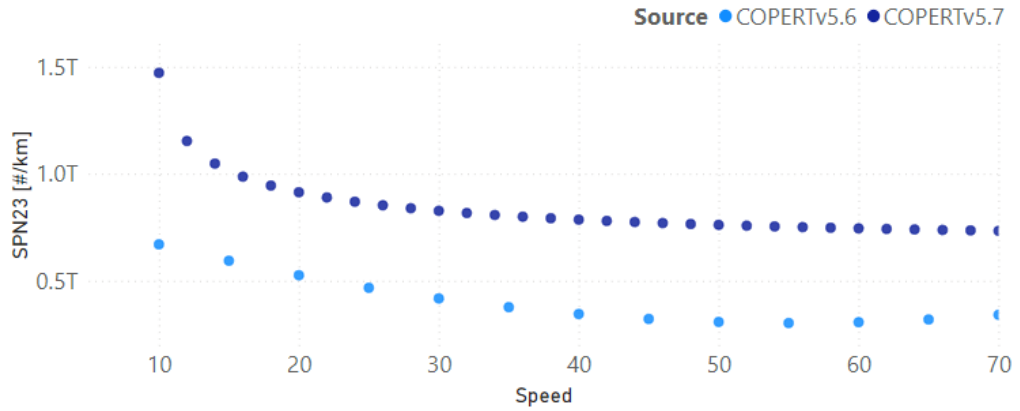
Euro VI diesel hybrid buses









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Conclusions

Euro VI diesel buses

- Similar energy consumption with COPERTv5.6 in low speeds but increased in high speeds
- CO, NOX & SPN23 emissions are higher than COPERTv5.6 for all speeds

Euro VI diesel hybrid buses

- Small increase of energy consumption compared to COPERTv5.6, especially in high speeds
- CO emissions are higher for low speeds than COPERTv5.6
- NOX and SPN23 emissions are higher than COPERTv5.6 across all speeds

Vehicles affected by the last update

Characteristics	Diesel buses	Diesel hybrid buses
Category	Buses	Buses
Fuel	Diesel	Diesel Hybrid ~ Diesel
Segment	Urban Buses Standard 15 – 18 t	Urban Buses Diesel Hybrid
Euro Standard	Euro VI A/B/C, Euro D/E	Euro VI A/B/C, Euro D/E

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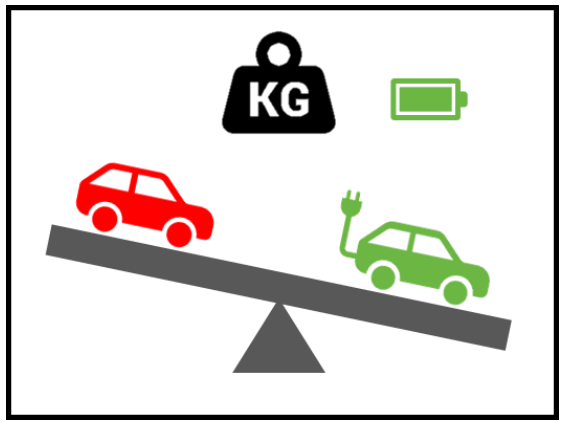
Revision of non-exhaust emission factors

Current state – COPERTv5.6



TSP base emission factors of PC [mg/km]

Powertrain	Tyre	Brake	Road
ICE	10.7	12.2	15.0
Hybrid	11.1	9.7	15.9
PHEV	11.2	6.6	16.1
BEV	11.6	3.4	16.9

No impact of vehicle weight among ICE vehicles

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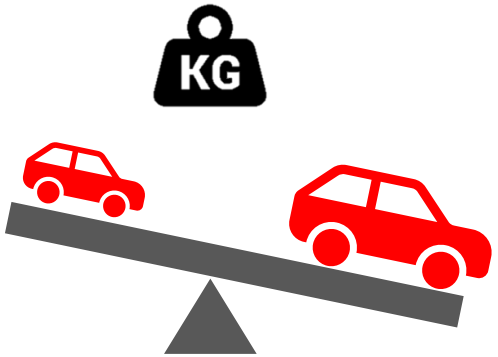
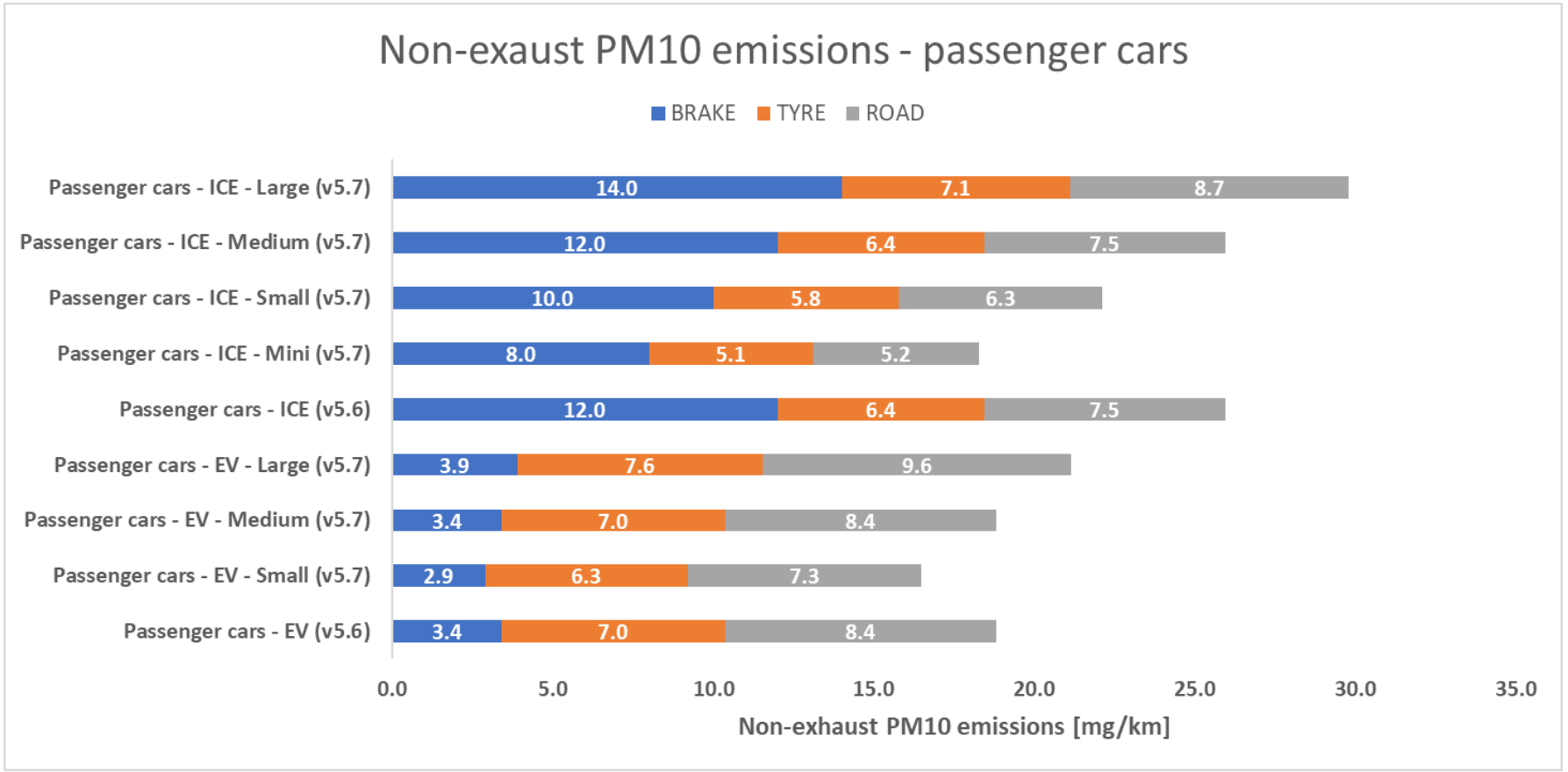
COPERTv5.7 - Impact of Vehicle Weight



- Impact of vehicle weight
- WLTP brake cycle
- Low-Steel brake pads
- Euro 7 targets for brake emissions of LDVs:
  - 7 mg/km from 2025
  - 3 mg/km from 2035



- Beddows & Harrison, 2021
- Liu et al, 2021
- Woo et al, 2022
- Oroumiyeh & Zhu, 2021

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Conclusions

Impact of vehicle weight on NEE

- Differentiation of non-exhaust emission factors based on vehicle weight
- No reliable data for HDVs
- non-exhaust emission factors for medium passenger cars same with COPERTv5.6
- Changes in mini, small, large based on recent studies

Vehicles affected by the last update

Category	Fuel	Technology	Segment
Passenger Cars	All	All	Mini/ Small/ Large

	Difference	Unit
Weight	350	kg
Non-Exhaust emissions		
Brake **Tire** **Road**	10 – 20	[%]

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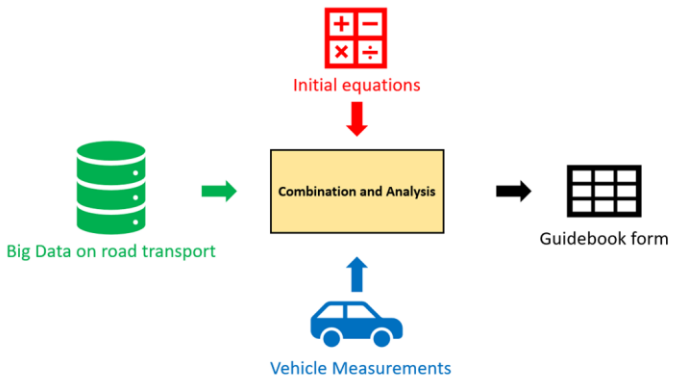
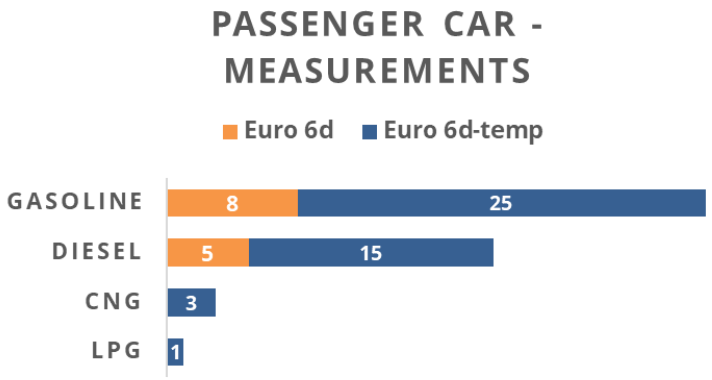
Bug corrections in COPERT v5.6.5 (coming soon)

COPERT v5.6.5 – Debugging of cold emissions





Euro Standards: Euro 6
Pollutants: Passenger Cars and Light Commercial Vehicles
Fuels: Petrol, Diesel
Pollutants: NOx, CO, VOC

Calculation of cold start emissions (overemissions)

$$E_{COLD} = \beta \times bc \times N \times M \times e^{hot} \times (e^{cold} / e^{hot} - 1)$$

where,

β	:	fraction of mileage driven in cold engine
bc	:	beta-reduction factor
N	:	number of vehicles (stock)
M	:	mileage per vehicle
e^{hot}	:	hot emission factor
e^{cold} / e^{hot}	:	cold/hot emission quotient

$e^{cold} / e^{hot} = A \times v + B \times T + C$

(v: vehicle speed, T: temperature)

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Impact of COPERT v5.6.5 vs v5.6.1

- decrease NOX Euro 6 petrol cars by about 56%
- decrease CO emissions of Euro 6 petrol cars by about 77%
- decrease VOC emissions of Euro 6 petrol cars by about 96% (excluding evaporation)
- decrease NOX emissions of Euro 6 LCVs N1-II & N1-III by about 75%
- decrease CO emissions of Euro 6 petrol LCVs N1-II & N1-III by about 85%
- decrease VOC emissions of Euro 6 petrol LCVs N1-II & N1-III by about 96% (excluding evaporation)
- decrease NOX emissions of Euro 6d-temp and Euro 6d diesel LCVs N1-I by about 75%
- decrease CO emissions of Euro 6d-temp and Euro 6d diesel LCVs by about 50%
- Corrections have also been done to cold emissions of earlier Euro standards, but their impact is lower than Euro 6 vehicles.

Vehicles affected by the last update

Category	Fuel	Technology	Segment
Passenger Cars	All	All	All
Light Commercial Vehicles	All	All	All

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HDVs classification based on REG EU 2017/2400

HDVs classification based on REG EU 2017/2400

HDTs groups based on REG EU 2017/2400

Description of elements relevant to the classification in vehicle groups			
Axle configuration	Chassis configuration	Technically permissible maximum laden mass (tons)	Vehicle group
4x2	Rigid lorry	> 3,5 –7,5	(0)
	Rigid lorry (or tractor)**	> 7,5 – 10	1
	Rigid lorry (or tractor)**	> 10 – 12	2
	Rigid lorry (or tractor)**	> 12 – 16	3
	Rigid lorry	> 16	4
	Tractor	> 16	5
	Rigid lorry	> 16	4v***
	Tractor	> 16	5v***
4x4	Rigid lorry	> 7,5 – 16	(6)
	Rigid lorry	> 16	(7)
	Tractor	> 16	(8)
6x2	Rigid lorry	all weights	9
	Tractor	all weights	10
	Rigid lorry	all weights	9v***
	Tractor	all weights	10v***
6x4	Rigid lorry	all weights	11
	Tractor	all weights	12
6x6	Rigid lorry	all weights	(13)
	Tractor	all weights	(14)
8x2	Rigid lorry	all weights	(15)
8x4	Rigid lorry	all weights	16
8x6 8x8	Rigid lorry	all weights	(17)

Mapping based on:

- Regulation
- NR reported by EEA
- Chassis configuration
- GVW

COPERT

Heavy-Duty Vehicles	
Petrol	>3,5 t
Diesel	Rigid <=7,5 t
Diesel	Rigid 7,5 - 12 t
Diesel	Rigid 12 - 14 t
Diesel	Rigid 14 - 20 t
Diesel	Rigid 20 - 26 t
Diesel	Rigid 26 - 28 t
Diesel	Rigid 28 - 32 t
Diesel	Rigid >32 t
Diesel	Articulated 14 - 20 t
Diesel	Articulated 20 - 28 t
Diesel	Articulated 28 - 34 t
Diesel	Articulated 34 - 40 t
Diesel	Articulated 40 - 50 t
Diesel	Articulated 50 - 60 t

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Allocation of VECTO HDTs groups to COPERT groups & vice versa

REG EU 2017/2400 groups → COPERT HDTs groups

				axles	4X2						4X4			6X2		6X4		6X6		8X2	8X4	8X6 8X8	8 axled tractor	5 axles
				Sales	123	3,121	13,327	12,031	32,608	283,107				66,283	13,613	2,377	1,314				3,576			
Category	Fuel	GVW Segment			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Heavy Duty Trucks	Petrol	>3,5 t	-->	% sales number inside the class	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Duty Trucks	Diesel	Rigid <= 7,5 t	-->		100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Heavy Duty Trucks	Diesel	Rigid 7,5 - 12 t	-->		0%	100%	100%	0%	0%	0%	33%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Heavy Duty Trucks	Diesel	Rigid 12 - 14 t	-->		0%	0%	0%	8%	0%	0%	33%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Heavy Duty Trucks	Diesel	Rigid 14 - 20 t	-->		0%	0%	0%	92%	61%	0%	33%	61%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Heavy Duty Trucks	Diesel	Rigid 20 - 26 t	-->		0%	0%	0%	0%	39%	0%	0%	39%	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Heavy Duty Trucks	Diesel	Rigid 26 - 28 t	-->		0%	0%	0%	0%	0%	0%	0%	0%	0%	75%	0%	7%	0%	7%	0%	0%	0%	0%	0%	0%
Heavy Duty Trucks	Diesel	Rigid 28 - 32 t	-->		0%	0%	0%	0%	0%	0%	0%	0%	0%	22%	0%	67%	0%	67%	0%	3%	3%	3%	0%	0%
Heavy Duty Trucks	Diesel	Rigid > 32 t	-->		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	26%	0%	26%	0%	97%	97%	97%	0%	100%
Heavy Duty Trucks	Diesel	Articulated 14 - 20	-->		0%	0%	0%	0%	0%	49%	0%	0%	49%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Heavy Duty Trucks	Diesel	Articulated 20 - 28	-->		0%	0%	0%	0%	0%	51%	0%	0%	51%	0%	81%	0%	7%	0%	7%	0%	0%	0%	0%	0%
Heavy Duty Trucks	Diesel	Articulated 28 - 34	-->		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	19%	0%	71%	0%	71%	0%	0%	0%	0%	0%
Heavy Duty Trucks	Diesel	Articulated 34 - 40	-->		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	22%	0%	22%	0%	0%	0%	0%	0%
Heavy Duty Trucks	Diesel	Articulated 40 - 50	-->		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	1%	0%	0%	0%	0%	0%
Heavy Duty Trucks	Diesel	Articulated 50 - 60	-->		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
				TOTAL	200%	200%	200%	200%	200%	200%	200%	200%	200%	200%	200%	200%	200%	200%	200%	200%	200%	200%	200%	200%

COPERT HDTs groups → REG EU 2017/2400 groups

				axles	4X2						4X4			6X2		6X4		6X6		8X2	8X4	8X6 8X8	8 axled tractor	5 axles	
					Veh Groups in to be updated based on REG 2017/2400/EU																				
Available in COPERT					0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	TOTAL
Category	Fuel	GVW Segment		Sales	123	3,121	13,327	12,031	32,608	283,107				66,283	13,613	2,377	1,314				3,576				431,480
Heavy Duty Trucks	Petrol	>3,5 t	-->		0.03%	0.72%	3.09%	2.79%	7.56%	65.61%	0.00%	0.00%	0.00%	15.36%	3.15%	0.55%	0.30%	0.00%	0.00%	0.00%	0.83%	0.00%	0.00%	0.00%	100.00%
Heavy Duty Trucks	Diesel	Rigid <= 7,5 t	-->	% sales number inside the class	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.00%
Heavy Duty Trucks	Diesel	Rigid 7,5 - 12 t	-->		0%	19%	81%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.00%
Heavy Duty Trucks	Diesel	Rigid 12 - 14 t	-->		0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.00%
Heavy Duty Trucks	Diesel	Rigid 14 - 20 t	-->		0%	0%	0%	36%	64%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.00%
Heavy Duty Trucks	Diesel	Rigid 20 - 26 t	-->		0%	0%	0%	0%	86%	0%	0%	0%	0%	14%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.00%
Heavy Duty Trucks	Diesel	Rigid 26 - 28 t	-->		0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.00%
Heavy Duty Trucks	Diesel	Rigid 28 - 32 t	-->		0%	0%	0%	0%	0%	0%	0%	0%	0%	89%	0%	10%	0%	0%	0%	0%	1%	0%	0%	0%	100.00%
Heavy Duty Trucks	Diesel	Rigid > 32 t	-->		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	15%	0%	0%	0%	0%	85%	0%	0%	0%	100.00%
Heavy Duty Trucks	Diesel	Articulated 14 - 20	-->		0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.00%
Heavy Duty Trucks	Diesel	Articulated 20 - 28	-->		0%	0%	0%	0%	0%	93%	0%	0%	0%	0%	7%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.00%
Heavy Duty Trucks	Diesel	Articulated 28 - 34	-->		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	74%	0%	26%	0%	0%	0%	0%	0%	0%	0%	100.00%
Heavy Duty Trucks	Diesel	Articulated 34 - 40	-->		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100.00%
Heavy Duty Trucks	Diesel	Articulated 40 - 50	-->		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100.00%
Heavy Duty Trucks	Diesel	Articulated 50 - 60	-->		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	100.00%

Conclusions

HDTs groups based on REG EU 2017/2400

Advantages:

- Do not replace existing HDTs' classification system in COPERT
- User can select the classification system for reporting emissions
- New Import/Export buttons of input structure/emissions of HDTs in groups based on REG EU 2017/2400
- Do not lose any emissions or activity during remapping
- Easily updated matrices in the background based on the latest data reported by EEA
- Future extension to buses

Limitations:

- Remapping based on limited EU data for NR
- Not all HDVs groups are regulated yet
- Matrices change each time new updated data are reported by EEA

Vehicles affected by the last update

Category	Fuel	Technology	Segment
HDTs	All	All	All

Planned updates for next year

Planned updates for next year

- Emission factors for Euro 7 vehicles
- Revision of energy consumption factors from BEVs
- Revision of brake emission factors
- Revision of emission factors from petrol hybrid passenger cars
- Revision of speciation of VOCs

Thank you for your attention!