

Guidebook updates



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

- New L-category vehicles and exhaust emission factors
 - Diesel mini-cars
 - Gasoline All Terrain Vehicles (ATVs)
- Updated evaporation emission factors for L-category vehicles
- Inclusion of fuel ethers (MTBE-ETBE) and their impact on evap NMVOC speciation
- Updated CO₂ correction methodology
- Update of NMVOC profile for evaporative emissions
- Minor revisions – error fixes



New L-category vehicles added

Vehicle categorisation	Typical Photos of Models			Key specifications
L1e - A Powered cycle				≤50 cc (PI), ≤25 km/h, ≤1 kW
L1e - B Two-wheel moped				≤50 cc (PI), ≤45 km/h, ≤4 kW
L2e Three-wheel moped	 L2e-P	 L2e-U		≤50 cc (PI) / ≤500 cc (CI), ≤45 km/h, <4 kW, ≤270 kg
L3e Two-wheel motorcycle	 L3e-A1	 L3e-A2	 L3e-A3	A1: ≤125 cc, ≤11 kW, ≤0.1 kW/kg A2: ≤35 kW, ≤0.2 kW/kg A3: >35 kW, >0.2 kW/kg
L4e Two-wheel motorcycle with side-car				Equivalent to the corresponding L3e
L5e-A Tricycle				3 wheels, ≤1000 kg, max 5 seats
L5e-B Commercial tricycle				3 wheels, ≤1000 kg, max 2 seats, loading volume ≥ 0.6m ³
L6e-A Light on-road quad				≤50 cc (PI) / ≤500 cc (CI), ≤45 km/h, ≤4 kW, ≤425 kg
L6e-B Light quadri-mobile	 L6e-BP	 L6e-BU		≤50 cc (PI) / ≤500 cc (CI), ≤45 km/h, ≤6 kW, ≤425 kg
L7e-A Heavy on-road quad	 L7e-A1	 L7e-A2		≤15kW, ≤450 kg
L7e-B Heavy all terrain quad	 L7e-B1	 L7e-B2		B1: ≤90 km/h, ≤450 kg B2: ≤15kW, ≤450 kg
L7e-C Heavy quadri-mobile	 L7e-CU	 L7e-CP		CU: ≤90 km/h, ≤15kW ≤600 kg CP: ≤90 km/h, ≤15kW ≤450 kg

- Changed the category name from 'two-wheelers' to L-category vehicles
- New sub-categories added

Vehicle category	Euro standard
Mini-cars	Conventional
	Euro 1
	Euro 2
	Euro 3
	Euro 4
All Terrain Vehicles (ATVs)	Euro 5
	Conventional
	Euro 1
	Euro 2
	Euro 3
	Euro 4
	Euro 5



L-category exhaust emission factors

- Added Tier 1, Tier 2 and Tier 3 emission and energy consumption factors

Tier 3 EF

Category	Emission standard	EC [MJ/km]	NOx [g/km]	HC [g/km]	PM2.5 [g/km]	CO [g/km]
Mini-cars	Conventional	1.449	0.589	0.308	0.250	1.152
	Euro 1	1.262	0.814	0.161	0.150	0.935
	Euro 2	1.262	0.814	0.161	0.150	0.935
	Euro 3	1.262	0.814	0.161	0.150	0.935
	Euro 4	1.136	0.689	0.120	0.080	0.935
	Euro 5	1.136	0.060	0.078	0.001	0.935
ATVs	Conventional	2.072	0.047	16.670	0.200	33.540
	Euro 1	1.795	0.300	9.000	0.080	13.320
	Euro 2	1.795	0.300	2.320	0.040	7.770
	Euro 3	1.795	0.300	2.320	0.040	7.770
	Euro 4	1.742	0.187	0.603	0.010	1.794
	Euro 5	1.742	0.060	0.088	0.002	1.000

Emission factors for additional pollutants set equal to corresponding larger vehicle categories (e.g. Motorcycles on Diesel Mini Passenger Cars)



L-category evaporation emission factors (1/2)

- New evaporation emission factors for all L-category vehicles
- Euro 5 mopeds and ATVs will have to pass a permeation test, hence permeation emission factors are reduced substantially compared to Euro 4

	Euro 4		Euro 5	
Vehicle category	Mopeds	ATVs	Mopeds	ATVs
Fuel tank size (l)	7.5	22	7.5	22
Permeation emissions (g/day)	1.80	5.28	0.52	1.53
Breathing emissions (g/day)	0.67	1.95	0.67	1.95
Total emissions [no canister] (g/day)	2.47	7.23	1.19	3.49



L-category evaporation emission factors (2/2)

- Euro 5 motorcycles have to pass a SHED test so they will need a breathing canister
- Emission levels of Euro 4 motorcycles already close to Euro 5 standards (2 g/test), hence only slight improvement over Euro 4

Vehicle category	Euro 4			Euro 5		
	L3-A1 (<250 cm ³)	L3-A2 (<750 cm ³)	L3-A3 (>750 cm ³)	L3-A1 (<250 cm ³)	L3-A2 (<750 cm ³)	L3-A3 (>750 cm ³)
Fuel tank size (l)	5	10	21	5	10	21
Permeation emissions (g/day)	0.35	0.70	1.46	0.35	0.70	1.46
Breathing through canister (g/day)	0.44 (no canister)	0.77	0.62	0.44 (no canister)	0.77	0.54
Total emissions (g/day)	0.79 (no canister)	1.47	2.08	0.79 (no canister)	1.47	2.00



Fuel consumption correction

- Baseline PC consumption factor function is the same for Euro 5 and later vehicle technologies
- Fuel consumption depends on model year and not Euro standard
- A correction has been introduced since COPERT 4 to reflect mean vehicle specifications effect on fuel consumption

$$FC_{corr}(V) = Correction \times FC_{Baseline}(V) \qquad Correction = \frac{FC_{InUse}}{FC_{Sample}}$$

FC_{Sample} is calculated as the average fuel consumption of the vehicle sample used in developing baseline COPERT emission factors over the three parts (Urban, Road and Motorway) of the Common Artemis Driving Cycles (CADC)



$$\text{Petrol: } FC_{InUse} \left[\frac{l}{100km} \right] = 0.06056 + 0.0004079 \times CC + 0.001214 \times m + 0.7551 \times FC_{TA} + Y_{RC}$$

$$\text{Diesel: } FC_{InUse} \left[\frac{l}{100km} \right] = -0.5682 + 0.0003539 \times CC + 0.001708 \times m + 0.6279 \times FC_{TA} + Y_{RC}$$

FC_{TA} stands for type-approval fuel consumption (in l/100km)

m stands for the vehicle reference mass (empty weight + 75 kg for driver and 20 kg for fuel)

CC stands for the engine capacity in cm^3

Y_{RC} stands for the Year regression coefficient (new addition in COPERT 5)



Fuel consumption deviation with time

- There is an increasing divergence between type-approval and in-use CO₂ emissions in passenger cars
- Updated methodology takes this into account
 - A regression model has been developed by Tietge et al., 2017* considering the registration year as an additional variable to the currently used variables (mass and capacity of vehicle)

Year	Petrol	Diesel
2002	0.06109	0.01423
2003	0.07502	0.09597
2004	0.21420	0.14220
2005	0.27260	0.20380
2006	0.30680	0.21990
2007	0.37350	0.21190
2008	0.47190	0.23600
2009	0.49580	0.21270
2010	0.53240	0.24680
2011	0.65210	0.35810
2012	0.67840	0.43610
2013	0.81580	0.53210
2014 and on	1.00100	0.77140

*Tietge, U., Mock, P., Franco, V., Zacharof, N. (2017) From laboratory to road: Modeling the divergence between official and real-world fuel consumption and CO emission values in the German passenger car market for the years 2001–2014, Energy Policy



Inclusion of fuel ethers for fuel blending

Fuel (<i>m</i>)	Typical Molecule	Ratio of hydrogen to carbon ($r_{H:C}$)	Ratio of oxygen to carbon ($r_{O:C}$)	kg CO ₂ per kg of fuel
Neat Petrol	[CH _{1.86}] _x	1.86	0.0	3.169
Neat Diesel	[CH _{1.86}] _x	1.86	0.0	3.169
Ethanol / Bio-ethanol	C ₂ H ₅ OH	3.00	0.5	1.911
Methanol	CH ₃ OH	4.00	1.00	1.373
Biodiesel	[CH] _x -COOH	1.95-2.03	0.11-0.13	2.797-2.727
ETBE	C ₆ H ₁₄ O	2.33	0.167	2.584
MTBE	C ₅ H ₁₂ O	2.40	0.20	2.496
Natural Gas / Biogas (REF)	CH ₄ , market fuels also contain C ₂ H ₆	4.00	0.00	2.473
LPG (REF)	C ₃ H ₈ (15%)-C ₄ H ₁₀ (85 %), market fuels may contain different proportions	2.525	0.00	3.024
E5		1.92	0.026	3.063
E10 (REF)		1.98	0.053	2.694
E75		2.73	0.38	2.111
E85 (REF)		2.84	0.429	2.026
ETBE11		1.91	0.018	3.094
ETBE22		1.96	0.036	3.021
B7 (REF)		1.86	0.007	3.144
B10		1.86	0.010	3.133
B20		1.87	0.020	3.096
B30		1.88	0.030	3.059



Update of NMVOC profile for evaporative emissions

- Current GB version provides fuel vapour speciation only for non-oxygenated petrol
- Almost all petrol sold in the EU in 2016 contains oxygenates
- Addition of ethanol to petrol may increase the concentration of benzene in fuel vapour
- New speciation (% vol) suggested for ethanol and ETBE containing petrol

	E5 – E10 liquid	E5 – E10 vapour	MTBE – ETBE liquid	MTBE – ETBE vapour
Saturates	51.0	68.8	47.3	64.8
Olefins	10.5	6.4	9	5.5
Aromatics	31.0	18.0	31	17.0
Benzene	0.7	0.8	0.7	0.7
Ethanol	6.8	6.0	---	---
Ethers	---	---	12	12



Comments/requests from review process

Issue for	Issue	Conclusion
Discussion	Calculation of Transport emissions	COPERT 5 is now more stable and it is recommended that all MSs shift from COPERT 4 to COPERT 5. MS should be aware that technical support for COPERT 4 will soon stop, thus COPERT 4 will become obsolete and all calculations should be performed with the latest COPERT 5 version.
Discussion	Emission factors for some categories, such as CNG light commercial vehicles, are not included in the Guidebook 2016.	Provide EFs for new technologies and fuels, such as LNG EFs for Heavy Duty Vehicles in the GB.
EMEP/EEA GB 2016 improvement	1A3b – GB COPERT comparability	Consider providing a simple version mapping table at the front of the 1A3b chapter listing all the COPERT & HBEFA version vs Guidebook version
EMEP/EEA GB 2016 improvement	1A3b – inconsistency in NH3 EFs for diesel vehicles	Review Table 3-21, Table 3-23 and Table 3-100 as NH3 EFs for diesel vehicles are inconsistent (in particular, different factors are suggested for Euro VI heavy duty vehicles)
EMEP/EEA GB 2016 improvement	1A3bi-vi – split of fuel and lubricant consumption	Provide explanation in the guidebook on how to split fuel and lubricant consumptions, in order to be able to report 2 stroke engines lubricant consumption in 1A3b and 4 stroke engines lubricant consumption in 2G
EMEP/EEA GB 2016 improvement	1A3bvi-1A3bvii - PM2.5/PM10 ratios	The PM2.5/PM10 ratios for the different abrasions seems high (between 40 & 70%), which means that a non- negligible part of emissions is PM2.5. Include newer literature in the GB.

Requests/Questions from German inventorying team

- **Ammonia (NH₃) slip from AdBlue-SCR in 1.A.3.b:** As the amount of AdBlue mixed to the exhaust gas needs to be adapted “in real-time”, a slip of ammonia is likely to occur which is not yet considered in the inventories.
 - Considered in the Guidebook
- **Sulphur dioxide (SO₂) from lubricant co-incineration:** As we already report CO₂ and heavy metals from lubricant co-incineration based on the lube oil’s C- and HM-content, we should also think about the lubricant’s sulphur content. From my understanding, this sulphur, just as the carbon, should not be covered by the SO₂ emission factors applied to the fuels.
 - Considered in COPERT, perhaps not enough guidance in the Guidebook
- **Abrasive emissions from NFR 1.A.3.c:** Within the 2018 submission, Germany, for the first time, includes abrasive PM and HM emissions from the wear
 - Details of the methodology to be considered for inclusion in the Guidebook



Minor parameter updates – error fixes (1/3)

	Old value	New value	Expected influence
Tier 2 NH3 Buses and coaches emission factor (correction)	0.029	0.0029	emission reduction
Mass fraction of NO2 in NOx emissions (correction)			
Euro 6 Petrol Passenger Cars and LCVs	3%	2%	emission reduction
Euro 5 Diesel Passenger Cars and LCVs	33%	40%	emission increase
Euro 6 Diesel Passenger Cars 2017 and on and LCVs	30%	20%	emission reduction
Euro IV HDVs	10%	14%	emission increase
Euro V HDVs	12%	10%	emission reduction
Euro VI HDVs	18%	10%	emission reduction



Minor parameter updates-error fixes (2/3)

	Expected influence
Hydrogen to carbon (H:C) and oxygen to carbon (O:C) ratios (update)	
Diesel fuel	minor CO ₂ emission increase
Petrol fuel	minor CO ₂ emission reduction
LPG	minor CO ₂ emission increase
CNG	minor CO ₂ emission increase



Minor parameter updates-error fixes (3/3)

	Old value	New value	Expected impact
Tier 3 diesel vehicles NH3 emission factors (update)			
Euro 5 and on Diesel LCVs		equal to Diesel PC	
Buses and Coaches		equal to HDVs	emission increase
Tier 3 methane emission factors (update and correction)			
Euro 5 and on Diesel Passenger Cars and LCVs	1.1	0.075	emission reduction
Addition of Diesel Mini-cars and ATVs			



2019 updates

- Review and uptake of Nordic study results
 - Update of NMVOC emissions profile
 - PAH and HM
- New exhaust emission factors for motorcycles
- New emission factors for electrified vehicles (diesel hybrids, plug-in hybrids, battery electric vehicles)
- Review of non-exhaust PM EFs ($PM_{2.5}$ over PM_{10})
- Conversion of Tier 1 and Tier 2 EFs to kg/MJ
- Consideration of rail abrasive emissions (German study)



Thank you for your attention!

