This project is co-financed by the European Union and the Republic of Turkey.

Technical Assistance for Developed Analytical Basis for Formulating Strategies and Actions towards Low Carbon Development

What is new in version 5.4

EMISIA SA presentation

October 2019, Ankara

New elements in COPERT v5.2

- New L-category vehicles
  - Diesel mini-cars
  - Gasoline All Terrain Vehicles (ATVs)
- Inclusion of fuel ethers (MTBE-ETBE)
- Updated CO_2 correction methodology
- Update of NMVOC profile for evaporative emissions
- Minor parameter updates – error fixes
- CLI (not yet official version)

New L-category vehicles added

Mini-cars (diesel)			ATVs (petrol)	
L6e-B	L7e-A	L7e-C	L7e-B1	L7e-B2
Light quadri-mobile	Heavy on-road quad	Heavy quadri-mobile	All terrain quad	Side by side buggy
 		 		

L6e: Light quadricycle with maximum design vehicle speed ≤ 45 km/h and mass in running order ≤ 425 kg and engine capacity ≤ 50 cm³ if a PI engine, or engine capacity ≤ 500 cm³ if a CI engine.

L7e: Heavy quadricycle with mass in running order ≤ 450 kg for the transport of passengers, or ≤ 600 kg for the transport of goods.

- Changed the naming from two-wheelers to L-category vehicles
- New categories added

L-category exhaust emission factors

- Added 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

Additional pollutant emission factors set equal to similar 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
Emissions without 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
- Emission levels of Euro 4 motorcycles already close to Euro 5 standards (2 grams/test), hence only slight improvements of Euro 5 over Euro 4

	Euro 4			Euro 5		
Vehicle category	L3-A1 (<250 cm3)	L3-A2 (<750 cm3)	L3-A3 (>750 cm3)	L3-A1 (<250 cm3)	L3-A2 (<750 cm3)	L3-A3 (>750 cm3)
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
Emissions controlled by canister (g/day)	0.79 (no canister)	1.47	2.08	0.79 (no canister)	1.47	2.00

Inclusion of fuel ethers

Fuel (m)	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
Petrol	$[CH_{1.86}]_x$	1.86	0.0	3.169
Diesel	$[CH_{1.86}]_x$	1.86	0.0	3.169
Ethanol	C_2H_5OH	3.00	0.5	1.911
Methanol	CH3OH	4.00	1.00	1.373
Biodiesel	[CH]x-COOH	1.95-2.03	0.11-0.13	2.797-2.727
ETBE	C6H14O	2.33	0.167	2.584
MTBE	C5H12O	2.40	0.20	2.496
Natural Gas / Biogas (REF)	CH4, market fuels also contain C2H6	4.00	0.00	2.473
LPG (REF)	C3H8 (15%)-C4H10 (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

Updated CO_2 correction methodology (1/3)

- There is a divergence between type-approval and in-use CO_2 emissions in passenger cars
- Updated methodology considers an increase in the divergence over time
  - A regression model has been developed by Uwe Tietge et al., 2017* considering the registration year as an additional variable to the currently used variables (mass and capacity of vehicle)

Regression coefficients for Petrol and Diesel vehicles

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

Year	Petrol	Diesel
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

*Uwe Tietge et al., 2017 Uwe Tietge, Peter Mock, Vicente Franco, Nikiforos Zacharof

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

Updated CO_2 correction methodology (2/3)

- The equations for petrol and diesel vehicles are the following:

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

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

Updated CO_2 correction methodology (3/3)

A correction then is applied to the fuel consumption and CO_2 emission factors based on the following equation:

$$Correction = \frac{FC_{InUse}}{FC_{Sample}}$$

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

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

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 CH4 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			

Future updates (2019)

- New exhaust emission factors for motorcycles
- Update of emissions NMVOC profile
- New emission factors for electrified vehicles (diesel hybrids, plug-in hybrids, battery electric vehicles)
- Review of non-exhaust PM EFs (PM2.5 over PM10)
- Conversion of Tier 1 and Tier 2 EFs to kg/MJ

COPERT CLI

- Command Line Interface
- Advantages include:
  - multiple database run in an automated way
  - execution from external software
  - JSON compatibility
  - towards an api (web application)

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Thank you for your attention!

http://www.lowcarbonturkey.org/