

COPERT and Guidebook updates

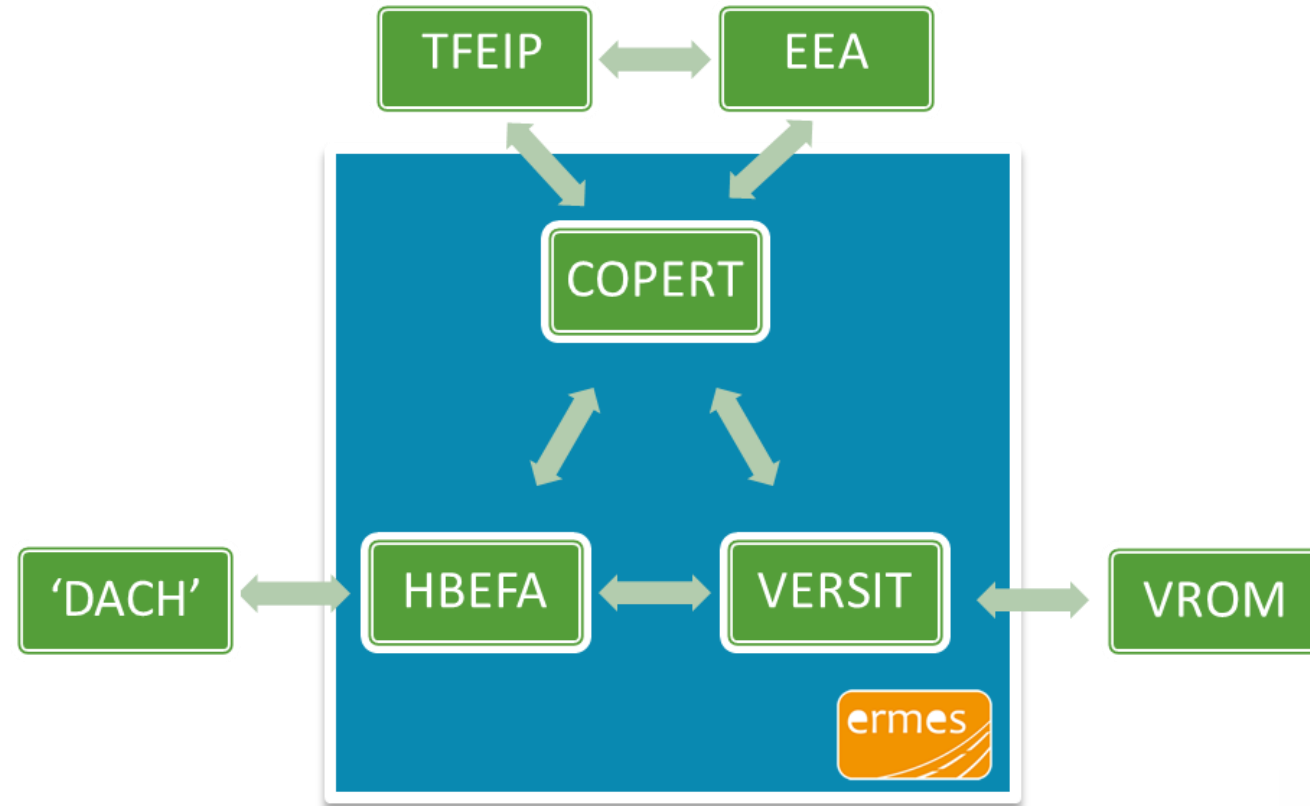
Chapters 1.A.3.b.i-iv / Road Transport



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COPERT 5 in the ERMES Ecosystem



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COPERT 5 spin-offs



- Estimates emissions from on-road vehicles in Australia
- Developed in collaboration with Queensland Government
- Official method in National Pollutant Inventory (NPI)
- Commercially available



- Calculates traffic emissions at street level using COPERT functions
- Can be combined with traffic analysis tools
- Visualization of results on GIS maps



- Provides real-time traffic and environmental information for the city of Thessaloniki
- Enables smart navigation based on user selected criteria
- Available on the web and as an Android application



- Includes historic and projected stock and activity data
- Delivers alternative scenarios for energy and emissions
- Includes advanced technologies and mobility patterns
- Commercially available

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Vehicle categories [432 types]

- Passenger Cars (165 types)
 - Petrol (mini, small, medium, large-SUV-executive)
 - Diesel (mini, small, medium, large-SUV-executive)
 - Petrol hybrid (mini, small, medium, large-SUV-executive)
 - Petrol plug-in hybrid (small, medium, large-SUV-executive)
 - Diesel plug-in hybrid (large-SUV-executive)
 - LPG Bifuel (mini, small, medium, large-SUV-executive)
 - CNG Bifuel (mini, small, medium, large-SUV-executive)
- Light Commercial Vehicles [trucks & vans] (54 types)
 - Petrol (N1-I, N1-II, N1-III)
 - Diesel (N1-I, N1-II, N1-III)
- Heavy Duty Vehicles [167 types]
 - Gasoline trucks
 - Diesel trucks (14 weight categories)
 - Buses (3 diesel types, hybrids, CNG, B30)
 - Coaches (2 types)
- L-category [46 types]
 - Mopeds <50 cc (2-stroke, 4-stroke)
 - Motorcycles (2-stroke, <250 cc, 250-750 cc, >750 cc)
 - All terrain vehicles (ATVs)
 - Mini cars



Status of Software (2020 – V5.4)

- Revised Euro 5/6 emission factors
 - Included correction for Euro 5 software update
 - Decreased Euro 6 NOx levels over original projection
- Introduced new vehicle categories
 - Petrol PHEV
 - Diesel PHEV
 - Hybrid urban buses
- Automated export to official reporting forms
 - GHG submission: IPCC CRF
 - Air Pollutants: Gothenburg protocol NFR



New elements in 2021

- Introduction of Solid Particle Number (SPN23) emission factors
- Revision of Particle Mass (exhaust only) emission factors
- Revision of emission factors for mini-cars and ATVs



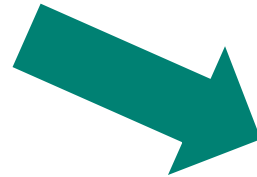
Introduction of Solid Particle Number (SPN23) emission factors and revision of exhaust PM emission factors

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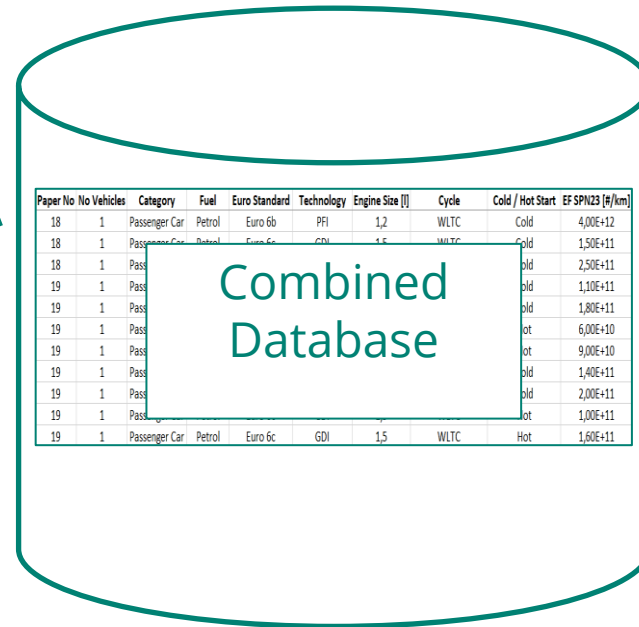
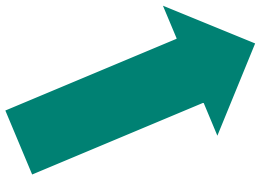


Data Collection

Laboratory
Measurements



Literature
Review



Passenger cars

Light commercial
vehicles

Heavy duty
vehicles

L-category
vehicles

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Methodology

- Vehicles sub-categories based on type, fuel, Euro Standard
- Driving cycles (lab and on-road) divided in cold or hot start
- Calculation of average emission factors and level of confidence
- Estimations, where needed
- Solid Particle Number (SPN23)
 - All vehicle types and Euro standards
- Particle Mass (PM Exhaust)
 - Revision of the most recent Euro standards based on latest research data



Number of measurements considered

Number of passenger cars SPN23 measurements

SPN23			Cold			Hot			Regeneration		
			Lab	On-road	Total	Lab	On-road	Total	Lab	On-road	Total
Diesel	Euro 5	DPF	4	2	6	3	-	3	1		1
Diesel	Euro 6	DPF	85	33	118	35	3	38	8	4	12
Petrol	Euro 6	GDI	29	21	50	19	2	21			
Petrol	Euro 6	GDI+GPF	11	11	22	5	-	5			
Petrol	Euro 6	PFI	14	18	32	5	1	6			
CNG	Euro 6		31	3	34	5	1	6			

Number of passenger cars PM measurements

PM			Cold			Hot		
			Lab	On-road	Total	Lab	On-road	Total
Diesel	Euro 5	DPF	8	-	8			
Diesel	Euro 6	DPF	7	3	10			
Petrol	Euro 5	GDI	10	-	10	5	-	5
Petrol	Euro 6	GDI	3	-	3	3		3

Number of Heavy-Duty Vehicles SPN23 measurements

SPN23	[/kWh]		Lab	On-road	Total
HDV	Diesel	HDV Rigid <12 t	4	2	6
HDV	Diesel	HDV Articulated 22-27 t	3	3	6
Urban Bus	Diesel	Urban Bus Diesel	1		1
Urban Bus	CNG	Urban Bus CNG	1		1

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Passenger Cars – SPN23

SPN23 [#/km]	Euro Standard	Urban	Rural	Highway
Diesel	Euro 1	3,97E+14	2,52E+14	4,70E+14
Diesel	Euro 2	2,12E+14	2,05E+14	4,35E+14
Diesel	Euro 3	1,64E+14	1,73E+14	2,82E+14
Diesel	Euro 4	7,48E+13	5,52E+13	9,00E+13

SPN23 [#/km]	Euro Standard	Technology	Urban	Rural	Highway
Petrol	Euro 1	PFI	8,76E+12	3,11E+12	1,81E+13
Petrol	Euro 2	PFI	6,16E+12	2,67E+12	1,18E+13
Petrol	Euro 3	PFI	3,07E+12	2,23E+12	5,60E+12
Petrol	Euro 4	PFI	9,00E+11	7,90E+11	8,40E+11
Petrol	Euro 4	GDI	9,50E+12	7,60E+12	6,06E+13

SPN23 [#/km]	Euro Standard	Technology	Cold	Hot
Diesel	Euro 5	DPF	2,09E+11	8,73E+10
Diesel	Euro 6	DPF	1,72E+11	4,82E+10
Petrol	Euro 5	GDI	1,85E+12	7,65E+11
Petrol	Euro 5	PFI	1,39E+12	6,10E+11
Petrol	Euro 6	GDI	1,97E+12	8,12E+11
Petrol	Euro 6	GDI+GPF	5,55E+11	1,30E+11
Petrol	Euro 6	PFI	1,47E+12	6,48E+11

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Heavy Duty Vehicles – SPN23

SPN23 [#/kWh]	Euro Standard	Urban	Rural	Highway
Heavy Duty Vehicle	Euro I	7,34E+14	3,18E+14	3,28E+14
Heavy Duty Vehicle	Euro II	5,13E+14	2,21E+14	2,30E+14
Heavy Duty Vehicle	Euro III	5,13E+14	2,21E+14	2,30E+14
Heavy Duty Vehicle	Euro IV	1,08E+14	5,54E+13	6,18E+13
Heavy Duty Vehicle	Euro V	1,08E+14	5,54E+13	6,18E+13
Heavy Duty Vehicle	Euro VI	1,79E+11	6,09E+10	4,75E+10

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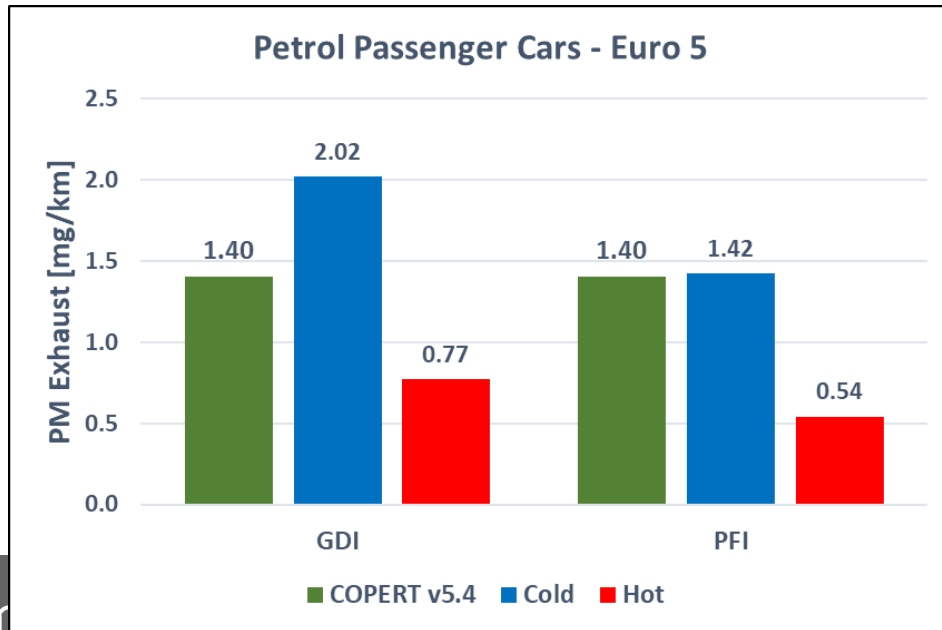
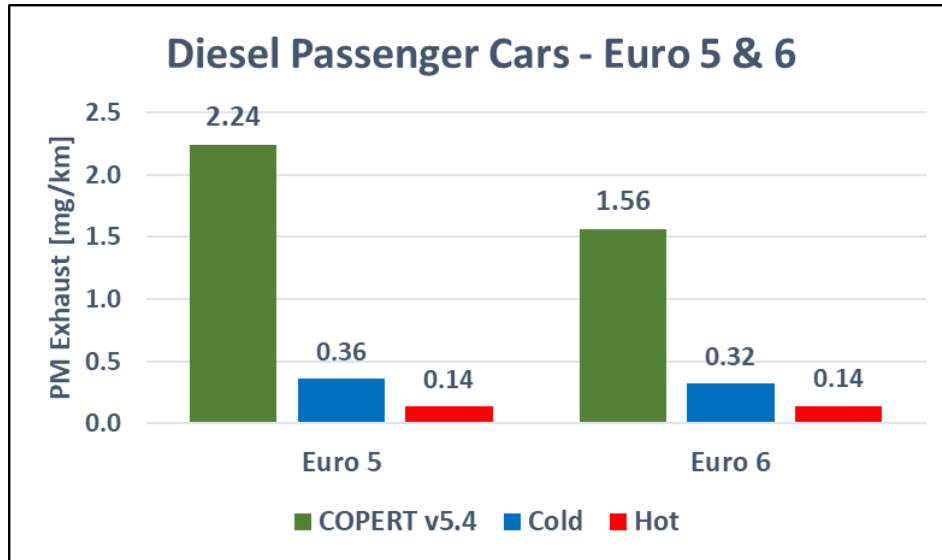
L-Category vehicles – SPN23

SPN23 [#/km]	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5
Mopeds 2s	1,00E+13	8,00E+12	7,00E+12	4,00E+12	4,00E+12
Mopeds 4s	1,00E+13	2,00E+12	5,00E+11	5,00E+11	5,00E+11
Motorcycles	3,00E+12	3,00E+12	1,07E+12	8,54E+11	8,54E+11
Quads	5,80E+12	2,90E+12	2,90E+12	1,00E+12	1,00E+12
Minicars	8,00E+13	4,00E+13	4,00E+13	2,00E+13	2,00E+13

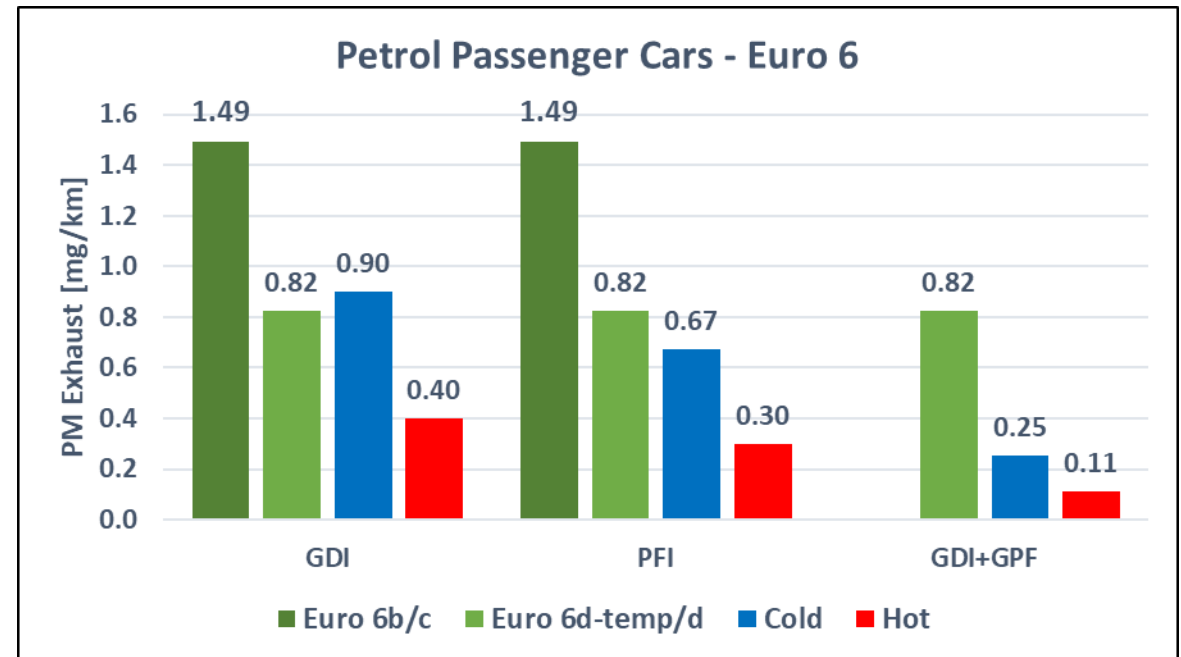
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PM exhaust emission factors revision



- Reduced emission factors for
- Euro 5 & 6 diesel passenger cars
 - Euro 6 petrol passenger cars



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Revision of emission factors for mini-cars and ATVs

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Data source

- Tests performed in the framework of the “Effect study of the environmental step Euro 5 for L-category vehicles” (Ntziachristos et al., 2017)
- Sample: two minicars (L6e-B) and four ATVs (L7e-B) were tested at JRC

category	category name	engine capacity class [cc]	rated power [kW]	engine combustion type*	# of cylinders	Maximum design speed [km/h]	Transmission	Euro class	Fuel delivery system	Secondary Air System (SAS)	catalyst**	reference mass class [kg]	year	mileage [km] ***	WMTC ****	ECE R47 ****	ECE R40 ****	WOT ****	SRC-LeCV ****	AMA ****
L6e-BP	light quadri-mobile	480	4	D-4S	2	45	CVT	Euro 2	injection	No	2w	470	2015	0	9	6		3		
L6e-BU	light quadri-mobile	400	4	D-4S	2	45	CVT	Euro 2	injection	No	n.a.	480	2014	988	4	2		1	1	2
L7e-B1	all terrain quad	980	15	G-4S	2	65	CVT	Euro 2	injection	No	3w	470	2016	538	2		2	1		
L7e-B1	all terrain quad	570	11	G-4S	1	70	CVT	Euro 2	injection	No	2w	450	2015	900	11		5	3	4	1
L7e-B1	all terrain quad	440	17	G-4S	1	67	CVT	Euro 2	injection	No	3w	370	2016	17	6		2	1		
L7e-B2	side-by-side buggy	700	15	G-4S	2	78	CVT	Euro 2	injection	No	2w	570	2016	638	6		5	4	3	2

* G = gasoline; D = Diesel; E=Electric; 2S = 2-stroke; 4S = 4-stroke

** 2w = 2-way catalyst; 3W = 3-way catalyst

*** mileage at vehicle take-in, before any applied degreening

**** number of repetitions

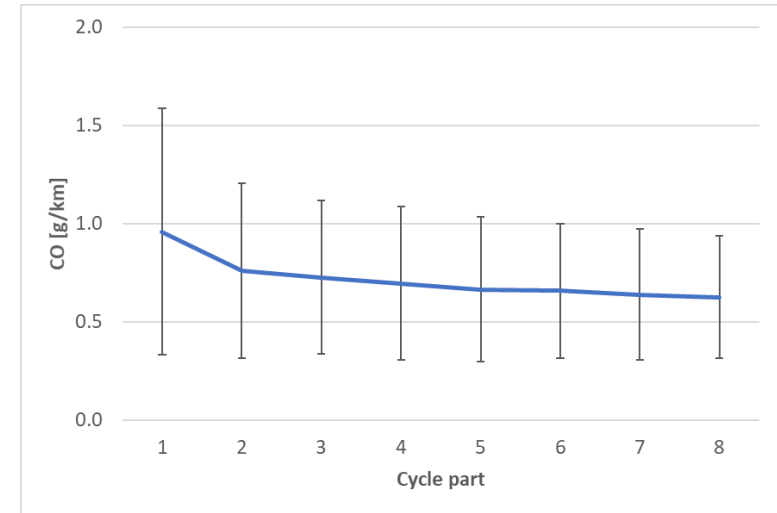
n.a. = not applicable

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Methodology for EFs development

- Second-by-second modal data used
- Pollutants: CO, HC, NOx and PM and FC
- Driving cycles:
 - ‘Revised’ Worldwide harmonized Motorcycle Test Cycle (WMTC Stage 3) class 2-1
 - The ECE R47 for minicars and the ECE R40 for ATVs
 - Wide-Open Throttle (WOT)
 - Standard Road Cycle for L-Category Vehicles (SRC-LeCV)
 - USA EPA Approved Mileage Accumulation (AMA)
- Each driving cycle split to cold/hot parts



Example graph: average emission levels of the ECE R47 driving cycle second-by-second data for minicars, for CO. Error bars indicate min and max values within the test vehicles (after averaging in each vehicle's cycle runs). Parts 1-2: cold start, parts 3-8: hot.



Test results for Euro 2 vehicles

		Average Speed [km/h]	CO [g/km]	HC [g/km]	NOx [g/km]	FC [l/100km]	PM [mg/km]	
Minicars								
urban	cold start	24	0.31	0.14	0.54	2.97	68.67	
	hot start	34	0.53	0.86	0.60	3.68	37.00	
ATVs								Share*
urban	cold start	21	18.19	1.06	0.49	22.39	5.77	47.80%
	hot start	28	1.89	0.16	0.25	8.15	1.42	
rural	cold start	-	-	-	-	-	-	52.20%
	hot start	53	11.47	0.29	0.53	7.13	5.72	

* Based on COPERT data

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Mini-cars and ATVs EFs per Euro standard

Category	Euro Standard	CO [g/km]	VOC [g/km]	NOx [g/km]	EC [MJ/km]	PM Exhaust [g/km]
Quad & ATVs	Euro 1	11.81	0.884	0.40	2.50	0.007
Quad & ATVs	Euro 2	6.89	0.228	0.40	2.50	0.004
Quad & ATVs	Euro 3	6.89	0.228	0.40	2.50	0.004
Quad & ATVs	Euro 4	1.59	0.228	0.25	2.43	0.004
Quad & ATVs	Euro 5	0.89	0.100	0.08	2.43	0.004
Mini-car	Euro 1	0.53	0.860	0.60	1.32	0.037
Mini-car	Euro 2	0.53	0.860	0.60	1.32	0.037
Mini-car	Euro 3	0.53	0.860	0.60	1.32	0.037
Mini-car	Euro 4	0.53	0.100	0.51	1.19	0.020
Mini-car	Euro 5	Not expected to enter the market				

- Assumptions for the development of EFs for each technology
 - Euro 2: developed directly from tests
 - Euro 3: the same EFs as Euro 2, considering that the respective emission limits have not changed
 - Euro 4 and Euro 5: based on engineering judgment, also considering the respective emission limits
 - Euro 5 mini-cars are not expected to be introduced in the market



Scheduled updates 2021/22

Item	Responsible
Review/revision of non-exhaust PM EFs (PM2.5 over PM10) from brake (tyre) wear	ETC/Emisia
Review/revision of emission degradation functions light duty vehicles	ETC/Emisia
Review/revision of Euro 6d EFs in light of new RDE measurements and the Euro 7 exercise (evap +cold start)	ETC/Emisia
Proposal for Euro 7 EFs (for projections)	ETC/Emisia
Update Euro 6 LPG Emission Factors – work on CNG (PCs&Buses) is ongoing and could be also introduced in the next update	Innovhub/ETC
Review/update of Hg emission factors	VTT/SYKE
COPERT Software revisions and updates	ETC/Emisia

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Thank you for your attention!

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