

copert₅ Main Elements

or, an unavoidable comparison to COPERT 4...

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Overview of main new or updated elements

- Software improvements
 - new and faster calculation kernel
 - new functionalities
 - user interface enhancements
- Methodology changes
 - new pieces of methodology
 - e.g. vehicle categories, methodological elements
 - updated methodology
 - e.g. energy balance, blends, lube oil

Software improvements

More flexible data import file

	COPERT 4	COPERT 5
File type	Access .mdb file	SQL compact
Storage size	7-10 years in one file	40 years in one file
Calculation time	2 min per year	10 s per year
File size	Unzipped file	Zipped file

- Data import file takes up less hard disk space, can handle complete time series and is faster to access

Enhanced user interface

- New and enhanced form functionality
- “Cancel” current run execution
- Flexibility in presenting results
- Enhanced results checking (implied emission factors)
- Several other visual and functional enhancements using DevExpress

Form functionality (1/3)

Category	Fuel	Segment	Euro Standard	Stock	Mean Activity	Lifetime Cumulative Activity	Fuel Consumption
Passenger Cars	Petrol	Mini	Euro 4	0	0	0	
Passenger Cars	Petrol	Mini	Euro 5	0	0	0	
Passenger Cars	Petrol	Mini	Euro 6 up to 2016	0	0	0	
Passenger Cars	Petrol	Mini	Euro 6 2017-2019	0	0	10,000	
Passenger Cars	Petrol	Small	PRE ECE	0	0	0	
Passenger Cars	Petrol	Small	ECE 15/00-01	0	0	0	
Passenger Cars	Petrol	Small	ECE 15/02	0	0	0	
Passenger Cars	Petrol	Small	ECE 15/03	0	0	0	
Passenger Cars	Petrol	Small	ECE 15/04	10,658.11	3,862.28	202,677.1	
Passenger Cars	Petrol	Small	Improved Conventional	44,304.77	4,412	192,137.69	
Passenger Cars	Petrol	Small	Open Loop	74,451.78	5,040.35	192,444.38	
Passenger Cars	Petrol	Small	Euro 1	1,105,145.15	5,759.26	179,363.25	
Passenger Cars	Petrol	Small	Euro 2	838,332.65	6,582.84	157,413.85	
Passenger Cars	Petrol	Small	Euro 3	1,620,813.2	7,528.75	143,250.71	
Passenger Cars	Petrol	Small	Euro 4	5,641,544.25	8,611.38	73,229.9	
Passenger Cars	Petrol	Small	Euro 5	2,636,427.34	9,855	21,735.67	
Passenger Cars	Petrol	Small	Euro 6 up to 2016	0	0	0	
Passenger Cars	Petrol	Small	Euro 6 2017-2019	0	0	10,000	
Passenger Cars	Petrol	Medium	PRE ECE	0	0	0	
Passenger Cars	Petrol	Medium	ECE 15/00-01	0	0	0	
Passenger Cars	Petrol	Medium	ECE 15/02	0	0	0	
Passenger Cars	Petrol	Medium	ECE 15/03	0	0	0	

- Undo and redo buttons in each form for recent activities
- Direct import and export to Excel of specific form

Form functionality (2/3)

Stock & Activity Data

All

Undo Redo Import Export

Category	Fuel	Segment	Euro Standard	Stock [n]	Mean Activity [km]	Lifetime Cumulative Activity [km]	Fuel Consumption [l/100km]
Passenger Cars	Petrol	Mini	Euro 4	0	0	0	0
Passenger Cars	Petrol	Mini	Euro 5	0	0	0	0
Passenger Cars	Petrol	Mini	Euro 6 up to 2016	0	0	0	0
Passenger Cars	Petrol	Mini	Euro 6 2017-2019	0	0	10,000	0
Passenger Cars	Petrol	Small	PRE ECE	0	0	0	0
Passenger Cars	Petrol	Small	ECE 15/00-01	0	0	0	0
Passenger Cars	Petrol	Small	ECE 15/02	0	0	0	0
Passenger Cars	Petrol	Small	ECE 15/03	0	0	0	0
Passenger Cars	Petrol	Small	ECE 15/04	10,658.11	3,862.28	202,677.1	0
Passenger Cars	Petrol	Small	Improved Conventional	44,304.77	4,412	192,137.69	0
Passenger Cars	Petrol	Small	Open Loop	74,451.78	5,040.35	192,444.38	0
Passenger Cars	Petrol	Small	Euro 1	1,105,145.15	5,768	308.25	0
Passenger Cars	Petrol	Small	Euro 2	838,332.65	6,832	418.85	0
Passenger Cars	Petrol	Small	Euro 3	1,620,813.2	7,288	250.71	0
Passenger Cars	Petrol	Small	Euro 4	5,641,544.25	8,111	3,229.9	0
Passenger Cars	Petrol	Small	Euro 5	2,636,427.34	9,111	735.67	0
Passenger Cars	Petrol	Small	Euro 6 up to 2016	0	0	0	0
Passenger Cars	Petrol	Small	Euro 6 2017-2019	0	0	10,000	0
Passenger Cars	Petrol	Medium	PRE ECE	0	0	0	0

Copy
Copy with headers
Paste
Set default values
Cancel changes

OK Apply Cancel

- Copy and paste directly from form to Excel and vice versa

Form functionality (3/3)

The screenshot shows the 'Hot Emissions Parameters' application window. It features a table with columns: Category, Fuel, Segment, Euro Standard, Technology, Pollutant, Mode, Road Slope, Load, Min Speed [km/h], Max Speed [km/h], and Alpha. A context menu is open over the table, with red boxes highlighting the '15' values in the 'Min Speed' column and the 'Set default values' option. The 'Set default values' option is highlighted with a red box, indicating the functionality being demonstrated.

Category	Fuel	Segment	Euro Standard	Technology	Pollutant	Mode	Road Slope	Load	Min Speed [km/h]	Max Speed [km/h]	Alpha
Passenger Cars	Petrol	Mini	Euro 4	GDI	CO				5	130	0.00000000000549670697736
Passenger Cars	Petrol	Mini	Euro 4	GDI	NOx				5	130	0.0000385566953442
Passenger Cars	Petrol	Mini	Euro 4	GDI	VOC				5	130	0.00000354913026550
Passenger Cars	Petrol	Mini	Euro 4	GDI	PM Exhaust	Urban Peak			10	130	
Passenger Cars	Petrol	Mini	Euro 4	GDI	PM Exhaust	Urban Off Peak			10	130	
Passenger Cars	Petrol	Mini	Euro 4	GDI	PM Exhaust	Rural			10	130	
Passenger Cars	Petrol	Mini	Euro 4	GDI	PM Exhaust	Highway			10	130	
Passenger Cars	Petrol	Mini	Euro 4	GDI	FC				15		4040
Passenger Cars	Petrol	Mini	Euro 4	GDI	CH4	Urban Peak			15		
Passenger Cars	Petrol	Mini	Euro 4	GDI	CH4	Urban Off Peak			15		
Passenger Cars	Petrol	Mini	Euro 4	GDI	CH4	Rural			10		
Passenger Cars	Petrol	Mini	Euro 4	GDI	CH4	Highway			10		
Passenger Cars	Petrol	Mini	Euro 4	PFI	CO				5	110	0.00000000000549670697736
Passenger Cars	Petrol	Mini	Euro 4	PFI	NOx				5	110	0.0000385566953442
Passenger Cars	Petrol	Mini	Euro 4	PFI	VOC				5	130	0.00000354913026550
Passenger Cars	Petrol	Mini	Euro 4	PFI	PM Exhaust	Urban Peak			10	130	
Passenger Cars	Petrol	Mini	Euro 4	PFI	PM Exhaust	Urban Off Peak			10	130	
Passenger Cars	Petrol	Mini	Euro 4	PFI	PM Exhaust	Rural			10	130	
Passenger Cars	Petrol	Mini	Euro 4	PFI	PM Exhaust	Highway			10	130	
Passenger Cars	Petrol	Mini	Euro 4	PFI	FC				5	130	0.0050823704040

- Track changes
- Change entries to 'default' values (if any)

“Cancel” current run execution

Status

File

Country : **Italy**
Run Mode : **Timeseries**
Created : **13 Oct 2016, 20:48**
Saved : **Never**

Year : 2014

Fuel Balance : **YES**
Improved Fuel Quality Year : **1996**
Mileage Degradation : **No Effect**
Lube-Oil CO2 Effect : **NO**
A/C Effect : **NO**
CO2 Effect : **NO**

Fuel Balance Calculated : **YES**
Emissions Calculated : **NO**

Calculate Fuel Balance

Calculate Emissions

All Years

Calculate All Years

Cancel

- Code execution is interrupted with no update of the results over previous run
- Useful when time-series are calculated and error is identified during execution
 - User request since many years!

Flexibility in presenting results

Emissions For All Years

FC Segment

All digits Export

Year Emission

2014

Category	Fuel	Hot				Total [TJ]	Cold	
		Urban Off Peak [TJ]	Urban Peak [TJ]	Rural [TJ]	Highway [TJ]		Urban Off Peak [TJ]	Urban...
Passenger Cars	Petrol	103,668.306	103,668.306	239,354.7239	204,954.542	651,645.8778	37,357.8107	37,357
	Diesel	94,966.5493	94,966.5493	232,575.8725	201,171.9743	623,680.9455	25,012.7142	25,012
	Petrol Hybrid	798.1386	798.1386	2,412.2749	2,431.2778	6,439.8299	653.0611	653
	LPG Bifuel	3,402.8361	3,402.8361	8,314.4624	6,099.0795	21,219.2142	1,259.1273	1,259
	CNG Bifuel	897.0599	897.0599	2,133.2549	1,791.0527	5,718.4274	364.1569	364
Passenger Cars Total		203,732.8899	203,732.8899	484,790.5887	416,447.9263	1,308,704.2949	64,646.8702	64,646
Light Commercial Vehicles	Petrol	1,373.2562	1,373.2562	1,259.6485	1,366.765	5,372.9259	478.3648	478
	Diesel	24,523.8527	24,523.8527	27,495.463	36,860.1753	113,403.3436	4,660.9162	4,660
Light Commercial Vehicles Total		25,897.1088	25,897.1088	28,755.1115	38,226.9404	118,776.2695	5,139.2811	5,139
Heavy Duty Trucks	Petrol	0	0	0	0	0		
	Diesel	44,261.8891	44,261.8891	130,470.2104	293,162.9902	512,156.9788		
Heavy Duty Trucks Total		44,261.8891	44,261.8891	130,470.2104	293,162.9902	512,156.9788		
Buses	Diesel	8,451.7643	8,451.7643	18,378.7701	5,937.2017	41,219.5003		
	CNG	720.6456	720.6456	855.5322	104.4989	2,401.3224		
	Biodiesel	0	0	0	0	0		

Close

- Pivot tables can be customized to present results at any level of aggregation requested

Enhanced results checking (Implied emission factors)

Implied Emission Factors For All Years

FC Segment All digits Export

		2014					
		Hot				Cold	
Category	Fuel	Urban Off Peak [MJ/km]	Urban Peak [MJ/km]	Rural [MJ/km]	Highway [MJ/km]	Total [MJ/km]	Urban Off Peak [MJ/km]
Passenger Cars	Petrol	2.9309	2.9309	2.2314	2.4094	2.4771	1.0562
	Diesel	2.5374	2.5374	2.0478	2.2864	2.2564	0.6683
	Petrol Hybrid	1.3922	1.3922	1.3855	1.7891	1.5165	1.1391
	LPG Bifuel	2.6147	2.6147	2.0947	2.6507	2.3914	0.9675
	CNG Bifuel	2.9623	2.9623	2.3195	2.4952	2.5493	1.2025
Passenger Cars Total		2.7173	2.7173	2.1312	2.3472	2.3587	0.8622
Light Commercial Vehicles	Petrol	3.9254	3.9254	2.5205	2.9302	3.2253	1.3674
	Diesel	3.305	3.305	2.5939	3.7257	3.2095	0.6281
Light Commercial Vehicles Total		3.333	3.333	2.5906	3.6899	3.2102	0.6614
Heavy Duty Trucks	Petrol	0	0	0	0	0	
	Diesel	10.8812	10.8812	8.0039	8.3822	8.6206	
Heavy Duty Trucks Total		10.8812	10.8812	8.0039	8.3822	8.6206	
Buses	Diesel	15.7443	15.7443	9.852	8.1981	11.2519	
	CNG	22.5409	22.5409	20.07	18.631	21.4065	
	Biodiesel	0	0	0	0	0	
Buses Total		16.1264	16.1264	10.0803	8.2783	11.5536	

Close

‘Implied’ emission factor calculation is the standard method for checking results consistency

New software elements

- Flexible import from COPERT 4
- Updates notification
- Error reporting
- Online help file
- Ticketing for COPERT questions
- No serial number required

Data import from COPERT 4

- Data Imported
 - Vehicle structure
 - Automated allocation to new categories
 - All activity data
 - C4 urban share 50-50 split to C5 Urban Peak and Off-Peak
 - Country temperatures
 - RVP
- Data not imported
 - advanced selections (*in progress*)
 - load, slope, CO₂ correction etc.
 - user data (e.g. any user-specific emission factors)
 - fuel specifications, incl. statistical fuel consumption, due to new fuels structure in C5

LDV segment structure (from C4 to C5)

COPERT 4				COPERT 5		
Sector	Subsector	Fuel		Category	Fuel Label	Segment
Passenger Cars	Gasoline <0,8l	Gasoline Unleaded	=>	Passenger Cars	Petrol	Mini
Passenger Cars	Gasoline 0,8 - 1,4l	Gasoline Leaded	=>	Passenger Cars	Petrol	Small
Passenger Cars	Gasoline 0,8 - 1,4l	Gasoline Unleaded	=>	Passenger Cars	Petrol	Small
Passenger Cars	Gasoline 1,4 - 2,0l	Gasoline Leaded	=>	Passenger Cars	Petrol	Medium
Passenger Cars	Gasoline 1,4 - 2,0l	Gasoline Unleaded	=>	Passenger Cars	Petrol	Medium
Passenger Cars	Gasoline >2,0l	Gasoline Leaded	=>	Passenger Cars	Petrol	Large-SUV-Executive
Passenger Cars	Gasoline >2,0l	Gasoline Unleaded	=>	Passenger Cars	Petrol	Large-SUV-Executive
Passenger Cars	Diesel <1,4l	Diesel	=>	Passenger Cars	Diesel	Mini
Passenger Cars	Diesel 1,4 - 2,0l	Diesel	=>	Passenger Cars	Diesel	Small
Passenger Cars	Diesel >2,0l	Diesel	=>	Passenger Cars	Diesel	Large-SUV-Executive
Passenger Cars	Hybrid Gasoline <1,4l	Hybrid Gasoline	=>	Passenger Cars	Petrol Hybrid	Mini
Passenger Cars	Hybrid Gasoline 1,4 - 2,0l	Hybrid Gasoline	=>	Passenger Cars	Petrol Hybrid	Small
Passenger Cars	Hybrid Gasoline >2,0l	Hybrid Gasoline	=>	Passenger Cars	Petrol Hybrid	Large-SUV-Executive
Passenger Cars	LPG	LPG	=>	Passenger Cars	LPG Bifuel	Small
Passenger Cars	CNG	CNG	=>	Passenger Cars	CNG Bifuel	Small
Light Commercial Vehicles	Gasoline <3,5t	Gasoline Leaded	=>	Light Commercial Vehicles	Petrol	N1-II
Light Commercial Vehicles	Gasoline <3,5t	Gasoline Unleaded	=>	Light Commercial Vehicles	Petrol	N1-II
Light Commercial Vehicles	Diesel <3,5 t	Diesel	=>	Light Commercial Vehicles	Diesel	N1-II

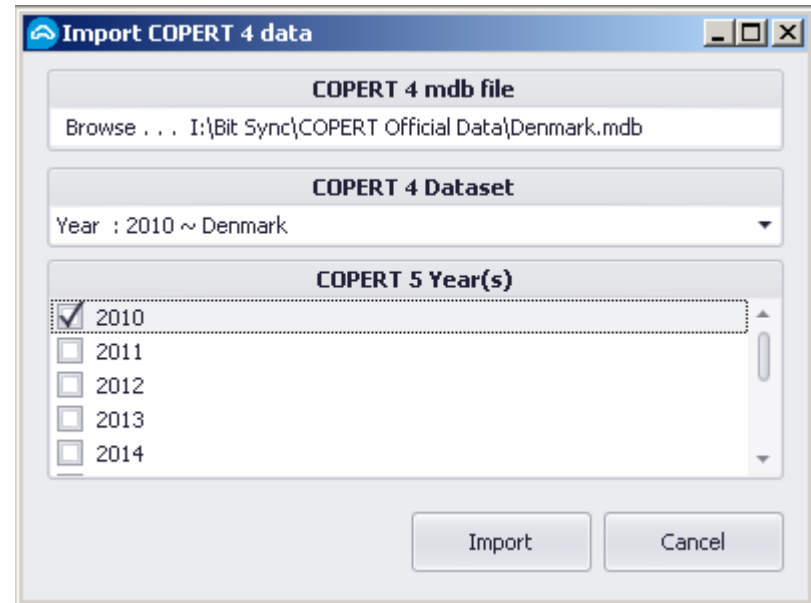
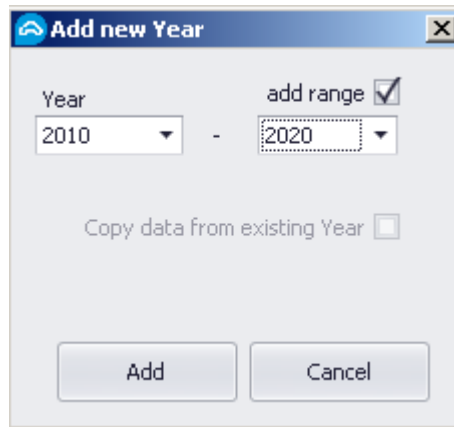
HDV segment structure (from C4 to C5)

COPERT 4				COPERT 5		
Sector	Subsector	Fuel		Category	Fuel Label	Segment
Heavy Duty Trucks	Gasoline >3,5 t	Gasoline Leaded	=>	Heavy Duty Trucks	Petrol	>3,5 t
Heavy Duty Trucks	Rigid <=7,5 t	Diesel	=>	Heavy Duty Trucks	Diesel	Rigid <=7,5 t
Heavy Duty Trucks	Rigid 7,5 - 12 t	Diesel	=>	Heavy Duty Trucks	Diesel	Rigid 7,5 - 12 t
Heavy Duty Trucks	Rigid 12 - 14 t	Diesel	=>	Heavy Duty Trucks	Diesel	Rigid 12 - 14 t
Heavy Duty Trucks	Rigid 14 - 20 t	Diesel	=>	Heavy Duty Trucks	Diesel	Rigid 14 - 20 t
Heavy Duty Trucks	Rigid 20 - 26 t	Diesel	=>	Heavy Duty Trucks	Diesel	Rigid 20 - 26 t
Heavy Duty Trucks	Rigid 26 - 28 t	Diesel	=>	Heavy Duty Trucks	Diesel	Rigid 26 - 28 t
Heavy Duty Trucks	Rigid 28 - 32 t	Diesel	=>	Heavy Duty Trucks	Diesel	Rigid 28 - 32 t
Heavy Duty Trucks	Rigid >32 t	Diesel	=>	Heavy Duty Trucks	Diesel	Rigid >32 t
Heavy Duty Trucks	Articulated 14 - 20 t	Diesel	=>	Heavy Duty Trucks	Diesel	Articulated 14 - 20 t
Heavy Duty Trucks	Articulated 20 - 28 t	Diesel	=>	Heavy Duty Trucks	Diesel	Articulated 20 - 28 t
Heavy Duty Trucks	Articulated 28 - 34 t	Diesel	=>	Heavy Duty Trucks	Diesel	Articulated 28 - 34 t
Heavy Duty Trucks	Articulated 34 - 40 t	Diesel	=>	Heavy Duty Trucks	Diesel	Articulated 34 - 40 t
Heavy Duty Trucks	Articulated 40 - 50 t	Diesel	=>	Heavy Duty Trucks	Diesel	Articulated 40 - 50 t
Heavy Duty Trucks	Articulated 50 - 60 t	Diesel	=>	Heavy Duty Trucks	Diesel	Articulated 50 - 60 t
Buses	Urban Buses Midi <=15 t	Diesel	=>	Buses	Diesel	Urban Buses Midi <=15 t
Buses	Urban Buses Standard 15 - 18 t	Diesel	=>	Buses	Diesel	Urban Buses Standard 15 - 18 t
Buses	Urban Buses Articulated >18 t	Diesel	=>	Buses	Diesel	Urban Buses Articulated >18 t
Buses	Coaches Standard <=18 t	Diesel	=>	Buses	Diesel	Coaches Standard <=18 t
Buses	Coaches Articulated >18 t	Diesel	=>	Buses	Diesel	Coaches Articulated >18 t
Buses	Urban CNG Buses	CNG	=>	Buses	CNG	Urban CNG Buses
Buses	Urban Biodiesel Buses	Biodiesel	=>	Buses	Biodiesel	Urban Biodiesel Buses

L-category segment structure (from C4 to C5)

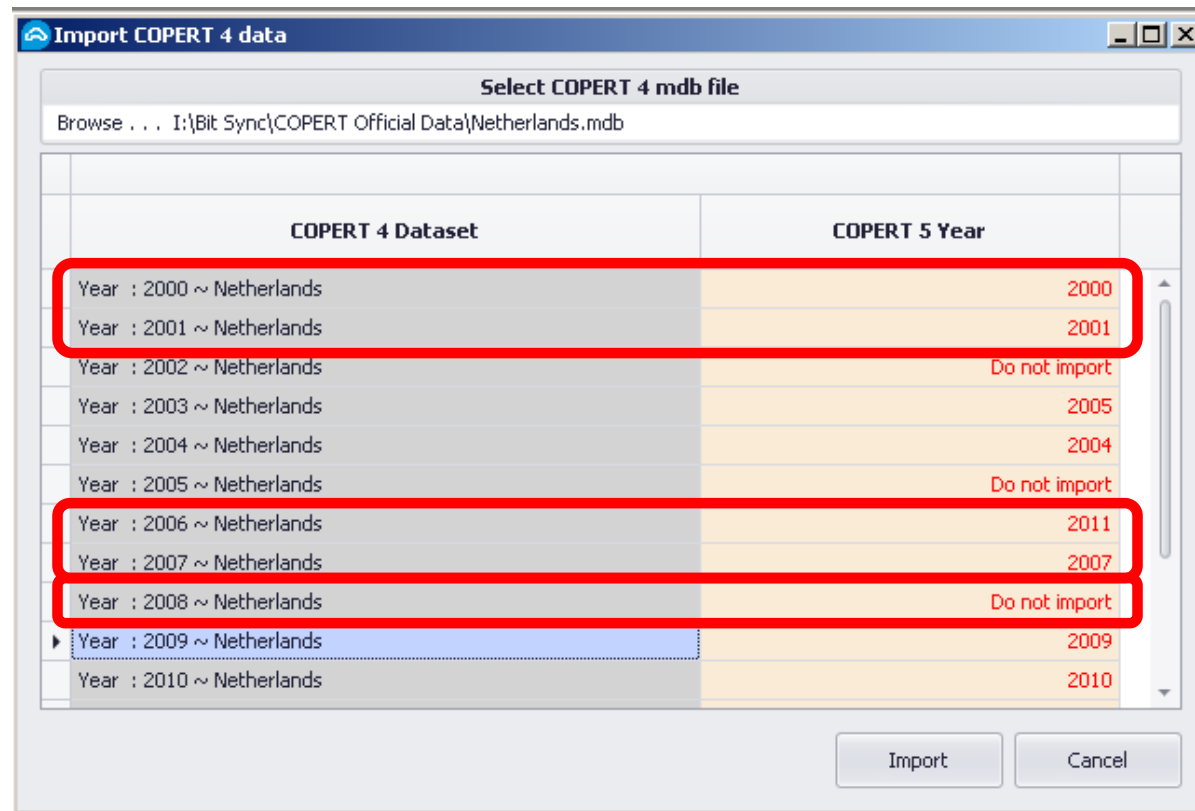
COPERT 4				COPERT 5		
Sector	Subsector	Fuel		Category	Fuel Label	Segment
Mopeds	2-stroke <50 cm ³	Gasoline Leaded	=>	L-Category	Petrol	Mopeds 2-stroke <50 cm ³
Mopeds	4-stroke <50 cm ³	Gasoline Leaded	=>	L-Category	Petrol	Mopeds 4-stroke <50 cm ³
Motorcycles	2-stroke >50 cm ³	Gasoline Leaded	=>	L-Category	Petrol	Motorcycles 2-stroke >50 cm ³
Motorcycles	4-stroke <250 cm ³	Gasoline Leaded	=>	L-Category	Petrol	Motorcycles 4-stroke <250 cm ³
Motorcycles	4-stroke 250 - 750 cm ³	Gasoline Leaded	=>	L-Category	Petrol	Motorcycles 4-stroke 250 - 750 cm ³
Motorcycles	4-stroke >750 cm ³	Gasoline Leaded	=>	L-Category	Petrol	Motorcycles 4-stroke >750 cm ³

COPERT 4 files consolidation (Many to one)



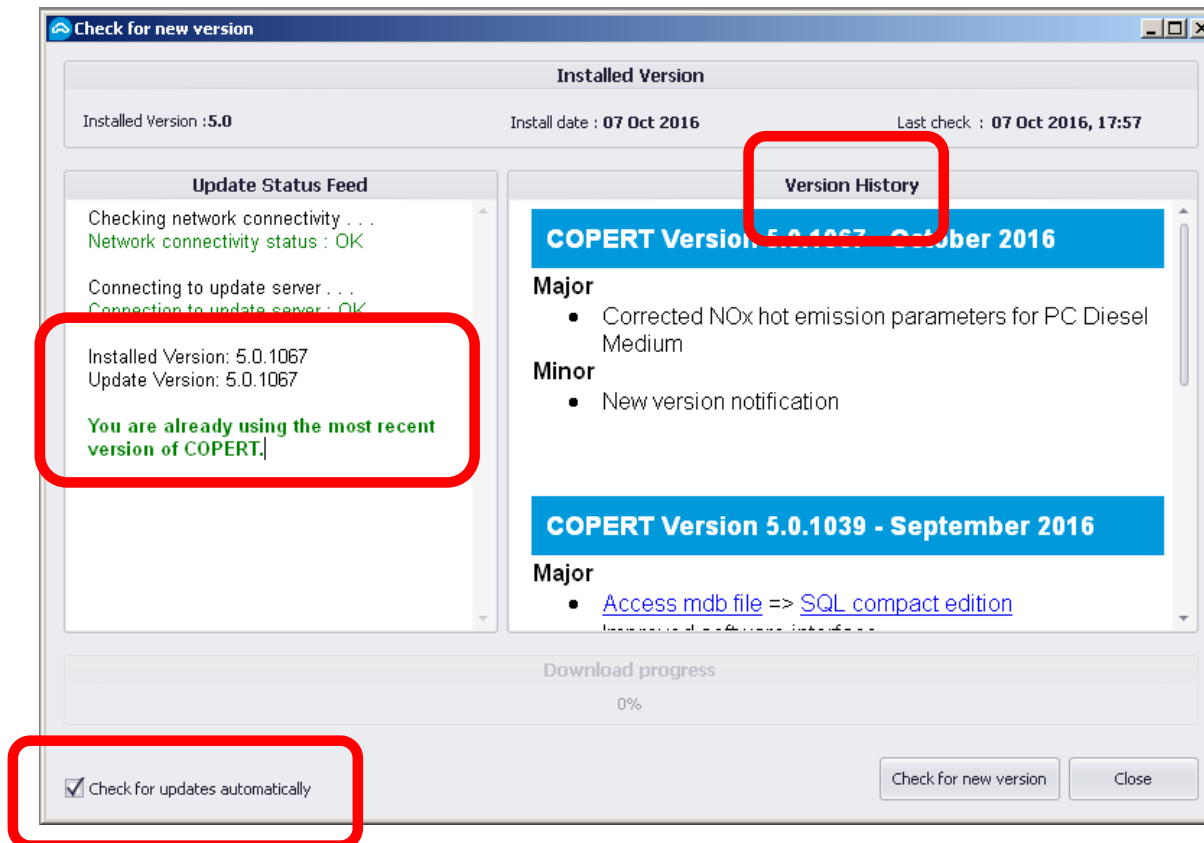
- A single C5 file can store information from many C4 files
- C4 known issue of not able to store more than ~8 years in one file
- Process starts by creating complete time-series file in C5 and import first C4 file
- Other C4 files can then be imported in the same file to build complete time-series

Automated recognition of year during import



- Years are automatically recognized during import
- User can alter year specification or decide not to import specific year(s)

New version “update” notification



- User is first informed about new version characteristics and decides whether this is to be installed or not

This functionality requires internet connection

Error reporting



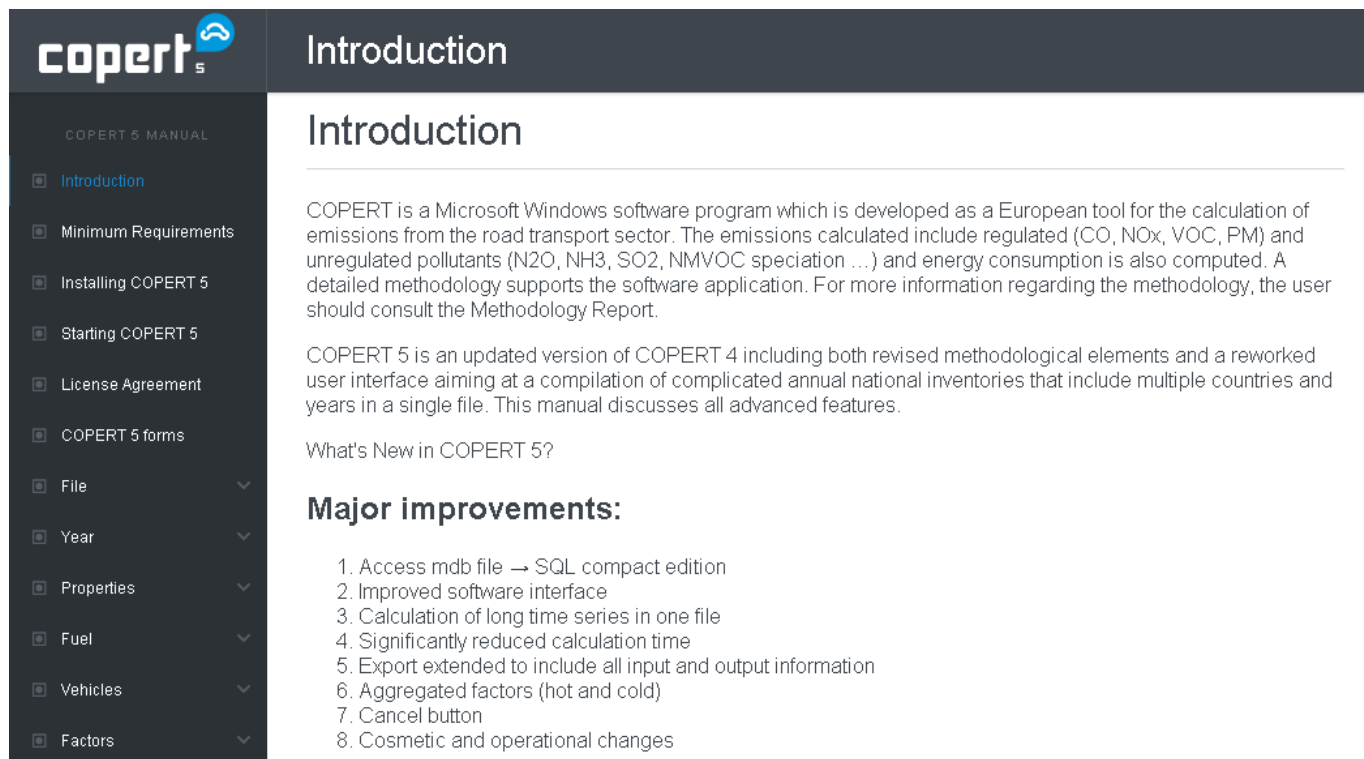
The screenshot shows a dialog box titled "Error Report Submission" with a red warning triangle icon. The main heading is "COPERT Error Report Submission". Below this, there is a request to send the error report to help fix software problems. A section for user details includes fields for "Name" and "Email", and a "Comments" text area. A confirmation message states: "By pressing the 'Send Error Report' button, I confirm that I am familiar with the contents of the report and accept to send it to COPERT technical team." At the bottom, there is a "Send error report" button, a "Cancel" button, and a link: "See what this report contains."

Notification send to support@emisia.com

This functionality requires internet connection

Online help file

<http://copert.emisia.com>



copert₅

COPERT 5 MANUAL

- Introduction
- Minimum Requirements
- Installing COPERT 5
- Starting COPERT 5
- License Agreement
- COPERT 5 forms
- File
- Year
- Properties
- Fuel
- Vehicles
- Factors

Introduction

COPERT is a Microsoft Windows software program which is developed as a European tool for the calculation of emissions from the road transport sector. The emissions calculated include regulated (CO, NO_x, VOC, PM) and unregulated pollutants (N₂O, NH₃, SO₂, NMVOC speciation ...) and energy consumption is also computed. A detailed methodology supports the software application. For more information regarding the methodology, the user should consult the Methodology Report.

COPERT 5 is an updated version of COPERT 4 including both revised methodological elements and a reworked user interface aiming at a compilation of complicated annual national inventories that include multiple countries and years in a single file. This manual discusses all advanced features.

What's New in COPERT 5?

Major improvements:

1. Access mdb file → SQL compact edition
2. Improved software interface
3. Calculation of long time series in one file
4. Significantly reduced calculation time
5. Export extended to include all input and output information
6. Aggregated factors (hot and cold)
7. Cancel button
8. Cosmetic and operational changes

This functionality requires internet connection

Enhanced user support

- e-mail concern to: support@emisiam.com
- Unique ID – ticketing
- Multiple EMISIA experts can engage to resolve issue
- Tracing all answers and questions
- Fast and reliable support

Requirement: Do not modify the subject

Methodology changes

New AEIG/C5 methodology elements

- Calculation Framework
 - Introduction of Tier 2 method and interface
 - Entity mode in parallel to time-series mode
 - Uncertainty estimation (under development)
- Energy, Fuels, and Lubricants
 - Energy instead of fuel mass calculations
 - Distinction between primary and end (blends) fuels
 - Automated energy balance
 - Enhanced fuel specs
 - Lubricant consumption and specifications
- Vehicle Types and Emissions
 - New vehicle structure
 - Bi-fueled vehicles
 - New vehicle technologies
 - Emission control technology level

Calculation framework

Introduction of a Tier 2 method

Country name

Continent : EUROPE

Country : Greece

Custom name

Name :

Run mode

Timeseries Entity :

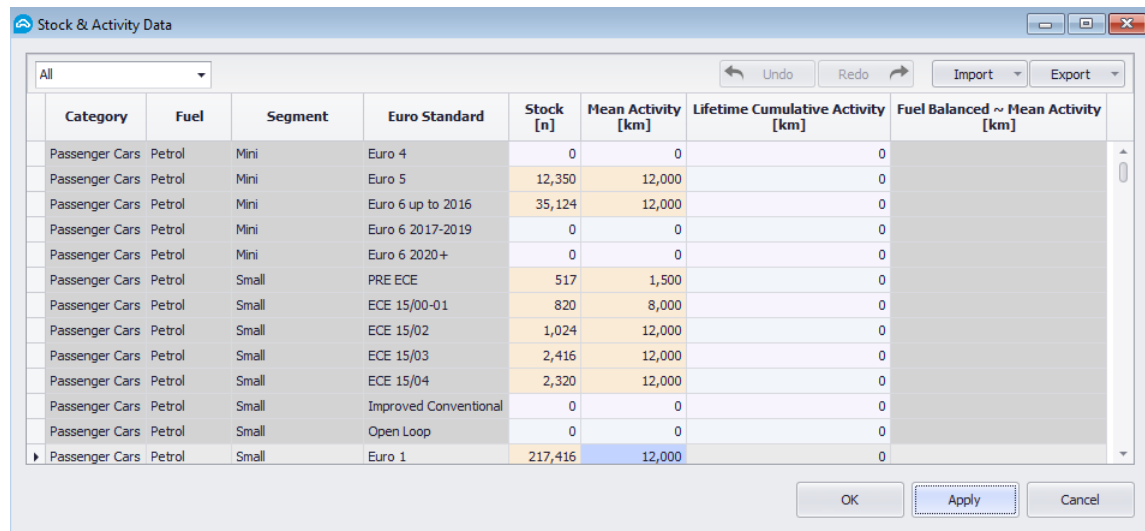
Tier mode

Tier 2 Tier 3

Create Cancel

- Tier 2 method is proposed in AEIG for parties with limited experience and data availability to perform a detailed inventory
- Although this is not the recommended method, it may be useful in cases
- Tier 2 usually comes up with higher total estimates than Tier 3 due to gross assumptions

Tier 2 method outline



The screenshot shows a software window titled "Stock & Activity Data". It contains a table with the following columns: Category, Fuel, Segment, Euro Standard, Stock [n], Mean Activity [km], Lifetime Cumulative Activity [km], and Fuel Balanced ~ Mean Activity [km]. The table lists various vehicle categories (Passenger Cars) with different Euro standards (Euro 4, Euro 5, Euro 6 up to 2016, Euro 6 2017-2019, Euro 6 2020+, PRE ECE, ECE 15/00-01, ECE 15/02, ECE 15/03, ECE 15/04, Improved Conventional, Open Loop, and Euro 1). The "Euro 1" row is highlighted in blue, showing a stock of 217,416 and a mean activity of 12,000 km. The interface also includes a dropdown menu set to "All", "Undo" and "Redo" buttons, "Import" and "Export" buttons, and "OK", "Apply", and "Cancel" buttons at the bottom.

Category	Fuel	Segment	Euro Standard	Stock [n]	Mean Activity [km]	Lifetime Cumulative Activity [km]	Fuel Balanced ~ Mean Activity [km]
Passenger Cars	Petrol	Mini	Euro 4	0	0	0	0
Passenger Cars	Petrol	Mini	Euro 5	12,350	12,000	0	0
Passenger Cars	Petrol	Mini	Euro 6 up to 2016	35,124	12,000	0	0
Passenger Cars	Petrol	Mini	Euro 6 2017-2019	0	0	0	0
Passenger Cars	Petrol	Mini	Euro 6 2020+	0	0	0	0
Passenger Cars	Petrol	Small	PRE ECE	517	1,500	0	0
Passenger Cars	Petrol	Small	ECE 15/00-01	820	8,000	0	0
Passenger Cars	Petrol	Small	ECE 15/02	1,024	12,000	0	0
Passenger Cars	Petrol	Small	ECE 15/03	2,416	12,000	0	0
Passenger Cars	Petrol	Small	ECE 15/04	2,320	12,000	0	0
Passenger Cars	Petrol	Small	Improved Conventional	0	0	0	0
Passenger Cars	Petrol	Small	Open Loop	0	0	0	0
Passenger Cars	Petrol	Small	Euro 1	217,416	12,000	0	0

Limited input required:

- Environmental information (temperature and humidity)
- Statistical energy consumption (required for energy balance only)
- Vehicle stock and activity data (stock, activity, lifetime cumulative activity)
- A number of default assumptions are made (speeds, shares, evap distribution, technology mix, ...)

Entity mode calculation

The screenshot shows a 'Create file' dialog box with the following settings:

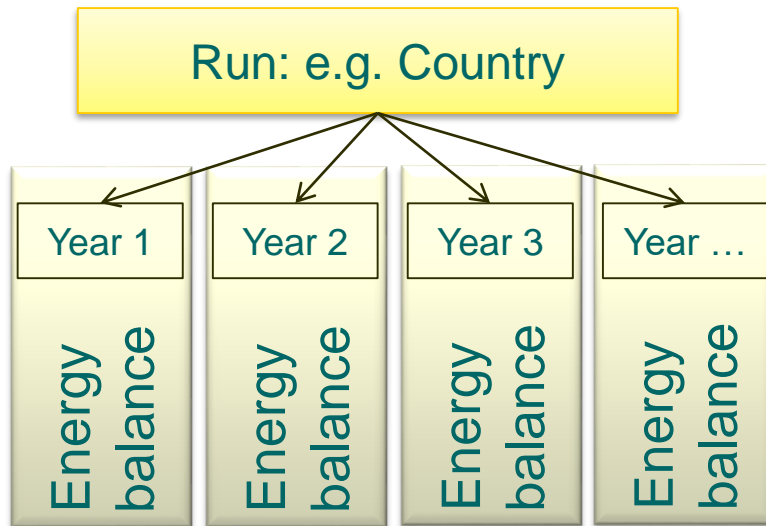
- Country name:** Continent: EUROPE, Country: Greece, Custom name: (unchecked), Name:
- Run mode:** Timeseries: (unchecked), Entity: (checked) with 'Region' in the text field
- Tier mode:** Tier 2: (unchecked), Tier 3: (checked)

Buttons: Create, Cancel

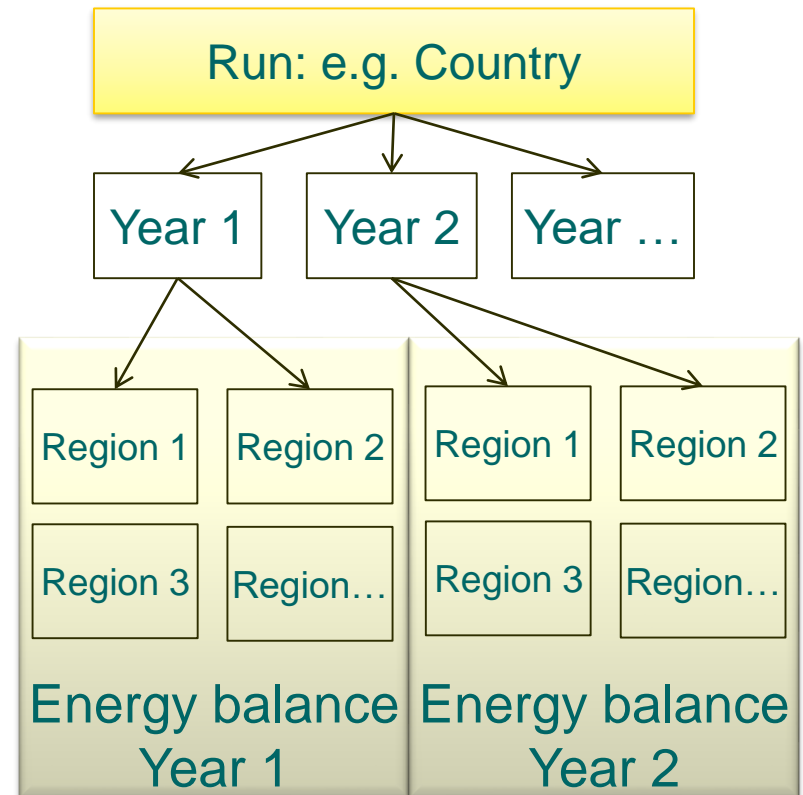
- Each 'entity' is an individual component of a 'system' for which a total calculation needs to be conducted. Example of entities:
 - Example 1: Separate regions (entities) within a country (system)
 - Example 2: Individual transport hubs (entities) within a logistics company (system)
- Energy balance is conducted at system level (9.2017 COPERT version)

'Time-series' vs 'entity' mode

Time-series mode



Entity mode



Inventory uncertainty estimation

- Methodology currently under development
- Quantified 'error' propagation calculations
 - Final expression may be quality rather than quantity indicator
- Uncertainty range to final inventory value to be given per pollutant
- Minimum user input to be required

Energy, Fuels, and Lubricants

Energy consumption calculation

- In consistency to IPCC guidelines, fuel energy instead of fuel mass calculations are conducted
- Fuels are distinguished to primary (statistics) and end fuel blends used by vehicles
- New primary fuels added (H₂, electricity) and two grades for each of liquid fossil fuels (Petrol, Diesel, LPG)
- ‘Gasoline’ (AmE) renamed to ‘Petrol’ (BrE)

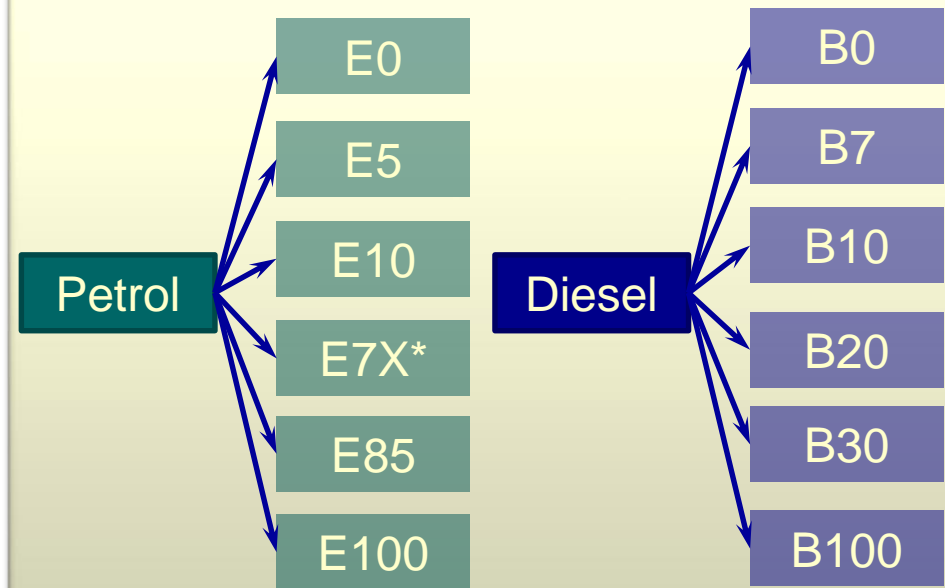
Primary and end fuels (blends)

Primary Fuels

Petrol 1	CNG
Petrol 2	Biodiesel
Diesel 1	Bio-EtOH
Diesel 2	Bio-ETBE*
LPG 1	H2
LPG 2	ELE

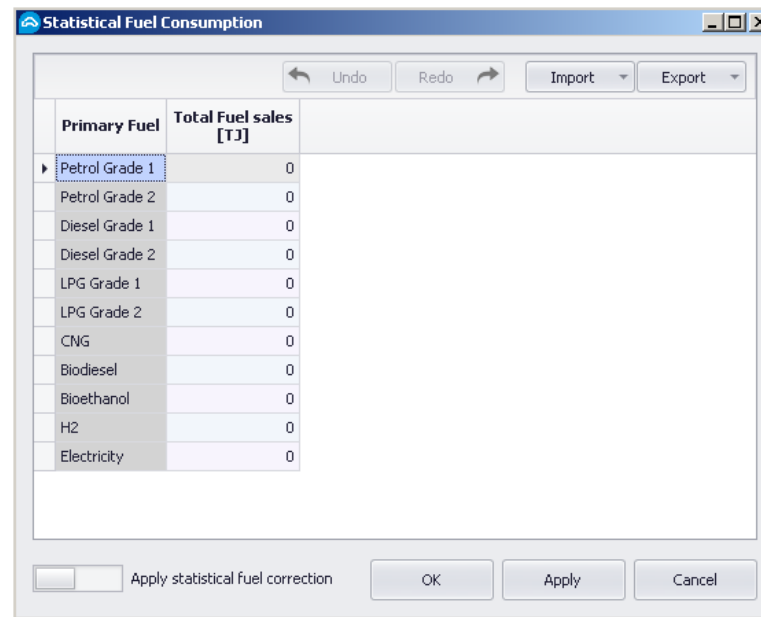
*AEIG 2018 Version

End fuels



*Change from E70 to E75 in 9.2017 C5 version

Primary fuels



Primary Fuel	Total Fuel sales [TJ]
Petrol Grade 1	0
Petrol Grade 2	0
Diesel Grade 1	0
Diesel Grade 2	0
LPG Grade 1	0
LPG Grade 2	0
CNG	0
Biodiesel	0
Bioethanol	0
H2	0
Electricity	0

Primary fuels: energy consumption

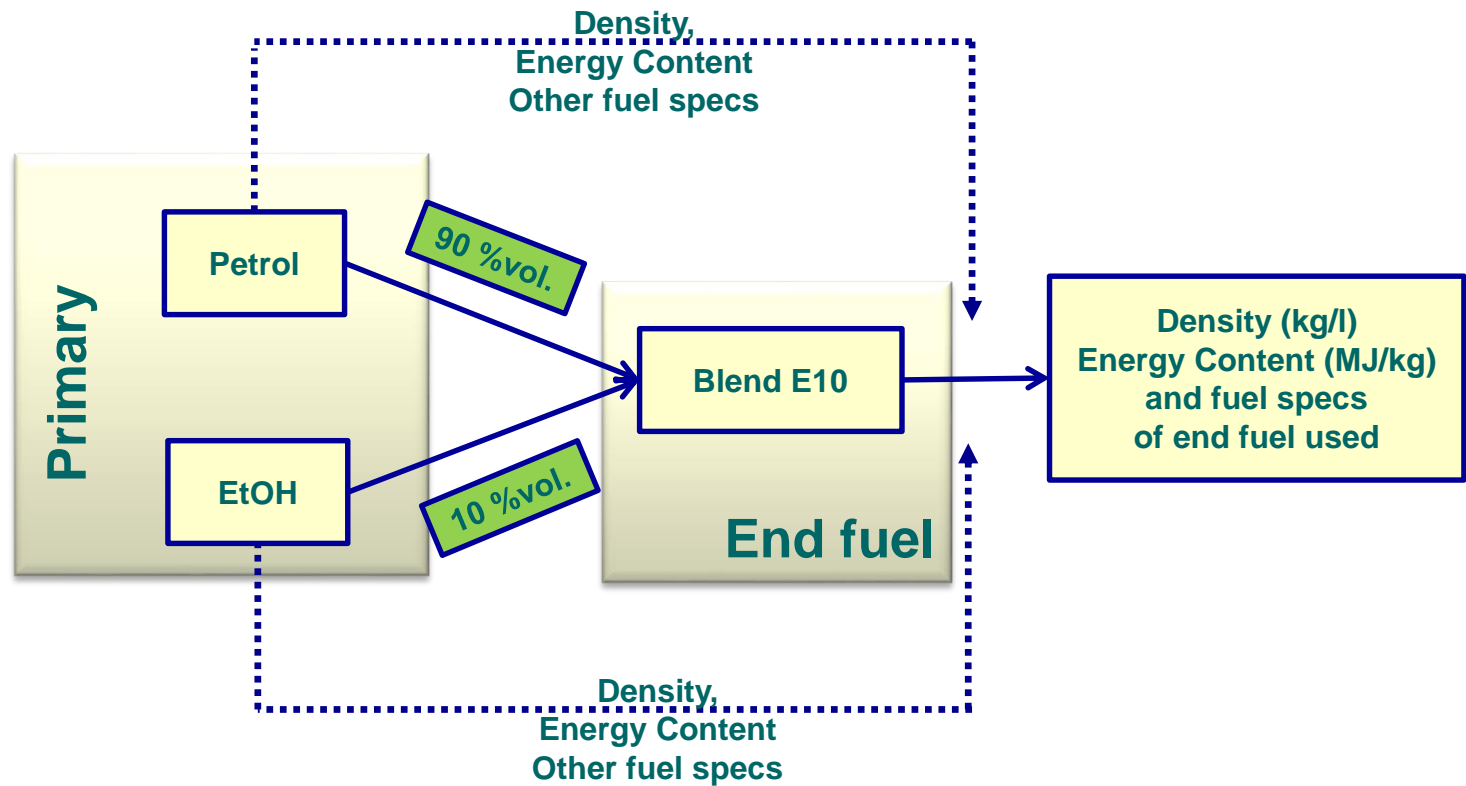
- Consistent to IPCC: Fuel sales in TJ for each primary fuel
- Two grades for major fuels: User-specific properties
- Addition of electricity and H₂ as separate fuels

End fuels (blends)

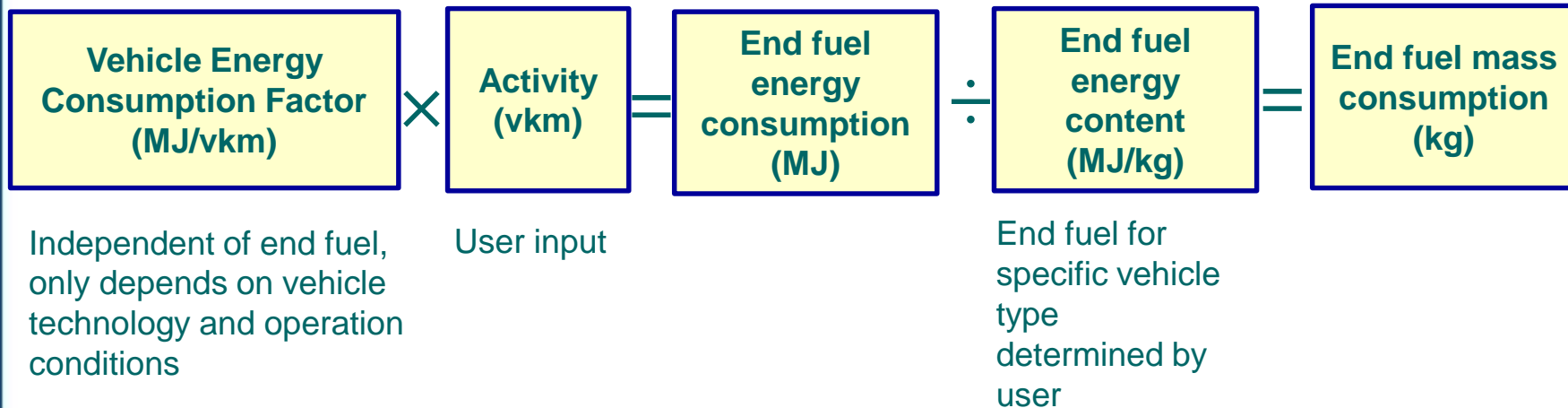
- End fuels: User may define up to two different fuel blends per vehicle type, e.g. EX blends, difference between winter-summer, etc.
- Example: Petrol passenger car, Small, EURO 1
 - Blends energy share: First order estimate by the user, e.g. 70% E5 and 30% E10 E5 consisting of
 - 5% vol. Bioethanol
 - 95% vol. Petrol (Grade 1 and/or Grade2)
 - E10 consisting of
 - 10% vol. Bioethanol
 - 90% vol. Petrol (Grade 1 and/or Grade2)

From primary fuels to blends (end fuels)

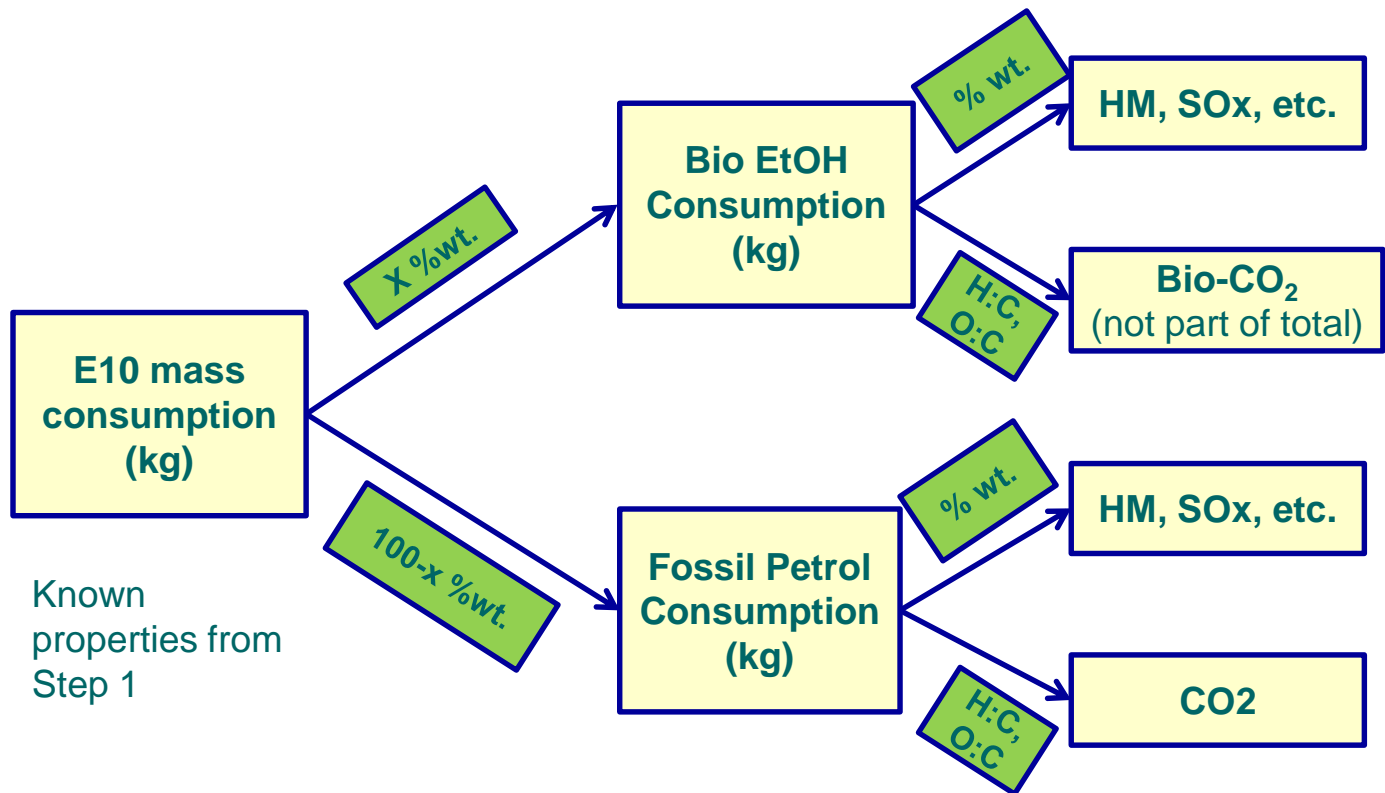
Example E10 fuel



End fuel consumption



From end fuels back to primary ones to calculate GHG and fuel dependent pollutants (e.g. E10)



Automated energy balance

- COPERT 4
 - fuel **mass** balance conducted by the user, most frequently by adjusting **mileage**
- COPERT 5
 - manual **energy** balance procedure still possible but cumbersome for blends
 - automated **energy** balance procedure available, adjusting **mileage**, blends **share** and exact blend **ratio**

Energy balance principles

- Total energy sold in country and energy calculated need to match (energy balance)
 - Primarily to correctly report GHG emissions
 - It also affects activity per vehicle type, hence conventional pollutant totals also affected
- Total energy consumption per primary fuel needs to be respected
 - Total end-fuel consumption energy should much total primary fuel energy
 - Ratio of primary bio/fossil equals ratio of end-fuel bio/fossil

Energy balance algorithm outline

1. Match primary fuel bio/fossil ratio
 - Starting with least certain: Blends energy share per vehicle type modified
 - E.g. an assumption of 70% E5 and 30% E10 may end up 72% E5 and 28% E10)
 - If previous step not enough: Modifying blend ratio per end-fuel
 - E.g. an E5 fuel may end up as E4.5 fuel
2. Adjust mileage to match total primary energy consumption:
 - Mileage adjustment corrects both fossil and bio, as the ratio is fixed

Energy balance related forms (1/2)

Primary Fuel	Total Fuel sales [TJ]
Petrol Grade	0
Petrol Grade	0
Diesel Grade	0
Diesel Grade	0
LPG Grade 1	0
LPG Grade 2	0
CNG	0
Biodiesel	0
Bioethanol	0
H2	0
Electricity	0

Apply statistical fuel correction

Total energy consumption of primary fuels sold in country needs to be provided and indication to perform energy balancing needed

Energy balance related forms (2/2)

Status

File

Country : **Italy**
Run Mode : **Timeseries**
Created : **13 Oct 2016, 20:48**
Saved : **Never**

Year : 2014

Fuel Balance : **YES**
Improved Fuel Quality Year : **1996**
Mileage Degradation : **No Effect**
Lube-Oil CO2 Effect : **NO**
A/C Effect : **NO**
CO2 Effect : **NO**

Fuel Balance Calculated : **YES**
Emissions Calculated : **NO**

Calculate Fuel Balance
Calculate Emissions
Calculate All Years

Cancel

Possibility to first execute energy balance and then to calculate pollutant emissions given, to save time if user needs to make additional modifications after first energy balancing

Reviewing energy balance (1/2)

The screenshot shows a software window titled "Stock & Activity Data". It contains a table with the following columns: Category, Fuel, Segment, Euro Standard, Stock [n], Mean Activity [km], Lifetime Cumulative Activity [km], and Fuel Balanced ~ Mean Activity [km]. The "Fuel Balanced ~ Mean Activity [km]" column is highlighted with a red box. The table lists various vehicle categories and Euro standards, with corresponding stock and activity values.

Category	Fuel	Segment	Euro Standard	Stock [n]	Mean Activity [km]	Lifetime Cumulative Activity [km]	Fuel Balanced ~ Mean Activity [km]
Passenger Cars	Petrol	Medium	ECE 15/02	0	0		0
Passenger Cars	Petrol	Medium	ECE 15/03	0	0		0
Passenger Cars	Petrol	Medium	ECE 15/04	16,201.04	3,034.76	249,099.0	2,973.1
Passenger Cars	Petrol	Medium	Improved Conventional	0	0		0
Passenger Cars	Petrol	Medium	Open Loop	0	0		0
Passenger Cars	Petrol	Medium	Euro 1	84,370.58	4,525.31	225,000.5	4,433.36
Passenger Cars	Petrol	Medium	Euro 2	613,432.04	5,172.43	201,407.1	5,067.33
Passenger Cars	Petrol	Medium	Euro 3	909,521.24	5,915.67	147,669.5	5,795.47
Passenger Cars	Petrol	Medium	Euro 4	1,376,650.77	6,766.35	79,513.	6,628.86
Passenger Cars	Petrol	Medium	Euro 5	478,653.35	7,743.51	32,025.7	7,586.17
Passenger Cars	Petrol	Medium	Euro 6 up to 2016	0	0		0
Passenger Cars	Petrol	Medium	Euro 6 2017-2019	0	0	10,00	0
Passenger Cars	Petrol	Large-SUV-Executive	PRE ECE	231.76	2,271.14	42,437.5	2,224.99
Passenger Cars	Petrol	Large-SUV-Executive	ECE 15/00-01	0	0		0

Both user specific and energy-balanced mileage available for user review

Reviewing energy balance (2/2)

Technology blends share

All

Undo Redo Import Export

Vehicle				Blend		Blend Energy Share		Fuel Balanced ~ Biofuel...		Fuel Balanced ~ Blend...	
Category	Fuel	Segment	Euro Standard	First Blend	Second Blend	First Blend [%]	Second Blend [%]	First Blend [%]	Second Blend [%]	First Blend [%]	Second Blend [%]
Light Commercial Vehicles	Petrol	N1-II	Euro 4	E5	E10	80%	20%	4.64%	0%	100%	0%
Light Commercial Vehicles	Petrol	N1-II	Euro 5	E5	E10	80%	20%	4.64%	0%	100%	0%
Light Commercial Vehicles	Petrol	N1-II	Euro 6 up to 2017	E5	E10	80%	20%	4.64%	0%	100%	0%
Light Commercial Vehicles	Petrol	N1-II	Euro 6 2018-2020	E5	E10	80%	20%	4.64%	0%	100%	0%
Light Commercial Vehicles	Diesel	N1-II	Conventional	B7	B20	80%	20%	7%	20%	98.18%	1.82%
Light Commercial Vehicles	Diesel	N1-II	Euro 1	B7	B20	80%	20%	7%	20%	98.18%	1.82%
Light Commercial Vehicles	Diesel	N1-II	Euro 2	B7	B20	80%	20%	7%	20%	98.18%	1.82%
Light Commercial Vehicles	Diesel	N1-II	Euro 3	B7	B20	80%	20%	7%	20%	98.18%	1.82%
Light Commercial Vehicles	Diesel	N1-II	Euro 4	B7	B20	80%	20%	7%	20%	98.18%	1.82%
Light Commercial Vehicles	Diesel	N1-II	Euro 5	B7	B20	80%	20%	7%	20%	98.18%	1.82%
Light Commercial Vehicles	Diesel	N1-II	Euro 6 up to 2017	B7	B20	80%	20%	7%	20%	98.18%	1.82%
Light Commercial Vehicles	Diesel	N1-II	Euro 6 2018-2020	B7	B20	80%	20%	7%	20%	98.18%	1.82%
Heavy Duty Trucks	Petrol	>3,5 t	Conventional	E5	E10	80%	20%	4.64%	0%	100%	0%
Heavy Duty Trucks	Diesel	Rigid <=7,5 t	Conventional	B7	B20	80%	20%	7%	20%	98.18%	1.82%
Heavy Duty Trucks	Diesel	Rigid <=7,5 t	Euro 1	B7	B20	80%	20%	7%	20%	98.18%	1.82%

Set main fuels

OK Apply Cancel

Both initial and final blend shares and ratios available for user review

Advanced fuel specifications

Fuel Specifications

Undo Redo Import Export

Primary Fuel	Specifications				Content In Species									
	Energy Content [MJ/kg]	H:C Ratio [-]	O:C Ratio [-]	Density [kg/m3]	S [ppm wt]	Pb [ppm wt]	Cd [ppm wt]	Cu [ppm wt]	Cr [ppm wt]	Ni [ppm wt]	Se [ppm wt]	Zn [ppm wt]	Hg [ppm wt]	As [ppm wt]
Petrol Grade 1	43.774	1.89	0.016	750	0	0.0016	0.0002	0.0045	0.0063	0.0023	0.0002	0.033	0.0087	0.0003
Petrol Grade 2	43.774	1.89	0.016	750	0	0.0016	0.0002	0.0045	0.0063	0.0023	0.0002	0.033	0.0087	0.0003
Diesel Grade 1	42.695	1.86	0.005	840	0	0.0005	0.00005	0.0057	0.0085	0.0002	0.0001	0.018	0.0053	0.0001
Diesel Grade 2	42.695	1.86	0.005	840	0	0.0005	0.00005	0.0057	0.0085	0.0002	0.0001	0.018	0.0053	0.0001
LPG Grade 1	46.564	2.525	0	835	0	0	0	0	0	0	0	0	0	0
LPG Grade 2	46.564	2.525	0	835	0	0	0	0	0	0	0	0	0	0
CNG	48	3.9	0	775	0	0	0	0	0	0	0	0	0	0
Biodiesel	37.3	1.94	0.11	750	0	0.0005	0.00005	0.0057	0.0085	0.0002	0.0001	0.018	0.0053	0.0001
Bioethanol	28.8	3	0.5	710	0	0.0016	0.0002	0.0045	0.0063	0.0023	0.0002	0.033	0.0087	0.0003
H2	43.774	0	0	0	0	0	0	0	0	0	0	0	0	0
Electricity	1,000	0	0	0	0	0	0	0	0	0	0	0	0	0

OK Apply Cancel

Extended list of HM included

Change in 'default' values over C4 reflects separate calculation of lube oil (next slide)

Lubricant consumption and specifications

Lubricant Type	Content In Species										Specifications	
	S [ppm wt]	Pb [ppm wt]	Cd [ppm wt]	Cu [ppm wt]	Cr [ppm wt]	Ni [ppm wt]	Se [ppm wt]	Zn [ppm wt]	Hg [ppm wt]	As [ppm wt]	H:C Ratio [-]	O:C Ratio [-]
Type 1	0	0.0332	4.56	778	19.2	31.89	4.54	450.2	0	0	2.08	0

- Lubricant consumption rate changes with vehicle age (lifetime mileage)
- Lube oil content in different species
 - In COPERT 4 it was assumed that a part of the HM emissions from fuel was actually from lubricant consumption – significant reduction of default values in fuel specifications in COPERT 5

Energy, Fuels, and Lubricants

Updated vehicle category naming (1/2)

Passenger Cars

COPERT 4	COPERT 5
<0.8 l	Mini
0.8 – 1.4 l	Small
1.4 – 2.0 l	Medium
>2.0 l	Large-SUV-Executive

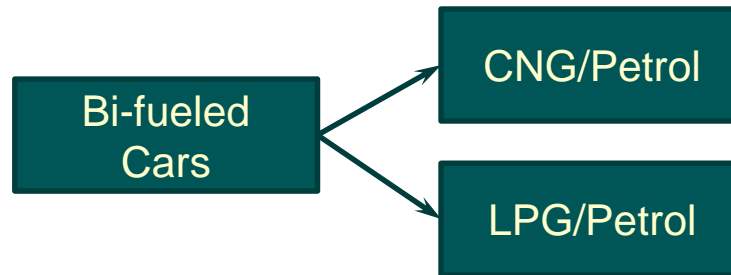
- Engine capacity as such little relevant for consumption
- Easier to implement C5 in projections
- Segmentation may be found by ACEA or vehicle dealers

Light Commercial Vehicles

COPERT 4	COPERT 5
Gasoline	Petrol N1-I
	Petrol N1-II
	Petrol N1-III
Diesel	Diesel N1-I
	Diesel N1-II
	Diesel N1-III

- Categories relevant to fuel consumption calculation
 - N1-I: $RW \leq 1305$ kg
 - N1-II: $1305 \text{ kg} < RW \leq 1760$ kg
 - N1-III: $1760 \text{ kg} < RW$

Bi-fueled vehicles



- Most LPG and converted CNG cars can operate on both petrol and alternative fuel (bi-fueled)
- Bi-fueled cars activity split into neat petrol and neat alternative fuel
 - Like two vehicles operating for less mileage

New vehicle types



- Fuel/energy consumption and emission factors still under development (AEIG 2018 version)



Emission control technology level

Category	Fuel	Euro	Tech 1	Tech 2	Tech 3
Passenger Cars	Petrol	4, 5, 6	PFI	GDI	
Passenger Cars	Diesel	6	DPF	DPF+SCR	DPF+LNT
Heavy Duty Trucks	Diesel	V	EGR	SCR	

- Emission control technology layer to distinguish between concepts with distinct emission behavior in same Euro class
- Initial values proposed, can be modified by the user

Enhanced L-vehicles list

L-category vehicles

COPERT 4	COPERT 5	
Mopeds and Motorcycles	L-category vehicles	
-	Quads and ATVs	
-	Micro-cars	

- Two categories completely missing from COPERT 4, coming in AEIG 2018 version:
- Quads and ATVs: Petrol powered
- Micro-cars: 500 cc diesel powered

Consolidated hot emission factor function

$$EF(v) = \frac{a \cdot v^2 + b \cdot v + c + \frac{d}{v}}{e \cdot v^2 + f \cdot v + g} (1 - RF_{EURO})(1 - RF_{FUEL}) \quad [\text{g/km}]$$

- Pollutants covered NO_x, PM, CO, VOC and fuel consumption
- New function adds flexibility
- Can accommodate fuel effects

Status of Diesel LDV NO_x EFs

- Diesel NO_x emission factors for Euro 6 LDVs last revised in October 2016 both for COPERT 4 and COPERT 5
 - Objective: to fast address concerns on time for 2016 submission
- New version of the HBEFA published end of 5.2017. First observations compared to COPERT:
 - Increased Euro 4 EFs by ~10%
 - Practically no change for Euro 5
 - Similar level to revised COPERT Euro 6 (w. T_{corr} – see below) but faster reduction for follow-up Euro 6 steps
- Inclusion of ambient temperature correction to diesel hot NO_x EF introduced. 0/20°C correction up to 1.9 so very important.
 - By introducing this correction for Northern EU countries may further increase mean NO_x levels by another **10-50%** for Euro 5

Next steps on Diesel LDV NO_x EFs

- Currently reviewing T_{corr} from HBEFA, admittedly this is considered as “indicative and require further investigation” by HBEFA team.
 - Still small sample of Euro 6 measured, new evidence is expected as RDE is coming
- Definitely no pressing need to change EFs for inventories in countries where average T is $>15^{\circ}\text{C}$.
 - Temperature correction becomes significant for Euro 5 below 15°C
- Cold start over-emission is negative in HBEFA, still marginally positive in COPERT.
- LCVs: COPERT 2016 Euro 5 update based on fast and dirty approach. No evidence on Euro 6 yet.
- Projections: COPERT expected improvements with Euro 6d-temp, 6d technologies lower than HBEFA expectations; no Euro 7 included in any model.

Next steps

- COPERT 4 not going to be updated/maintained any more
- COPERT 5 version recommended for Y2016 submission
- Feedback important, please email us at support@emisiam.com
- Current COPERT 5 version
 - Already includes the new AEIG components
 - Can handle complete time-series in one file
 - Provides automated energy balance
 - Consistent to IPCC guidelines and contributes to QA/QC your inventory
- AEIG/C5 methodology continuously being revised
 - Diesel NOx issue being monitored

Thank you for your attention!

