

COPERT introduction and methodology

copert ₄

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General background



Administrative status

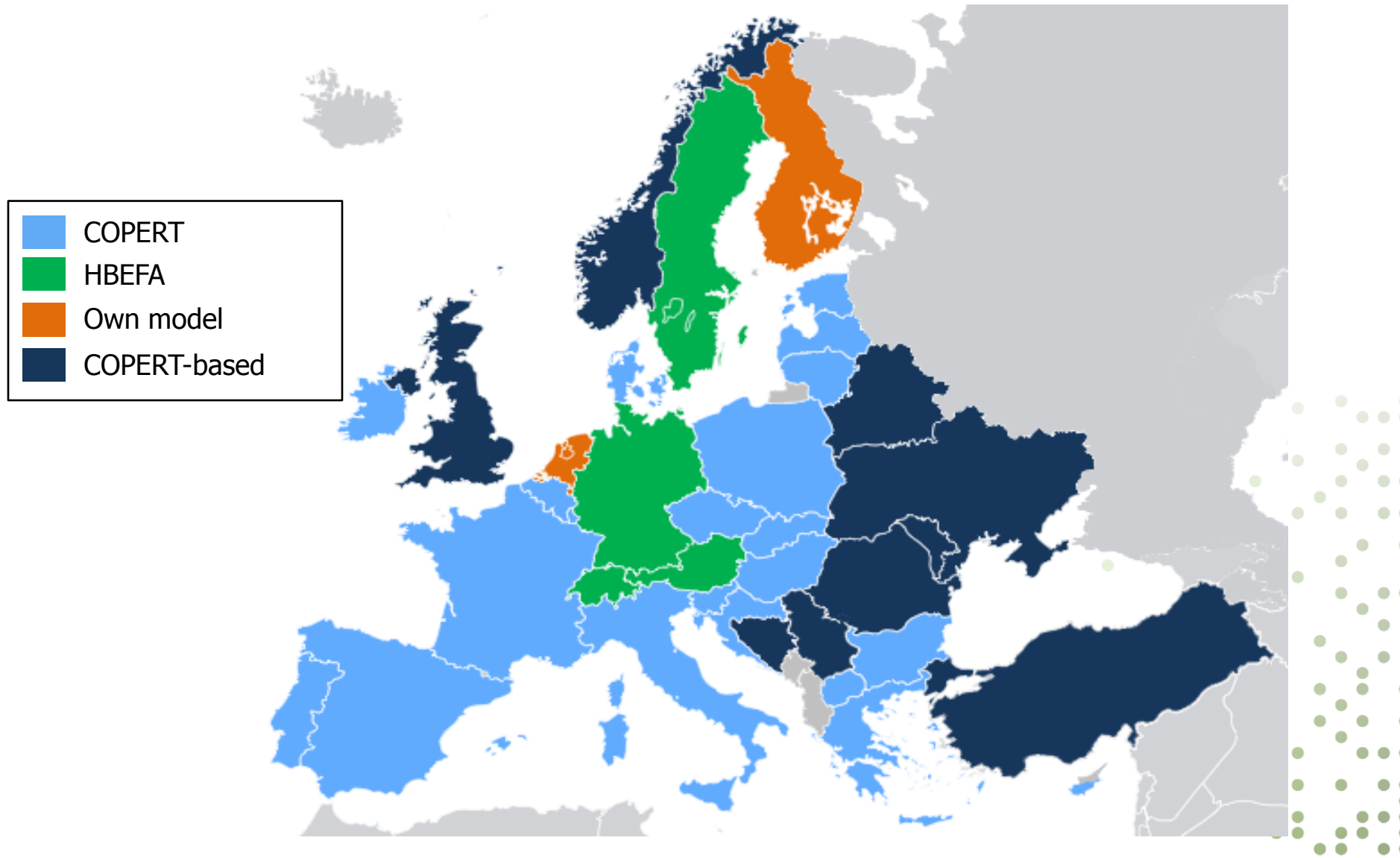
- The name stands for **CO**mputer **P**rogramme to calculate **E**missions from **R**oad **T**ransport
- Now in its COPERT 4 Version (fourth update of the original COPERT 85)
- It incorporates results of several technology, research, and policy assessment projects
- Funded by the European Environment Agency & Joint Research Centre
- It is scientifically and technically supported by Emisia and the Lab of Applied Thermodynamics



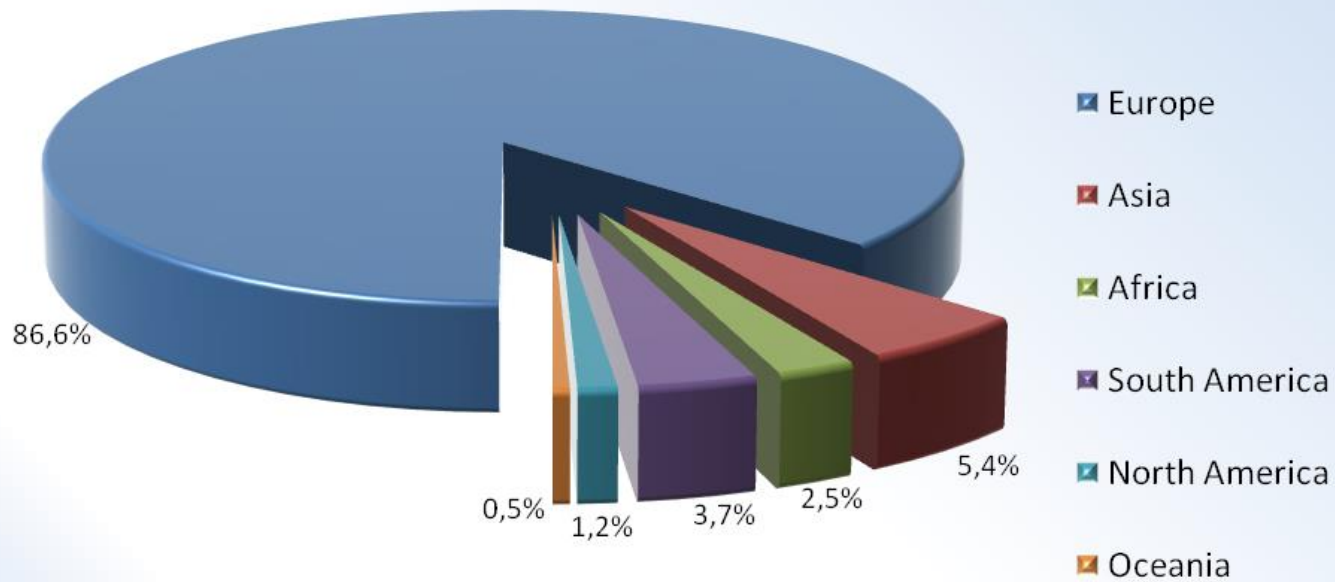
Technical status

- Calculates emissions of all (important) pollutants from road transport
- Covers all (important) vehicle classes
- Can be applied in all European countries, in Asia, S. America and Oceania
- Can be used to produce total emission estimates from 1970 to 2030
- Provides a user-friendly (MS-Office like) GUI to introduce, view, and export data
- Can be downloaded from <http://www.emisia.com/copert/>

Vehicle emission model usage in Europe

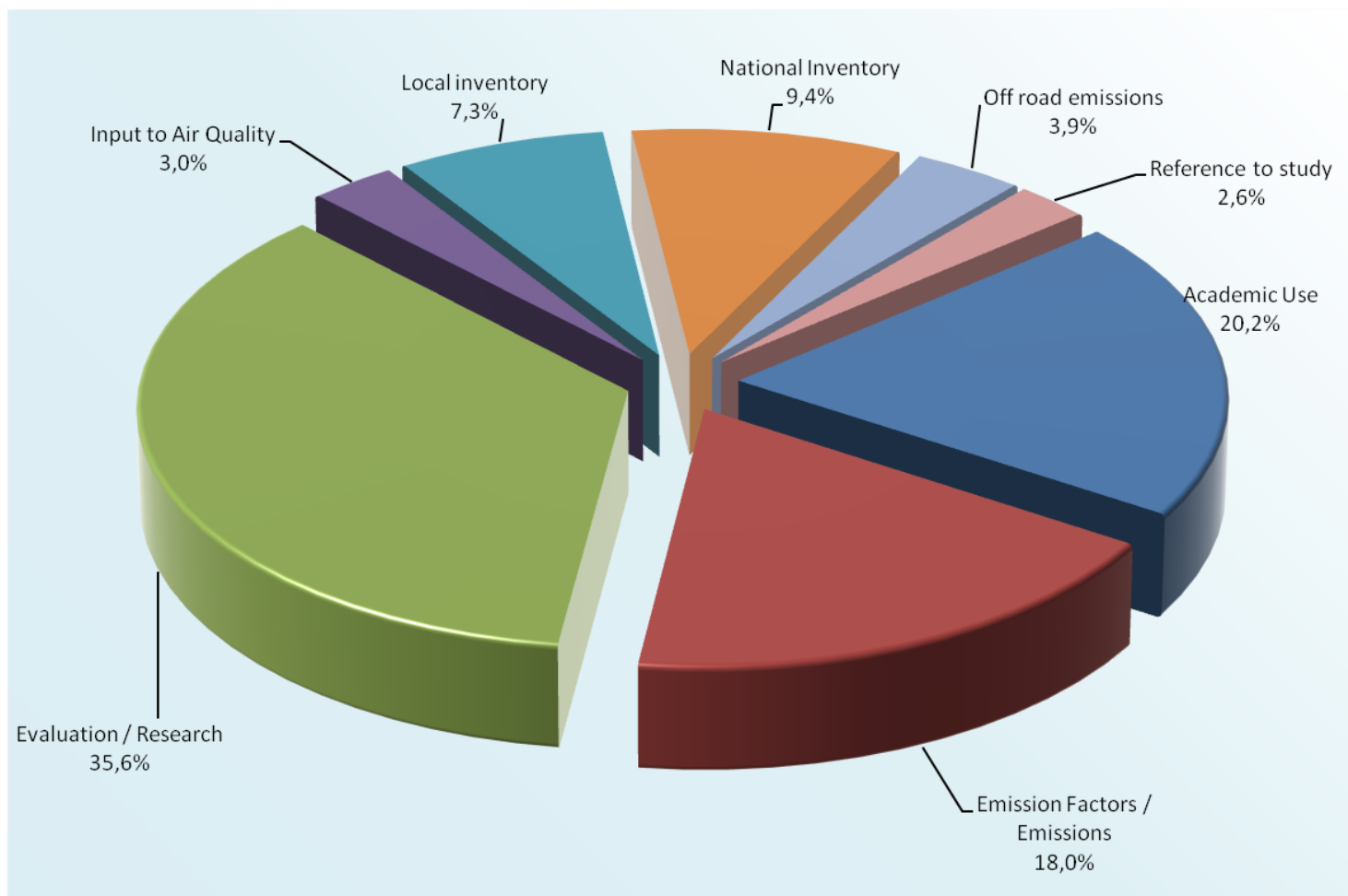


COPERT users



➤ Based on ~1000 downloads/year

COPERT applications



Coverage of vehicles / pollutants



Vehicle categories

Passenger Cars



Light Duty Vehicles



Heavy Duty Vehicles



Mopeds



Motorcycles



Vehicle sub-categories

- Passenger cars
 - Gasoline (<0.8 l, 1.4-2.0 l, 1.4-2.0 l, >2.0 l)
 - Diesel (<1.4 l, 1.4-2.0 l, >2.0 l)
 - LPG
 - CNG
 - E85
- Light duty vehicles (trucks & vans)
 - Gasoline
 - Diesel
- Heavy duty vehicles
 - Gasoline
 - Diesel trucks (14 weight categories)
 - Buses (3 weight types, CNG, B30)
 - Coaches (2 weight types)
- Power two wheelers
 - Mopeds < 50 cc (2-stroke, 4-stroke)
 - Motorcycles (2-stroke, <250 cc, 250-750 cc, >750 cc)



Passenger cars & light duty vehicles

Passenger cars	Light duty vehicles
PRE ECE (~1970 technology)	Conventional
ECE 15/00-01	LD Euro 1 - 93/59/EEC
ECE 15/02	LD Euro 2 - 96/69/EEC
ECE 15/03	LD Euro 3 - 98/69/EC Stage2000
ECE 15/04	LD Euro 4 - 98/69/EC Stage2005
Improved Conventional	LD Euro 5 - EC 715/2007
Open Loop	LD Euro 6/6c - EC 715/2007
PC Euro 1 - 91/441/EEC	
PC Euro 2 - 94/12/EEC	
PC Euro 3 - 98/69/EC Stage2000	
PC Euro 4 - 98/69/EC Stage2005	
PC Euro 5 - EC 715/2007	
PC Euro 6/6c - EC 715/2007	

Heavy duty vehicles, buses & PTWs

Heavy duty trucks / buses	Mopeds / motorcycles
Conventional	Conventional
HD Euro I - 91/542/EEC Stage I	Euro 1 - 97/24/EC
HD Euro II - 91/542/EEC Stage II	Euro 2 - 97/24/EC
HD Euro III - 1999/96/EC	Euro 3 - 2002/51/EC (only motorcycles)
HD Euro IV - 2005/55/EC	
HD Euro V - 2005/55/EC	
HD Euro VI - 595/2009	



Pollutants (1/2)

Pollutants for which a detailed methodology exists, based on specific emission factors

Pollutants which are estimated based on fuel consumption

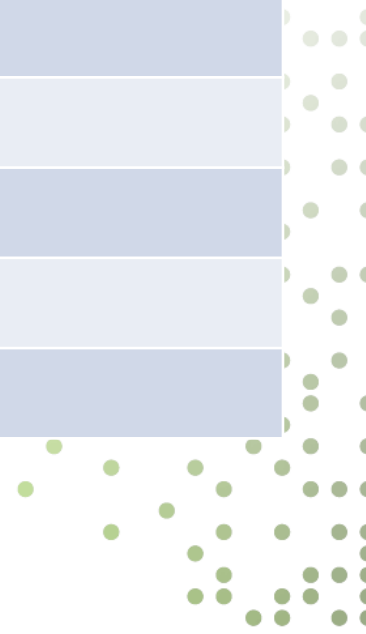
Group 1	Group 2
Carbon monoxide (CO)	Carbon dioxide (CO ₂)
Nitrogen oxides (NO _x : NO and NO ₂)	Sulphur dioxide (SO ₂)
Volatile organic compounds (VOCs)	Lead (Pb)
Methane (CH ₄)	Cadmium (Cd)
Non-methane VOCs (NMVOCs)	Chromium (Cr)
Nitrous oxide (N ₂ O)	Copper (Cu)
Ammonia (NH ₃)	Nickel (Ni)
Particulate matter (PM)	Selenium (Se)
PM number and surface area	Zinc (Zn)

Pollutants (2/2)

Pollutants for which a simplified methodology is applied, mainly due to the absence of detailed data

Pollutants which are derived as a fraction of total NMVOC emissions

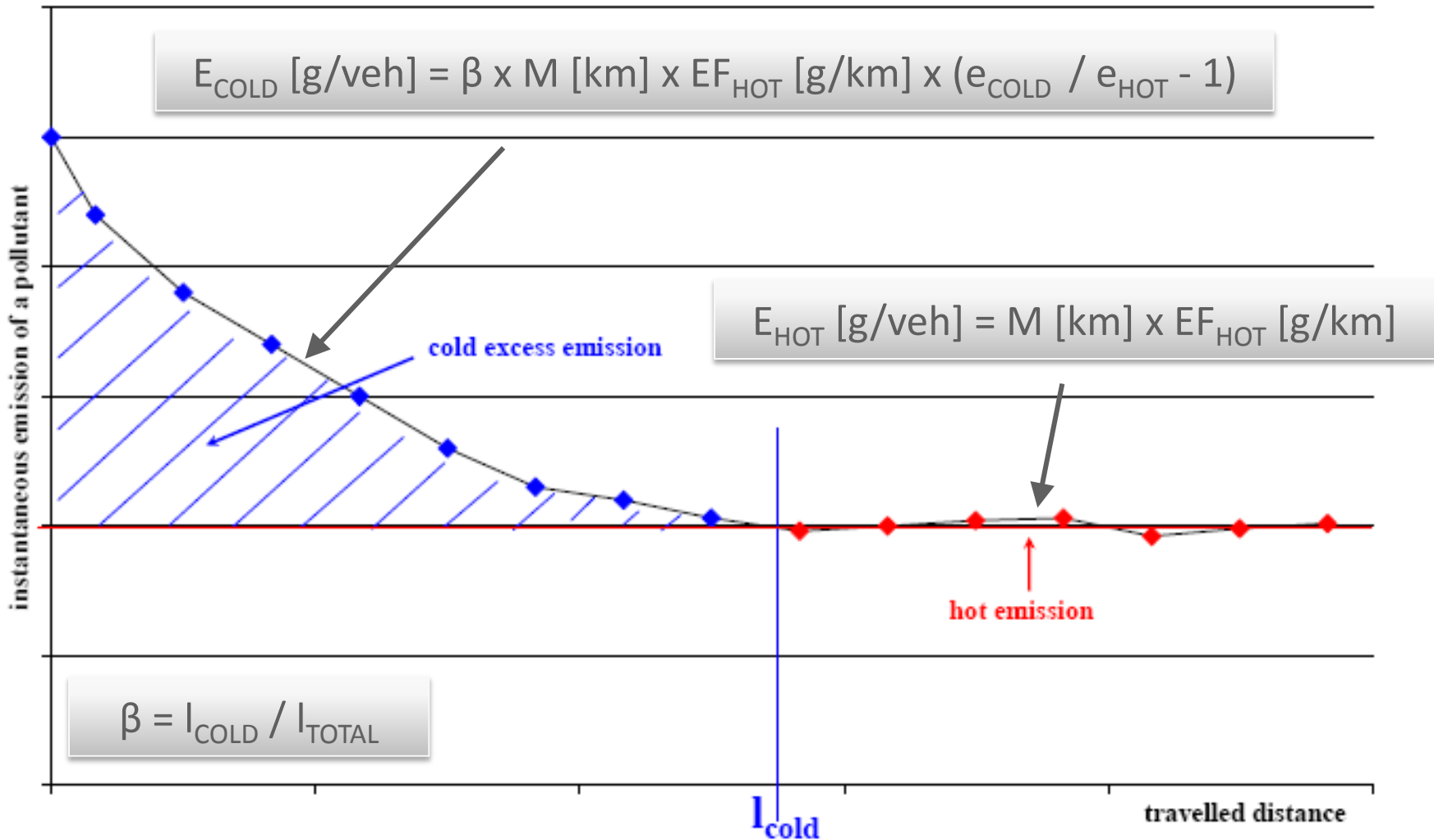
Group 3	Group 4
Polycyclic aromatic hydrocarbons (PAHs) and persistent organic pollutants (POPs)	Alkanes (C_nH_{2n+2})
	Alkenes (C_nH_{2n})
Polychlorinated dibenzo dioxins (PCDDs) and polychlorinated dibenzo furans (PCDFs)	Alkynes (C_nH_{2n-2})
	Aldehydes ($C_nH_{2n}O$)
	Ketones ($C_nH_{2n}O$)
	Cycloalkanes (C_nH_{2n})
	Aromatic compounds



Basic methodology



General concept for exhaust emissions



What are exhaust emissions dependent on?

▶ Activity

- ▶ Number of vehicles [veh]
- ▶ Distance travelled [km/period of inventory]

▶ Hot emissions

- ▶ Technology / emission standard
- ▶ Mean travelling speed [km/h]

▶ Cold emissions

- ▶ Technology / Emission Standard
- ▶ Mean travelling speed [km/h]
- ▶ Ambient temperature [°C]
- ▶ Mean trip distance [km]



Methodology: Total Emissions

➤ Total Exhaust Emissions: $E_{EXH} = E_{HOT} + E_{COLD}$

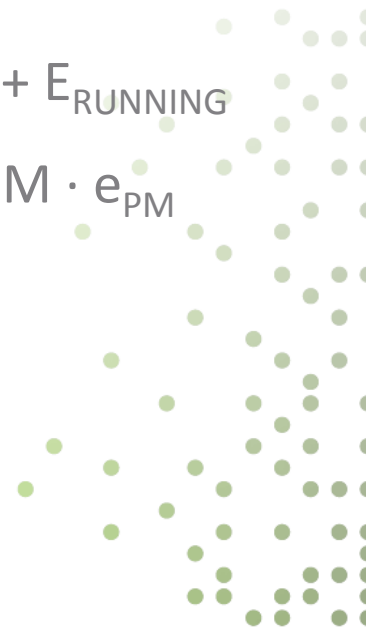
➤ Hot (stabilized engine temperature): $E_{HOT} = N \cdot M \cdot e_{HOT}$

➤ Cold-start emissions: $E_{COLD} = \beta \cdot N \cdot M \cdot e_{HOT} \cdot (e_{COLD}/e_{HOT} - 1)$

➤ Non-Exhaust Emissions

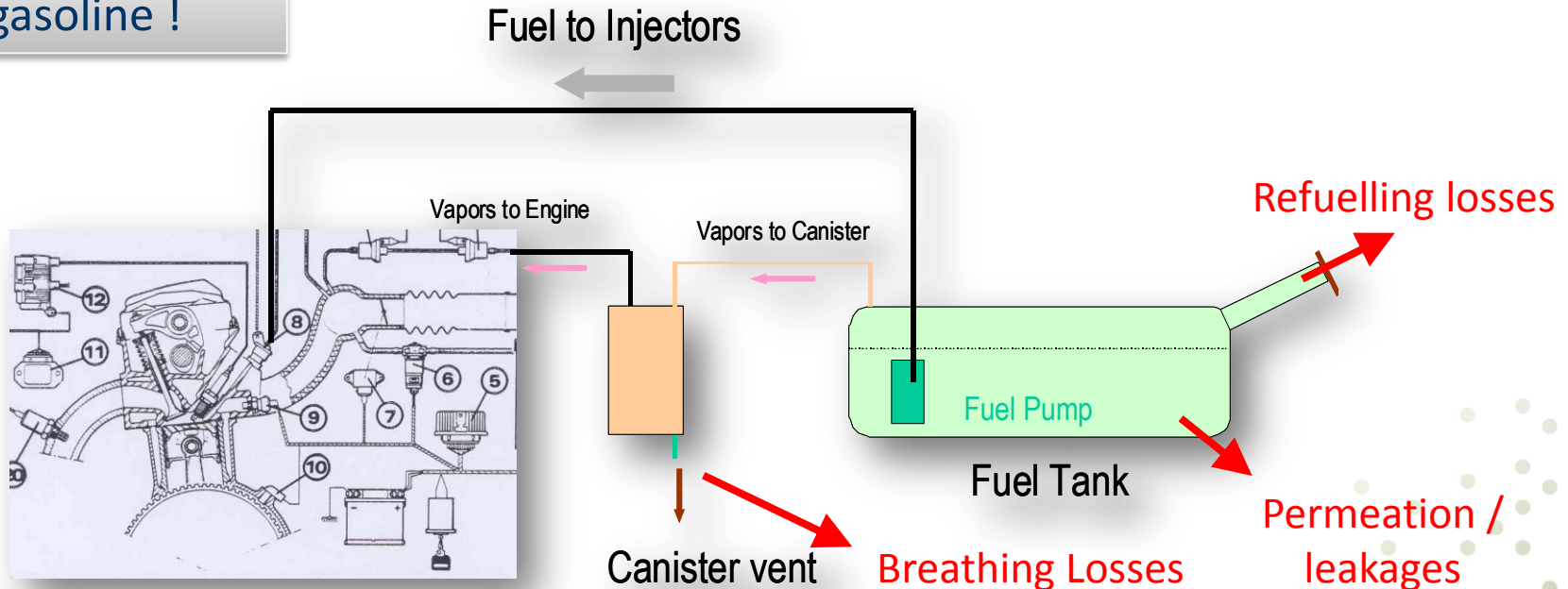
➤ NMVOC from fuel evaporation: $E_{EVAP} = E_{DIURNAL} + E_{SOAK} + E_{RUNNING}$

➤ PM from tyre and brake attrition: $E_{ATTRITION} = N \cdot M \cdot e_{PM}$



Non-exhaust emissions (evaporation)

Only relevant for gasoline !



Mechanisms causing evaporation emissions

- Diurnal emissions
- Hot soak emissions
- Running losses

Parked vehicle

Engine running

What is evaporation dependant on?

Fuel

- Vapour pressure
- Ethanol content

Vehicle

- Fuel tank size and structure
- Mass and quality of activated carbon
- Purging strategy

Activity

- Parking duration
- Distance travelled
- Ambient temperature

Non-exhaust PM

- ▶ Particulate Matter due to road transport is also produced by:
 - ▶ Tyre abrasion
 - ▶ Brake abrasion
 - ▶ Road wear (not included in COPERT 4)
- ▶ Emission rates depend on:
 - ▶ Vehicle category (car, truck, motorcycle)
 - ▶ Number of axles/wheels (trucks)
 - ▶ Vehicle load
 - ▶ Vehicle speed

