Guidebook updates

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

European Environment Agency
European Topic Centre on Air pollution,
transport, noise and industrial pollution

New elements in 2022

- Revision of non-exhaust PM emissions

- Revision of emissions degradation methodology

- Revision of cold start methodology

- Revision of Euro 6 LPG passenger cars

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Revision of non-exhaust PM emissions

Update fields

- Passenger Cars & Light Commercial Vehicles
    - Brake wear emissions
- Introduction of Electric Vehicles
    - Impact of vehicle weight
    - Impact of regenerative braking
    - New non-exhaust emission factors

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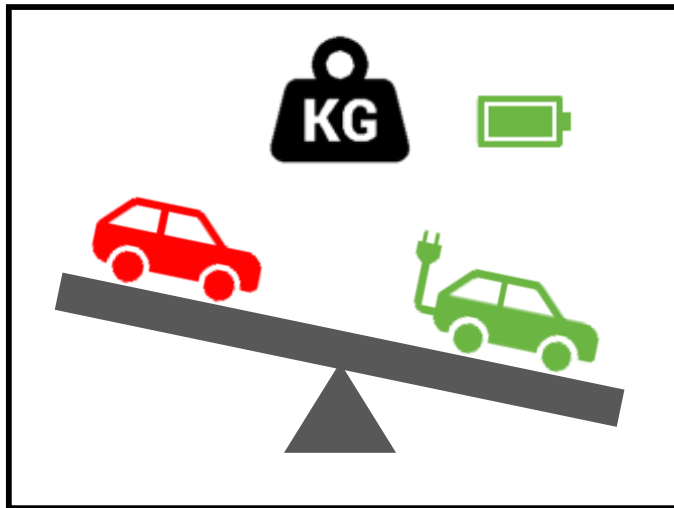**Climate change mitigation**

Brake wear emissions

- Standardized measurement procedure from PMP Programme: WLTP brake cycle

- Measurements on WLTP brake cycle

- Revision of brake wear emission factors for PCs and LCVs

PM10 brake wear:

- Low-Steel (LS) pads : 12 mg/km

- Non-Asbestos Organic (NAO) pads: 3 mg/km (possibly in Euro 7?)

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Electric Vehicles – Impact of Vehicle Weight

EV ✕ ICE

	Increase	Unit
Weight	257 - 318	kg
Non-Exhaust emissions		
Brake	10 – 15	[%]
Tire	7 – 10	[%]
Road	10 – 15	[%]

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Electric Vehicles – Impact of Regenerative braking

Regenerative braking

- Energy recovery mechanism

- Braking energy → Electricity → Driving/acceleration

- Brake emission reduction potential

Measurement data show ~75 % reduction of brake emissions

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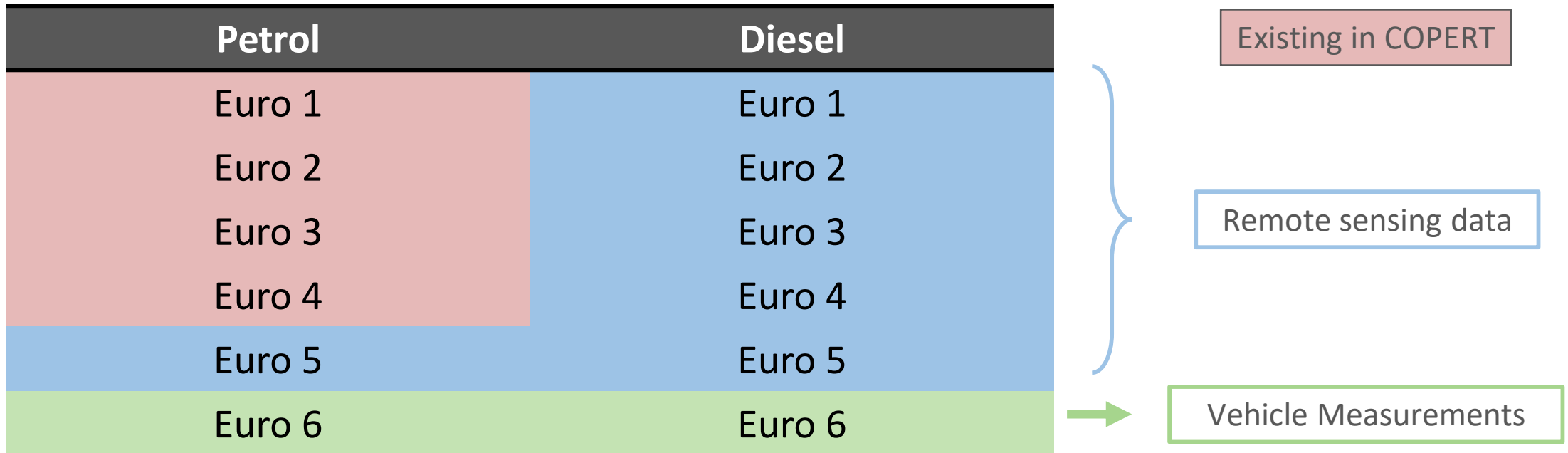**European Topic Centre**
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Revised non-exhaust emission factors

Non-Exhaust Emissions - passenger cars
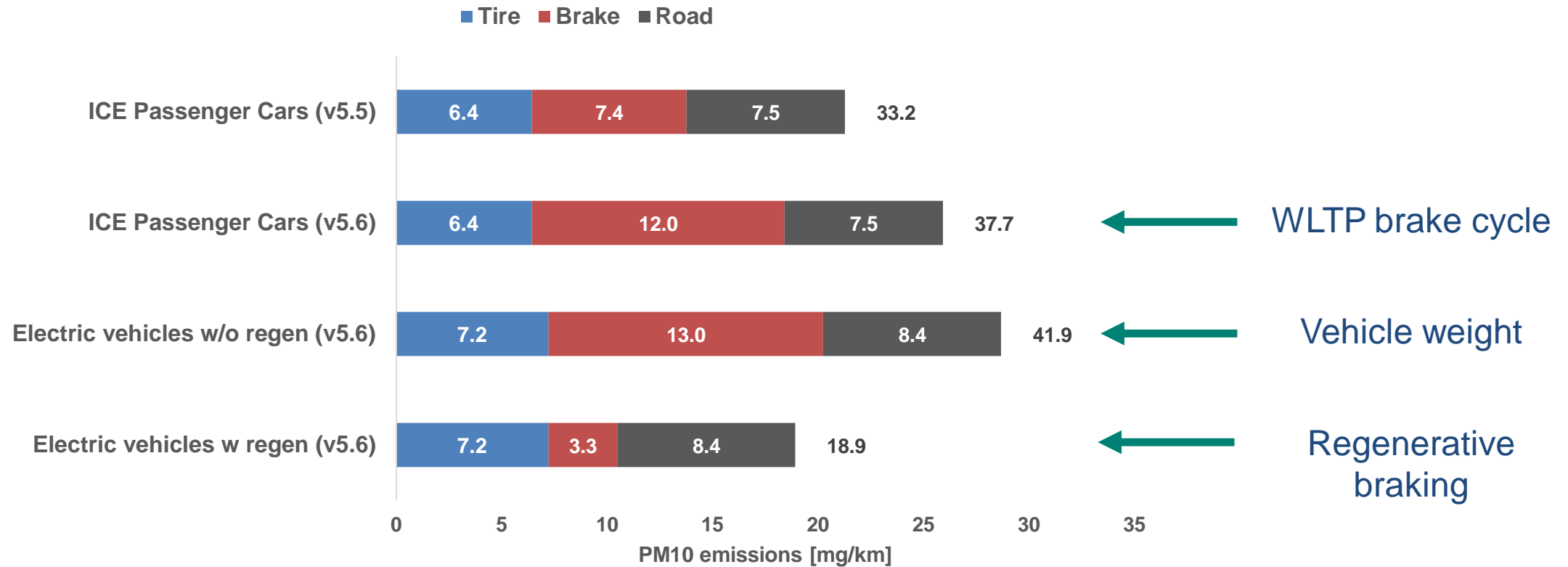
Revision of degradation methodology

Update fields

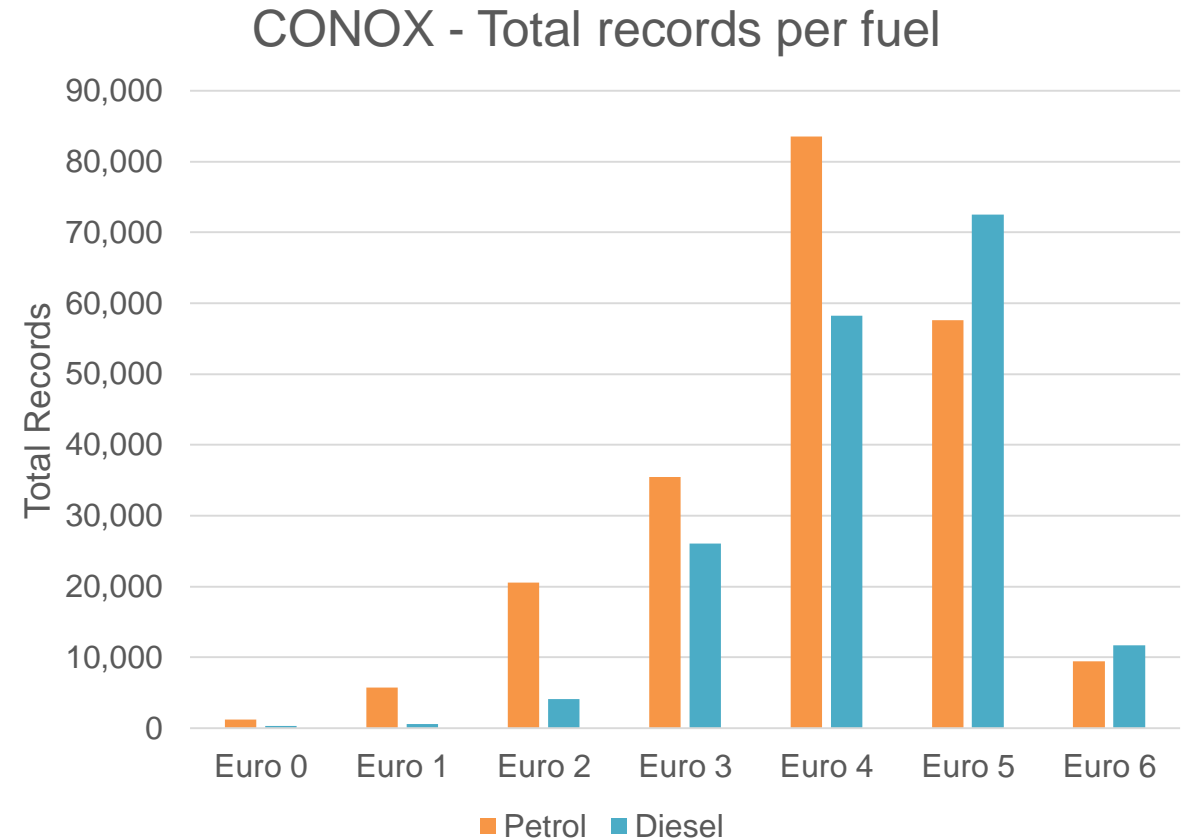| Petrol	Diesel
Euro 1	Euro 1
Euro 2	Euro 2
Euro 3	Euro 3
Euro 4	Euro 4
Euro 5	Euro 5
Euro 6	Euro 6

Existing in COPERT

Remote sensing data
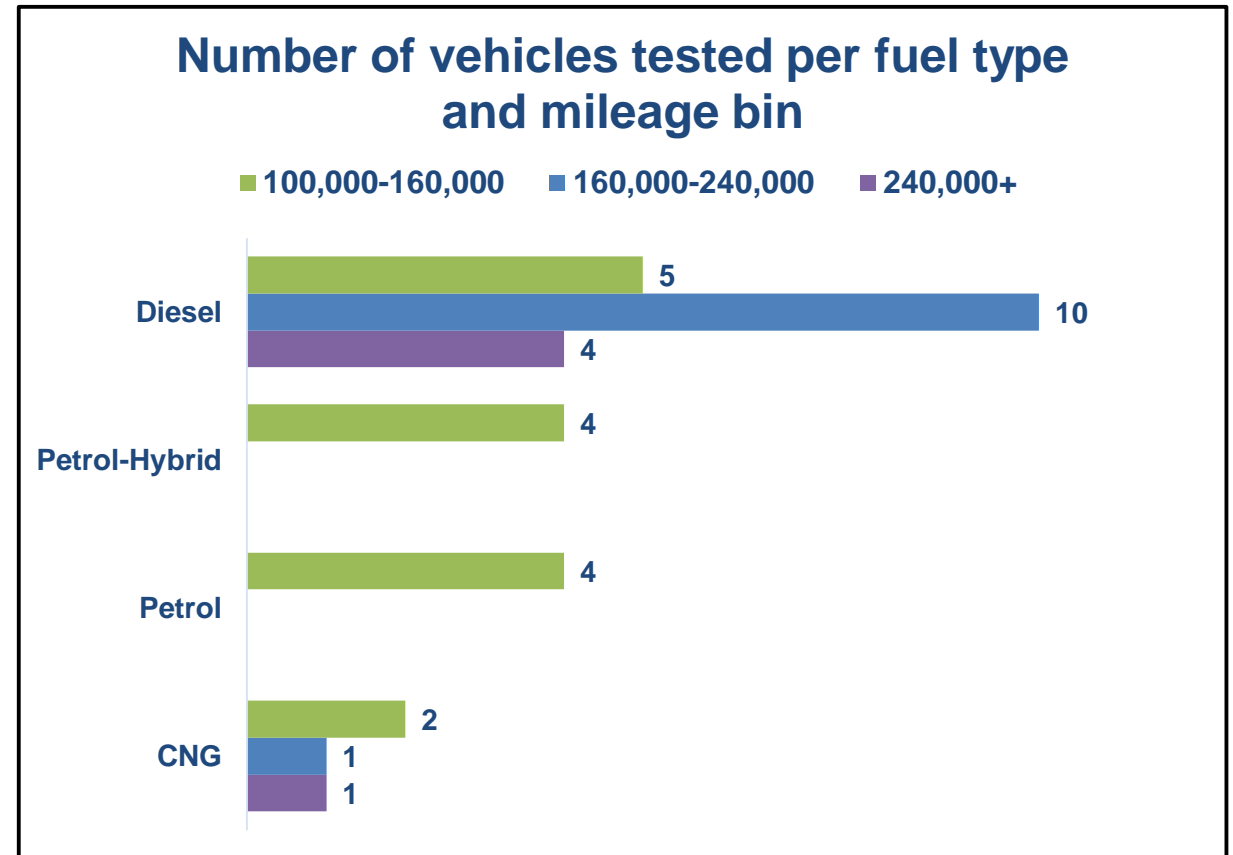
Vehicle Measurements

Remote sensing data

CONOX database

- Largest database of remote sensing measurements in Europe

- Multiple campaigns (France, Spain, Sweden, Switzerland, United Kingdom)

- Duration: 2011 – 2017

- More than 700,000 records

CONOX - Total records per fuel

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Vehicle measurements

- 35 Euro 6 vehicles tested
- Measurements
  - WLTC
  - RDE
  - Non-RDE
- Deterioration trends over mileage

Number of vehicles tested per fuel type and mileage bin

■ 100,000-160,000   ■ 160,000-240,000   ■ 240,000+

Diesel: 5, 10, 4
Petrol-Hybrid: 4
Petrol: 4
CNG: 2, 1, 1

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Degradation equation

- Pollutants: NOx, CO, VOC
- Degradation after 50,000 km
- No further degradation after 200,000 km

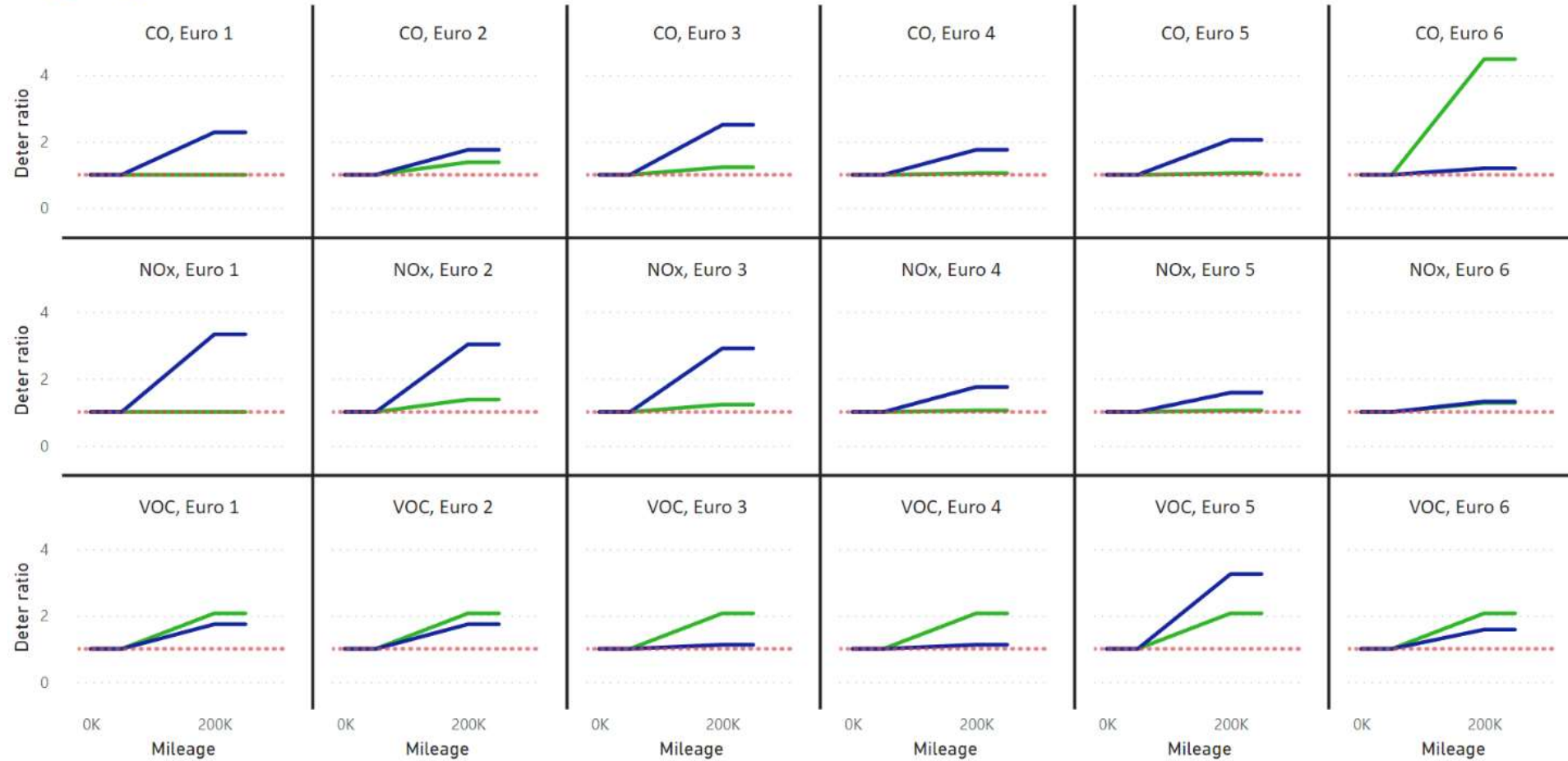**Degradation of CO emissions of Euro 5 petrol passenger cars**
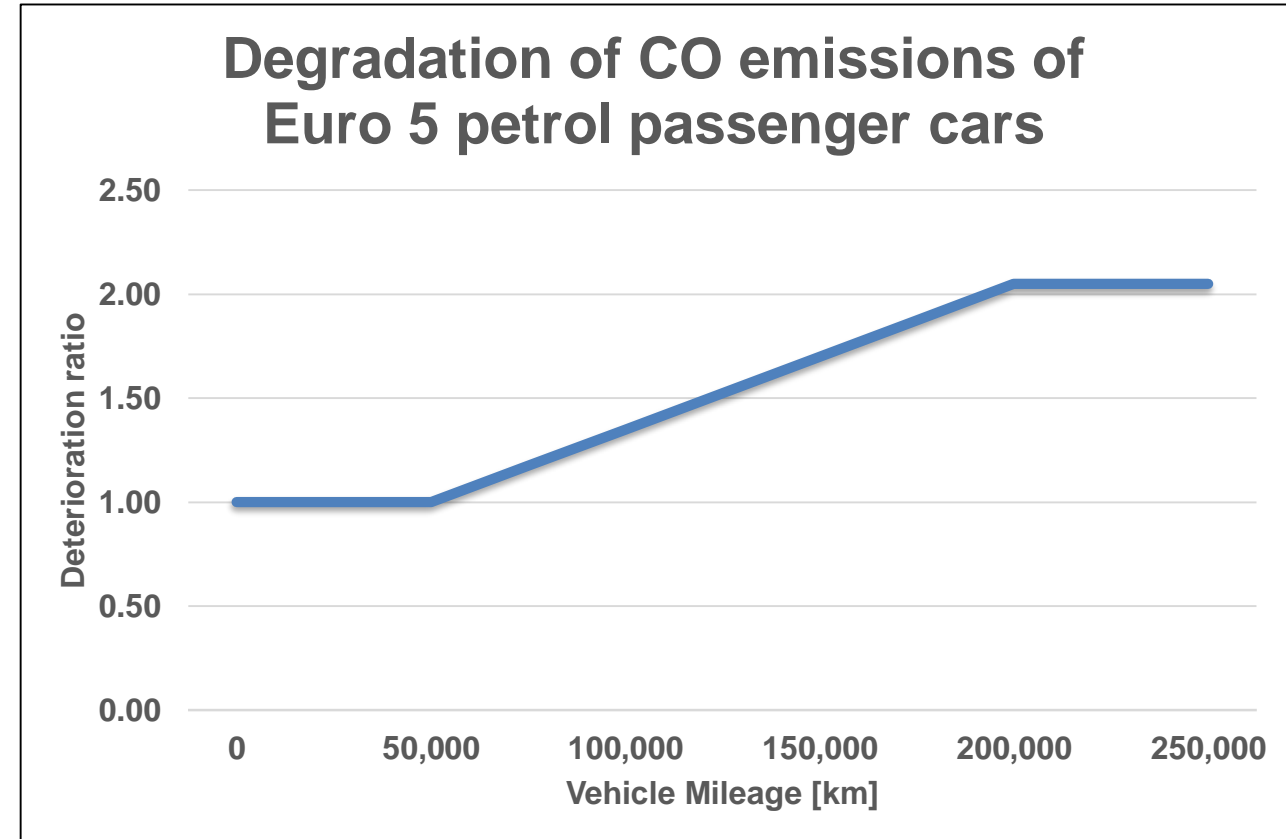
Deterioration equation example

Degradation graphs

Deterioration factor by Mileage, Fuel, Pollutant and Euro Standard

Fuel ● Diesel ● Petrol
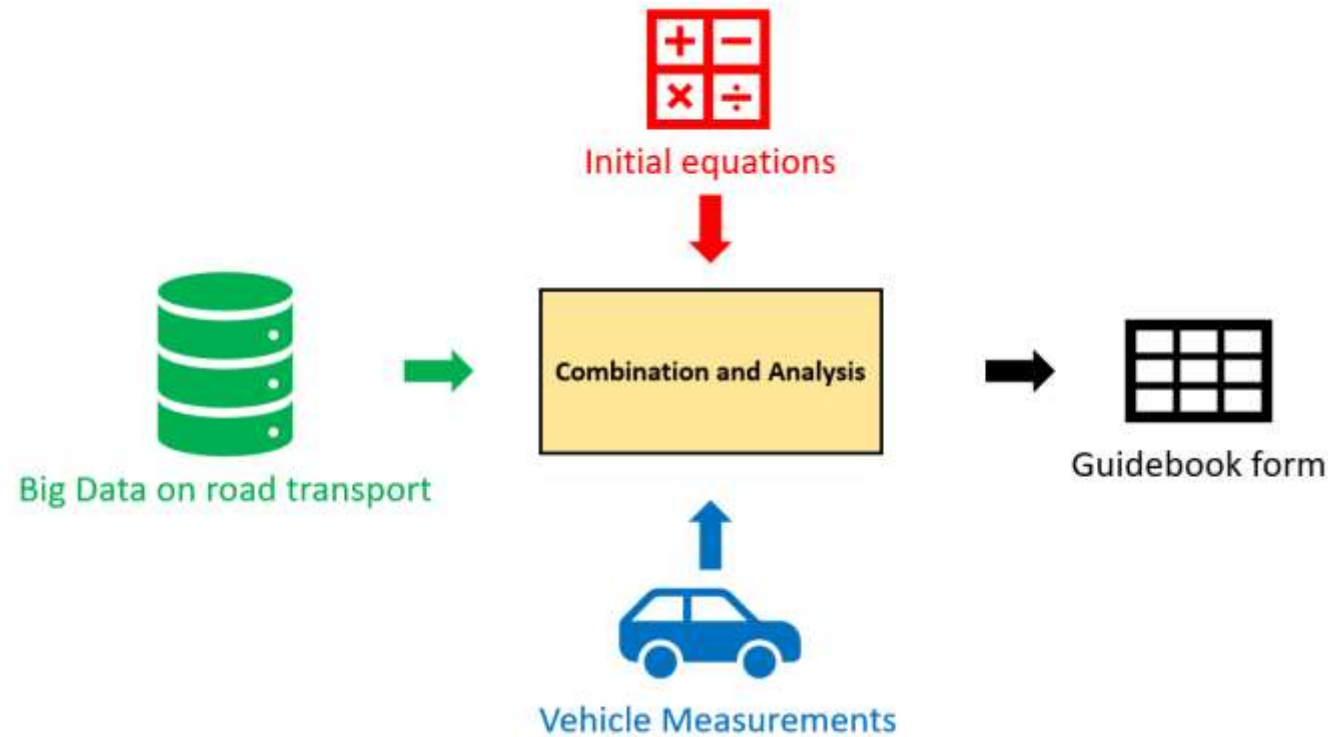
Revision of cold start methodology

Initial equations

Big Data on road transport

Combination and Analysis

Vehicle Measurements

Guidebook form

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Initial equations

Equations based on:

Modelling of cold start emissions for passenger cars,

Joumard & Andre (1999)

Equations used:

- ✓ Impact of parking time
- ✓ Impact of travelled distance
- × Impact of speed and temperature
- × Main equation of cold excess emissions

Big data on road transport

Studies:

- *A pilot study to address the travel behavior and the usability of electric vehicles in two Italian provinces*, M. De Gennaro, E. Paffumi, G. Martini, H.Scholz (2014)
  - 28,000 vehicles, Italy

- *European-wide study on big data for supporting road transport policy*, E. Paffumi, G. Martini, M. De Gennaro (2018)
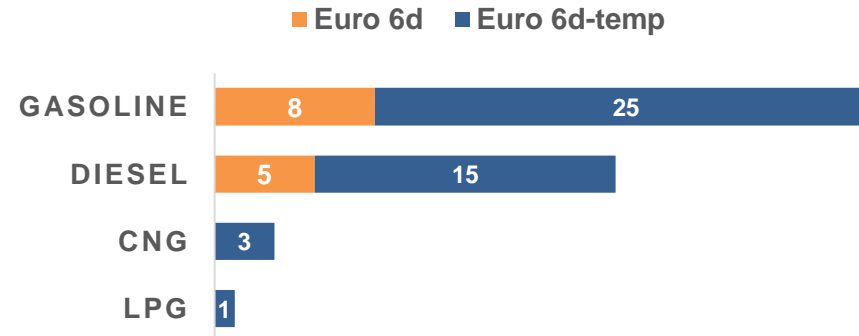 - 600,000 vehicles, multiple cities in Europe

Data used:

- Probability distribution of parking duration → *Impact of parking duration*

- Trip number per trip length → *Impact of travelled distance*

Vehicle measurements

Vehicle Measurements

PASSENGER CAR - MEASUREMENTS

■ Euro 6d ■ Euro 6d-temp

Fuel	Euro 6d	Euro 6d-temp
GASOLINE	8	25
DIESEL	5	15
CNG		3
LPG		1

HEAVY DUTY VEHICLES MEASUREMENTS

Euro Standard	Fuel	Categories
Euro V	Diesel	Heavy Duty Trucks, Buses
Euro VI-ABC	Diesel	Heavy Duty Trucks, Buses
Euro VI-DE	Diesel	Heavy Duty Trucks, Buses

Measurements
- hot conditions
- cold conditions

⬇
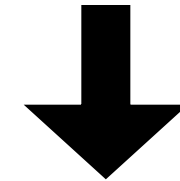
Cold start excess emission [mg per trip]

Guidebook form – Passenger cars

Euro Standards: Euro 6
Fuels: Petrol, Diesel
Pollutants: NOx, CO, VOC

Calculation of cold start emissions (overemissions)

$$E_{COLD} = \beta \times bc \times N \times M \times e^{hot} \times (e^{cold} / e^{hot} - 1)$$

where,
β   :   fraction of mileage driven in cold engine (beta parameter)
bc   :   beta-reduction factor
N   :   number of vehicles (stock)
M   :   mileage per vehicle
e^{hot} :   hot emission factor
e^{cold} / e^{hot} :   cold/hot emission quotient

$e^{cold} / e^{hot} = A \times v + B \times T + C$
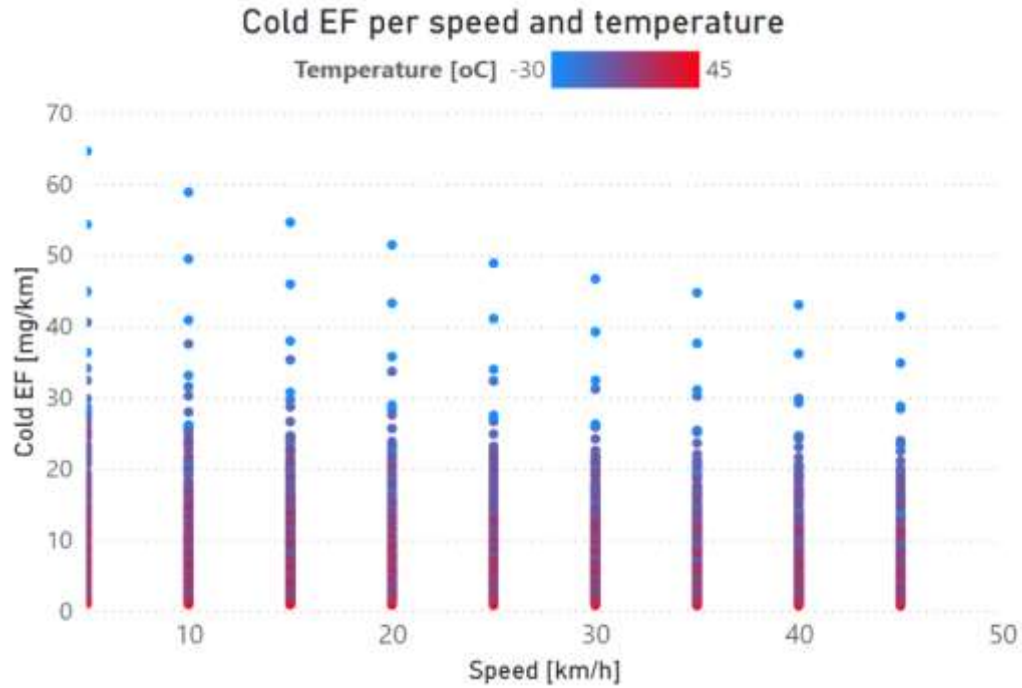*(v: vehicle speed, T: temperature)*

Guidebook form

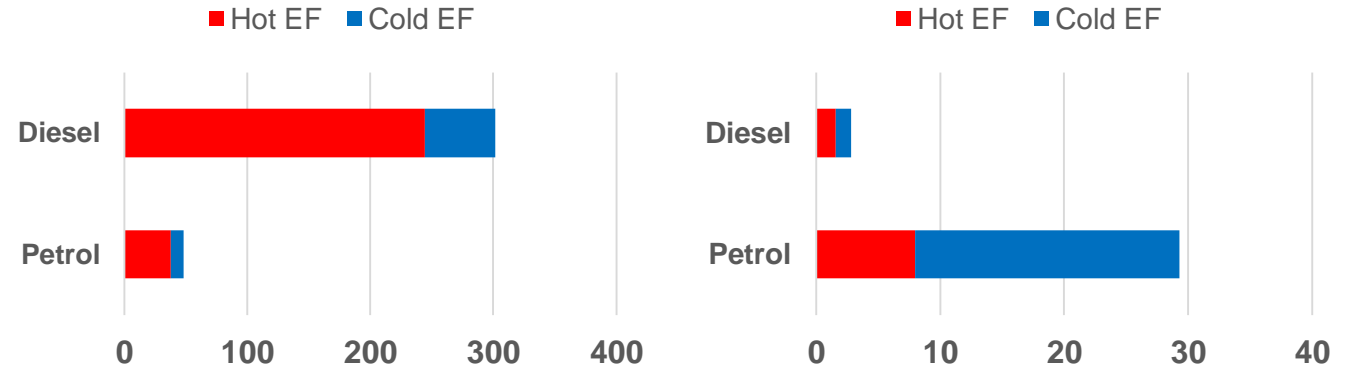European Environment Agency
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Passenger car - example

Cold EF per speed and temperature

Temperature [oC] -30 ■■■■ 45

Petrol NOx cold EF

Average NOx EF [mg/km] for Euro 6 vehicles

■ Hot EF ■ Cold EF

Average VOC EF [mg/km] for Euro 6 vehicles

■ Hot EF ■ Cold EF
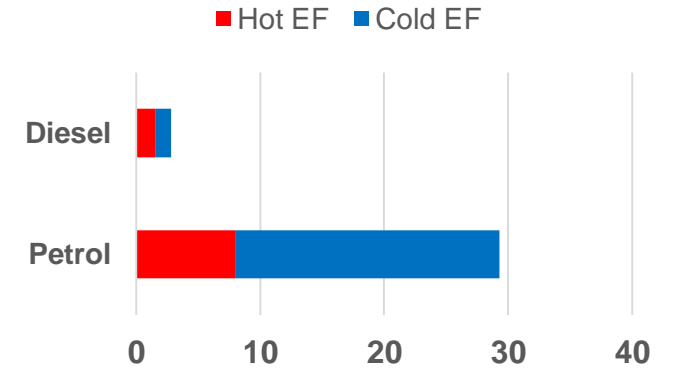
Average CO EF [mg/km] for Euro 6 vehicles

■ Hot EF ■ Cold EF

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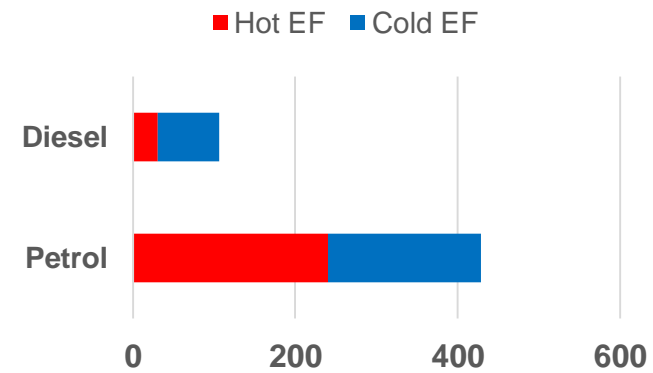
Guidebook form – Heavy Duty Vehicles

Guidebook form

Vehicle Categories: Heavy Duty Trucks, Buses
Euro Standards: Euro V, Euro VI
Fuels: Diesel
Pollutants: NOx, CO, VOC

Calculation of cold start emissions (overemissions)

$$E_{COLD} = \beta \times N \times M \times e^{cold}$$

where,
β :   fraction of mileage driven in cold engine (beta parameter)
N :   number of vehicles (stock)
M :   mileage per vehicle
e^{cold} :   cold emission factor

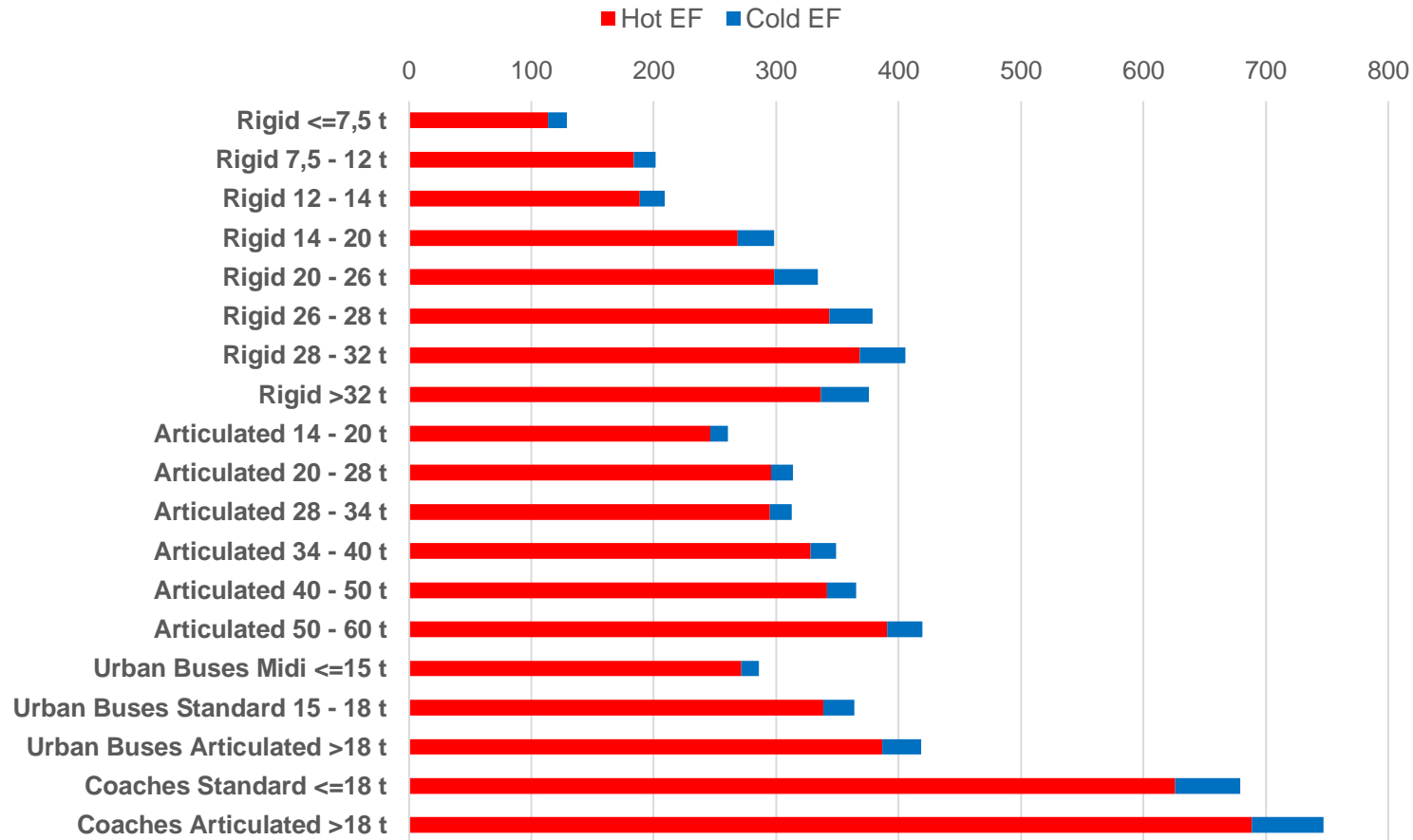$e^{cold} = A \times v + B \times T + C$
(v: vehicle speed, T: temperature)

Heavy Duty Vehicles - example

CO EF [mg/km] for Euro VI A/B/C heavy vehicles

Revision of Euro 6 LPG passenger cars

Vehicle measurements

- ## Vehicles

  Categories: 4 passenger cars, 1 LCV (Euro 6b, 6c)

  Euro Standards: Euro 6b, Euro 6c

  Engine size: 1.2 – 1.6 l

- ## Measurements

  Laboratory and On-road cycles
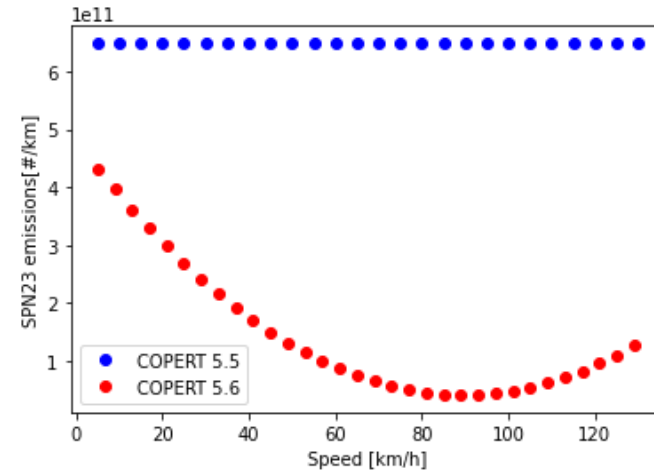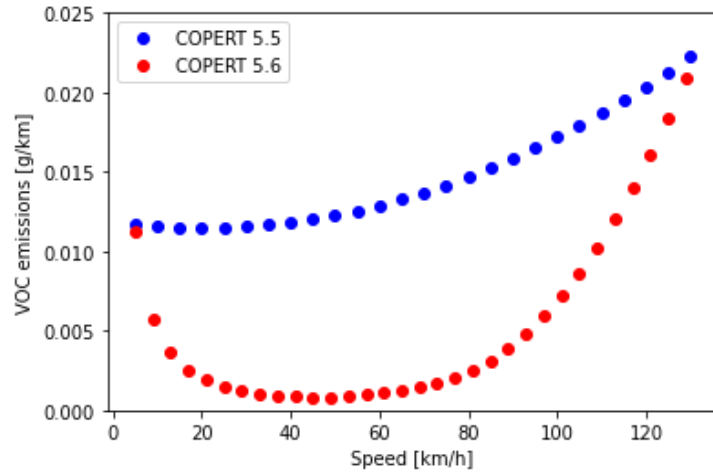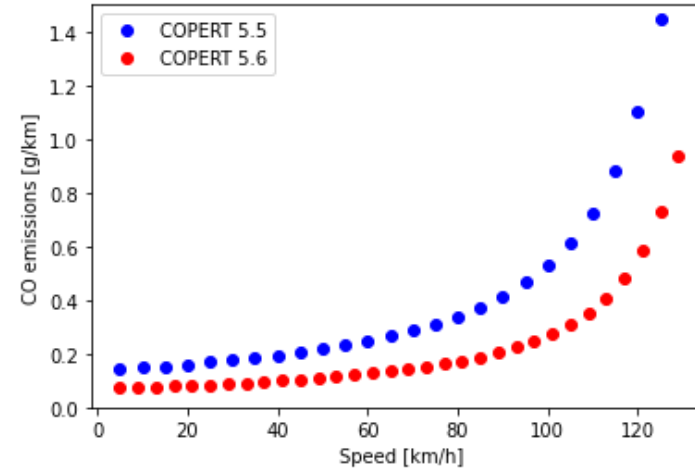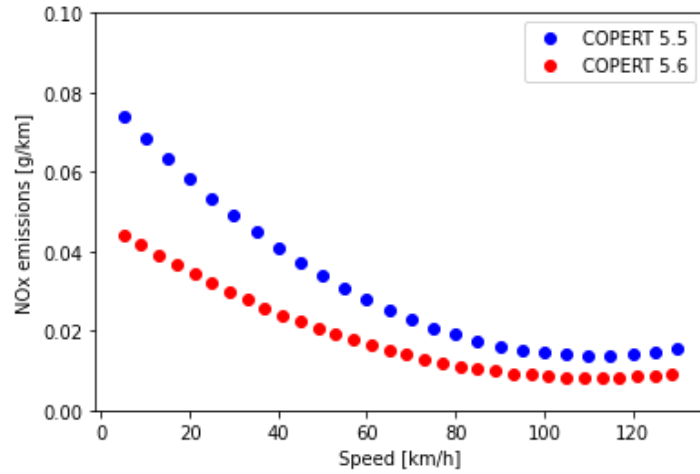 (conducted by Innovhub in Italy)

- ## Revised pollutant equations

  NOx, CO, VOC, SPN23

RDE cycle in Milan (Low speed – High Speed)

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Revised equations

Planned updates for next year

- Revision of Heavy-Duty Vehicles categories

- Revision of emission factors of urban buses

- Introduction of Euro 7 vehicles

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Thank you for your attention!

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