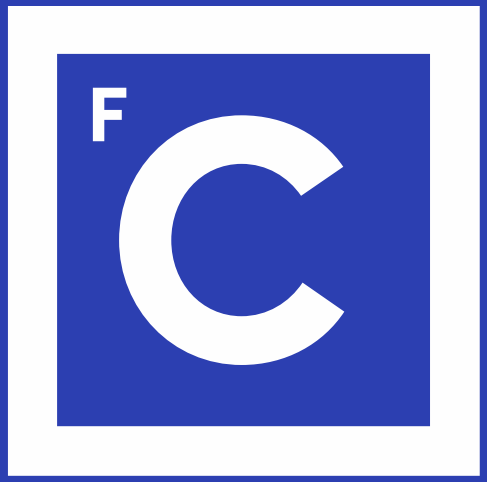


Ciências ULisboa

Faculdade
de Ciências
da Universidade
de Lisboa

DISCIPLINA MIEA 2018

Mobilidade Sustentável

Energy and emissions

Home ⟷ **Work/ University**

on a regular basis

Commuting by motorized or soft modes

↑ **Emissions**

Energy →

Emissions g/km

EMEP/EEA air pollutant emission inventory guidebook

Emissions g/km

EMEP/EEA air pollutant emission inventory guidebook

- Part B: sectoral guidance chapters
  - 1. Energy
    - 1.A Combustion
      - 1.A.1 Energy industries [2.4 MB]
      - 1.A.2 Manufacturing industries and construction [893.2 KB]
      - 1.A.3.a Aviation 2016 [1.5 MB]
      - 1.A.3.b.i-iv Road transport 201[illegible] [3.3 MB]
      - 1.A.3.b.i-iv Road transport Annex HDVs 201[illegible] [3.0 MB]
      - 1.A.3.b.v Gasoline evaporation 2016 [861.2 KB]
      - 1.A.3.b.vi-vii Road tyre and brake wear 2016 [542.7 KB]
      - 1.A.3.c Railways 2016 [476.0 KB]
      - 1.A.3.d Navigation (shipping) 2016 [804.2 KB]
      - 1.A.3.e.i Pipeline transport 2016 [93.3 KB]
      - 1.A.4 Small combustion 2016 [3.5 MB]
      - 1.A.4 Non road mobile machinery 2016 [1.7 MB]
      - 1.A.4 Non road mobile machinery Annex [99.6 KB]

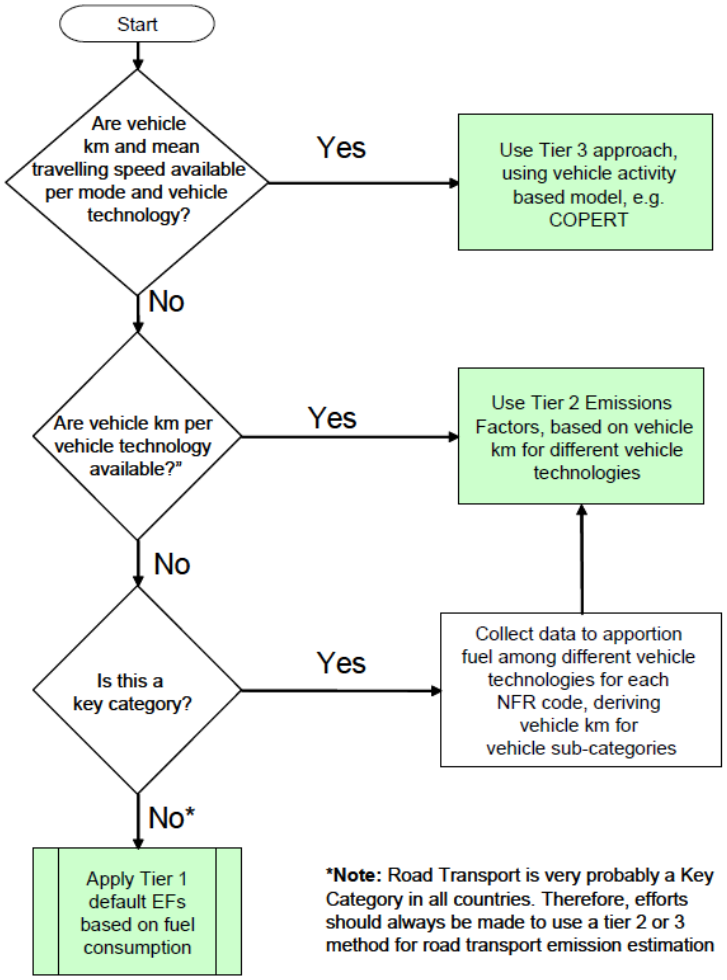
Not electric rail!

Emissions g/km

1.A.3.b.i, 1.A.3.b.ii, 1.A.3.b.iii, 1.A.3.b.iv

Passenger cars, light commercial trucks, heavy-duty vehicles including buses and motor cycles

Figure 3-1 Decision tree for exhaust emissions from road transport

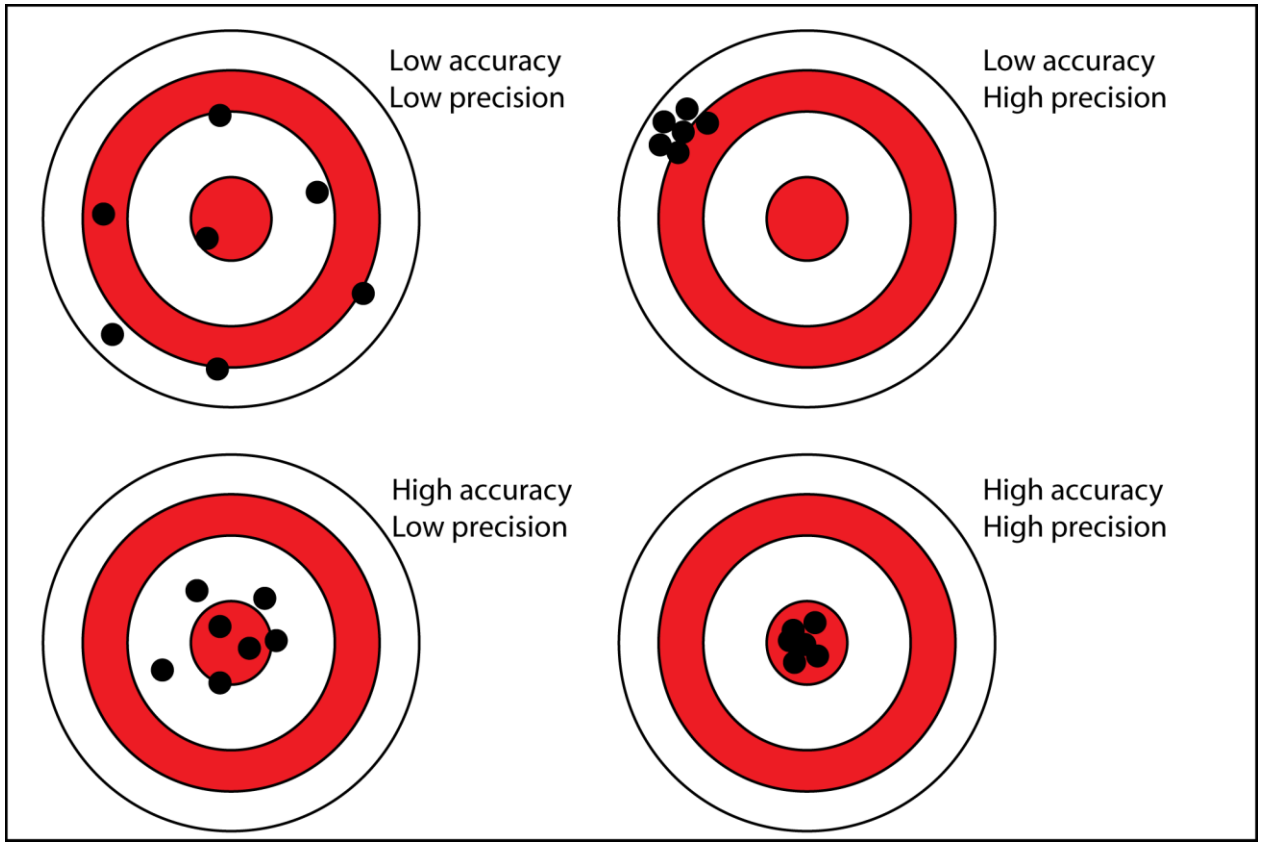


Community 10 people

	VCA/standard	Tier 1 EEA	Tier 2 EEA	Tier 3 EEA (COPERT)
MJ/year	12052	16957	12338	
$TonCO_2$/year	0.619	1.245	0.91	
kgNOx/year	0.3	4.5	2.75	
kgPM/year	0.01	0.23	0.018	

Tier 3…should be more accurate

Surveys, energ. & emissions



Tier 3…should be more accurate

Surveys, energ. & emissions

Tier 3

https://www.emisia.com/utilities/copert/download/

emisia

CONSCIOUS OF TRANSPORT'S IMPACT

EMISIA NEWSLETTER

COPERT v5.3 available for download

copert

A new version of COPERT (v5.3) has been officially released in September. The new and updated methodological elements of this new version are:

- New Emission Factors for mopeds 4-stroke.
- New Emission Factors for motorcycles.
- Revised evaporation factors for Euro 6d-temp and Euro 6d passenger cars and light commercial vehicles.
- Revised Euro 6 LCV NOx emissions factors.
- Calculation of the fossil fuel fraction in biodiesel.

Surveys, energ. & emissions

Tier 3 https://www.emisia.com/utilities/copert/download/

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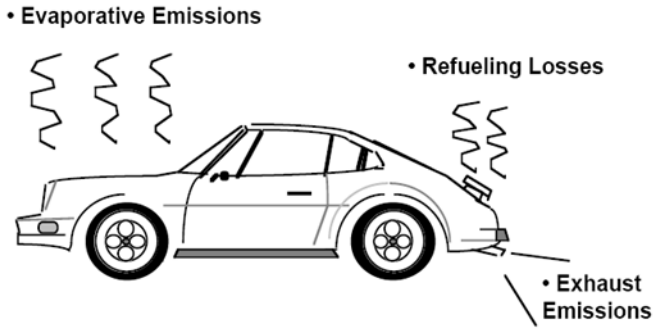

Table 4.1: Typical average speed ranges for the application of the methodology in different driving situations

Driving Situation	Typical Speed Range (km/h)
Urban	10 - 50
Rural	40 - 80
Highway	70 - 130

Surveys, energ. & emissions

Tier 3 https://www.emisia.com/utilities/copert/download/

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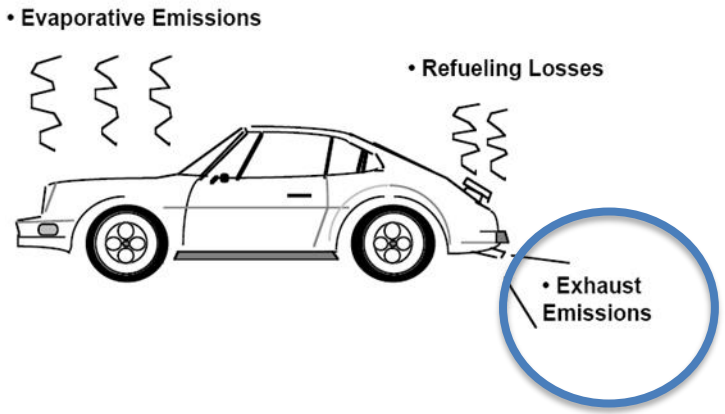

Divided in.....

$$E_{TOTAL} = E_{URBAN} + E_{RURAL} + E_{HIGHWAY}$$

$$E_{TOTAL} = E_{HOT} + E_{COLD} + E_{EVAP}$$

Surveys, energ. & emissions

Tier 3 https://www.emisia.com/utilities/copert/download/

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Table 5.5: Speed dependency of NO_x emission factors for gasoline passenger cars

Vehicle Class	Engine Capacity	Speed Range [km/h]	NO_x Emission Factor [g/km]	R^2
PRE ECE & ECE 15-00/01	CC < 1,4 l	10-130	$1,173 + 0,0225V - 0,00014V^2$	0,916
	1,4 l < CC < 2,0 l	10-130	$1,360 + 0,0217V - 0,00004V^2$	0,960
	CC > 2,0 l	10-130	$1,5 + 0,03V + 0,0001V^2$	0,972
ECE 15-02	CC < 1,4 l	10-130	$1,479 - 0,0037V + 0,00018V^2$	0,711
	1,4 l < CC < 2,0 l	10-130	$1,663 - 0,0038V + 0,00020V^2$	0,839
	CC > 2,0 l	10-130	$1,87 - 0,0039V + 0,00022V^2$	-
ECE 15-03	CC < 1,4 l	10-130	$1,616 - 0,0084V + 0,00025V^2$	0,844
	1,4 l < CC < 2,0 l	10-130	$1,29e^{0,0099V}$	0,798
	CC > 2,0 l	10-130	$2,784 - 0,0112V + 0,000294V^2$	0,577
ECE 15-04	CC < 1,4 l	10-130	$1,432 + 0,0026V + 0,000097V^2$	0,669
	1,4 l < CC < 2,0 l	10-130	$1,484 + 0,013V + 0,000074V^2$	0,722
	CC > 2,0 l	10-130	$2,427 - 0,014V + 0,000266V^2$	0,803

E_{HOT}=function (average speed in km/h)

Tier 3 emissions factors

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Table 3-47: Values of e^{COLD} / e^{HOT} for diesel passenger cars (temperature range -10 °C to 30 °C)

Pollutant or FC	e^{COLD} / e^{HOT}
CO	$1.9 - 0.03\ t_a$
NO_x	$1.3 - 0.013\ t_a$
VOC	$3.1 - 0.09\ t_a$ (1)
PM	$3.1 - 0.1\ t_a$ (2)
Fuel consumption	$1.34 - 0.008\ t_a$

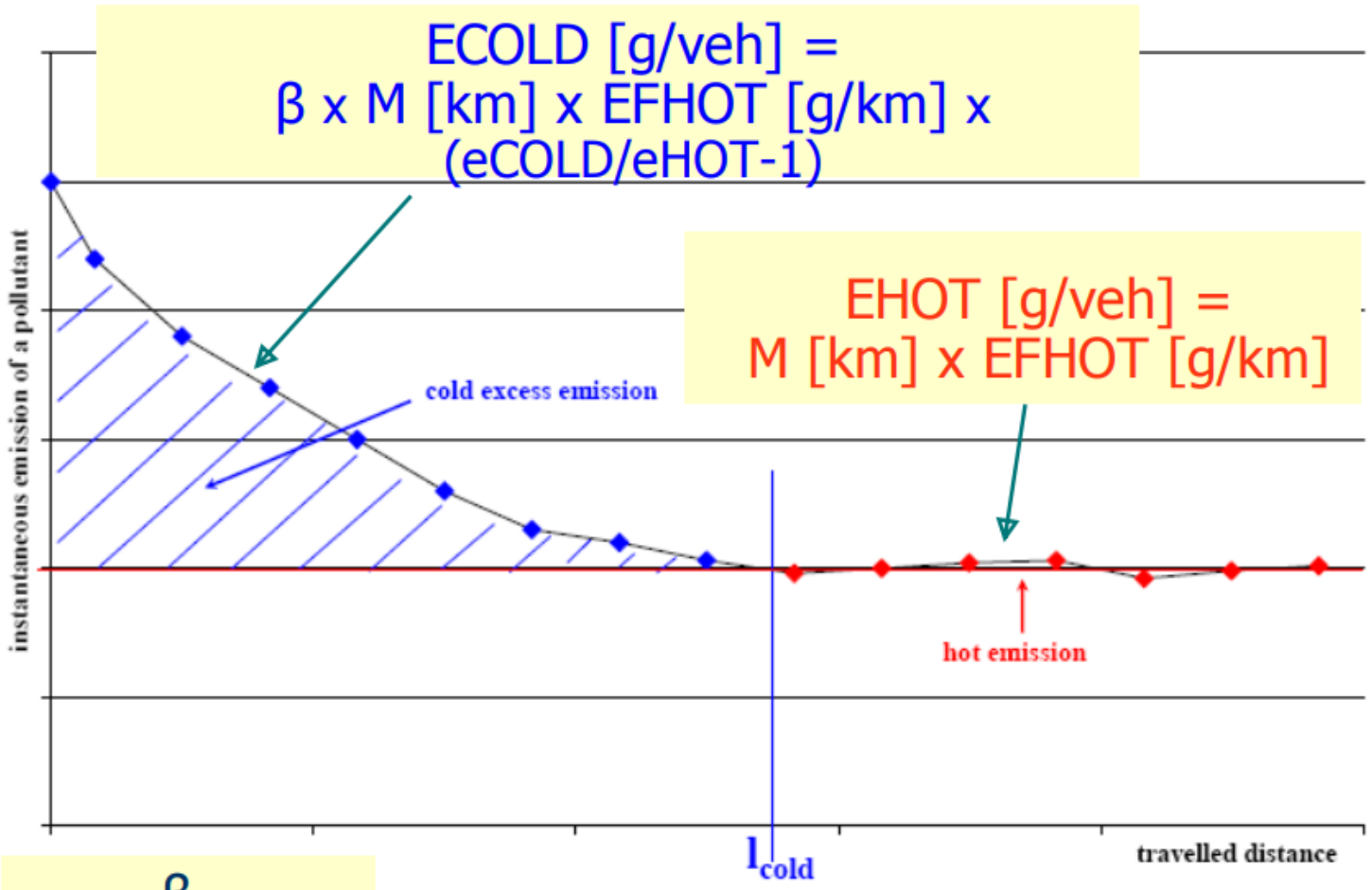
Note

(1) VOC: if ta > 29 °C then e^{COLD} / e^{HOT} > 0.5.

(2) PM: if ta > 26 °C then e^{COLD} / e^{HOT} > 0.5.

Diesel cold emissions

General Concept for Exhaust Emissions/Consumption



β = ICOLD/ITOTAL

Sensitivity analysis examples

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Cold emissions:

Table 5.26: Cold mileage percentage β

Calculations based on	β-parameter (Beta parameter)
Estimated l_{trip}	$0{,}6474 - 0{,}02545 \times l_{trip} - (0{,}00974 - 0{,}000385 \times l_{trip}) \times t_a$

β is the fraction of km driven in cold mode

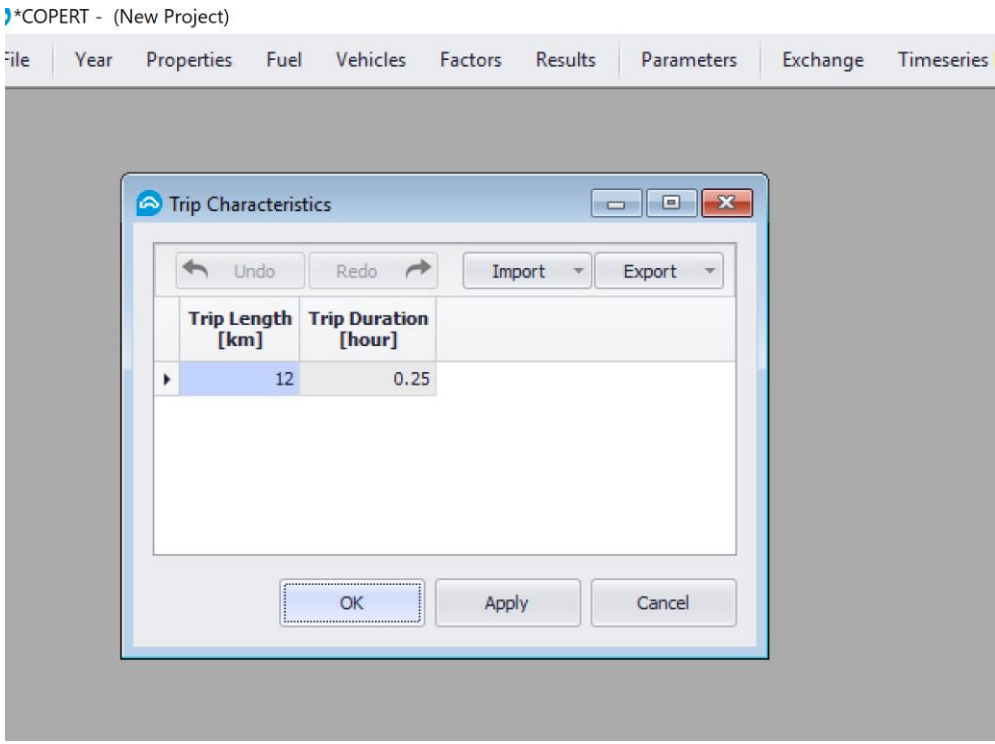
ltrip is ….

This will be applied to the all km of the year, and then extra emissions/fuel consumption….

Sensitivity analysis examples

Cold emissions:

ltrip is country's average Trip Length in km and Trip Duration in hours.



Tier 3 emissions factors

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1.A.3.b.i, 1.A.3.b.ii, 1.A.3.b.iii, 1.A.3.b.iv

Passenger cars, light commercial trucks, heavy-duty vehicles including buses and motor cycles

Table 3-44: Over-emission ratios e^{COLD} / e^{HOT} for Euro 1 and later gasoline vehicles (*V*: speed in km/h, t_a: temperature in °C)

Case	Category	Speed [km/h]	Temp [°C]	$e^{COLD}/e^{HOT} = A \times V + B \times t_a + C$ A	B	C
CO	cc< 1.4 l	5– 25	-20 : 15	0.156	-0.155	3.519
		26–45	-20 : 15	0.538	-0.373	-6.24
		5–45	> 15	8.032E-02	-0.444	9.826
	1.4 l < cc < 2.0 l	5–25	-20 : 15	0.121	-0.146	3.766
		26–45	-20 : 15	0.299	-0.286	-0.58
		5–45	> 15	5.03E-02	-0.363	8.604
	cc> 2.0 l	5–25	-20 : 15	7.82E-02	-0.105	3.116
		26–45	-20 : 15	0.193	-0.194	0.305
		5–45	> 15	3.21E-02	-0.252	6.332
NOx	cc< 1.4 l	5–25	> -20	4.61E-02	7.38E-03	0.755
		26–45	> -20	5.13E-02	2.34E-02	0.616
	1.4 l < cc < 2.0 l	5–25	> -20	4.58E-02	7.47E-03	0.764
		26–45	> -20	4.84E-02	2.28E-02	0.685
	cc>2.0 l	5–25	> -20	3.43E-02	5.66E-03	0.827
		26–45	> -20	3.75E-02	1.72E-02	0.728

Diesel cold emissions

$$FChot\ (g/km) = (a + c \times V + e \times V^2)/(1 + b \times V + d \times V^2)$$

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Table 8-9: Values for eq.(21) to calculate emissions from Euro 1 and later gasoline passenger cars

Pollutant	Emission Standard	Engine capacity	Speed Range (km/h)	R^2	a	b	c	d	e
FC	Euro 1	<1.4	10-130	0.99	1.91E+02	1.29E-01	1.17E+00	-7.23E-04	
		1.4-2.0	10-130	0.98	1.99E+02	8.92E-02	3.46E-01	-5.38E-04	
		>2.0	10-130	0.93	2.30E+02	6.94E-02	-4.26E-02	-4.46E-04	
	Euro 2	<1.4	10-130	0.99	2.08E+02	1.07E-01	-5.65E-01	-5.00E-04	1.43E-02
		1.4-2.0	10-130	0.98	3.47E+02	2.17E-01	2.73E+00	-9.11E-04	4.28E-03
		>2.0	10-130	0.98	1.54E+03	8.69E-01	1.91E+01	-3.63E-03	
	Euro 3	<1.4	10-130	0.99	1.70E+02	9.28E-02	4.18E-01	-4.52E-04	4.99E-03
		1.4-2.0	10-130	0.99	2.17E+02	9.60E-02	2.53E-01	-4.21E-04	9.65E-03
		>2.0	10-130	0.99	2.53E+02	9.02E-02	5.02E-01	-4.69E-04	
	Euro 4	<1.4	10-130	0.95	1.36E+02	2.60E-02	-1.65E+00	2.28E-04	3.12E-02
		1.4-2.0	10-130	0.96	1.74E+02	6.85E-02	3.64E-01	-2.47E-04	8.74E-03
		>2.0	10-130	0.98	2.85E+02	7.28E-02	-1.37E-01	-4.16E-04	

Table 8-11: Over-emission ratios e^{COLD} / e^{HOT} for Euro 1 and later gasoline vehicles (V: speed in km/h, t_a: temperature in °C)

Case	Category	Speed [km/h]	Temp [°C]	$e^{COLD}/e^{HOT} = A \times V + B \times t_a + C$ A	B	C
FC	All Classes	-	-10 : 30	0	-0.009	1.47

Note: e^{COLD}/e^{HOT} should be replaced with unit when it is calculated less than unit within the temperature and speed application limits

$$FChot\ (g/km) = (a + c \times V + e \times V^2)/(1 + b \times V + d \times V^2) + f/V$$

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Table 8-15: Values for eq.(23) to calculate emissions from Euro 1 and later diesel passenger cars

Pollutant	Emission Standard	Engine capacity	Speed Range (km/h)	R^2	a	b	c	d	e	f
FC	Euro 1	<2.0	10-130	0.98	1.45E+02	6.73E-02	-1.88E-01	-3.17E-04	9.47E-03	
		>2.0	10-130	0.96	1.95E+02	7.19E-02	1.87E-01	-3.32E-04	9.99E-03	
	Euro 2	<2.0	10-130	0.97	1.42E+02	4.98E-02	-6.51E-01	-1.69E-04	1.32E-02	
		>2.0	10-130	0.96	1.95E+02	7.19E-02	1.87E-01	-3.32E-04	9.99E-03	
	Euro 3	<2.0	10-130	0.95	1.62E+02	1.23E-01	2.18E+00	-7.76E-04	-1.28E-02	
		>2.0	10-130	0.96	1.95E+02	7.19E-02	1.87E-01	-3.32E-04	9.99E-03	

Table 8-14: Over-emission ratios e^{COLD} / e^{HOT} for diesel passenger cars (temperature range -10°C to 30°C)

Pollutant	e^{COLD} / e^{HOT}
CO	$1.9 - 0.03\ t_a$
NO_x	$1.3 - 0.013\ t_a$
VOC	$3.1 - 0.09\ t_a$ (1)
PM	$3.1 - 0.1\ t_a$ (2)
Fuel Consumption	$1.34 - 0.008\ t_a$

(1) VOC: if $t_a > 29°C$ then $e^{COLD} / e^{HOT} > 0.5$

(2) PM: if $t_a > 26°C$ then $e^{COLD} / e^{HOT} > 0.5$

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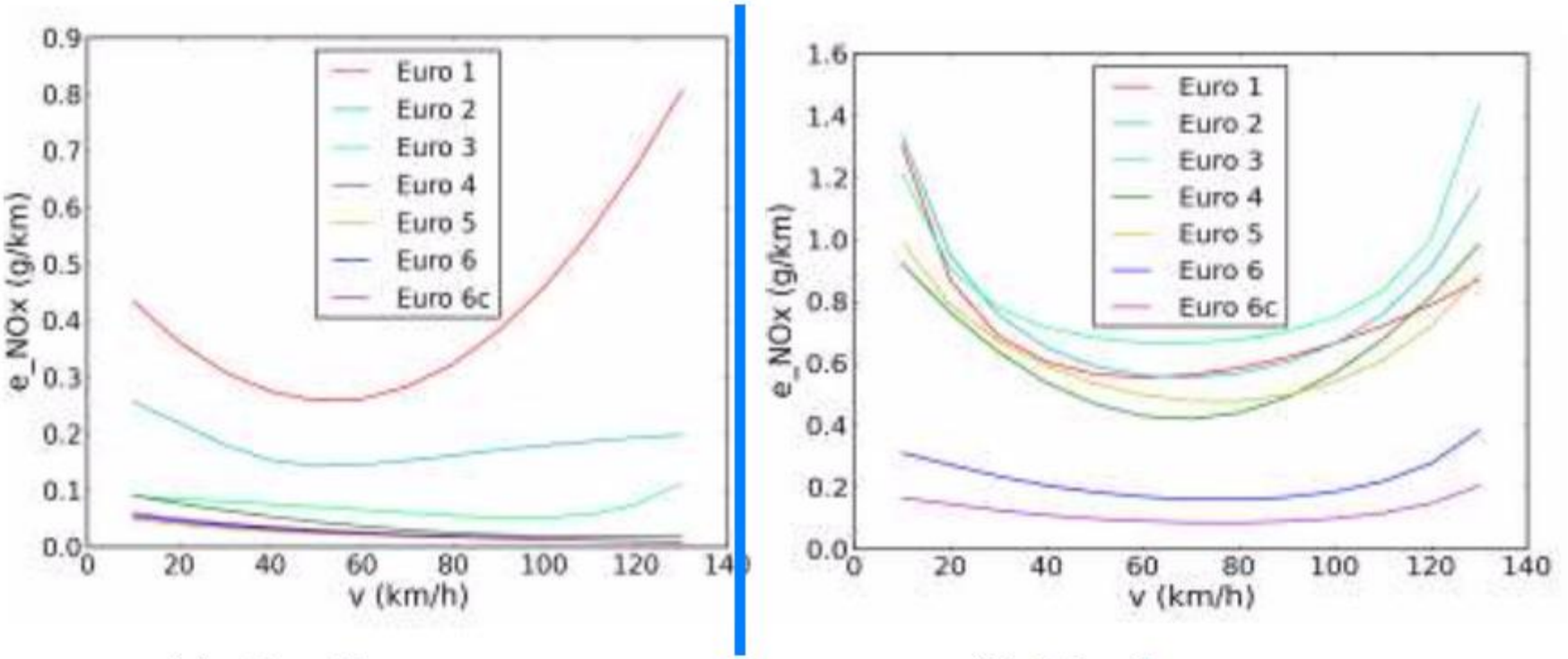

Figure 14: Sensitivity of hot emission factor of passenger cars for NO_x to the average speed.

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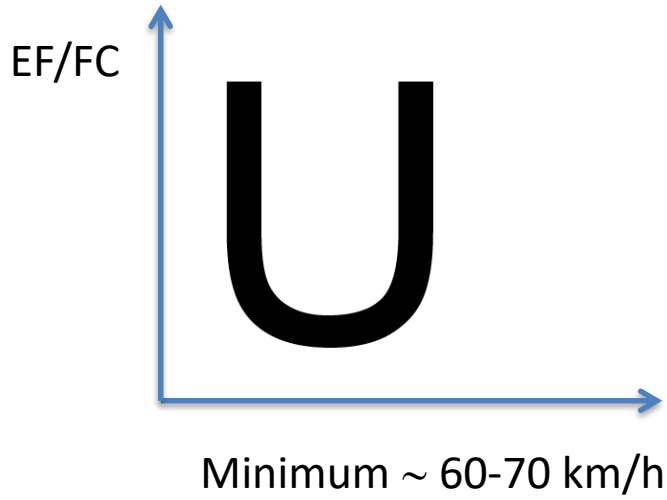

EF = Emission Factor (g/km) = f(vehicle category & standard, **average speed**, ambient temperature, A/C, Road slope, load)

Pollutants – 1(2)

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

Group 1
Carbon monoxide (CO)
Nitrogen oxides (NOx: NO and NO2)
Volatile organic compounds (VOCs)
Methane (CH4)
Non-methane VOCs (NMVOCs)
Nitrous oxide (N2O)
Ammonia (NH3)
Particulate matter (PM)
PM number and surface area

Pollutants which are estimated based on fuel consumption

Group 2
Carbon dioxide (CO2)
Sulphur dioxide (SO2)
Lead (Pb)
Cadmium (Cd)
Chromium (Cr)
Copper (Cu)
Nickel (Ni)
Selenium (Se)
Zinc (Zn)

COPERT 4 Training (2. Methodology) 9

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Pollutants - 2

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

Group 3
Polycyclic aromatic hydrocarbons (PAHs) and persistent organic pollutants (POPs)
Polychlorinated dibenzo dioxins (PCDDs) and polychlorinated dibenzo furans (PCDFs)

Pollutants which are derived as a fraction of total NMVOC emissions.

Group 4
Alkanes (CnH2n+2):
Alkenes (CnH2n):
Alkynes (CnH2n-2):
Aldehydes (CnH2nO)
Ketones (CnH2nO)
Cycloalkanes (CnH2n)
Aromatic compounds

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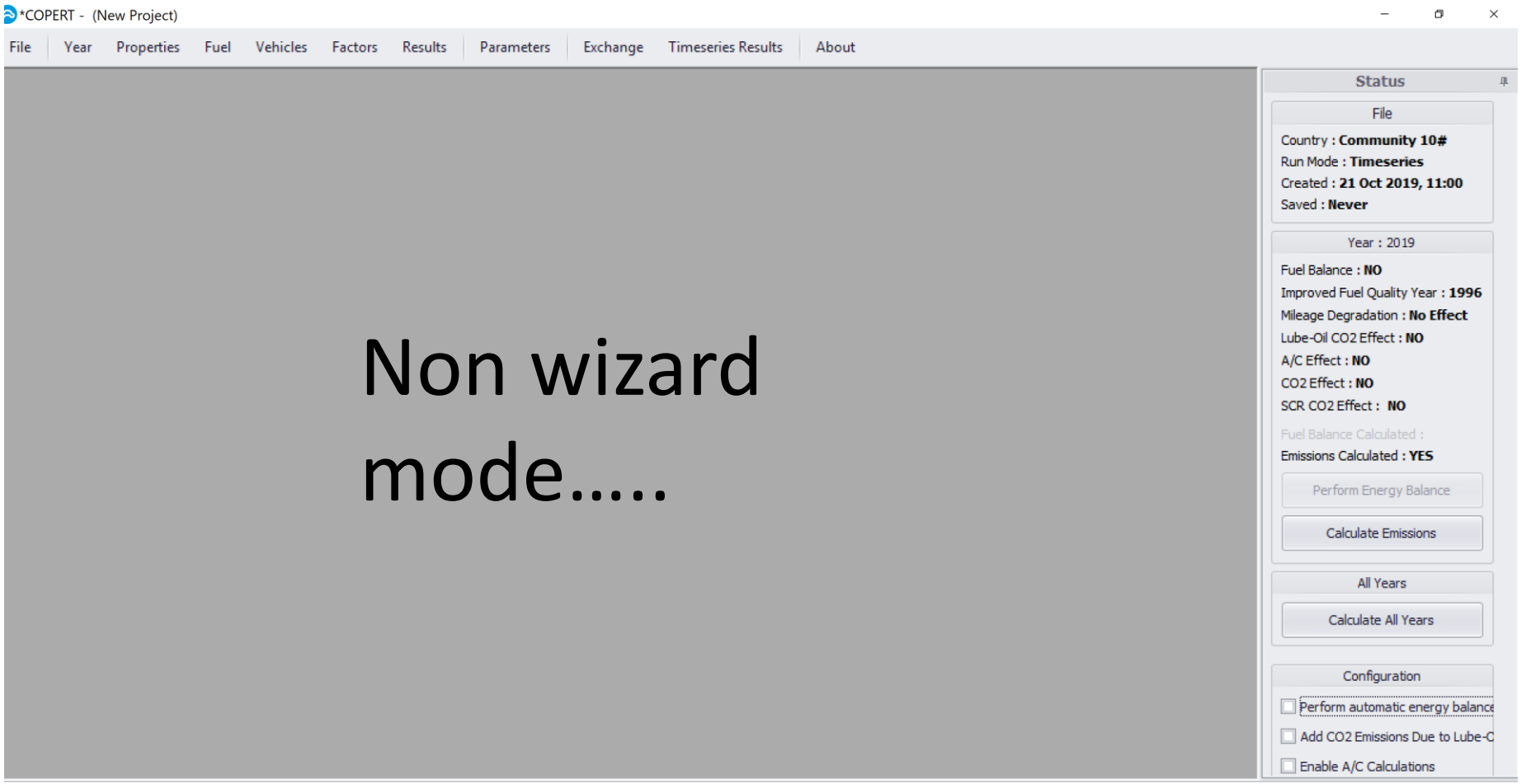
*COPERT - (New Project)
File
Year
Properties
Fuel
Vehicles
Factors
Results
Parameters
Exchange
Timeseries Results
About
Non wizard mode…..
Status
File
Country : Community 10#
Run Mode : Timeseries
Created : 21 Oct 2019, 11:00
Saved : Never
Year : 2019
Fuel Balance : NO
Improved Fuel Quality Year : 1996
Mileage Degradation : No Effect
Lube-Oil CO2 Effect : NO
A/C Effect : NO
CO2 Effect : NO
SCR CO2 Effect : NO
Fuel Balance Calculated :
Emissions Calculated : YES
Perform Energy Balance
Calculate Emissions
All Years
Calculate All Years
Configuration
Perform automatic energy balance
Add CO2 Emissions Due to Lube-C
Enable A/C Calculations

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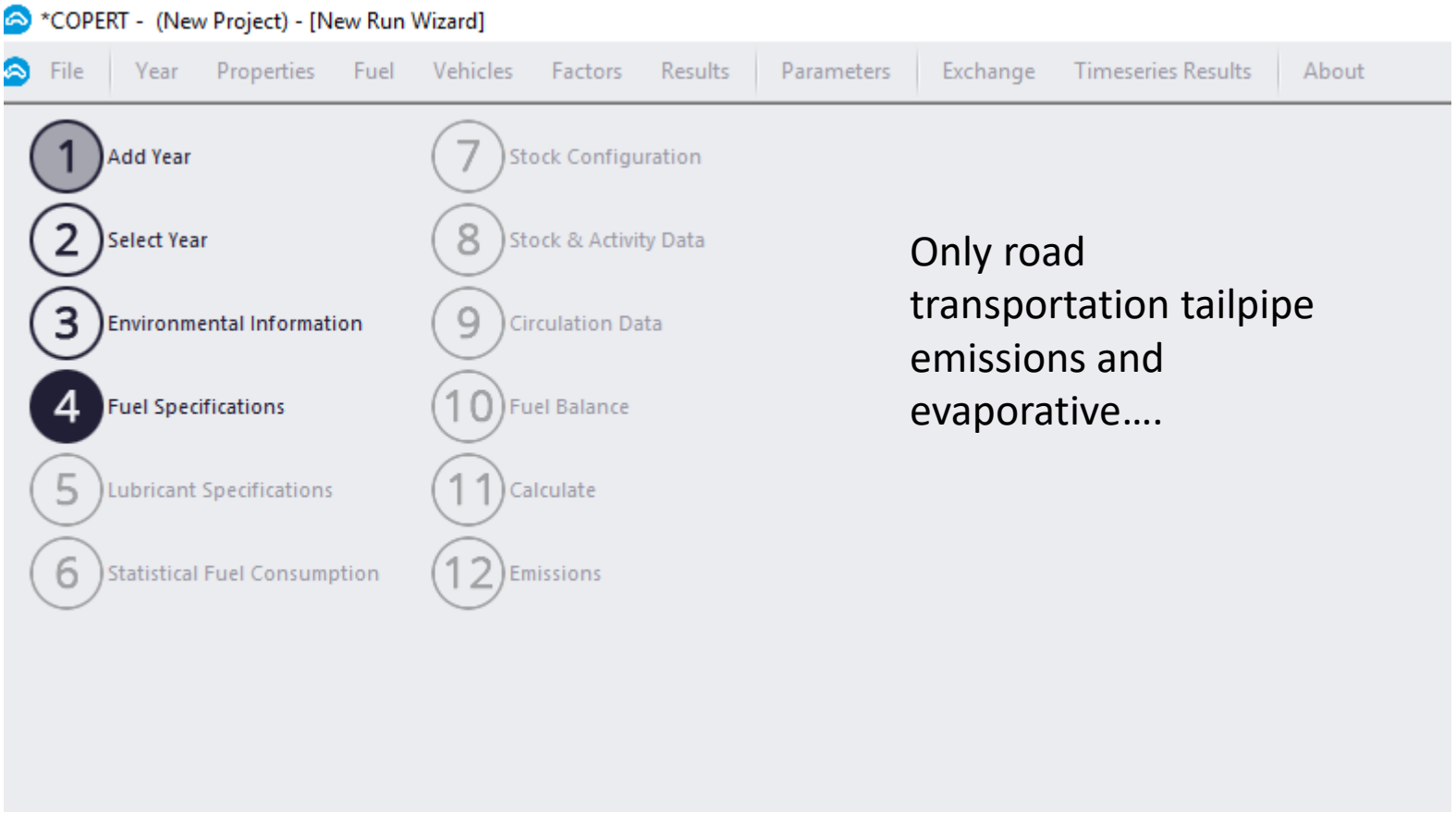
Wizard mode 12 info to go…..



Only road transportation tailpipe emissions and evaporative….

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*COPERT - (New Project) - [Environmental Information]

File | Year | Properties | Fuel | Vehicles | Factors | Results | Parameters | Exc

Month	Min Temperature [°C]	Max Temperature [°C]	Humidity [%]
January	3	18	50%
February	2	19	50%
March	5	21	50%
April	6	27	50%
May	9	29	50%
June	12	37	50%
July	14	28	50%
August	16	44	50%
September	14	37	50%
October	8	32	50%
November	6	20	50%
December	6	20	50%

Metereological station(s) of the local

https://www.tempo.pt/lisboa-sactual.htm

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*COPERT - (New Project) - [Fuel Specifications]

File | Year | Properties | Fuel | Vehicles | Factors | Results | Parameters | Exchange | Timeseries Results | About

		Specifications			Content In Species									
Primary Fuel	Fame 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	1.86	0	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	1.86	0	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	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	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	520	0	0	0	0	0	0	0	0	0	0
LPG Grade 2	46.564	2.525	0	520	0	0	0	0	0	0	0	0	0	0
CNG	48	4	0	175	0	0	0	0	0	0	0	0	0	0
Biodiesel	37.3	1.95	0.11	890	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	794	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
ETBE	36.2	2.33	0.167	736	0	0.0016	0.0002	0.0045	0.0063	0.0023	0.0002	0.033	0.0087	0.0003

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*COPERT - (New Project) - [Lubricants Specifications]

File | Year | Properties | Fuel | Vehicles | Factors | Results | Parameters | Exchange | Timeseries Results | About

	Content In Species										Specifications	
Lubricant Type	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

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Energy matrix for the region

*COPERT - (New Project) - [Statistical Energy Consumption]

File | Year | Properties | Fuel | Vehicles | Factors | Results | Parameters | Exchange | Timeseries Results | About

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 + ETBE	0
H2	0

LISBOA e·nova

Matriz Energética de Lisboa

Elaborada no âmbito da definição
da Estratégia Energético Ambiental
para a Cidade de Lisboa

Sensitivity analysis examples

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Evaporative losses:

Table 5.32: Summary of emission factors for estimating evaporative emissions of gasoline vehicles (all RVP in kPa, all temperatures in °C)

Emission factor (units)	Uncontrolled vehicle	Small carbon canister controlled vehicle
Diurnal (g/day)	$9{,}1 \times \exp(0{,}0158\,(RVP-61{,}2)+ 0{,}0574\,(t_{a,min} - 22{,}5) + 0{,}0614 \times (t_{a,rise} - 11{,}7))$	0,2 × uncontrolled
warm soak (g/procedure)	$\exp(-1{,}644 + 0{,}01993\,RVP + 0{,}07521\,t_a)$	$0{,}2 \times \exp(-2{,}41 + 0{,}02302\,RVP + 0{,}09408\,t_a)$
hot soak (g/procedure)	$3{,}0042 \times \exp(0{,}02\,RVP)$	$0{,}3 \times \exp(-2{,}41 + 0{,}02302\,RVP + 0{,}09408\,t_a)$
warm and hot soak for fuel injected vehicles (g/procedure)	0,7	none
warm running losses (g/km)	$0{,}1 \times \exp(-5{,}967 + 0{,}04259\,RVP + 0{,}1773\,t_a)$	0,1 × uncontrolled
hot running losses (g/km)	$0{,}136 \times \exp(-5{,}967 + 0{,}04259\,RVP + 0{,}1773\,t_a)$	0,1 × uncontrolled

Note: $t_a = (t_{a,max} + t_{a,min}) / 2$ $\qquad t_{a,rise} = t_{a,max} - t_{a,min}$

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Sensitivity analysis examples

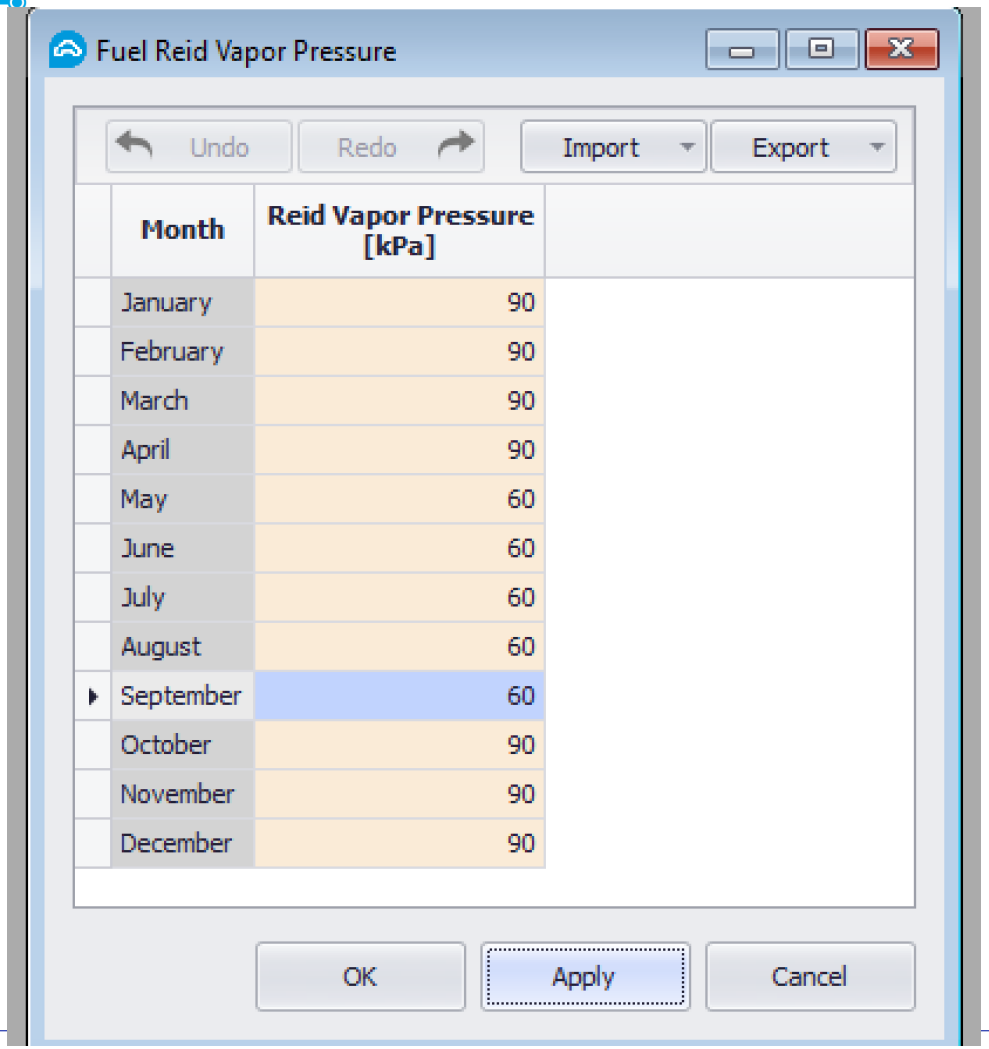
Europe limits:

Table 3.129 – Reid Vapour Pressure (kPa)

Month	1990 to 1995	1996 to 1999	2000 to 2012
January	98	95	90
February	98	95	90
March	98	95	90
April	83	80	90
May	83	80	60
June	70	70	60
July	70	70	60
August	70	70	60
September	70	70	60
October	83	95	90
November	98	95	90
December	98	95	90

Sensitivity analysis examples

Evaporative losses:



Depends on the country:

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*COPERT - (New Project) - [Stock Configuration]

File | Year | Properties | Fuel | Vehicles | Factors | Results | Parameters | Exchange | Timeserie

Passenger Cars

Category	Fuel	Segment	Euro Standard	Include
Passenger Cars	Petrol	Mini	Euro 4	☐
Passenger Cars	Petrol	Mini	Euro 5	☐
Passenger Cars	Petrol	Mini	Euro 6 up to 2016	☐
Passenger Cars	Petrol	Mini	Euro 6 2017-2019	☐
Passenger Cars	Petrol	Mini	Euro 6 2020+	☐
Passenger Cars	Petrol	Small	PRE ECE	☐
Passenger Cars	Petrol	Small	ECE 15/00-01	☐
Passenger Cars	Petrol	Small	ECE 15/02	☐
Passenger Cars	Petrol	Small	ECE 15/03	☐
Passenger Cars	Petrol	Small	ECE 15/04	☐
Passenger Cars	Petrol	Small	Improved Conventional	☐
Passenger Cars	Petrol	Small	Open Loop	☐
Passenger Cars	Petrol	Small	Euro 1	☐
Passenger Cars	Petrol	Small	Euro 2	☐
Passenger Cars	Petrol	Small	Euro 3	☐
Passenger Cars	Petrol	Small	Euro 4	☐
Passenger Cars	Petrol	Small	Euro 5	☐
Passenger Cars	Petrol	Small	Euro 6 up to 2016	☐
Passenger Cars	Petrol	Small	Euro 6 2017-2019	☑
Passenger Cars	Petrol	Small	Euro 6 2020+	☐
Passenger Cars	Petrol	Medium	PRE ECE	☐
Passenger Cars	Petrol	Medium	ECE 15/00-01	☐

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*COPERT - (New Project) - [Stock Configuration]

File | Year | Properties | Fuel | Vehicles | Factors | Results | Parameters | Exchange | T

Passenger Cars

Category	Fuel	Segment	Euro Standard	Include
Passenger Cars	Petrol	2-Stroke	Conventional	☐
Passenger Cars	Diesel	Mini	Euro 4	☐
Passenger Cars	Diesel	Mini	Euro 5	☐
Passenger Cars	Diesel	Mini	Euro 6 up to 2016	☐
Passenger Cars	Diesel	Mini	Euro 6 2017-2019	☐
Passenger Cars	Diesel	Mini	Euro 6 2020+	☐
Passenger Cars	Diesel	Small	Conventional	☐
Passenger Cars	Diesel	Small	Euro 1	☐
Passenger Cars	Diesel	Small	Euro 2	☐
Passenger Cars	Diesel	Small	Euro 3	☐
Passenger Cars	Diesel	Small	Euro 4	☐
Passenger Cars	Diesel	Small	Euro 5	☐
Passenger Cars	Diesel	Small	Euro 6 up to 2016	☐
Passenger Cars	Diesel	Small	Euro 6 2017-2019	☑
Passenger Cars	Diesel	Small	Euro 6 2020+	☐
Passenger Cars	Diesel	Medium	Conventional	☐
Passenger Cars	Diesel	Medium	Euro 1	☐
Passenger Cars	Diesel	Medium	Euro 2	☐
Passenger Cars	Diesel	Medium	Euro 3	☐

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*COPERT - (New Project) - [Stock Configuration]

File | Year | Properties | Fuel | Vehicles | Factors | Results | Parameters | Exchange | Timeseries Res

Buses

Category	Fuel	Segment	Euro Standard	Include
Buses	Diesel	Urban Buses Midi <=15 t	Conventional	☐
Buses	Diesel	Urban Buses Midi <=15 t	Euro I	☐
Buses	Diesel	Urban Buses Midi <=15 t	Euro II	☐
Buses	Diesel	Urban Buses Midi <=15 t	Euro III	☐
Buses	Diesel	Urban Buses Midi <=15 t	Euro IV	☐
Buses	Diesel	Urban Buses Midi <=15 t	Euro V	☐
Buses	Diesel	Urban Buses Midi <=15 t	Euro VI	☐
Buses	Diesel	Urban Buses Standard 15 - 18 t	Conventional	☐
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro I	☐
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro II	☐
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro III	☐
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro IV	☐
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro V	☐
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	☑
Buses	Diesel	Urban Buses Articulated >18 t	Conventional	☐
Buses	Diesel	Urban Buses Articulated >18 t	Euro I	☐
Buses	Diesel	Urban Buses Articulated >18 t	Euro II	☐
Buses	Diesel	Urban Buses Articulated >18 t	Euro III	☐
Buses	Diesel	Urban Buses Articulated >18 t	Euro IV	☐
Buses	Diesel	Urban Buses Articulated >18 t	Euro V	☐

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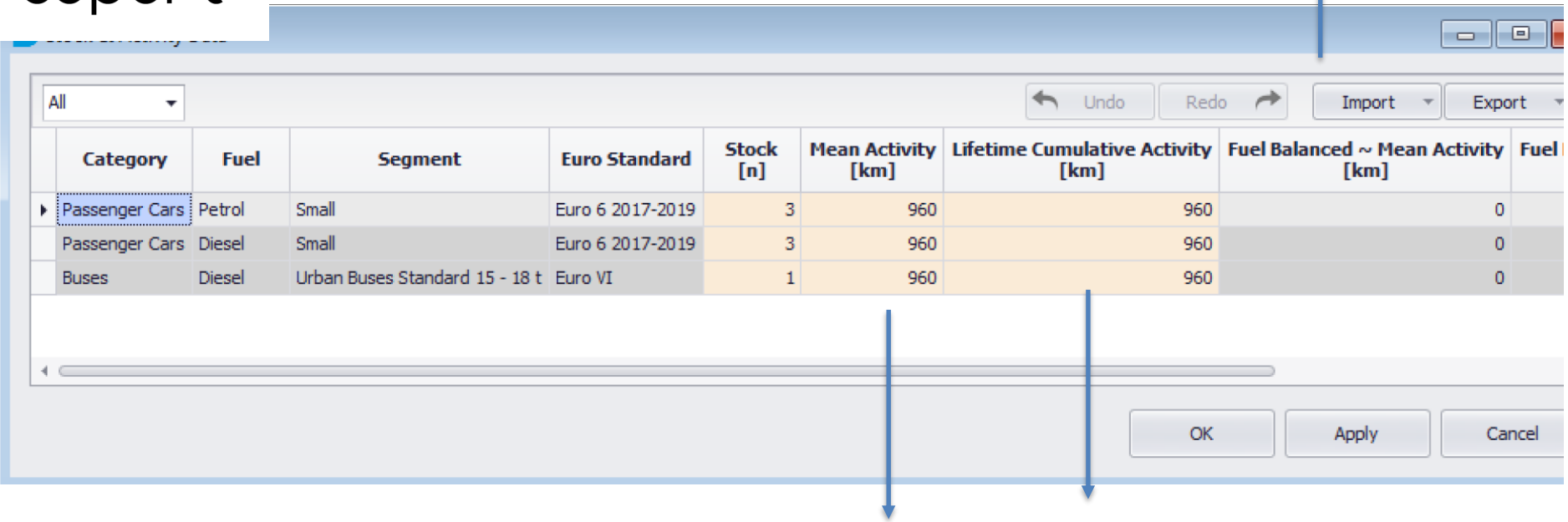
calculated consumption to match the statistical



km/year for each vehicle (2*2*5*48 for the community 10 people)

mean distance traveled by each vehicle of a specific technology level since the introduction in the market (assuming new vehicles)

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*COPERT - (New Project) - [Circulation activity]

File | Year | Properties | Fuel | Vehicles | Factors | Results | Parameters | Exchange | Timeseries Results | About

All

Vehicle				Share				Speed				
Category	Fuel	Segment	Euro Standard	Urban Peak [%]	Urban Off Peak [%]	Rural [%]	Highway [%]	Urban Peak [km/h]	Urban Off Peak [km/h]	Rural [km/h]	Highway [km/h]	Min - Max Speed [km/h]
Passenger Cars	Petrol	Small	Euro 6 2017-2019	100%	0%	0%	0%	30	0	0	0	5 - 130
Passenger Cars	Diesel	Small	Euro 6 2017-2019	100%	0%	0%	0%	30	0	0	0	10 - 130
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	100%	0%	0%	0%	14	0	0	0	5 - 85

Assuming 100% peak urban……

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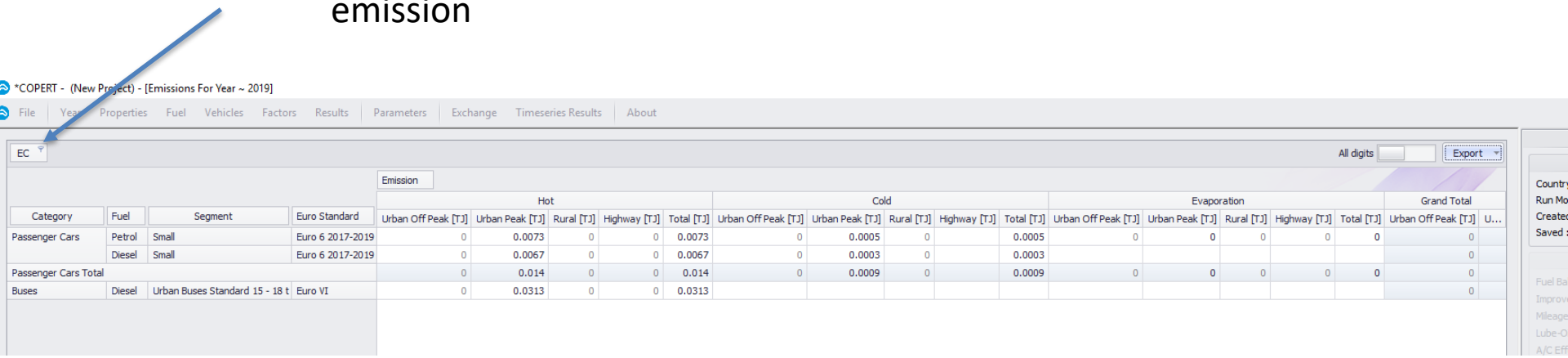
Choose energy consumption (final energy consumption) or emission



Category	Fuel	Segment	Euro Standard	Hot					Cold					Evaporation					Grand Total	
				Urban Off Peak [TJ]	Urban Peak [TJ]	Rural [TJ]	Highway [TJ]	Total [TJ]	Urban Off Peak [TJ]	Urban Peak [TJ]	Rural [TJ]	Highway [TJ]	Total [TJ]	Urban Off Peak [TJ]	Urban Peak [TJ]	Rural [TJ]	Highway [TJ]	Total [TJ]	Urban Off Peak [TJ]	U...
Passenger Cars	Petrol	Small	Euro 6 2017-2019	0	0.0073	0	0	0.0073	0	0.0005	0		0.0005	0	0	0	0	0	0	
	Diesel	Small	Euro 6 2017-2019	0	0.0067	0	0	0.0067	0	0.0003	0		0.0003						0	
Passenger Cars Total				0	0.014	0	0	0.014	0	0.0009	0		0.0009	0	0	0	0	0	0	
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	0	0.0313	0	0	0.0313											0	

Passenger cars: 14800 MJ for 6 people

Bus: 156500 MJ for 40 people allocated to only 2 people, 7800 MJ

Total: 22625 MJ/year

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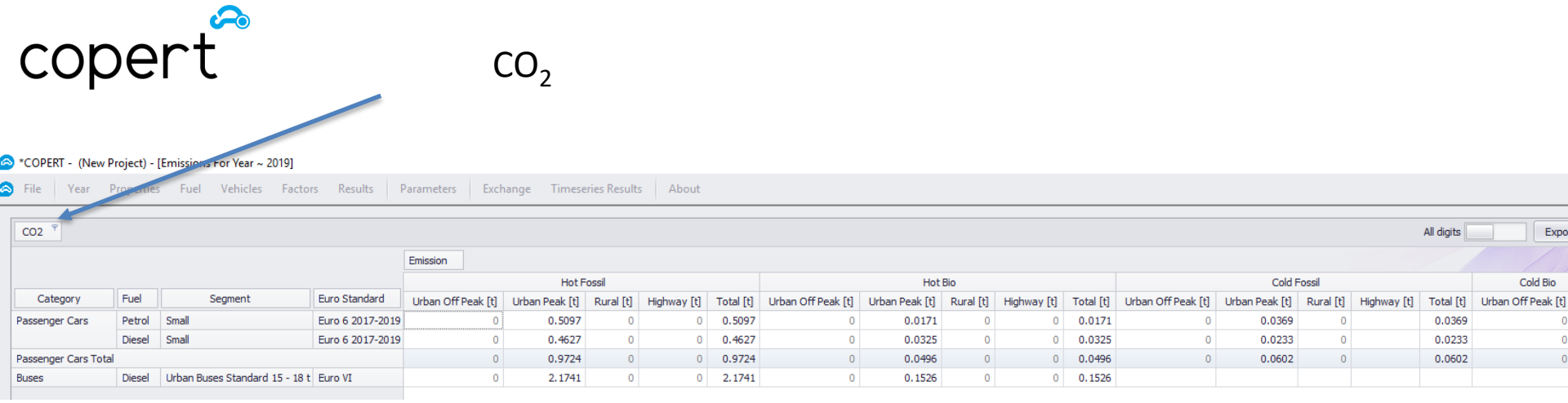
CO_2



Category	Fuel	Segment	Euro Standard	Hot Fossil					Hot Bio					Cold Fossil					Cold Bio
				Urban Off Peak [t]	Urban Peak [t]	Rural [t]	Highway [t]	Total [t]	Urban Off Peak [t]	Urban Peak [t]	Rural [t]	Highway [t]	Total [t]	Urban Off Peak [t]	Urban Peak [t]	Rural [t]	Highway [t]	Total [t]	Urban Off Peak [t]
Passenger Cars	Petrol	Small	Euro 6 2017-2019	0	0.5097	0	0	0.5097	0	0.0171	0	0	0.0171	0	0.0369	0		0.0369	0
	Diesel	Small	Euro 6 2017-2019	0	0.4627	0	0	0.4627	0	0.0325	0	0	0.0325	0	0.0233	0		0.0233	0
Passenger Cars Total				0	0.9724	0	0	0.9724	0	0.0496	0	0	0.0496	0	0.0602	0		0.0602	0
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	0	2.1741	0	0	2.1741	0	0.1526	0	0	0.1526						

Passenger cars: 1.0852 Ton for 6 people

Bus: 1.163 Ton for 40 people allocated to only 2 people, 0.05815Ton

Total: 1.2 Ton/year

Cold emissions 6% of total
Urban peak 100% of total

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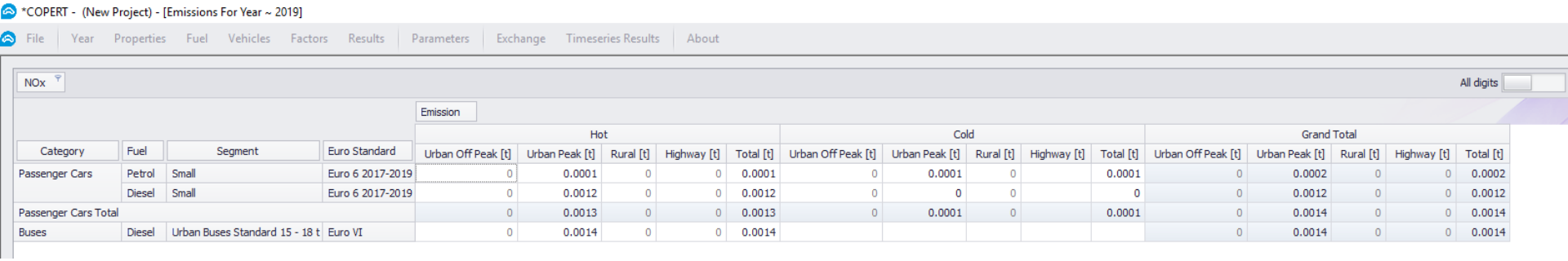
NO_x



*COPERT - (New Project) - [Emissions For Year ~ 2019]

File | Year | Properties | Fuel | Vehicles | Factors | Results | Parameters | Exchange | Timeseries Results | About

NOx — All digits

Emission

Category	Fuel	Segment	Euro Standard	Hot					Cold					Grand Total				
				Urban Off Peak [t]	Urban Peak [t]	Rural [t]	Highway [t]	Total [t]	Urban Off Peak [t]	Urban Peak [t]	Rural [t]	Highway [t]	Total [t]	Urban Off Peak [t]	Urban Peak [t]	Rural [t]	Highway [t]	Total [t]
Passenger Cars	Petrol	Small	Euro 6 2017-2019	0	0.0001	0	0	0.0001	0	0.0001	0		0.0001	0	0.0002	0	0	0.0002
	Diesel	Small	Euro 6 2017-2019	0	0.0012	0	0	0.0012	0	0	0		0	0	0.0012	0	0	0.0012
Passenger Cars Total				0	0.0013	0	0	0.0013	0	0.0001	0		0.0001	0	0.0014	0	0	0.0014
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	0	0.0014	0	0	0.0014						0	0.0014	0	0	0.0014

Passenger cars: 0.0014 Ton for 6 people

Bus: 0.0007 Ton for 40 people allocated to only 2 people, 0.00035Ton

Total: 0.00147 Ton/year

Cold emissions 71% of total
Urban peak 100% of total

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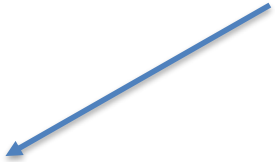
PM2.5



All digits Export

	Grand Total				
al [t]	Urban Off Peak [t]	Urban Peak [t]	Rural [t]	Highway [t]	Total [t]
0001	0	0.0001	0	0	0.0001
0001	0	0.0001	0	0	0.0001
0002	0	0.0002	0	0	0.0002
0002	0	0.0002	0	0	0.0002

Passenger cars: 0.0002 Ton for 6 people

Bus: 0.0001 Ton for 40 people allocated to only 2 people, 0.000005 Ton

Total: 0.00021 Ton/year

Cold emissions 0 % of total
Urban peak 100% of total

Surveys, energ. & emissions

Community 10 people



	VCA/standard	Tier 1 EEA	Tier 2 EEA	Tier 3 EEA (COPERT)
MJ/year	12052	16957	12338	22625
TonCO_2/year	0.619	1.245	0.91	1.2
kgNOx/year	0.3	4.5	2.75	1.47
kgPM/year	0.01	0.23	0.018	0.21

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Sensitivity analysis examples

Not on wizard mode…
Once all fleet stock and activity data ok, lets play…..

Degradation:

Average speed:

A/C on:

Evaporative losses:

Biodiesel/etanol blend:

Sensitivity analysis examples

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Biodiesel blend:

Table 3.131 – National biodiesel blends with diesel (% v/v)

2006	2007	2008	2009	2010	2012
1.6	3.0	2.9	5.1	7.4	7.7

Source: (DGEG, 2011)

http://apambiente.pt/_zdata/DPAAC/INERPA/IIR_global_20140325.pdf

Sensitivity analysis examples

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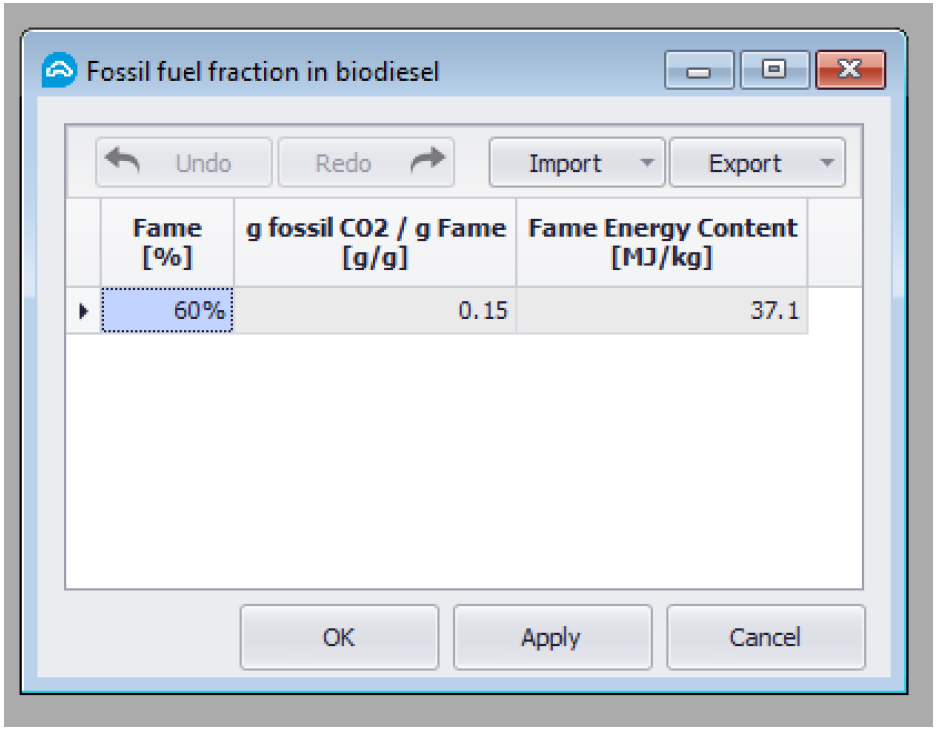
Biodiesel blend:

Table 3.130 – Effect of biodiesel blends on diesel vehicles emissions

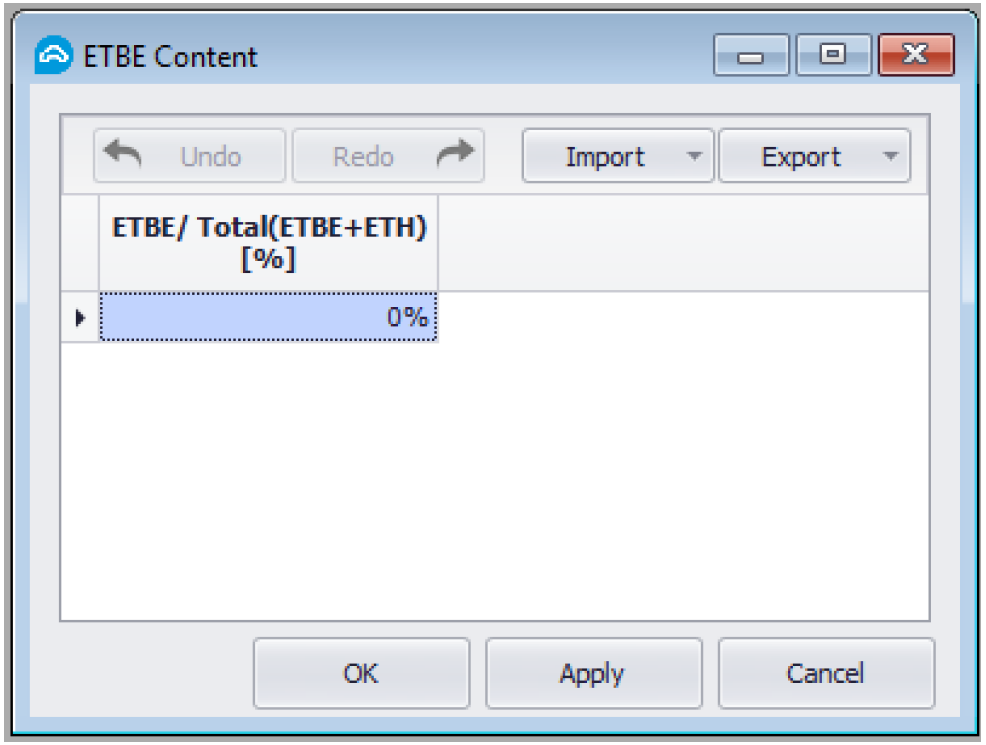
Pollutant	Vehicle Type	B10	B20	B100
CO_2	Passenger Cars	-1.5%	-2.0%	
	Light duty vehicles	-0.7%	-1.5%	
	Heavy duty vehicles	0.2%	0.0%	0.1%
NO_x	Passenger Cars	0.4%	1.0%	
	Light duty vehicles	1.7%	2.0%	
	Heavy duty vehicles	3.0%	3.5%	9.0%
PM	Passenger Cars	-13.0%	-20.0%	
	Light duty vehicles	-15.0%	-20.0%	
	Heavy duty vehicles	-10.0%	-15.0%	-47.0%
CO	Passenger Cars	0.0%	-5.0%	
	Light duty vehicles	0.0%	-6.0%	
	Heavy duty vehicles	-5.0%	-9.0%	-20.0%
HC	Passenger Cars	0.0%	-10.0%	
	Light duty vehicles	-10.0%	-15.0%	
	Heavy duty vehicles	-10.0%	-15.0%	-17.0%

http://apambiente.pt/_zdata/DPAAC/INERPA/IIR_global_20140325.pdf

Fatty acid methyl esters (FAME) are a type of fatty acid ester that are derived by transesterification



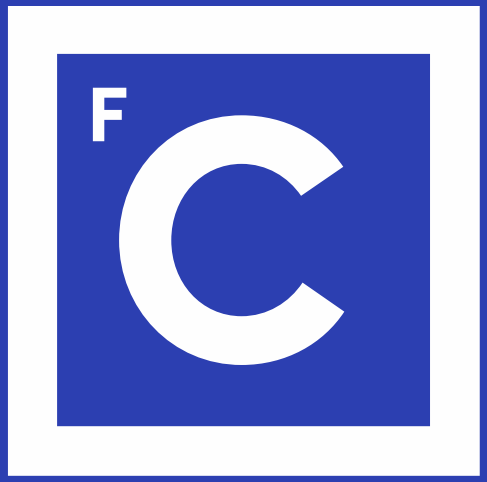
Ethyl tert-butyl ether (ETBE) is commonly used as an oxygenate gasoline additive



You learned….

- Tier 3 EEA COPERT V application to a community of 10 people;

Obrigado



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