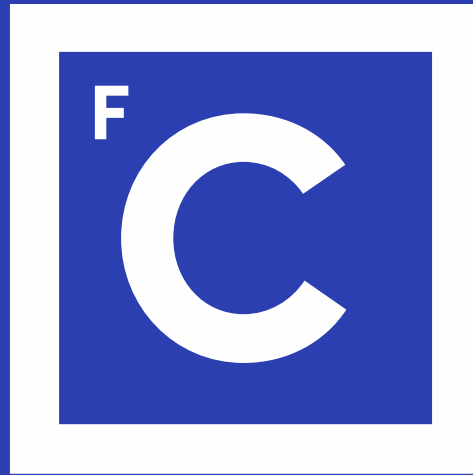




Ciências ULisboa

Faculdade
de Ciências
da Universidade
de Lisboa

DISCIPLINA MIEA 2018

move ► green



Mobilidade Sustentável

Home  Work/ University

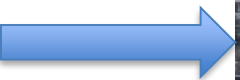
on a regular basis

Commuting by motorized or soft modes



Emissions

Energy



EMEP/EEA air pollutant emission inventory guidebook

EEA Report | No 21/2016

EMEP/EEA air pollutant emission inventory guidebook 2016

Technical guidance to prepare national emission inventories

ISSN 1977-8449



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 2016 [3.3 MB]
 - 1.A.3.b.i-iv Road transport Annex HDVs 2016 [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!

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

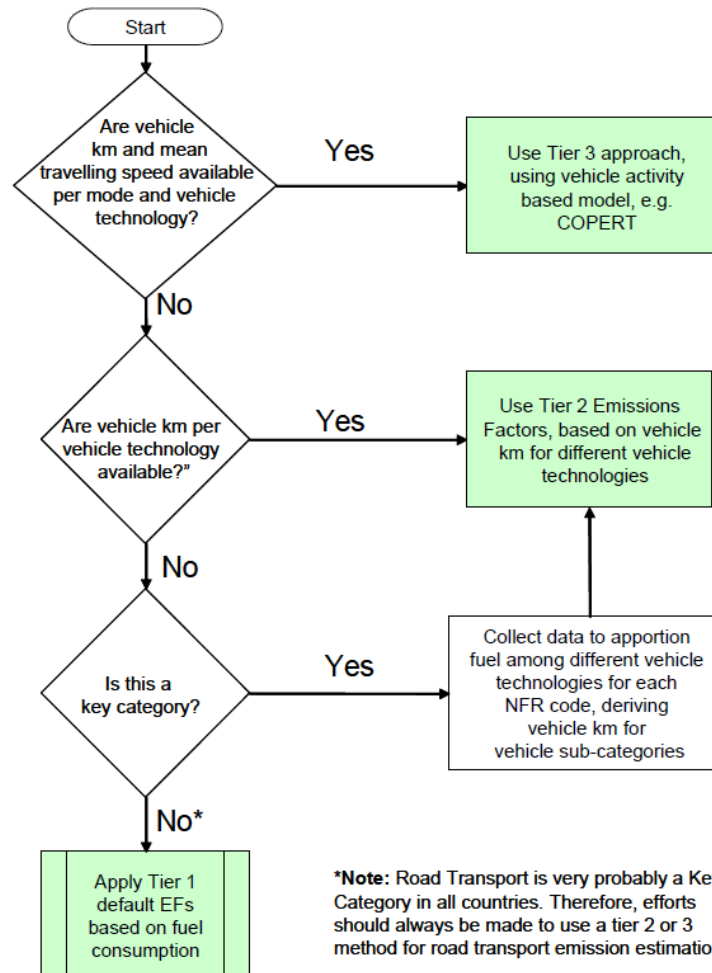


Table 3.6: Tier 1 emission factors for NO_x and PM

Category	Fuel	NO _x			PM		
		(g/kg fuel)			(g/kg fuel)		
		Mean	Min	Max	Mean	Min	Max
PC	Petrol	8.73	4.48	29.89	0.03	0.02	0.04
	Diesel	12.96	11.20	13.88	1.10	0.80	2.64
	LPG	15.20	4.18	34.30	0.00	0.00	0.00
LCV	Petrol	13.22	3.24	25.46	0.02	0.02	0.03
	Diesel	14.91	13.36	18.43	1.52	1.10	2.99
HDV	Diesel	33.37	28.34	38.29	0.94	0.61	1.57
	CNG (Buses)	13.00	5.50	30.00	0.02	0.01	0.04
Two-wheel	Petrol	6.64	1.99	10.73	2.20	0.55	6.02

Table 3-17: Tier 2 exhaust emission factors for passenger cars, NFR 1.A.3.b.i

Type	Technology	CO	NMVOC	NO _x	N ₂ O	NH ₃	Pb	CO ₂ lube
Units		g/km	g/km	g/km	g/km	g/km	g/km	g/km
Notes			Given as THC-CH ₄	Given as NO ₂ equivalent				due to lube oil
Petrol Mini	Euro 4 - 98/69/EC II	0.67	0.048	0.056	0.002	0.0339	1.82E-05	0.398
	Euro 5 - EC 715/2007	0.67	0.048	0.056	0.0013	0.0123	1.82E-05	0.398
	Euro 6 up to 2016	0.67	0.048	0.056	0.0013	0.0123	1.82E-05	0.398
	Euro 6 2017-2019	0.67	0.048	0.056	0.0013	0.0123	1.82E-05	0.398
	Euro 6 2020+	0.67	0.048	0.056	0.0013	0.0123	1.82E-05	0.398
Petrol Small	PRE ECE	37.3	2.77	1.91	0.01	0.0020	1.82E-05	0.663
	ECE 15/00-01	29.6	2.19	1.91	0.01	0.0020	1.82E-05	0.663
	ECE 15/02	21.7	2.06	2.12	0.01	0.0020	1.82E-05	0.663
	ECE 15/03	21.1	2.06	2.30	0.01	0.0020	1.82E-05	0.663
	ECE 15/04	13.1	1.68	2.07	0.01	0.0020	1.82E-05	0.663
	Open Loop	11.3	0.96	1.53	0.01	0.0020	1.82E-05	0.663
	Euro 1 - 91/441/EEC	4.88	0.467	0.426	0.01	0.0922	1.82E-05	0.596
	Euro 2 - 94/12/EEC	2.42	0.206	0.229	0.006	0.1043	1.82E-05	0.530
	Euro 3 - 98/69/EC I	2.07	0.089	0.090	0.002	0.0342	1.82E-05	0.464
	Euro 4 - 98/69/EC II	0.69	0.048	0.056	0.002	0.0341	1.82E-05	0.398
	Euro 5 - EC 715/2007	0.69	0.048	0.056	0.0013	0.0123	1.82E-05	0.398
	Euro 6 up to 2016	0.69	0.048	0.056	0.0013	0.0123	1.82E-05	0.398
	Euro 6 2017-2019	0.69	0.048	0.056	0.0013	0.0123	1.82E-05	0.398

Tier 3

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



COPERT v5.3 available for download

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.



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
kgNO _x /year	0.3	4.5	2.75	1.47
kgPM/year	0.01	0.23	0.018	0.21

Sensitivity analysis



Status

File

Country : **community 10**
 Run Mode : **Timeseries**
 Created : **22 Oct 2019, 17:11**
 Saved : **04 Nov 2019, 13:01**

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-Oil

☐ Enable A/C Calculations

☐ Enable CO2 Reduction

☐ Apply SCR CO2 Emissions

☐ Apply for all years

- Cold start impact (Ltrip 5 km β parameter)
- Humidity impact if A/C effect on or off ($RH_{average}$ 100%)
- Mileage degradation (car 100 000 km
bus 500000 km)
- FAME % (biodiesel)
- Road slope?
- Bus Load?

COPERT v.5.3 automated export
Date created : 06 Nov 2019, 10:28

Project : community 10
Year : 2019



Status

File

Country : **community 10**
Run Mode : **Timeseries**
Created : **22 Oct 2019, 17:11**
Saved : **04 Nov 2019, 13:01**

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-Oil

☐ Enable A/C Calculations

☐ Enable CO2 Reduction

☐ Apply SCR CO2 Emissions

☐ Apply for all years

Fossil Bio Fuel [TJ]	Category	Fuel	Segment	Euro Standard	Total [t]
Fossil Petrol	Passenger Cars	Petrol	Small	Euro 6 2017-2019	0.007682
Fossil Diesel	Passenger Cars	Diesel	Small	Euro 6 2017-2019	0.006533
Fossil Diesel	Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	0.01461
Bio Diesel	Passenger Cars	Diesel	Small	Euro 6 2017-2019	0.000455
Bio Diesel	Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	0.001018
Bio Ethanol	Passenger Cars	Petrol	Small	Euro 6 2017-2019	0.000282

COPERT v.5.3 automated export
Date created : 06 Nov 2019, 10:28

Project : community 10
Year : 2019



Status

File

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Run Mode : **Timeseries**
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Year : 2019

Fuel Balance : **NO**
Improved Fuel Quality Year : **1996**
Mileage Degradation : **No Effect**

Lube-Oil
A/C Effect
CO2 Effect
SCR CO2

Fuel Balance
Emission

☐ Performance
☐ Add CO2
☐ Enable
☐ Enable CO2 Reduction
☐ Apply SCR CO2 Emissions
☐ Apply for all years

Emission	Category	Fuel	Segment	Euro Standard	NOx	Urban Off Peak [t]	Urban Peak [t]	Rural [t]	Highway [t]	Total [t]
Hot	Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	0	0.000121	0	0	0.000121
Hot	Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	0	0.001221	0	0	0.001221
Hot	Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	0	0.000681	0	0	0.000681
Cold	Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	0	6.23E-05	0		6.23E-05
Cold	Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	0	2.3E-05	0		2.3E-05

COPERT v.5.3 automated export
Date created : 06 Nov 2019, 10:28

Project : community 10
Year : 2019



Status
File
Country : **community 10**
Run Mode : **Timeseries**
Created : **22 Oct 2019, 17:11**
Saved : **04 Nov 2019, 13:01**

Emission	Category	Fuel	Segment	Euro Standard	PM 2.5	Urban Off Peak [t]	Urban Peak [t]	Rural [t]	Highway [t]	Total [t]
Hot	Passenger Cars	Petrol	Small	Euro 6 2017-2019	PM 2.5	0	5.33E-06	0	0	5.33E-06
Hot	Passenger Cars	Diesel	Small	Euro 6 2017-2019	PM 2.5	0	5.87E-06	0	0	5.87E-06
Hot	Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	PM 2.5	0	8.11E-06	0	0	8.11E-06
Cold	Passenger Cars	Diesel	Small	Euro 6 2017-2019	PM 2.5	0	5.45E-07	0		5.45E-07
Non Exhaust	Passenger Cars	Petrol	Small	Euro 6 2017-2019	PM 2.5	0	4.37E-05	0	0	4.37E-05
Non Exhaust	Passenger Cars	Diesel	Small	Euro 6 2017-2019	PM 2.5	0	4.37E-05	0	0	4.37E-05
Non Exhaust	Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	PM 2.5	0	5.28E-05	0	0	5.28E-05

☐ Apply for all years



Cold emissions represent in passenger cars

$$0.0001/0.0014*100\% = 7\% \text{ NO}_x$$

$$0.0009/0.015*100\% = 6\% \text{ EC}$$



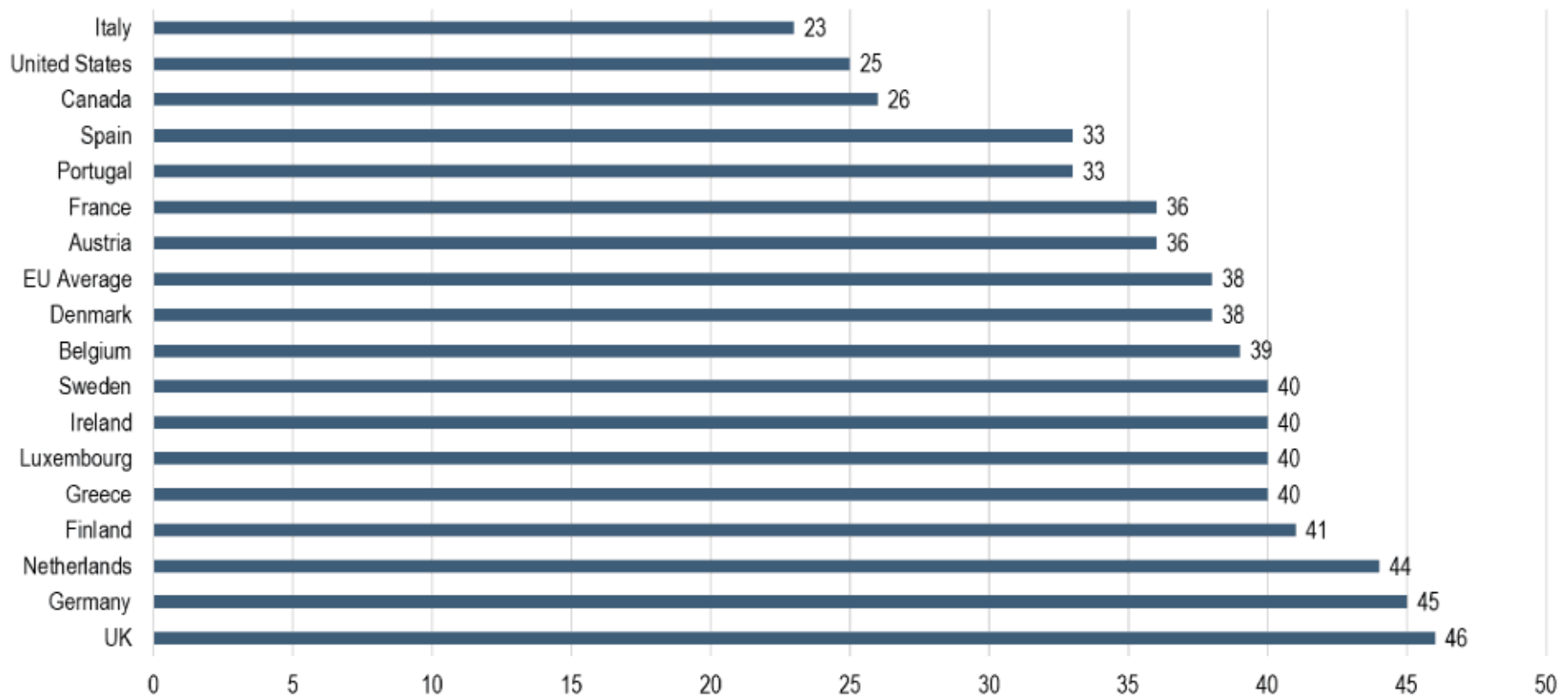
Table 3-35: Examples of average estimated trip length values- l_{trip} — as taken by COPERT 1990 updated run

Country	Trip length [km]	Country	Trip length [km]
Austria	12	Hungary	12
Belgium	12	Ireland	14
Denmark	9	Italy	12
Germany	14	Luxembourg	15
Spain	12	Netherlands	13.1
France	12	Portugal	10
Finland	17	UK	10
Greece	12		

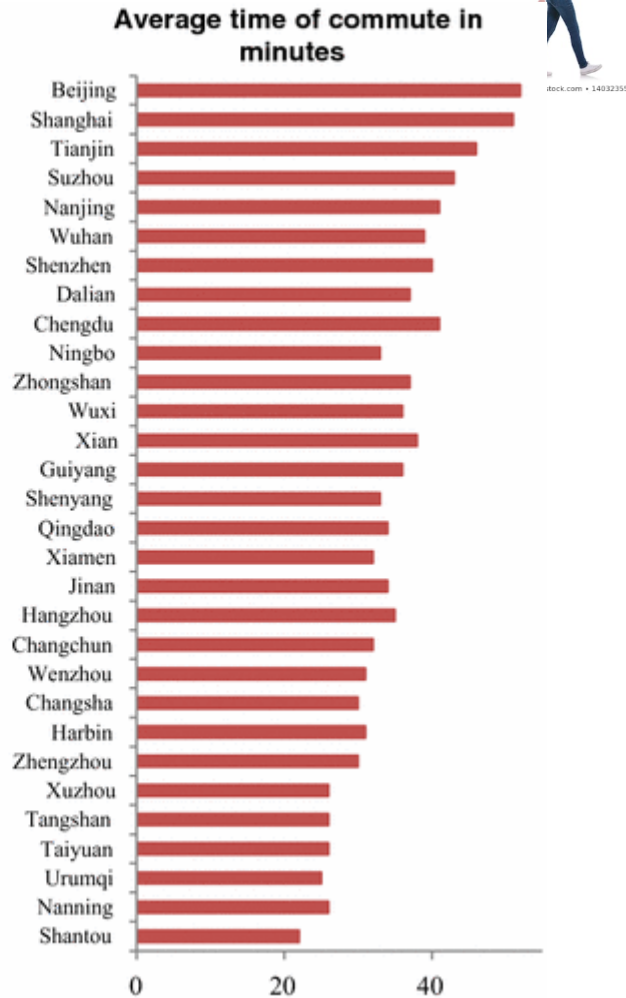
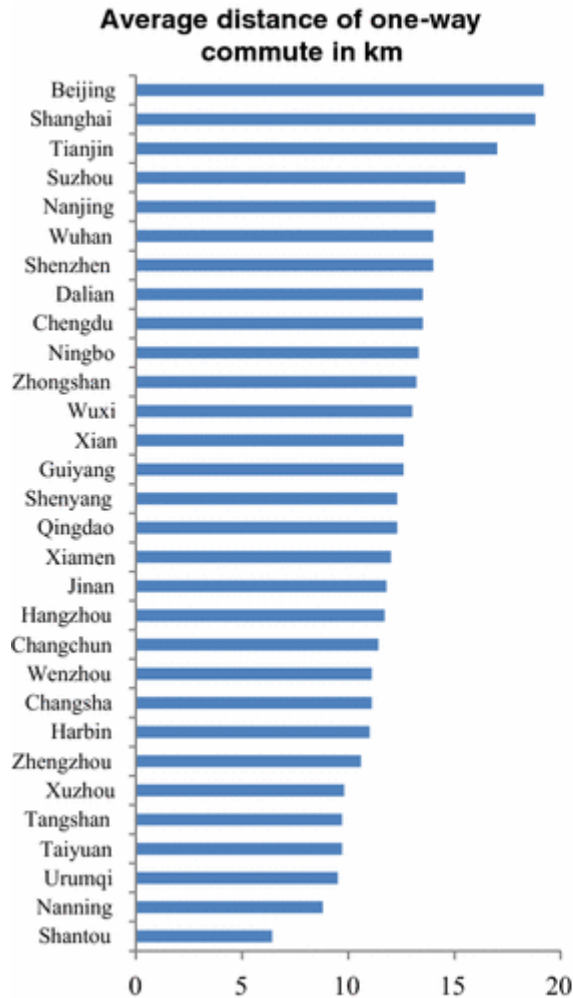
- Average Daily Commuting Time, European and North American Countries, 2005 (in minutes)



Portugal 5.07 km 2014



- 2012 china



Cold start impact

β parameter



- 12 km 0.25 h changed to
Ltrip 5 km ...0.25 h

Status

File

Country : community 10

Run Mode : Timeseries

Created : 22 Oct 2019, 17:11

Saved : 04 Nov 2019, 13:01

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-Oil

☐ Enable A/C Calculations

☐ Enable CO2 Reduction

☐ Apply SCR CO2 Emissions

☐ Apply for all years

Emission	Category	Fuel	Segment	Euro Standard	NOx	Urban Off Peak [t]	Urban Peak [t]	Rural [t]	Highway [t]	Total [t]
Hot	Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	0	0.000121	0	0	0.000121
Hot	Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	0	0.001221	0	0	0.001221
Hot	Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	0	0.000681	0	0	0.000681
Cold	Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	0	9.47E-05	0	0	9.47E-05
Cold	Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	0	3.49E-05	0	0	3.49E-05

5 km ...0.25 h

Emission	Category	Fuel	Segment	Euro Standard	NOx	Urban Off Peak [t]	Urban Peak [t]	Rural [t]	Highway [t]	Total [t]
Hot	Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	0	0.000121	0	0	0.000121
Hot	Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	0	0.001221	0	0	0.001221
Hot	Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	0	0.000681	0	0	0.000681
Cold	Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	0	6.23E-05	0	0	6.23E-05
Cold	Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	0	2.3E-05	0	0	2.3E-05

Cold start impact

β parameter



- 12 km 0.25 h changed to Ltrip 5 km ...0.5 h the time is not importante...only distance

Status

File

Country : community 10

Run Mode : Timeseries

Created : 22 Oct 2019, 17:11

Saved : 04 Nov 2019, 13:01

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-Oil

☐ Enable A/C Calculations

☐ Enable CO2 Reduction

☐ Apply SCR CO2 Emissions

☐ Apply for all years

Emission	Category	Fuel	Segment	Euro Standard	NOx	Urban Off Peak [t]	Urban Peak [t]	Rural [t]	Highway [t]	Total [t]
Hot	Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	0	0.000121	0	0	0.000121
Hot	Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	0	0.001221	0	0	0.001221
Hot	Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	0	0.000681	0	0	0.000681
Cold	Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	0	9.47E-05	0	0	9.47E-05
Cold	Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	0	3.49E-05	0	0	3.49E-05

5 km0.5 h

Emission	Category	Fuel	Segment	Euro Standard	NOx	Urban Off Peak [t]	Urban Peak [t]	Rural [t]	Highway [t]	Total [t]
Hot	Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	0	0.000121	0	0	0.000121
Hot	Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	0	0.001221	0	0	0.001221
Hot	Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	0	0.000681	0	0	0.000681
Cold	Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	0	6.23E-05	0	0	6.23E-05
Cold	Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	0	2.3E-05	0	0	2.3E-05

Cold start impact β parameter

All	All	NOx				
Category	Fuel	Segment	Euro Standard	Pollutant	Month	Beta Factor [%]
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	January	7.89%
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	February	7.89%
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	March	7.53%
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	April	7.04%
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	May	6.69%
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	June	5.92%
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	July	6.41%
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	August	5.14%
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	September	5.78%
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	October	6.55%
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	November	7.53%
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	December	7.53%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	January	43.81%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	February	43.81%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	March	41.86%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	April	39.12%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	May	37.17%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	June	32.87%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	July	35.6%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	August	28.57%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	September	32.09%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	October	36.39%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	November	41.86%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	December	41.86%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	January	43.81%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	February	43.81%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	March	41.86%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	April	39.12%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	May	37.17%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	June	32.87%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	July	35.6%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	August	28.57%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	September	32.09%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	October	36.39%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	November	41.86%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	December	41.86%



5 km0.25 h

All	All	NOx				
Category	Fuel	Segment	Euro Standard	Pollutant	Month	Beta Factor [%]
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	January	5.19%
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	February	5.19%
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	March	4.96%
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	April	4.64%
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	May	4.4%
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	June	3.9%
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	July	4.22%
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	August	3.39%
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	September	3.81%
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	October	4.31%
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	November	4.96%
Passenger Cars	Petrol	Small	Euro 6 2017-2019	NOx	December	4.96%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	January	28.82%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	February	28.82%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	March	27.54%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	April	25.75%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	May	24.47%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	June	21.66%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	July	23.45%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	August	18.84%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	September	21.14%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	October	23.96%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	November	27.54%
Passenger Cars	Diesel	Small	Euro 6 2017-2019	NOx	December	27.54%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	January	28.82%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	February	28.82%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	March	27.54%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	April	25.75%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	May	24.47%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	June	21.66%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	July	23.45%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	August	18.84%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	September	21.14%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	October	23.96%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	November	27.54%
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	NOx	December	27.54%



12 km0.25 h

Sensitivity analysis



Status

File

Country : **community 10**
 Run Mode : **Timeseries**
 Created : **22 Oct 2019, 17:11**
 Saved : **04 Nov 2019, 13:01**

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-Oil

☐ Enable A/C Calculations

☐ Enable CO2 Reduction

☐ Apply SCR CO2 Emissions

☐ Apply for all years

- Cold start impact (Ltrip 5 km β parameter) ✓
- Humidity impact if A/C effect on or off ($RH_{average}$ 100%)
- Mileage degradation (car 100 000 km
bus 500000 km)
- FAME % (biodiesel)
- Road slope?
- Bus Load?

Sensitivity analysis



- Humidity impact if A/C effect on or off (RH_{average} 100%)

A/C off

RH change from 50% to 100%

No effect!!!!

Status

File

Country : **community 10**
Run Mode : **Timeseries**
Created : **22 Oct 2019, 17:11**
Saved : **04 Nov 2019, 13:01**

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-Oil

☐ Enable A/C Calculations

☐ Enable CO2 Reduction

☐ Apply SCR CO2 Emissions

☐ Apply for all years

Sensitivity analysis



- Humidity impact if A/C effect on or off (RH_{average} 50%)

A/C on

Status

File

Country : **community 10**
 Run Mode : **Timeseries**
 Created : **22 Oct 2019, 17:11**
 Saved : **04 Nov 2019, 13:01**

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-Oil

☐ Enable A/C Calculations

☐ Enable CO2 Reduction

☐ Apply SCR CO2 Emissions

☐ Apply for all years

Oil Bio Fuel	Category	Fuel	Segment	Euro Standard	Total [t]
Fossil Petrol	Passenger	Petrol	Small	Euro 6 201	0.008257
Fossil Diesel	Passenger	Diesel	Small	Euro 6 201	0.006813
Fossil Diesel	Buses	Diesel	Urban Bus	Euro VI	0.01461
Bio Diesel	Passenger	Diesel	Small	Euro 6 201	0.000475
Bio Diesel	Buses	Diesel	Urban Bus	Euro VI	0.001018
Bio Ethanol	Passenger	Petrol	Small	Euro 6 201	0.000303

COPERT v.5.3 automated export
 Date created : 06 Nov 2019, 13:33

Project : community 10
 Year : 2019

Sensitivity analysis



- Humidity impact if A/C effect on or off (RH_{average} 100%)

A/C on

Status

File

Country : **community 10**
Run Mode : **Timeseries**
Created : **22 Oct 2019, 17:11**
Saved : **04 Nov 2019, 13:01**

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-Oil

☐ Enable A/C Calculations

☐ Enable CO2 Reduction

☐ Apply SCR CO2 Emissions

☐ Apply for all years

Fossil Bio Fuel [TJ]	Category	Fuel	Segment	Euro Standard	Total [t]
Fossil Petrol	Passenger Cars	Petrol	Small	Euro 6 2017-2019	0.008685
Fossil Diesel	Passenger Cars	Diesel	Small	Euro 6 2017-2019	0.007026
Fossil Diesel	Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	0.01461
Bio Diesel	Passenger Cars	Diesel	Small	Euro 6 2017-2019	0.00049
Bio Diesel	Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	0.001018
Bio Ethanol	Passenger Cars	Petrol	Small	Euro 6 2017-2019	0.000318

Sensitivity analysis



A/C on represent in passenger cars

6% increase EC and CO₂

No effect on pollutant emissions NOx and PM

Sensitivity analysis



Status

File

Country : **community 10**
Run Mode : **Timeseries**
Created : **22 Oct 2019, 17:11**
Saved : **04 Nov 2019, 13:01**

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-Oil

☐ Enable A/C Calculations

☐ Enable CO2 Reduction

☐ Apply SCR CO2 Emissions

☐ Apply for all years

- Cold start impact (Ltrip 5 km β parameter) ✓
- Humidity impact if A/C effect on or off (RH_{average} 100%) ✓
- Mileage degradation (car 100 000 km
bus 500000 km)
- FAME % (biodiesel)
- Road slope?
- Bus Load?

Sensitivity analysis



- Mileage degradation (car 100 000 km
bus 500000 km)

Status

File

Country : **community 10**

Run Mode : **Timeseries**

Created : **22 Oct 2019, 17:11**

Saved : **04 Nov 2019, 13:01**

Year : 2019

Fuel Balance : **NO**

Improved Fuel Quality Year : **1996**

Stock & Activity Data

All

Undo Redo Import Export

Category	Fuel	Segment	Euro Standard	Stock [n]	Mean Activity [km]	Lifetime Cumulative Activity [km]	Fuel Balanced ~ Mean Activity [km]	Fuel Ba
Passenger Cars	Petrol	Small	Euro 6 2017-2019	3	960	100,000	0	
Passenger Cars	Diesel	Small	Euro 6 2017-2019	3	960	100,000	0	
► Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	1	960	500,000	0	

OK Apply Cancel

☐ Apply for all years

Sensitivity analysis



- Mileage degradation (car 100 000 km; bus 500000 km)

Status

File

Country : **community 10**

Run Mode : **Timeseries**

Created : **22 Oct 2019, 17:11**

Saved : **04 Nov 2019, 13:01**

Year : 2019

Mileage Degradation Parameters

All **NOx** [Undo] [Redo] [Import] [Export]

	Fuel	Segment	Euro Standard	Pollutant	Am ~ Speed < 19 Km/h	Bm ~ Speed < 19 Km/h	Am ~ Speed > 63 Km/h	Bm ~ Speed > 63 Km/h	Max Mileage [km]
cars	Petrol	Small	Euro 6 2017-2019	NOx	0	1	0	1	160,000

☐ Enable A/C Calculations
☐ Enable CO2 Reduction
☐ Apply SCR CO2 Emissions
☐ Apply for all years

Only for gas vehicles – catalytic converter ageing – affects only NOx, VOC, CO

Sensitivity analysis



- Mileage degradation (car 100 000 km; bus 500000 km)

Emission	Category	Fuel	Segment	Euro Standard	NOx	Urban Off Peak	Urban Peak	Rural [t]	Highway [t]	Total [t]
Hot	Passenger	Petrol	Small	Euro 6 201	NOx	0	0.000121	0	0	0.000121
Hot	Passenger	Diesel	Small	Euro 6 201	NOx	0	0.001221	0	0	0.001221
Hot	Buses	Diesel	Urban Bus	Euro VI	NOx	0	0.000681	0	0	0.000681
Cold	Passenger	Petrol	Small	Euro 6 201	NOx	0	6.23E-05	0	0	6.23E-05
Cold	Passenger	Diesel	Small	Euro 6 201	NOx	0	2.3E-05	0	0	2.3E-05

No effect observed because only euro 6 vehicles

Status

File

Country : **community 10**
Run Mode : **Timeseries**
Created : **22 Oct 2019, 17:11**
Saved : **04 Nov 2019, 13:01**

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-Oil

☐ Enable A/C Calculations

☐ Enable CO2 Reduction

☐ Apply SCR CO2 Emissions

☐ Apply for all years

Sensitivity analysis



- Mileage degradation

$$MC_{C,i} = A_M \times M_{MEAN} + B_M$$

(23)

where,

- $MC_{C,i}$ = the mileage correction factor for a given mileage (M_{av}) and pollutant i ,
- M_{MEAN} = the mean fleet mileage of vehicles for which correction is applied,
- A_M = the **degradation** of the emission performance per kilometre,
- B_M = the emission level of a fleet of brand new vehicles.

Status

File

Country : **community 10**

Run Mode : **Timeseries**

Created : **22 Oct 2019, 17:11**

Saved : **04 Nov 2019, 13:01**

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-Oil

☐ Enable A/C Calculations

☐ Enable CO2 Reduction

☐ Apply SCR CO2 Emissions

☐ Apply for all years

Sensitivity analysis



Table 3-81: Emission degradation due to vehicle age for Euro 1 and Euro 2 petrol passenger cars and light commercial vehicles

$MC = A^M \times M^{MEAN} + B^M$	Capacity class [l]	Average mileage [km]	A^M	B^M	Value at $\geq$ 120 000 km
				(Value at 0 km)	
Correction for $V < 19$ km/h (MC_{URBAN})					
CO – MC_{URBAN}	0.8–1.4	29 057	1.523E-05	0.557	2.39
	1.4–2.0	39 837	1.148E-05	0.543	1.92
	> 2.0	47 028	9.243E-06	0.565	1.67
NO _x – MC_{URBAN}	ALL> 0.8	44 931	1.598E-05	0.282	2.20
HC – MC_{URBAN}	≤ 1.4	29 057	1.215E-05	0.647	2.10
	1.4–2.0	39 837	1.232E-05	0.509	1.99
	> 2.0	47 028	1.208E-05	0.432	1.88
Correction for $V > 63$ km/h (MC_{ROAD})					
CO – MC_{ROAD}	0.8–1.4	29 057	1.689E-05	0.509	2.54
	1.4–2.0	39 837	9.607E-06	0.617	1.77
	> 2.0	47 028	2.704E-06	0.873	1.20
NO _x – MC_{ROAD}	ALL> 0.8	47 186	1.220E-05	0.424	1.89
HC – MC_{ROAD}	0.8–1.4	29 057	6.570E-06	0.809	1.60
	1.4–2.0	39 837	9.815E-06	0.609	1.79
	> 2.0	47 028	6.224E-06	0.707	1.45

Sensitivity analysis



Table 3-82: Emission degradation due to vehicle age for Euro 3 and Euro 4 petrol passenger cars and light commercial vehicles (and Euro 1 and 2 vehicles in case of an enhanced landM scheme)

$MC = A^M \times M^{MEAN} + B^M$	Capacity class [l]	Average mileage [km]	A^M	B^M	Value at $\geq$ 160,000 km
				(Value at 0 km)	
Correction for $V < 19$ km/h (MC_{URBAN})					
CO – MC_{URBAN}	≤ 1.4	32 407	7.129E-06	0.769	1.91
	> 1.4	16 993	2.670E-06	0.955	1.38
NO _x – MC_{URBAN}	≤ 1.4	31 313	0	1	1
	> 1.4	16 993	3.986E-06	0.932	1.57
HC – MC_{URBAN}	≤ 1.4	31 972	3.419E-06	0.891	1.44
	> 1.4	17 913	0	1	1
Correction for $V > 63$ km/h (MC_{ROAD})					
CO – MC_{ROAD}	≤ 1.4	30 123	1.502E-06	0.955	1.20
	> 1.4	26 150	0	1	1
NO _x – MC_{ROAD}	ALL	26 150	0	1	1
HC – MC_{ROAD}	ALL	28 042	0	1	1

Sensitivity analysis



- Mileage degradation

emissions do not further degrade above 120 000 km for Euro 1 and Euro 2 vehicles, and above 160 000 km for Euro 3 and on vehicles

Status

File

Country : **community 10**
Run Mode : **Timeseries**
Created : **22 Oct 2019, 17:11**
Saved : **04 Nov 2019, 13:01**

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-Oil

☐ Enable A/C Calculations

☐ Enable CO2 Reduction

☐ Apply SCR CO2 Emissions

☐ Apply for all years

Sensitivity analysis



- Blend

Status

File

Country : **community 10**
Run Mode : **Timeseries**
Created : **22 Oct 2019, 17:11**
Saved : **04 Nov 2019, 13:01**

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-Oil

☐ Enable A/C Calculations

☐ Enable CO2 Reduction

☐ Apply SCR CO2 Emissions

☐ Apply for all years

Blends share

All

Undo Redo Import Export

Vehicle				Blend		Blend Energy Share		Fuel Balanced ~ Biofuel...		Fuel Balance
Category	Fuel	Segment	Euro Standard	First Blend	Second Blend	First Blend [%]	Second Blend [%]	First Blend [%]	Second Blend [%]	First Blend [%]
Passenger Cars	Petrol	Small	Euro 6 2017-2019	E5	~ NO BLEND	100%	~ NO BLEND			
Passenger Cars	Diesel	Small	Euro 6 2017-2019	B7	~ NO BLEND	100%	~ NO BLEND			
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	B7	~ NO BLEND	100%	~ NO BLEND			

Set main fuels

OK Apply Cancel

Select main fuels

Select main petrol blend : E5

Select main diesel blend : B7

Reset changed blends : ☐

Save Cancel

Sensitivity analysis



- Load and slope

Status

File

Country : **community 10**

Run Mode : **Timeseries**

Created : **22 Oct 2019, 17:11**

Saved : **04 Nov 2019, 13:01**

Year : 2019

Fuel Balance : **NO**

Improved Fuel Quality Year : **1996**

Driving Conditions

All

Undo Redo Import Export

Vehicle				Load				Road Slope			
Category	Fuel	Segment	Euro Standard	Urban Off Peak [%]	Urban Peak [%]	Rural [%]	Highway [%]	Urban Off Peak [%]	Urban Peak [%]	Rural [%]	Highway [%]
Buses	Diesel	Urban Buses Standard 15 - 18 t	Euro VI	50%	50%	50%	50%	0%	0%	0%	0%

OK Apply Cancel

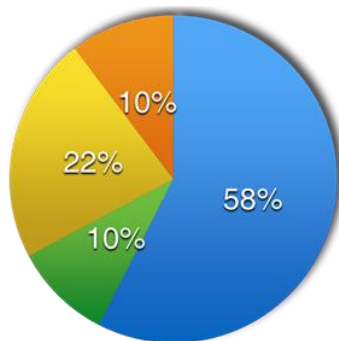
☐ Apply SCR CO2 Emissions

☐ Apply for all years

Universe of study.... Check the survey

FCUL population 5849

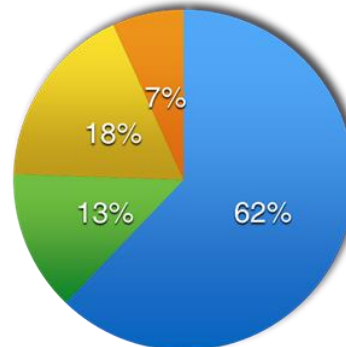
Staff 2015



690

- Professors
- Researchers
- Non-Academic Staff
- Grantees

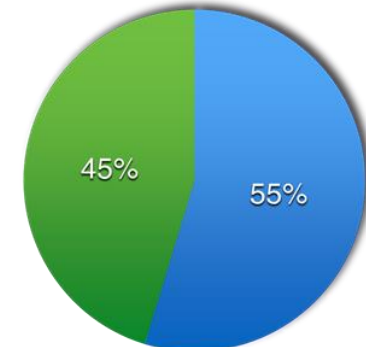
Students 2015



5159

- Undergraduate
- Undergraduate+MSc
- MSc
- PhD

Students 2015



5159

- M
- F

Energy matrix for the Lisbon city ...check the survey

FORMA DE ENERGIA	LISBOA		PORTUGAL	
	CONSUMO PER CAPITA (kgep/hab)	%	CONSUMO PER CAPITA (kgep/hab)	%
ELETRICIDADE	944	57	717	40
GÁS NATURAL	228	14	147	8
GASÓLEO	345	21	455	26
GASOLINA	119	7	111	6
G.P.L.	20	1	57	3
OUTRAS	2	0	297	17
FUEL	0	0	68	4
PETRÓLEO	2	0	0	0
CARVÃO	0	0	1	0
RESÍDUOS	0	0	8	0
CALOR	0	0	118	7
RENOVÁVEIS	0	0	102	6
TOTAL	1.659	100	1.784	100

Tabela 15: Distribuição do consumo per capita de energia primária por forma de energia (kgep/hab) em 2014.

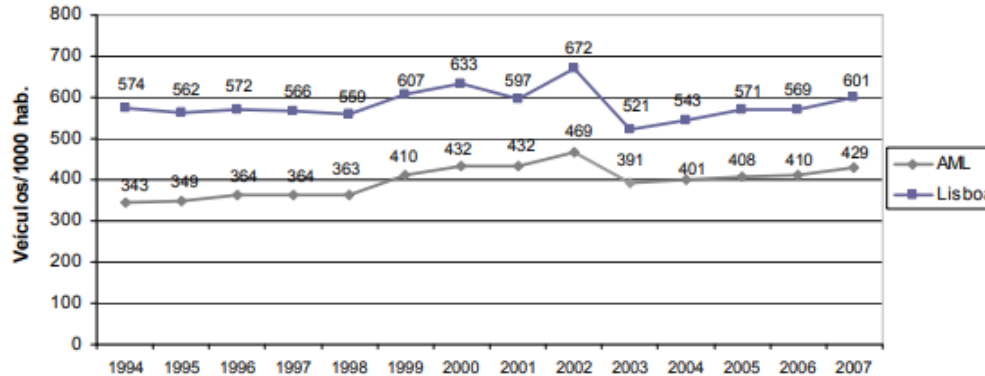


Matriz Energética de Lisboa

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

Motorization index Lisbon city and AML – check the survey

Evolução da Taxa de Motorização em Lisboa e na AML



Fonte: Instituto de Seguros de Portugal, 2008

#cars/1000 people

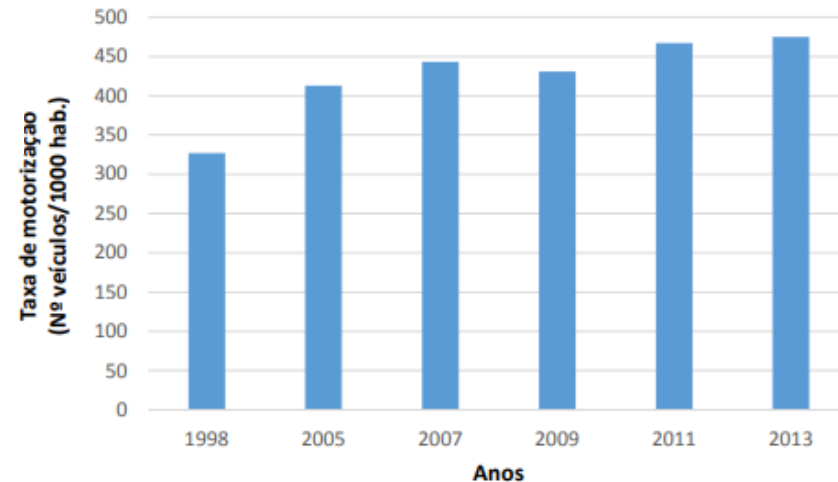
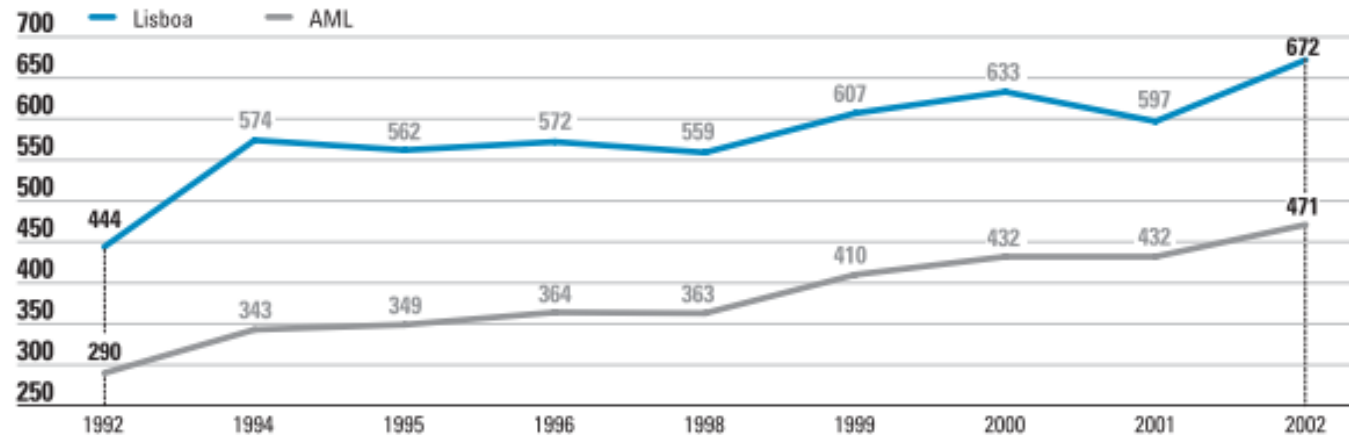


Figura 5 – Taxa de Motorização.

Fonte: AML, 2001 e 2016

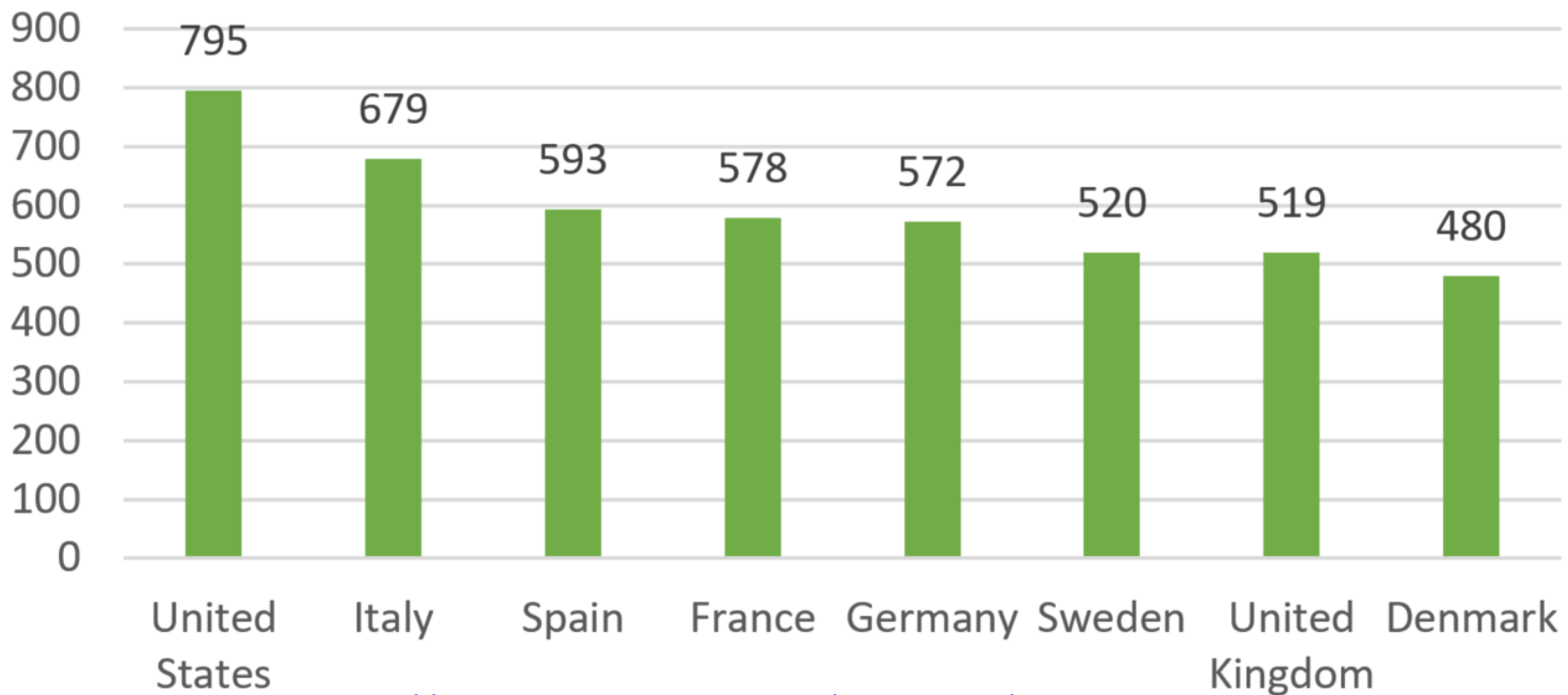
25. Evolução da Taxa de Motorização em Lisboa e na AML



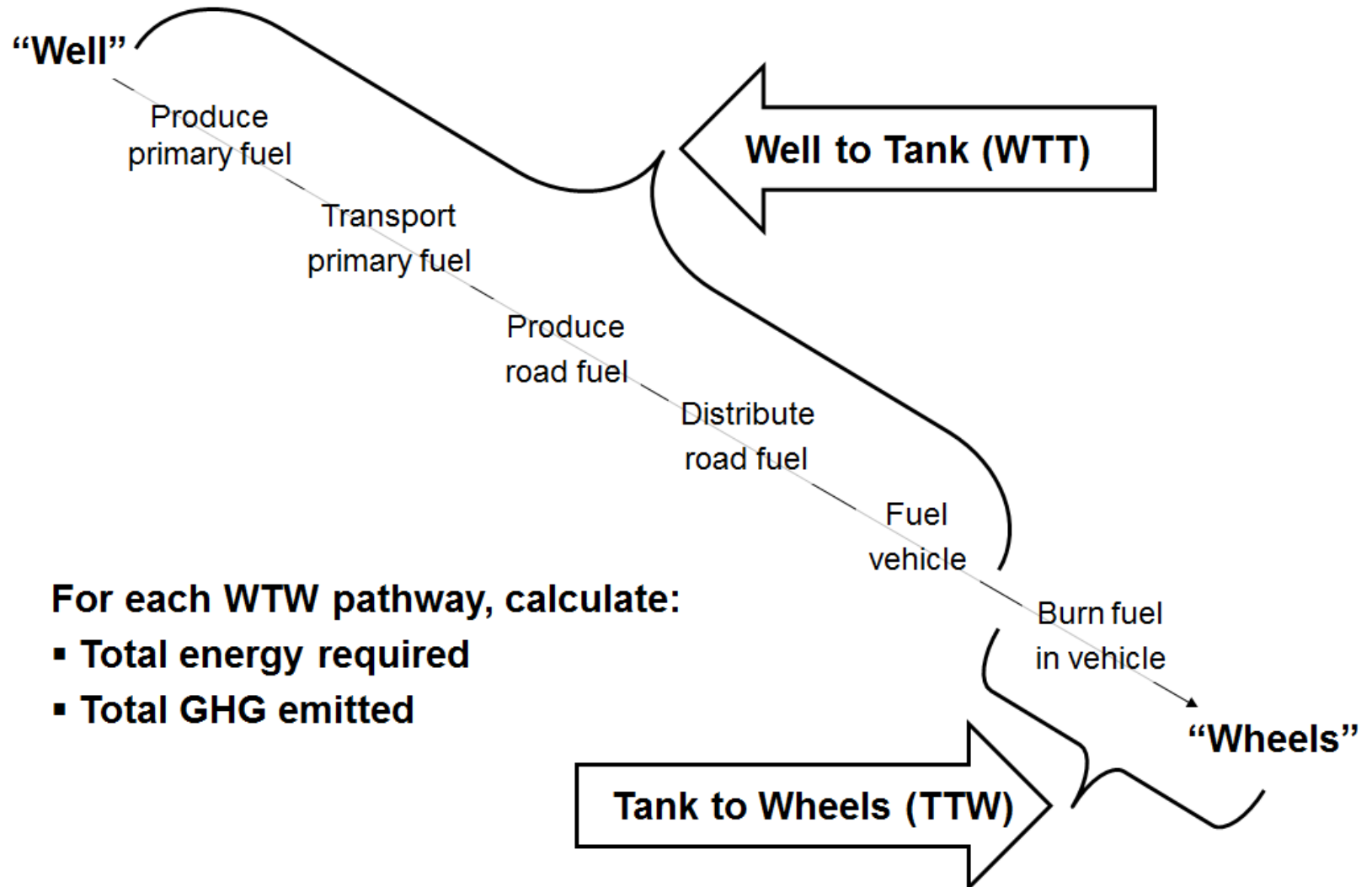
Fonte: Instituto de Seguros de Portugal, 1992-2002 e Instituto Nacional de Estatística, Censos Populacionais, 1991 e 2001

Chart 1: Car Ownership per Capita

Motor Vehicles per 1000 people



<https://www.cbinsights.com/research/transportation-service-smart-commuting/> 2013

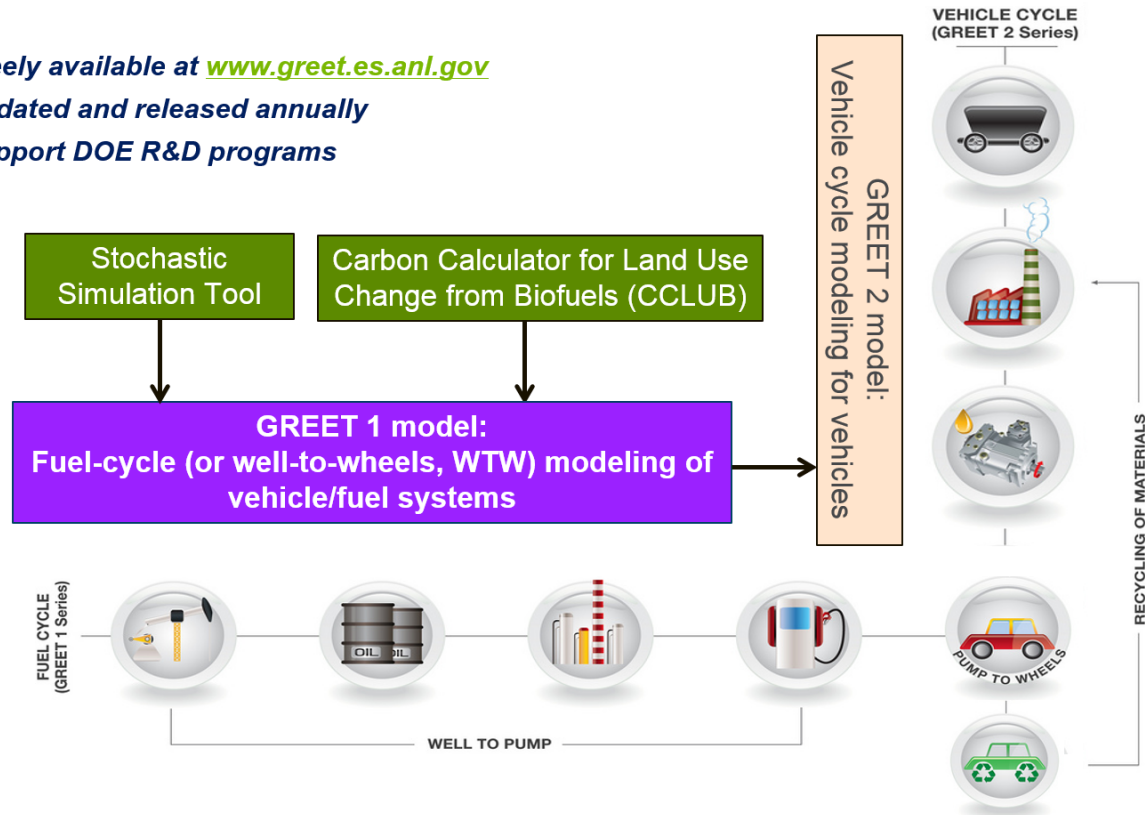


For each WTW pathway, calculate:

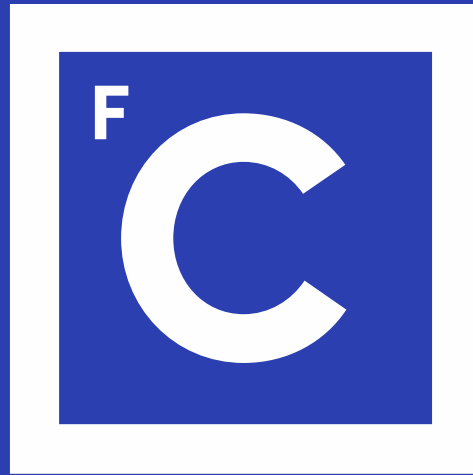
- Total energy required
- Total GHG emitted

The GREET® (Greenhouse gases, Regulated Emissions, and Energy use in Transportation) model

- ✓ Freely available at www.greet.es.anl.gov
- ✓ Updated and released annually
- ✓ Support DOE R&D programs



Obrigado



Ciências ULisboa

Faculdade
de Ciências
da Universidade
de Lisboa