

# **European funded project results: Reduction of CO<sub>2</sub> emissions from Heavy-Duty Trucks**

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**European Commission**

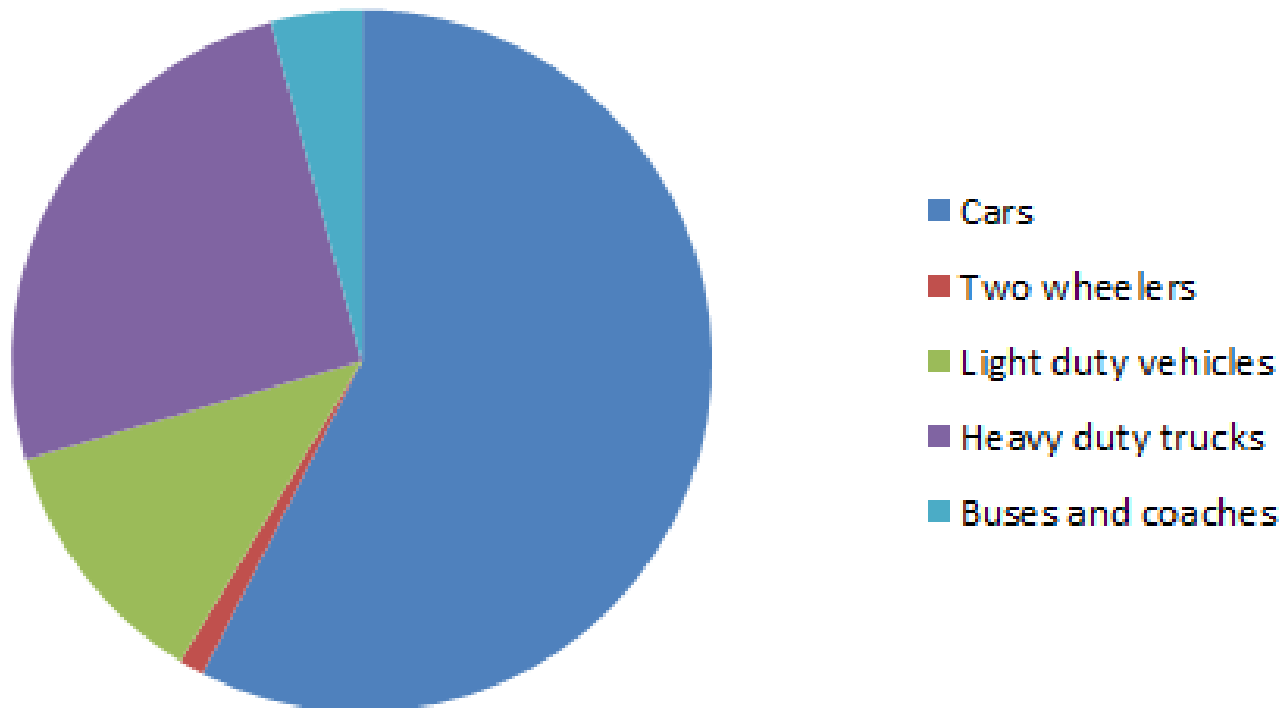
**DG Climate Action**

**Unit C4: Road Transport**

EGVI - European Green Vehicle Initiative  
31 May 2017, Brussels, Belgium

# Road transport emissions

Estimated CO<sub>2</sub> emission by type of road vehicle



- Cars and light duty vehicles (vans)  $\approx$  70%
- Heavy duty trucks, buses and coaches  $\approx$  30%

# HDV CO<sub>2</sub> emissions: three-step solution



**VECTO simulation tool** to calculate fuel consumption and CO<sub>2</sub> emissions from new HDVs placed on the EU market

**Certification** regulation: Procedure to calculate CO<sub>2</sub> emissions and fuel consumption with VECTO for new HDVs placed on the EU market

**Monitoring and reporting** legislation: VECTO CO<sub>2</sub> emissions & fuel consumption from every new HDV registered in the EU to be monitored and reported to EC

# HDVs are more complicated than LDVs

- Low, medium, high, long, short cab etc
- 2,3,4,5,6 axles, 4x2, 4x4, 6x2, 6x4, 6x6 etc
- Different tires for each axle, single/twin tires etc
- Same engine but different gear boxes/axles ect
- Rigid, semi-trailer, tractor, coach, bus, citybus etc
- Any combination mentioned above

**Millions of types!!!**



Simulation tool to calculate  
both, fuel consumption and  
CO<sub>2</sub> emissions from the **whole**  
vehicle



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VECTO 2.2 / VectoCore 3.0.1315 - Declaration Mode

Job Files (1/1) Options

Filepath  
C:\PGM\VECTO\2015\_11\_12\VECTO-3.0\betaeta1\Generic Vehicles\Declaration Mode\40t Long Haul Truck\40t\_Long\_Haul\_Truck.vecto

START V2.2  
START V3

Declaration Mode

40t\_Long\_Haul\_Truck.vecto

Job File

Engine Only Mode

General Driver Assist

Vehicle 40t\_Long\_Haul\_Truck.vveh  
Engine 40t\_Long\_Haul\_Truck.veng  
Gearbox 40t\_Long\_Haul\_Truck.vgbox

Auxiliaries

ID	Type	Technology
FAN	Fan	Hydraulic driven - Constant displacement pump
STP	Steering pump	Variable displacement
AC	HVAC	Default
ES	Electric System	Custom Technology List
PS	Pneumatic System	Default

Double-Click to edit auxiliary

Cycles

Long Haul  
Regional Delivery

Double-Click to open file

12.71 351 kW Generic 40t Long Haul Truck

12-Speed AMT Generic 40t Long Haul Truck

engine torque [Nm]

engine speed [1/min]

Save Cancel

VECTO Engine

Make and Model Generic 40t Long Haul Truck

Idling Engine Speed 560 [rpm] Inertia incl. Flywheel 5.1471 [kgm<sup>2</sup>]  
Displacement 12730 [ccm]

Full Load and Drag Curve  
40t\_Long\_Haul\_Truck.vfld

Fuel Consumption Map  
40t\_Long\_Haul\_Truck.vmap

WHTC Correction  
Correction Factors calculated with VECTO-Engine  
Urban 0.97 Rural 0.99 Motorway 1.02

Import from VECTO-Engine

engine torque [Nm]

engine speed [1/min]

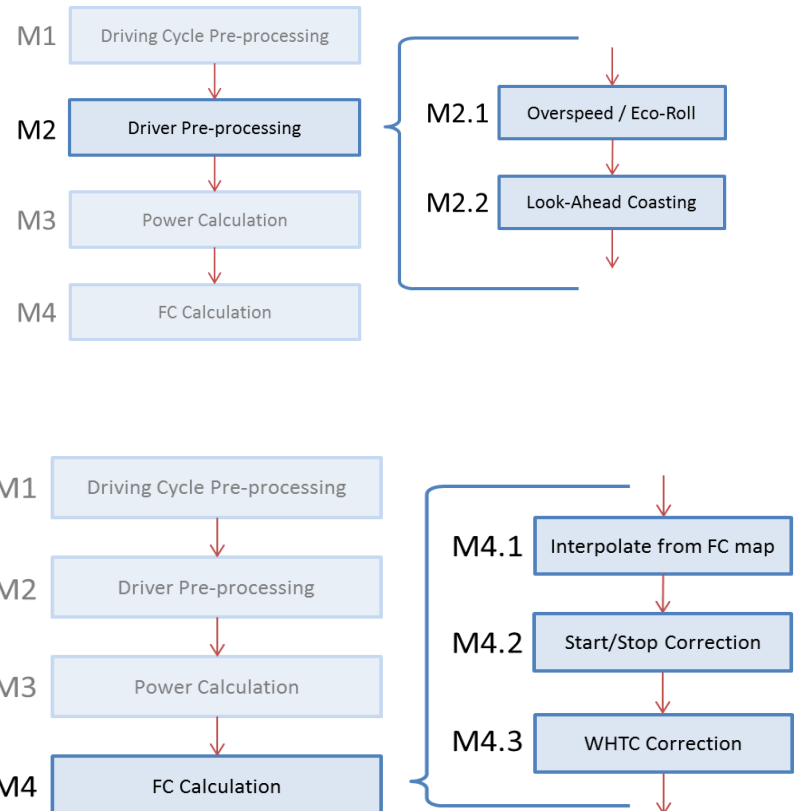
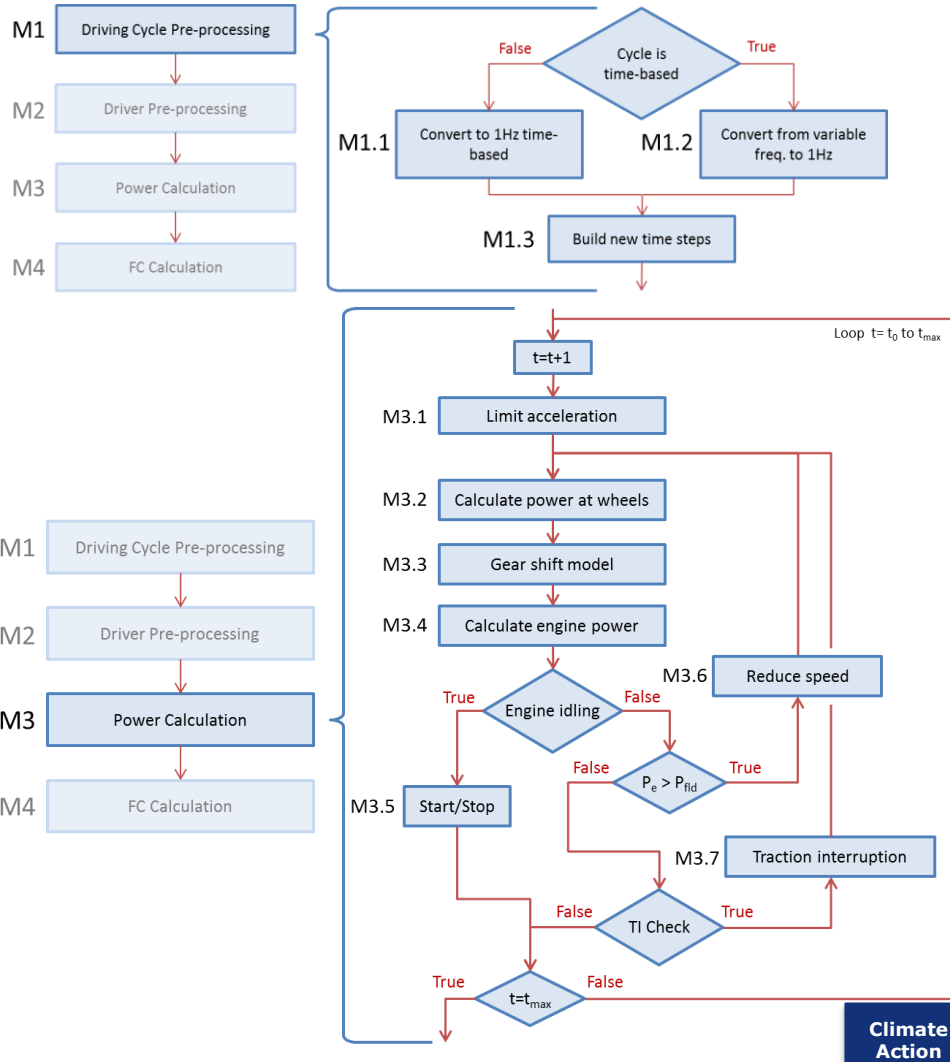
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Declaration Mode

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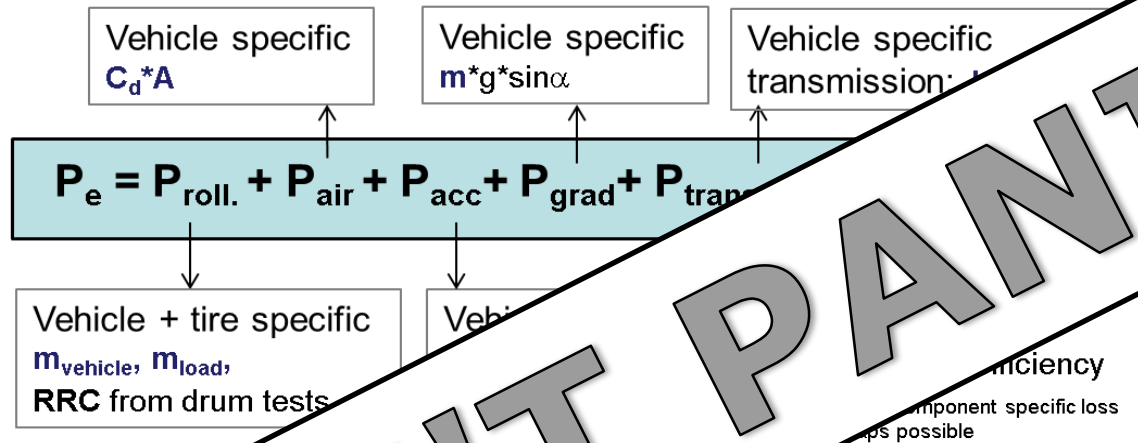
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## Model structure - Four main modules

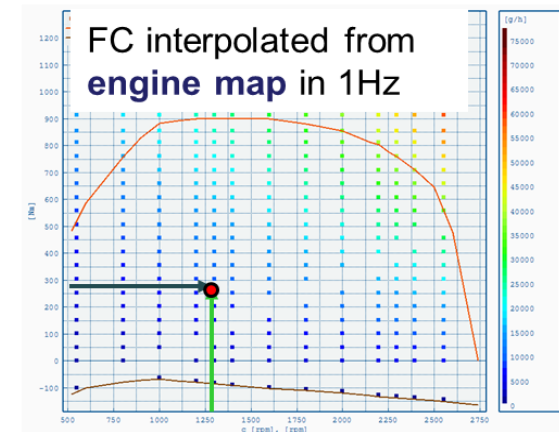


# Simulation of engine power

Simulation of engine power:



Simula





# VECTO's modes

**Declaration mode** where all *generic data* and the *test cycle* are allocated automatically as soon as the ***vehicle class*** is defined.

**Engineering mode** where the user can select and change all input data to allow recalculation of test data e.g. for model validation.

## VECTO output

In the ***declaration mode*** FC and CO<sub>2</sub> emissions are automatically calculated for all test cycles allocated to the vehicle for average payload and full load.

Results given in **g/km, g/cm<sup>3</sup>-km, g/ton-km** or **g/pass-km**. Other metrics can be also considered at a later stage



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# Vehicle groups for vehicles of category N

Description of elements relevant to the classification in vehicle groups			Vehicle group	Allocation of mission profile and vehicle configuration							Standard body allocation
Axle configuration	Chassis configuration	Technically permissible maximum laden mass (tons)		Long haul	Long haul (EMS)	Regional delivery	Regional delivery (EMS)	Urban delivery	Municipal utility	Construction	
4x2	Rigid	>3.5 – <7.5	(0)								
	Rigid (or tractor)**	7.5 – 10	1			R		R			B1
	Rigid (or tractor)**	>10 – 12	2	R+T1		R		R			B2
	Rigid (or tractor)**	>12 – 16	3			R		R			B3
	Rigid	7.5 – 16	4	R+T2		R			R		B4
	Tractor	>16	5	T+ST	T+ST+T2	T+ST	T+ST+T2				
4x4	Rigid	7.5 – 16	(6)								
	Rigid	>16	(7)								
	Tractor	>16	(8)								
6x2	Rigid	all weights	9	R+T2	R+D+ST	R	R+D+ST		R		B5
	Tractor	all weights	10	T+ST	T+ST+T2	T+ST	T+ST+T2				
6x4	Rigid	all weights	11	R+T2	R+D+ST	R	R+D+ST		R	R	B5
	Tractor	all weights	12	T+ST	T+ST+T2	T+ST	T+ST+T2			R	
6x6	Rigid	all weights	(13)								
	Tractor	all weights	(14)								
8x2	Rigid	all weights	(15)								
8x4	Rigid	all weights	16							R	(generic weight+ CdxA)
8x6 8x8	Rigid	all weights	(17)								

\* EMS - European Modular System

\*\* in these vehicle classes tractors are treated as rigids but with specific curb weight of tractor

R = Rigid & standard body  
T1,  
T2 = Standard trailers  
ST = Standard semitrailer  
D = Standard dolly

# Busses classification

Identification of vehicle class						Segmentation and cycle allocation				
Axles	Axle configuration	Chassis configuration	Characteristics	Maximum GVW [t]	Vehicle class	Heavy Urban	Urban	Suburban	Interurban	Coach
2	4x2	City	Class I + low floor or low entry, no luggage compartment	<18	B 1	HU	UR	SU		
		Interurban	Class II + luggage compartment and/or floor height $\leq 0.9\text{m}$	<18	B2				IU	
		Coach	Class III + floor height $\geq 0.9\text{m}$ and/or double decker	<18	B3					CO
3	6x2	City	Class I + Low floor or low entry, no luggage compartment	>18	B4	HU	UR	SU		
		Interurban	luggage compartment and/or floor height $\leq 0.9\text{m}$	>18	B5				IU	
		Coach	floor height $\geq 0.9\text{m}$ and/or double decker	>18	B6					CO

# Mission profiles

## Trucks

- Urban delivery
- Regional delivery
  - Long haul
  - Construction
- Municipal utility

## Buses and coaches

- City-bus heavy urban
  - City-bus urban
- City-bus suburban
  - Interurban bus
  - Coach

# Reference fuels for testing

Engine fuel technology	Reference fuel type	Standard used for determination of NCV
Diesel CI	B7	at least ASTM D240 or DIN 59100-1 (ASTM D4809 is recommended)
Ethanol CI	ED95	at least ASTM D240 or DIN 59100-1 (ASTM D4809 is recommended)
Petrol PI	E10	at least ASTM D240 or DIN 59100-1 (ASTM D4809 is recommended)
Ethanol PI	E85	at least ASTM D240 or DIN 59100-1 (ASTM D4809 is recommended)
LPG	LPG Fuel B	ASTM 3588 or DIN 51612
Natural Gas	G <sub>25</sub>	ISO 6976 or ASTM 3588

# Test vehicles



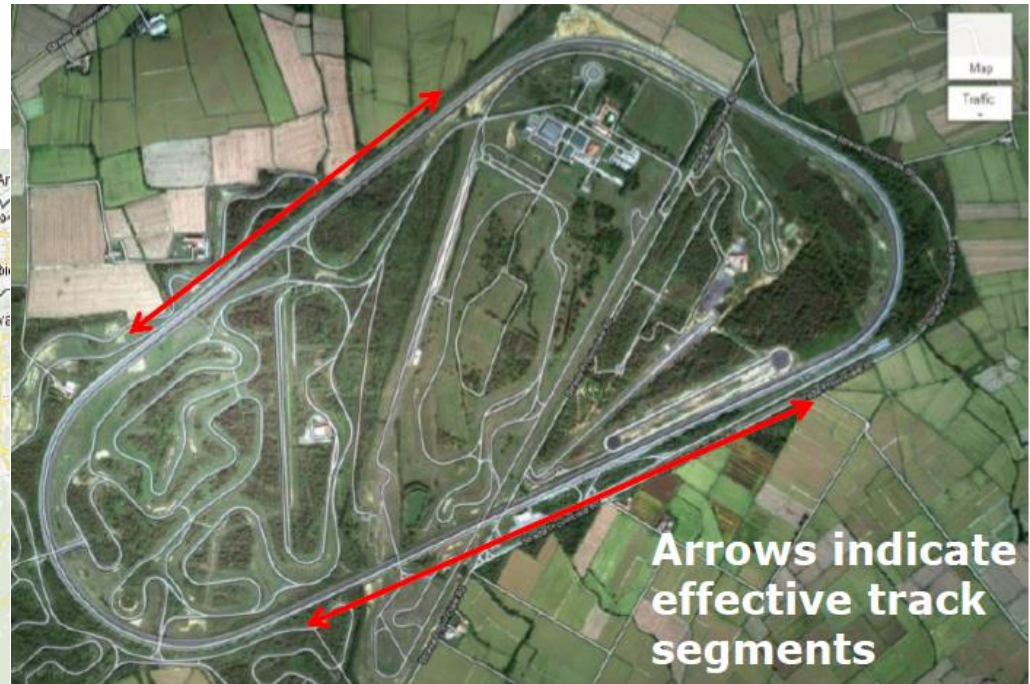
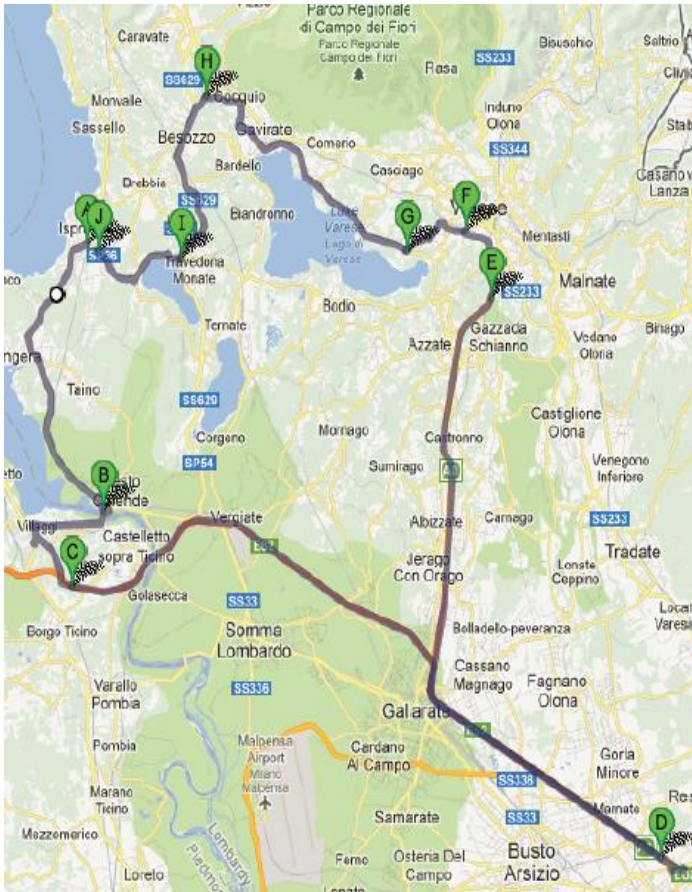
OEM	Daimler	DAF
Model	Actros	CF75
Maximum vehicle weight [kg]	40000	18600
Test mass [kg]	33580	14270
Engine Emission Standard	Euro VI	Euro V
Rated power [kW]	330	265
Rated Torque [Nm]	2200	1050
Displacement [l]	12.8	9.2
Fuel Consumption Map	From steady state RPM vs Torque points as measured by manufacturers	
Gearbox & Final Drive characteristics	As provided by manufacturers	





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# Test Route



Arrows indicate  
effective track  
segments

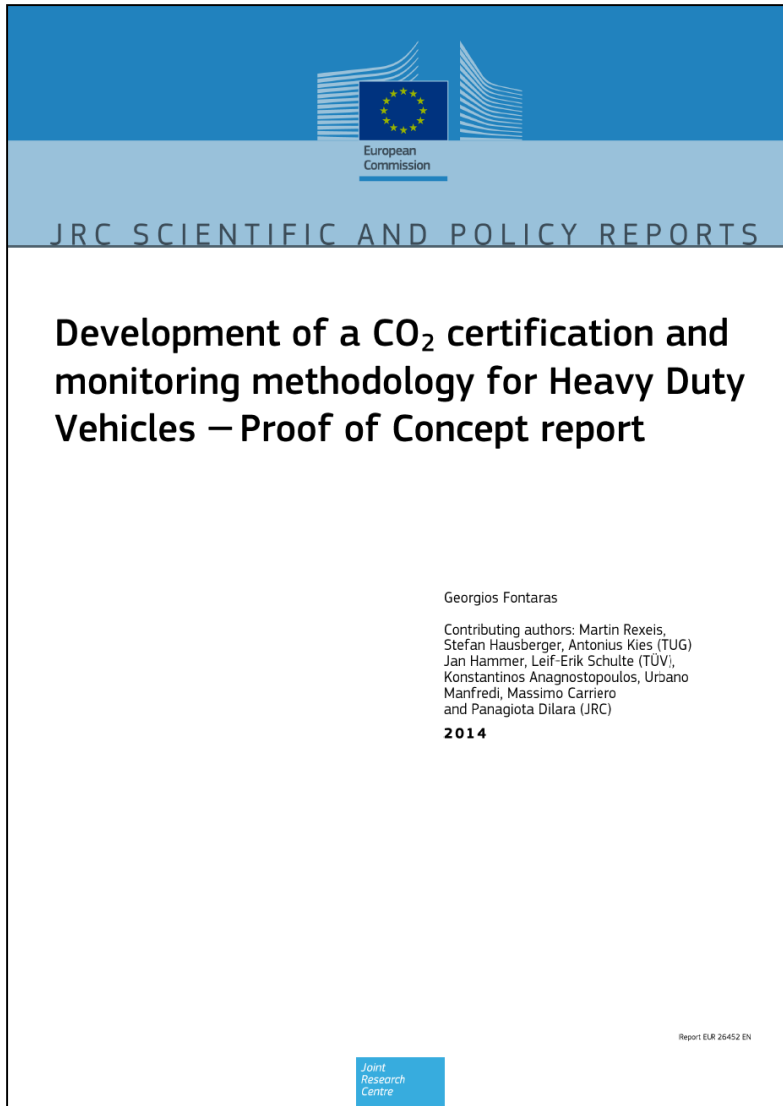


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# Buses & coaches Pre Pilot Phase (PPT)





**The full report can be found on  
DG Clima's website**

[http://ec.europa.eu/clima/policies/transport/vehicles/heavy/docs/hdv\\_co2\\_certification\\_en.pdf](http://ec.europa.eu/clima/policies/transport/vehicles/heavy/docs/hdv_co2_certification_en.pdf)

# HDV CO<sub>2</sub> emissions certification

In the EU certification of motor vehicles takes place under type approval legislation (2007/46/EC Framework Directive)

Upcoming new regulation on the certification of HDVs' CO<sub>2</sub> emissions and fuel consumption under the existing EURO VI Regulation (595/2009)

**-approved by the TCMV on 11 May 2017-**

Outcome of certification procedure: set of vehicle specific fuel consumption and CO<sub>2</sub> emissions values calculated with VECTO

# CO<sub>2</sub> emissions monitoring and reporting

**2014 HDV Strategy:** *"Fuel consumption and CO<sub>2</sub> emissions to be measured and monitored to increase market transparency and vehicle comparability"*

Without monitoring & reporting, benefits of certification not fully attained

Monitoring and reporting legislative proposal coming up shortly

Monitoring data to be reported subset of the VECTO output data as declared under the certification regulation

## **Timeline (for trucks only)**

- VECTO development: on-going
- Dissemination and trials: from 2013 to mid-2016
- Preparation of legislative proposals: 2015-2017
- Possible first reporting year: 2019
- HDV CO<sub>2</sub> emission standards: analytical work ongoing

# Thank you for your attention!

- I will be happy to address your questions

- More info can be found at:

<http://ec.europa.eu/clima/policies/transport/vehicles/heavy>

- Contact details:

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