Heavy Duty Vehicles' CO_2 legislation in Europe and VECTO simulation tool

Dr Dimitrios Savvidis

European Commission

DG Climate Action

8th Forum on Energy Efficiency in Transport: "Energy Efficiency Regulation for Heavy-Duty (HD) Vehicles"
28-30 September 2015, Mexico City, Mexico

Climate Action

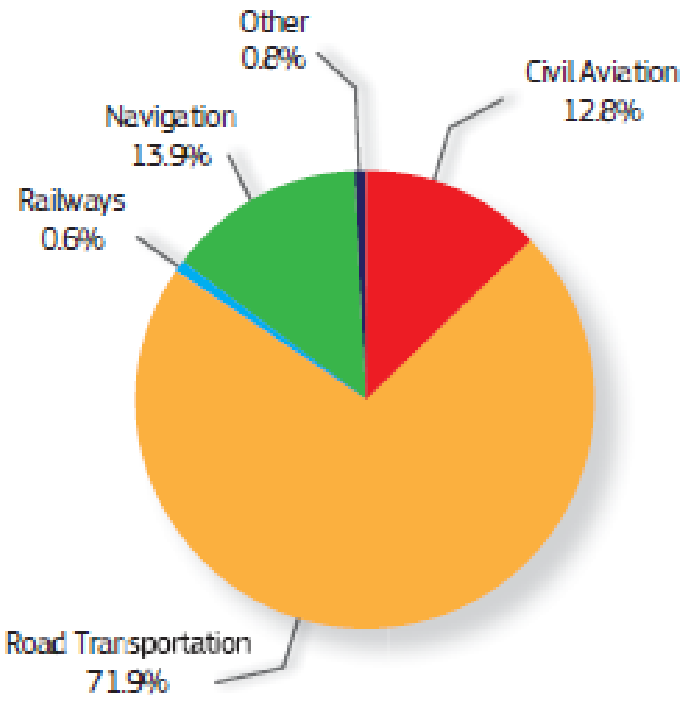
HDV CO_2 in the EU Policy context

Transport within the EU is responsible for around one fifth of our greenhouse gas emissions.

While these emissions fell by 3.3% in 2012, they are still 20.5% higher than in 1990.

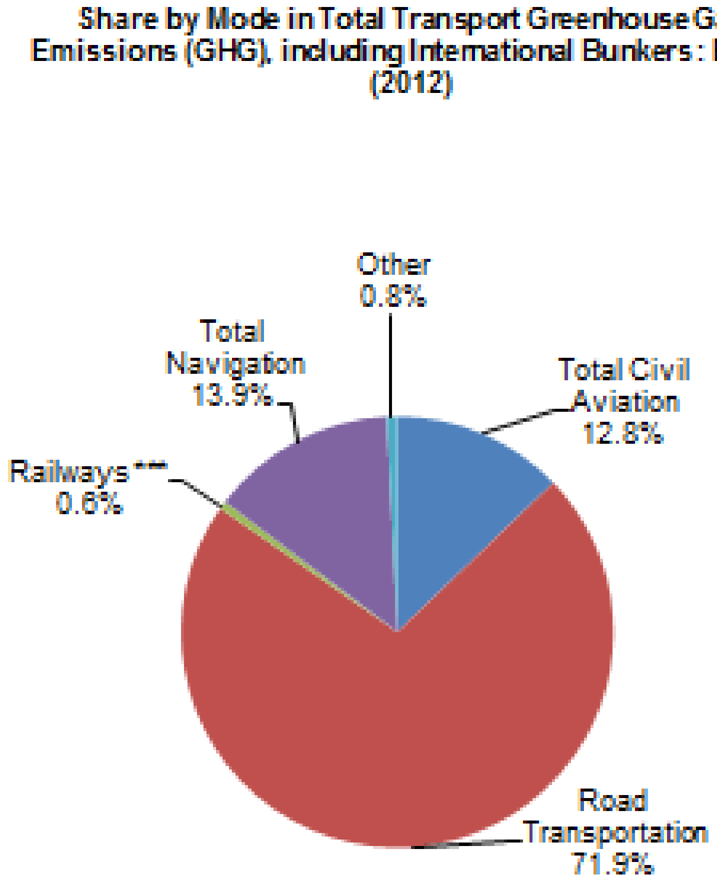
Road transport accounts for the vast majority – around 70% – of all transport emissions.

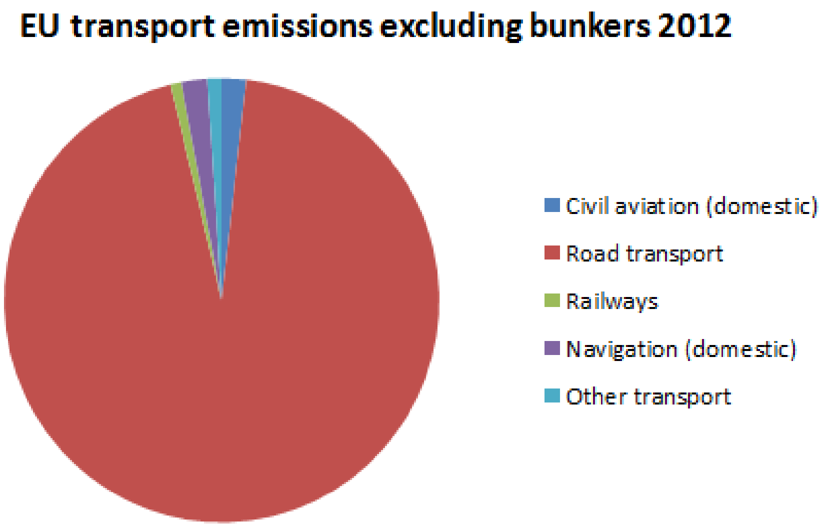
EU greenhouse gas emissions from transport by mode



Data source: European Commission: Transport pocketbook 2014

Transport emissions by mode



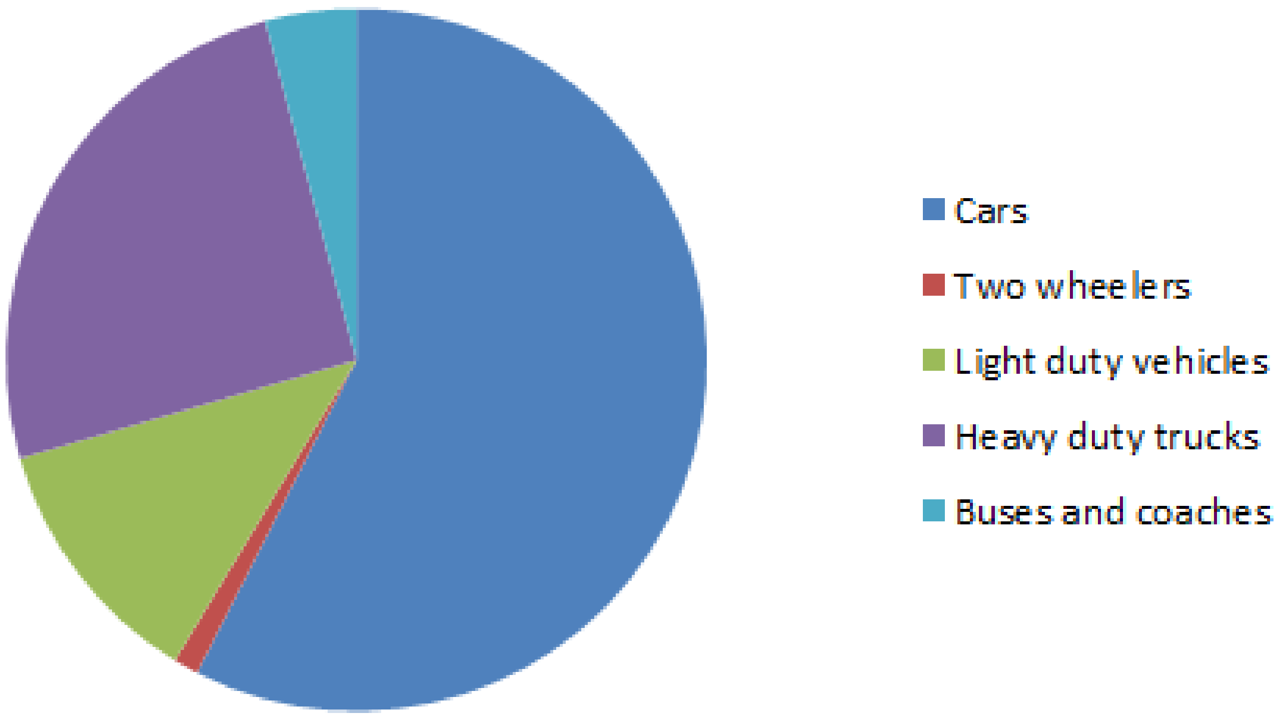


Road transport accounts for 72% of total transport and 95% of total transport when international bunkers are excluded

*** Source: Eurostat**

Road transport emissions

Estimated CO_2 emission by type of road vehicle



-- Cars and light duty vehicles (vans): 70%

-- Heavy duty trucks, buses and coaches: 30%

* Source: Ricardo-AEA

European Commission

Communication strategy

EUROPEAN COMMISSION

Brussels, 21.5.2014
COM(2014) 285 final

COMMUNICATION FROM THE COMMISSION TO THE COUNCIL AND THE EUROPEAN PARLIAMENT

Strategy for reducing Heavy-Duty Vehicles' fuel consumption and CO2 emissions

In May 2014 the Commission adopted a Communication entitled "Strategy for reducing HDV fuel consumption and CO_2 emissions" COM(2014)285

European Commission

Roadmap for the Energy Union (Feb 15)

EUROPEAN COMMISSION

Brussels, 25.2.2015
COM(2015) 80 final

ANNEX 1

ENERGY UNION PACKAGE

ANNEX

ROADMAP FOR THE ENERGY UNION

to the

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE, THE COMMITTEE OF THE REGIONS AND THE EUROPEAN INVESTMENT BANK

A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy

EN EN

Actions	Responsible party	Timetable	SoS	IEM	EE	GHG	R&I
2030 Climate and Energy Framework							
Transport actions							
Fair and efficient pricing for sustainable transport – revision of the Eurovignette Directive and framework to promote European electronic tolling	Commission	2016			X	X	
Review of market access rules for road transport to improve its energy efficiency	Commission	2016			X	X	
Master Plan for the deployment of Cooperative Intelligent Transport Systems	Commission Member States Industry	2016			X	X	X
Review of Regulations setting emission performance standards to establish post-2020 targets for cars and vans	Commission	2016 - 2017			X	X	X
Establishing a monitoring and reporting system for heavy duty vehicles (trucks and buses) with a view to improving purchaser information	Commission	2016-2017			X	X	X

Climate Action

CO_2 growth-reduction of fuel saving potential

Current trends in CO_2 emissions from HDVs are unsustainable.

Between 1990 and 2010 CO_2 emissions are estimated to have grown by about 36%, despite the economic crisis interrupting the previous steady growth.

HDVs account for about a quarter of road transport emissions and around 5% of total EU CO_2 emissions - a greater individual share than international aviation or shipping.

European Commission

CO_2 growth-reduction of fuel saving potential

Without action, CO_2 emissions from HDVs are expected to remain at best stable over the long term at around 35% above their 1990 level.

Such 'no policy change' outcomes are clearly incompatible with the EU long term objective of reducing greenhouse gas emissions from transport by around 60% by 2050 (vs. 1990 levels).

Lack of market transparency

CO_2 emissions from, and fuel consumption of, cars and vans are established when vehicles are manufactured.

However, there is no system of measurement for CO_2 emissions from HDVs in the EU and this reduces transparency for prospective vehicle purchasers in the EU market.

Absence of a measurement methodology

This lack of knowledge is a barrier to the purchase of more efficient HDVs and is a gap that needs to be addressed.

To this end the Commission has put great effort in recent years into developing the VECTO computer simulation tool to estimate HDVs' fuel consumption and CO_2 emissions for the **whole vehicle**.

Accordingly, the first priority is to close the knowledge gap on these emissions and to start their registering and monitoring.

Challenges

Further development of the VECTO simulation methodology; its testing to ensure its accuracy compared to real world emissions and its adaptation as a ***downloadable executable file***;

Working with DG GROW to amend the "type approval" legislation to enable the application of VECTO when the vehicle is produced/registered;

Preparing co-decision legislation to require the monitoring and reporting of data when the vehicle is produced/registered.

International competitiveness

EU manufacturers account for over 40% of the global production of HDVs. The Commission's whole vehicle measurement approach is not comparable with those of the US and Japan.

US:

The 2011 HDV CO_2 rule issued by EPA does not cover the complete emissions of each vehicle, but only the cabin and chassis parts, in combination with a separate rule on engine emissions. In June 2015, new standards have been proposed to reduce the fuel consumption and GHG of HDVs. The new Phase 2 regulations would be implemented from model years 2018 to 2027, building upon initial standards that cover model years 2014 to 2018.

International competitiveness

Japan:

For its part, Japan has a fuel consumption rule with targets based on the best-performing vehicles. Over the long term the various national legislations are expected to converge, as those addressing emissions of vehicles' exhaust gases have done.

Need for action

Many countries, such as Japan, the US, Canada and China have already introduced CO_2 standards.

EU companies account for over 40% of the global production of trucks and buses and, while they are fuel efficient, the introduction of greater transparency, to allow purchasers greater choice, would clearly benefit the market.

Commission action in this area is necessary.

Delivering this ambitious agenda will not be easy, and will require major efforts to convince all stakeholders to take rapid action.

CO_2 Standards

Feedback from the consultation on the preparation of a legislative proposal on the effort of MS to reduce their GHG emissions to meet the EU's GHG emission reduction commitment in a 2030 perspective:

UK: "We also support the *development of CO_2 emission standards for HGVs*"

Slovenia: "Promoting energy efficiency and overall reducing energy demand, e.g. in transport sector with regard to already identifies caveats in testing vehicles emissions, reviewing the CO_2 emission performance standards for new cars and light-duty vehicles, and *new similar standards for HDVs*"

CO_2 Standards

***Belgium**:* "A further tightening of CO_2 emission performance standards for new passenger cars and LDVs, and the *adoption of similar standards for HDVs post-2020*, as well as other initiatives aimed at the use of alternative fuels and the electrification of the transport system;"

***Netherlands**:* "The Netherlands would like to see a comprehensive EU transport policy which aims at a substantial reduction of CO_2 in fuels as well as vehicles. Important components of a comprehensive EU transport policy should be the continuation of the CO_2 reduction target in the Fuel Quality Directive post-2020 and *an ambitious CO_2 target for vehicles*.

Vehicle Energy Consumption Calculation Tool

Simulation tool to calculate both, fuel consumption and CO_2 emissions from the **whole** vehicle

Vecto development

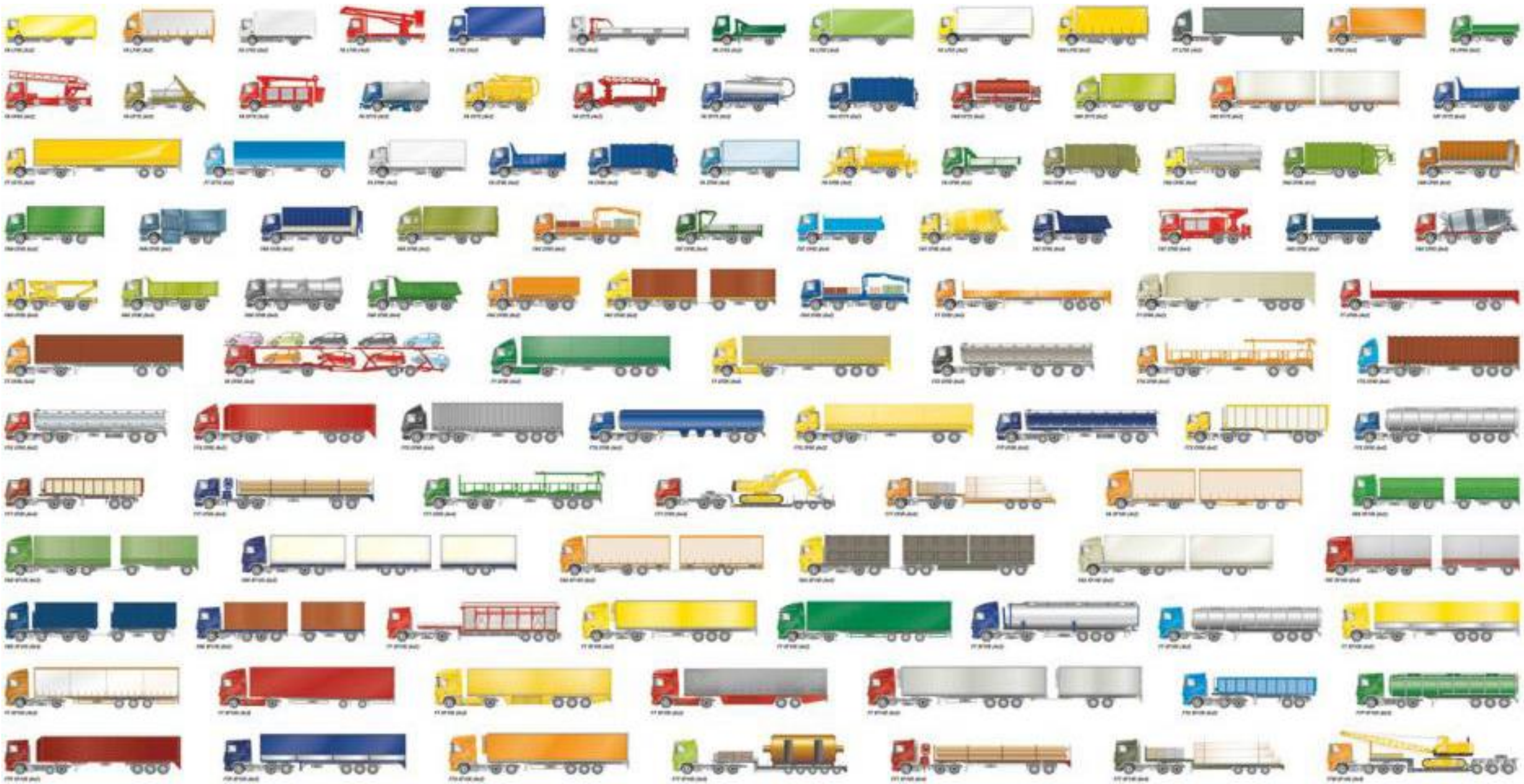
- VECTO has been developed by the Commission (DG CLIMA and JRC) with TUG support over the last four years
- ACEA, OEMs and component manufacturers have been also involved and provided key input and test vehicles
- DG CLIMA is the leader for this project
- Further development will take place in the next years.

European Commission

Passenger cars: Easy to measure CO_2

European Commission

Heavy Duty Vehicles…??????



*Source: ACEA

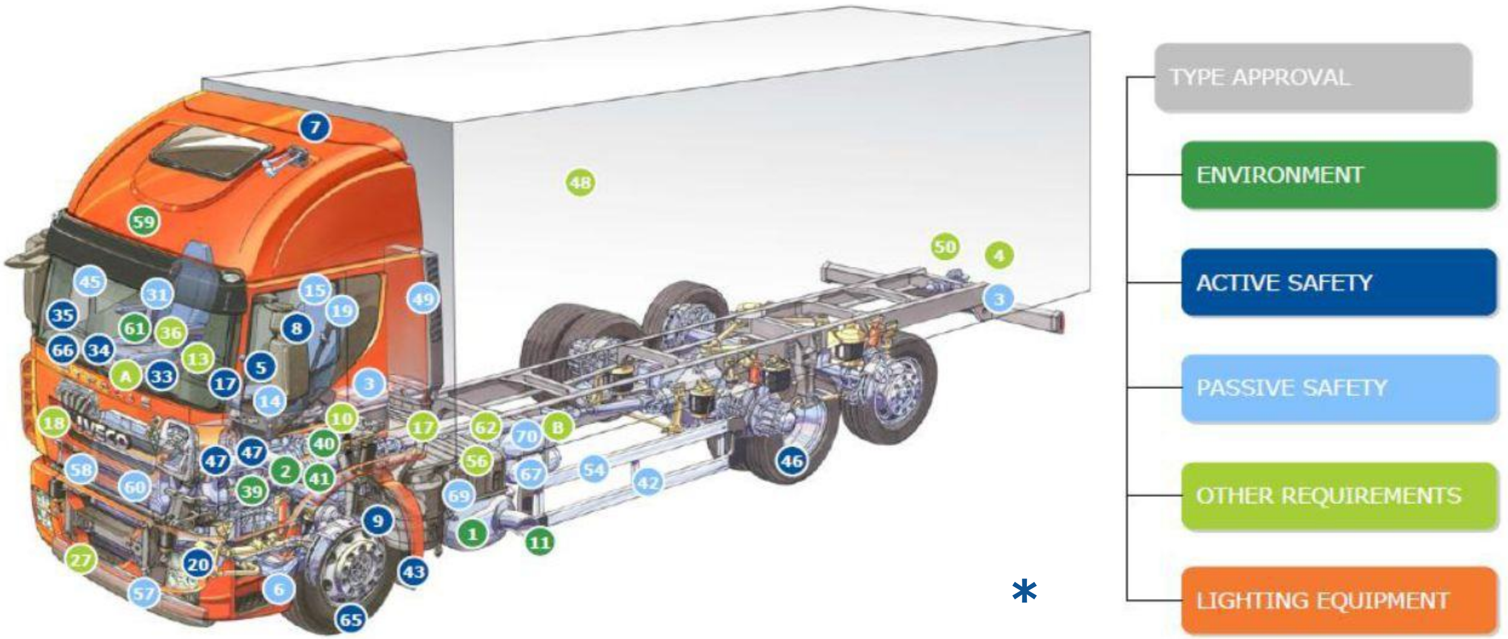
Climate Action

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!!!

HDVs Type Approval



Most requirements are safety-related:

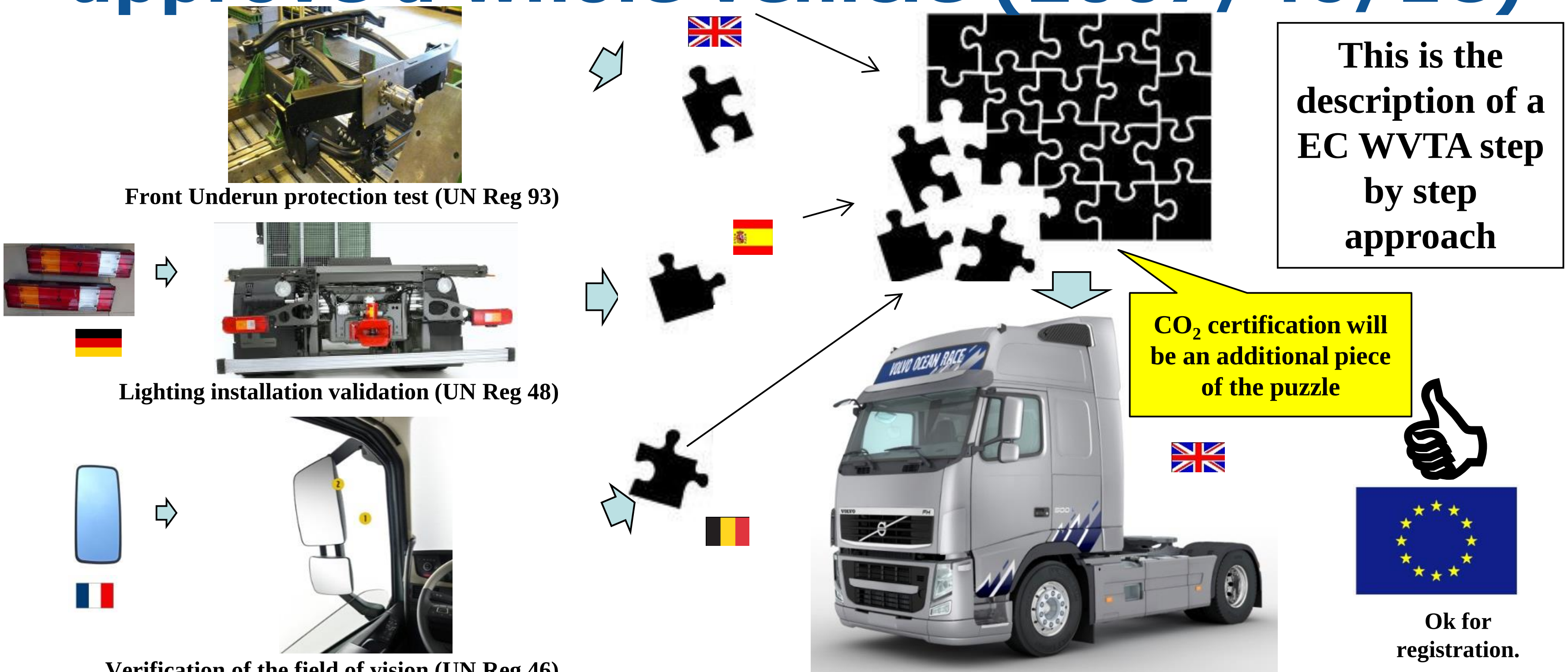
Cab Strength
FUP & RUP
Lateral Protection
AEBS
LDWS
EVSC

Steering Effort
Audible warning
Braking
Speedometer
Speed limiters
Tyres

Identification of controls
Windscreen defrosting and demisting
Indirect vision devices
Lighting installation
Spray suppresion systems
Windscreen wiper/washer

*Source: ACEA

The following scheme is applicable to type approve a whole vehicle (2007/46/EC)



1
We need type approved components from our suppliers, issued by their TAA

2
We perform the system certification with any Technical Service /Type Approval Authority

3
We obtain system type approvals from Type Approval Authorities we work with

4
Once the puzzle is completed (around 60 system approvals), the whole vehicle (type) approval can be issued by one Type Approval Authority

5
Once the TA is obtained, the complete vehicles fulfilling this approval shall be registered

*Source: ACEA

Regulatory situation in EU

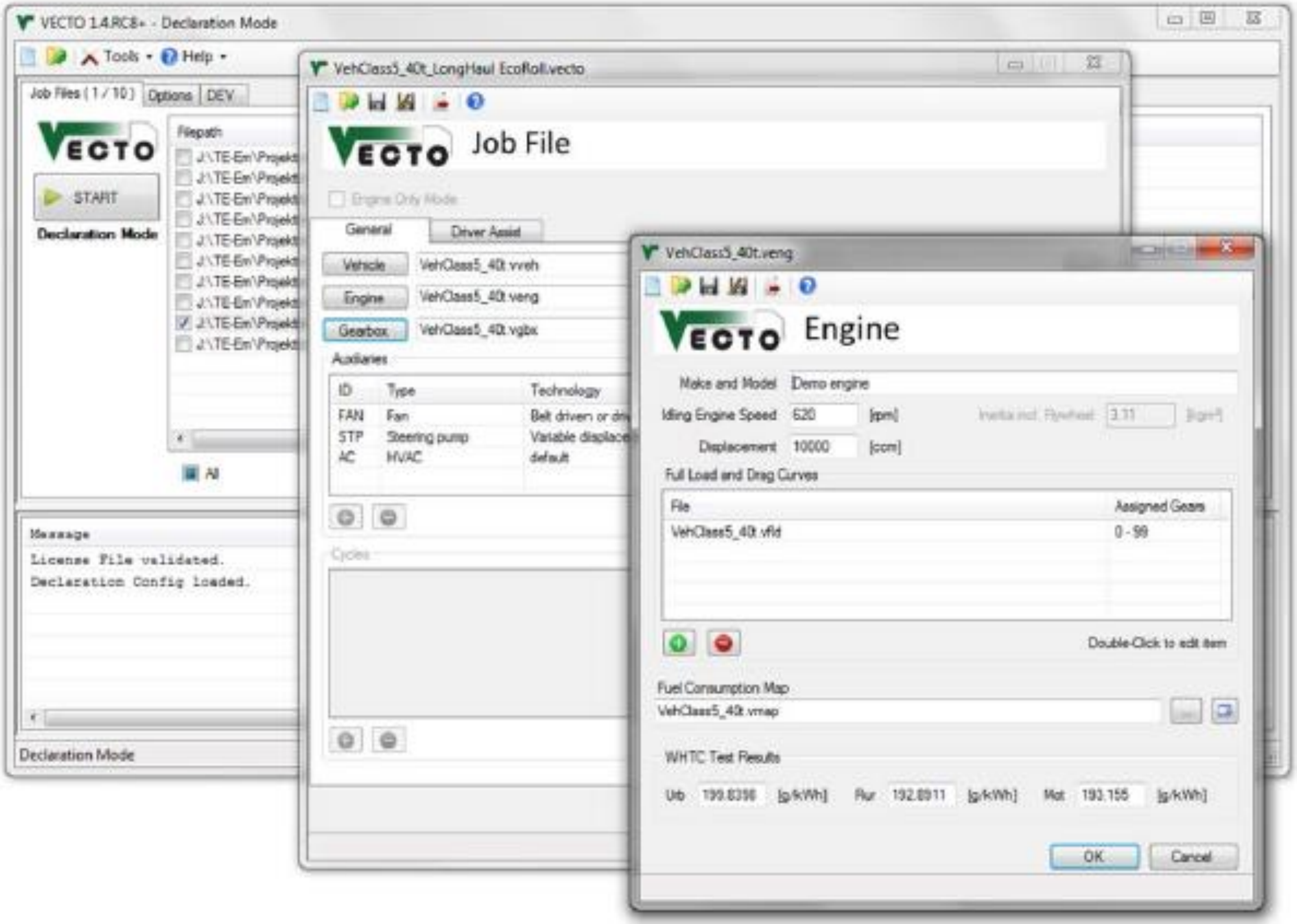
Existing Regulations setting performance standards for:

- **Cars (Reg. 443/2009), and**
- **Vans (Reg. 510/2011)**

Currently no legislation setting performance standards for HDV CO_2 emissions or parts thereof

Current test cycle procedure for HDVs is based on the engine (e.g. for regulation air pollutant emissions), not the whole vehicle

VECTO Graphical User Interface (GUI)



VECTO's modes

VECTO offers a ***declaration mode***, where all *generic data* and the *test cycle* are allocated automatically as soon as the ***vehicle class*** is defined.

An ***engineering mode*** is also offered, where the user can select and change all input data to allow recalculation of test data e.g. for model validation.

VECTO's characteristics

-- VECTO can do any simulation if given the input data, like in the Proof of Concept, but this is only in the engineering mode.

-- Test cycle file can be replaced and take any cycle or route travelled

-- In general, input files are open and fully described in the manual

VECTO's characteristics

A non-expert will **not** be able to perform a correct simulation for various reasons:

- Access to official data???
- Can always use the templates already loaded in VECTO but results won't be accurate
- Most likely to get wrong results at the end of the simulation

VECTO's characteristics

- Current VECTO includes data for a 12t rigid and a 40t tractor in the declaration mode.
- A 24t coach is also included in the engineering mode in addition to the established default factors.
- These data do not correspond to real vehicles in order to avoid confidentiality issues.
- However, they are realistic data including engine maps and produce realistic output results.

VECTO output

In the ***declaration mode*** of VECTO fuel consumption and CO_2 emissions are automatically calculated for all CO_2 test cycles allocated to the vehicle for average payload, full load and empty driving. Results are given in **g/km, g/cm³-km** and **g/ton-km** or **g/pass-km**.

Which of these values will be used in a final certification process is not decided yet.

Components and input data

For the following components, relevant **input data** for VECTO have to be delivered from standardised test procedures :

-- Vehicle mass

-- Tires (dimensions and rolling resistance coef)

-- Engine (engine fuel flow map)

-- Transmission (transmission ratios, loss maps for gear box and axle, default values optional)

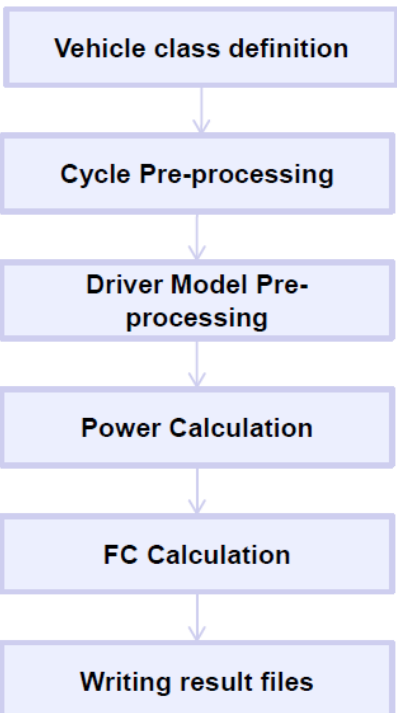
-- Aerodynamic drag (Cd x A, for some vehicle classes generic values can be used)

Components and generic values

For the following components **generic values** are defined, which are allocated by the software VECTO to the vehicle depending on the vehicle class and mission profile. :

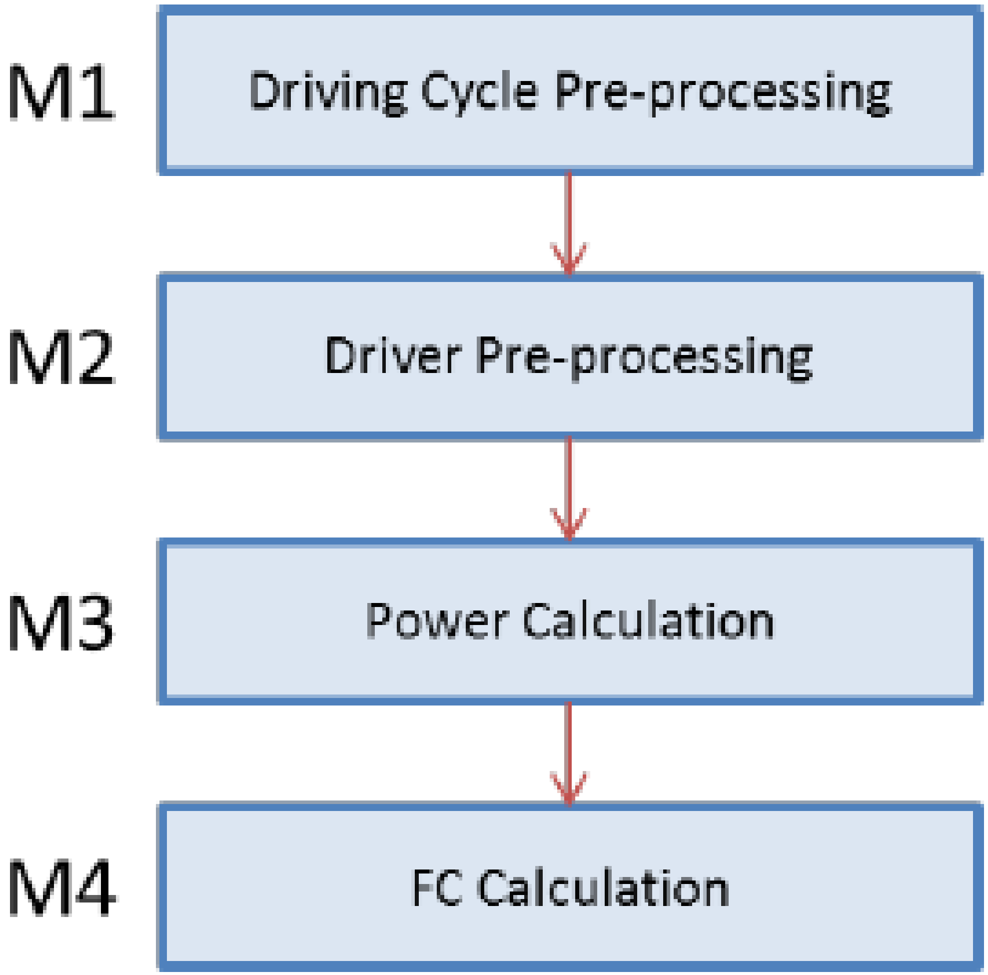
- Auxiliaries (alternator, air-compressor, steering pump, cooling fan, Heating Ventilation AC - HVAC)
- Mass of the standard bodies and trailers
- Vehicle payload (truck) or passengers weight (bus)
- Test cycle

Simulations steps

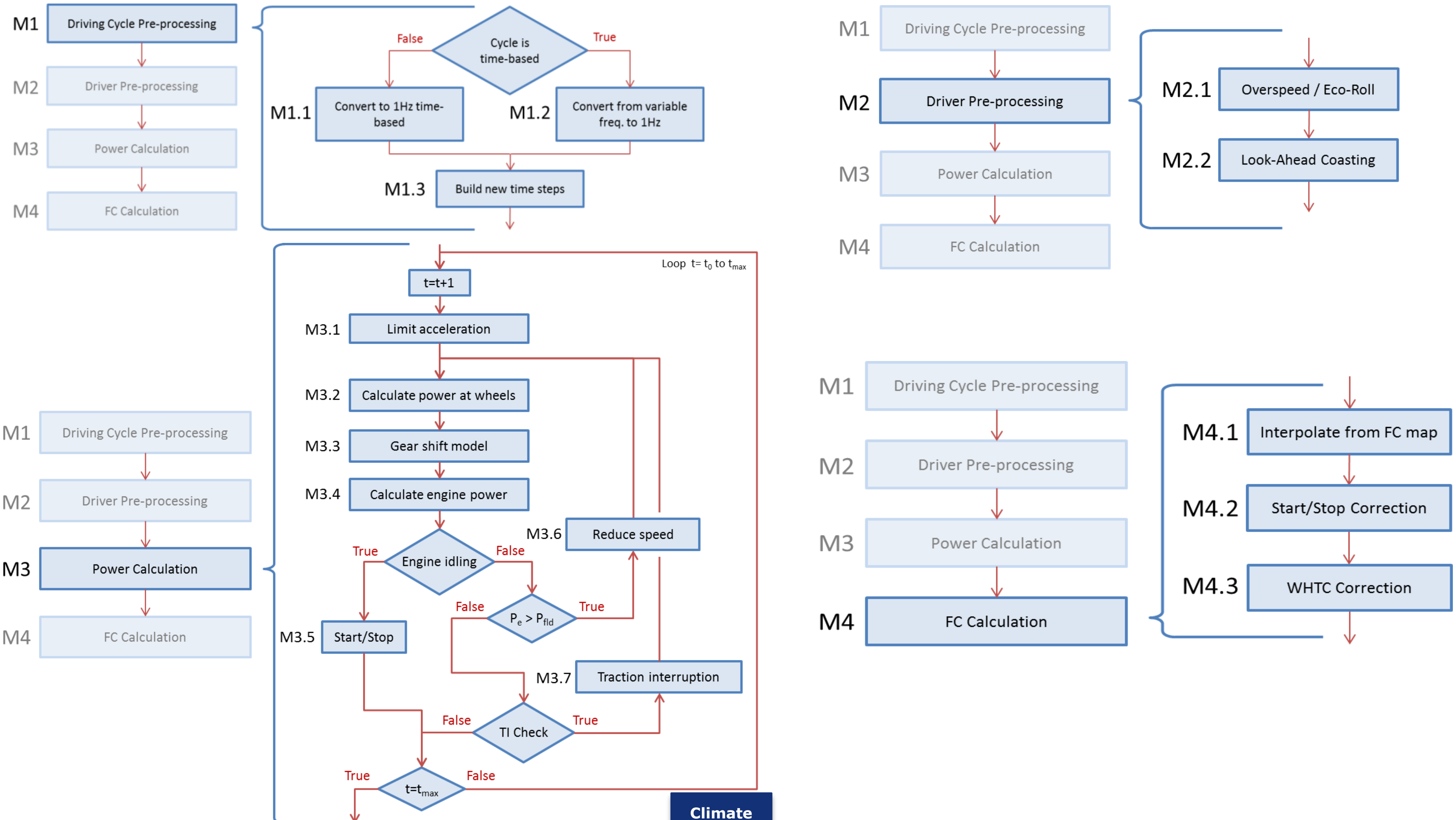


- Identification of the vehicle
- Allocation of generic data
- Convert distance based cycle to time based
- Apply driver's assist functions (overspeed, Eco-Roll, Forward looking braking etc.)
- Vehicle longitudinal dynamics
- Generic driver gear-shift model (AMT,AT,MT) to compute rpm
- Interpolation from fuel map, application of "WHTC correction factors"
- Information for customer
- Reporting for TAA
- Data for monitoring purposes

Model structure - Four main modules



Model structure - Four main modules



Mission profiles

Trucks

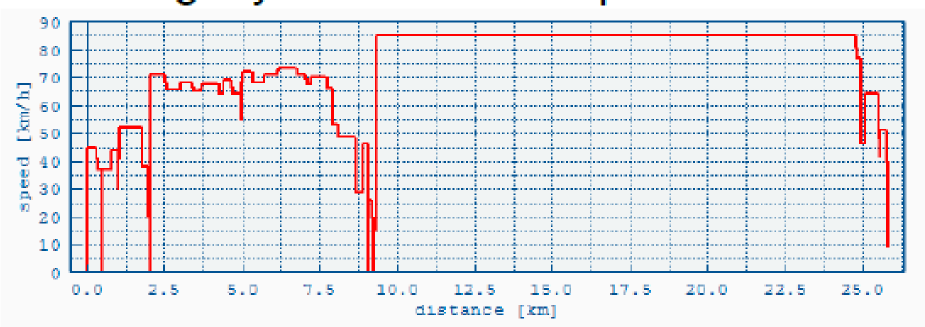
- Urban delivery
- Regional delivery
- Long haul
- Construction
- Municipal utility

Buses and coaches

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

Test cycles – Target speed cycles

Pros: gives realistic engine load pattern for all weight/power/transmission combinations
Cons: slightly increased computation time



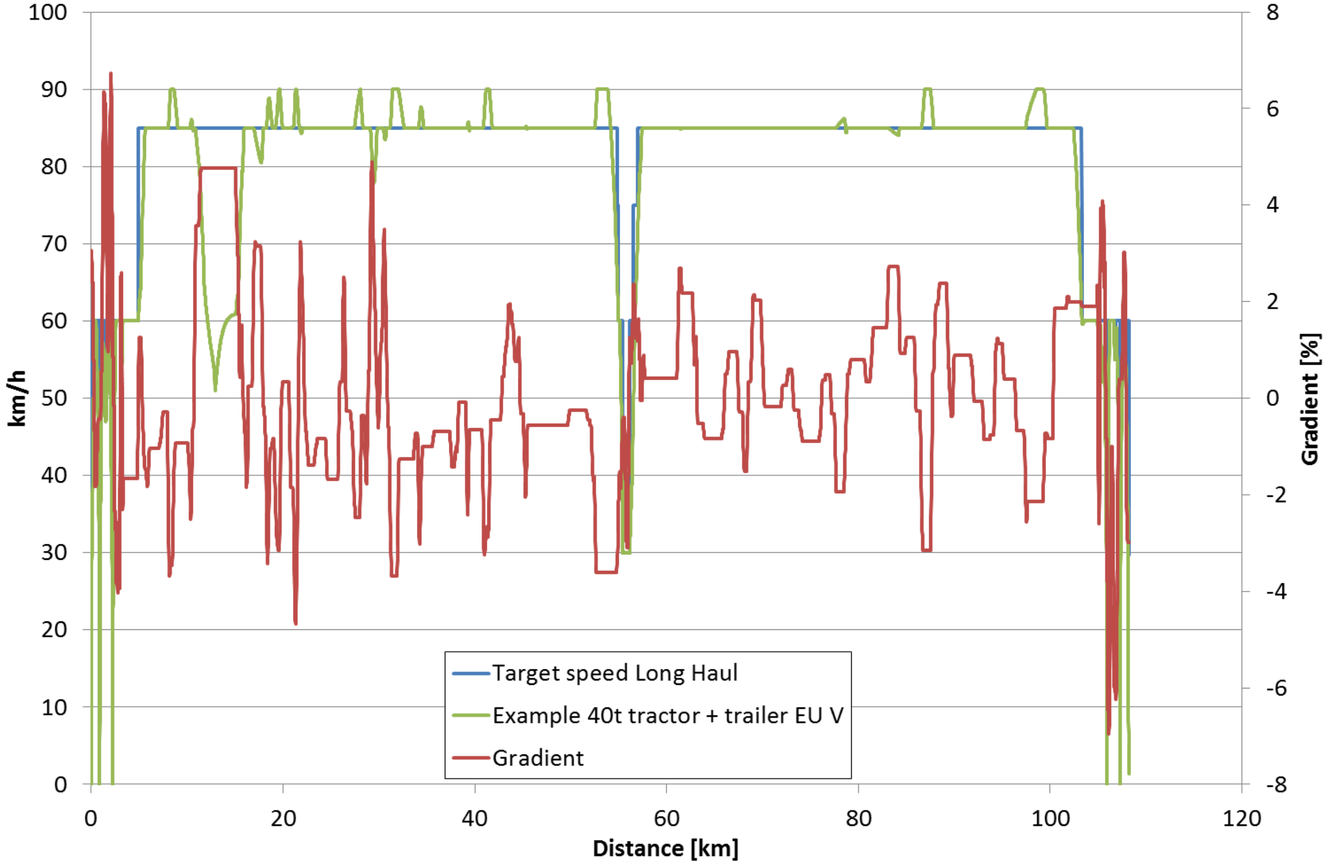
Truck cycles:

- Long Haul
- Regional Delivery
- Urban Delivery
- Municipal Utility
- Construction

Velocity and gradient over disctance

Input data: Test cycles - driver models

Example: long haul cycle



Driver model

Acceleration: limited by full load and max. driver demand

Gear selection with torque interruption

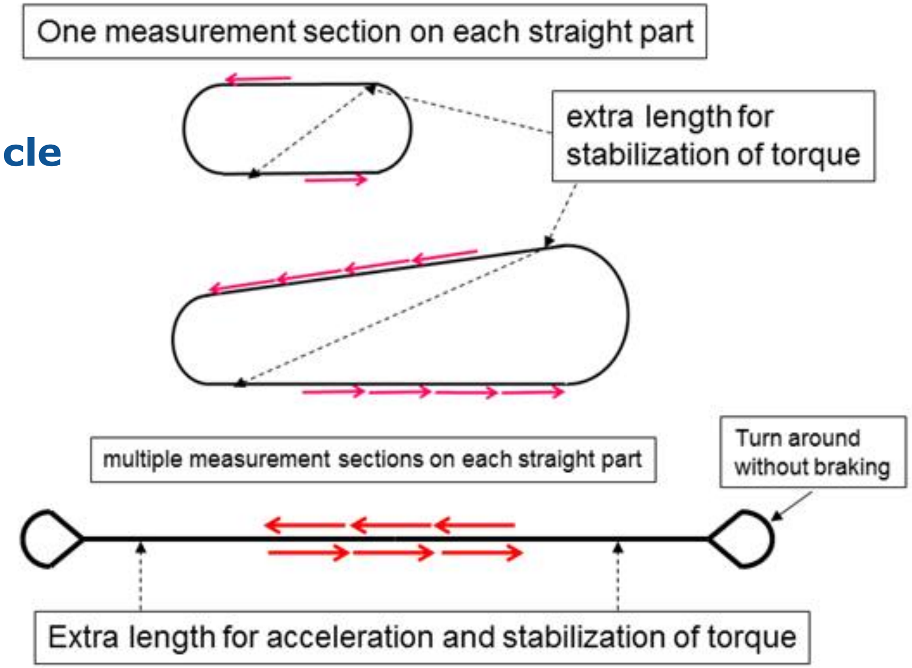
Overspeed function optional eco-roll or none

"Look ahead" braking

Input data: Aerodynamic drag - RRC

Constant speed test (at 2 speeds)

- Rim torque meter
- Anemometer
- Correction for gradient and for vehicle speed variations
- Correction for ambient P and T
- $F = F0 + Cd * A * v^2 * r/2$



Important tire and vehicle conditioning for accurate Cd*A results.

RRC calculated in these tests not to be used. Official value to be used for monitoring purposes

Rigid and tractors classification

The generic values are allocated to the vehicle by VECTO automatically depending on the HDV class in which the vehicle falls.

For each class the corresponding test cycles, the standard body or trailer and the payload are defined as well as the data relevant for the simulation of the generic auxiliaries.

Identification of vehicle class					Segmentation (vehicle configuration and cycle allocation)					Norm body allocation		
Axles	Axle configuration	Chassis configuration	Maximum GVW [t]	<-- Vehicle class	Long haul	Regional delivery	Urban delivery	Municipal utility	Construction	Standard body	Standard trailer	Standard semitrailer
2	4x2	Rigid	>3.5 - 7.5	0		R	R			B0		
2	4x2	Rigid or Tractor	7.5 - 10	1		R	R			B1		
		Rigid or Tractor	>10 - 12	2	R	R	R			B2		
		Rigid or Tractor	>12 - 16	3		R	R			B3		
		Rigid	>16	4	R+T	R		R		B4	T1	
		Tractor	>16	5	T+S	T+S						S1
	4x4	Rigid	7.5 - 16	6				R	R	B1		
		Rigid	>16	7					R	B5		
		Tractor	>16	8					T+S			W1?
3	6x2/2-4	Rigid	all weights	9	R+T	R		R		B6	T2	
		Tractor	all weights	10	T+S	T+S						S2
	6x4	Rigid	all weights	11					R	B7		
		Tractor	all weights	12					R			S3
	6x6	Rigid	all weights	13					R	W7		
		Tractor	all weights	14					R	W7		
4	8x2	Rigid	all weights	15					R	B8		
	8x4	Rigid	all weights	16					R	B9		
	8x6 & 8x8	Rigid	all weights	17					R	W9		

R = Rigid & Body
R+T = Rigid & Body & Trailer *)
T+S = Tractor & Semitrailer
W =no (Cd*A) measurement, only vehicle weight and frontal are

*) Whether it is sufficient to simulate the truck-trailer combination based on cd*A for Rigid & Body or the full-vehicle test for aerodynamic drag has to be performed additionally with Rigid & Body & Trailer has to be clarified

Vehicles' segmentation

ACEAproposal Vehicle segmentation trucks ≥ 7.5 t

	Identification vehicle configuration: Axle configuration	Chassis configuration	weight ***	Class: Vehicle Class	Cycle allocation – Vehicle configuration / weight / axle loads: Long haul	Regional delivery	Urban delivery	Municipal utility	Construction	Body/ trailer allocation: Standard Bodies (B)	Standard Trailer (T)	Standard Semitrailer (ST)
2 axles	4x2	Rigid + (Tractor*)	7.5t - 10t	1		R (pc)	R (pc)			B1		
		Rigid + (Tractor*)	> 10t - 12t	2	R+T (pc)	R (pc)	R (pc)			B2	T1	
		Rigid + (Tractor*)	> 12t - 16t	3		R (pc)	R (pc)			B3		
		Rigid	> 16t	4	R+T (14,0t)	R (4,4t)		R (4,4t)**		B4	T2	
		Tractor	> 16t	5	Tr+ST (19,3t)	Tr+ST (12,9t)						ST1
	4x4	Rigid	7.5t - 16t	(6)	exclude all-wheel-drive vehicles 4x4 (sales volume < 1%)							
		Rigid	> 16t	(7)	exclude all-wheel-drive vehicles 4x4 (sales volume < 1%)							
		Tractor	> 16t	(8)	exclude all-wheel-drive vehicles 4x4 (sales volume < 1%)							
3 axles	6x2/2-4	Rigid	all	9	R+T (19,3t)	R (7,1t)		R (7,1t)**		B6	T2	
		Tractor	all	10	Tr+ST (19,3t)	Tr+ST (12,9t)						ST1
	6x4	Rigid	all	11					R (7,1t)	(generic weight+CdxA)		
		Tractor	all	12					Tr+ST (12,9t)	(generic weight+CdxA)		
	6x6	Rigid	all	(13)	exclude all-wheel-drive vehicles 6x6 (sales volume < 1%)							
		Tractor	all	(14)								
4 axles	8x2	Rigid	all	(15)	exclude 8x2 (very low sales volume < 1%)							
	8x4	Rigid	all	16					R (12,9t)	(generic weight+CdxA)		
	8x6/8x8	Rigid	all	(17)	exclude all-wheel-drive vehicles (sales volume < 1%)							
EMS 2 axles	4x2	Tractor	all		Tr+ST+T (26,5t)	Tr+ST+T (17,5t)	ST1-v2 T2				T2	ST1-v2#
EMS 3 axles	6x2	Rigid	all		R+D+ST (26,5t)	R+D+ST (17,5t)	B6 D+ST1-v2			B6		ST1-v2#
		Tractor	all		Tr+ST+T (26,5t)	Tr+ST+T (17,5t)	ST1-v2 T2				T2	ST1-v2#

R=Rigid+Body; Tr=Tractor; B=Body; T=Trailer; ST=Semitrailer; D=Dolly; (x,xt)=payload; (pc)=payloadcurve over GVW; # ST1-v2=ST1 in simulation issues

* Tractors are treated as Rigids but with specific curb weight of tractor. Airdrag and weight/payload for semitrailer as for Rigid (simplification)

** Municipal utility vehicles with generic weight + CdxA

*** Weight is maximum gross vehicle weight

Buses and coaches have separate table

Source: ACEA white book

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 ≤ 0.9m	<18	B2				IU	
		Coach	Class III + floor height ≥ 0.9m 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 ≤ 0.9m	>18	B5				IU	
		Coach	floor height ≥ 0.9m and/or double decker	>18	B6					CO

European Commission

Simulation of engine power

Simulation of engine power:

Vehicle specific
C_d*A

Vehicle specific
m*g*sinα

Vehicle specific
transmission:

$P_e = P_{roll.} + P_{air} + P_{acc} + P_{grad} + P_{tran}$

Vehicle + tire specific
$m_{vehicle}$, m_{load},
RRC from drum tests

Veh

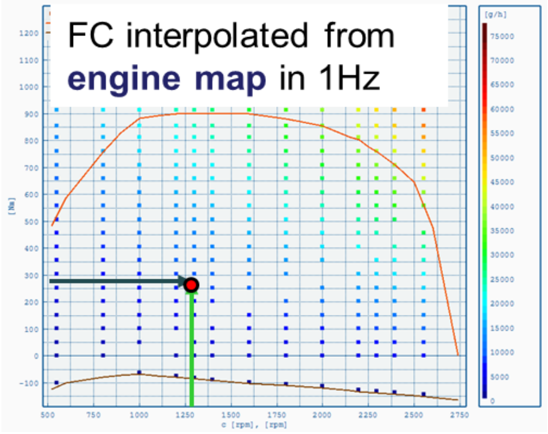
ficiency

mponent specific loss
ps possible

Simul

$(d_{tire} \times \pi)$

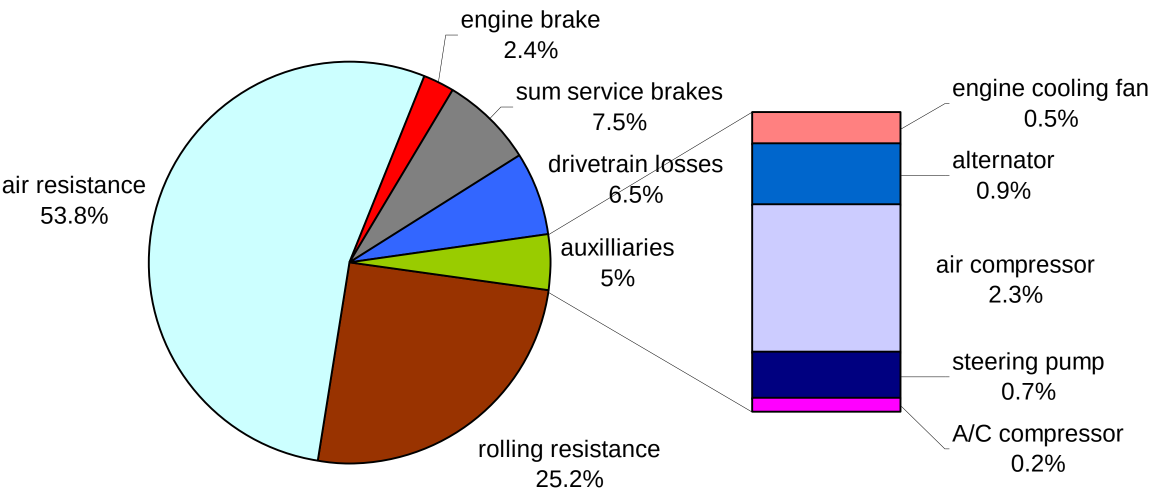
icle transmission ratios
i_{gear}, i_{axle}



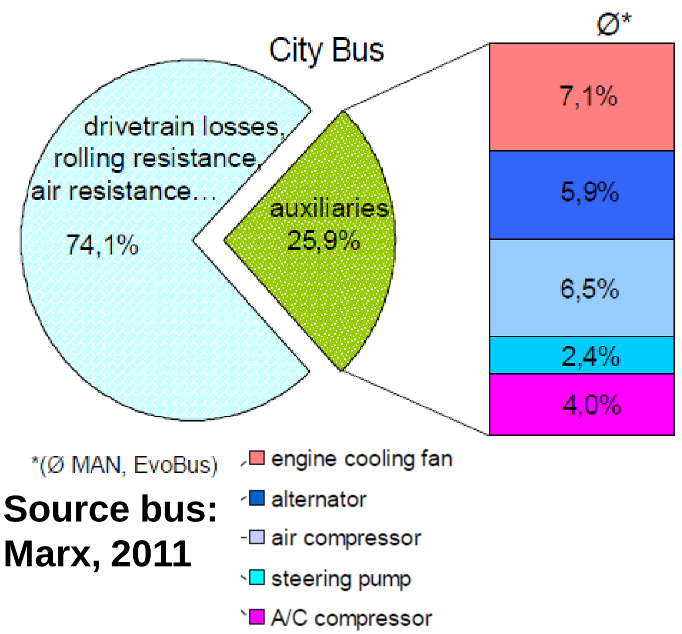
DON'T PANIC!

Shares of energy consumption

EURO V semitrailer 28 t



EURO V city bus



Source bus: Marx, 2011

→ Must be included:
***** Air resistance**
***** Rolling resistance**
***** Engine efficiency**
→ +transmission ratios

Shall be included:
**** Transmission losses**

Should be included as far as possible:
*** Auxiliaries**
*** Power consumers**

European Commission

Proof of Concept activity

Scope:

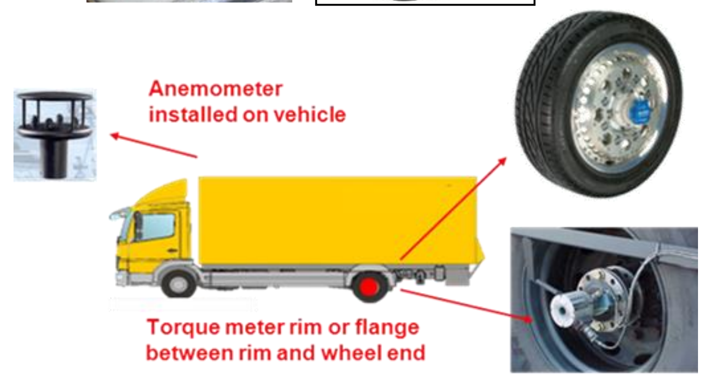
- Prove that simulation based monitoring can deliver results that accurately reflect fuel consumption and performance of modern HDVs
- Verify the validity and soundness of the approach
- Extensive measurements concluded February 2013
- Joint Commission-ACEA activity

Included

- 2 HDVs provided by DAF and Daimler
- Proving ground testing (Iveco's circuit)
- Chassis dyno testing (JRC)
- On – road / PEMS testing (JRC)
- Engine test bed testing (JRC)

Equipment used

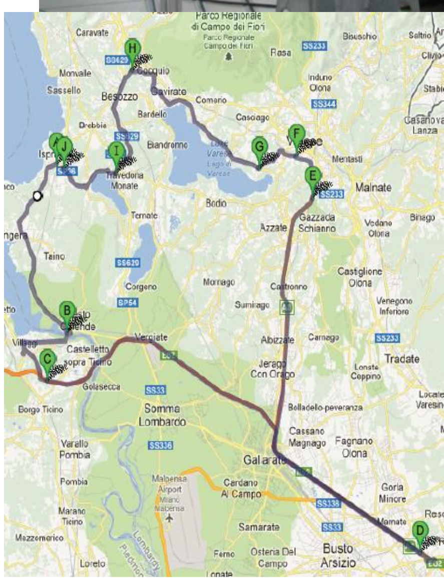
Torque measurement	Wheel rim (Actros) Axis (CF75)
Zeroing	Daily basis to eliminate drift
Positioning / speed	High precision GPS (Actros) Sensors at fixed points on ground (CF75)
Wind speed and wind angle	Ultrasonic Wind Anemometer (both)
Ambient temperature, humidity, pressure	Weather station installed on board (both)
Fuel consumption	OEM integrated flow meter (both) AVL KMA flowmeter (where possible)
Vehicle mass	JRC's balance



Climate Action

European Commission

Test vehicles-Route



Climate Action

Report's conclusion and follow-up

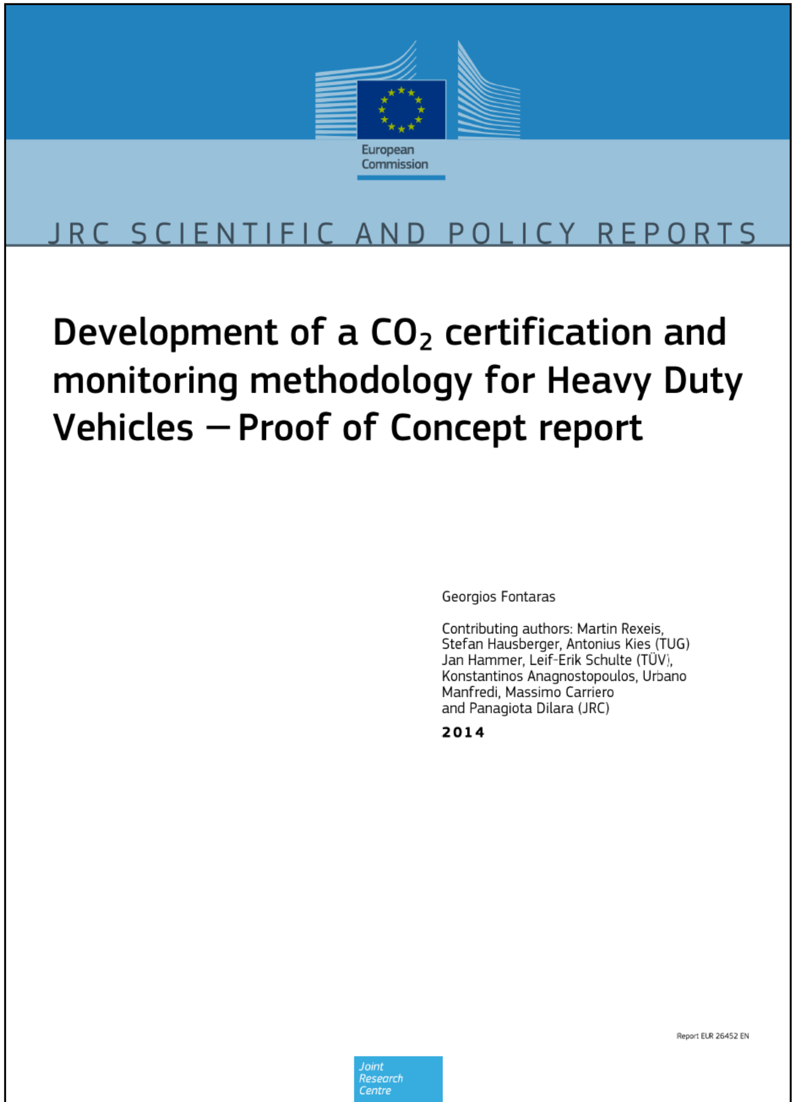
- Simulated FC was calculated with a range of **±3%** from the real world measurements or even less.

- Finalize and validate topics remaining open in the methodology such as gearbox and driveline efficiency, auxiliary units power consumption, automatic gear shifting strategies, mobile air-conditioning simulation for city buses.

- Perform a sensitivity analysis in order to more accurately quantify the uncertainty of the method for different vehicle types/categories.

- Investigate the necessary conditions for expanding the methodology to other HDV categories.

European Commission


European Commission

JRC SCIENTIFIC AND POLICY REPORTS

Development of a CO_2 certification and monitoring methodology for Heavy Duty Vehicles – Proof of Concept report

Georgios Fontaras

Contributing authors: Martin Rexeis, Stefan Hausberger, Antonius Kies (TUG) Jan Hammer, Leif-Erik Schulte (TÜV), Konstantinos Anagnostopoulos, Urbano Manfredi, Massimo Carriero and Panagiota Dilara (JRC)

2014

Report EUR 26452 EN

Joint Research Centre

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

European Commission

- 1 -

Monitoring CO_2 Emissions from HDV in Europe – An Experimental Proof of Concept of the Proposed Methodological Approach

G. Fontaras[1]*, R. Luz [2], K. Anagnostopoulos[1], D. Savvidis[3], S. Hausberger[2] and M. Rexeis[2]

[1] European Commission, Joint Research Centre, Institute for Energy and Transport, georgios.fontaras@jrc.ec.europa.eu

[2] University of Technology Graz

[3] European Commission, Directorate General Climate Action (DG CLIMA)

Abstract

The European Commission in joint collaboration with Heavy Duty Vehicle manufactures, the Graz University of Technology and other consulting and research bodies has been preparing a new legislative framework for monitoring and reporting CO_2 emissions from Heavy Duty Vehicles (HDVs) in Europe. In contrast to passenger cars and light commercial vehicles, for which monitoring is performed through chassis dyno measurements, and considering the diversity and particular characteristics of the HDV market, it was decided that the core of the proposed methodology should be based on a combination of component testing and vehicle simulation. Emphasis is put on accurately simulating the performance of different vehicle components and achieving realistic fuel consumption results. A proof of concept was launched aiming to test and prove that these targets are achievable.

A series of experiments were conducted on 2 different trucks, a Daimler 40ton Euro VI, long haul delivery truck with semi-trailer and a DAF 18 ton Euro V rigid truck. Measurements were performed at the Joint Research Centre's HDV chassis dyno labs and on the road. A vehicle simulator (Vehicle Energy Consumption Calculation Tool - VECTO) has been developed to be used for official monitoring purposes and the results of the measurements were used for its validation. As inputs the simulation based methodology considers test track measurement of driving resistances (eg air drag), determination of drivetrain losses (e.g. gearbox), determination of power demand of engine auxiliaries (eg. cooling fan) and other consumers (e.g. steering pump), measurement of the engine fuel consumption map as extension to the engine's type approval tests (as described in EURO VI legislation). CO_2 emissions of the vehicle are then calculated using the aforementioned input data for predefined representative driving cycles and mission profiles.

For the two Heavy Duty vehicles tested and simulated on the same test route, fuel consumption was calculated always within a ±3% range from the real world measurement, and in several cases even closer than that (in the order of ±1.5%). Given the variability of the actual measurement (σ = 2%), it is concluded that a future certification scheme can be based on vehicle simulation tools.

Introduction

Heavy-Duty Vehicles (HDV) represent about a quarter of the European Union's (EU) road transport CO_2 emissions and some 6% of the total CO_2 emissions. In spite of some improvements in fuel efficiency in recent years, overall HDV CO_2 emissions are still rising, mainly due to increasing road freight traffic. The need for a strategy addressing CO_2 emissions from the transport sector has been recognized by the European Commission (EC) in its 2010 Strategy on Clean and Energy Efficient Vehicles. Moreover, the EC's 2011 White Paper on transport (EC 2011) describes a pathway to increase the sustainability of the transport system with technological innovation, enabling the transition to a more efficient and sustainable European transport system.

One key factor for achieving such targets is a robust CO_2 and fuel consumption monitoring method that reflects to the best possible extent the actual performance of the vehicles over real operating conditions and the comparative advantages of different vehicle models and technology packages available in the market. This in turn provides appropriate information to the end user and better supports the introduction into the market of vehicles with lower fuel consumption(AEA-Ricardo 2011). It also allows the collection of valuable information needed for implementing necessary policy measures to facilitate the achievement of the targets set.

While car and van CO_2 emissions (M1-N1 vehicles) are being measured according to an agreed method, HDV emissions so far are not measured in a standardized and consistent way. Consequently no reliable baseline as to the actual amount of these emissions exists. To fill this gap, a series of still on-going projects was initiated by EC. Aim of the research performed was the creation of standardized method to quantify and report CO_2 emissions from HDVs. Initial studies and feedback received from OEMs suggested that the approach that best fits the characteristics and particularities of the HDV

Published in TAP Conference, Graz, Austria, September 2014

Climate Action

Proof of concept 12t 4x2 rigid, Class 2

EUROCARGO ML120 E25

Wheelbase: 4818mm

Cab: MLC, aerodynamic spoiler

Engine: 185kW, 6cyl, EURO VI

Gearbox: ZF 9S-75TO

Rear Axle: AM MS10, ratio 1:4.68

Tires: Continental 245/70R19.5

Payload: 3t (ACEA White book)

Test campaigns

Urban:

- Collection of data on a typical urban mission (24Km) in Turin - Italy

- 11 tests

- Good statistical margin of error of the measured fuel consumption

- Monitored values:

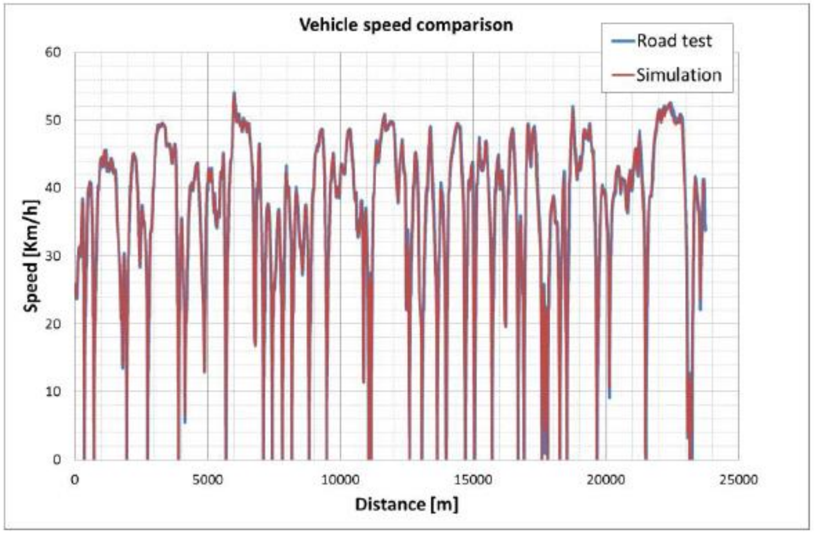
  --Vehicle and engine speed

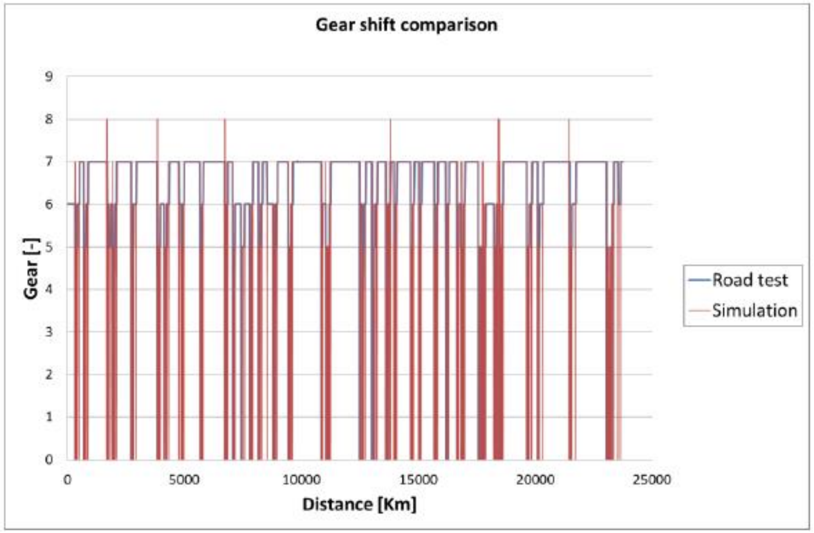
  --Instantaneous and accumulated fuel consumption

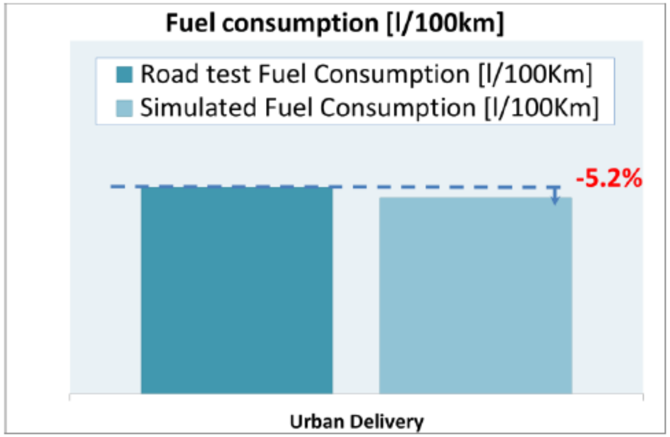
  --Gear and Torque

  --Acceleration

Correlation with VECTO







Simulated fuel consumption in a typical urban mission is 5,2% less than the real fuel consumption

Vehicle speed and gear shift had a similar trend

Further steps

Main topics for trucks are:

- influence of tire RRC on the aerodynamic drag test
- engine test accuracy demands
- enhance the validation method (SiCo test procedure)
- improvement of the software reliability
- test and validation of all parts of the certification procedure and of the entire system
- Automatic gear box model is relevant for some trucks

Further steps

The truck category below 7t is not yet included in VECTO but shall be integrated into future legislation.

It is assumed that the existing method covers the small truck class to a large extent but some technical details may demand different approaches in some simulation and test details and certainly all default data sets have to be elaborated for this new HDV class (mission profiles, loading, generic component data sets).

Semi-Forward LCV Vehicles

Scudo/Boxer/
Jumper

IVECO

Transit

Sprinter/Crafter

Master/NV400

RENAULT

*Source: ACEA

Climate
Action

Cabover "Japanse type" Vehicles

FUSO

RENAULT

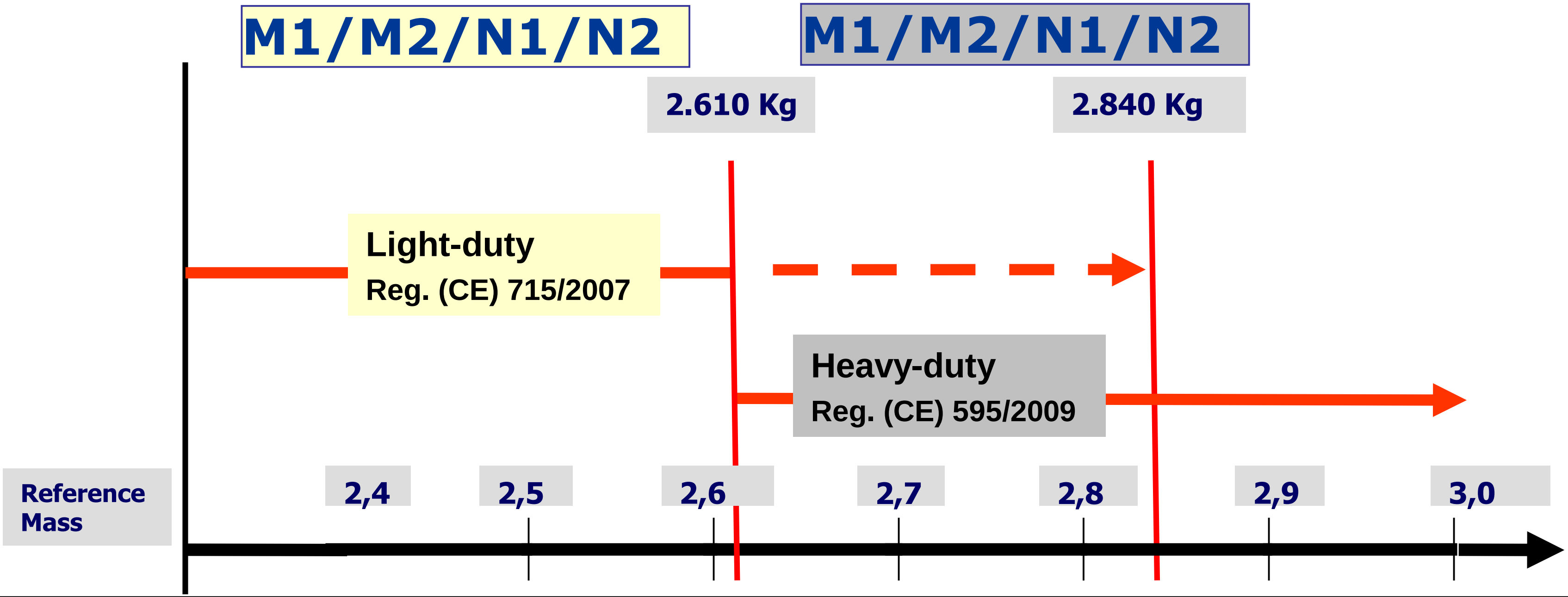
NISSAN

*Source: ACEA

Cabover "European type" Vehicles

*Source: ACEA

Vehicle categories N2 and M2



Light-duty: Test of the complete vehicles on the chassis-dyno

Heavy-duty: Test of the engine on the engine-bench

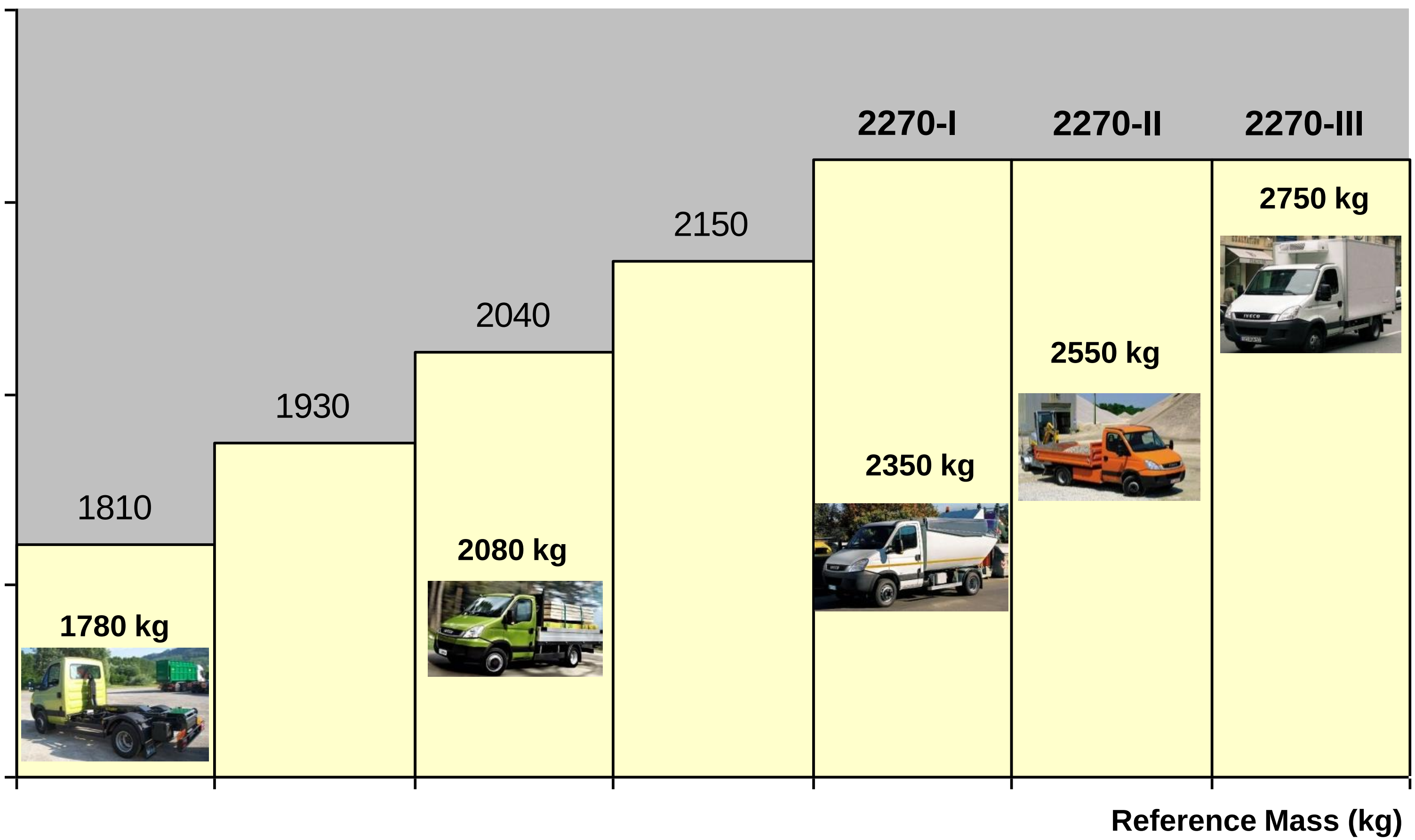
(*) Only for variant/version of vehicle with RM > 2.610 provided that they also meet the requirements of GHG.

Climate Action

*Source: ACEA

European Commission

Vehicle categories N2 and M2



*Source: ACEA

Timeline (trucks)

- VECTO development: on-going

- Dissemination and trials: from 2013 to mid-2016

- Preparation of possible legislative proposals: 2015-2016

- Possible first reporting year: 2018

Thank you for your attention

- I will be happy to address your questions
- VECTO demonstration will follow
- More info can be found at: http://ec.europa.eu/clima/policies/transport/vehicles/heavy
- Contact details:

Dimitrios SAVVIDIS: dimitrios.savvidis@ec.europa.eu