EELS
Van Mourik Broekmanweg 6
2628 XE Delft
P.O. Box 49
2600 AA Delft
The Netherlands

www.tno.nl

T +31 88 866 30 00
F +31 88 866 30 10

TNO 2014 R10843 | Interim report

Interim report: Cost-benefit analysis of options for certification, validation, monitoring and reporting of heavy-duty vehicle fuel consumption and CO_2 emissions

Date	8 September 2014
Author(s)	R. Vermeulen (TNO) J. Hammer (TüV-Nord) R. Munchrief (ICCT) R. Verbeek (TNO)
Example number	2014-TM-RAP-0100008010
Number of pages	47 (incl. appendices)
Number of appendices	2
Sponsor	European Commission - DG CLIMA Performed under FRAMEWORK CONTRACT CLIMA.C.2/FRA/2013/0007
Project name	CLIMA HD CO2 SR1 Cost-benefit of HDV CO2
Project number	060.06625

Summary

A specific service request has been issued by the EC under Framework Service Contract CLIMA.C.2/FRA/2013/0007. The work under this contract, managed by TNO, has the following objectives:

- to identify, define and analyse options for Certification, Validation, and Reporting and Monitoring of fuel consumption and CO_2 emissions from heavy-duty vehicles.
- to determine the costs of these options to the relevant stakeholders.

The Commission will ultimately utilize this work to support the development of future legislation to curb CO_2 emissions of heavy-duty vehicles, along with a cost-benefit analysis which will be needed to complement the almost completed (but not publically available) Impact Assessment.

The consortium assembled for this task consists of specialists from TÜV NORD, the International Council on Clean Transportation (ICCT) and TNO.

This interim report describes primarily the work performed for the tasks 1, 2 and 3 of the project. This concerns the definition and the elaboration of options for the Certification, Validation, and Reporting and Monitoring of fuel consumption and CO_2 emissions from heavy-duty vehicles. It is an interim report which describes ongoing work meant to inform and to receive feedback from the stakeholders, especially on the certification options. For that reason, this report does not contain any conclusions. The comparative assessment of options shall take place once all relevant stakeholders have been consulted for their view, and information has been retrieved regarding the options. Consequently, the costs of the different options will be estimated (tasks 4, 5 and 6).

The definition of options is not necessarily complete yet. Depending on the outcome of other service contracts and the stakeholder consultations new or additional options may come up and may need to be included at a later stage in the project.

Contents

Summary **2**

1 Introduction **4**
1.1 Background 4
1.2 Aim and approach 5
1.3 Structure of the report 5

2 Methodology **7**
2.1 Overall project methodology and structure of the work plan 7
2.2 Planning 8
2.3 Progress and future work 9

3 Task 1: certification and ex-post validation **10**
3.1 Introduction 10
3.2 CO_2 and Fuel Consumption Determination Methodology 11
3.3 Conformity of Production (CoP) 17
3.4 Certification related issues 21

4 Task 2: ex-post validation **23**

5 Task 3: monitoring and reporting **24**
5.1 Introduction 24
5.2 Current status of the method for the determination of CO_2 emission of HDV 25
5.3 Goal of task 3 27
5.4 Approach for task 3 28
5.5 Current monitoring for light duty vehicles 28
5.6 Requirements and considerations for monitoring and reporting of the CO_2 emissions of HDV 31
5.7 Options for monitoring 34
5.8 Current reporting for light duty vehicles and considerations for heavy-duty vehicles 34
5.9 Reporting options HDV 35

6 Stakeholder consultation **36**

7 References **40**

8 Signature **41**

Appendices
A Stakeholders
B Implementation

1 Introduction

1.1 Background

Transport is responsible for approximately a quarter of EU greenhouse gas (GHG) emissions, with the road freight sector accounting for nearly 6%. While GHG emissions from other sectors have decreased by almost a quarter between 1990 and 2009, emissions from transport have increased by almost a third in the same period. In the future significant increases in total GHG emissions from transport – and in particular HDVs – are expected if no additional policies are implemented (AEA, 2010).

The long-term objective of the European Commission is a CO_2 reduction of 90% by 2050 for all sectors combined. For transportation the target is lower, around 60%.

In order to achieve this objective, the Commission is engaged with industry stakeholders and contractors on the subject of HDV CO_2 emissions since 2007. It commissioned the study 'Reducing Greenhouse Gas Emissions from Heavy-Duty Vehicles' (March 2008 by Faber Maunsell), in which GHG reduction potential and policy options were evaluated.

From 2009 onwards, several projects were initiated for further evaluation of CO_2 reduction potential, policy options and the development of a certification procedure:

- LOT 1 project: 'Reduction and Testing of Greenhouse Gas (GHG) Emissions from Heavy Duty Vehicles – Lot 1: Strategy';
- LOT 2 project: 'Reduction and Testing of Greenhouse Gas (GHG) Emissions from Heavy Duty vehicles, LOT 2, service contract N° 070307 /2009/548300/SER/C3;
- HDV-CO_2 simulation tool: (ARES(2012)401058 "Development of a Heavy Duty Vehicle CO_2, Emissions and Fuel Consumption Simulation Tool", JRC Internal reference: IET/2012/F/08/03/NC;
- JRC "Proof of concept report", 03/02/2014;
- LOT 3 project: 'Development and validation of a methodology for monitoring and certification of greenhouse gas emissions from heavy duty vehicles through vehicle simulation'; Service contract CLIMA.C.2/SER/2012/0004 (report 2014);
- Marginal abatement cost curves for Heavy Duty Vehicles, Publication code: 12.4726.63, for the establishment of cost curves for packages of technical measures for CO_2 reduction (2012).

Most reports are available under:
http://ec.europa.eu/clima/policies/transport/vehicles/heavy/studies_en.htm

The LOT 1 project provided a solid overview of the European truck manufacturing industry, an overview of possible policy and technical measures for reducing HDV energy consumption and CO_2 emissions. In 2011 TIAX carried out a study for the ICCT on the "European Union Greenhouse Gas Reduction Potential for Heavy-Duty Vehicles", which is available through the DG CLIMA website, and provides a more detailed assessment of costs and potentials of CO_2 reduction options for HD vehicles in 2030, a comparison to the results of the LOT 1 study, as well as a comparison between EU and US baseline trucks.

In LOT 2, the basis of the certification procedure was developed. Several options for a procedure were studied:

- Chassis dynamometer measurements
- On road testing with PEMS
- Simulation tool & component testing

The third option, the simulation tool, was chosen because it provides the most cost efficient, flexible and accurate basis to cover all truck models and the best incentive to improve all systems that play a role in the HDV energy consumption. These are the base truck including engine, gear box and axle transmission, auxiliaries and tires, the body (cargo) of the truck and the (semi) trailer. In the future, the simulation tool may also provide a good basis for individual fleet owners to use to select truck types and configurations that would best serve their particular usage pattern. The accuracy of the simulation approached was assessed positively in the above-mentioned JRC "Proof of concept report' released in February 2014.

LOT 3 provided a complete description of the CO_2 test procedure in the form of a technical annex for a regulation and the corresponding software together with a set of default values for those components were generic data is allowed instead of vehicle specific values. Within LOT 3, the test procedure was validated in a proof of concept phase on a sample of vehicles and components. Additionally a method for verification of the CO_2 declaration values by the type approval authority will be developed. The entire test procedure was elaborated and validated for three important HDV categories in LOT 3.

The subject of this service request (1) includes the identification and analysis of options for the certification, validation, and reporting and monitoring of HDV fuel consumption and CO_2 emissions. It also includes a detailed costs analysis of what the options would mean for the main stakeholders.

1.2 Aim and approach

A specific service request has been issued by the EC under Framework Service Contract CLIMA.C.2/FRA/2013/0007. This work under this contract, managed by TNO, has the objectives to identify, define and analyse options for Certification, Validation, and Reporting and Monitoring of fuel consumption and CO_2 emissions from heavy-duty vehicles and to determine the costs of these options to the relevant stakeholders. The Commission would ultimately utilize this work to support future legislation along with a full cost-benefit analysis which will be needed to complement the already completed (but not publically available) Impact Assessment.

The consortium assembled for this task consists of senior and support staff from TÜV NORD, the International Council on Clean Transportation (ICCT) and TNO.

1.3 Structure of the report

Under section 2, this report describes the overall project methodology and structure of the work plan, including the actual planning.

The work performed under the tasks 1, 2 and 3 is described in the sections 3, 4 and 5 respectively. In section 6 an overview of key questions for stakeholders is given. The work done on tasks 1, 2 and 3 includes the definition and the in-depth analysis of options for respectively certification, validation and monitoring & reporting.

2 Methodology

2.1 Overall project methodology and structure of the work plan

The table below summarises the tasks that will be completed for this project and the main activities of each task. Also the respective task leaders are indicated. The tasks are schematically presented in figure 1 below.

Table 1: Description of tasks and task leaders.

Task #	**Task**	**Main activities**	**Task leader**
1	Certification ex-ante	- Identification, definition and assessment of certification options for HDV fuel consumption and CO_2 emissions, including a clear definition of tasks and responsibilities of the different stakeholders involved.	TÜV NORD
2	Ex-post: validation	- Identification, definition and assessment of validation options for HDV fuel consumption and CO_2 emissions, including a clear definition of tasks and responsibilities of the different stakeholders involved.	TÜV NORD
3	Monitoring & Reporting	- Identification, definition and assessment of options for a European monitoring and reporting system for HDV fuel consumption and CO_2 emissions. - Identification of tasks and responsibilities of the different stakeholders involved.	TNO
	Stakeholders consultation	Stakeholders consultation for tasks 1-6: - Interviews and questionnaires - Workshop - Stakeholders include truck manufacturers, trailer and body manufacturers, key (driveline) parts suppliers, Technical Services, Approval Authorities, the European Commission and EEA	ICCT
4	Costs of Certification	A detailed costs analysis of the (ex-ante) certification for the industrial stakeholders on these options for certification, validation and monitoring and reporting.	ICCT
5	Costs of validation	A detailed costs analysis of the certification validation (ex-post) for the industrial stakeholders.	ICCT
6	Costs of Monitoring & Reporting	A detailed costs analysis for a European monitoring and reporting system, including costs for Industrial stakeholders, for Technical Services, Approval Authorities and the Commission.	ICCT

The stakeholder consultation will be performed in parallel with the other tasks throughout the project (figure 2). It is necessary to involve the Stakeholders early in the project in order to introduce the project, its goals, and the Consortium (project team). It is also key to highlight the importance of the stakeholder's contribution and buy in. The earlier that the stakeholders are aware of their role and the fact that they will likely be called on to participate in the project though consultation, the higher the likelihood of fruitful Stakeholders discussions. A stakeholder

consultation shall take place in the middle of the project (tentatively September 2014), upon completion of tasks 1, 2 and 3, yet prior to the start of tasks 4, 5, and 6. In addition to the mid-project stakeholder consultation, we intend to have a final presentation for briefing key stakeholders at the conclusion of the project.

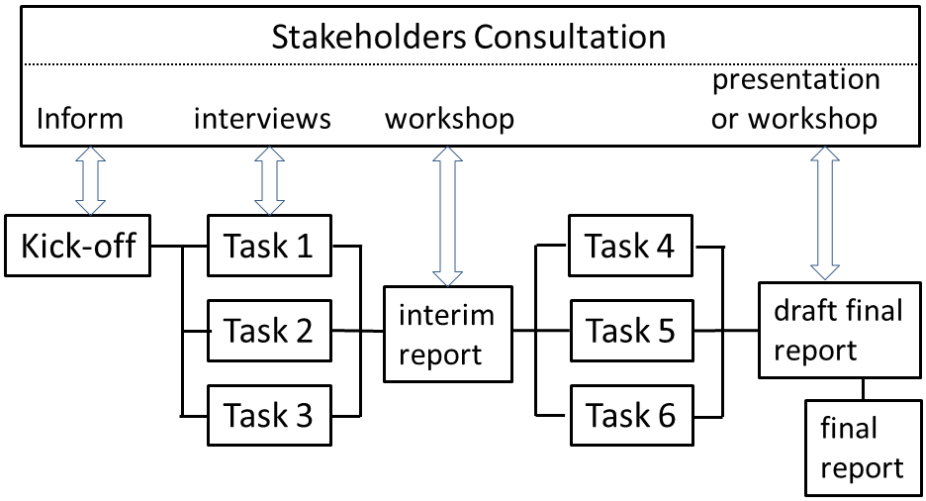

Figure 1: schematic representation of the project.

2.2 Planning

The planning of the project, as confirmed during the kick-off meeting, is presented in table 2 below. The planning is shifted 1 month later compared to the project proposal.

Table 2: Time planning of the project.

	2014												2015
Month	1	2	3	4	5	6	7	8	9	10	11	12	
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan
Task 1: Certification ex-ante													
Task 2: Certification ex-post : validation													
Task 3: Monitoring & Reporting													
Task 4: Costs of Certification ex-ante													
Task 5: Costs of validation ex-post													
Task 6: Costs of Monitoring & Reporting													
Stakeholders consultation and workshop									SW				SW
Meetings & Telephone conf.	M				T	M			M		M		
Inception report	IR												
Interim report									IR				
Draft Final Report										DF			
Final Report												FR	

S = Stakeholders consultation (interviews), SW = Stakeholders Workshop (either in month 6 or month 10/11)

M = Meeting, T = telephone conference

2.3 Progress and future work

Work in other service contracts related to the topic CO_2 emissions of HDV, which may serve as important input to the work reported here, had yet to be finished as a result of which the definition of options for this service request was postponed by a month. Also the definition of options is not necessarily complete yet. Depending on the outcome of other SR and the stakeholder consultations, new or additional options may come up and may need to be included at a later stage in the project.

This interim report describes primarily the work performed for the tasks 1, 2 and 3 of the project. This concerns the definition and the elaboration analysis of options for the Certification, Validation, and Reporting and Monitoring of fuel consumption and CO_2 emissions from heavy-duty vehicles.

The options defined shall be further assessed with stakeholders in a second phase following. The comparative assessments of options shall take place once all relevant stakeholders have been consulted for their view, and information has been retrieved regarding the options. Consequently, the costs of the different options will be estimated (tasks 4, 5 and 6).

3 Task 1: certification and ex-post validation

3.1 Introduction

Within the activities of service contract CLIMA.C.2/SER/2012/0004 "*Development and validation of a methodology for monitoring and certification of greenhouse gas emissions from heavy duty vehicles through vehicle simulation*" a certification procedure related to the new methodology to provide robust data on the level of CO_2 emitted by the whole HDV including trailers and different bodies was developed.
In view of the vast number of variations and combinations possible in the construction and usage of HDV's it does not seem to be possible to determine the CO_2 emissions and fuel consumption through tests that are representative for a vehicle type, as it is done for light duty vehicles. Instead of such testing the simulation tool, "VECTO" has been developed. This working assumption of the Commission is however tested in the present report which compares the simulation based approach with other options.

VECTO can simulate the CO_2 emission and fuel consumption of each vehicle produced, based on input data of vehicle components. With that tool it seems appropriate that the CO_2 values per vehicle produced can be generated by the manufacturers of the vehicles themselves, taking into account the final specification of the vehicle by applying a downloadable and executable version of the VECTO simulations tool.
The aim of the certification procedure is therefore to ensure that the determined CO_2 and fuel consumption values are **comparable** between different manufacturers, **verifiable** by a third party and **monitorable** by the competent authorities (Commission and Member States). The certification process shall

- create a procedure to generate a robust CO_2 / fuel consumption value for each HDV produced and
- to allow for recording and monitoring of such values

In mid-term perspective the monitoring of CO_2 emissions shall generate knowledge of the CO_2 emissions of different vehicle segments which could also be a basis for later regulation of CO_2 emissions.

For the development and assessment of options for certification the legal implementation is also considered briefly in appendix B. For this implementation the most obvious options are considered

The assessment of these options regarding the legal base to consider is not part of the present report. The way forward will be further discussed within the editing board that is being established by DG ENTR.

The focus of this chapter (3) and the following (4) is the definition of options for:

- the determination of a specific CO_2 value / fuel consumption,
- the process of conformity of production (CoP),
- and an ex-post validation procedure that is being considered either independently, or as a cornerstone of CoP.

This is the basis for a comparative assessment and cost-benefit analysis which will be done for the options.

3.2 CO_2 and Fuel Consumption Determination Methodology

The methodology for the determination of the specific CO_2 emission and fuel consumption shall be as fair, robust, reliable, traceable and repeatable/reproducible as possible. Furthermore, the development and optimization of vehicle components that reduce the CO_2 emission shall be stimulated.

Below the options are summarized for the method of determination of the vehicle CO_2 emission and fuel consumption. Option D3 is more or less similar to the process of CO_2 determination for light duty vehicles, where the CO_2 emission is determined by means of coast down tests and chassis dynamometer testing. The other options use VECTO, the simulation tool, as basis for the determination of the vehicle CO_2 emission. The options vary in the effort needed to determine the contribution of the components, from simulation to testing.

3.2.1 Option D1: Combination of component testing and simulation / VECTO (baseline option, Lot3)

A particular CO_2 and fuel consumption value shall be generated for each newly produced vehicle. The simulation by VECTO with component input values for each specific vehicle put on the road requires well defined procedures on how to establish these input values (described in the “Technical Annex”).
The VECTO tool is designed in such a way, that on the very beginning the particular vehicle configuration is specified and described within the applicable vehicle segment(s) defined. For the time being 17 vehicle classes (trucks only, buses and coaches to be integrated later) are defined. Beside the base vehicle definition also the bodies respectively trailer / semi-trailers are allocated to the vehicles based on standard configurations (in a further step also individual bodies and trailers shall be integrated).
After the overall vehicle configuration is specified, the CO_2 and fuel consumption affecting parameters necessary as input for the VECTO are determined by testing and verification. This part of the process is considered as *component testing*. In a very generic view the component testing activities are related to following issues:

- Air drag test; an additional assessment tool called the *CSE (constant speed test evaluation)* tool for the calculation of the air drag coefficient C_d is part of the *VECTO.*
- Transmission / Axle test; this covers the determination of the efficiency of the complete vehicle drive train, such as gearboxes, axles, transfer cases etcetera.
- Engine test; this test is necessary to describe the engine fuel consumption map as VECTO input.

As an option it is considered to describe default values (at least for the Axle, the transmission and with respect to few applications for the Air Drag) which can be used instead of values generated by testing. Those default values shall be set to ranges which are less attractive than values possible by state-of-the-art technologies in order to provoke the use of advanced components.
Furthermore, some of the auxiliaries installed in the vehicle and on the engine are CO_2 and fuel consumption affecting components. Unlike the testing specification

indicated in the Technical Annex for the Air Drag, the Transmission / Axles and the Engine, specific testing provisions for such auxiliaries are not available so far. For that reason the power consumption of truck auxiliaries is considered within the CO_2 and fuel consumption calculation by adding a constant power demand to the engine load. Under the present version of VECTO power demand is defined (in tables within the Technical Annex) in dependence of the auxiliary type and can be dependent on the vehicle segment, the application and the specific technology.

The power consumption of the following auxiliaries shall be considered:

- Cooling fan(s)
- Steering pump(s)
- Electrical system/Alternator
- Pneumatic system(s)/Air compressor
- Air-Conditioning system(s)

For the time being these default auxiliaries values are only applicable to trucks. For buses and coaches (where auxiliaries may have a higher share on the total energy consumption) a more sophisticated approach is currently under development[1]. This is of particular importance for *HVAC* (heating, ventilation, and air-conditioning) systems for buses and coaches.

Another important VECTO input value is the *rolling resistance co-efficient (RRC)* of the vehicles tyres. This value does not need to be determined separately within the CO_2 process since it is available via the tyre manufacturer (considered as supplier to the vehicle manufacturer). For the tire labelling of Regulation EC 1222/2009 (EC 1235/2011) the RRC to be declared is already determined in accordance with ISO 28580. The applicable tyre rolling resistance coefficient (RRC) for each of the tyres installed on the vehicle is declared by the vehicle manufacturer.
The general layout of the procedure is depicted in Figure 2.

[1] Quantify energy consumption of Heavy Duty Vehicle auxiliary components and their contribution to CO_2 emissions of buses and coaches. Integrate auxiliaries into the VECTO simulator and into the certification methodology for HDV CO_2 emissions. CLIMA.C.2/FRA/2013/0007

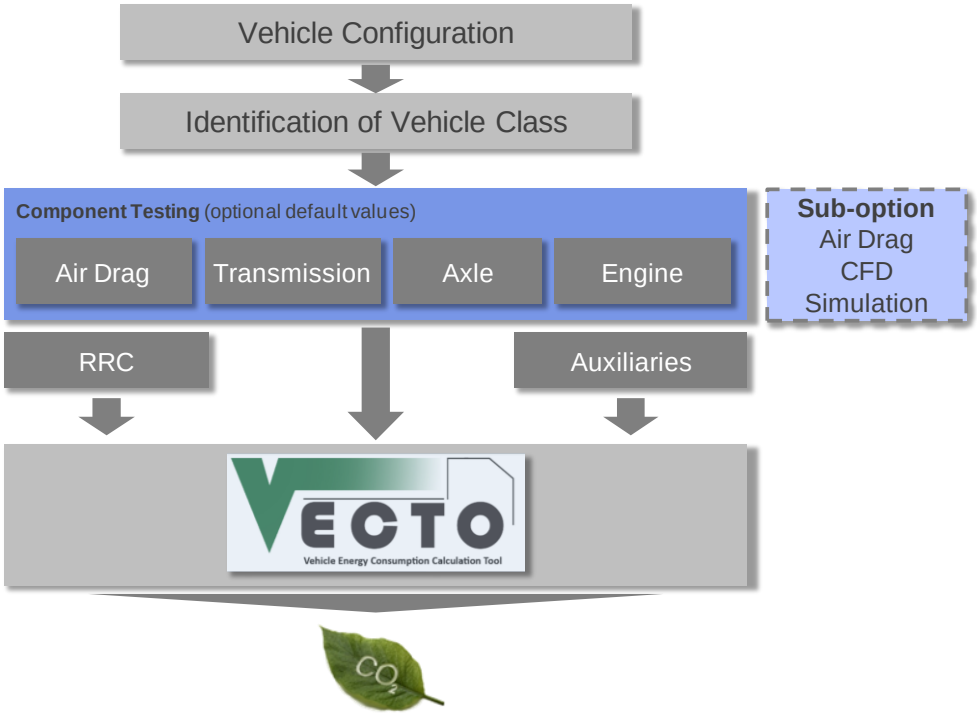

Figure 2: Process scheme of baseline option.

3.2.2 *Option D2: Simulation and Reduced Testing Effort (simplified baseline option)*

The second option is mainly a simplification of the baseline option by reducing the test effort. Testing is in this approach only done for the engine by generating a detailed fuel map. Transmission and axle efficiencies are based on technology specific default values /maps. The air drag can be computed by a CFD simulation, RRC values could still be taken from the measurements in accordance with ISO 28580 (to be performed by the tyre manufacturer and communicated between vehicle and tyre manufacturer). Auxiliaries are based on technology specific default values.

Effects of these options would be an appreciable reduction of costs and efforts for the vehicle manufacturer but in parallel loss of accuracy (part of the assessment) and a strong limitation on technology drivers for manufacturers and component suppliers.

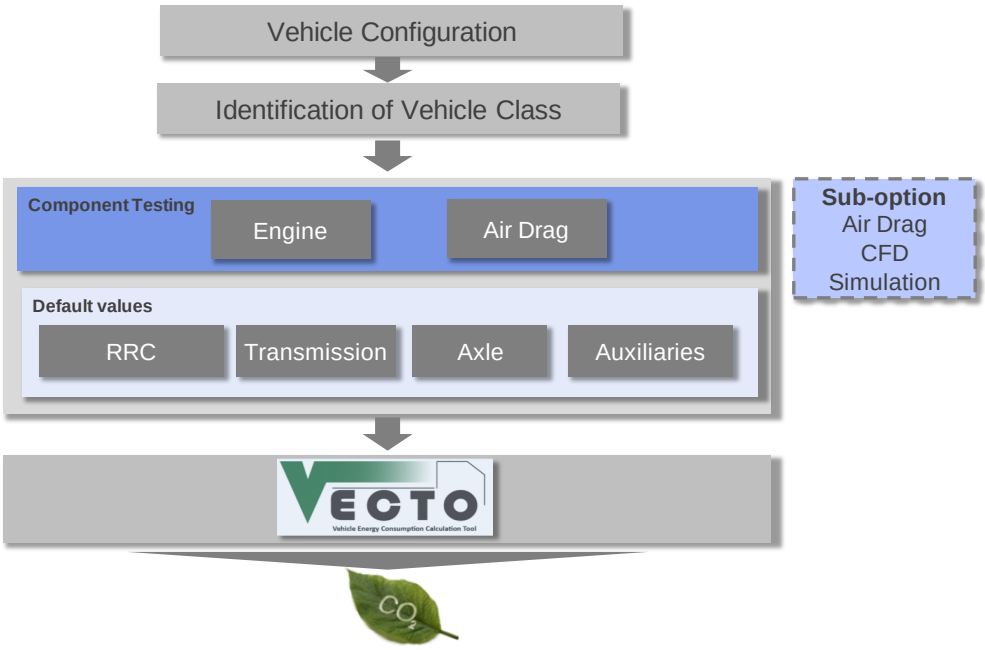

Figure 3: Process scheme for simplified baseline option.

3.2.3 *Option D3: Chassis Dyno Test*

The third option for the determination of CO_2 emissions is based on chassis dyno tests. Because of the huge variety of commercial vehicle specifications with respect to cabin and drivetrain design, auxiliaries, add-ons, etc., it will not be possible to test each vehicle configuration on a chassis dyno. An option would be the building of families on basis of a worst case approach with the result, that not every produced vehicle gets a specific CO_2 value in the first step. This could be overcome by generating technology specific bonifications and therewith build the opportunity to label each vehicle with a specific value.

Nevertheless, driving resistances (air drag and rolling resistance) have to be measured as input data for the chassis dyno. This can be done either by the combination of constant speed tests and RRC values communicated by the tyre manufacturers or similar to passenger cars on basis of coast down tests (which was pointed out to be not accurate enough for simulations). An approach based on standard bodies/trailer/semi-trailers could be used, similar to option 1, to determine the driving resistance of the complete configuration.

Tests are finally performed on the chassis dyno, simulating defined payloads. Applications specific cycles could be applied, similar to those defined in the baseline option.

The possibility and burdens regarding the definition of vehicle families have to be further assessed.

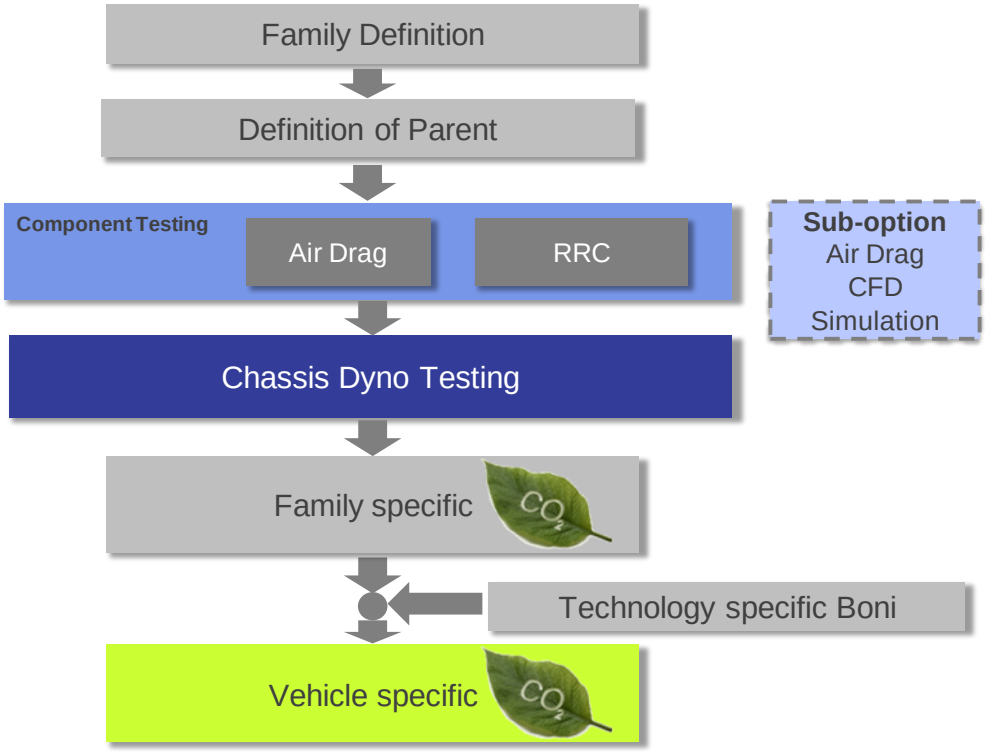

Figure 4: Process scheme chassis dyno testing.

3.2.4 *Option D4: Fuel Consumption Measurement during Real Driving*

Another option would be the direct measurement of CO_2 or fuel consumption during real driving conditions on a similar basis as defined for the In-Service Conformity measurements according to 582/2011/EC (related to the measurement procedure, not the choice of vehicles).
In 582/2011/EC "the conformity of in-service vehicles or engines of an engine family shall be demonstrated by testing vehicles on the road operated over their normal driving patterns, conditions and payloads. The in-service conformity test shall be representative for vehicles operated on their real driving routes, with their normal load and with the usual professional driver of the vehicle. When the vehicle is operated by a driver other than the usual professional driver of the particular vehicle, this alternative driver shall be skilled and trained to operate vehicles of the category subject to be tested. Ambient conditions (temperature, wind, rain) have a significant impact on fuel consumption. Therefore a bandwidth for ambient conditions would need to be defined or/and a correction formula for ambient conditions would need to be developed.
Similar to option 3 (chassis dyno), vehicle families and parents could be defined to reduce test efforts and be tested on basis of application specific operating conditions. The boundary conditions for testing would have to be tightened because it is not measured against a limit with compliance factor (pass/fail criterion) but a specific value shall be generated.

To finally generate vehicle specific data, similar to option 3 (chassis dyno), technology specific bonifications could be defined and applied.
The possibility and burdens regarding the definition of vehicle families that are required under this option (testing is only possible on a small number of vehicles) have to be further assessed.

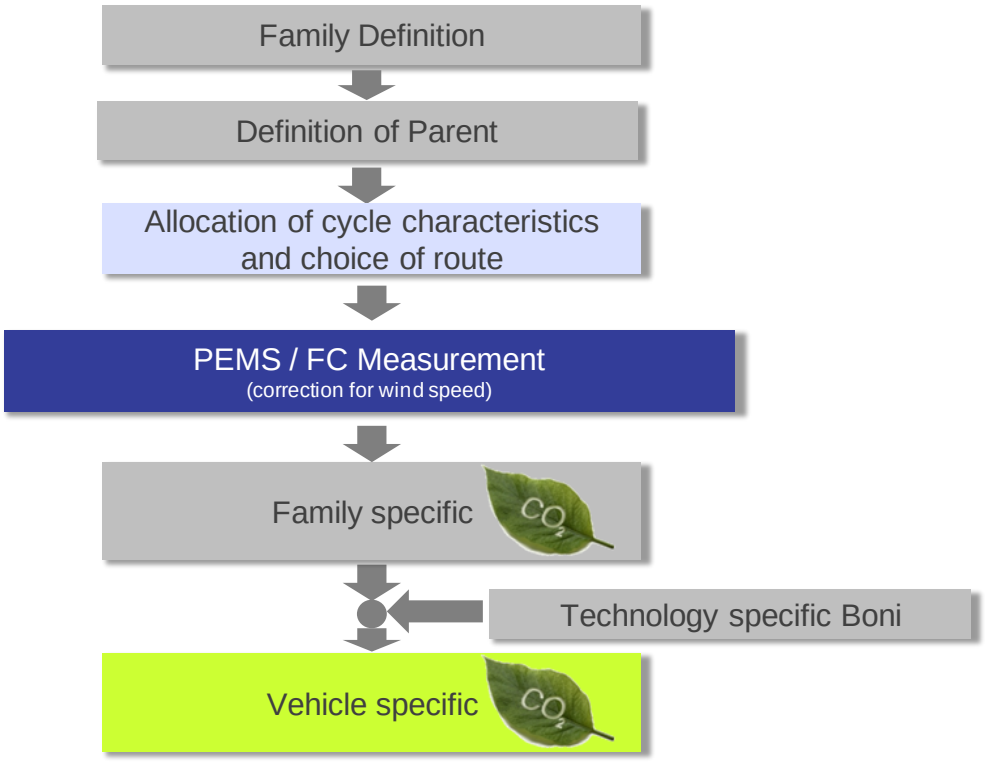

Figure 5: Process scheme FC real driving testing.

3.2.5 *Option D5: Simulation and Transient Engine Test*

A further option is the reversion of the baseline option. On basis of the specific vehicle, body/trailer/semi-trailer configuration and tested, simulated or default data related to air drag, rolling resistance, transmission, axle and auxiliaries, a simulation of the longitudinal dynamics within application specific cycles can be performed, similar to the baseline option. Different to the base line option, the fuel map of the engine is not measured and not part of the simulation tool. Based on the vehicle speed and the resistance forces, torque and speed at the wheels can be calculated and passed through axle and transmission to the engine. As the fuel map is not part of the simulation, the result is not a vehicle specific CO_2 or fuel consumption based on an engine fuel map, but a specific load and speed profile of the engine in a first step. This simulation can be performed for each vehicle configuration and therewith result in different load/speed profiles of the engine. The determination of fuel consumption, respectively CO_2 emission, is afterwards done by testing the engine on a transient engine test bench on basis of the before simulated and vehicle and application specific load and speed profiles. Advantage of this approach compared to the baseline option is the possibility of display the transient behaviour of the engine. Example of such an approach is the HILS methodology for heavy duty hybrids.

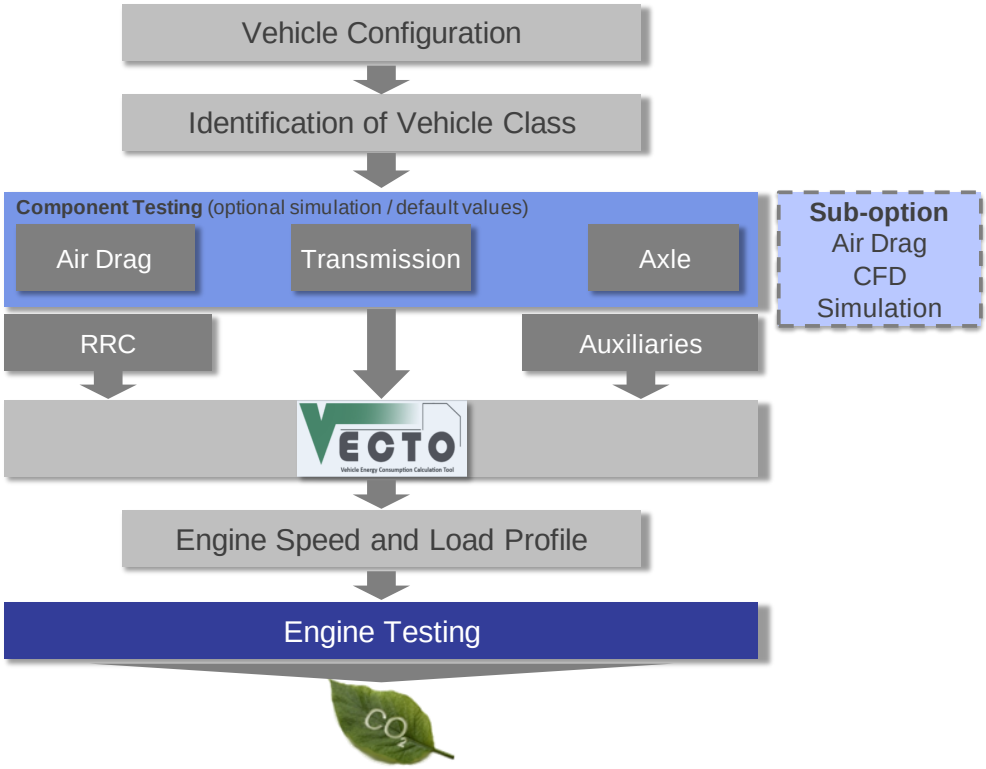

Figure 6: Process scheme simulation and engine test.

3.2.6 *Sub-Option CFD*

For all options a sub-option analysing the cost-benefit of the use of CFD simulations to examine the air drag instead of measurements will be assessed.

3.3 Conformity of Production (CoP)

CoP shall ensure that adequate arrangements have been made to safeguard that produced vehicles, systems, components or separate technical units conform to the certified product. In principle, three options how to test the conformity of production can be defined:

- Component specific
- Process specific
- Complete vehicle test

For sure, the applicability of these options depends on before defined approaches of the determination of the CO_2 and fuel consumption value and the later legislative implementation.

3.3.1 *Option P1: Component specific CoP*

Related to an approach based on a combination of component testing and simulation for the determination of CO_2 and fuel consumption values, the input data to the simulation, this means the tested components, could be in the focus of a CoP. This option is based on the assumption, that if the different components and therewith the input data to the simulation are conform to the data delivered for the certification of the vehicle/CO_2 value, the certified product (vehicle) is still conform. The component specific CoP tests could be done in accordance with the defined

test procedures used for the determination of input data for the simulation. Tolerances or conformity factors have to be defined for each component / data set.

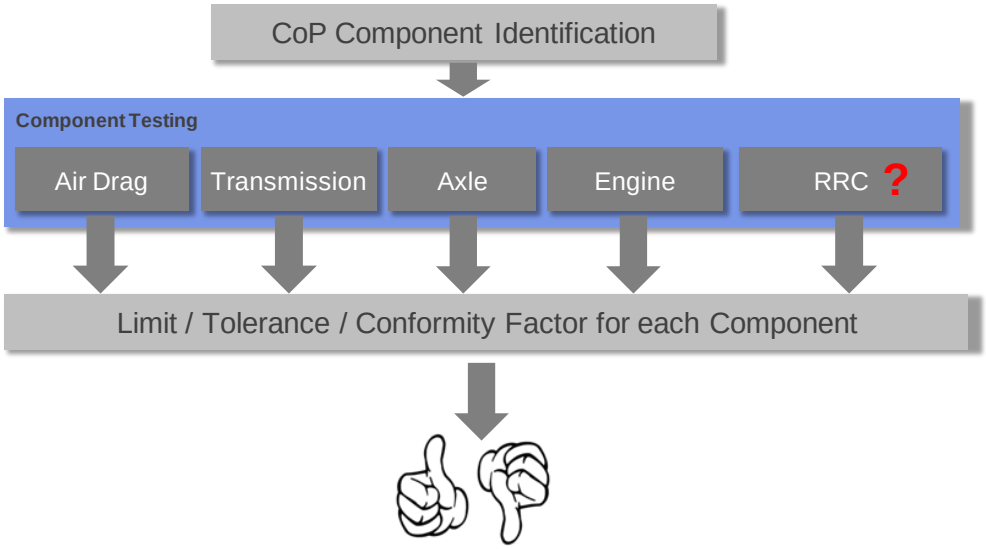

Figure 7: Component specific CoP.

3.3.2 *Option P2: Process specific CoP*

The process specific CoP includes a complete repetition of the process, from the component testing to the simulation of the final, vehicle and application specific CO_2 and fuel consumption value. Therewith, the certified and retested/simulated CO_2 values can be directly compared. If larger deviations are recognized, the causing component(s) has/have to be identified and further investigations to be carried out.

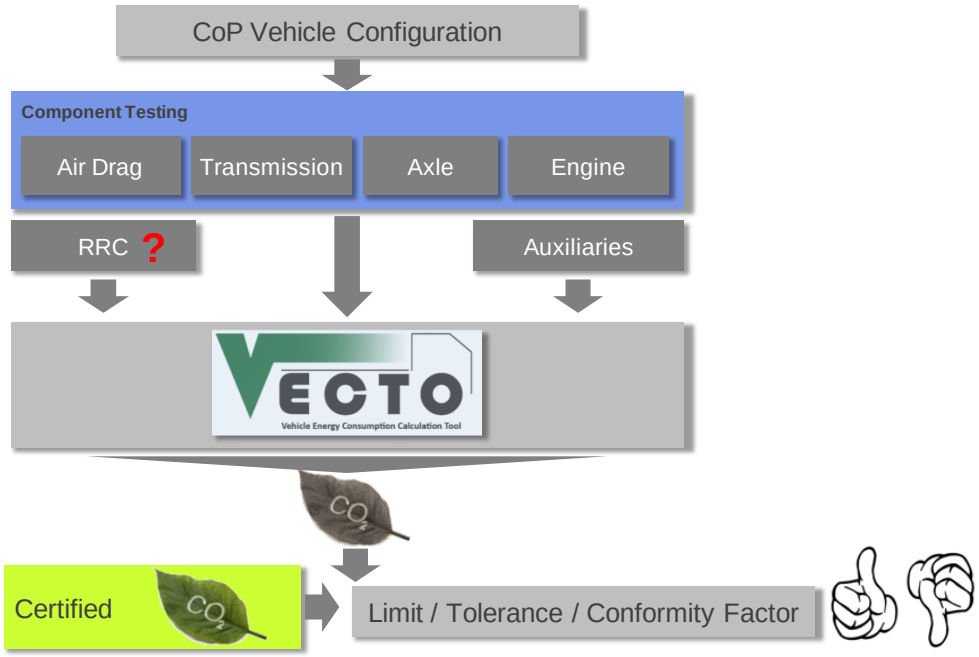

Figure 8: Process specific CoP.

3.3.3 *Option P3: Vehicle specific CoP*

3.3.3.1 *Simplified Short Cycle Test (baseline option)*

The currently as ex-post validation discussed option is based on a simplified test cycle consisting of constant speed and acceleration/deceleration events to be driven on a test track monitoring the fuel consumption. During the certification of the vehicle, based on the approach combining component testing and simulation, the CO_2 value / fuel consumption within this simplified cycle is simulated in parallel to the later registered CO_2 / fuel consumption value based on the realistic, application specific cycle. Therewith, the simulated CO_2 / fuel consumption value for the simplified cycle can be directly compared to the measured one on the test track during CoP.

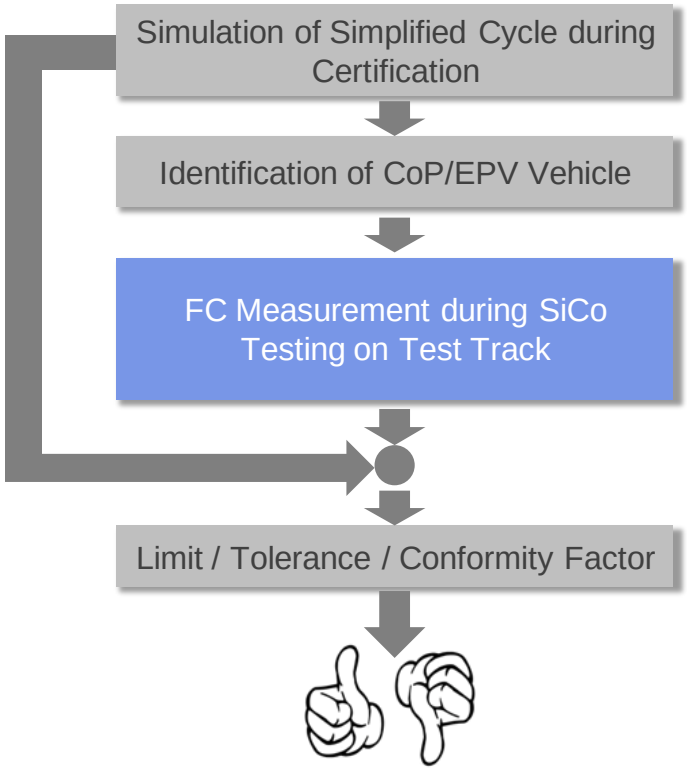

Figure 9: Vehicle specific CoP - SiCo

3.3.3.2 PEMS or fuel meters

Another option would be the direct measurement of CO_2 or fuel consumption during real driving on a similar basis as defined for the In-Service Conformity measurements according to 582/2011/EC (related to the measurement procedure, not the choice of vehicles).

In 582/2011/EC “the conformity of in-service vehicles or engines of an engine family shall be demonstrated by testing vehicles on the road operated over their normal driving patterns, conditions and payloads. The in-service conformity test shall be representative for vehicles operated on their real driving routes, with their normal load and with the usual professional driver of the vehicle. When the vehicle is operated by a driver other than the usual professional driver of the particular vehicle, this alternative driver shall be skilled and trained to operate vehicles of the category subject to be tested.”

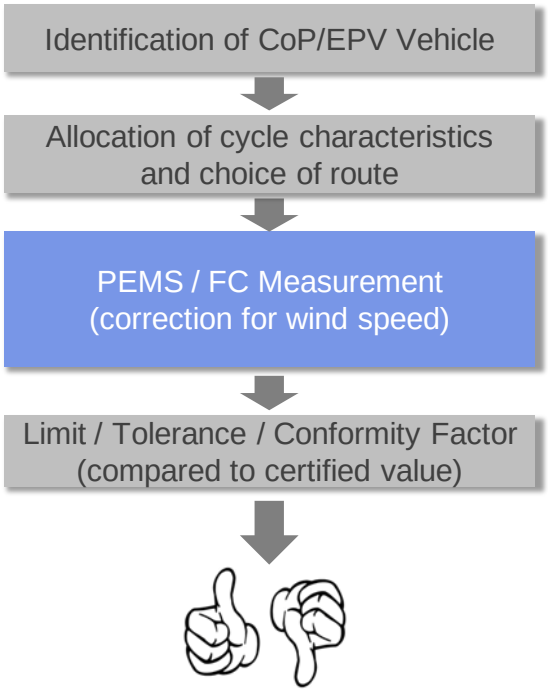

Figure 10: Vehicle specific CoP – Real Driving

3.4 Certification related issues

3.4.1 Non-standard bodies/trailers/semi-trailers and Multi-Stage Vehicles

HDVs are often individual vehicles produced by more than one manufacturer in several stages (e.g. base vehicle produced by manufacturer A, completed with a super-structure by manufacturer B). A rigid tipper truck is a typical example of such a vehicle, where the tipper body is installed by manufacturer B onto a base vehicle of manufacturer A. Within the type approval framework a so called multi-stage approach is described to cover the type approval of vehicles completed in more than one stage.

The methodologies considered above for the certification of HDVs CO_2 emissions do neither foresee a certification of non-standard bodies/trailers/semi-trailers nor a multi-stage approach. Currently, incomplete vehicles are to be completed with defined standard bodies, vehicle combinations are to be certified with standard trailers/semi-trailers. Vehicles equipped with others than standard bodies/trailers/semi-trailers are therewith not covered within the procedure so far. As the CO_2 labeling approach should also push the improvements within the body/trailer/semi-trailer industry, a corresponding legislative basis in matters of a second stage of certification **could** be developed. Therewith the first stage of certification ("first-stage-certification") is directly done by the OEM of the vehicle for vehicle with default bodywork, an optional "second-stage-certification" **could** be introduced to give the possibilities to body/trailer/semi-trailer manufacturers to get a certification for their product which may differ from and be better than the vehicle with standard body/trailer/semi-trailer.

In principle, two options for an integration into the actual methodology are conceivable :

3.4.1.1 Option S1:Simulation of further stages with VECTO:

After the certification of the complete vehicle on the basis of a standard body/trailer/semi-trailer any further certification (multi) of the complete vehicle with a non-standard body/trailer/semi-trailer can be performed by the corresponding body/trailer/semi-trailer manufacturer by running through the complete simulation again with the changed relevant data (air drag and mass to be measured by manufacturer B). Such a proceeding raises confidentiality issues regarding data transfer / black box models from manufacturer A to manufacturer B, which have to be intensively discussed and solved beforehand.

3.4.1.2 Option S2: Table based calculation:

For this second option the influence of a defined bandwidth around the measured air drag and mass on the fuel consumption and CO_2 emission has to be simulated with VECTO. For the second or any further stage of the certification with a non-standard bodies/trailers/semi-trailers the corresponding CO_2 emissions and fuel consumption can be calculated on basis of the **actual** air drag and mass by manufacturer B and the corresponding table values from stage 1. Any possible issues regarding data confidentiality are therewith solved. This however requires an air drag value to be calculated (air drag test or CFD calculation) which may be costly.

3.4.2 Families

Families within the different options may need to be implemented on different levels. While for simulation based approaches (D1, D2, D5) families can be defined on component level (engine, transmission, axle, air drag), whole vehicle families have to be defined for approaches related to vehicle testing (D3, D4) to guaranty reasonable effort. Due to the huge variety of bodies/trailers/semi-trailers, a family approach is necessary for the “first-stage-certification” for all options.

The possibilities and burdens to identify/define those kinds of families need to be intensively discussed within the editing board. The effects regarding the loss of accuracy for single vehicles have to be analyzed and compared with the objectives set by the COM.

4 Task 2: ex-post validation

A random verification of the VECTO calculated fuel consumption and CO_2 emission versus real on-road measured fuel consumption and CO_2 emissions is considered necessary as additional measure. The recent status stipulates certain measures for this verification. The simulated CO_2 value for a certain vehicle can be checked by applying real-world testing to vehicles equipped with fuel flow measurement devices[2]. The real-world fuel consumption can then be checked against the VECTO fuel consumption receptively CO_2 value calculated for a correlative simplified and partial driving profile. (see option P3.1). Additionally, the above described options related to the vehicle specific CoP should be considered also as possible ex-post validation of the certified CO_2 value.

Options within this sections and the corresponding assessment of those will be further detailed and described within the final report.

[2] Similar to Euro VI PEMS testing

5 Task 3: monitoring and reporting

5.1 Introduction

Monitoring is defined as the activity to collect information of the heavy-duty vehicle (HDV) fleet related to CO_2 emissions, while reporting is the activity to process and present results of fuel consumption and CO_2 emissions.

In the EU, the monitoring and reporting of CO_2 emissions is in place for passenger cars and light commercial vehicles (Regulations (EU) No 1014/2010 and (EU) No 293/2012). These regulations have prescribed methodologies for monitoring and reporting the CO_2 emissions of the given group of road vehicles of EU vehicle class M1 and N1 ((with a reference mass not exceeding 2610kg) and to vehicles of category N1 to which type approval is extended.)

The short-term action of the EC with regard to HDVs is now focussed on monitoring & reporting of fuel consumption and CO_2 emissions. The primary objective of the EC is the annual reporting of the fuel consumption and CO_2 emissions for the newly registered HDV, per HDV manufacturer and per EU Member State, to be able to track the development of the fuel consumption and CO_2 emission of the EU fleet of HDV.

For HDVs the situation is different than for passenger cars and most LCVs. HDVs are used in different configurations such as tractors with different type of semi-trailers, rigid trucks with different bodies and rigid trucks with or without trailers. Like for the group of Multi-stage Vans (MSV), rigid trucks are often constructed in more than one stage and into many configurations, meaning that more parties than the base vehicle manufacturer are involved in the process of construction of a completed vehicle. Also different ways of (type) approval are used: national small series, whole vehicle type approval, individual type approval. This means that information regarding the specific CO_2 emission of a completed vehicle has to be made available in all these instances so that the specific CO_2 value can be registered in the Member State vehicle registration. For MSVs, a method for measuring and monitoring CO_2 emissions was already developed and implemented in EU regulation (carried out by TNO). The importance of MSV in the EU fleet is small however (about 7% of N1), and as such an approach which is based on a 'default added mass' keeps the system for CO_2 measuring and monitoring simple, cost effective. I.e. the reference (test) mass of the base vehicle is increased by a default added mass representative of the completed vehicle in order to deliver a value for the specific CO_2 emission that is representative for the completed vehicle but may be reported in the CoC of the base vehicle. In that case the vehicle manufacturer knows the CO_2 emission value of his product already at the moment of production.

For HDV, the situation is somewhat comparable to MSV, especially given the typical distributed market of production of completed HDV by either the vehicle manufacturer, or through stages of production, including a base vehicle manufacturer and further stages where small to large bodybuilders add bodywork.

There are however several differences. With HDV, the trucks are used in very different applications (such as distribution, long haulage, construction, etc.), which results in entirely different driving patterns (mission profiles) and entirely different bodies & (semi)trailers. For the monitoring this difference seems mostly relevant for the further aggregation of data at the reporting stage. I.e. depending on the use of the data, it may or may not make sense to lump together HDVs with different missions, masses and applications.

A technical way to reduce the fuel consumption and CO_2 emissions of HDV is to optimise the body/trailers and accessories. However, in that case it would be necessary to measure and attribute CO_2 emissions not only to the (base) vehicles, but also to the (semi) trailers (see sub-option on second stage certification). This would help to ensure that technical options to decrease fuel consumption and CO_2 emissions are used to the full potential. This however would increase the complexity of the system of measuring, monitoring and reporting and also divides responsibilities over different stakeholders.
The focus of this work on options for reporting and monitoring is therefore on vehicles with default bodywork or (semi-) trailers.

In the LOT2 report, the market shares for the different bodies were estimated by TNO. In Table 5, these market shares are given for rigid trucks.

5.2 Current status of the method for the determination of CO_2 emission of HDV

The current method for 'measuring' fuel consumption and CO_2 emissions for HDVs (with the tool named VECTO) is a model based approach and can, in principle, handle a wide variety of vehicle types and technical variations. As such, already early in the process the CO_2 value can be calculated, if the total set up of the vehicle produced or to be produced is known.

For certification and monitoring & reporting system, the vehicle segmentation proposed by ACEA (Table 3) can be involved in the options. The segmentation is based on the axle configuration. Additionally to this a number of standard bodies were defined, indicated by B1 thru B9 for rigid trucks and ST1, ST2, T1 and T2 for (semi) trailers. Refer to Table 4 for an overview and the Lot 3 report. It should be noted however, that in practise there are substantial variations in bodies or mounted accessories and not all body types are covered.
The estimated market shares of different body types of rigid trucks is included in Table 5.

Table 3: Vehicle segmentation proposed by ACEA.

ACEA proposal Vehicle segmentation trucks ≥ 7.5 t													
	Identification vehicle configuration			Class	Cycle allocation Vehicle configuration / weight / axle loads								
	Axle configuration	Chassis configuration	weight	Vehicle Class	Long haul	Regional delivery	Urban delivery	Municipal utility	Construction	Standard Bodies (B)	Standard Trailer (T)	Standard Semitrailer (ST)	National specific variation (N)
2 axles	4x2	Rigid + (Tractor)	7.5t - 10t	1		R/W	R/W			B1			
		Rigid + (Tractor)	> 10t - 12t	2	R/W	R/W	R/W			B2			
		Rigid + (Tractor)	> 12t - 16t	3		R/W	R/W			B3			
		Rigid	> 16t	4	R+T/W	R/W		R/W		B4	T1		
		Tractor	> 16t	5	T/W	T/W						ST1	
	4x4	Rigid	7.5t - 16t	(6)	exclude all-wheel-drive vehicles 4x4 (sales volume < 1%)								
		Rigid	> 16t	7					R/W	B5			
		Tractor	> 16t	(8)	exclude all-wheel-drive vehicles 4x4 (sales volume < 1%)								
3 axles	6x2/2-4	Rigid	all	9	R+T/W	R/W		R/W		B6	T2		
		Tractor	all	10	T/W	T/W						ST1	
	6x4	Rigid	all	11					R/W	B7			
		Tractor	all	12					T/W			ST2	
	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/W	B9			
	8x6/8x8	Rigid	all	(17)	exclude all-wheel-drive vehicles (sales volume < 1%)								

T = tractor + semi-trailer, R+T = Rigid + Body + Trailer, T+T = tractor + semi-Trailer + Trailer

R = Rigid + Body, D = 2-axle Dolly for semi-trailer

Table 4: Overview of standard body types with formally defined dimensions. Source Lot 3 report.

Truck	Reference body type	Reference body	GVM (tonne) [1]
2 axle 4x2 rigid truck	hard shell box	B1 B2 B3 B4	10 12 16 19
2 axle 4x2 rigid truck	tipper for sand/cement	*B5*	19,5 – 20.5
3 axle 6x2 rigid truck	hard shell box	B6	27
3 axle 6x4, 6x6	tipper for sand/cement	*B7*	33 – 34,5
4 x axle 8x2 rigid truck	Construction	*B8*	all
4 axle 8x4, 8x6	tipper for sand/cement	*B9*	43 – 46
Semi-trailer	hard shell box tipper sand/cement	ST1 *ST2*	27
Trailer	box body	T1 = T2	18

[1] Indicative numbers, precise mass varies between countries

Table 5: Estimated market shares for body types for rigid trucks (source: LOT2 report).

Truck type	Config	GVW	Rigid	Bodywork rigid truck				
				Box	Bulk/ tank	Container/Swap body	Tipper	Other
Truck 2axl	4x2	7,5 - 10	36.7%	19%			6%	12%
		10 - 12						
		12 - 16						
		18 - 19	20.0%	10%	0.5%	4%	2%	4%
		all						
	4x4	7,5 -16	1.5%				0.5%	1.0%
		18 - 19	1.6%				0.6%	1.0%
		18 - 19						
Truck 3axl	6x2/2-4	24 - 26	19.4%	10%	2%	4%	1%	3%
		all						
	6x4	24 - 26	7.8%				3%	5%
		all						
	6x6	24 - 26	1.6%				0.6%	1.0%
		all						
Truck 4axl	8x2	30	0.5%				0.2%	0.3%
	8x4	30	10.2%				3.5%	6.7%
	8x6/8x8	30	0.7%				0.2%	0.5%
Total			100.0%	39.0%	2.0%	7.5%	17.5%	34.0%

For special constructions build on HDV, the same issue arises as for MSV; the use of a 'default approach' may be desirable but the choice for such a method depends on what CO_2 emission should exactly be monitored; the real CO_2 emission of a complete(d) vehicle, the CO_2 emission of the half product (base vehicle) from vehicle manufacturers or of a default vehicle? E.g. compared to MSV N1 vehicles, the default approach for HDV is intended to provide a CO_2 value that is representative for the vehicle on the road.

The design of the monitoring process and thus its complexity and costs will likely depend on what exactly should be monitored.

5.3 Goal of task 3

The aim of the work in task 3 is to identify, define and assess the options for the monitoring and reporting of HDV fuel consumption and CO_2 emissions to gain more information to enable a better statistical evaluation of the fleet and trends with regard to the CO_2 emission and the attributes which affect the CO_2 emission of HDV.

In this task the work from LOT3, the technical procedure to measure fuel consumption and CO_2, the options for certification and validation of task 1 and 2 of this study and the options for monitoring and reporting, should be brought together, taking account of:

- the current market situation of construction and certification of HDV and its consequences for the possibilities regarding monitoring and reporting, and
- the (experience with) current procedures in place for monitoring and reporting the CO_2 emissions of passenger cars and vans.
- the Commission's long term goals regarding policies to reduce fuel consumption and CO_2 emissions from HDVs.

5.4 Approach for task 3

The definition of options for monitoring and reporting will build further on the options for certification of task 1 as well as previous experience gained from the monitoring and reporting for passenger cars and vans. Interaction with task 1 of this Service Request is required as task 1 delivers the options and a comparative assessment of the options for certification of HDVs. For these options the various stakeholders taking part in the certification process and their roles will be identified (task 4). For the definition of the final options for monitoring and reporting it will be necessary to have consulted the stakeholders for their experience with monitoring and reporting CO_2 emissions of cars and vans to take note of their views.

The options on the table should be in principle the simplest processes delivering the most accurate information and should allow a robust monitoring and reporting. It should be noted that more complex processes may be needed depending on the preferred options developed in task 1. The options may include, in discussion with the Commission, alternatives to the current methodology.

The options of tasks 3 will be compared and assessed against the criteria which will have been developed with the Commission at project kick-off.
Basic criteria are:

- *Complexity, feasibility.* Are stakeholders equipped to deal with the process? Is learning time, additional communication or training required? Are additional investments needed?
- *Risks and Reliability:* are there any risks for the long term CO_2 policy of the EU (eg. loopholes, the design of the procedure and process needs to take account of this)? Risks for incorrect data? Risk for manipulation/fraud?
- *Comparability:* Could the resulting dataset be used for comparison of vehicles?
- *Fairness*: Is the impact/burden of the introduction of the monitoring and reporting process even for the individual stakeholders?
- *Representativeness, accuracy, consistency:* How well is the real CO_2 emission performance and other parameters covered by the procedure/process?
- *Confidentiality:* is data confidential and available for the process?
- *Costs:* which are to be assessed under tasks 4-5-6 of the present Service Request.

5.5 Current monitoring for light duty vehicles

The monitoring and reporting principle for light duty vehicles is that the specific CO_2 emission of each vehicle registered in a certain year in an EU Member State will be taken into account for the calculation of the 'average specific CO_2 emissions' for a given manufacturer for that given year.

The vehicle registrations of one year are reported by each EU Member State to the EEA (European Environment Agency), the body which keeps the register of the data on behalf of the Commission. The provisional detailed specific CO_2 data is sent to the manufacturer for checks and after the data has returned, the Commission, supported by the EEA, calculates and confirms for each manufacturer the final average specific CO_2 emission. This confirmed value is then compared with a target value, the 'specific emission target', set for each individual

manufacturer. The target CO_2 emission is related to the vehicles' average mass in running order, which compensates manufacturers of either lighter or heavier than average vehicles with regard to the absolute level of CO_2 emission to be reached. In this case, the responsibilities are clear. A vehicle manufacturer can, taking account of lead time, technically improve his complete product portfolio to achieve an 'average specific CO_2 emission' which is at or below the 'specific emission target'.

Once the new vehicle is sold and is registered by a MS, it enters the national registration database. For passenger cars and vans the collection of this data, the method and the format for the monitoring and reporting are defined. The information are mostly taken from the Certificate of Conformity (CoC) (Annex IX of 2007/46/EC) but some Member States also collect the data from Type Approval data/documents. After the calendar year the Member State has to report the information to the EEA:

From 2007-46-EC: "*….The certificate of conformity is a statement delivered by the vehicle manufacturer to the buyer in order to assure him that the vehicle he has acquired complies with the legislation in force in the European Union at the time it was produced. The certificate of conformity also serves the purpose to enable the competent authorities of the Member States to register vehicles without having to require the applicant to supply additional technical documentation. For these purposes, the certificate of conformity has to include: (a) the Vehicle Identification Number; (b) the exact technical characteristics of the vehicle (i.e. it is not permitted to mention any range of value in the various entries)…"*

From 2013-297-EC:"*…The detailed data referred to in point 1 shall be taken from the certificate of conformity of the relevant passenger car or be consistent with the certificate of conformity issued by the manufacturer of the relevant passenger car. Where the certificate of conformity is not used, Member States shall put the necessary measures in place to ensure adequate accuracy in the monitoring procedure*…"

As such the CoC is a good source for information from the vehicle and could also for HDV serve as data carrier for the monitoring data throughout the process from production to registration. Therefore, the current status of the CoC, including the entries/parameters needs to be assessed with regard to its suitability to serve as basis for reporting and monitoring CO_2 emissions of HDV.

For passenger cars and vans, monitoring is done for each individual vehicle registered in a calendar year in an EU Member State taking into account the following data parameters:

An example of detailed monitoring data of vans:

- Manufacturer name— EU standard denomination
- Manufacturer name— Manufacturer denomination
- Manufacturer name— National Registry denomination
- Type-approval number and its extension(s)
- Type
- Variant
- Version
- Make

- Category of vehicle type-approved
- Category of vehicle registered
- Total number of new registrations
- Specific emissions of CO_2 (g/km)
- Mass (kg)
- Technically permissible maximum laden mass (kg)
- Wheelbase (mm)
- Track width steering axle (mm)
- Track width other axle (mm)
- Fuel type
- Fuel mode
- Capacity (cm_3)
- Electric energy consumption (Wh/ km)
- Innovative technology or group of innovative technologies code

Table 6: Flow scheme of current system in place in the EU for monitoring and reporting of the specific CO_2 emissions of passenger cars, as regulated by Regulation (EU) No 1014/2010 (latest amended by 396/2013).

For light duty vehicles: Specific CO_2 value measured according to Regulation 715/2007 and implementing acts.
Specific CO_2 value and detailed data of the vehicle recorded at the time of 1st registration and taken from the COC or type approval documentation
End of calendar year: Specific CO_2 value and detailed data from MS registration to MS report.
End of February: Report with specific CO_2 value and detailed data from MS to the Commission, i.e. to central register (kept by EEA /public).
By 30 June Commission provisionally calculates: - average specific CO_2 emissions - specific emission target for the preceding calendar year - The difference between the average specific emissions in the preceding year and the specific emission target for that year
The Commission notifies manufacturer of the provisional calculation and include data per MS on number of vehicles and their specific CO2 emissions.
The manufacturers notify within 3 months after being notified of the provisional calculation of possible errors to the Commission.
The Commission shall consider the corrections made and either confirm or amend the provisional calculations before 31 October.
Final register of CY with monitoring data. Commission Decision confirming the final targets and OEM performance.
The Commission issues of excess emission premium in case it is confirmed that an OEM exceeds its specific emissions target

5.6 Requirements and considerations for monitoring and reporting of the CO_2 emissions of HDV

For the definition of options for monitoring and reporting of CO_2 emissions of HDV, the following elements need to be considered:

- Vehicle aggregation.
- Data to be monitored, including the specification of the CO_2 value(s) and possible additional technical parameters.
- Sources of monitoring information and monitoring entities. What is the source of monitoring data, who is involved in the process and who has responsibilities in the monitoring process for what?

For each element above a set of options can be defined. From combinations of these options, process options can be designed: given the required data, data source and responsible entity, how could the process work?

Level of aggregation

Passenger cars and vans data are currently aggregated on a calendar year basis based on the vehicle type, variant and version code combined with the type approval number. This means in practice that vehicles with the same TVV code and Type Approval number are aggregated into one data row.

Because HDVs are less homogeneous regarding construction, and variations in construction that affect the fuel consumption and CO_2 emissions than passenger cars, the option to monitor CO_2 emissions on a per vehicle basis seems logical. Monitoring on per vehicle basis requires a unique identifier, other than T-V-V, to be able to distinguish the different specific CO_2 as per difference in vehicle specifications. The VIN number is seen as the most suitable key/identifier. Such a unique identifier could ultimately be used by the manufacturer to check the monitoring database or allow combining data from different sources (i.e. Member State data with OEM data). This supports the option to certify on a per vehicle basis which is one of the options for certification in chapter 3. On the other hand the monitoring and reporting of VINs may be surrounded by certain restrictions due to the fact that these data are considered in some Member States as subject to personal data protection.

The basic working assumption is to monitor at least individual vehicles with standard bodies, but additionally completed vehicles (body builders) and trailers (trailer manufacturers) can be monitored as well. The latter two would in principle deliver more accurate CO_2 emission values.

Data parameters to be monitored

The most important is the CO_2 value or set of values that needs to be monitored. It has yet to be determined if this needs to be a single value, for instance an absolute CO_2 emission for the representative vehicle (with representative payload) or if it needs to be several values to monitor for instance the CO_2 emission of different types of missions (given the mission profiles and underlying mix of drive cycles), different levels of payload, or for instance duty specific values like g / t.km or g / m^3.km.

As for the current methodology applied for passenger cars and vans, additional parameters, next to the specific CO_2 emission, may need to be monitored for the purpose of monitoring technical specifications of heavy-duty vehicles. Additional parameters could be specifications of the vehicle (masses, dimensions, performance), engine and specifications of the (real and or standard) bodywork. Starting point for the definition of options, i.e. the baseline line option, would be to define a minimum set of parameters needed to follow the trends of the CO_2 emissions and the technical attributes of HDV which determine/influence the CO_2 emissions.

The data parameters:

- CO_2 emissions/fuel consumption per vehicle as determined by VECTO (minimum requirement)
- CO_2/fuel consumption per mission profile and/or per vehicle class
- OEMs (data of the default vehicle only; minimum), second stage manufacturers (data of the completed vehicle), trailer manufacturers (data of trailers: maximum)
- Technical data, e.g. relating to powertrains, masses and dimensions, bodywork, (minimum requirements need to be defined)
- Input data for VECTO and for developing and/or reviewing default data used in the VECTO

Sources of the monitoring information and monitoring entities

For HDV the monitoring data can be sourced at different moments in the process from production of a HDV to the registration of a HDV. This can be at:

- type approval
- production
- sale
- registration

These options each requires different stakeholders to take part in the process. The options also deliver data from different moments of the process. Sources can be combined, e.g. registration data can be combined with technical data from type approval or production. As such, combined monitoring processes can be designed where responsibilities are divided over stakeholders.

The different data sources:

- Data sourced at the moment of type approval:
    - Type approval databases, ETAES database (not clear whether these exist for all type approval authorities, the ETAES database is based on pdf documents so difficult to use)
    - Responsible entity: Type Approval Authorities

- Data sourced at the moment of production:
    - CoC data relating to the base vehicle, may be both incomplete or completed or type approval documentation, or OEM specific data
    - OEMs, trailer manufacturers …

- Data sourced at the moment of sales:
    - CoC data for both complete and completed vehicles

  - Responsible entities: OEMs, second stage manufacturers, dealers …

- Data sourced at the moment of registration of new vehicles
  - National registration documentation databases which include data from CoCs and/or type approval data; (note – registration data do usually not include all the CoC data and may be different from one Member State to another)
  - Responsible entity: National Registration Authorities

The process of monitoring

The process of monitoring for LDV is based on the data collection by the national registration authorities of the EU member States on vehicles and technical data of these vehicles newly registered in a Member State in a certain Calendar Year. The databases are annually submitted by the Member States to the Commission, supported by the EEA who collects the databases. The final database for the given CY consists of data that have been verified or accepted by vehicle manufacturers and this data is subsequently confirmed by a Commission Decision. The EEA also annually reports cross sections of the database focusing on OEM and Member States performances in terms of CO2 emissions.

Other processes can be distinguished where responsibilities are different than for the case of LDV. E.g. combined monitoring can be seen as a process where a Member State delivers to the EEA limited data on the registered vehicles, for instance only a unique registration code and the manufacturer adds technical data, based on the unique code.

Relation with reporting

The options for monitoring and reporting are strongly related. The monitoring requirements depend on the reporting requirements. However, it can be decided to collect more information than initially needed for reporting. This information can then be used for the evaluation of trends of technical characteristics of the HDV fleet. For example the mass of actual bodywork or other specifications can be collected. The same can be the case for vehicle auxiliaries such hydraulic lifts, pumps, cranes, etc.. This would allow sufficient flexibility for analyses of trends of technical specifications of the vehicles.

Multistage vehicles.

Given the process of construction for a significant share of HDV in multiple stages the CO_2 value can best be attributed to the vehicle manufacturer or the base vehicle manufacturer. The CO_2 value should be for a default vehicle. The basic option for certification is thus to assume a default bodywork for all HDV with default mass and dimensions which can be entered in the VECTO tool. This keeps a level playing field for vehicle manufacturers of single stage vehicles and manufacturers of base vehicles. The downside is that the CO_2 value will be virtual and may have a weak relation with the real CO_2 value if completely different bodywork is mounted than was assumed to be the default.

There are two options defined for alternative determination of a more accurate CO_2 value for MSV i.e. an optional second stage certification, see paragraph 3.4.1.

Therefore, it may be desirable to monitor (and report) additional characteristics, of the real configuration of the complete and completed vehicle:

- Masses and dimensions of bodies (MSV) and (semi-)trailers
- For standard and for alternative bodies:
  → Development in bodies can be reported and defaults can be adjusted accordingly
- Reporting based on weighted average of typical bodies
  → this can be implemented via correction factors to the database

5.7 Options for monitoring

The options for monitoring still need to be defined. This would be done, taking into consideration stakeholder views to be obtained from the questionnaire, the stakeholder meeting and further initial assessment of the possibilities. Monitoring options will probably be defined as packages for combinations of *data*, *data source / responsible entity* and the *procedures* which are possible when the options are combined. For data the options could be defined as min-max with regard to the amount of data to be collected.

5.8 Current reporting for light duty vehicles and considerations for heavy-duty vehicles

Currently, in the EU data is reported regarding the specific CO_2 emission of passenger cars registered in every CY in each EU Member State. The reporting is in fact the aggregation of monitoring data to arrive at average specific CO_2 emissions. For passenger cars this is used to report and regulate the specific CO_2 emissions per manufacturer and to report the CO_2 emissions per Member State. The final "report" is the Commission Decision confirming the relevant CY data and the performance of each OEM in meeting its target (NB: the latter would not apply for HDVs as no targets are currently foreseen). This decision is published around 30 October each year and will also provide a legal basis for recovery of any excess emission premiums should an OEM exceed its target. The Commission decision is complemented by the EEA report on the monitoring exercise for the CY in question.

From eea.europa.eu: *"…The Regulation (EC) No 443/2009 requires Member States to record information for each new passenger car registered in its territory. Every year, each Member State shall submit to the Commission all the information related to their new registrations. In particular, the following details are required for each new passenger car registered: manufacturer name, type, variant, version, make and commercial name, specific emissions of CO_2, mass of the vehicle, wheel base, track width, fuel type and fuel mode. Additional information, such as type approval number, engine power and engine capacity were also submitted…*"

The EEA has collected the data from the Member States on passenger car registrations. This resulted in a provisional database and a final database for instance for 2012. For 2013 a provisional database is available. The final data for 2012 is published in Commission Decision 2013/632/EU. The evaluation of the data is summarized in the report [EEA 2013] titled CO_2 emissions performance of car manufacturers in 2012.

The Decision provides the confirmed average specific CO_2 emissions per manufacturer and the specific CO_2 emission targets per manufacturer. The average specific CO_2 emissions are corrected for phase-in, super credits, E85 reductions and eco-innovations. The specific emission targets are determined taking account of manufacturer pooling, derogation and niche derogation. Important to note is the use of a utility parameter, in the case of light duty vehicles the vehicle mass in running order. This parameter is used to define a CO_2 target per manufacturer or pool of manufacturers which depends on the average vehicle mass of the vehicles registered in a certain CY.

Mutatis mutandis, this methodology as applied for LDVs could in principle serve as base option for HDV (with clear differences e.g. the absence of targets to monitor), however taking notice of the market of HDV as well as of the typical characteristics of HDV which both are very different from LDVs.

Minimum needed for reporting are CO_2 aggregated per responsible entity (body/person), i.e. manufacturer and CO_2 aggregated per Member State. Furthermore, data should be collected that allows monitoring of the HDV market and fleet enabling a better statistical evaluation of the fleet and trends with regard to the CO_2 emission and the attributes which affect the CO_2 emissions/fuel consumption.

Further, options could be reporting of data that has been used to: relate CO_2 to utility (cargo mass, volume, passengers) to monitor the transport efficiency and the data needed to characterise and classify vehicles, CO_2 and fuel consumption per vehicle class and or per missions profile (e.g. weighing of mission profiles and cargo mass) with a view to ensuring comparability between vehicles from different OEMs.

Options for reporting could be determined as minimum to maximum amount of data to be reported.

5.9 Reporting options HDV

The options for reporting should be defined taking into account the level of aggregation of data, which in turn is based on criteria such as comparability and coherence with other datasets, i.e. LDVs.

The options mainly consider the type of CO_2 metrics, the HDV classification/aggregation and usage and the attributable entities:

- Reporting metrics: gCO_2/km , CO_2/tonne km, CO_2/passenger km
- HDVs, HDV classes, mission profiles …
- OEMs, trailer manufacturers, second-stage manufacturers…
- Member States

It should be explored with OEMs to what extent a reporting process such as that in place for the LDVs is appropriate or whether a lighter process could be envisaged. As the monitoring data may provide a tool for comparing fuel efficiency between different OEMs, it is however expected that OEMs may wish to be actively involved in the collection and validation of the data to be reported.

6 Stakeholder consultation

This chapter briefly describes the work to consult the stakeholders. It is part of the working method for the project and is needed to obtain information about the options for certification (including ex-post validation), monitoring and reporting. More specific, information is to be requested from the stakeholders regarding costs, feasibility and other criteria that determined the effectiveness of the systems under evaluation.

The stakeholders that are identified in the beginning of the project are given in appendix A.
The individual stakeholder consultation exercise will be led by the ICCT. It comprises the following phases:

1 **Identification of stakeholders and key persons**. The stakeholders identified so far are listed in the separate spreadsheet file. The final list will be presented to the rest of the project partners by June 2014.
2 **Initial engagement**. This is accomplished through the two-page document describing the exercise. If possible, this should be accompanied by a formal letter from the European Commission.
3 **Consultation phase 1**: This phase comprises the individual consultation with stakeholders (to be performed mid June- August 2014).
   3.1 All participating stakeholders will be invited to fill an online questionnaire (current proposal is to use the paid services of SurveyMonkey; www.surveymonkey.com), which enables question logic (i.e., the type of questions asked can differ on the basis of e.g. the stakeholder type, or the answers provided.
   3.2 Selected stakeholders will be contacted for follow-up phone interviews to complement the information provided in the questionnaires.
4 **Consultation phase 2**: This phase comprises the analysis of the results and the joint consultation (to be performed in August-September 2014). The analysis of the results and interim reporting of the results will be prepared during August 2014. Further desktop research activities may be needed to improve the cost estimates.
   4.1 A one-day workshop will be held in Brussels (EC premises, 16th of September 2014). This workshop will be used to present the provisional options and interim results of the analysis and discussion of results, and to refine the conclusions of the consultation exercise.
   4.2 Final reporting. The final report to be delivered to the EC will be drafted during the months October and November 2014.

About the questionnaires
It is envisaged that the questionnaires will contain 75~150 individual questions presented in the form of positive statements. Respondents will be asked to state their level of agreement from 1 to 5, where 1 means ‘I strongly disagree’, 3 is a neutral stance and 5 means ‘I strongly disagree’. This is standard practice in questionnaire design and provides a good balance between the required granularity and the required standardized formats for data input. The estimated time to complete the questionnaire should be approximately 1 hour.

The questionnaires will be implemented in an on-line environment. There will be a common set of questions for all stakeholder types, and a sub-set of questions will be tailored to specific stakeholder types (see example questions in the annex).

Each option will be evaluated on the basis of three dimensions:

- Quality: This dimension comprises aspects such as the technical merit of each option, its prospects for further technical development, etc.
- Cost: This dimension comprises the costs borne by each stakeholder. Note that the questionnaires can only be used for qualitative/ordinal assessments (*i.e.* stakeholders can rank the different options in terms of co. Quantitative cost estimates will be gathered in the follow-up telephone interviews with selected stakeholders and complemented with desktop research activities during phase 2.
- Preference: The preference of each stakeholders regarding the relevant options will be gathered from both direct (stated preference) and indirect questions (inferred preference). To the extent possible, the preference will be separated from cost considerations.

Additionally, specific questions will be included to gather information about the stakeholders, the respondents of the questionnaires and their individual attitudes.

Example questions

To improve the standardization of input, all questions will be formulated as positive statements. Respondents will be asked to specify their level of agreement (follow-up questions in parentheses).

General questions to assess *quality*

Option A …
…will produce reliable results
…will be easy to implement in the EU legislation
…will bring new customers to my organization
…will foster innovation in HDV efficiency at the engine level
…is futureproof
…is good for transparency
…will improve stakeholder trust in the reported results
…is a technically proven option
…is likely to be adopted in other regions
…will require training my staff
…is a step toward harmonization with other markets
…implies risks for my organization (which?)
…is beneficial for stakeholder type x (how?)
…will be easy to implement in the EU legislation (why?)
…will foster innovation in HDV efficiency at the engine level
…will produce efficiency results close to real-world (why?)

General questions to assess *cost*

Option A …
…will require additional my organization to hire additional staff (how many?)
…will require additional capital investments
…will increase my organization's fixed costs
…will increase the activity in my organization (by how much?)

…will lower the barriers for new competitors in my field

General questions to infer preference

Option A …
…implies risks for my organization
…is beneficial for stakeholder type x
…will change the behavior of stakeholder type x (how?)
…will make type-approval more difficult (how?)

General questions to categorize stakeholders/respondents and their attitudes

I am an expert in vehicle testing
I am an expert in vehicle simulation
I think CO_2 standards are needed for HDVs
I think monitoring HDV CO_2 emissions is good for the European HDV industry

6.1.1 Certification and ex-post validation

A summary of required key information is given below for the tasks about 'certification and ex-post validation'. This forms the basis for the definition of the questions for the questionnaire.

CO_2 Determination

- Availability of measurement equipment
- Experiences with measurement equipment
- Use of simulation
  - Air drag
  - CO_2 (forward / backward calculating approach)
  - Use of OEM specific simulation tools
- Which option is favored and why?
- Witnessing of tests:
  - Which component tests are critical?
  - Which should be witnessed by a third party?
- Vehicle family approach possible?
- More detailed auxiliary approach needed for trucks?
- Handling of future technologies
- Eco innovations to be considered?
- Handling of vehicles with low sales volume

CoP

- CoP on component level or complete vehicle test?
- Share of responsibility between OEM and supplier
- Which option is favored and why?
- Witnessing of tests
- Tolerances for components, compliance factor for CO_2, limits?

„Ex-post" Validation

- Validation to be combined with CoP?
- Which option is favored and why?
- Witnessing of tests
- Compliance factor for CO_2, limits?

Legal setting for certification
- Which option/sub-option is favored and why?
- Share of responsibilities
- CO_2 in CoC
- Extension of information documents
- Information document
- Third party control
- Family approach, CO_2 range for families

6.1.2 Monitoring and reporting

A summary of required key information is given below for the task on 'monitoring and reporting'. This forms the basis for the definition of the questions for the questionnaire.

To EC and EEA
- Please, indicate the goals of reporting and monitoring, for now and the future.
- What criteria are (most) important to consider for the evaluation of options.
- What data/information is minimal needed? For monitoring. As output for reporting?
- What is the status of the discussion on VIN as possible identifier?

To EC, EEA, Ereg and ACEA
- Give an accurate as possible description of the current process of reporting by Member States, monitoring and reporting.
- What entities are involved (see also stakeholder list).
- What type of costs are involved? What are the costs per type?
- Anymore options to consider for monitoring and reporting?
- Please indicate advantages, disadvantages of the (final) options for monitoring and reporting.

To ACEA
- Please, describe your experience with the process of data validation.

To EC, EEA, ACEA
- Please, describe as accurate as possible the experience with the monitoring and reporting system for passenger cars. Focus on criteria mentioned above.

To TAAM/Ereg group
- Is there a discussion of the development of a EU wide (live) database?
- What is the status?
- How would such a system work? Advantages, disadvantages.

7 References

[EEA 2013] CO_2 emissions performance of car manufacturers in 2012

LOT 1 project : 'Reduction and Testing of Greenhouse Gas (GHG) Emissions from Heavy Duty Vehicles – Lot 1: Strategy';

LOT 2 project: 'Reduction and Testing of Greenhouse Gas (GHG) Emissions from Heavy Duty vehicles, LOT 2, service contract N° 070307 /2009/548300/SER/C3;

HDV-CO_2 simulation tool: (ARES(2012)401058 "Development of a Heavy Duty Vehicle CO_2, Emissions and Fuel Consumption Simulation Tool", JRC Internal reference: IET/2012/F/08/03/NC;

JRC "Proof of concept report", 03/02/2014;

LOT 3 project: 'Development and validation of a methodology for monitoring and certification of greenhouse gas emissions from heavy duty vehicles through vehicle simulation'; Service contract CLIMA.C.2/SER/2012/0004 (report 2014);

Marginal abatement cost curves for Heavy Duty Vehicles, CE Delft Publication code: 12.4726.63, for the establishment of cost curves for packages of technical measures for CO_2 reduction. 2012.

Most reports are available under:
http://ec.europa.eu/clima/policies/transport/vehicles/heavy/studies_en.htm

8 Signature

Delft, 8 September 2014

Ruud Verbeek
Project Leader

Robin Vermeulen
Author

A Stakeholders

Organization name	**Organization type**	**Focus of consultation**
ACEA	Association of European Vehicle OEMs	Certification, validation
JAMA	Association of Japanese Vehicle OEMs	Certification, validation
Truck Manufacturer (TBD)	Vehicle OEM	Certification, validation
Truck Manufacturer (TBD)	Vehicle OEM	Certification, validation
CLCCR	Association of suppliers (bodybuilders)	Certification
Trailer Manufacturer	Component supplier	Certification
Body Manufacturer	Component supplier	Certification
CLEPA	Association of component suppliers	Certification
Component supplier	Component supplier	Certification
EEA	EU Regulatory agency	Reporting, monitoring
DG Clima	EU Regulatory agency	Certification, Validation, Monitoring, reporting
DG Move	EU Regulatory agency	Registration
DG Enterprise	EU Regulatory agency	Certification, validation, CO2 determination
JRC	EU Regulatory agency	Certification, validation, CO2 determination
EReg	Association of European Vehicle and driver registration authorities	Registration
TAAM	Umbrella organisation Type Aproval Auhorities	Certification
RDW	Type Approval Authority	Certification, validation, registration
KBA	Type Approval Authority	Certification, registration
UTAC	Technical Service	Certification, validation, registration
TUV	Technical Service	Certification, validation
T&E	Not-for-profit association promoting sustainable transport	Reporting, monitoring
IRU	Internation Road Transport Union	Certification

B Implementation

The following options and sub-options are considerable as basis for a legal implementation:

C1. 2007/46/EC => Type Approval Framework (baseline option, Lot3)

- 1.1 Amendment to Commission Regulation (EU) No 582/2011 which is an implementing act under Regulation 595/2009 (legal basis Article 5(4)(e)).
  - sub-option 1(i): amendment to Annex VIII on CO_2 emissions and fuel consumption;
  - sub-option 1(ii): new Annex.
- 1.2 New Commission implementing act (Regulation) under Regulation (EU) No 595/2009 (Euro VI) (legal basis Article 5(4)(e) of the latter).
- 1.3 New co-decided Regulation parallel to Regulation (EU) No 595/2009

C2. Standalone directive

- 2.1 "New Approach "
- 2.2 New independent Regulation/Directive

In any case, the certification procedure shall be able to cope with the following exemplary requirements which build the basis for an assessment:

- Certification of the CO_2 determination process or certification of input data to VECTO
- Possibility to introduce simulation to the certification process
- Measures to ensure conformity of production
- Clear definition of responsibilities
- Provisions for all possible HDV configurations (e.g. multi-stage / non-standard bodies, trailers, semi-trailers)
- Measures to validate the CO_2 value after certification
- Build a basis for registration and monitoring of the CO_2 value and other needed information (information documents, Certificate of Conformity (CoC), etc.)
- Third party control

Option C1: Type Approval Framework (baseline option)
Since almost all motor vehicle[3] related EC requirements are regulated by the framework directive 2007/46/EC[4] this well-established Type Approval scheme was

[3] 'motor vehicle' means any power-driven vehicle which is moved by its own means, having at least four wheels, being complete, completed or incomplete, with a maximum design speed exceeding 25 km/h

[4] framework for the approval of motor vehicles and their trailers and of systems, components and separate technical units intended for such vehicles

considered for the future greenhouse gas certification of heavy-duty vehicles (HDV) with respect to their CO_2 emissions and fuel consumption.
Beside the fact that the framework directive 2007/47/EC is used since a very long time (its predecessor was directive 70/156/EEC) and for that reason allocated to long-term experiences within the motor industry other reasons are evident for hosting the HDV CO_2 issue under the umbrella of the current framework. Those reasons are:

- Article 3.32 of 2007/46/EC allows making use of simulation based on virtual testing (*virtual testing method*). Since the determination method (VECTO model) considered for the HDV CO_2 explained in the following is based on a calculation model, the *virtual testing method* reference in 2007/46/EC gives adequate freedom for this approach.

- Article 3.27 of 2007/46/EC indicates clearly the responsibility of a *manufacturer* which is considered being the accountable entity for the CO_2 value to be generated. This adds certainty to the procedure and gives clarity to the process which is responsible for the nomination of a particular CO_2 value. It is also clearly stated that it is not essential that the manufacturer need to be involved in all stages of the construction of the vehicle, system, component or separate technical unit. This opens the way to delegate certain tasks of necessary verifications and analysis to supplier and component manufacturer.

- In accordance with Article 12 the manufacturer (as responsible and accountable entity) is obliged to carry out conformity of production (*COP*) measure in order to ensure that production vehicles, systems, components or separate technical units conform to the approved type. This provides an additional requirement within the process to ensure that all vehicles produced are in conformity with the product characteristics specified and certified.

Furthermore, the framework directive 2007/46/EC requires in Article 18 that the manufacturer shall deliver a certificate of conformity (*CoC document*) to accompany each vehicle, whether complete, incomplete or completed, that it is manufactured in conformity with the approved vehicle type. This document (*CoC*) provides an already existing basis for the indication of the HDV CO_2 value.
For passenger cars and light-duty vehicles where a CO_2 declaration procedure is already in force, the CO_2 value is also indicated in the *CoC*. The European type approval scheme for motor vehicles (such as passenger cars, trucks and buses and their trailers) is based, as already mentioned, on the framework directive 2007/46/EC and a large number of technical regulations. The currently applicable Framework Directive on type approval of motor vehicles makes a whole vehicle type approval (WVTA) possible for all categories of motor vehicles and their trailers. For that reason a third party approval is needed for testing, certification and production conformity assessment by a Type Approval Authority (TAA), respectively Technical Service (TS). Each Member State is required to appoint an Approval Authority to issue the approvals and Technical Services to carry out the testing to the applicable EC or ECE regulations (UN). An approval issued by one Authority is accepted in all other Member States. A comparable procedure is given for the applicable ECE regulations where the Contracting Parties are put into a similar role as the EC Member States.

The Framework Directive requires the Member States to take appropriate measures at two stages:

- before granting type-approval, the approval authority must verify that the type to be approved complies with the relevant safety and environmental requirements and that adequate arrangements for ensuring conformity of production have been taken by the manufacturer;

- after having granted type-approval, the approval authority must verify that the conformity of production (CoP) arrangements of the manufacturer continue to be adequate. This verification must be carried out in accordance with the procedures set out in the Directive, and, where appropriate, with the specific provisions of the relevant Regulatory Acts listed in the Framework Directive. This procedure may be carried out with manufacturers' technical equipment and control programs, but may also be extended to the actual testing of selected production samples.

The type approval approach is based on the proposition that new types of components, systems or vehicles are tested and checked prior to their placing on the EU market. This means the overall approach of approval is based on “prototype stage” testing and verification. Nonetheless, the type-approval legislation does not refer only to the prototype stage, but also to the production process through conformity of production (CoP) and registered vehicles through in-service conformity (ISC).
The granted type approval is then applied to such types of vehicles without the need of any confirmation check for each vehicle produced within the type approved specifications. The manufacturer must however certify that each vehicle conforms to the type approved by issuing a certificate of conformity for the individual vehicle.
The CO_2 / fuel consumption approach for HDVs as described above is intended to generate a specific CO_2/FC value for each vehicle produced. In this sense the approach differs from the determination of CO_2 emissions from light duty vehicles, where emissions are tested and considered representative for a vehicle type or pre-defined vehicle families. This difference will also have implications for how the certification procedure can be implemented in the type approval framework.

The objective of this study is to analyse whether or in which respects the existing type approval legislation offers an appropriate framework for the implementation of the CO_2 certification procedure outlined above.
Inter alia, this will require consideration of the CoP issue, noticing it is one of the cornerstones of the type approval framework. CoP describes the measures and provisions to be introduced by the applicant for type approval to make sure that his products are produced in accordance with the type approved qualities and performance criteria. The CoP process is typically applied to a type approved value or criteria (by means of a finalised product) to be checked during / after production. The same circumstances are obvious for the CoC. This document usually contains values, characteristics and properties originated from type approval.
To account the above described difficulties and make use of the 2007/46/EC framework two, respectively three options can be considered.

C1 Sub-option 1
Amendment to Commission Regulation (EU) No 582/2011 which is an implementing act under Regulation 595/2009.

In 582/2011, Annex VIII describes already the fuel consumption and CO_2 emission measures to be applied for HDV engines. A new annex could be introduced dealing with the whole HDV vehicle. Nonetheless such a proceeding would cause an engine only regulation to deal with whole vehicle aspect.

C1 Sub-option 2
New Commission implementing act (Regulation) under Regulation (EU) No 595/2009 (comitology)
This would be a new stand-alone technical implementing act (Regulation) dealing with fuel consumption / CO_2 emission of the whole HDV.
It needs to be verified if the legal basis, Article 5(4)(e) of Regulation (EC) No 595/2009, provides the necessary scope.

C1 Sub-option 3
Option 3 deals with a complete new, and for that reason, Regulation adopted under the ordinary legislative procedure, i.e. as a parallel act to Regulation (EU) No 595/2009.
In chapter 2 the possibility of a regulation" adopted under the ordinary legislative procedure (co-decision) was mentioned. This would be the way forward should the legal basis provided in Regulation (EC) 595/2009 not be appropriate for the implementation of the whole HDV CO_2 procedure.

Option C2: Stand-alone directive
The working assumption under this option should thus be to establish such a new regulation outside the type approval framework in order to be able to define new boundary conditions customised to the particular needs of HDV CO_2 certification. There are already existing examples which can be considered. One example for such standalone legislative requirements is Directive 94/25/EC (2003/44/EC) for recreational crafts (also limiting the exhaust gas criteria pollutant for engines to be used on such boats) or Regulation 1222/2009 on the labelling of tyres with respect to fuel efficiency and other essential parameters. Directive 94/25/EC is based on the new approach making use of the CE sign and includes elements similar to the type approval (Notified Body vs. Technical Service).

Option C2.1: New approach
Another possibility to be considered is a regulation under the "New Approach" scheme in accordance with the EC conformity assessment criteria. "New Approach" directives were designed to streamline the certification / approval process for the European market. Such regulations can be configured from labelling of a product by a manufacturer to very challenging provisions similar to the established type approval procedures.

An example for such regulation is Directive 94/25/EC based on the new approach making use of the CE sign. Directive 94/25/EC includes elements very similar to the type approval procedures such as a third party involvement. The inspection bodies involved are so called Notified Bodies and act somehow similar to the Technical Services in the Type Approval framework.

Option C2.2: New independent Regulation/Directive
The possibility of a regulation adopted under the ordinary legislative procedure (co-decision) was mentioned. This would be the way forward, should the legal basis

provided in Regulation (EC) 595/2009 not be appropriate for the implementation of the whole HDV CO_2 procedure.

A complete new regulation can be considered also being applied under the type approval framework. The working assumption under this option should thus be to establish such a new regulation in order to be able to define new boundary conditions customised to the particular needs of HDV CO_2 certification.
By detaching the HDV CO_2 certification completely from the type approval framework, which means to create a separate act outside the framework, further work is necessary to define appropriate general conditions. Nonetheless, numerous of the doubtlessly very well established type approval specifications and requirements can be transferred to such a new act. Accountability and responsibility of the applicant as well as the incorporation of Type Approval Authorities and Technical Services are only a few of these well-developed type approval principles. The earlier mentioned need to integrate a CoP process and to make use of the CoC (or similar procedure) can be solved by creating appropriate new provisions for these tasks. Furthermore, the framework of 2007/46/EC need to be slightly adjusted anyhow as long as the mentioned indication of the CO_2 value in the CoC remains necessary. If an additional document for the CO_2 value is contemplated such a slight adjustment is not necessary.
An example for such a “stand-alone regulation” outside an existing framework is Regulation 1222/2009 on the labelling of tyres with respect to fuel efficiency and other essential parameters.