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IMPACT ASSESSMENT

Impact Assessment

Accompanying the document

Proposal for a Regulation of the European Parliament and of the Council

on the monitoring and reporting of CO2 emissions from and fuel consumption of new heavy-duty vehicles

{COM(2017) 279 final}
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ACRONYMS AND DEFINITIONS

CO_2	Carbon dioxide
ETS	Emissions Trading Scheme. The EU emissions trading scheme (carbon market on which allowances for tons of CO_2 are being traded among participating entities) does not currently include road, waterways and maritime transport emissions (aviation emissions have been included as of 1.1.2012)
Euro VI	The latest HDV exhaust gas emission standards for gaseous pollutants and particulate matter as set out in Regulation (EC) 595/2009.
GHG	Greenhouse gases: gases that have a global warming effect
HDV	Heavy-Duty Vehicles, i.e. lorries, buses and coaches (vehicles of more than 3.5 tons)
LDV	Light-Duty Vehicles, i.e. cars and vans
NOx	Nitrogen oxides (nitric oxide (NO) and nitrogen dioxide (NO_2))
OEM	Original Equipment Manufacturer: the main truck and bus manufacturers of complete vehicles, tractors and chassis/cabin unfinished vehicles
PM	Particulate matter
Tailpipe emissions	TTW emissions (see below)
TTW emissions	"Tank-to-wheel" –or tailpipe- emissions: emissions that occur throughtout the drive cycle of vehicles. This only includes dowstream emissions, excluding upstream emissions (see below WTW emissions)
VECTO	Vehicle Energy Consumption calculation TOol
WTW emissions	"Well-to-wheel" emissions = TTW + upstream "well-to-tank" emissions attached to the fuel production and transport

1. PROBLEM DEFINITION

1.1 CONTEXT

This Commission's primary political objectives are to create jobs, growth and investment, and in this context to make the transition to clean energy for all Europeans. This is underpinned by an investment plan aimed at reindustrialising Europe based on new business models and cutting-edge technologies. The medium- to long-term aim is to achieve, a circular low carbon economy.

In the context of transport, particularly with respect to lorries, buses and coaches, i.e. heavy-duty vehicles (HDVs), the Commission's vision is to ensure that European citizens and business have access to fair, sustainable and competitive mobility:

- In 2014, the Commission adopted a Communication on a Strategy for Reducing Heavy-Duty Vehicles' fuel consumption and CO_2 emissions[1] (referred to hereafter as "the HDV Strategy"), announcing firstly an implementing measure setting out the procedure for the certification of carbon-dioxide (CO_2) emissions from new HDVs, calculated by the VECTO simulation tool, and secondly upon its adoption to propose legislation to monitor and report them for all new vehicles placed on the EU market.

- In July 2016, the Commission's European Strategy for low-emission mobility[2] set the ambition for the transport sector to reduce greenhouse gas (GHG) emissions by at least 60% in 2050 compared to 1990 levels and of drastically reducing the emission of air pollutants. The strategy[3] includes an action plan to improve fuel efficiency and to reduce emissions from HDVs. So far, only pollutant emissions from these vehicles are regulated under the so-called Euro VI Regulation[4]. The Strategy confirmed the earlier 2014 work and also announced that the Commission will speed up analytical work on design options for HDV CO_2 emission standards to prepare a legislative proposal during the mandate of this Commission.

- In October 2015, the EU ratified the Paris Agreement which then entered into force 30 days thereafter. The EU committed to an at least 40% domestic emission reduction by 2030 compared to 1990. As part of the implementation, the Commission proposed in July 2016 the Effort Sharing Regulation on binding annual GHG emission reductions by Member States for the period 2021 to 2030. Central policy scenarios used inter alia for the low-emission mobility strategy and for the impact assessment underpinning the Effort Sharing Regulation show that for reaching the EU's ambitious 2030 target emission reductions for transport would have to be around 18 to 19% by 2030 compared to 2005 levels.

- In December 2016, the Commission also proposed a revision of the Energy Efficiency Directive setting a binding headline target at EU level of 30% for improving energy efficiency in 2030 compared to business as usual. Total primary energy consumption should come down to 1 321 Mtoe by 2030. In 2015, total primary energy consumption was 1529.6 Mtoe.

[1] COM (2014)285, available under: http://ec.europa.eu/clima/policies/transport/vehicles/heavy/documentation_en.htm
[2] https://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/1-2016-501-EN-F1-1.PDF
[3] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=SWD:2016:244:FIN
[4] Regulation (EC) No 595/2009, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32009R0595

This impact assessment (IA) accompanies a Commission proposal for a Regulation on the monitoring and reporting of CO_2 emissions and fuel consumption from HDVs, which is part of the Clean, Connected and Competitive Mobility Package and constitutes an additional step to address HDV CO_2 emissions, as announced in the abovementioned strategies.

The scope of this IA therefore covers specifically the monitoring and reporting of CO_2 emissions and fuel consumption of new vehicles. It also takes into account the first two steps which have already been decided and are therefore not subject to this IA:

1) the VECTO simulation tool, developed to calculate new HDVs CO_2 emissions and fuel consumption, and

2) the certification procedure for calculating these emissions with VECTO through a draft Commission Regulation under the type approval legislation.

This constitutes the first block of EU measures in relation to CO_2 emissions from HDVs.

This measure will close the knowledge gap on EU HDV CO_2 emissions identified in the 2014 HDV Strategy. At the same time, it provides the key enforcement tool for the future CO_2 emission standards for these vehicles, which will be proposed before the end of this Commission mandate and will be subject to another dedicated IA.

This Regulation will also help with the establishment of a methodology for the differentiation of infrastructure use charges for new HDVs according to CO_2 emissions, supporting the implementation of the review of the "Eurovignette" Directive.

1.2 WHAT IS THE PROBLEM?

1. Missed opportunities to design policies to reduce the fuel bill for transport operators

Freight transport operators can experience fuel costs greater than a quarter of their operational costs[5] and rank fuel efficiency as their top purchase criterion. While the fuel efficiency of heavy-duty vehicles has improved over past decades, many of the more than half a million transport companies, which are to a large extent SMEs, do not have access yet to standardised information to evaluate fuel efficiency technologies, compare lorries in order to make the best informed purchasing decisions and reduce their fuel costs. This is also made more difficult by the absence of a commonly agreed methodology to measure fuel consumption.

A study[6] assessed market barriers to increased efficiency in the European freight sector and concluded that the lack of information and comparability between vehicles' CO_2 emissions and fuel consumption was one of the main market barriers to the uptake of fuel saving innovation. Despite being aware of a number of fuel saving technologies, transport operators were not able to make informed choices and purchase the most energy efficient vehicles as they could not compare the different brands and models at the stage of vehicle purchase.

Over time, these missed fuel savings cumulatively increase the EU's dependency on fossil fuel imports and represent a missed opportunity to reduce fuel imports.

2. Increasing competitiveness challenges for vehicle manufacturers

In 2015, according to industry data, the exports of lorries generated a trade balance surplus of € 5.1 billion. This sector is part of an automotive industry which generates 12.1 million direct and indirect jobs in Europe (5.6% of total EU employment)[7].

EU HDV manufacturers face increasing global competitive pressures. Significant markets such as the United States, Canada, Japan and China have in recent years implemented certification and fuel efficiency measures in the form of fuel consumption and/or emission standards in order to stimulate innovation and rapidly improve vehicle efficiency. A summary of the experiences for the other main HDV markets in the world is provided in **Annex 9**. The city buses market sees also an increasing competition in the field of electric vehicles, in particular from Chinese manufacturers. The EU HDV manufacturing sector will need to keep up with the technological improvements in these markets to preserve its current market position.

The lack of market transparency translates into lesser pressure for EU HDV manufacturers to make further efforts to improve vehicle efficiency and invest in innovation in such competitive global market. This creates risks for the EU manufacturing sector to lose its current leading role in vehicle fuel efficiency. Transparency on the fuel and CO_2 emission performance of the vehicles would also stimulate competition inside the EU market, where in 2016 the Commission revealed a cartel among a number of manufacturers of lorries that operated between 1997 and 2011[8].

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[5] Fuel cost assessment studies illustrated in **section 5.6** and **Annex 7**.

[6] Study by CE Delft on Market Barriers to Increased Efficiency in the European On-road Freight Sector carried out for the International Council on Clean Transportation (October 2012) available under the link: http://www.theicct.org/sites/default/files/publications/CE_Delft_4780_Market_Barriers_Increased_Efficiency_European_Onroad_Freight_Sector_def-2.pdf

[7] http://www.acea.be/uploads/publications/ACEA_Pocket_Guide_2016_2017.pdf

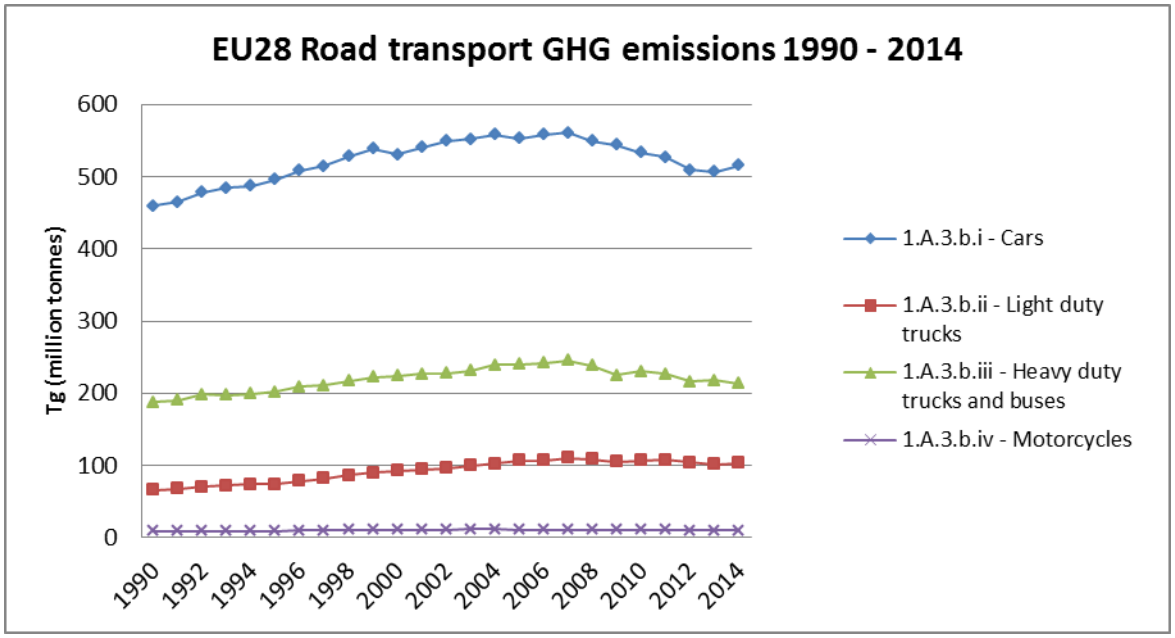
[8] In particular regarding coordinating prices at "gross list" level for medium and heavy lorries in the European Economic Area (EEA), the timing for the introduction of emission technologies for medium and heavy lorries to comply with the increasingly strict European

3. Barrier for setting policies to address the GHG emissions challenges for the heavy duty vehicles sector

The HDV sector is a significant source of GHG emissions. In 2014, GHG emissions from HDVs represented 5% of total EU emissions, a fifth of all transport emissions and about a quarter of road transport emissions[9].

During the period 1990-2014, overall GHG transport emissions[10] have increased by 20% and HDV emissions by 14%[11] as illustrated in **Figure 1**.

Figure 1. Road transport GHG emissions 1990-2014



Note: 1.A.3. b.ii / Light duty trucks includes light-duty vehicles < 3.5 t Source: GHG Inventory data 2016[12]

As shown in **Figure 2**, without further action, HDV CO_2 emissions are set to increase by up to 10% between 2010 and 2030[13]. Given action already taken to curb emissions from cars and vans, HDV CO_2 emissions are bound –particularly as regards emissions from lorries – to represent an increasing share of road transport emissions, from around 25% in 2015 to around 30% in 2050.

emissions standards (from Euro III through to the currently applicable Euro VI) and the passing on to customers of the costs for the emissions technologies, http://europa.eu/rapid/press-release_IP-16-2582_en.htm

[9] GHG Inventory data 2016, http://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer

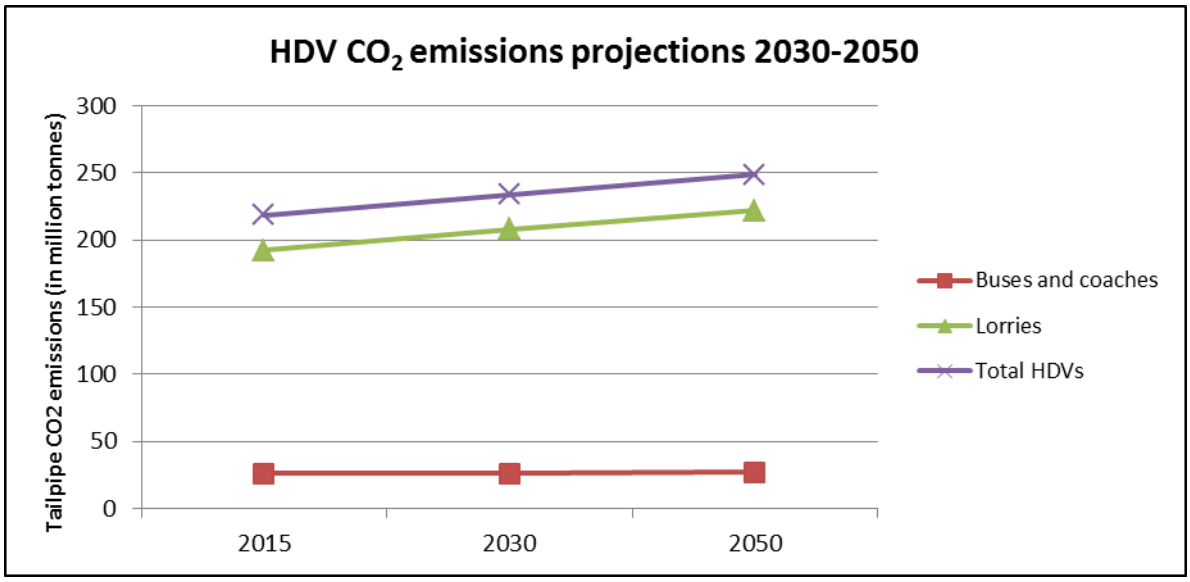
[10] Including international aviation but excluding international shipping.

[11] GHG Inventory data 2016, http://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer

[12] http://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer

[13] EU Reference Scenario 2016: Energy, transport and GHG emissions - Trends to 2050

Figure 2. HDV CO_2 emissions projections 2030-2050



Source: EU Reference scenario 2016, PRIMES-TREMOVE Transport Model (ICCS-E3MLab)

At the same time, the EU has set ambitious targets for GHG reduction in 2030 to which the transport sector must contribute. The EU has an overall domestic emissions reduction target for 2030 of at least 40% below 1990 levels which has been divided in a cost-effective manner into reductions by 2030 compared to 2005 of 43% for the emissions from the EU ETS sectors and of 30% for the non-ETS sectors, to which transport belongs.

Member States' transport emissions range from 21% to 69% of total national emissions in the not-ETS sectors covered by the Effort Sharing Regulation. While no sector-specific targets have been set for 2030, transport will need to contribute its share to the achievement of the non-ETS emission reduction target in the context of the Effort Sharing Regulation, together with buildings, agriculture, and waste.

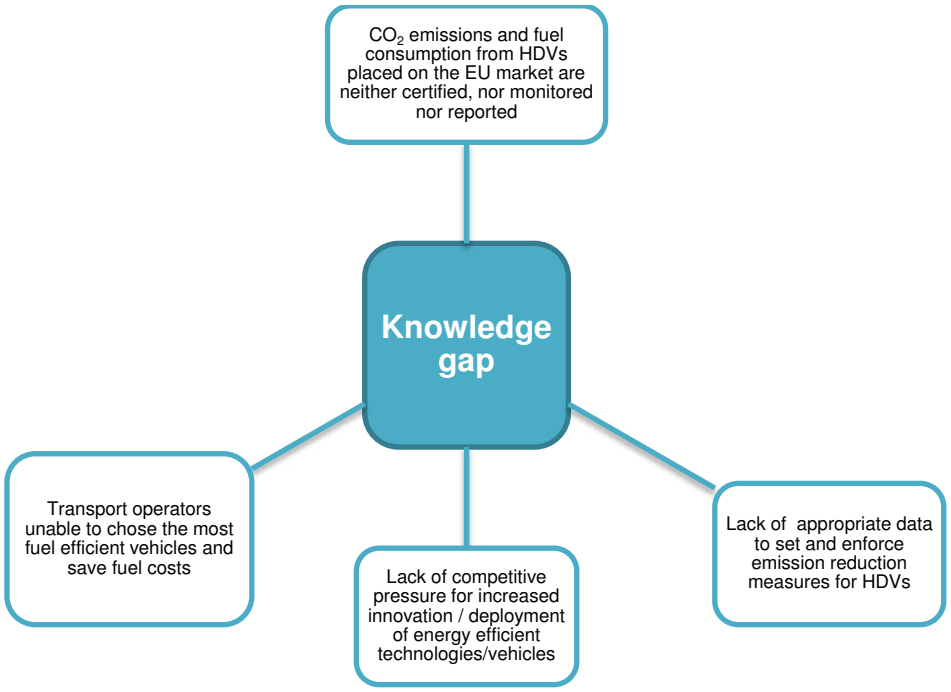
The above mentioned lack of information is, however, hampering action at national or EU level to reduce HDV CO_2 emissions. For instance, at national level the lack of availability of data on fuel consumption and CO_2 emissions prevents Member States to provide further incentives for the uptake of efficient HDVs, and design for example appropriate taxation or incentive schemes including road charging and public procurement to promote emission reductions. At EU level, the absence of robust and comparable data prevents the implementation and enforcement of future harmonised CO_2 emission standards across the EU market.

1.3 WHY IS IT A PROBLEM? WHAT ARE THE MAIN DRIVERS?

The main driver for the identified knowledge gap is a market failure, i.e. the absence of monitoring and reporting of objective, standardised and comparable CO_2 emissions from HDVs.

Figure 3 illustrates the problem tree.

Figure 3. Problem tree



CO_2 emissions from new heavy-duty vehicles placed on the EU market have so far not been monitored and reported in an objective and comparable manner, implying that no reliable data are available regarding their magnitude at fleet and vehicle level. This is also true for fuel consumption of these vehicles, which is directly correlated to the CO_2 emissions, as well as the real benefits of fuel efficiency technologies.

The only EU HDV fleet data available at the moment with regards to CO_2 emissions come from the greenhouse gas emission inventories, for which emissions of the whole HDV sector are estimated by each Member States based on fuel sales. Such data does not provide information on CO_2 emissions of each specific vehicle, and therefore cannot be used to define policies aimed at increasing fuel efficiency and reducing CO_2 emissions at vehicle level.

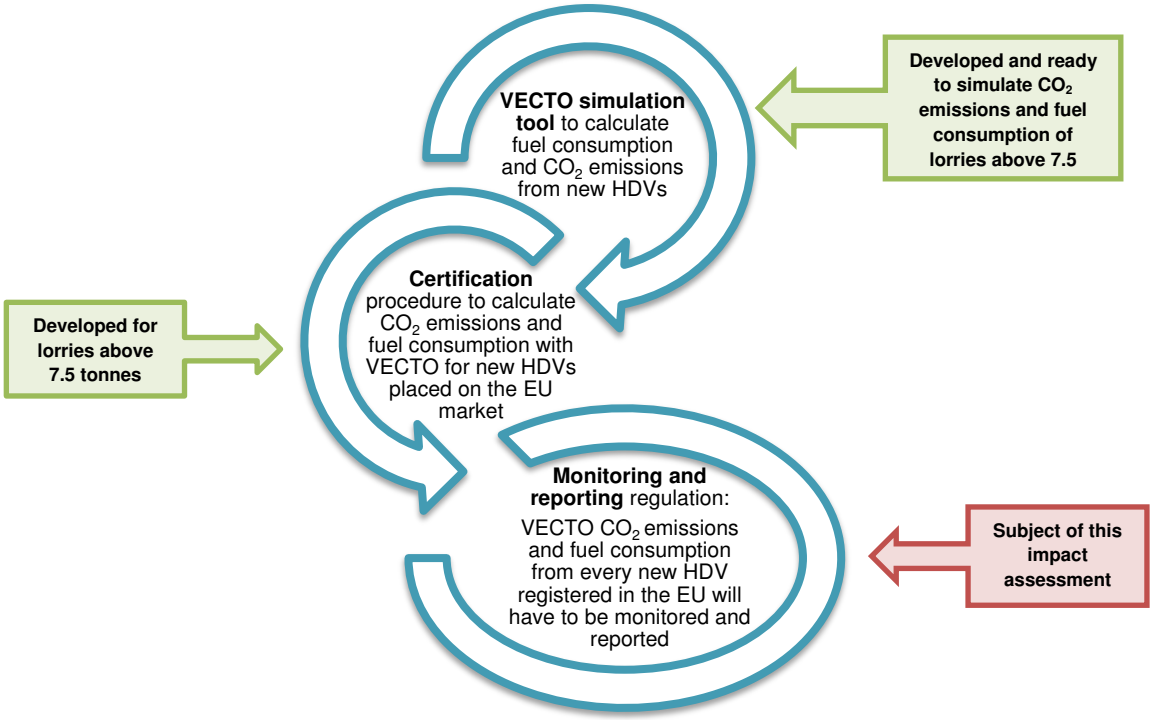
At vehicle level, and until certification becomes mandatory, the information available to buyers of new HDVs concerning their fuel consumption is based on different testing and simulation methodologies depending on each HDV manufacturer, and are therefore not directly comparable. Buyers have also no broader information on the development of competition with respect to fuel efficiency in the EU-wide market for transport services

The EU HDV market is therefore lacking transparency as regards fuel consumption and CO_2 emissions of new vehicles preventing well informed purchasing and policy decisions promoting the most fuel efficient vehicles.

1.3.1 WHERE ARE WE NOW IN ADDRESSING THE PROBLEM?

Against this background and in application of the 2014 HDVs Strategy, the Commission has taken action to address this knowledge gap, based on the following three-step approach illustrated in **Figure 4**.

Figure 4. Identified three-step solution



Step 1: Development of a simulation software - the Vehicle Energy Consumption calculation TOol (VECTO) - in order to calculate fuel consumption and CO_2 emissions of new vehicles

The first measure has been to develop an IT simulation tool, so-called VECTO, to calculate HDV CO_2 emissions and fuel consumption in a comparable manner among different heavy-duty vehicles across all manufacturers. The decision to develop this tool was made after considering other options for test procedures, including engine test beds, chassis dynamometer and on-board tests in real traffic with Portable Emission Measurement Systems (PEMS).

The key reasons to opt for simulation rather than any of the other testing procedures were:

1) Comparability: test results for different types of HDVs are directly comparable;
2) Cost efficiency because of high costs of testing facilities compared to simulation;
3) Capability to deal with high variability: HDV series of production are very small since vehicles are to a large extent customized to end-users' prescriptions;
4) Repeatability: simulation offers the highest scores for reproducibility of the tests;
5) Accuracy: small savings from single component optimisations can be detected;
6) Comprehensiveness: simulation can be used to optimise the total vehicle configuration in order to achieve lower fuel consumption, since it includes all components (i.e. cabin, tyres, engine, transmission, etc.).

This approach was confirmed in the 2014 HDV Strategy and its accompanying IA.

Other major countries have also opted for using simulation tools. For instance, the US EPA has developed a similar simulation software, the Greenhouse Gas Emissions Model (GEM) to calculate CO_2 emissions and fuel consumption from HDVs (see **Annex 9**).

The Commission in close cooperation with stakeholders have developed VECTO. The current version is ready to support CO_2 certification for lorries above 7.5 tonnes. Simulation module for buses and coaches is still under development. Simulation results have been compared to real driving, and the VECTO simulations have shown a high level of accuracy of around +/- 3%. Further details on VECTO are provided in **Annex 4**.

Step 2: New Commission Regulation on the determination of new heavy-duty vehicles' CO_2 emissions (so-called "certification" Regulation)

The development of VECTO has laid the ground for a certification methodology for CO_2 emissions and fuel consumption of new heavy-duty vehicles before being placed on the EU market. It will be possible to calculate VECTO values in a comparable and certifiable way under the existing type approval legislation[14].

According to the upcoming Commission Regulation on certification each heavy-duty vehicle of the categories identified, which is going to be placed on the EU market, will need to be simulated in terms of CO_2 emissions and fuel consumption with VECTO. Vehicle manufacturers themselves will perform the simulation on the basis of certified input data of all different vehicle components and of a certified process of sourcing, managing and applying such input data. Further details on the draft certification methodology are provided in **Annex 5**.

The certification methodology has been developed in 2015-2017 based on extensive stakeholder consultation and input. The Technical Committee on Motor Vehicles provided a positive opinion on 11 May 2017 on the draft Commission Regulation on certification proposed by the Commission. It covers the main categories of lorries above 7.5 tonnes, to be followed by amendments to cover smaller lorries (above 3.5 tonnes) as well as buses and coaches. The Regulation is not accompanied by a specific impact assessment beyond the IA on the 2014 HDV Strategy. Nonetheless studies on the costs of its implementation have been carried out. Relevant cost information is illustrated in **Annex 5**.

Once the certification regulation enters into force in 2019, HDVs manufactures will be required to calculate with VECTO fuel consumption and CO_2 emissions of every single HDV produced and placed on the EU market.

Certification, however, **would only close the knowledge gap partially**, since information on the performance of the vehicles will only be available to each individual purchaser and to the national authorities where the vehicle is registered.

In order to close the knowledge gap and create full market transparency, this information should be made available to all stakeholders, so that:

- Transport operators can have an understanding of the performance of lorries from different brands with similar characteristics, to be able to make better informed purchasing decisions.
- Vehicle manufacturers can compare their vehicles' performances with those of other brands, and have increased incentives for innovation.
- Public authorities can have access to comprehensive data for designing and implementing policies to promote more fuel efficient lorries, for instance through taxation, road user charging, etc. This would not otherwise be possible as Member

[14] Directive 2007/46/EC, http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32007L0046

States have access only to VECTO data from the vehicles registered in their territory.

- Non-governmental organisations can make analysis of the data, e.g. assessing the penetration level of certain technologies, etc.

Step 3: Monitoring and reporting certified CO_2 emissions from new heavy-duty vehicles

Through this third step, all relevant data calculated by manufacturers according to the certification methodology would be monitored, reported and published at EU level. In this way the data would be available to all stakeholders.

Whether and how such monitoring and reporting system should be designed is the subject of this IA.

Since emission data will become available from the first year of the entry into force of certification in 2019, it will be paramount to set up the system in order to have such data reported and published the year after.

This is a necessary step also in the process to prepare the implementation and enforcement of future CO_2 emission standards for HDVs. A monitoring and reporting system is necessary in particular for assessing the compliance of such future standards, as it is the case for cars and vans.

A system already in place by the time future HDV CO_2 emission standards will enter into force will allow for the actors involved, especially vehicle manufacturers, to become familiar with the obligation to monitor and report, and for the system to be tested, and implementation guidance developed if need be.

Stakeholders' view

All stakeholders, who replied to the online public consultation, agreed that monitoring HDV fuel consumption and CO_2 emissions in the EU is needed in order to gather the necessary data to close the identified knowledge gap.

1.4 WHO IS AFFECTED BY THE PROBLEM, IN WHAT WAYS, AND TO WHAT EXTENT? WHOSE BEHAVIOUR WOULD HAVE TO CHANGE TO IMPROVE THE SITUATION?

The lack of information on fuel efficiency directly affects freight transport operators as well as logistics companies, i.e. the buyers and users of HDVs.

This lack of information and possibility to compare prevents them from choosing the most efficient vehicles and to benefit from the corresponding potential fuel savings. These could be significant considering that fuel represents a large share of vehicle operating costs[15]. It has therefore impacts on intermediate transport costs and potentially on the costs of goods and services for consumers and companies.

HDV manufacturers and automotive component suppliers in the absence of such transparency have only limited incentives from the market to invest in innovation and deployment of energy efficient technologies to improve their vehicles and hence their competitiveness.

Member States are also affected. At the moment few Member States have set up voluntary schemes to promote HDV CO_2 emissions reductions and fuel efficiency.

[15] See **section 5.6** and **Annex 8**.

In France, under the initiative Objectif CO_2[16], transport companies can sign a charter of commitments, pledging to work towards an overall CO_2 emission reduction goal over a period of three years. In Ireland, the Sustainable Energy Authority recognises best practice in energy performance, management and design through the annual Sustainable Energy Awards[17], for the individuals and groups who demonstrate a commitment to include energy management as part of their overall management structure, including transport companies.

However, the lack of availability of data on fuel consumption and CO_2 emissions from HDVs prevents Member States to regulate effectively on that basis, and design for example appropriate taxation schemes, including road user charging, which can currently only be based for HDVs on the EURO air pollutants emission classes. It would also provide information to design incentives schemes, for instance embedded in public procurement, to promote fuel efficient and low emission HDVs. Moreover it would make existing fuel taxation[18] more effective.

In addition, lower fuel consumption would reduce the necessity for imports of fossil fuels into the EU and contribute to overall energy security and trade balance.

1.5 WHAT IS THE EU DIMENSION OF THE PROBLEM?

Markets for new HDVs and transport services are both operating EU-wide and are integral parts of the Single Market. The lack of transparency concerning fuel consumption and CO_2 emissions from new vehicles is not yet addressed in any of the Member States and concerns the EU as a whole. Moreover, HDV CO_2 emissions are covered under the EU's greenhouse gas emission reduction target.

The development of the vehicle emissions simulation tool VECTO has been carried out cost efficiently by the Commission in close cooperation with experts from Member States and stakeholders.

The certification of HDV fuel consumption and CO_2 emissions is set out in a Commission Regulation, under the EU type-approval framework which covers HDVs.

For cars and vans a mandatory EU-wide system to monitor and report CO_2 emissions is already in place[19].

1.6 HOW WOULD THE PROBLEM EVOLVE, ALL THINGS BEING EQUAL?

In the absence of an EU-wide monitoring and reporting legislation, national authorities may adopt different monitoring and reporting approaches leading to a fragmented and inconsistent collection of such data across the EU. This would lead to high administrative burden for HDV manufacturers who would have to keep different reporting systems. However, this risk is unlikely as illustrated by the public consultation indicating that national authorities would rather not act at all.

In case HDV certification is put in place without monitoring and reporting CO_2 emission and fuel consumption data at EU level, information on the level of penetration and actual diffusion of advanced fuel efficient technologies will not become fully available to manufacturers, HDV buyers and policy makers. One would not be able to compare the

[16] http://www.ademe.fr/en/objectif-co2-an-emissions-reduction-program
[17] http://www.seai.ie/EnergyMAP/Transport/Intro/
[18] In particular on diesel fuel.
[19] Regulation (EC) No 443/2009 and Regulation (EU) No 510/2011.

performance of vehicles across the whole fleet, assess the wider effective demand for fuel efficient vehicles and evaluate national policy incentives for fuel efficient lorries. With certification alone, only the direct buyer of a vehicle would receive the information at the moment of purchasing and Member States would have access to the information only for the vehicles registered in their territory.

As a result, technological progress in terms of fuel efficiency and CO_2 emissions would stay at business as usual. Freight operators would lose in terms of fuel costs, transport costs would be higher than necessary, EU manufacturers risk falling gradually behind their competitors outside Europe, and the share of emissions from heavy-duty vehicles would increase in the coming decades.

Furthermore, it would not enable the implementation and enforcement of future CO_2 emission standards and would also hamper action at Member States level to reduce emissions from this sector. For example, road user charging schemes could not be effectively designed to address CO_2 emissions as Member States do not have access to the full database on CO_2 emissions from HDVs that could operate on their territory.

1.7 HAS ANY FITNESS CHECK/RETROSPECTIVE EVALUATION BEEN CARRIED OUT OF THE EXISTING POLICY FRAMEWORK?

HDV CO_2 emissions are currently not subject to specific EU legislation. Consequently, no evaluation could be carried out.

2. THE RIGHT OF THE EU TO ACT

2.1 LEGAL BASIS

Climate change is a trans-boundary problem and at the same time is a competence shared between the EU and Member States. Coordination of climate action at European level is therefore necessary and EU action is justified on grounds of subsidiarity.

Articles 191 to 193 of the Treaty on the Functioning of the European Union confirm and further specify EU competencies in the area of climate change. In particular, the TFEU provides the legal basis for acting on HDV fuel consumption and CO_2 emissions.

The EU has already acted in the area of vehicle emissions, adopting Regulations (EC) 443/2009 and (EU) 510/2011 which set limits for CO_2 emissions from cars and vans, and with implementing legislation on monitoring and reporting of data on registration and CO_2 emissions of new light commercial vehicles ((EU) No 410/2014 and 2012/293). These Regulations were based upon the Environment chapter of the Treaty and namely on Article 192 TFEU.

In addition, there is a need to maintain a functioning Single Market for HDV manufacturers and to preserve a level playing field for all transport operators in the EU.

2.2 ANALYSIS OF SUBSIDIARITY AND ADDED VALUE OF EU ACTION

EU action is justified in view of both the cross-border impact of climate change and the need to safeguard single markets in fuel, vehicles and transport services.

The EU-28 share of international transport[20] in total road freight transport in 2015 was 40%, in some Member States reaching above 80%[21], see **figure 5** below.

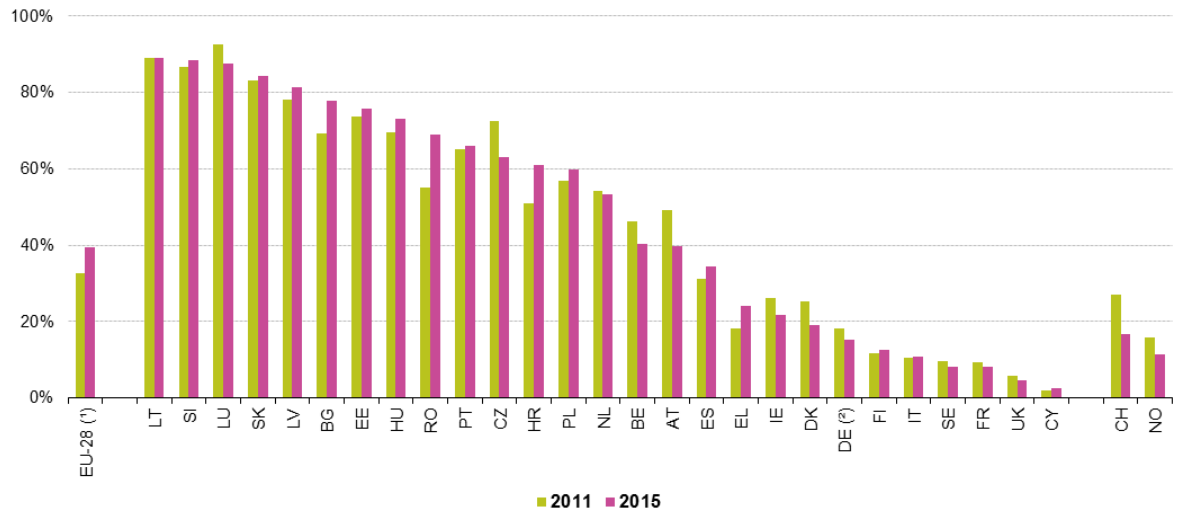
Moreover, new HDVs registered in a given Member States are often produced by a manufacturer in another Member State. Monitoring at national level instead of EU level would thus require extensive cooperation among Member States, including the adoption of various pieces of national legislation.

Even if such monitoring at national level were to materialize, comparable and homogeneous monitoring data would not be guaranteed due to differences between Member States' legislation and policy practices, for instance in the field of taxation or organization of the transport network. Comparability and completeness of data would be difficult to achieve, triggering EU market fragmentation and loss of market transparency.

Another difficulty related to the proliferation of monitoring schemes at national level would be the lack of a common database containing all Member States' monitoring data. This would, in particular, hamper the utility and use of the data by the purchasers of vehicles and by policy makers at EU level.

A common monitoring scheme at EU level appears to be the most straightforward and simple approach. This would reap the benefits of the adoption of the certification procedure on HDV fuel consumption and CO_2 emissions. For similar reasons, this is the approach followed for cars and vans through EU level action.

Figure 5. Share of international transport in total road freight transport, 2011 and 2015 (% in tonne-kilometres)



(1) EU-28: provisional data for reference year 2015; Malta: excluded (see chapter 'data sources and availability')
(2) DE: 2014 data was used for reference year 2015.

Source: Eurostat, 2016 (road_go_ta_tott)[22]

[20] International road freight transport is defined as the transport by road between two places (a place of loading and a place of unloading) in two different countries irrespective of the country in which the vehicle is registered.

[21] Eurostat statistics on international road freight transport (2016), http://ec.europa.eu/eurostat/statistics-explained/index.php/Road_freight_transport_by_journey_characteristics

[22] http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Share_of_international_transport_in_total_road_freight_transport,_2011_and_2015_(%25_in_tonne-kilometres)_F3.png

2.3 PROPORTIONALITY CHECK

HDV emissions are significant representing about 5% of EU CO_2 emissions and 20% of transport emissions. In view of their scale and their long-term increasing trend, it appears proportionate to collect and report HDV CO_2 emissions and fuel consumption data for new vehicles, thereby improving market transparency.

Conclusions on proportionality (**section 6**) will further take into consideration how the options meet effectiveness requirements, notably with regards to its costs and benefits.

3. OBJECTIVES

General policy objectives:

1) Facilitate a reduction in fuel costs for transport operators, many of which are SMEs
2) Contribute to the improvement of the competitiveness of HDV manufacturers
3) Contribute to the achievement of the EU's climate and energy target and objectives

Specific objectives:

- Enable informed purchasing decisions and deployment of more fuel efficient vehicles
- Foster innovation and development of fuel efficiency technologies
- Promote cost-effective reductions of CO_2 emissions and reduce overall fuel consumption from HDVs
- Enable the development of rational policies promoting the uptake of advanced fuel efficient and low emission HDVs

Operational objective:

Monitor and report in a cost efficient manner:

- CO_2 emissions and fuel saved over time per vehicle group, manufacturer and Member State
- uptake levels of more fuel efficient vehicles and rate of annual efficiency improvement in each vehicle group
- technology development and penetration levels in the fleet

4. OPTIONS

With the entry into force of the certification obligation, CO_2 and fuel consumption of all new lorries above 7.5 tonnes placed on the EU market and falling under the scope of the new Commission Regulation will have to be simulated using VECTO.

Options will be considered in this impact assessment on whether and how these data should be reported and monitored at EU level to close the knowledge gap on CO_2 emissions from heavy-duty vehicles.

4.1 COMMON ELEMENTS OF THE OPTIONS CONSIDERED

4.1.1 SCOPE OF MONITORING AND REPORTING

The options considered relate to the monitoring and reporting of CO_2 emissions from all new HDVs placed on the EU market, which will be subject to the certification process under the type approval framework.

The monitoring system will only cover CO_2 emissions, resulting from the certification procedure. Emission pollutants, such as particulate matter (PM), nitrogen oxides (NOx), un-burnt hydrocarbons (HC) and carbon monoxide (CO), as well as methane (CH_4) emissions from CNG fuelled engines, are already covered by the EURO VI engine standards[23]. Fluorinated greenhouse gases due to leakages from refrigeration systems in the case of refrigerated trucks and from the air conditioning systems of HDVs are covered by the so-called F-gas Regulation[24].

The monitoring system will only cover new vehicles, since vehicles in use cannot technically be subject to certification. The input data needed to run the VECTO simulation tool are not available for vehicles already sold and in operation. Moreover, fuel efficiency technologies can generally not be (cost-effectively) retrofitted to existing vehicles. Furthermore, the first purchasing decisions are crucial for the diffusion in the fleet of more fuel efficient vehicles. It is thus essential to provide the right set of information to influence them.

Considering the average lifetime of a lorry of around ten years[25], it can be assumed that in ten-year time the whole (or most) of the EU fleet will be covered by the monitoring scheme.

Manufacturers will generate the digitised monitoring data at the time of production. This will contain a subset of around 80 parameters coming out of the certification process under type approval (see **Figure 6** below for an illustration of the link between VECTO, certification and monitoring and reporting).

The parameters in the monitoring data file have been chosen from the VECTO output data file following a technical analysis, which took into account the relevance of these parameters for the objective of closing the knowledge gap on HDV CO_2 emissions and future policy action, in particular having in mind the enforcement needs for future HDV CO_2 emission standards.

The key parameters are fuel consumption and CO_2 emission values and other parameters relevant for the determination of such values coming from the certification process. **Table 1**

[23] Regulation (EC) No 595/2009, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32009R0595

[24] Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0517&from=EN

[25] Ricardo AEA (2015), *Light weighting as a means of improving Heavy Duty Vehicles' energy efficiency and overall CO_2* emissions, Report for DG Climate Action, https://ec.europa.eu/clima/sites/clima/files/transport/vehicles/heavy/docs/hdv_lightweighting_en.pdf

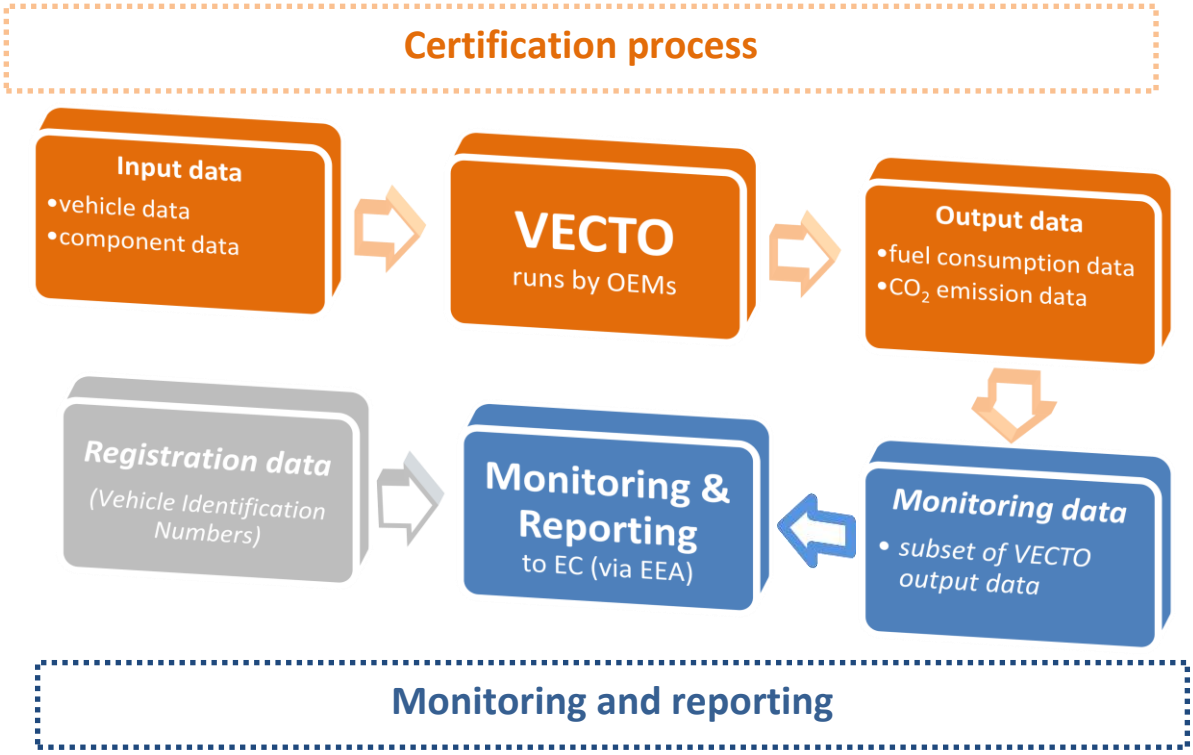
below provides a list of the main elements of the monitoring data which will have to be reported.

Table 1. Main elements of the data to be monitored and reported

General (mission profile independent) vehicle information	Component identification
	Vehicle classification
	Vehicle and chassis specification
	Main engine specifications
	Aerodynamics
	Main transmission specifications
	Main axle specifications
	Angle drive
	Main tyre specifications
	Main auxiliary specifications
	Technologies to reduce CO_2 emissions, e.g. advanced driver assistance systems
Mission profile and loading dependent values	Vehicle mass
	Vehicle driving performance and information for simulation quality check
	Fuel and CO_2 results
VECTO version	

Manufacturers' reported monitoring data will not include information on where the vehicle was registered. National authorities will need to complement manufacturer's information with vehicle registration data on the basis of the Vehicle Identification Numbers (VIN, described in **Annex 6**). This will allow calculating average values for CO_2 and fuel efficiency across the fleet of new heavy-duty vehicles registered in certain Member States for each calendar year.

Figure 6. Links between VECTO, certification and monitoring and reporting



4.1.2 STATISTICAL ANALYSIS

Taking into account future regulatory use of the monitoring data, it is necessary to provide effective safeguards ensuring the objectivity and precision of the data. It is therefore appropriate to foresee an empowerment for the Commission to develop a methodology for carrying out statistical data analysis for detecting and taking into account possible unjustified divergences found in the reported data, e.g. lorries of the same model reported with very different CO_2 emissions. This could trigger for example further targeted verification according to future provisions of the certification Regulation, thereafter improving market surveillance.

4.1.3 ROLE OF THE EUROPEAN ENVIRONMENT AGENCY (EEA)

The European Environment Agency (EEA) is the most appropriate body at European level to act on behalf of the Commission in order to collate data, build a new database, analyse and perform quality checks of the reported monitoring data from heavy-duty vehicles. This was also confirmed by comments received through the public consultation, which underlined the need of an independent agency to perform the monitoring at EU level.

The EEA already carries out these tasks for different monitoring and reporting schemes, including for CO_2 emissions from cars and vans[26] (see **Annex 8** for more information). Impacts on EEA's resources are assessed in **section 5**.

[26] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014R0410

4.1.4 PUBLICATION OF MONITORING DATA

The annual monitoring process would be completed with the publication by the Commission/EEA at the end of year n of monitoring data for year n-1 per vehicle, manufacturer and Member State.

Stakeholders expressed different views concerning the publication of the full set of monitoring data reported per vehicle. On the one hand, civil society organisations consider that all monitoring parameters should be published per individual vehicle in order to ensure full transparency. On the other hand, HDV and some component manufacturers have expressed concerns about the commercial confidentiality of some of the parameters like the coefficients of the rolling resistance of the tyres and of the aerodynamic drag.

In duly justified cases, such as where it is clearly demonstrated that a public disclosure of the data would seriously undermine commercial interests, the transparency objective may nevertheless be achieved by e.g. the publication of ranges of values instead of the specific values or the parameter may not be made public if absolutely critical. In the latter case, the data would be kept only for Commission internal use.

The Commission has also considered the risks that publication of data for each new HDV registered in the EU would entail in terms of market reactions. The risk of market collusion in a market with a very limited number of players, such as the EU HDV market, is considered to be limited as a result of the publication of the monitoring data. The availability of such data is expected rather to enhance competition in the market, given the information available on the performance of each player's vehicles.

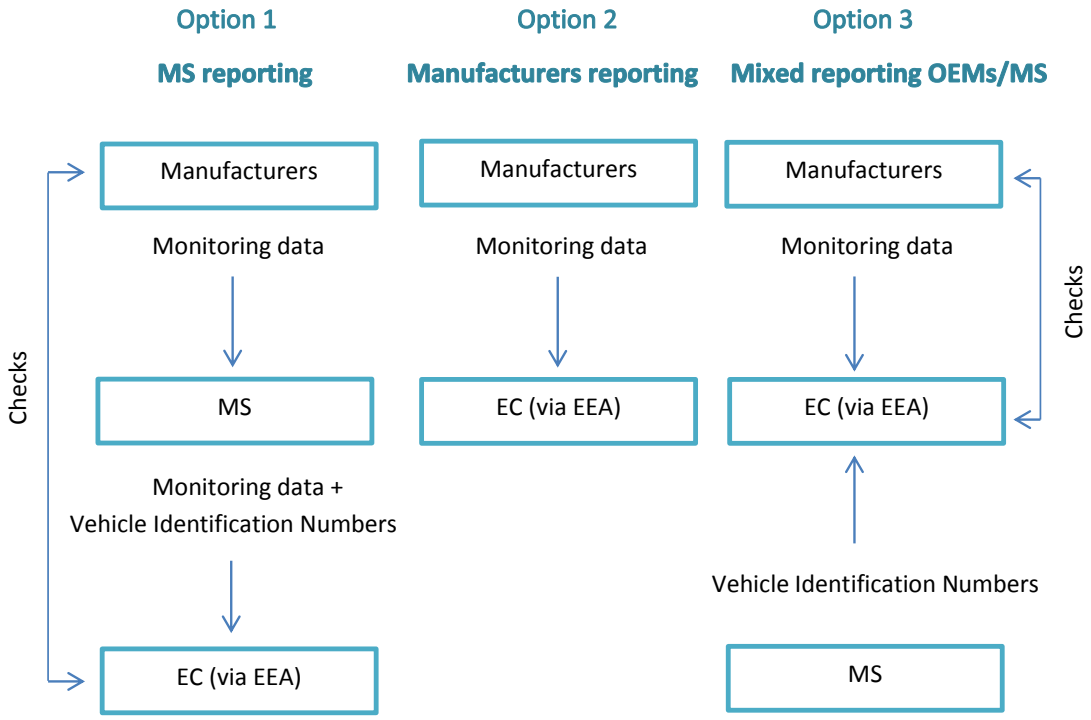
4.2 BASELINE OPTION "NO ACTION AT EU LEVEL"

This option does not entail any action at EU level on setting up a monitoring and reporting system for the CO_2 emission and fuel consumption data from new heavy-duty vehicles resulting from the certification process. The certification legislation would be adopted under the type-approval framework, but no instrument would be proposed to gather such data at EU level in a common database. The other options below are assessed against this baseline.

4.3 OPTIONS ASSESSED ON HOW TO MONITOR AND REPORT

The options relate to <u>how</u> to monitor and report CO_2 emissions and fuel consumption from new HDVs. Three main options are considered as illustrated in **Figure 7**.

Figure 7. Overview of option 1, 2 and 3



Source: EC/CE Delft, 2016

4.3.1 OPTION 1: REPORTING BY NATIONAL AUTHORITIES

Under this option, national authorities report the monitoring data and the registration data of the vehicles concerned via the EEA to the Commission.

As is the case for monitoring and reporting CO_2 emissions from vans, Member States will designate a competent authority for the collection and forwarding of the monitoring information, which would be the registration authorities in most cases. They will gather the monitoring data as part of the vehicle registration process.

The activities required for monitoring and reporting of HDV CO_2 emissions under this option include the following:

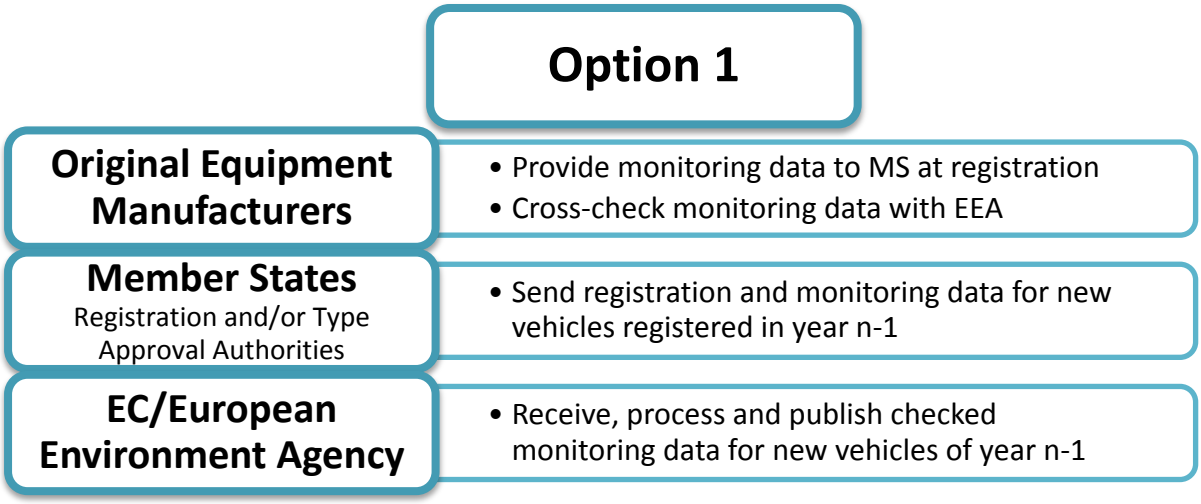
- adaptation of the national vehicle register, if needed;
- gathering of the monitoring data from the national vehicle register;
- submission of data to EC/EEA;
- combining national data sets and processing of data by EEA;
- eventually fixing of mismatches of data upon comparison of national data and manufacturers' data.

Under the assumption that all VECTO data is available due to the vehicle certification, the role of manufacturers would be to submit monitoring data to national authorities or intermediary persons (such as importers or dealers), during the registration procedure. In addition, manufacturers would review the data set compiled by EEA.

Implementation of this option will require extra investments, for example concerning training staff in all Member States. The amount of additional costs will depend on the existing expertise and technical system already available in the specific Member State.

Full digitisation of monitoring and reporting may not be easily feasible under this option as the majority of national registration authorities still process paper files to register HDVs (see **Table 2** in section **5.1.2**), therefore adaptation to fully digitised flows of monitoring data may be challenging and costly, this will be further assessed in section **5.1.2**.

Figure 8. Actors and related role for option 1



Stakeholders' view

Option 1 was deemed the most appropriate option for monitoring and reporting HDV CO_2 emissions and fuel consumption by 31% of the 121 respondents to the online public consultation (see Annex 2). The stakeholders most in favour of this option belong mainly to professional organisations, e.g. dealing with transport and logistics, private enterprises like component manufacturers, business, industry, and trade associations, some civil society organisations and some public authorities.

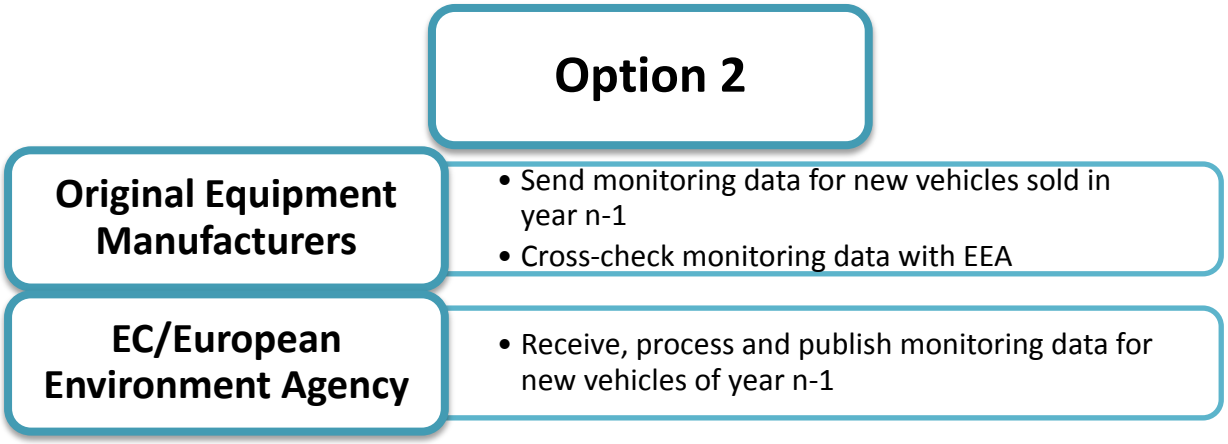
4.3.2 OPTION 2: REPORTING BY MANUFACTURERS

This option would alternatively put HDV manufacturers in charge of reporting the monitoring data for each new vehicle via the EEA to the Commission. In such a case the monitoring data would be annual sales-based data in the possession of vehicle manufacturers and no registration data would be reported (i.e. no information would be available on where the vehicle was registered).

Under this option manufacturers would thus annually collect and report the required monitoring data of their produced vehicles to the EC/EEA, including sales numbers on EU territory. The country of registration is not necessarily the country where vehicle and documents are sent to from the manufacturer. Dealers may register it elsewhere and, consequently, the manufacturers have no reliable information on where vehicles are registered.

Under this option, only manufacturers, the EEA and the Commission would have specific obligations with respect to monitoring and reporting of HDVs CO_2 emissions and fuel consumption, whereas Member States would play no role, as illustrated in **Figure 9**.

Figure 9. Actors and related role for option 2



Full digitisation of monitoring and reporting appears feasible under this option since manufacturers deal with digital files (e.g. they already own the digital VECTO input and output data) and could efficiently transfer them.

Stakeholders' view

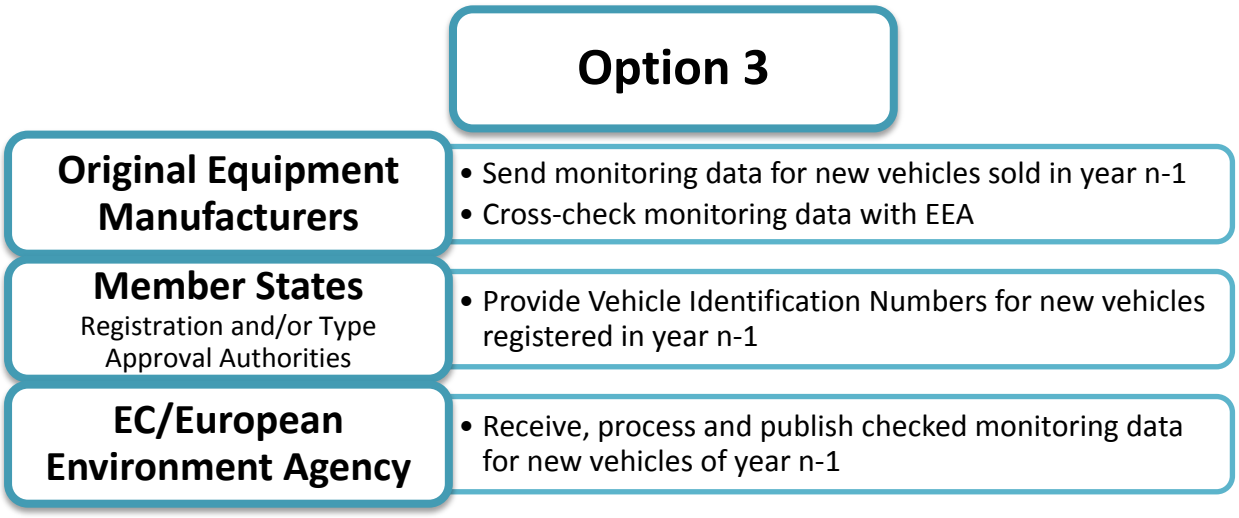
Option 2 was considered the most appropriate option by 12% of the respondents to the online public consultation, mainly by professional organisations (e.g. representing shippers).

4.3.3 OPTION 3: MIXED REPORTING BY NATIONAL AUTHORITIES AND MANUFACTURERS

This third option is an intermediate option between 1 and 2. Designated national authorities – most of which are expected to be the national registration authorities– would annually report via the EEA to the Commission registration data (VIN numbers) of new registered vehicles.

Vehicle manufacturers would submit via the EEA to the Commission the corresponding monitoring data. On the basis of the VIN numbers the two datasets are combined in order to obtain monitoring data at a Member State level.

Figure 10. Actors and related role for option 3



Under this option, full digitalisation of the flow of data is ensured, since manufacturers are in charge of reporting the monitoring data.

Stakeholders' view

Option 3 was considered as the most appropriate option by the highest number of respondents (42%) to the online public consultation, belonging to civil society organisations, the automotive industry, sector/trade/employers' associations, private and public companies, not for profit organisation, professional organisations (mainly linked to the automotive industry), private enterprises (e.g. from the energy sector), public authorities, individuals and international organisations.

4.4 DISCARDED OPTIONS

Voluntary cooperation

Voluntary cooperation among national authorities and/or vehicle manufacturers could provide a monitoring of fuel consumption and CO_2 emissions of new vehicles in the EU.

However:

- Harmonised checks and controls of these data would not be possible and the quality of the reporting may be affected.
- Cooperation cannot be taken for granted. In the absence of full cooperation of all players EU-wide monitoring/reporting would not be possible.
- The absence of such voluntary monitoring so far points to the difficulty of such approaches.

In view of the latter this option was discarded. It has not been supported by any stakeholder.

Collection of real-world fuel consumption data

Some stakeholders suggested that the emission data reported by manufacturers should be supplemented with "on-road/actual operations" data. Real-world fuel consumption data could be collected directly from on-board units fitted on the vehicles or requesting the operators to retrieve and report such data from their fleet management systems. This would require in particular on-board fuel flow meters to be made compulsory.

This option goes beyond the scope of this Impact Assessment which focuses on the monitoring data generated by VECTO through the certification process. It has therefore been discarded.

It should, however, be noted that the relationship between the HDV CO_2 emissions calculated ex-ante with VECTO and the real world emissions has been subject to thorough reflection in the preparation of the first block of HDV CO_2 emission legislation. In particular, the Commission has considered the following elements:

- Firstly, the high accuracy of the VECTO simulation tool. The simulation tool has been designed and calibrated in such a way to ensure a high accuracy, in the order of +/-3 % according to tests carried out by DG JRC. This measures the ability of VECTO to accurately calculate the emissions and fuel consumption of a specific vehicle on a specific route.

- Secondly, it will be important to set up periodic verification on VECTO and its use by manufacturers to ensure that this accuracy remains high and that manufacturers use the VECTO simulation tool in a correct manner. This safeguard will consist of periodic verification of the results of the certification procedure and of the accuracy of the

simulation tool. Discussions have started in view of the introduction of this requirement in the certification Regulation as soon as a robust verification testing procedure is agreed (see **Annex 5**).

- Thirdly, from the side of the monitoring and reporting legislation, an additional safeguard will be foreseen to detect possible unjustified divergences found in the reported data through statistical analysis of the reported data (see above section **4.1.2**).

- Fourthly, the Commission aims to monitor the gap between the future VECTO data and real-world data. This gap should be as small as possible but cannot be entirely closed in view of the large variability in the use of the vehicles in real-world. A quantified analysis is not yet possible as VECTO is not in place and on-board fuel meters are not mandatory under the type approval. Further work will be needed in this respect and goes beyond the scope of this IA.

VECTO as an open tool

A non-governmental organisation and other stakeholders[27] submitted a joint memorandum to the Commission[28] requesting VECTO to be made available to third parties such as transport operators or suppliers. This should enable third parties to independently consult and compare vehicle combinations, their energy performance and CO_2 emissions.

The design of VECTO largely accommodates this request since it has been established as an open source software under EU Public License. It can be run under so-called 'declaration' mode for certification purposes and under 'engineering' mode with various possible assumptions to assess vehicles' energy performance and emissions in a customized way (see **Annex 4** for more details). However, the confidentiality of some of the input data, e.g. fuel and engine maps, does not allow the access of VECTO 'declaration' mode to third parties. Furthermore, this concerns the regulation on certification. It was therefore discarded in this IA.

Coverage of Well-to-Wheel emissions

Some stakeholders proposed that the monitoring and reporting should have a broader approach providing information not only of HDV tailpipe CO_2 emissions but also of the GHG emissions from the whole fuel production process.

This option has been discarded in the present IA for several reasons:

- Certification only provides tank to wheel CO_2 emission data.
- Furthermore, this could lead to double regulation. Today, upstream "well-to-tank" GHG emissions are subject to other EU legislation through the inclusion of the oil industry and energy production sector into the EU Emission Trading System and by the Fuel Quality Directive[29].
- Creation of legal ambiguity as the responsibility for the fuel production process lies with the fuel producers, and the final choice of fuels is left to the truck operator.
- A tank to wheel approach has also been taken in the case of cars and vans.

[27] The International Road Union (IRU), The European association for forwarding, transport, logistics and customs services (CLECAT), Leaseurope, the European Transport Board, the European Express Association, Green Freight Europe, and the Nordic Logistics association

[28] https://www.transportenvironment.org/sites/te/files/publications/Memorandum%20on%20Heavy%20Duty%20Vehicle%20CO2_final.pdf

[29] Directive 2009/30/EC (http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0030) amending Directive 98/70/EC (http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31998L0070)

4.5 ARE SMALL AND MEDIUM SIZED ENTERPRISES TARGETED BY THE DIFFERENT OPTIONS?

HDV manufacturers responsible for the monitoring and reporting are all very large international companies, namely Daimler, Volvo Trucks (which is also the owner of Renault Trucks), MAN and Scania which are part of the VW group, Iveco (CNH Industrial Group) and DAF (Paccar Group) (see **Annex 7**).

Body and trailer manufacturers are to a large extent SMEs: the trailer and body-builder sector is highly diverse with thousands of enterprises most of which operate only in local markets. The sector is, however, not impacted as body and trailer manufacturers are not involved in the first stage of implementation of the certification regulation. VECTO simulations will use generic default values on body and trailer characteristics to calculate entire vehicle emissions.

5. WHAT ARE THE IMPACTS OF THE DIFFERENT POLICY OPTIONS AND WHO WILL BE AFFECTED?

5.1 ECONOMIC IMPACTS

5.1.1 GENERAL ECONOMIC IMPACTS

Depending on consumer choices, rates of technological progress in manufacturing more efficient vehicles, and the actual downstream use of the monitoring and reporting data by policy makers, the potential benefits could be sizeable. The impact assessment that underpinned the 2014 HDV Strategy has shown that a more transparent HDV market would stimulate competition among HDV manufacturers and transport operators. This should foster innovation to produce more energy efficient vehicles in the EU market (see paragraph 5.6). For instance this could trigger new design of the driving cabin to improve aerodynamic according to the directive on weights and dimensions[30]. Such redesign was quantified in the related impact assessment[31] as yielding up to 8.9% of fuel savings.

The effects of more energy efficient freight and passenger road transport are expected to, at least partially, pass-through and spread to most sectors of the EU economy: lower fuel operating costs of transport will under the current competitive environment of transport trigger lower transport prices, and thereby reduce other sectors' costs for intermediate and consumer goods, eventually benefitting EU consumers. However, transport costs are generally a small share of overall product costs: the elasticity of output prices to increases in road transport prices has been assessed in the context of past legislation and varies significantly[32] across sectors.

Options 1 and 3 are considered not to have different economic impacts. However, the second option provides much less detailed information for policy makers and therefore benefits should be expected to be smaller.

In the absence of knowledge on how exactly the gathered information will be used over time, it is difficult to assess the exact vehicle percentage efficiency gains that monitoring and

[30] Directive (EU) 2015/719 of the European Parliament and of the Council of 29 April 2015 amending Council Directive 96/53/EC laying down for certain road vehicles circulating within the Community the maximum authorised dimensions in national and international traffic and the maximum authorised weights in international traffic, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32015L0719

[31] Commission Staff Working Document Impact Assessment Accompanying the document Proposal for a Directive of the European Parliament and of the Council amending Council Directive 96/53/EC laying down for certain road vehicles circulating within the Community the maximum authorized dimensions in national and international traffic and the maximum authorized weights in international traffic (SWD/2013/0108 final), http://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:52013SC0108

[32] See COM(96)339 final, Proposal of a Council Directive on the charging of heavy goods vehicles for the use of certain infrastructures, see in particular Annex 2 p. 34, available under http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:51996PC0331&from=EN

reporting alone could trigger on top of business as usual, which is assumed by manufacturers at around 1.3% per year during the period 2005-2020[33].

However, a simple marker of the potential economic benefits that could be reaped from such efficiency gains is illustrated in **Box 1**. It shows, under the assumptions made, that an incremental 1% improvement of the energy efficiency of the fleet could lead to savings of fuel costs for transport operators of about € 725 million per year.

Box 1 Potential benefits of monitoring HDV fuel efficiency and CO_2 emissions

Potential benefits of monitoring HDV fuel efficiency and CO_2

The HDV fleet in the EU in 2014 consisted of around **5.6 million trucks and 0.6 million buses**[34], emitting some 214 MT of CO_2[35]. Assuming over time that the full fleet is purchased in light of more transparent information benefiting from such monitoring, each 1% efficiency gain on the HDV fleet would translate annually into 2.1 MT emission savings and fuel savings of 790 M litres, i.e. a gain of some € 725 M for transport operators at current automotive gas oil prices[36] or 4.9 M barrels of oil. As this is mostly imported, i.e. a non-refined oil value of some € 250 M annually based on an oil price (brent) of USD 54.15[37] i.e. € 50.9 it would reduce Member States' oil imports.

Stakeholders' view

The majority of stakeholders which replied to the online public consultation (see Annex 2) share the opinion that the economic impacts of monitoring and reporting HDV CO_2 emissions and fuel consumption are expected to be positive even though limited.

5.1.2 COST OF OPTIONS (ADMINISTRATIVE BURDEN FOR MAIN STAKEHOLDERS CONCERNED)

Monitoring costs have been estimated in an external study[38] (see **Annex 10**) for each of the three options considered and of the actors involved (Member States, OEMs, EEA/EC). Monitoring costs are estimated between **€ 1** (Option 3) and **€ 5** (Option 1) per heavy-duty vehicle registered in the EU.

These costs are **additional to the costs for certification** (available in **Table 1** and **2** in **Annex 5**).

Two cost components have been assessed:

- **transition costs**: implementation costs and database development/IT investments;
- **annual costs**: technical maintenance and IT costs, VECTO data transfer costs, reporting costs, and costs for making checks and answering questions.

These cost components have been described in more details and indicated for each option and respective actor in **Table 2** below.

Transition costs have been annualised with a discount rate of 4%, in accordance with the Better Regulation Toolbox[39], and a 10 year depreciation period. Labour costs have been

[33] ACEA, 2016, ACEA Position Paper Reducing CO2 Emissions from Heavy-Duty Vehicles, p. 14, https://www.acea.be/uploads/publications/ACEA_Position_Paper_Reducing_CO2_Emissions_from_Heavy-Duty_Vehicles.pdf
[34] ANFAC, 2016, European Motor Vehicle Parc 2014, http://www.acea.be/uploads/statistic_documents/ACEA_PARC_2014_v4.pdf, pp. 9-10
[35] GHG Inventory data 2016,
[36] Based on automotive gas oil Price EU28 average week of 13 February 2017, https://ec.europa.eu/energy/en/data-analysis/weekly-oil-bulletin, and http://www.eea.europa.eu/data-and-maps/indicators/fuel-prices-and-taxes/assessment-6
[37] Crude oil brent price for Europe on 13 February 2017, http://www.eia.gov/dnav/pet/pet_pri_spt_s1_d.htm
[38] CE Delft, 2016, Monitoring heavy-*duty vehicles' CO_2* emissions and their costs - An assessment, available in **Annex 11**
[39] http://ec.europa.eu/smart-regulation/guidelines/docs/br_toolbox_en.pdf

estimated based on an hourly rate of 30€/hour (60.000€ for one working year), and the figure includes also social charges and costs for pension (25%).

Table 2. Cost components[40]

Cost component	Sub-component description	Description	Relevant for actor under option 1, 2 or 3		
			MS	OEM	EEA
Transition costs	Implementation costs	The implementation costs are defined as non-technical costs for organising the process, making arrangements between actors (between MS and OEM on registration procedure, between EEA and MS/OEM on reporting format). These costs are non-recurring costs.	1,3	1,2,3	1,2,3
	Database development/ IT investments	The technical implementation costs refer to investments in the development of needed databases and additional IT requirements. OEMs database costs are defined as certification costs and therefore not taken into account. These costs are non-recurring costs.	1		1,2,3
Annual costs	Technical maintenance & IT costs	Data management costs concern the technical maintenance costs for IT systems and databases. These only apply when IT systems are in use for the sole purpose of HDV monitoring. OEMs database costs are defined as certification costs and therefore not taken into account. The data management costs are estimated at 10% of the technical investments.	1,3		1,2,3
	VECTO data transfer costs	VECTO data transfer costs apply only to monitoring option 1. In this option, not all Member States use a fully digitalised registration system, and additional costs will occur when registration procedure is extended for the sole purpose of HDV monitoring. This is the case for all registrations for the OEM and only for non-digitalised registrations for Member States.	1	1	
	Reporting costs	Reporting costs are defined as costs of transfer of data to EEA and management by EEA. These costs refer to the effort made by the responsible entity (MS in Option 1, OEM in Option 2 and both in Option 3) to perform the annual reporting. In case of EEA, this cost components represents the processing of the received datasets.	1,3	1,2,3	1,2,3
	Costs for making checks, answering questions	EEA and EC will perform several quality checks in order to evaluate the accuracy and the quality of the datasets. On the basis of the checks and the feedbacks from the responsible entity(ies) a preliminary database is published. Depending on the quality control system in each monitoring option, various actors will be able to give feedback on the datasets and notify the Commission of any errors in the data. The	1,3	1,2,3	1,2,3

[40] CE Delft, 2016, Monitoring heavy-*duty vehicles' CO_2* emissions and their costs - An assessment, available in **Annex 11**

		feedback is assessed and, when justified, taken into account for the final database.			

1) Costs of Option 1

Monitoring costs under option 1 vary greatly among Member States in function of the number of registrations and the degree of digitalisation of the registration systems (for example a number of Member States still uses mainly paper work, see **Table 3**).

Table 3. Rate of digitalised registrations and registration methods allowed in various countries[41]

Country	MS uses CoC[42] on *paper* for registration (WVTA[43])	MS uses CoC *XML file* for registration (WVTA)	MS uses other (than) XML file for registration	Rate of total number of registrations on the basis of transferred digital files (from interviews)
Austria	Yes	Yes	Yes, adapted	
Croatia	Yes	Yes	No	Moderate
Czech Republic	Yes	Yes	No	
Denmark	No	Yes	Not decided yet, system DMR	Moderate
Finland	Yes	No	No	Low
France	Yes	No	Yes (OTC file)	High
Germany	Yes	Yes	Yes adapted	None
Greece	Yes	No	No	None
Hungary	Yes	No	No	
Italy	Yes + local declaration paper	Yes	No	High
Lithuania	Yes	No	No	
Netherlands	Only for incomplete HDV	Yes	IVI standard designed by EReg	High
Romania	Yes	No	No	
Slovakia	Yes	No	No	
Slovenia	Yes	Yes	No	
Spain	No	Yes	Yes	High
Sweden	No	Yes	No	Low
United Kingdom	Only for complete vehicles, other vehicles via national IVA	No	No	Low

Decisive cost categories are thus the development and operation of the needed IT systems by Member States in order to process large monitoring data files and the transfer of individual data files per vehicle.

[41] CE Delft, 2016, Monitoring heavy-*duty vehicles' CO_2* emissions and their costs - An assessment, available in **Annex 11**
[42] CoC = Certificate of Conformity
[43] WVTA= Whole Vehicle Type-Approval

Total one-off transition costs for all Member States are estimated to be around €2 million and the annual costs for all EU Member States around €500.000 per year. When transition costs are annualised, the total costs are estimated to about € 800.000 per year in average for each Member State.

Transition costs for all manufacturers have been estimated in the range of €125.000-250.000 and annual costs between €75.000-180.000 per year, plus €20.000 for data checking.

2) Costs of Option 2

This option entails no additional costs for Member States. Transition costs per manufacturer are estimated to be around €16.500 and annual costs around €7.000 for reporting plus €6.750 for checking data.

3) Costs of Option 3

This option does not involve transition costs for Member States and in total annual costs are estimated in average at around €100.000 for all Member States (around €3.500 per Member State) per year. Costs for manufacturers are similar as for option 2.

All three options require transition costs of around €250.000 for the EEA/EC and around €175.000 of annual costs. Total annualised costs for the EEA/EC are estimated to be around €205.000.

Table 4. Comparison of total costs of monitoring options

Entity	Cost component	Option 1 national authorities reporting to EC/EEA	Option 2 manufacturers reporting to EC/EEA	Option 3 Mixed : national authorities/manufacturers reporting to EC/EEA
HDV Manufacturers	Transition costs	k€ 1.313	k€ 116	k€ 116
	Annual costs	k€ 901	k€ 96	k€ 96
	Total annualised(*)	k€ 1.062	k€ 110	k€ 110
Member States	Transition costs	k€ 2.242	0	0
	Annual costs	k€ 534	0	k€ 98
	Total annualised (*)	k€ 811	0	k€ 98
EC/EEA	Transition costs	k€ 250	k€ 250	k€ 250
	Annual costs	k€ 175	k€ 175	k€ 175
	Total annualised(*)	k€ 206	k€ 206	k€ 206
Total annualised	**Total annualised (*)**	**k€ 2.079**	**k€ 316**	**k€ 414**

(*) Transition costs were annualised using a discount rate of 4% and a period of 10 years **Source: CE Delft (2016)**

Stakeholders' view

These results of the cost assessment carried out by CE Delft were presented at the stakeholders' meeting on 17 October 2016[44] and have not been challenged.

5.2 SOCIAL IMPACTS

There is no expected appreciable impact on employment from either option in the short term.

The possible short term impact on employment could be the few jobs related to the monitoring and reporting function in national authorities (options 1 and 3), vehicle manufacturers (option 2 and 3). In all three options, two[45] additional full time employees will be required in the EEA and 0.5 in the EC.

In the medium to long-term, positive social impacts are expected through the stimulation of competitiveness and innovation for manufacturers and transport operators. No quantification is however possible at this stage.

Stakeholders' view

The majority of stakeholders which replied to the online public consultation agree that social impacts will not be material for any of the options.

5.3 ENVIRONMENTAL IMPACTS

5.3.1 CO_2 EMISSIONS

As indicated in the impact assessment that underpinned the 2014 HDV Strategy, certification, monitoring and reporting of HDV CO_2 emissions in curbing HDV fuel consumption and CO_2 emissions is expected to be effective.

This action would establish a reliable track record of whole HDV emissions, independent from each manufacturer's measurement, providing reliability and transparency to the market as to real vehicle performances. This would be expected to increase awareness among fleet operators on the most cost effective vehicles to operate, and influence decision making in purchasing new HDVs.

A second dynamic impact related to increased transparency in the HDV market, is expected to be the creation of an incentive for HDV manufacturers to innovate and to the uptake of fuel efficiency technologies, which in the long term will contribute to an increasing share of more energy efficient heavy-duty vehicles in the fleet.

A precise quantification of the impacts of monitoring and reporting over time on HDV CO_2 emissions in the EU could not be carried out due to the lack of reliable methodology for such an assessment. However, the simple marker illustrated in **Box 1** above provides an indicative benchmark. Assuming over time that the full fleet is purchased in light of more transparent information benefitting from such monitoring, an incremental 1% efficiency improvement in the EU fleet would translate into around 2.1 Mt CO_2 emission reductions.

Impacts are therefore expected to be favourable. CO_2 emissions reductions would be relevant for new vehicles and progressively for the whole HDV fleet.

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[44] The stakeholder meeting on 17 October 2016 took place in Brussels with around 70 participants representing EU Member States, the automotive industry (original equipment manufacturers and component suppliers), transport operators, the logistics sector, non-governmental organisations, the European Environment Agency and other Commission services (http://ec.europa.eu/clima/events/articles/0113_en).

[45] This assessment differs from the CE Delft study in **Annex 10**, since after the study was completed, it became clear that additional tasks would be necessary, with important implications for the resources required at the Agency. In particular, an additional post, compared to 1FTE estimated in the study, would be needed due to the additional statistical analysis to be performed by the Agency on behalf of the Commission for verification purposes (see **section 4.1.2**).

The three options are not expected to have different impacts on CO_2 emissions.

Stakeholders' view

The large majority of stakeholders, who replied to the online public consultation, agree that HDV monitoring and reporting will increase awareness among fleet operators on the most effective vehicles to operate and consequently influence their purchasing decisions. They also agree that its effect on reducing HDV fuel consumption and CO_2 emissions will be real but limited.

5.3.2 OTHER EMISSIONS

Other environmental impacts considered relate to emissions of air pollutants (particulate matter, nitrogen oxides, un-burnt hydrocarbons and carbon monoxide), which are already regulated under the Euro VI Regulation. As underlined in the impact assessment attached to the 2014 HDV Strategy, favourable but only negligible impacts can be expected. Given that HDV engines are already subject to not-to-exceed limits according to the EURO VI standard for such pollutant emissions, favourable impacts on the overall pollutant emissions from the vehicle can only be expected from efficiency measures outside the engine, e.g. aerodynamic improvements of the cabin. Quantitative estimates cannot be provided at this stage.

The three options are not expected to have any differentiated environmental impacts.

Stakeholders' view

The majority of stakeholders, who replied to the online public consultation, shared the opinion that the increased fuel efficiency of vehicles would lead to some reduction of other non-CO_2 emissions.

5.4 IMPACT ON COMPETITIVENESS AND INNOVATION

Within the EU market, positive impacts on competitiveness and innovation are expected in the medium / long-term, irrespective of the options. Such impacts would be differentiated by sector.

1) Automotive manufacturing industry. As anticipated in the 2014 HDV Strategy impact assessment, no material impacts are expected, even though, to some extent, comparability between manufacturers' vehicles energy efficiency may foster innovation and the industry's competitiveness on the EU internal market. Innovation would be fostered both at the level of component and vehicle manufacturers.
2) Transport operators. The combined cost of vehicle purchase and operation would be expected to be reduced by improved comparability of the HDVs' energy performance, leading to improved performance of transport operators expected to be at least partly passed through to their customers through lower prices, as this is a very competitive industry.
3) Other sectors of the economy. Lower transport costs may (marginally) lead to lower prices of intermediate goods, and thereby to increases in competitiveness of many other segments of the economy. In relative terms on the EU market this would only affect the competitiveness of companies operating in the same market if they have very different shares of transport costs in their product costs.

Stakeholders' view

The large majority of stakeholders responding to the online public consultation agreed that increased transparency in the HDV sector would improve competition among HDV

manufacturers and transport operators. Stakeholders also agreed that marginal positive impacts can be expected in terms of improved competitiveness.

5.5 IMPACTS ON THIRD COUNTRIES AND ON EU INTERNATIONAL TRADE

There is not likely to be any direct impact on third countries.

Switzerland has in the past largely replicated EU car and light commercial vehicle Regulations and might continue to do so in the future. It is possible that other countries might take inspiration from the EU approach in this field. However, most of the large countries such as the US, China and Japan, have already put in place a system of certification, monitoring and reporting of HDVs emissions.

Impacts on EU international trade and investment are expected to be positive in the medium / long-term and differentiated among sectors of the economy:

- Automotive manufacturing industry. As indicated in the competitiveness assessment (annex 10) of the 2013 impact assessment underpinning the 2014 HDV Strategy[46], the EU HDV industry is highly competitive, has a positive trade surplus and specialisation index in HDV production and trade. Expected improvements in innovation uptakes and the industry's competitiveness would benefit the EU HDV industry's international competitiveness and its global market penetration both through trade or Foreign Direct Investment (FDI) and overseas production. It should also be noted that the other major HDV markets in the world (US, China and Japan) have already enacted HDV CO_2 emissions, setting emission standards, leading manufacturers from these other markets to enhance the efficiency of their fleet to comply with the standards.
- Transport operators. While benefitting from improved competitiveness in the EU market, the industry of transport services would not be expected to significantly improve its international position (outside the EU) as differences in labour costs would not be affected. More energy efficient vehicles would also be expected to be available to competitors in neighbouring countries.
- Other sectors of the economy**.** The above mentioned competitiveness assessment took the view that the implementation of legislative measures to reduce HDV fuel consumption and CO_2 emissions may change the costs of intermediate products and hence also the costs of final products through changes in transport costs. For products offered on a global market, the change in transport costs due to measures aimed at reducing HDV CO_2 emissions may also affect the global competitive position of European companies. For both situations, however, transport costs are generally a small share of overall product costs. Direct or indirect impacts on EU international trade through changes in the cost price of intermediate and final products will therefore most likely be negligible.

Options are not expected to differ with respect to these impacts.

Stakeholders' view

Most of the stakeholders, respondents to the online public consultation, agree that, if the assumptions above mentioned are fulfilled, the EU HDV industry's international competitiveness and EU exports could marginally benefit.

[46] http://ec.europa.eu/clima/policies/transport/vehicles/heavy/docs/swd_2014_160_en.pdf

5.6 IMPACT ON SMES

1) Manufacturing industry

In the case of HDV manufacturers, there is no expected impact on SMEs as the main HDV manufacturers are all very large international companies, in particular 6 large manufacturing companies dominate the EU HDV market (see **Annex 7**).

Body and trailer manufacturers are mostly SMEs but no impacts are expected since they are not involved in the monitoring and reporting. In the first stage of certification, trailers and body will be included in the VECTO simulation using default values.

2) Transport operators

Transport companies, most of which are SMEs (see **Annex 7**) operating only a few trucks or buses, would benefit from the monitoring of emissions as this would provide more transparency on the fuel consumption performance of HDVs. The transport companies will be able to take this information into consideration in their purchasing decisions, thereby realising fuel savings and reducing their operating costs.

The economic impact for transport operators is subject to the evolution of fuel prices. An assessment of mid-2015 (i.e. when oil prices were around 60 USD/barrel) estimated fuel to represent between 26% and 36% of transport operators costs, with variations to the category of vehicle and cycle[47]. Another assessment by the French Fédération Nationale du Transport Routier suggests lower fuel relative costs in 2016 between 14.3 and 20.7% of operating costs (see **Annex 8**) as a result of the recent fall in oil prices. The Freight Transport Association (FTA) in the UK estimated in July 2016 that fuel costs represented a percentage ranging between 17 and 32% of total annual vehicle operating costs[48], depending on mileage and gross vehicle weight[49]. The Comité National Routier (CNR) estimated the share of fuel costs of total operating costs[50] for a heavy-duty vehicle of 40tonnes to be 21.1% for regional delivery and 23.1% for long haul in December 2016[51].

While these operating costs follow fuel price developments, this points to fuel operating costs that represent a very significant share of transporters' overall costs.

Depending on the penetration of fuel efficient HDVs, the impact may be significant on transport prices as well, given the highly competitive situation in the transport industry. This suggests that with high penetration the fuel cost saving is expected to be passed through to transport end-users.

Options are not expected to have differentiated impacts in this respect.

Stakeholders' view

The vast majority of stakeholders, respondents to the online public consultation, agree that transport companies, most of which are small SMEs, are expected to benefit from the monitoring of fuel consumption and CO_2 emissions from HDVs.

[47] "Transporte Profesional", Separata especial N°354, October 2015
[48] Vehicle standing costs, vehicle running costs and driver costs
[49] Source: FTA's Manager's Guide to Distribution Costs - July 2016 Update Report http://www.fta.co.uk/policy_and_compliance/fuel_prices_and_economy/fuel_prices/fuel_fractions.html
[50] Including cost of fuel (excluding VAT, taking into account the partial reimbursement of excise), maintenance costs, infrastructure charges, equipment , driver (remuneration + employers' contributions), travel expenses and charges.
[51] http://www.cnr.fr/Indices-Statistiques/Longue-distance-40T#haut, and http://www.cnr.fr/Indices-Statistiques/Regional-40T#haut

6. HOW DO THE OPTIONS COMPARE?

6.1 EFFECTIVENESS

Against the general policy objectives:

1) Facilitate a reduction in fuel costs for transport operators

All options would make available to transport operators data on fuel consumption and CO_2 emissions from new HDVs placed on the EU market, through the publication of a database where vehicle efficiency could be compared. Regardless of the option chosen, transport operators will benefit from the information available, which will influence their purchasing decision towards the vehicles that would allow the highest fuel savings for their specific operations.

2) Contribute to the improvement of the competitiveness of HDV manufacturers

Providing information on fuel consumption and CO_2 emissions will create an additional incentive for HDV manufacturers to invest in innovation in order to put on the market more fuel efficient technologies and vehicles, improving their competitiveness worldwide. This is the case for all of the options.

3) Contribute to the achievement of the EU's climate and energy targets and objectives

All options would make available data on fuel consumption and CO_2 emissions to policy makers, providing a baseline for policy action to reduce HDV emissions and also a tool for implementation and enforcement of future CO_2 emission standards.

Against the specific objectives:

- Enable informed purchasing decisions and deployment of more fuel efficient vehicles
- Foster innovation and development of fuel efficiency technologies
- Promote cost-effective reductions of CO_2 emissions and reduce overall fuel consumption from HDVs
- Enable the development of rational policies promoting the uptake of advanced fuel efficient and low emission HDVs

All options would provide for information on fuel consumption and CO_2 emissions per vehicle and would allow comparing the performance of new vehicles placed on the EU market from various manufacturers by market segment.

However, option 2 is considered to meet the specific objectives only partly, as it will not provide information at the level of each Member State. The HDV monitoring data reported by manufacturers would be based on the vehicles sold. Registration information held by national authorities would not be provided under this option. As a result, the reported emissions data could not be allocated to a particular Member State. This would make it more difficult for Member States to design effective national policies to increase the uptake of more efficient HDVs.

Option 2 is in this respect less effective than options 1 and 3, under which Member States' HDV emissions would be satisfactorily covered through the registration data provided to the EC/EEA by their national authorities.

Options 1 and 3 are equally effective in meeting all specific objectives, since they would equally contribute to market transparency, overcoming the main market barrier identified i.e. the lack of information on the most efficient vehicles.

Option 1 is less effective than option 3 in meeting the last specific objective of enabling the development of rational policies promoting the uptake of advanced fuel efficient and low emission HDVs. This is due to the risks concerning the quality of the data. Under option 1, the digital flow of information may be interrupted if national registration authorities operate in a non- or partly digitalised mode. This may cause errors in reporting the monitoring data to the EEA. This risk does not materialise under option 3 as the data flow will be fully digitalised.

Under option 3, the possible risks of errors identified relate to the EEA matching each vehicle's registration data provided by Member States with the corresponding monitoring data reported by manufacturers. These risks will be mitigated through the implementation of a quality assurance and quality check (QA/QC) process by the EEA, for example performing checks on:

- the completeness of the data;
- the variability;
- the plausibility, in order to identify outliers (e.g. vehicles with similar characteristics and very different emissions).

Similar mitigation measures have been put in place successfully by the EEA for the monitoring and reporting of CO_2 emissions from vans (see **Annex 8**).

In light of the above, option 3 is considered the most effective option in meeting the specific objectives.

6.2 EFFICIENCY

The main efficiency criterion that is being considered is the administrative costs.

This costing exercise exhibits a quite significant difference between option 1, which turns out to be the most costly, and the two others, that have modest cost implications.

The main reason for this lies in the current state of play, in which registration is in most countries not a digitalised process. The cost assessment has assumed that digitalisation would be required. Significant costs are therefore anticipated for establishing the necessary digitalised IT procedures and database systems, mainly for Member States, and more limited costs for manufacturers to adapt to possible shortcomings in the transmission chain of digital data. While overall relatively moderate in view of the size of the EU economy, option 1 costs are high for Member States considering the available resources of the relevant authorities.

In the case of options 2 and 3, costs would be minimal for Member States. Authorities in the Member States are not involved for option 2, and only have to submit one monitoring parameter, i.e. the Vehicle Identification Number (VIN) for option 3. Manufacturers would not face high costs either, as they will have to set up the necessary databases to implement the certification obligations. The main costs lie with the EC/EEA, which is in charge of processing the data, publishing them and reporting.

6.3 PROPORTIONALITY

In view of its necessity and potential magnitude of the economic benefits, EU monitoring envisaged in the three options would meet proportionality requirements: at the EU scale, efforts needed are rather limited and costs reported above almost negligible compared with potential benefits.

In addition, the costs estimated per vehicle for the options rank between €1 for option 3 and €5 for option 1, which compared to the cost of a vehicle (in the order of hundred thousand

euros) and to the annual fuel cost (in average estimated above €20.000 per vehicle) can be considered as negligible. Saving 1 litre of fuel from around 30.000 litres consumed in average per year by a vehicle would be enough to cover the total administrative costs related to the monitoring of this vehicle.

6.4 SUBSIDIARITY

In all cases, EU-level action is deemed superior to fragmented national initiatives to monitor HDV fuel consumption and CO_2 emission.

6.5 COHERENCE WITH OTHER MAINSTREAM EU POLICIES

Options 1 and 3 are expected to rank equally in addressing the identified knowledge gap and in providing accurate and complete information on CO_2 emissions from HDVs in the EU to serve as baseline for future policy action. Option 2 would instead be expected to provide a less complete baseline, lacking the geographical distribution of emissions.

Option 2 would therefore risk a lower level of coherence with the main EU policies concerning GHG emissions from transport as it would not provide data at the Member States level. This could lead to inconsistencies and inefficiencies when implementing key EU policies: the European Strategy for low-emission mobility[52], the review of the "Eurovignette" Directive[53] and the Effort Sharing Regulation setting 2030 national targets for GHG emissions in non-ETS sectors, including transport.

6.6 STAKEHOLDERS' VIEWS

The majority of stakeholders agree that manufacturers of heavy-duty vehicles and public authorities should share the administrative burden of monitoring HDV fuel consumption and CO_2 emissions.

Most of the stakeholders, across all categories, expressed a preference for option 3, pointing out that the administrative burden of monitoring and reporting is shared between manufacturers and Member States' authorities and that the digital flow of data is ensured.

6.7 CONCLUSIONS

Table 5 provides an illustration on how the options compare and rank based on the explanations given in the previous paragraphs.

[52] https://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/1-2016-501-EN-F1-1-ANNEX-1.PDF
[53] Review of Directive 1999/62/EC ("Eurovignette") as amended, on the charging of heavy goods vehicles for the use of certain roads.

Table 5. Comparison of monitoring options

	Option 1 national authorities reporting to EC/EEA	Option 2 manufacturers reporting to EC/EEA	Option 3 Mixed: national authorities/manufacturers reporting to EC/EEA
Effectiveness in meeting objectives	**+** Objectives are expected to be met under this option, however there are risks for the integrity of the monitoring data due to the possible interruption of the digital flow of information during the reporting	**-** Objectives are expected to be partly met with an important caveat: manufacturer's monitoring data would be sales-based and would not include national registration data. This option would hence not provide full set of information at EU level nor at Member State level	**++** Objectives are expected to be met under this option
Efficiency (proportionality of effort, in particular costs, needed to reach objectives)	**=** This option is the most costly, but its overall cost remains moderate (to keep the continuous flow of digital monitoring data national authorities would need to make significant investments as a large number of them currently process data with paper)	**++** This option has a zero cost for national authorities, and a moderate one for manufacturers as well as the EC/EEA	**++** This option has only a marginal cost for national authorities, and a moderate one for manufacturers as well as the EC/EEA
Stakeholders views	**+** Option considered as possible by around 30% of the stakeholders. However not favored by many of them in view of its costs, the interruption of the digital flow of information and hence its low efficiency	**-** Option considered as possible but not favored by most stakeholders given its burden falling exclusively on HDV manufacturers and the lack of MS data coverage	**++** Option favored by most of stakeholders (above 40%) in view of its good efficiency and effectiveness
Subsidiarity	**++** EU scheme superior to aggregation of national ones	**+** EU scheme superior to aggregation of national ones, however limited information hampers development of national policies	**++** EU scheme superior to aggregation of national ones
Coherence with other mainstream EU policies	**++** Option expected to contribute to the broader EU objectives and mainstream policies	**-** Option expected to contribute in a less effective way to the broader EU objectives and mainstream policies	**++** Option expected to contribute to the broader EU objectives and mainstream policies
Ranking	**2**	**3**	**1**

In view of this assessment, Option 3 is the preferred option for the following key reasons:

1) Its administrative cost is modest compared to the more costly option (option 1) and comparable to the cost of option 2.
2) It is more effective than options 1 and 2 as it ensures the digital flow of information and provides for the expected degree of reliability of national data.
3) This option meets subsidiarity requirements.

Given the latter three criteria findings, it is the option that is the most proportionate in view of effort needed compared with effectiveness in meeting objectives.

In the stakeholders' consultation it appeared as the most favoured option by the majority of stakeholders, from all categories.

On other criteria, namely the economic and social impacts, environmental impacts, addressing market barriers, and possible effects for SMEs this option appears as effective as options 1 and 2. The option 3 also meets all the general, specific and operational objectives.

It should thus be concluded from the present Impact Assessment that this option should be the one retained in the upcoming regulation on monitoring and reporting HDV CO_2 emissions and fuel consumption.

A fully-fledged new legislative basis, under the ordinary (co-decision) legislative approval procedure will be required to establish such monitoring and reporting.

7. HOW WOULD ACTUAL IMPACTS BE MONITORED AND EVALUATED?

In order to monitor and evaluate the progress made towards the operational objectives of this monitoring and reporting initiative, the following four indicators are proposed:

1) Average annual CO_2 emissions and fuel consumption per vehicle group, manufacturer and Member State from new HDVs registered in the EU within the scope of the certification legislation.

This indicator should be calculated each year by the European Environment Agency based on the reported data for the retained option. Over time, it will give an indication on the amount of fuels saved and the reduced costs for operators.

2) Comparison of average annual CO_2 emissions and fuel consumption of the same group of vehicles across different years.

This indicator should be calculated every year by the European Environment Agency based on the reported data for the retained option. Over the time it would help monitor and evaluate progress towards the three general policy objectives, indicating the uptake of more fuel efficient vehicles, and in particular showing each year the rate of annual efficiency improvement in each vehicle group, i.e. whether new vehicles in the same group have an increased fuel efficiency and lower CO_2 emissions. It would also demonstrate the level of innovativeness of the manufacturing industry and the acceptance by transport operators.

3) Annual overview of fuel efficiency technologies fitted in the new vehicles and their penetration level.

This indicator should be calculated each year by the European Environment Agency based on the reported data for the retained option. The results of this monitoring will enable better design of emission reduction measures, and especially the further development of CO_2 emission standards, providing knowledge about technology development and penetration level in the fleet and therefore allowing a more accurate estimation of the level of ambition for such measures. It would also be an indicator of overall innovation in the manufacturing industry.

4) Exports and imports of HDVs

This indicator would give an indication on the competitive position of EU HDV manufacturers, based on data being collected via EUROSTAT.

ANNEX 1 - PROCEDURAL INFORMATION

1. Organisation and Timing

The Directorate-General (DG) for Climate Action was leading the preparation of this initiative and the work on the impact assessment in the European Commission.

An inter-service steering group (ISG), chaired by DG Climate Action and the Secretariat-General, was established in December 2015 on CO_2 emissions from road vehicles and was tasked of preparing this initiative. The ISG met four times in the period from December 2015 to February 2017. The following Directorates-General (DGs) participated in the work of the group: Secretariat-General (SG), Legal Service (SJ), DG GROW, DG MOVE, DG ECFIN, DG ENER, DG ENV, DG JUST, DG RTD, JRC, DG TAXUD, DG CNECT, DG COMP. The EEA was also consulted.

An indicative roadmap was adopted in July 2016.

An online public consultation took place from 20 July to 28 October 2016 (see Annex 2). A stakeholder consultation meeting took place on 17 October 2016[54].

2. Consultation of the Regulatory Scrutiny Board

The Regulatory Scrutiny Board received the draft version of the present impact assessment report on 24 February 2017 and following the Board meeting on 22 March 2017 issued a positive opinion on 24 March 2017. The Board made recommendations. Those were addressed in the revised IA report as follows:

RSB recommendations	Modification of the IA report
1) The introduction is not sufficiently clear on the context and scope of the impact assessment. Explanation of interlinked prior and future decisions on emission reporting and certification regulation is inadequate.	Explanations have been added in the first section to clarify what decisions had already been taken in the past, concerning the development of a simulation tool and a certification procedure for CO_2 emissions and fuel consumption from new HDVs, and how future decisions, in particular on CO_2 emission standards for HDVs, are linked with this initiative on monitoring and reporting HDV CO_2 emissions.
2) Data sensitivity and the potential market-disruptive risks relating to the monitoring and data collecting system lack assessment.	Section 4.1.4 has been expanded to provide considerations on the risks related to the publication of monitoring data for the EU HDV market.
3) The differences in digitalisation costs between options lack specificity.	Sections 4.3 and 5.1.2 have been further elaborated to provide more details about the costs of each option.

3. Evidence and external expertise used

The cost assessment of the different monitoring and reporting options was carried out by CE Delft. The CE Delft study is largely based on interviews to national registration authorities and HDV manufacturers, in order to collect their opinion about various monitoring options and receive targeted input with regard to the costs for their organisation, taking into account the current procedures and required adaptations.

[54] http://ec.europa.eu/clima/events/articles/0113_en

Moreover, the IA relies on the previous Impact Assessment from 2014 accompanying the Strategy for Reducing Heavy-Duty Vehicles Fuel Consumption and CO_2 Emissions, in relation to the assessment of the other impacts.

ANNEX 2 - STAKEHOLDER CONSULTATION

1. Process and quantitative results of the public consultation

The European Commission organised a public online consultation from 20 July to 28 October 2016, i.e. 12 weeks, on the preparation of legislation on monitoring and reporting of Heavy-Duty Vehicle fuel consumption and CO_2 emissions[55]. The Part A of the consultation sought input on how to monitor and report fuel consumption and CO_2 emissions from heavy-duty vehicles, with questions concerning the need of action, the objectives, the options and their anticipated impacts. Part B of the consultation focused on requesting general feedback on the need and design of CO_2 emissions and fuel efficiency standards. The public consultation was carried out using the "General principles and minimum standards for consultation of interested parties by the Commission".

The consultation received responses among others from professional organisations, private enterprises, civil society organisations, public authorities, international organisations, individuals/private persons and 'others'.

This analysis will only focus on the replies to Part A of the online consultation as directly linked to the initiative on monitoring and reporting HDV CO_2 emissions and fuel consumption that this impact assessment aims to underpin. Replies to Part B of the online consultation will be analysed in the frame of the future impact assessment on HDV CO_2 emission standards.

Part A of the public consultation consisted of a questionnaire in English with twelve main questions, ten multiple choices (in some cases articulated) and two spaces limited to 2 000 characters for additional comments. This report follows the structure of the questions in the consultation questionnaire. The individual stakeholder submissions can be downloaded on the consultation website for those stakeholders that gave their consent to publication (either under the given name or anonymously), whereas 6 submissions are not available either because missing publication consent or because received in a modified format.

Main conclusions from the consultation replies can be summarised as follows:

- general agreement with the need of action at EU level to monitor vehicle efficiency to close the identified knowledge gap;
- broad support of the objectives put forward, especially reducing HDV fuel consumption and CO_2 emissions, improving market transparency in the HDV sector and ensuring competitiveness of the European HDV manufacturing sector;
- option 3, i.e. mixed reporting by national authorities and HDV manufacturers, is considered as the most appropriate option by most stakeholders, followed by option1, i.e. national authorities reporting;
- broad agreement with the expectation of a positive although limited economic impact;
- increased transparency in the HDV market is expected to contribute to an improved level playing field among HDV manufacturers and the available comparability is likely to foster innovation;
- a marginal increased competitiveness of the transport sector is expected by the majority of stakeholders, as a result of lower transport costs due to more fuel efficient vehicles placed in the market;

[55] The results of the public consultation are available at http://ec.europa.eu/clima/consultations/articles/0031_en

- fleet operators, and in particular SMEs, are anticipated to benefit from the monitoring, since they will be able to take more informed purchasing decisions concerning the fuel efficiency of the vehicles;
- the administrative burden of monitoring and reporting HDV CO_2 emissions and fuel consumption should be shared between national authorities and HDV manufacturers, according to the majority of respondents;
- real but limited effects on reducing CO_2 emissions are expected from the initiative, as well as limited reductions in non-CO_2 emissions.

2. Stakeholders' participation in the public consultation

The Commission received 121 formal replies from a broad spectrum of stakeholders as shown in **Table 1**, three of which were received by email and not through the EU Voice website.

Table 1. Classification of stakeholders responding to the questionnaire

Stakeholder category	Number of responses	% of responses
Professional organisation	32	26%
Private enterprise	21	17%
Civil society organisation	20	16.5%
Other	20	16.5%
Public authority	12	10%
International organisation	9	7%
As an individual / private person	6	5%
Academic / Research institution	1	1%
Grand Total	**121**	**100%**

Notes: Other includes: one employers' association, 2 trade associations, 5 automotive/and body builders industries, one association for manufactures, one industry association, 3 business organisations, one sector association, one alliance of private companies operating in the logistics industry, one public company, one company, 2 non-governmental organisations and one non-profit organisation.

A number of coordinated responses were received, indicating that respondents followed a common answer, although with different degrees of variations. Since respondents were free to adapt the answers to correspond with their own views all responses have been analysed individually in the following sections.

Responses were received from organisations based in, or respondents residing in, 19 EU Member States (Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Netherlands, Poland, Portugal, Romania, Slovenia, Spain, Sweden and the United Kingdom), while few responses were also received from other non-EU locations such as Norway and the United States. The highest number of responses came from organisations residing in Belgium, followed by respondents from Germany, France and the United Kingdom, as shown in **Table 2**.

Table 2. Country of residence/establishment of stakeholders responding to the questionnaire

Country of residence/establishment	Number of responses
Belgium	29
Germany	13
France	10
United Kingdom	8
Austria	7
Netherlands	7
Sweden	7
Hungary	6

3. Responses to the individual questions

Need of action

All stakeholders, but one that gave no answer, agreed that monitoring vehicle efficiency (both in terms of fuel consumption and CO_2 emissions) in the EU is important in order to gather the necessary data to close the identified knowledge gap, with 70% of the respondents considering it as very important.

The majority of respondents (56%) were of the opinion that if no action is taken at EU level, monitoring of HDV CO_2 emissions would likely not take place. Only 25% of the respondents were of opposite views, with 18% being neutral. 44% of the respondents believed that Member States would separately take the necessary measures to monitor and report HDV CO_2 emissions in case of no action at EU level, whereas 27% saw this as unlikely, in particular most of the public authorities, and 26% were neutral.

Objectives

All stakeholders, but one that gave no answer, agreed that objective 1 'reducing fuel consumption and HDV CO_2 emissions' is important, with 86% of the respondents considering it as very important.

Most of the stakeholders considered objective 2 'Improving market transparency in the HDV sector' as important, however with a lower number of respondents considering it as very important (58%).

Stakeholders' opinions are more mixed regarding objective 3 'Improving road transport competitiveness', with the vast majority recognising it as important, but 12% of stakeholders belonging to different categories indicated it as not important.

Almost all stakeholders agreed that objective 4 'Ensuring competitiveness of the European HDV manufacturing sector' is important, with 47% of the respondents considering it as very important.

Options

Option 1 is deemed the most appropriate option for monitoring and reporting HDV CO_2 emissions and fuel consumption by 31% of the respondents, belonging mostly to professional organisations (10 respondents, among which organisations dealing with transport and logistics), private enterprises (7 respondents, including component manufacturers), 'other' (business/ industry/ trade associations, 6 respondents), civil society organisations (6 respondents) and public authorities (5 respondents).

Option 2 is the most appropriate option according to 12% of the respondents, mainly from professional organisations (8 respondents, mainly representing shippers), 2 private enterprises, 2 international organisations, 2 'other' (non-governmental organisations) and 1 public authority.

Option 3 is considered as the most appropriate by the highest number of respondents (42%): 11 civil society organisations, 11 belonging to the 'other' category (automotive industry, sector/trade/employers' associations, private and public companies, not for profit organisation), 10 professional organisations (mainly linked to the automotive industry), 8 private enterprises (e.g. from the energy sector), 4 public authorities, 4 individuals and 3 international organisations.

Suggested other options and comments on proposed options

Limiting the administrative burden and ensuring data reliability

Several stakeholders from private enterprises, automotive industry and trade association provided similar replies, according to which the system for monitoring should be based on whole vehicle values provided by VECTO, should avoid double reporting and seek an easy handling of the (digital) data submission, minimizing the risk of errors. Similarly, one international organisation and a business organisation indicated as main requirements for the monitoring and reporting system that: it should be cost-effective and minimize the administrative burden for manufacturers and Member States; and sufficient guarantees should be built into the system to ascertain the reliability of the data which is being communicated.

Publication of data

A number of civil society organisations provided similar replies advocating for option 3 and adding that VIN numbers should be made public in the EEA database to allow Member States to introduce other necessary measures, e.g. differentiated toll for trucks. A civil society organisation expressed a similar comment, according to which CO_2 emissions per vehicles should be made public to make possible the introduction of complementary measures at local or national level.

An international organisation argued that regardless of the reporting option, the values published by the Commission should be more detailed than average values per vehicle type/manufacturer, since the limited potential of the monitoring and reporting system to curb CO_2 emissions from HDVs depends on the granularity of the data made available to inform the public (i.e. the impact on CO_2 emission reduction can be strengthened by making available the fuel consumption data from each vehicle sold).

Real-world fuel consumption data

One international organisation proposed a different monitoring and reporting system, where actual fuel consumption information should be measured, recorded and transmitted through the electronic tachographs (on-board units of trucks) to data collection points from where the information is then conveyed to the European Commission for compilation into a report.

A similar idea is expressed by a private enterprise, which is of the opinion that the operator should be responsible for monitoring and reporting emissions of the vehicle operated.

Another private enterprise provides the example of Ireland where HDV operators have incentives to report actual fuel use (and therefore emissions) under a commercial performance scheme established to implement Article 7 of the Energy Efficiency Directive.

Another international organisation stressed the need to supplement the emission data reported by manufacturers with “on-road/actual operations”. A public authority underlined the need to

implement mechanisms to ensure the real-world compliance in order to avoid differences between VECTO and the real driving emissions.

Benefits of VECTO

Some private enterprises and professional organisations praised the VECTO simulation tool as a key aid in the decision-making process towards a carbon efficient fleet strategy, especially for small and medium sized transport companies. In order to fully grasp the benefits of it, they proposed that access to the VECTO simulation should be opened up to transport buyers and operators and that it should be mandatory that they receive the VECTO results. A public authority also agreed that VECTO should be transparent and accessible for all stakeholders.

Independence of the monitoring process

A number of stakeholders from different categories underlined the need for independence and robustness of the monitoring process, with different proposals for who should be in charge of it: either national environment agencies or a central EU agency.

Different approach compared to cars and vans

Two professional organisations stressed the need of not copy pasting the monitoring system in place for light duty vehicles, as heavy-duty vehicles have different characteristics and require a system with a more complex (e.g. individual vehicle values and not vehicle types monitored and reported).

Coverage of pollutant and Well-to-Wheel emissions

Three private enterprises are of the opinion that pollutant emissions such as NOx, SOx and particulate matters (PM) as well as noise should also be covered, and in addition two of them believe that a well-to wheel (WTW) methodology should be adopted when calculating fuel consumption, to take into account of the whole production process.

Likely economic impacts

The majority of stakeholders fully agreed (33%) or tended to agree (39%) with the statement that the economic impacts of monitoring and reporting HDV CO_2 emissions and fuel consumption are expected to be positive even though limited, with 21% of the respondents having no strong view and only 5% of the respondents either fully disagreeing or tending to disagree.

39% of stakeholders tended to agree with the statement that economic impacts of the various options are expected to be broadly similar, 36% had no strong view and 18% tended to disagree (7 professional organisations, 6 'others' including automotive industry, business organisation, trade association and NGO, 3 international organisations, 2 civil society organisations, 2 private enterprises, 1 individual and 1 academic/research institute).

Likely impacts on competitiveness and innovation

Views were quite split concerning the statement that no sizeable competitiveness impacts are expected in the Internal market, with 33% of stakeholders tending to disagree or fully disagreeing (3%) versus 30% tending to agree or agreeing (2%), and 29% not having a strong view.

The vast majority of the respondents agreed with the statement that a more transparent HDV market would contribute to an improved level playing field among HDV manufacturers and transport operators, with 45% in full agreement and 42% tending to agree.

Most of the stakeholders (52%) tended to agree with the statement that marginal impacts on competitiveness are expected: comparability between manufacturers' vehicles energy efficiency may foster innovation, with 28% fully agreeing.

The majority of the respondents were either in full agreement (31%) or tended to agree (42%) with the statement that fuel savings on more energy efficient vehicles would further foster lower transport costs in the EU, leading to (marginal) increased competitiveness of the transport sector, while 17% had no strong view and 8% either tended to disagree or fully disagreeing (3 professional organisations, 3 international organisations, 1 private enterprise, 2 'others' from a business organisation and an NGO).

Half of the stakeholders tended to agree (36%) or fully agreed (15%) with the statement that increased competitiveness of the transport sector would, by way of lower prices of intermediate goods, translate into increased (marginal) competitiveness of many other segments of the EU economy, however a very high number of respondents had no strong view (31%) and 14% either tended to disagree (12%, including 5 professional organisations, 3 international organisations, 4 'other' from automotive industry, 2 private enterprises and 1 public authority) or fully disagreeing (2%).

Likely impacts on third countries and EU international trade

45% of the stakeholders had no strong view concerning the statement that there is no expected material direct impact on third countries, the rest of the opinions were almost equally split between tending to agree (26%) and tending to disagree (22%).

Stakeholders mostly tended to agree (52%) or fully agreed (24%) with the statement that if as assumed above improvements in innovation uptakes and the industry's competitiveness are possible, this will (marginally) benefit the EU HDV industry's international competitiveness, while 21% had no strong views.

Stakeholders' opinions on the statement that pass-through of lower transport costs to many sectors of the EU economy would (marginally) benefit EU exports and international competitiveness were mainly tending to agree (37%) or fully agreeing (15%), however a high number of stakeholders had no strong opinion (36%) and 8% either tended to disagree (6%, mainly from professional organisations) or fully disagreed (2%).

Likely impacts on SMEs

Respondents were rather split with regards to the statement that there is no expected impact on SMEs from the manufacturing sector since HDV manufacturers on which the monitoring burden shall fall, are all very large international companies, 45% either tended to agree (28%) or fully agreed (17%) while 38% either tended to disagree (19%) or fully disagreed (19%), and 16% had no strong view.

The vast majority of the stakeholders fully agreed (57%) or tended to agree (21%) with the following statements: Transport companies, most of which are small SMEs, are expected to benefit from the monitoring of fuel consumption and CO_2 emissions as this would provide more transparency on the most energy efficient HDVs. SMEs could take this into consideration in their purchase decisions, thereby realising fuel savings. 16% of the respondents had no strong view.

Likely social impacts

A high number of respondents (39%) had no strong view on the statement that no material social impact is expected from either option, while half them either tended to agree (33%) or fully agreed (17%) with it and 9% either tending to disagree (6%) or fully disagreeing (3%).

42% of the stakeholders had no strong view with regards to the statement that social impacts of options would only slightly differ, while 35% tended to agree and 17% fully agreed with it.

Likely administrative burden

The majority of the respondents either tended to disagree (39%) or fully disagreed (15%) with the statement that manufacturers of heavy-duty vehicles should bear the essential administrative burden of monitoring HDV fuel consumption and CO_2 emissions. Only 20% of the respondents either fully agreed (12%) or tended to agree (8%) and 18% had no strong view.

Most of stakeholders tended to disagree (35%) or fully disagreed (3%) with the statement that public authorities should bear the essential administrative burden of monitoring HDV fuel consumption and CO_2 emissions, whereas 29% had no strong view and 31% of stakeholders, mainly from professional organisations or public authorities, either tended to agree (18%) or fully agreed (13%).

The majority of stakeholders either fully agreed (28%) or tended to agree (26%) with the statement that manufacturers of heavy-duty vehicles and public authorities should share the administrative burden of monitoring HDV fuel consumption and CO_2 emissions, while a rather high number of respondents had no strong view (32%) and 12%, mainly from private enterprises and professional organisations, either tended to disagree (10%) or fully disagreed (2%).

Likely environmental impacts (on CO_2 emissions)

A large number of respondents either fully agreed (26%) or tended to agree (48%) with the statement that real but limited effect on reducing HDV fuel consumption and CO_2 emission, whereas 15% of stakeholders, mainly from private enterprises and professional organisations, either tended to disagree (12%) or fully disagreed (3%).

The vast majority of stakeholders either fully agreed (29%) or tended to agree (50%) with the establishment of a reliable and transparent track record of whole HDV CO_2 emissions, independent from each manufacturer's measurement, while 8% of stakeholders, mainly professional organisations and private enterprises, either tended to disagree or fully disagreed.

88% of stakeholders tended to agree or fully agreed that monitoring and reporting HDV CO_2 emissions and fuel consumption would increase awareness among fleet operators on the most effective vehicles to operate and influence decision making in purchasing more effective HDVs.

Most of the respondents (43%) had no strong view concerning the statement that there would be no differentiated environmental impacts of the various options on CO_2 emissions, however 38% tended to agree or fully agreed and 16% tended to disagree or fully disagreed.

The vast majority of stakeholders (87%) fully disagreed or tended to disagree with the statement that HDV CO_2 monitoring should be focussed only on the main petrol and diesel fuels. Correspondingly 83% of stakeholders were fully in agreement or tended to agree with the statement that the scope of the HDV CO_2 monitoring should be broadened to incorporate alternative fuels such as biofuels, CNG or LPG, while 8% of stakeholders, mainly from civil society organisations, tended to disagree or fully disagreed.

49% of stakeholders fully agreed or tended to agree with the statement that HDV CO_2 monitoring should focus on tailpipe (tank-to-wheel) emissions, but on the other hand 36% of respondents fully disagreed or tended to disagree.

Half of the respondents (51%) fully agreed or tended to agree with the statement that HDV CO_2 monitoring should incorporate a comprehensive approach on well-to-wheel emissions, to better reflect the lower carbon content of some alternative fuels, while 24% of stakeholders had no strong view and 24%, mainly from civil society, professional organisations and public authorities, fully disagreed (15%) or tended to disagree (9%).

Likely environmental impacts (on non-CO_2 emissions)

More than half of the respondents (54%) tended to agree or fully agreed with the statement that increased fuel efficiency of vehicles would lead to limited reduction of other non-CO_2 emissions, 28% had no strong view and 17% of stakeholders, mainly belonging to the 'other' category and in particular from the automotive industry and private enterprises, tended to disagree or fully disagreed.

Almost half of the stakeholders (47%) had no strong view with regards to the statement that options will not have differentiated environmental impacts on non-CO_2 emissions, 37% tended to disagree or fully disagreed, especially respondents from civil society and professional organisations, and only 14% tended to agree or fully agreed.

Other comments

According to a number of different stakeholders (trade and employers' associations, a private enterprise, an international organisation, and a not-for-profit organisation), besides reporting to customers who purchase the vehicles and providing information to authorities, the most important customer benefit of establishing common procedures (i.e. standardised methodologies for generating inputs to a common simulation tool) is that, for the first time, potential customers can compare the expected vehicle performances of different specifications and from different manufacturers. This is the main “market driving” element of the upcoming regulation which has not in the view of these stakeholders been properly addressed in the inception impact assessment.

A number of civil society organisations consider that the monitoring and reporting system needs to be a transparent tool to empower truck-makers when they buy a truck but also and to provide the European Commission with more accurate data for future legislative initiatives. All the input parameters for VECTO should be monitored and published (especially the tyre rolling resistance and the aerodynamic drag). According to these stakeholders, OEMs should be obliged to provide interested buyers with the VECTO results so that transport companies can easily compare different vehicles of different brands. Moreover, the truck fuel consumption information monitored by fleet management systems should also be reported every year in order to provide the EC with an extensive real world database. Such a database would enable to discern real world trends, including whether improvements in type approval CO_2 performance also translates in lower vehicle fuel consumption. According to these stakeholders, the Commission should also include trailers as soon as possible in the MRV system and develop a procedure how trailer performance can be tested.

One international organisation and a private enterprise stressed the key importance of monitoring and reporting data for different payloads.

Some stakeholders (an international organisation, two professional organisations, a private enterprise and a business organisation) are of the opinion that fuel consumption and CO_2 emission reductions should lead not only to environmental benefits but also provide road freight and passenger transport operators with benefits in terms of reductions of operational costs and guarantees for a return on their investments in the latest and cleanest technologies, including vehicles, over an adequate period of time. They believe monitoring should in first instance be focused on tank-to-wheel emissions; however, they see the need for a certain

degree of well-to-wheel information, as it would allow commercial road transport operators to make better-informed decisions on switching to alternative fuels. They also stress that commercial road transport operators should be further encouraged to reduce fuel consumption and increase efficiency of their existing fleets and operations, and that they will be less inclined to do so if their efforts are offset by additional taxes, charges and duties, higher vehicle and technology prices and reduced transport rates. They finally think that efforts should not only be limited to new vehicles.

Two private enterprises underlined the need to ensure that all alternative fuels are measured using the same methodology, and a number of stakeholders highlighted the role of alternative fuels in reducing emissions.

ANNEX 3 - WHO IS AFFECTED BY THE INITIATIVE AND HOW

Who is affected	How are they affected?
Member States public administrations	Under option 1, national public administrations (in most countries these would be Registration Authorities) would have to monitor and report HDV CO_2 emission data to the EEA. This may imply an additional burden in terms of IT data management systems and staff for the relevant national administrations. Option 3 would significantly reduce this burden on national administrations as they would only need to report registered vehicle identification numbers ("VIN") to the EEA. Option 2 would not trigger any additional burden on national administrations. Member States would have access to a public database, which under option 1 and 3 would be Member State specific, with accurate information on CO_2 emissions from heavy-duty vehicles that could be used for national emission reduction measures.
Manufacturers of HDVs	No simplification of administrative burden can be expected as HDV CO_2 emissions are not currently monitored or reported. An administrative burden is possible (on top of the administrative burden attached to the certification of HDV CO_2 emissions under type approval legislation) for vehicle manufacturers in the second option on "self-monitoring" under which manufacturers would be expected to report to the EEA, and likewise, in the third option under which the EEA would retrieve monitoring data from manufacturers, based on Vehicle Identification Numbers (VINs) of newly registered vehicles provided by national registration authorities.
Transport Operators and logistics companies – many of which SMEs	Under all three options, freight transport operators as well as logistics companies (i.e. the buyers and users of HDVs) would, for the first time, have the information and the possibility to compare the performance of the vehicles, and be able to choose the most efficient ones. This should allow them to realise potential fuel savings, which could be significant considering that fuel represents a large share of their vehicle operating costs.
Consumers	Under all three options, transparency, and the subsequent uptake of more fuel efficient HDVs to transport goods and passengers, would be likely to reduce costs for consumers of those goods and services, since the intermediate transport cost may be reduced thanks to the improved fuel efficiency.
EEA/EC	Under all three options the EEA and the Commission would need to devote additional resources to HDV CO_2 monitoring and reporting (IT systems, staff), on top of resources already devoted to monitoring and reporting cars and vans CO_2 emissions. The Commission would gather for the first time accurate information on CO_2 emissions of heavy-duty vehicles and would be able to implement and enforce appropriate emission reduction measures.

ANNEX 4 - DEVELOPMENT OF A NEW SIMULATION TOOL, VECTO[56], FOR THE DETERMINATION OF CO_2 EMISSIONS FROM HEAVY-DUTY VEHICLES

1. Current situation

Unlike for cars and vans, where pursuant to the existing type-approval regulation the fuel consumption of each new type approved vehicle is tested on a chassis dynamometer, there is no official and comparable determination for the fuel consumption or its equivalent for the CO_2 emissions for a whole new Heavy-Duty Vehicle (HDV). For a consistent policy on reducing CO_2 emissions and measuring the future achievement of fuel efficiency a robust, reliable and cost effective determination of fuel consumption has to be established.

Several approaches for the determination of CO_2 emissions from the whole vehicle have been investigated:

- Chassis dynamometer
- Portable Emission Measurement Systems (PEMS) and
- Component testing and computer simulation

Due to multiple combinations of axle type, number of driven axles, gear boxes, engines and cabins, the number of variations within one HDV model range can exceed 1000. Therefore measuring every possible configuration on a chassis dynamometer or with PEMS would be a very burdensome approach.

2. Development of a simulation tool of whole HDV CO_2 emissions

The Commission has since 2009 engaged with main industry stakeholders in the development of a simulation tool for whole vehicles CO_2 emissions and fuel consumption that should be applicable to all main categories of HDVs.

In the project "Reduction and testing of Greenhouse Gas Emissions from Heavy duty vehicles" - (call for tender ENV.C.3/SER/2009/0038) a simulation based test procedure where the relevant components of the HDV were tested and based on this data a simulation tool calculating the fuel consumption and the CO_2 emissions in vehicle class specific test cycles was chosen as the method that delivers robust results of CO_2 figures for HDVs and appears manageable for the manufacturers and public administrations that have to deal with the test procedure.

The relevant data needs for the simulation of HDV CO_2 data that have been identified include the engine fuel efficiency map, vehicle weight, tires rolling resistance coefficients (RRC), aerodynamic drag coefficient multiplied by the frontal area (A) of the vehicle (CdxA), moments of inertia from the vehicle including standardised bodies or trailers, the specifications of the gear boxes and efficiency of the auxiliaries.

Such a simulation based approach should allow cost efficient testing of multiple HDV variations by compiling the measured component data in the simulator. This approach also makes it possible to easily assess the CO_2 emissions impact of improved trailer and body structure design. The proposed test procedure has been applied experimentally on three HDV categories so far and appears to give reliable and accurate results.

The simulation-based method consists of:

- On-road measurement of driving resistances
- Determination of drivetrain losses
- Determination of power demand of engine auxiliaries and other consumers
- Measurement of the engine fuel consumption map as extension to the engine's type approval tests

[56] VECTO = Vehicle Energy Consumption calculation TOol

- Simulation of the fuel consumption and the resulting CO_2-emisions from the vehicle using the aforementioned input data for predefined representative driving cycles.

The single steps described in brief:

The driving resistances of the vehicle will be measured during constant speed or coast down rides on a test track. Standardized bodies and trailers will be used to obtain reliable air resistance values. For reproducible results, corrections for influences of road gradient, wind speed, ambient temperature and air pressure as well as for velocity unsteadiness, have to be applied to the measured driving resistance values.

For the body and trailer manufacturers an option for a less extensive procedure can be applied. Improved bodies or trailers (aerodynamics, curb weigh) can be tested in comparison to the standard components via constant speed tests or via coast down tests at high velocities. The relative change against the standard body or trailer can then be introduced into the simulation tool to calculate the fuel consumption and the CO_2 emissions of the alternative vehicle and body-configuration.

Drivetrain friction losses and the power demand of engine auxiliaries like engine fan, air compressor or heating and air conditioning, will be defined as default functions. If OEMs use more efficient components, the default values can be replaced by component specific efficiency maps.

Since several technical options to improve the fuel efficiency of HDV have different reduction potentials at varying driving conditions, the definition of representative driving cycles is important for a realistic ranking of the specific fuel consumption. Driving cycles (or mission profiles) for the different categories and usage of HDVs are newly developed to give more realistic results on fuel consumption.

It is desirable for the methodology to address all characteristics that are relevant to the efficiency of the entire vehicle. Realistic values for the fuel efficiency of various HDV in different mission profiles will improve customer information and incentivise manufacturers to develop and apply fuel saving technologies. In future a standardised test procedure could support other measures in the HDV sector including CO_2 emissions monitoring, labelling or programmes for HDV customers to calculate HDV fuel efficiency.

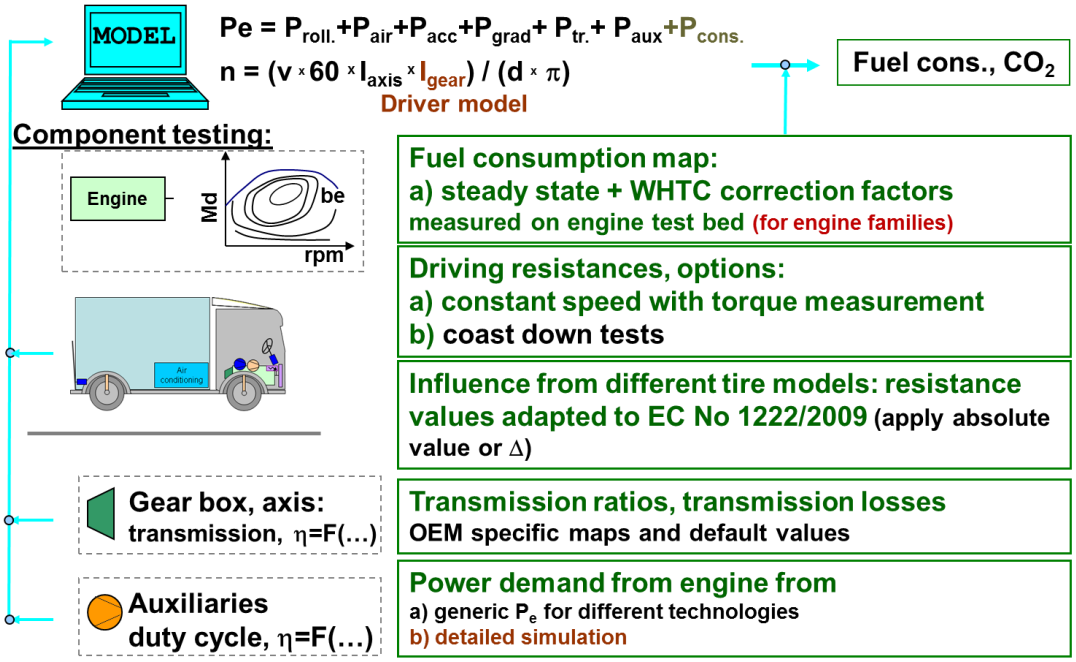
The main targets for the test procedure are:

1. Repeatable (within same laboratory) and reproducible (between different laboratories)
2. Incentive to apply efficient technologies and to optimise the entire vehicle set-up
3. High sensitivity for fuel saving measures
4. Reasonable costs and efforts to run and examine the procedure
5. Simple and robust

Schematic overview of simulation model and computational programme

Figure 1 below gives an overview of the test procedure. Rolling resistance, air resistance, power to accelerate translational and rotatory moved masses, power resulting from road gradients, losses in the transmission system and power demand from auxiliaries are considered in the simulation.

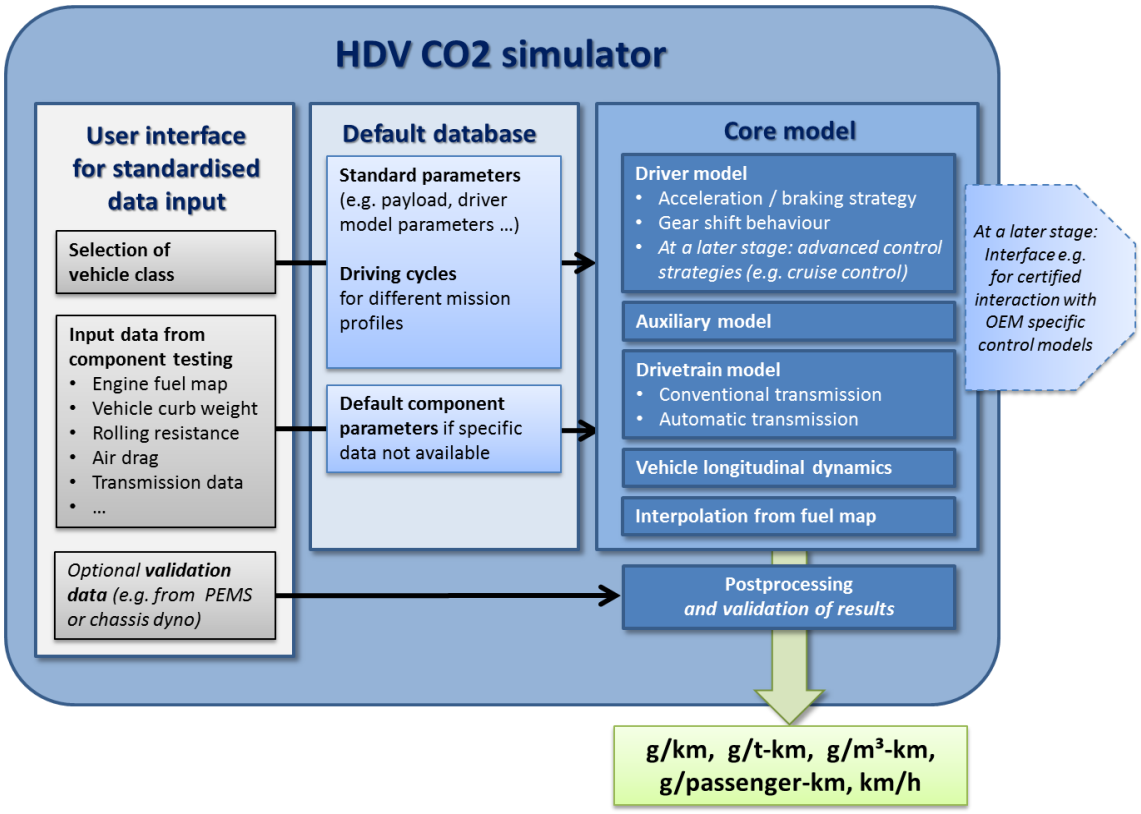
Figure 1. **Schematic picture of the test procedure**



All the measured data of the components / subsystems of a HDV will then be used as input data in a HDV energy/CO_2 simulation.

Figure 2. Structure of the simulation tool

The structure of the simulation tool is shown below:



The simulation tool will calculate the energy consumption of the whole HDV and give as a result the fuel consumption or CO_2 emissions in g/km, g/t*km, g/m^3*km or g/passenger*km (for buses).

3. On-going and future development steps of the VECTO tool

The development of the VECTO tool entered in October 2012 in a new phase with tests of the methodology with an active participation of the manufacturers to prove the reliability of the test procedure and simulation.

Until June 2017:

This phase (on-going), based on currently contracted assignments, is expected to last until June 2017, and includes:

- the current development and test of the VECTO tool which covers three categories of HDV vehicles, i.e. long haul, regional/city delivery but also buses and coaches;
- and the preparation of the required documentation of certification/registration process (to be finalised in May 2017).

The model has been validated for the above mentioned trucks that represent more than 50% of new HDV registrations and further testing is planned for buses and coaches by the end of spring 2017.

Mid-2017 until end 2018 (tentatively):

The VECTO tool thereafter will have to be extended to other categories of HDVs (e.g. city and inter-city buses, municipal utility trucks, service and urban delivery trucks, construction trucks). Moreover, the IT platform of VECTO will have to be created. The next and last phase of development of the VECTO tool is thus expected to include:

- the further development and finalisation of VECTO to cover other categories of HDVs;
- the IT development of a user-friendly software platform to support the deployment of the VECTO tool;
- and the adaptation of the required documentation of the certification/registration process for all relevant categories of vehicles.

4. Cost of developing the Vehicle Energy Consumption calculation TOol

The development of the Vehicle Energy Consumption calculation TOol (VECTO) required 4 contracts and did altogether cost around 2.4 M€. Further costs are to be expected to maintain the tool and provide end-user support (a new contract is signed for this purpose), as well as to upgrade it to future needs.

	Budget (€)
"Lot 2" contract 2009-2011: initial assessment	499.000
"Lot 3" contract 2012-2014: core development of tool	659.523
"Lot 4 contract" 2014-2017 (ongoing): refactoring and completing the tool	699.914
Contract on bus auxiliaries 2015-2017 modelling into VECTO	248.508
"VECTO helpdesk support, maintenance and further development" 2016-2019	299.764
Total	**2.406.709**

This assessment is based on contractual development work that has been outsourced to external contractors. However, it does not include internal Commission costs, related to staff working on this programme, nor costs incurred by manufacturers –deemed much higher than this – to provide the vehicles needed, run the programme and test VECTO on their various facilities: such costs are difficult to be assessed.

ANNEX 5 - DRAFT CERTIFICATION METHODOLOGY FOR THE DETERMINATION OF THE CO_2 EMISSIONS FROM HEAVY-DUTY VEHICLES

1. Background

DG GROW, as responsible for the type-approval legislation of vehicles, has developed the certification procedure whose outcome will be a set of vehicle specific fuel consumption and CO_2 emission values calculated on the basis of the VECTO tool (see Annex 4). In order to support the Commission services in the development of the certification procedures for heavy-duty vehicles, an Expert Group ('HDV CO_2 Editing board') with the participation of the Member States, industry and NGOs was established.

Taking into consideration that the type-approval framework has proved its robustness and applicability in the context of the certification of vehicles, the new piece of legislation was developed under the framework Directive 2007/46/EC. Moreover, the simulation approach was already mentioned in the framework Directive giving a legal base for the application of the 'VECTO' software for the purpose of the certification procedure.

There is, however, a main difference from the usual type-approval approach due to the large variety of vehicle types in heavy-duty vehicles, and vehicle manufacturers will be obliged to provide CO_2 values for each vehicle put on the European market. Certification under the type-approval framework will also imply that the component and vehicle manufacturers will need to fulfil the obligations resulting from the conformity of production (CoP) requirements.

2. Structure of the new Regulation

The new Regulation consists of the following parts:

1) certification of the input data (components)
2) CO_2 calculation by means of VECTO
3) conformity of production provisions for the components and whole vehicles and on-road verification
4) Output data including a CO_2 information file for the consumer

2.1. Certification of the input data (components)

In order to perform the calculation of the CO_2 emissions of a complete vehicle by means of the VECTO software, it is necessary to obtain reliable input data of the performance of the CO_2 related components. During the work on the simulation model, it has been decided that the following components have a major impact on the CO_2 emissions:

- engine
- tyres
- transmission
- axles
- air-drag (NB: air-drag is a VECTO input and, as such, assimilated to a "component")
- auxiliaries

2.2. CO_2 calculation by means of VECTO

For the purpose of VECTO, the heavy-duty vehicle market has been divided into 18 categories depending on the number of axles, structure and weight. For each vehicle category a specific standard body/trailer has been defined, as well as dedicated test cycles, over which a vehicle will be simulated, have been assigned.

Figure 1. Vehicle groups

Identification of vehicle class			Vehicle group	Allocation of mission profile and vehicle configuration							Standard body allocation
Axle configuration	Chassis configuration	Maximum GVW		Long haul	Long haul (EMS)	Regional delivery	Regional delivery (EMS)	Urban delivery	Municipal utility	Construction	
4x2	Rigid	>3.5 – <7.5	**(0)**								
	Rigid (or tractor)*	7.5 - 10	**1**			R		R			B1
	Rigid (or tractor)*	>10 - 12	**2**	R+T1		R		R			B2
	Rigid (or tractor)*	>12 - 16	**3**			R		R			B3
	Rigid	>16	**4**	R+T2		R			R		B4
	Tractor	7.5 - 16	**5**	T+ST	T+ST+T2	T+ST	T+ST+T2				
4x4	Rigid	>16	**(6)**								
	Rigid	>16	**(7)**								
	Tractor	all weights	**(8)**								
6x2	Rigid	all weights	**9**	R+T2	R+D+ST	R	R+D+ST		R		B5
	Tractor	all weights	**10**	T+ST	T+ST+T2	T+ST	T+ST+T2				
6x4	Rigid	all weights	**11**	R+T2	R+D+ST	R	R+D+ST		R	R	B5
	Tractor	all weights	**12**	T+ST	T+ST+T2	T+ST	T+ST+T2			R	
6x6	Rigid	all weights	**(13)**								
	Tractor	all weights	**(14)**								
8x2	Rigid	all weights	**(15)**								
8x4	Rigid	all weights	**16**							R	(generic weight+CdxA)
8x6 8x8	Rigid	all weights	**(17)**								

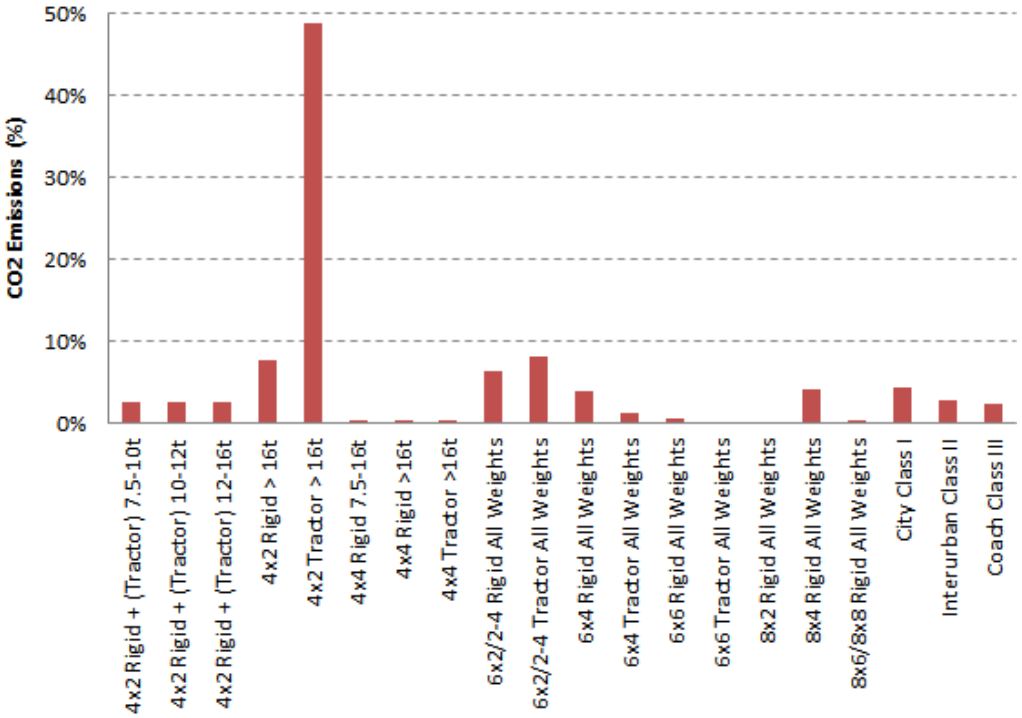
* in these vehicle groups tractors are treated as rigids but with specific curb weight of tractor

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

On the basis of the certification procedure described in point 2.1, the input values for the simulation will be defined. The calculation will be performed by VECTO for each test cycle assigned to the category to which a specific vehicle belongs.

The CO_2 impact of some vehicle categories was found to be rather small (below 1% of total HDV CO_2 emissions), in particular for categories 6, 7, 8, 13, 14, 15 and 17. It was therefore decided not to include them for the purpose of certification.

Figure 2. Estimated share of total CO_2 emissions from different HDV categories[57]



Source: TU Graz et al, 2012

2.3. Conformity of production provisions for the components and whole vehicles and On-road Verification

In order to ensure that the fuel and CO_2 values declared by the vehicle manufacturer accurately reflect the actual values, CoP provisions were introduced on different levels of the certification procedure. They are based on the already existing provisions in the framework Directive supplemented by specific points designed for the purpose of this Regulation.

In the first place, all the certified components fall under the CoP requirements. Before granting a type-approval, component manufacturers will be audited by the Type-approval Authority to verify the processes related to the production of parts and management of data. After receiving a type-approval, manufacturers will be subject to annual audits and will be requested to perform a specific number of tests.

As the vehicle manufacturers are also the producers of components (ex. they will certify air drag value), the procedures described above will also apply to them. In addition, vehicle manufacturers will be subject to more detailed provisions related to data management/handling and they will perform, together with the Type-approval Authorities, an on-road verification test.

[57]TU Graz, TNO, TUV Nord, VVT, AVL, LAT and Heinz Steven (2012), Reduction and Testing of Greenhouse Gas Emissions from Heavy Duty Vehicles - LOT 2: Development and testing of a certification procedure for CO2 emissions and fuel consumption of HDV, https://ec.europa.eu/clima/sites/clima/files/transport/vehicles/heavy/docs/hdv_2011_01_09_en.pdf

The purpose of the on-road verification test will be an identification of possible discrepancies between the simulated and actual CO_2 values of a complete vehicle. The testing procedure is currently under development. The tests will be performed under the supervision of the Type-approval Authorities. In case a verification test identifies significant discrepancies with the initial VECTO calculated value, the vehicle manufacturer will be asked to identify the root cause of the problem –possibly in most cases wrong input values into VECTO– and introduce remedial measures.

2.4. CO_2 certificate for the consumer

As one of the objectives of the CO_2 certification is an increase of the transparency of the heavy-duty market, the results of the simulations will be available to the customers. Due to the fact that a substantial number of heavy-duty vehicles are certified under the individual type-approval schemes, inclusion of the data in the certificate of conformity of vehicles would only have a very limited value. Instead, it was decided that an additional certificate with all the fuel and CO_2 related values should be provided to the purchasers with each vehicle registered.

3. Cost of certification

The above assessment of costs related to certification is drawn from a 2015 report to the Commission by a team of consultants led by TNO (including ICCT and TNM).[58]

TNO assessed several options for certification. The table below is based on the option eventually retained in the certification regulation as the preferred one by not only the Commission, but also vehicle manufacturers, technical services and Member States Type Approval authorities, based on simulation (using the VECTO tool) and component testing (option "D1" in the TNO report[59]).

Table 1. Transition cost estimates

Cost type	Large manufacturers		Medium manufacturers	
	Total cost	Cost per vehicle	Total cost	Cost per vehicle
Direct variable costs	€ 2,5 M	€ 65	€ 1.4 M	€ 81
Fixed costs	€ 1,1 M	€ 28	€ 0.4 M	€ 21
Total / Manufacturer	**€ 3.6 M**	**€ 93**	**€ 1.8 M**	**€ 102**

Source: TNO, TNM and ICCT (2015)

[58] TNO et al. (2015), Final report: Cost-benefit analysis of options for certification, validation, monitoring and reporting of heavy-duty vehicle fuel consumption and CO2 emissions, https://ec.europa.eu/clima/sites/clima/files/transport/vehicles/heavy/docs/tno_2015_final_report_en.pdf, pp 75-76

[59] See table 20 and 21 p.76.

Table 2. Annual cost estimates

Cost type	Large manufacturers		Medium manufacturers	
	Total cost	Cost per vehicle	Total cost	Cost per vehicle
Direct variable costs	€ 0.2 M	€ 5	€ 0.1 M	€ 7
Fixed costs	€ 1.1 M	€ 28	€ 0.4 M	€ 21
Total / Manufacturer	**€ 1.3 M**	**€ 34**	**€ 0.5 M**	**€ 28**

Source: TNO, TNM and ICCT (2015)

Definitions

Costs

The costs were divided into direct (mostly related to physical testing required for compliance, especially relevant for the "D" options) and indirect costs (administrative and other types of overhead costs. As for the time horizon of measuring costs, both the transition costs and annual costs were estimated: the transition costs here refer to expenses associated with the certification of CO2 emissions for all vehicle variants currently being marketed (i.e., it is assumed that, once the regulation is in place, a substantial, one-off economic effort will be made ensure that the current product portfolio is in compliance). Annual costs refer to recurrent costs associated with certifying new vehicles and vehicle components as they enter the market, assuming that the rest of the product portfolio is already certified (in other words, these are the "business as usual" costs to be expected once the regulatory scheme is fully phased in).

Classification of large and medium manufacturers

In addition to the time dimension, the costs were also estimated for two representative categories of vehicle OEMs. To that avail, the European market for HDVs was divided into two tiers, namely three brands with more than 30,000 newly registered vehicles each in 2012 ("large manufacturers"), and four vehicle brands with 10,000 to 30,000 registered vehicles in 2012 ("medium manufacturers"). These two tiers cover around 95 percent of all registrations in 2012. While results are presented for large and medium vehicle manufacturers, costs throughout the entire industrial value chain were considered.

ANNEX 6 - VEHICLE IDENTIFICATION NUMBER (VIN)

'Vehicle identification number' (VIN) means the alphanumeric code assigned to a vehicle by the manufacturer in order to ensure proper identification of every vehicle; The first three characters uniquely identify the manufacturer of the vehicle using the **World Manufacturer Identifier** or **WMI** code. Some manufacturers use the third character as a code for a vehicle category (e.g., bus or truck), a division within a manufacturer, or both.

Part B of Regulation (EU)19/2011 (OJ, L 8/6 12/01/2011) states that:

1. **General provisions**

1.1. A VIN shall be marked on each vehicle.

1.2. The VIN shall be unique and unequivocally attributed to a particular vehicle.

1.3. The VIN shall be marked on the chassis or the vehicle when the vehicle leaves the production line.

1.4. The manufacturer shall ensure the traceability of the vehicle by means of the VIN over a period of 30 years.

1.5. The existence of measures taken by the manufacturer to ensure the traceability of the vehicle referred to in point 1.4 needs not be checked at the time of the type-approval.

2. **Composition of the VIN**

2.1. The VIN shall consist of three sections:

(a) the world manufacturer identifier (WMI);

(b) the vehicle descriptor section (VDS);

(c) the vehicle indicator section (VIS).

2.2. The WMI shall consist of a code assigned to the vehicle manufacturer to enable him to be identified.

2.2.1. The code shall comprise three alphanumeric characters, capital roman letters or Arabic numerals, which shall be assigned by the competent authority in the country where the manufacturer has his principal place of business.

2.2.2. The competent authority shall act in agreement with the international organisation referred to in Standard ISO 3780: 2009 on 'Road vehicles — World manufacturer identifier (WMI) code'.

2.2.3. Where the manufacturer's global production is less than 500 vehicles per annum, the third character shall always be '9'. In order to identify such manufacturers, the competent authority referred to in point 2.2.1 shall assign the third, the fourth and the fifth character of the VIS.

2.3. The VDS shall consist of six alphanumeric characters, capital roman letters or Arabic numerals, which shall serve to indicate the general characteristics of the vehicle. Where the manufacturer does not use one or more of the six characters, the unused spaces shall be filled in with alphanumeric characters at the manufacturer's discretion in order that the total number of characters required shall be 6.

2.4. The VIS shall consist of eight alphanumeric characters, capital Roman letters or Arabic numerals, of which the last four shall consist of digits only.

It shall provide, in conjunction with the WMI and the VDS, clear identification of a particular vehicle. Any unused space shall be filled in with the digit '0' in order that the total number of characters required shall be 8.

2.5. The height of the characters of the VIN stamped on the chassis shall be no less than 7 mm.

2.6. There shall be no space between the characters.

2.7. The use of the letters 'I', 'O' or 'Q' shall not be permitted.

2.8. The beginning and the end of the VIN shall be limited by one symbol at the choice of the manufacturer neither symbol should be a Roman capital letter nor an Arabic numeral.

2.8.1. This provision may be waived when the VIN is marked on a single line.

2.8.2. When the VIN is marked on two lines, this provision shall apply to each line.

ANNEX 7 - HDV SECTOR STATISTICS

1. Heavy-duty vehicles categories

Heavy-duty vehicles include lorries, buses and coaches of various categories:

N2 vehicles	Lorries used for the carriage of goods and having a maximum mass exceeding 3.5 tonnes but not exceeding 12 tonnes
N3 vehicles	Lorries used for the carriage of goods and having a maximum mass exceeding 12 tonnes
M2 vehicles	Small busses, i.e. passenger vehicles used for the carriage of passengers, comprising more than eight seats in addition to the driver's seat, and having a maximum mass not exceeding 5 tonnes
M3 vehicles	Large busses and coaches, i.e. passenger vehicles used for the carriage of passengers, comprising more than eight seats in addition to the driver's seat, and having a maximum mass exceeding 5 tonnes

2. HDV Registrations

The number of new HDVs registered in the EU per year is on the rise although still below pre-crisis numbers, with around 400,000 vehicles registered in 2016.

According to the latest figures, in 2016, 365,051 new trucks (medium and heavy commercial vehicles over 3.5 tonnes) were registered in the EU, 11.0% more than in 2015. The highest increases have been observed in Italy, France and Spain. The EU market for buses and coaches registered only a +2.3% increase, with 40,370 new vehicles. Spain, Italy and Germany contributed the most to such increase, while France saw a demand decline[60].

In 2015, latest year for which consolidated registration figures are available, around 365,000 HDVs were registered in the EU[61]. New trucks (medium and heavy commercial vehicles over 3.5 tonnes) registered in the EU saw an increase of +16.2% compared to 2014, and the EU market increased also by +17.8% for new medium and heavy buses and coaches (over 3.5 tonnes)[62].

[60] http://www.acea.be/press-releases/article/commercial-vehicle-registrations-11.6-in-2016-10.4-in-december
[61] http://www.acea.be/statistics/tag/category/by-country-registrations
[62] http://www.acea.be/press-releases/article/commercial-vehicle-registrations-12.4-in-2015-14.8-in-december

Table 1. Total new registrations in the EU in 2015 by country and vehicle

Country	Total Medium Commercial Vehicles from 3.5t to 16t	Total Medium Buses and Coaches from 3.5t To 16t	Total Heavy Commercial Vehicles over 16t	Total Heavy Buses and Coaches over 16t
Austria	830	106	6.461	790
Belgium	2.374	288	6.992	635
Bulgaria	0	0	0	0
Croatia	228	67	749	62
Czech Republic	1.818	189	9.540	1.159
Denmark	390	281	4.363	169
Estonia	49	129	772	79
Finland	548	276	2.122	246
France	5.927	1.478	36.856	5.867
Germany	27.766	1.174	61.956	4.945
Greece	185	19	279	32
Hungary	471	138	5.231	401
Ireland	759	61	1.491	303
Italy	3.376	841	11.991	1.565
Latvia	69	118	1.236	83
Lithuania	106	163	3.609	29
Luxembourg	147	17	1.005	234
Netherlands	1.604	53	12.490	291
Poland[1]	2.069	1.403	20.586	0
Portugal	577	101	3.464	146
Romania[2]	347	2.251	5.778	181
Slovakia	218	16	2.390	173
Slovenia	164	75	1.743	88
Spain	3.178	694	19.390	1.923
Sweden	607	334	4.849	996
United Kingdom	11.607	5.151	36.239	2.499
European Union[3] (EU)	65.414	15.423	261.582	22.896
European Union[3] (EU)	**80.837**		**284.478**	
Total (EU)[3]	**365.315**			

Source: Association Auxiliaire de l'Automobile, http://www.acea.be/statistics/tag/category/by-country-registrations

[1]Data for Poland taken from PZPM (Polish Automotive Industry Association)
[2]Data for Romania refers to sales (APIA). For registrations, see ACAROM figures at www.acea.be
[3]Data for Cyprus and Malta not available

3. HDV manufacturers

The European HDV market is dominated by six manufacturers: Daimler Trucks, Volvo Trucks together with Renault Trucks, MAN Truck and Bus, DAF (Paccar Group), Scania and Iveco.

Figure 1. Share of truck registrations in the EU and EFTA countries by manufacturers in 2015

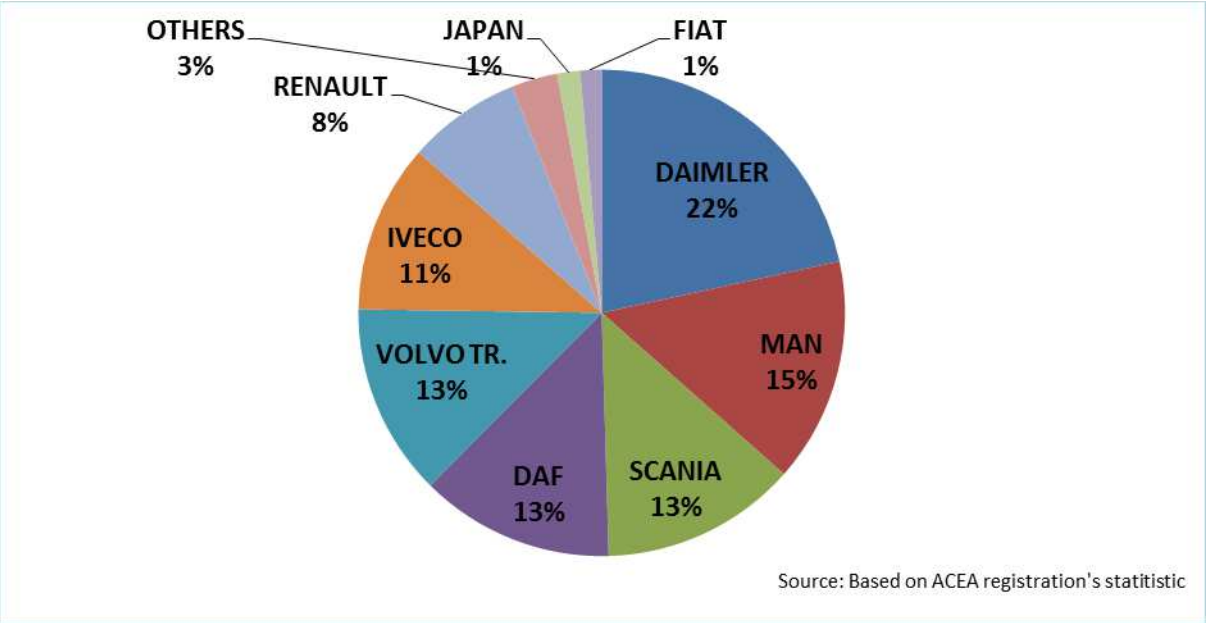


Table 2. HDV manufacturers' revenues and European market share in 2015 as published in their annual reports

	2015 revenues	**European market share 2015 (*)**
DAF (Paccar Group) [63]	~€4.5 bn	(>6<16t) 8.9% (>16t) 14.6%
Daimler Trucks [64]	€ 37,6 bn	22.5% (Western Europe)
Iveco (CNH Industrial Group)[65]	USD 26.4 bn (~€ 24.8 bn, data for the whole group)	11.3%
MAN (VW Group) [66]	€ 13,7 bn	16.3%
Scania (VW Group) [67]	94, 9 bn SEK (~€ 10.3 bn)	16.5%
Volvo Trucks (incl. Renault Trucks) [68]	312 bn SEK (~€ 34 bn)	23.8%

(*) Definitions of "Europe" in manufacturers' annual accounts vary and may not necessarily coincide

[63] DAF annual report 2015, https://www.daf.com/~/media/files/about%20daf/annual-report-daf-in-2015-en-68220.pdf, p.5 and p.15; Paccar annual report 2015, http://www.paccar.com/media/2486/paccar-ar-2015.pdf

[64] Daimler annual report 2015, https://www.daimler.com/documents/investors/berichte/geschaeftsberichte/daimler/daimler-ir-annual-report-2015.pdf, p.3 and 92

[65] CNH Industrial annual report 2015, http://www.cnhindustrial.com/en-us/investor_relations/financial_information/annual_reports/CNH_2015_Annual_Report.pdf, p. 14 and p. 59

[66] MAN 2015 annual report, https://www.volkswagenag.com/presence/investorrelation/publications/annual-reports/2016/man/11_03_2016_man_gruppe_gb_2015.pdf, p. 11 and p. 69

[67] The Scania report 2015, https://www.scania.com/group/en/wp-content/uploads/sites/2/2016/03/Scania_Annual_and_Sustainability_Report_2015.pdf, p.2 and p. 39

[68] The VOLVO Group annual and sustainability report 2015, http://www.volvogroup.com/content/dam/volvo/volvo-group/markets/global/en-en/investors/reports-and-presentations/annual-reports/Volvo-group-annual-report_2015_eng.pdf, p.1 and p. 88

Table 3. Registrations in the EU and EFTA by manufacturer of total commercial vehicles (trucks) over 3.5t in 2015

GROUP	BRAND	2015
DAF	D.A.F.	**43.462**
DAIMLER	MERCEDES	72.778
	Others	4
	Total	**72.782**
FIAT	DODGE	32
	FIAT	4.761
	Total	**4.793**
FORD	FORD	**669**
G.M.	CHEVROLET	41
	OPEL	281
	Others	15
	Total	**337**
IVECO	IVECO	**37.811**
JAGUAR LAND ROVER	LAND ROVER	1
	Others	1
	Total	**2**
JAPAN	MITSUBISHI	2.617
	NISSAN	534
	Others	1.962
	Total	**5.113**
KOREA	HYUNDAI	**16**
MAN	M.A.N.	**50.273**
PSA	CITROEN	50
	PEUGEOT	213
	Total	**263**
RENAULT	RENAULT	25.349
	Others	44
	Total	**25.393**
SCANIA	SCANIA	**43.860**
TOYOTA	TOYOTA	**118**
VAG	VOLKSWAGEN	**1.616**
VOLVO TR.	VOLVO	**43.073**
OTHERS	Others	**7.289**
TOTAL		**336.870**

Source: Association Auxiliaire de l'Automobile, http://www.acea.be/statistics/article/consolidated-registrations-by-manufacturer

Table 4. Registrations in the EU and EFTA by manufacturer of total buses & coaches over 3.5t in 2015

GROUP	BRAND	2015
CHINA	Others	**6**
DAF	D.A.F.	**809**
DAIMLER	MERCEDES	10.815
	Others	2.054
	Total	**12.869**
FIAT	FIAT	**222**
FORD	FORD	**3.687**
G.M.	OPEL	**1.280**
IVECO	IVECO	**5.904**
JAPAN	Others	**54**
KOREA	HYUNDAI	**1**
MAN	M.A.N.	3.113
	Others	154
	Total	**3.267**
PSA	CITROEN	11
	PEUGEOT	6
	Total	**17**
RENAULT	RENAULT	**283**
SCANIA	SCANIA	**1.789**
VAG	SKODA	1
	VOLKSWAGEN	482
	Total	**483**
VOLVO TR.	VOLVO	**2.235**
OTHERS	Others	**7.078**
TOTAL		**39.984**

Source: Association Auxiliaire de l'Automobile, http://www.acea.be/statistics/article/consolidated-registrations-by-manufacturer

Table 5 – EU motor vehicle trade

EU motor vehicle trade — BY TYPE, IN MILLION € / 2015

Trade in value	PC [1]	LCV [2]	CV & BC [3]	TOTAL
2015				
Imports	32,488	5,003	1,560	39,051
Exports	129,104	3,957	6,382	139,443
Trade balance	96,616	-1,046	4,822	100,392
2014				
Imports	26,203	3,973	1,136	31,312
Exports	114,993	3,922	6,236	125,151
Trade balance	88,789	-51	5,100	93,838
% change 15/14				
Imports	24.0%	26.0%	37.4%	24.7%
Exports	12.3%	0.9%	2.4%	11.4%
Trade balance	8.8%	1951.2%	-5.5%	7.0%

[1] Passenger cars
[2] Commercial vehicles up to 5t
[3] Commercial vehicles over 5t, inlcuding buses and coaches

Source: ACEA, The Automobile Industry Pocket Guide 2016-2017[69]

4. HDV Production

Table 7 - Motor vehicle production in the EU

Motor vehicle production in the EU — BY COUNTRY / 2015

	PC [1]	LCV [2]	MCV [3]	HCV [4]	TOTAL
Austria	102,512	–	11,342	7,759	121,613
Belgium	364,574	222	0	30,990	395,786
Bulgaria	975	758	–	–	1,733
Czech Republic	1,244,406	11,137	0	789	1,256,332
Finland	79,564	–	–	278	79,842
France	1,492,402	445,322	11,091	44,960	1,993,775
Germany	5,557,943	390,818	36,918	116,133	6,101,812
Hungary	522,955	–	–	0	522,955
Italy	666,234	280,606	32,383	10,287	989,510
Lithuania	–	–	0	70	70
Netherlands	56,778	–	–	62,485	119,263
Poland	472,041	172,519	0	10,372	654,932
Portugal	102,151	50,425	2,782	–	155,358
Romania	381,080	0	0	0	381,080
Slovakia	909,551	–	–	–	909,551
Slovenia	128,829	–	–	–	128,829
Spain	2,174,826	530,210	8,366	22,144	2,735,546
Sweden	171,949	–	–	35,918	207,867
United Kingdom	1,588,062	73,997	6,926	8,812	1,677,797
European Union	16,016,832	1,956,014	109,808	350,997	18,433,651

[1] Passenger cars
[2] Light commercial vehicles up to 3.5t
[3] Medium commercial vehicles from 3.5t to 15t
[4] Heavy commercial vehicles over15t (incl. artic trucks)

Source: ACEA, The Automobile Industry Pocket Guide 2016-2017[70]

[69] http://www.acea.be/uploads/publications/ACEA_Pocket_Guide_2016_2017.pdf, p.50
[70] http://www.acea.be/uploads/publications/ACEA_Pocket_Guide_2016_2017.pdf, p. 22

5. Transport operators

Table 8. 2014 Annual detailed enterprise statistics for freight transport by road in the EU28
(Extracted from annual detailed enterprise statistics for services, NACE Rev. 2 H-N and S95)

EU28 - 2014	Number of enterprises	Production value	Number of employees	Number of persons employed per enterprise	Gross operating surplus/turnover (gross operating rate) (%)
H4941 - Freight transport by road	542.358	287.160	2.392.019	5,2	12,1

Source: Eurostat, [sbs_na_1a_se_r2]

Table 9. Distribution of transport and storage companies according to their size

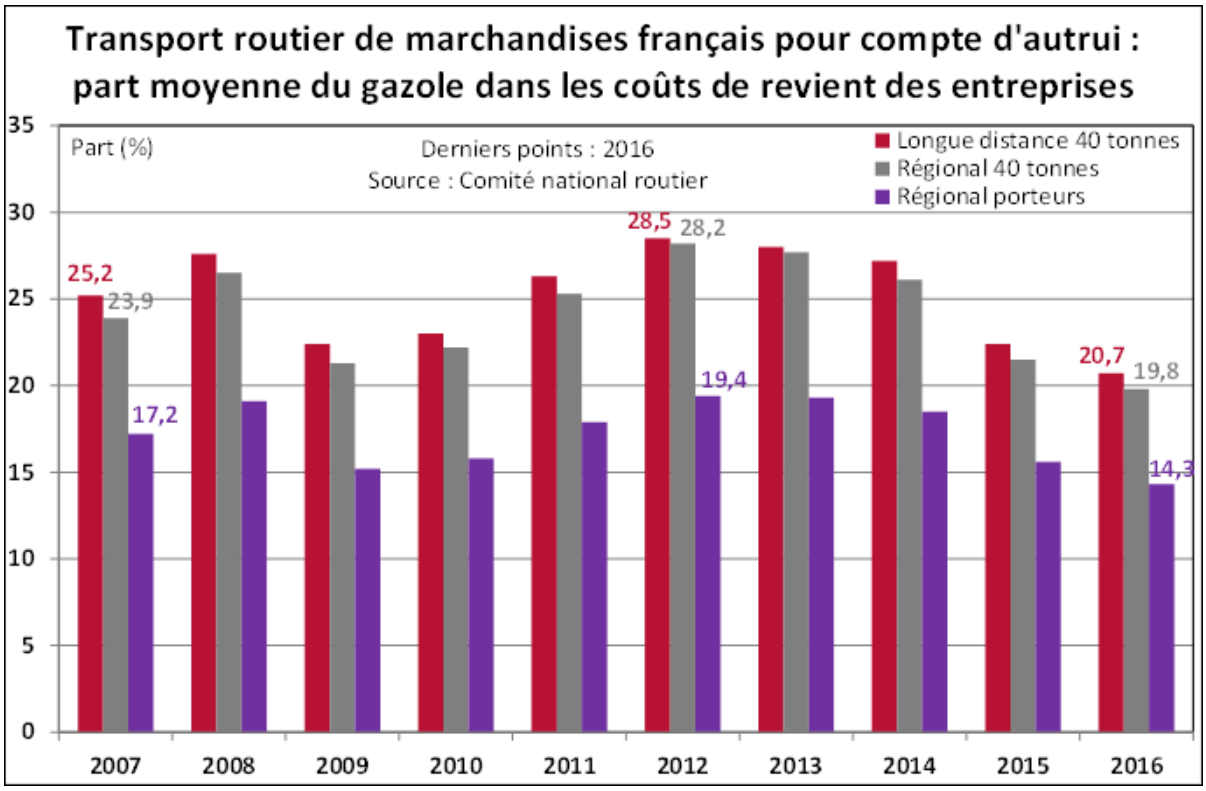
Number of persons employed by enterprise size class, transportation and storage (NACE Section H), 2013[71]

	Total (thousands)	SMEs	Micro	Small	Medium-sized	Large
			(% of total)			
EU-28	10 521.3	52.3	19.1	17.2	16.1	47.6
Belgium	215.0	54.0	14.1	21.1	17.7	46.0
Bulgaria	155.5	57.8	24.6	18.4	14.8	42.2
Czech Republic	262.9	51.6	21.1	14.7	15.8	48.4
Denmark	147.3	48.2	13.6	17.3	17.3	51.8
Germany	2 062.4	51.1	9.7	21.1	20.3	48.9
Estonia	37.8	70.8	21.3	25.6	23.9	22.0
Ireland	:	:	:	:	:	:
Greece	166.6	52.1	28.1	14.0	10.1	20.4
Spain	824.6	55.0	24.2	18.0	12.7	30.4
France	1 378.5	37.0	6.9	14.2	15.9	57.7
Croatia	77.2	42.7	16.8	11.8	14.1	51.6
Italy	1 059.7	51.5	15.8	18.8	17.0	42.0
Cyprus	17.9	52.2	12.1	16.5	23.6	37.2
Latvia	74.9	54.9	14.3	23.2	17.3	42.8
Lithuania	108.7	64.3	16.7	25.2	22.4	31.8
Luxembourg	19.8	60.8	7.1	21.9	31.8	38.3
Hungary	216.3	38.1	13.0	13.9	11.2	54.2
Malta	9.9	48.6	10.5	19.3	18.7	42.9
Netherlands	409.0	45.7	9.4	16.1	20.3	47.7
Austria	206.8	50.6	13.0	21.5	16.1	47.3
Poland	720.8	42.8	20.7	10.3	11.8	42.1
Portugal	147.8	54.3	17.5	19.9	16.9	36.9
Romania	337.5	51.3	17.9	18.1	15.3	44.0
Slovenia	43.4	56.5	21.5	22.5	12.5	31.5
Slovakia	121.9	33.5	9.2	10.9	13.4	54.9
Finland	148.0	52.8	23.2	17.9	13.7	40.2
Sweden	270.0	49.2	13.9	19.3	16.0	45.8
United Kingdom	1 205.1	35.0	7.7	14.4	12.9	63.4
Norway	153.4	49.7	18.9	15.5	15.4	45.3
Switzerland	209.5	39.4	6.8	14.7	17.9	60.6

(:) not available
Source: Eurostat (online data code: sbs_sc_1b_se_r2)

[71] Available at: http://ec.europa.eu/eurostat/statistics-explained/images/c/c6/Table_6a_Number_of_persons_employed_by_enterprise_size_class%2C_Transportation_and_storage_%28NACE_Section_H%29%2C_2013.png

Figure 2. Share of fuel (diesel) costs in the costs of French transport operators



Source: Fédération Nationale du Transport Routier 2016, data Comité National Routier

Table 10. Share of fuel costs in operating costs[72] for 40t long haul as estimated in the index "Longue distance 40 tonnes" by the Comité National Routier (France)

	Dec-06	Dec-07	Dec-08	Dec-09	Dec-10	Dec-11	Dec-12	Dec-13	Dec-14	Dec-15	Dec-16
Gazole professionnel	25,2	27,6	22,4	23	26,3	28,5	28	27,2	22,4	20,7	23,1

Source: http://www.cnr.fr/Indices-Statistiques/Longue-distance-40T#haut, retrieved February 2017

Table 11. Share of fuel costs in operating costs for 40t regional delivery as estimated in the index "Régional 40 tonnes" by the Comité National Routier (France)

	Dec-06	Dec-07	Dec-08	Dec-09	Dec-10	Dec-11	Dec-12	Dec-13	Dec-14	Dec-15	Dec-16
Gazole professionnel	23,9	26,5	21,3	22,2	25,3	28,2	27,7	26,1	21,5	19,8	21,1

Source: http://www.cnr.fr/Indices-Statistiques/Regional-40T#haut, retrieved February 2017

[72] Including cost of fuel (excluding VAT, taking into account the partial reimbursement of excise), maintenance costs, infrastructure charges, equipment, driver (remuneration + employers' contributions), travel expenses and charges.

Table 12. UK Freight Transport Association (FTA) 'fuel fractions' table

The table below shows fuel costs as a proportion of total annual vehicle operating costs (including vehicle standing costs, vehicle running costs and driver costs) for a range of HDVs. (Fuel prices based on bulk prices and exclude VAT).

	Low mileage (miles p.a.)	Fuel costs as a percentage of total cost of vehicle and driver	Average mileage (miles p.a.)	Fuel costs as a percentage of total cost of vehicle and driver	High mileage (miles p.a.)	Fuel costs as a percentage of total cost of vehicle and driver
7.5t rigid	30,000	17	40,000	17	50,000	18
10 - 12t rigid	42,500	22	50,000	22	60,000	21
12 - 14t rigid	35,000	19	40,000	19	50,000	19
16 - 18t rigid	50,000	25	60,000	25	70,000	25
26t rigid	50,000	26	60,000	26	70,000	25
32t rigid	50,000	29	55,000	26	65,000	26
33t (2+2) artic	60,000	30	75,000	30	85,000	29
38t (2+3) artic	65,000	30	75,000	29	85,000	29
38t (3+2) artic	50,000	28	70,000	29	85,000	30
32.5t drawbar	45,000	24	60,000	26	80,000	28
40t (2+3) artic	50,000	27	70,000	29	80,000	28
44t (3+3) artic	70,000	32	85,000	31	100,000	30

Cost data as at 1 July 2016.
Source: FTA's Manager's Guide to Distribution Costs - July 2016 Update Report.
http://www.fta.co.uk/policy_and_compliance/fuel_prices_and_economy/fuel_prices/fuel_fractions.html

ANNEX 8 - MONITORING OF CO_2 EMISSIONS FROM VANS

The following details are required for each new van (category N1 vehicle) registered in the EU:

- VIN number of vehicle (reported both by Registration Authorities and OEMs);
- Manufacturer name;
- Type approval number;
- Type, variant, version, make, commercial name;
- Specific emissions of CO_2;
- Mass of the vehicle, wheel base, and track width;
- Fuel type and fuel mode;
- Engine power;
- Engine capacity;
- Electric energy consumption;
- Innovative technologies and emission reductions through innovation technologies.

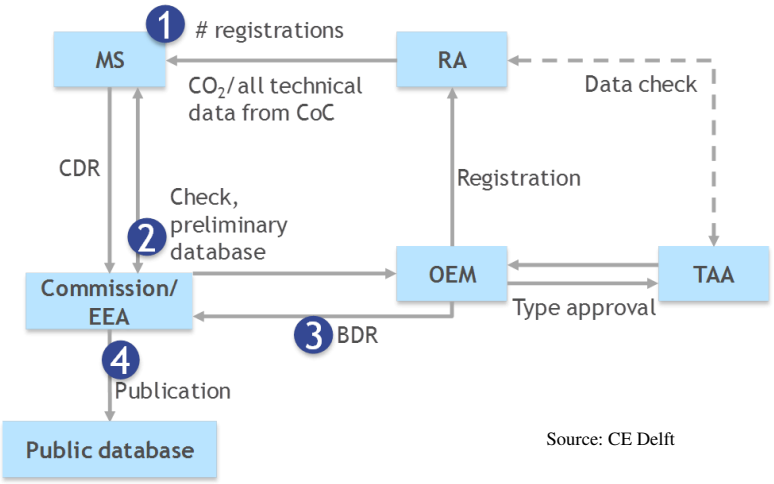
Regulation (EC) No 510/2011 requires Member States to record information for each new van registered in its territory. Every year, each Member State submits to the Commission all the information related to their new registrations. Since 2013 the EEA is collecting data on newly registered vans in all EU Member States.

The structure for the monitoring is as follows:

1. Member States record information for each new passenger van registered in their territory and transmit this information to the Commission by 28 February of each year. Data are submitted to the Central Data Repository (CDR) managed by the EEA (http://cdr.eionet.europa.eu/).
2. The EEA performs several quality checks in order to evaluate the accuracy and the quality of the dataset. On the basis of the checks and the feedbacks from Member States the EEA finalises and publishes the preliminary database. At the same time, notification letters are sent to manufacturers informing them of their provisional CO_2 performances.
3. For the purpose of the verification of the provisional data, manufacturers shall submit to the Commission, at the latest by 28 February each year, the vehicle identification numbers of any light commercial vehicle (complete, completed or incomplete) they sold in the preceding calendar year in the EU. Manufacturers can, within three months of being notified of the provisional calculation, notify the Commission of any errors in the data via the BDR (repository for businesses, https://bdr.eionet.europa.eu/).
4. The Commission assesses the manufacturers' corrections, and, where justified, amends the provisional data for the calculation of the manufacturer final average CO_2 emissions and specific emission targets. The final data and targets are confirmed by the Commission by 31 October each year through a Commission Implementing Decision. The final database is published on the EEA website.

The type approval, registration and monitoring process is illustrated in **Figure 1**.

Figure 1. Overview of N1 vehicle type approval, registration and monitoring



Source: CE Delft

Note: this figure describes the most common situation in Member States (MS), where –in most cases- registration data is used for monitoring purposes. However, in some Member States type approval data is (partly) used. The data check, if performed by Registration Authorities (RA), is not necessarily performed between RA and the Type Approval Authorities (TAA) of the same MS, as TA can be granted in any MS.

ANNEX 9 - INTERNATIONAL EXPERIENCES WITH HDV FUEL EFFICIENCY

Extract from: Ricardo Energy and Environment (2017), Analysis of fuel economy and GHG emission reduction measures from Heavy-duty Vehicles in other countries and of options for the EU[73]

Main markets

United States, California and Canada

1. Introduction and broad market characteristics

The United States has had CO_2 and fuel consumption regulations in place since 2014. The regulations are developed and managed by the Environmental Protection Agency (EPA; for CO_2) and the National Highway Traffic Safety Administration (NHTSA; for fuel consumption). The regulations cover all on-road vehicles with a gross vehicle weight rating over 8,500lbs (3,850 kg), which are broken down into 7 subcategories. Almost identical legislation is in place in Canada.

2. Background to measures

The drivers behind these measures involved a combination of energy security and environmental protection concerns. The regulations took 7 years from conception to implementation, beginning in 2007 and becoming effective for the 2014 model year (MY). The current regulations are known as Phase 1 and run until 2017, after which Phase 2 regulations will be implemented and run until 2027.

The regulations use a baseline derived from actual vehicle market data, taking representative vehicles for each subcategory for MY2010. From this baseline, improvements are expected through a range of technologies with varied adoption rates. Compliant MY2017 vehicles will be used as the baseline for Phase 2.

A number of studies were carried out that informed the regulations, including assessment of the environmental and economic impacts and reviewing which technologies would best achieve the required results. Furthermore, extensive consultation was carried out with a wide range of stakeholders in the sector.

3. Scope

The current US regulations give standards for fuel consumption and CO_2 emissions for engines and whole vehicles. In Phase 2, further regulations will also be introduced specifically for trailers. The standards for CO_2 emissions and fuel consumption are given in gCO_2e/ton-mile and gal/1,000 ton-miles, respectively. The standards also cover nitrous oxide and methane emissions, as well as air-conditioning leakage and hydrofluorocarbon release.

Engines are certified using an engine dynamometer running two different drive test cycles. The standards for whole vehicle emissions and fuel consumption use the GEM simulation model, which has three different drive cycles and a further two idle cycles for vocational vehicles. The simulation currently uses default engine maps, but in Phase 2 manufacturers will provide engine maps to better simulate transient drive cycles. Pickups and vans (Class 2B/3) are tested on a chassis dynamometer instead, similar to the LDV programme.

[73] Ricardo Energy and Environment (2017), Analysis of fuel economy and GHG emission reduction measures from Heavy Duty Vehicles in other countries and of options for the EU, Interim Report contract 340201/2016/736088/SER/CLIMA.C.4, unpublished. Final report will be available at https://ec.europa.eu/clima/policies/transport/vehicles/heavy_en#tab-0-2

Manufacturers must meet certain standards within each manufacturing year, although there are flexibility options to allow manufacturers sufficient lead-time to introduce technologies to their fleet. The flexibilities are provided through an averaging, banking and trading scheme that also gives credits for early adoption and advanced technologies.

Through adopting separate engine and vehicle standards, the US agencies have sought to drive technology improvements in both engines and vehicles, while also leaving the market to decide the most cost effective technologies to meet the standards.

Overall, significant savings in fuel reduction (530 million gallons), CO_2 emissions (270 million metric tonnes of GHGs), fuel cost savings ($50 billion) and other social and environmental benefits ($49 billion) are expected in Phase 1 alone. Phase 2 would see further savings significantly greater than Phase 1 in all respects.

4. Monitoring, reporting, verification and enforcement

Under the Clean Air Act, all vehicles must be certified at the point of sale. Testing is carried out by the manufacturer before sale, but also throughout the useful life of the vehicle (though no standards are in place for the latter). Testing data is sent to the EPA and the NHTSA prior to manufacture, and this data is used to calculate model year emissions. Violations and penalties are issued on the basis of this information. There is a single reporting structure in which manufacturers report their sales for the year and their emissions given in the Certificates of Conformity. Given the flexibilities in place and the feasibility of compliance to the Phase 1 regulation, no penalties have yet been necessary.

California

California holds a unique regulatory position in the US, as the only state with an air quality regulator independent from the Federal Government. Regarding HDV CO_2 and fuel consumption regulations, California has followed the federal US Phase 1 regulations in 2014. However, it is possible that California will decide to adapt slightly more stringent Phase 2 standards than the Federal level. A decision is expected in 2017 on this.

In addition, California has adopted two separate programmes that go beyond the Federal HDV regulations. Firstly, California have a Hybrid Truck and Bus Voucher Incentive Project (HVIP), which provides vouchers for the purchase of new hybrid trucks and buses. Secondly, California have made the EPA's SmartWay programme, mandatory for certain trucks and trailers under the Tractor-Trailer regulation. This programme is voluntary on a national scale and provides SmartWay-certified technology to improve aerodynamics and tyres. However, many of the measures set out in this regulation are incorporated into Phase 2 of the US regulations (applying from 2018) and will therefore essentially become obsolete.

Canada

Canada has followed US standards and adopted Phase 1. Similarly, it is expected that Canada will adopt the Phase 2 standard along the same timeline as the US.

Administration, monitoring and enforcement is handled by Environment Canada. Before the introduction of Phase 1, Environment Canada undertook a separate regulatory impact assessment which estimated a reduction of approximately 19.1 Mt CO_2e, 7.2 billion litres of fuel and economic benefits of $5.3 billion[74].

[74] Canadian dollars (2011).

The Canadian Phase 1 standards contain very minor changes to the US equivalent. First, Canada allows for an optional certification for vehicles over 80,000 lbs which are not covered by the US regulations, due to the greater use of such vehicles in the Canadian fleet. Second, limit values in Canada are purely defined in terms of GHG emissions.

China

1. Introduction

China have had regulations in place for heavy-duty fuel consumption since 2008. These first standards are the responsibility of the Ministry of Transport (MOT) and regulate fuel consumption from in-use vehicles. In 2012, the Ministry of Industry and Information Technology (MIIT) implemented a second standard which requires manufacturers to obtain a certificate of conformity for all new type approvals before production can take place. In 2014, this became a requirement for all vehicles sold. Later in 2014, the second stage of these regulations was introduced for all new type approvals (2016 for all vehicles sold). The third stage of the regulations, expected to be introduced for all new type approvals in 2019 (2021 for all vehicles sold), has recently been announced and is currently open to public comment.

2. Background to measures

The measures were pursued following environmental and economic rationale. China has expressed its interest in controlling emissions from its rapidly growing HDV sector, whilst it is also interested in its energy security, road safety, and improving technological capability within the sector.

A modified version of the World Harmonised Vehicle Cycle (WHVC) test procedure was developed by China Automotive Technology and Research Center (CATARC) in order to take into account typical accelerations, decelerations, and weighting between urban, rural, and motorway driving of the Chinese heavy-duty sector. Due to the lack of data concerning the fuel efficiency and composition of the fleet, efforts were focussed on accumulating fuel consumption data in order to inform the development of the standards. Vehicles were tested by the CATARC and the results used to inform regulatory subcategories and limit values. Stage I was seen as a data collection exercise by MIIT. Further data collection through testing by CATARC and data submission required from manufacturers informed the development of Stage II and III, which as a result are much more difficult to satisfy.

3. Scope

Stage I regulations cover rigid trucks, articulated trucks and coaches, whilst for Stage II the scope expanded to include construction HDVs and urban buses. The proposed scope remains the same for Stage III. Function-specific HDVs, such as salt spreading vehicles, are exempt.

4. Monitoring, reporting, verification, and enforcement

China regulates new type approvals, conducts conformity of production testing and runs inspection and maintenance programmes as a part of its heavy-duty emissions regulation programme. The former two compliance mechanisms are the responsibility of the Ministry of Environmental Protection (MEP). The institution implementing the programmes is the Vehicle Emission Control Center (VECC) under the MEP.

China's emissions regulatory programme primarily focuses on enforcing requirements at the pre-market stage, by requiring manufacturers to obtain emission type approvals and to satisfy conformity of production. The MOT standards are responsible for regulating in-use vehicle emissions.

Japan

1. Introduction

Japan implemented its HDV fuel efficiency measures in 2006, and was the first country to have such regulations. The measures are the responsibility of the Ministry of the Environment (MOE), the Ministry of Land, Infrastructure and Transport (MLIT) and the Ministry of Economy, Trade and Industry (METI). Japan's fleet is quite different from the US and EU, being composed largely of light trucks. Japan's HDV fuel efficiency measures follow the Top Runner Approach, which has been applied to a wide range of industries to achieve energy efficiency improvements.

2. Background to measures

Japan began pursuing fuel efficiency measures following a series of oil crises in the 1970s. As such, energy security has always been an important aspect of the measures. More recently, meeting global climate targets has been a significant factor driving regulation.

As with other Top Runner Approaches, the baseline was derived from the top performing product in the market. The regulations used the most fuel efficient MY2002 vehicle in each category to set targets for MY2015, also factoring for further improvement of the 'Top Runner' vehicle over that time.

3. Scope

Japan's fuel efficiency measures cover diesel fuelled vehicles with a gross vehicle weight rating (GVWR) in excess of 3.5 tonnes, broken down into 12 categories for buses and 13 categories for freight vehicles, including tractors. For each category, a target standard is given for MY2015. The fuel efficiency standards are part of a wider suite of energy saving measures, including subsidies for new vehicles, eco-driving, improved traffic management, efficient logistics and mobility management. The fuel efficiency standards are given in km/L and amount to a 12.2% fuel efficiency improvement by 2015 over 2002 levels.

Japan have a similar testing process to that of the US. An engine dynamometer is used, running two drive cycles in a ratio based on the vehicle category.

The fuel map created by the dynamometer test is then fed into a simulation model that includes actual engine and transmission specifications, and standard values for aerodynamics, tyres and size. The Top Runner approach does not specifically incentivise any technologies. This allows manufacturers to reach the standards by any technology pathway.

The deadline for compliance was set in 2006 giving standards for MY2015. Unlike the US regulation, only a single MY standard is set for each vehicle category.

4. Monitoring, reporting, verification and enforcement

METI and MLIT monitor manufacturers through their corporate average fuel efficiency (CAFE). This average gives some flexibility across a manufacturer's range of products. The penalties for non-compliance are relatively loose. The most notable enforcement mechanism is a public announcement by the Authorities, which is considered a severe enough incentive to ensure compliance.

Other markets

India

India currently does not have measures to reduce heavy-duty vehicle fuel consumption but has been considering them in more depth since 2014. It is expected that HDV engine standards will be introduced in the next few years, whilst the likely end goal of full vehicle standards may take longer.

Mexico

Mexico is the world's leading exporter of heavy-duty vehicles, but does not yet have any fuel consumption or CO_2 regulations. However, as most of the vehicles are exported to the US, Mexico's manufacturers most likely comply with US regulations. Regulations are expected to be implemented in Mexico in the future as part of an aligned North American standard, and would be in line with Phase 2 US regulations.

South Korea

South Korea does not currently have any HDV fuel consumption or CO_2 regulations. An HDV fuel efficiency programme is currently under consideration, although the timeline is not known.

Monitoring heavy-duty vehicles' CO_2 emissions and their costs

An assessment

Monitoring heavy-duty vehicles' CO_2 emissions and their costs

An assessment

The information and views set out in this report are those of the author(s) and do not necessarily reflect the official opinion of the Commission.

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Client: European Commission, DG CLIMA.

Further information on this study can be obtained from the contact person, Eelco den Boer.

CE publications are available from www.cedelft.eu

* Limited update in October 2016 to cover the presentation of the findings to a stakeholder meeting.

Glossary

Glossary	
ECWVTA	European Community Whole Vehicle Type Approval
GVW	Gross Vehicle Weight
eCoC	electronic Certificate of Conformity
IVA	Individual Vehicle Approval
MSV	Multi Stage Vehicle
EEA	European Environment Agency
OEM	Original Equipment Manufacturer
MS	Member State
NSSTA	National Small Series Type Approval
RA	Registration Authority
TAA	Type Approval Authority
XML	Extensible Markup Language
XSD	XML Scheme Definition
IVI	Individual Vehicle Information
EReg	Association of European Vehicle and Driver Registration Authorities
HDV	Heady Duty Vehicle
VECTO	Vehicle Energy consumption Calculation TOol
VIN	Vehicle Identification Number
N1, N2, N3	A vehicle category classifying a land vehicle for regulatory purposes. N1: Vehicles used for the carriage of goods and having a maximum mass not exceeding 3.5 tonnes (Pick-up Truck). N2: Vehicles used for the carriage of goods and having a maximum mass exceeding 3.5 tonnes but not exceeding 12 tonnes (Commercial Truck). N3: Vehicles used for the carriage of goods and having a maximum mass exceeding 12 tonnes (Commercial Truck).
EC	European Commission
TA	Type Approval
ECWVTA	European Community Whole Vehicle Type Approval
IAC	Individual Approval Certificate

Abstract

This study identifies three options for monitoring of HDV CO_2 emissions and fuel consumption data ensuing from the future certification procedure under type-approval: 1) Member States reporting through the national vehicle registration process per individual vehicle to the EC (via the EEA), 2) OEMs once a year reporting directly to the EC (via the EEA) and 3) by cross reporting of VIN numbers by Member States and VECTO result data by OEMs to the EC (via the EEA). OEMs prefer cross reporting, mainly since this option limits their administrative costs. Member States have expressed different views: some supported the cost argument favouring option 3, others argued that option 1 provides more credibility to the monitoring data. Monitoring costs are between € 1 (Option 3) and € 5 (Option 1) per vehicle registered in the EU. Decisive cost categories are development and operation of the needed IT systems by Member States in order to process large VECTO result files (Option 1) and the definition and agreement of the modus operandi of OEMs with 28 Member States and transfer of individual data files per vehicle (Option 1).

Summary

Introduction

On 21 May 2014 the European Commission adopted a Communication to the Council and the European Parliament on a Strategy for reducing HDV fuel consumption and CO_2 emissions in Europe. This strategy focusses on short term actions to certify, monitor and report HDV fuel consumption and CO_2 emissions.

The upcoming HDV CO_2 certification methodology is based on vehicle simulation performed via a dedicated VECTO simulation software tool. In addition to certification, a monitoring system needs to be set up in order to inform policy makers and other stakeholders on newly registered vehicles' fuel and CO_2 emission performance. To this end, DG CLIMA aims to inventory the available options for monitoring and reporting VECTO data and to assess the related costs, following on an indicative assessment of costs by TNO (2015)[1].

Objective and study methodology

The objective of the study is twofold:

- to better understand the various options for monitoring HDV CO_2 emissions; and
- to make a proper costs assessment of monitoring options.

The main feature in designing monitoring options is defining the responsible body for monitoring VECTO data and identifying the respective pros and cons[2]. We conducted interviews with national registration authorities, OEMs and EEA in order to better understand the current monitoring procedures in EU countries, to hear their opinion about various identified monitoring options and to receive targeted input regarding the costs for their organisation, taking into account the current practice and required adaptations. The results of this study are used as input for the internal EC impact assessment on monitoring options.

Monitoring options for HDVs

Taking into account the current practice in EU Member States regarding N1 monitoring, three main monitoring options have been identified for HDVs. Among all options, VECTO data is transferred to the European Commission or the European Environment Agency (EEA) on behalf of the Commission. This data is submitted by either Member States (Option 1) or OEMs (Option 2 and Option 3):

1. Monitoring responsibility for Member States only:
   a Only digital file submittal.
   b In a number of MS digital & paper data flows (variant).
2. Monitoring responsibility for OEMs only: Based on sales data ('self-reporting').

[1] TNO 2015 R10150 Final report, Cost-benefit analysis of options for certification, validation, monitoring and reporting of heavy-duty vehicle fuel consumption and CO_2 emissions.

[2] The exact definition of data to be monitored shall be discussed in parallel to this study as part of the stakeholder dialogues organised by the European Commission.

3. Intermediate option (between 1 and 2): designated national authorities annually report vehicle identification numbers ('VINs') of new registered vehicles to the Commission, which is used for the extraction of monitoring data from OEMs' files.

Option 1 is expected to mirror the monitoring already carried out for light-duty vehicles' CO_2 emissions in which the monitoring responsibility lies with Member States. VECTO data is submitted by OEMs to Member States as part of the vehicle registration process.

Transfer of monitoring data

Registration procedures vary widely among EU Member States. In some Member States the HDVs are registered through vehicle certificate of conformity (CoC), others use type approval documents, or a combination of forms. HDV CO_2 monitoring takes place via the transfer of VECTO data (up to 500 data points) from OEMs to the reporting authority. It can be done in different ways:

- as part of an extended vehicle CoC or type approval document (PDF) used for registration (Option 1);
- as part of a standardised XML file (extended Individual Vehicle Information (IVI) file) that can replace the current CoC and type approval documents (Option 1);
- as an additional file (XML) that can either be added to the current registration documents (Option 1) or can be handed over directly by OEMs to European authorities (Option 2/3).

Many countries are digitalising their processes of registration, but the degree of digitalisation varies and digitalisation processes are not harmonized. From a technical point of view it would be possible to use the IVI message file that is developed by EReg[3], but current digitalisation efforts are hardly based on this file. It is therefore unrealistic to assume that the registration process will be based on an extended IVI message file. It is rather expected that HDV CO_2 registration will occur:

- By the use of one harmonized XML file with VECTO results (Option 1, 2 or 3).
- Or by amendment and expansion of the existing and upcoming digital national registration processes. This would imply that OEMs and national registration authorities have to agree on the file structure (Option 1 only). This option holds the risk of a non-aligned file structure.

Member States and OEMs' perspectives

The use of paper documents (Option 1b) would be expensive and lacks support of Member States or OEMs. Therefore this method will not be analysed in this report. Both stakeholder groups stated that VECTO data should be processed in standardised electronic formats (XML) and need to be compatible with database systems.

Option 3 is favoured by six out of twelve interviewed Member States, Option 1 is preferred by four Member States and two Member States expressed no preference. The most important argument in favour of Option 3 is that it will put less burden on Member States and requires no extra investments in IT systems (vehicle registration databases). The main argument supporting Member State monitoring is related to data credibility and reliability, and

[3] Association of European Vehicle and Driver Registration Authorities.

parallels with the light-duty vehicle monitoring that is currently performed by Member States. Since Option 1 imposes a high burden on OEMs, due to data transfers for every individual vehicle, they prefer Option 3. However, OEMs do not necessarily know in which country vehicles are registered, when the VECTO CO_2 results are produced on the production line. Subsequently, OEMs and Member States are not in favour of Option 2.

Based on the interviews, it seems unlikely that Member States will have introduced sufficiently harmonized electronic data handling and registration procedures before 2018. This implies that OEMs would need to send the files to each of the national registration authorities, with the risk of deviating data formats. This is currently the case with digital registration.

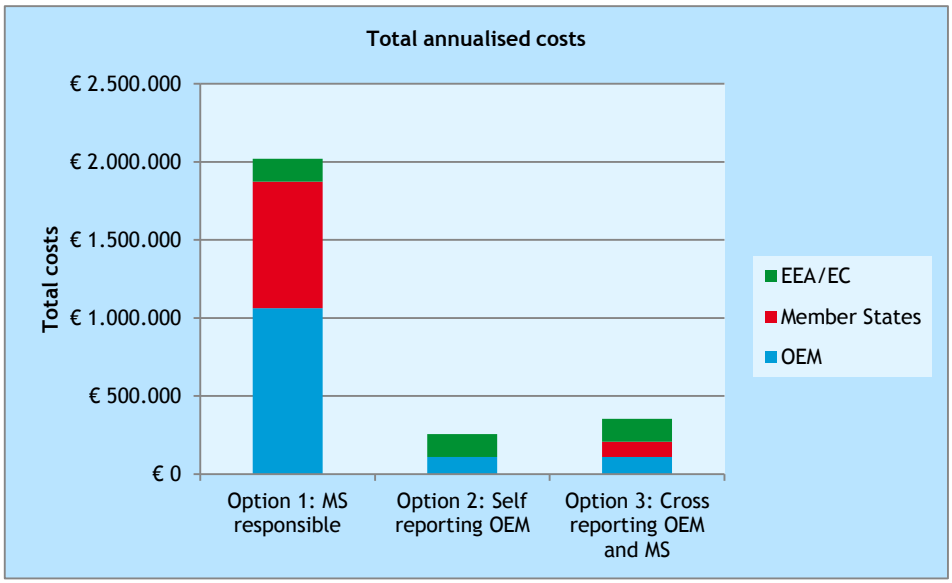
Multi stage vehicles

When VECTO data files are directly added by OEMs to a central EU database (Option 2/3), multi stage vehicles (MSV, representing approximately 40% of the market) can also be included in the monitoring system without special efforts by n-stage manufacturers. In case of Option 1, MSVs can only be included if n-stage manufacturers need to register MSVs along with the VECTO data. This may result in a significant additional administrative burden, since these companies are often small and medium sized companies.

Costs of the different options

We estimated the costs of the various monitoring options for Member States, OEMs and the EEA. Total cost figures are quantified for 28 Member States and 7 OEMs and include one-off investment costs and annual costs. Non-technical implementation costs and database development costs have been quantified as non-recurring costs. Database maintenance, VECTO data reporting costs and quality and accuracy checks have been identified as annual costs.
Figure 1 shows the total annualised costs, consisting of the one-off transition costs and the annually recurring costs.

Figure 1 **Comprehensive total annualised costs of monitoring and reporting options**



The figures show that the costs of Option 1 are the highest, representing:

- the high annual costs for OEMs that is linked to the transfer of VECTO data to registration authorities;
- the high transition costs for Member States and the high annual costs as a result of the development or adaption of databases and IT systems.

The costs of Options 2 and 3 are lower because Member States' registration systems do not need adaptation and VECTO data is not transferred for every single vehicle registered. Instead, OEMs extract the relevant monitoring data from the database where VECTO certification data is stored, on an annual basis. In case of Option 3, Member States report the identity of vehicles registered in their countries. This is a relative simple operation that can be performed on the basis of existing registration practice.

Contents

Introduction

Background

Heavy Duty Vehicle (HDV) emissions represent an estimated 5% of total EU GHG emissions and more than a quarter (about a 27%) of road transport emissions. Unlike car emissions, they are not covered by EU legislation and, without action, would probably remain at their current level, i.e. some 20% above their 1990 levels (EEA, 2015a/b)[4]. Such a result would be clearly incompatible with the objective to reduce greenhouse gas emissions from transport by around 60% in 2050 (compared to 1990 levels), as set out in the Commission's 2011 Transport White Paper and Roadmap for moving to a competitive low carbon economy in 2050.

On 21 May 2014 the European Commission adopted a Communication to the Council and the European Parliament on a Strategy for reducing HDV fuel consumption and CO_2 emissions in Europe. This strategy focusses on short term actions to certify, monitor and report HDV fuel consumption and CO_2 emissions. This will require legislation on certifying, monitoring and reporting these emissions.

The upcoming HDV CO_2 certification methodology is based on vehicle simulation performed via a dedicated VECTO (Vehicle Energy consumption Calculation TOol). This approach offers the possibility to accurately capture the highly diverse characteristics of HDVs and their influence on fuel consumption and CO_2 emissions, without heavily increasing the complexity and the costs for vehicle certification. An 'editing board' has been established by DG GROW to facilitate stakeholder involvement and to define the exact certification methodology and legislation.

Currently, the HDV certification methodology is being finalized and tested, and adaptations to the relevant regulatory framework (Regulation (EC) 595/2009) are being proposed. Certification will basically use the VECTO simulation software tool, which requires input parameters from components testing. Since mid-2015, a draft certification procedure is available for testing in a 'pilot phase'. This pilot phase ran until the end of 2015 and its outcomes are currently being assessed. The goal is to have the system operational in 2018.

Original equipment manufacturers (OEM) will be responsible for certification of the entire vehicle (partly based on default values, e.g. for bodies/trailers). The process covers both single stage manufactured vehicles and multistage vehicles (for all HDV, default values on the body or trailer will be used in the simulation).

[4] EEA, 2015a. Annual European Union greenhouse gas inventory 1990–2013 and inventory report 2015, Submission to the UNFCCC Secretariat, 27 November 2015.
EEA, 2015b. Evaluating 15 years of transport and environmental policy integration TERM 2015: Transport indicators tracking progress towards environmental targets in Europe.

In addition to a certification scheme, a monitoring system needs to be set up in order to inform policy makers and other stakeholders on newly registered vehicles' fuel and CO_2 performance. DG CLIMA aims to inventory the available options for monitoring and reporting of VECTO data and to assess the related costs, following on an indicative assessment of costs by (TNO, 2015)[5].

Project objective and scope

The objective of the project is twofold:
- to better understand the various options for monitoring HDV CO_2 emissions and fuel consumption; and
- to make a proper costs assessment to feed the internal EC impact assessment on monitoring options.

Two main questions arise regarding the HDV monitoring options:
- What VECTO data should be monitored?
- Who should monitor and report?

The first question is outside the scope of this study but will be discussed during the stakeholder dialogues. Quite a number of parameters can potentially be monitored. We can aggregate them into the following groups:

1. General vehicle information (mission profile independent):
   - component identification;
   - vehicle classification;
   - engine specifications;
   - transmission specifications;
   - axle specifications;
   - transfer case specifications;
   - tyre specifications;
   - auxiliary specifications;
   - advanced driver assistance systems.
2. Mission profile and loading conditions:
   - mission profile and loading dependent values;
   - vehicle mass;
   - vehicle driving performance and information for simulation quality check;
   - results for energy consumption (fuel) and CO_2 emissions per CO_2 test cycle and weight assumptions;
   - average energy consumption values;
   - software and user information.

We assume that OEMs will produce a VECTO result file with above mentioned values for any new vehicle. Vehicles that do not include generic standard bodies (used in the actual VECTO approach to define air drag and weight) will still be assigned CO_2 values of the generic configuration. Subsequently, the CO_2 values of produced HDVs give an indication of their efficiency, but they not necessarily reveal the absolute fuel consumption when alternative bodies and trailers are mounted later on. This may change in the future if a methodology that considers different body and trailer designs is implemented.

[5] TNO, 2015. R10150 Final report, Cost-benefit analysis of options for certification, validation, monitoring and reporting of heavy-duty vehicle fuel consumption and CO_2 emissions.

The use of generic values irrespective of whether the vehicle is produced in multistage or by the OEM completely. It should, however, be guaranteed that fuel efficiency of base vehicles can be compared in order to meet the objective of improved consumer information. The share of MSVs is significant in some countries and typically around 40%.

It should also be realised that the impact of future adding n-stage buildings to the CO_2 monitoring can be significant. This would imply that n-stage builders (often SMEs) are responsible for transferring data to OEMs, registration authorities or the European Commissions (EEA). Since OEMs co-operate with up to several hundreds of n-stage builders, the costs data transfer might be significant.

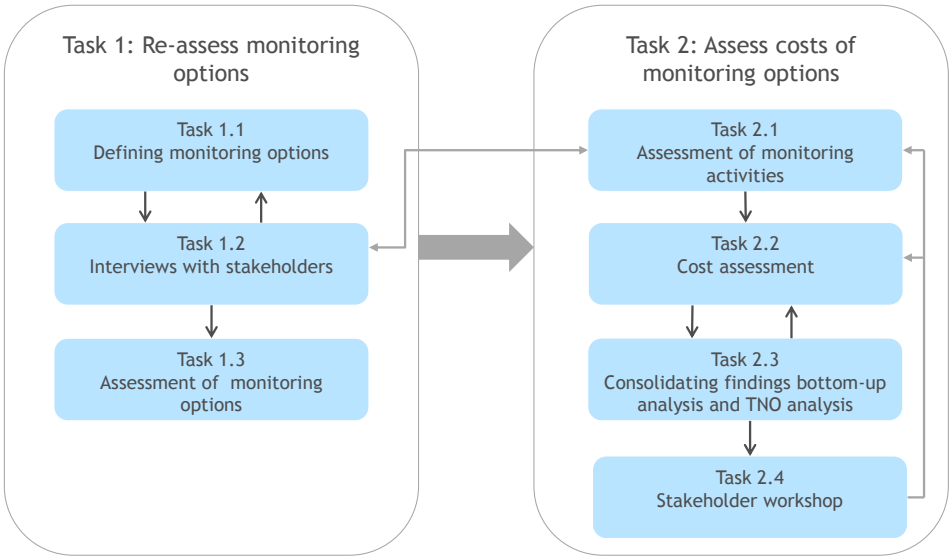
This study will focus on the monitoring process. It identifies monitoring entities, pros and cons of the various available options. Cost estimates of the identified options are also included.

Research structure

The structure of the research is illustrated in Figure 2.
Two main tasks can be identified:

- definition and assessment of monitoring options:
  - definition of options;
  - consultation of stakeholders;
  - assessment of pros, cons and stakeholder preferences.
- cost assessment of monitoring options:
  - assessment of activities;
  - assessment of costs;
  - consolidation of findings with (TNO et. al., 2015)[6];
  - presentation of findings to stakeholders.

Figure 2 **Overview of project structure**



[6] TNO, 2015. R10150 Final report, Cost-benefit analysis of options for certification, validation, monitoring and reporting of heavy-duty vehicle fuel consumption and CO_2 emissions.

Definition of monitoring and reporting

Type approval and certification is not part of this study, but is discussed in TNO et al. (2015). It is the certification process, including verification by type approval authorities, which needs to ensure that a representative CO_2 emission figure is attached to each single vehicle that is certified. Monitoring only needs to ensure that the certified data is transferred to the relevant monitoring authorities, exactly as it was certified.

For the purpose of this study, monitoring and reporting is defined as "gathering and forwarding data made available through type approval processes for newly registered vehicles for the purpose of information provision". The process ranges from data storage by OEM and National Authorities to central database development and operation by the European Commission (or the EEA on behalf of the Commission). This implies that the following activities are not taken into account when measuring monitoring costs: component certification, running the VECTO simulation software, conformity testing, VECTO data storage, the type approval process and registration. With respect to national authorities, only costs that relate to the storage and submission of monitoring data to the Commission should be taken into consideration when defining costs in the context of the present impact assessment.

Figure 3 shows which steps are required for bringing a vehicle to the market.

Figure 3 **Three steps related to bringing a vehicle to the market**

	Production & type approval	Registration	Monitoring
Type approval costs	TA		
Registration costs		R	
Monitoring costs			M

Only the latter category of 'M' costs is considered in this study. These are additional activities needed for monitoring that cannot be allocated to type approval and registration. For example, the eventual expansion of Member States' registration databases (in order to process VECTO data) is included in the analysis.

Research methodology

This study is largely based on interviews. They have been mainly applied for national registration authorities and OEMs in order to better understand the current monitoring procedures in EU countries, to hear their opinion about various monitoring options and to receive targeted input with regard to the costs for their organisation, taking into account the current procedures and required adaptations.

It should be noted that some registration authorities and national governments have only been involved to a limited extent in the EU discussions on the development of heavy-duty vehicle CO_2 certification and monitoring and have not started analysing the requirements for HDV CO_2 monitoring within their

organisations. Therefore it is difficult for them to understand and oversee the impact of monitoring and reporting. Furthermore, various details have not yet been defined (e.g. the number of data to be monitored). As a result, some interviewees could not answer all questions.

Table 1 shows the countries and OEMs that have been approached for an interview, as well as their feedback, either written or oral.

Table 1 Overview of countries and OEMs approached

	Member States	OEMs
Interviewed (17)	Croatia, Denmark, France, Finland, Germany, Greece, Netherlands, Slovakia, Sweden, UK, Spain, Italy	ACEA, Scania, DAF, Volvo, Daimler
No or negative response (8)	Belgium, Cyprus, Estonia, Luxembourg, Lithuania, Poland, Romania, Ireland	Iveco, MAN
Not contacted (8)	Austria, Bulgaria, Czech Republic, Hungary, Latvia, Malta, Portugal, Slovenia	Renault

Report structure

In Chapter 0, the concept of vehicle CO_2 monitoring is introduced with N1 vehicles (vans) as a reference. Subsequently, three monitoring options are identified and assessed. Chapter 0 covers a cost assessment of the various options. In Chapter 0, the main conclusions are drawn.

Assessment of HDV monitoring options

Introduction

In this chapter, the available options for future monitoring of HDV's are inventoried and discussed. The current practice of registration and monitoring of N1 vehicles is an appropriate case of reference, since vans are already monitored on an individual bases using their vehicle identification number. Therefore, the chapter starts with an overview of N1 registration and monitoring. Subsequently, the monitoring options are inventoried and assessed.

Vans (N1 vehicle) registration and monitoring

New vehicle registration data is the main source of information for N1 monitoring in EU countries. Such registration and consequently N1 monitoring procedures are not uniform across Europe. They differ significantly. The two main variables are:

- national registration procedures;
- sources of monitoring data.

National registration procedures

Most countries use centralised registration. In the Netherlands, for example, N1 vehicles are centrally registered by the Dutch RDW registration authority, which also performs the monitoring activities on behalf of the Dutch government. It forwards the data to the European Environment Agency (EEA).

Germany and Greece are examples of countries that work with a system of local registration, while centralised authorities (e.g. German KBA) are responsible for the transfer of data to the EEA. These countries have more complex systems of N1 monitoring and reporting, which are more labour intensive. In Germany, for example, the type approval (TA) database is used for enriching the registration data, e.g. adding wheel base data to this database.

Which national authority is responsible for N1 monitoring differs among countries. In most countries the registration authority solely performs the reporting of data to the EEA, but in several countries various organisations are involved. In Greece for instance, the TAA is responsible for aggregating the locally registered data.

N1 vehicle monitoring

Since 2012, N1 vehicle CO_2 data has been monitored. Information that must be provided for each new van that is registered in the EU includes:

- VIN number of vehicle (since 2014 data only, reported both by Member States and OEMs[7]);
- manufacturer name;
- type approval number;
- type, variant, version, make, commercial name;
- specific emissions of CO_2;
- mass of the vehicle, wheel base, track width;
- fuel type and fuel mode;
- engine power;
- engine capacity;
- electric energy consumption;
- innovative technology(ies) and emissions reductions through innovation technology(ies).

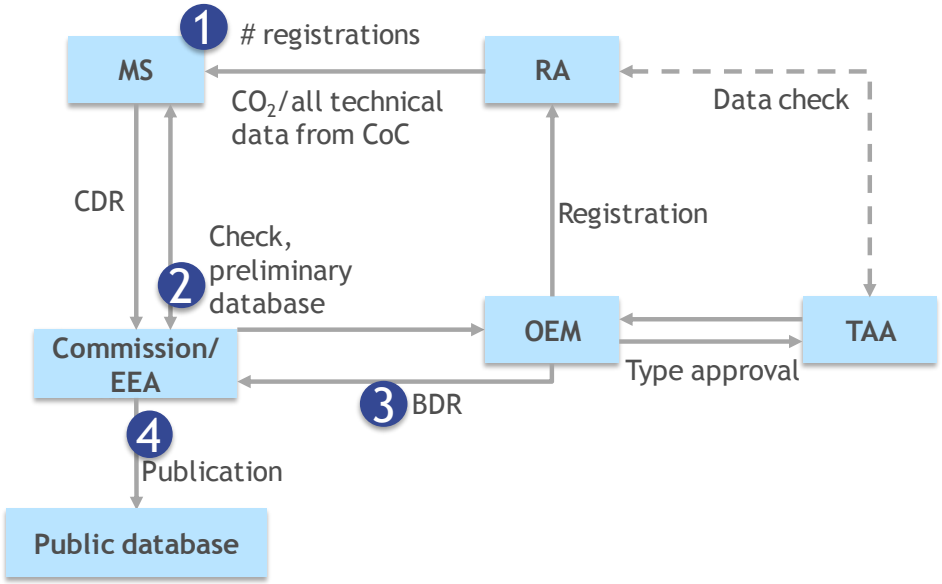
Regulation (EC) No 510/2011 requires Member States to record the above information of each new van registered within its territory. Member States yearly submit all information related to their new registrations to the Commission. Since 2014 OEMs must also submit the VINs for the vehicles sold and/or for which warranties were issued for the monitoring year (whichever is the closest in time to the date of registration) including the last three months of the previous year. In addition OEMs may submit detailed data. The structure of this monitoring system is as follows:

1. Member States record information for each new van registered in their territory and transmit this information to the Commission. Data are submitted to the Central Data Repository (CDR) managed by the EEA (http://cdr.eionet.europa.eu/). At the same time manufacturers submit a list of VINs and possibly detailed data (see above) to the EEA's Business Data Repository (BDR, https://bdr.eionet.europa.eu/).
2. The EEA performs several quality checks in order to evaluate the quality of the submitted data. VIN matching is used for gap filling and to identify base vehicle manufacturers in case of multi stage vehicles. Based on the checks and feedbacks received from Member States, the EEA finalises and publishes the provisional database. At the same time, the Commission notifies the manufacturers of their provisional CO_2 performance.
3. Manufacturers can, within three months of being notified of the provisional calculation, notify the Commission of any errors in the data via the BDR. In order to facilitate their error notifications manufacturers are informed via the BDR about the data records for which matching VINs were submitted.
4. The Commission considers the manufacturers' corrections and confirms or, where justified, amends the provisional data for the calculation of the manufacturers' final average specific emissions and specific emissions target. The final CO_2 performance data and targets are confirmed by the Commission through a Commission Implementing Decision which is notified to each manufacturer. The final database is published on the EEA website.

The type approval, registration and monitoring process is illustrated in **Figure 4.**

[7] VINs for the vehicles sold and/or warranties (whichever is the closest in time to the date of registration) issued for the monitoring year including the last three months of the previous year.

Figure 4 Overview of N1 vehicle type approval, registration and monitoring



Note: This figure describes the most common situation in Member States (MS), where – in most cases - registration data is used for monitoring purposes. However, in some MS type approval data is (partly) used. The data check, if performed by RA, is not necessarily performed between RA and the TAA of the same MS, as TA can be granted in any MS.

Source of monitoring data

The documents used for vehicle monitoring also differ among Member States. Some countries use registration data for CO_2 monitoring, other countries also extract data from the type approval (TA) database. Some countries can relatively easily combine these data as one organisation performs both type approval and monitoring. However, it should be noted that type approval and registration do not necessarily take place in the same country. OEMs may ask any appointed authority in the EU for type approval.

In all countries, N1 registration data is stored digitally nowadays, based on both type approval data and/or the certificate of conformity (CoC). However, some countries still use a manual digitalisation step starting from e.g. paper documents or PDF documents. The Nortype process[8] is an example of such a registration system where data is digitalised by the registration authority. Accordingly, data flows and the time required gathering and forward the monitoring data differs significantly per country.

EReg[9] digitalisation efforts

In the context of Directive 2009/443 registration authorities have made significant efforts to implement CO_2 monitoring in the period 2009-2010. At that time, countries did not have a complete registration of the required characteristics.
An EReg (Association of European Vehicle and Driver Registration Authorities) topic group has agreed on a definition file (XSD/XML) for CoC data exchange. This file, called the initial vehicle information (IVI) file or message[10], can be

[8] The NorType project is a cooperation between Sweden, Finland, Norway and Iceland, takes place in Iceland. The purpose of the NorType project, which started in the beginning of year 2000, is to have a common registration of European Whole Vehicle Type Approval Information, and to distribute it to participating countries, over the Internet, through a password protected website or via XML.
[9] Association of European Vehicle and Driver Registration Authorities.
[10] www.ereg-association.eu/documents/subjects.php#

used for the purpose of CO_2 monitoring. It describes the data exchange on individual vehicles. The IVI file can be used for all vehicle classes. See also the following textbox.

CoC data harmonization

A joint TAAM/EReg Topic Group XII on CoC data exchange and the XML Sub Working Group have developed electronic means of data exchange of the CoC information. The CoC message file is called IVI message (initial vehicle information) and can also be used for the Individual Vehicle Approval vehicles. Primary the message was developed to make it possible to exchange the information on the CoC in a harmonized electronic way all over Europe. For this purpose the topic group has agreed to the first version of a definition file (XSD) on data exchange of CoC data.

The file describes the data that is exchanged when receiving data from manufacturers or manufacturer's representative on individual vehicles. It consists of a range of attributes the importer/manufacturer needs to deliver in a specific order.

The fields of the EC Individual Vehicle Approval Certificate (IAC) and of 1999/37/EC are also in the message to make it possible for the approval authorities to exchange the data of an individually approved vehicle. The message contains also optional fields for additional technical information.

The new message was designed to use throughout the European Union. The IVI message fits the future European model, which involves all EU Member States using the XSD message.

The predefined IVI file has not been broadly used. Although it facilitates a harmonized electronic exchange of information on the CoC all over Europe, national specificities in terms of data requirements, e.g. for tax purposes, impede broad use. The message also contains optional entry fields for additional technical information. The fields of the EC Individual Vehicle Approval Certificate (IAC) and of 1999/37/EC are also in the message to allow the approval authorities to exchange the data of an individually approved vehicle.

Current practice of heavy-duty vehicle type approval and registration in EU Member States

Registration procedures for heavy-duty vehicles vary significantly among EU Member States. This can be explained by differences in organisations and responsibilities, but also by the variety of type approval procedures used in various countries. Two important characteristics of the HDV type approval and registration practices in EU Member States are:

- type approval procedures;
- rate of digital registrations.

Type approval procedures for HDV in EU Member States

HDVs can be type approved by means of three methods: ECWVTA, NSSTA and IVA[11]. Generally, ECWVTA is used for single stage approved truck series produced in large numbers, e.g. 4x2 or 6x2 truck types. Multi stage vehicles (MSV) are developed for specific purposes. Generally, a base vehicle (normally

[11] ECWVTA, NSSTA and IVA respectively refer to European Community Type Approval, National Small Series Type Approval, and Individual Vehicle Approval.

a chassis or chassis/cab) is produced and another manufacturer (normally a body builder or converter) subsequently finishes the vehicle.

Directive 2007/46 requires the issuing of a CoC for ECWVTA vehicles, but not for individually approved vehicles. The share of individual approvals (IVA) varies significantly per country. In Scandinavian countries, it is around 80-100%, which can be explained by the high share of vehicles with a GVW of 70-80 tonnes. In most other countries, gross vehicle weights (GVWs) are around 40 tonnes. For that reason, many vehicles are built in multiple stages and/or small series. In Sweden, for example, HDV registrations are based on IVA for 98.5% of all registrations. In Finland, the number of IVA registrations is around 80%, corresponding with the high number of MSVs produced in that country. In other European countries, the number of individual vehicle approvals cited is much less, typically around 20-40%. It means that a larger share of vehicles is type approved on the basis of Directive 2007/46 and produced with a CoC.

One respondent mentioned that the ECWVTA procedure is relatively new and that its use is still increasing, thereby reducing the number of IVA certifications. **Table 2** provides information on the use of type approval methods and the share of multistage vehicles, based on interviews.

Table 2 **Type approval details in various countries**

Member State	Share IVA/NSS (no CoC)	Share WVTA (CoC)	Share multi stage vehicle (no CoC)
Germany	80%	20%	80%
Netherlands			40%
Finland	55%	45%	80%
Spain	1%	99%	22%
Sweden	98.5%	1.5%	>80%
Croatia	40%	60%	30%
Denmark	85%	15%	90%
Italy	20%	80%	40%
UK	81%	9%	

Multi stage vehicles

Registration of MSVs can be done by importer (our distributor), body builder, dealer or customer. This varies depending on the country and business case. In order to register, the vehicle needs to have the necessary approval (WVTA, NSSTA or IVA). The vehicle manufacturer (either body builder or OEM) is responsible for type approval of the vehicle. In a multi-stage approach each vehicle manufacturer (OEM or n-stage) is responsible for the 'parts' added by him. For bus and coach type approval the body builder is often responsible for the last stage of the type approval. OEMs usually provide necessary documents where appropriate. OEMs state that a high number of bus and truck body builders are cooperating with them (typically more than 100 up to 400 per OEM).

Digitalised registrations of HDVs in EU Member States

These days, registration practices vary significantly across Europe. Both TA documents and CoC data (ECWVTA) are used at the moment, depending on the approval procedure. The dealer, body builder, distributer or the customer can be responsible for providing data to the registration authority (RA).

Data is delivered in paper or digitally, depending on the requirements of the national authority. The OEMs interviewed have all CoC data in digital form.

Paper is only used when necessary. Many countries are in a transition phase for trucks now. They are moving towards a more digitalised registration procedure, after the digitisation of registration and monitoring for light-duty vehicles has been finished in recent years. Typically, digital data is sent from OEM to importer and from the importer to national authorities. The dealer receives the paper version of the CoC from the importer.

Of all countries interviewed, The Netherlands is the first country where digital registration on the basis of the IVI file has been required for complete vehicles since 01/2016. In Spain digital registration is in the final stage of implementation. However, it is not based on the standardised IVI message, but on a nationally developed method, using a combination of information documents and CoC. In Sweden, digital registration is possible, but not used. The Croatian representative also mentioned that importers/OEMs are reluctant to digital registration. Other counties that are running e-CoC pilots are Germany and Finland. Implementation years mentioned were 2017-2018. In Croatia, a PDF file of the CoC or a standardised Excel file has to be submitted to the registration authority.

As mentioned before, not all vehicles are approved by means of the EC WVTA. One challenge of using the e-CoC for digital registration could be the HDVs that are type approved via NSS and IVA. Typically, these vehicles do not have a CoC. However, the IVI message (initial vehicle information) can also be used for Individual Vehicle Approval, which implies that the dataset can be stored and issued in the same way as the e-CoC dataset. The format for the IVI message was jointly developed by EU countries via EReg (see the textbox in Section 0).

Finalising the standardisation and digitalisation of processes will most likely take some more years, since a trend towards standardisation is currently not yet visible. In several countries dealers face higher costs due to today's different national demands for registration (e.g. additional documents to CoC). Therefore some stakeholders argue in favour of obligatory use of the IVI file for registration.

Table 3 provides an overview of registration options in EU countries. It shows the variation in use of digital files, paper files (PDF) and file type. The table also illustrates the current situation in which countries are testing the use of digital registration, but still allow registration on paper.

Table 3 Rate of digitalised registrations and registration methods allowed in various countries

Country	MS uses CoC on *paper* for registration (WVTA)	MS uses CoC *XML file* for registration (WVTA)	MS uses other (than) XML file for registration	Rate of total number of registrations on the basis of transferred digital files (from interviews)
Austria	Yes	Yes	Yes, adapted	
Croatia	Yes	Yes	No	Moderate
Czech Republic	Yes	Yes	No	
Denmark	No	Yes	Not decided yet, system DMR	Moderate
Finland	Yes	No	No	Low
France	Yes	No	Yes (OTC file)	High
Germany	Yes	Yes	Yes adapted	None
Greece	Yes	No	No	None
Hungary	Yes	No	No	
Italy	Yes + local declaration paper	Yes	No	High
Lithuania	Yes	No	No	
Netherlands	Only for incomplete HDV	Yes	IVI standard designed by EReg	High
Romania	Yes	No	No	
Slovakia	Yes	No	No	
Slovenia	Yes	Yes	No	
Spain	No	Yes	Yes	High
Sweden	No	Yes	No	Low
United Kingdom	Only for complete vehicles, other vehicles via national IVA	No	No	Low

Monitoring options for HDVs

Taking into account the current practice in EU Member States regarding N1 monitoring, three main monitoring options have been identified for HDVs. Among all options, VECTO data is transferred to the European Environment Agency. This data is submitted by either Member States (option 1) or OEMs (Options 2 and 3):

1. Monitoring responsibility for Member States only:
   b Only digital file submittal.
   c In a number of MS digital & paper data flows (variant).
2. Monitoring responsibility for OEMs only: Based on sales data ('self-reporting').
3. Intermediate option (between 1 and 2): designated national authorities annually report vehicle identification numbers ('VINs') of new registered vehicles to the Commission, which is used for the extraction of monitoring data from OEMs' files.

For passenger cars and vans, Member States report the registrations and technical data to the EC/EEA. A similar monitoring process is defined as first option for HDV CO_2 monitoring. However, alternatives for data collection exist when data as reported by different entities can be combined.

It is assumed that a rather large number of data points[12] will be monitored, which are direct inputs and outputs of the VECTO tool.

Option 1: Member States responsible for reporting to the EC/EEA

Member States gather HDV CO_2 monitoring data from registration authorities and type approval authorities in some cases, or mandate these bodies to submit monitoring data to EEA.

This option reflects provisions on vans (as formulated in Regulation (EC) NO. 510/2011), that require monitoring and reporting of a defined set of data (see Section 0). The data originate both from registration and type approval data, or a combination of both.

For trucks – as for vans - Member States will designate a competent authority for the collection and forwarding of the monitoring information, which would be the registration authorities in most cases. They will gather the CO_2 monitoring data as part of the vehicle registration process. Only data reported in the certification procedures (up to several hundreds of data points) will be monitored.

The activities required for monitoring/reporting of HDV CO_2 include the following:

- adaptation of the national vehicle register, if needed;
- gathering of the monitoring data from the national vehicle register;
- submission of data to EC/EEA;
- combining national data sets and processing of data by EEA;
- eventually, fixing of mismatches of data upon comparison of national data and OEM data.

Under the assumption that all VECTO data is available due to the vehicle certification, the role of OEMs would be to submit monitoring data to national authorities or intermediary persons (such as importers or dealers or body builders), during the registration procedure. On top of that, OEMs should review the data set compiled by EEA.

Implementation of this monitoring option will require extra investments, for example concerning training staff in all MS. The amount of additional costs will depend on the existing expertise and technical system already available in the MS.

The European Commission/EEA will publish a report and a public database containing the relevant monitoring data on an aggregate and individual vehicle level.

This option assumes a fully digitalised transfer of data, which makes it easier to handle the data flow using predefined structure of input files. Although it might be an efficient option, it needs to be verified whether it is feasible in view of the heterogeneous situation in Member States with regard to digitalisation (see Section 0).

[12] This remains to be decided; the number of data points could be a few to several hundred data points.

Sub-option 1b: In a number of MS digital data flows will not be completely feasible. Therefore, MS will continue requiring paper or PDF files. Member States may have difficulties in processing and implementing changes in their registration systems that are needed to transfer digital files to EC/EEA. For that reason, this sub-option shows similarities with the current monitoring for N1 vehicles, but digitalisation is done by the MS. OEMs provide a PDF or alike file to Member States, which is also the data carrier in the HDV registration process in many countries. In this option the additional work of digitalisation for these MS is taken into account.

Option 2: OEM responsible for reporting to the EC/EEA

The responsibility for monitoring lies with the vehicle OEM. Vehicle OEMs annually collect and report the required monitoring data of their produced vehicles to the EC/EEA, including sales numbers on EU territory. The country of registration is not necessarily the country where vehicle and documents are sent to from the OEM. Dealers may register it elsewhere and, consequently, the OEMs have no reliable information on where vehicles are registered.

Just as in Option 1, the OEMs make sure that CO_2 certification data is available to TAAs, but the OEMs would also send the data to the EC/EEA, instead of the national authorities.

Regarding the cost effects of this option, OEMs may be able to perform monitoring and reporting tasks more efficiently as they already own the VECTO digital input and output files.

This option may result in an unbalanced record of national developments, since OEMs cannot report on the country of vehicle registration, which implies that developments on the country level cannot be monitored as sharply as with registration data.

Option 3: Cross-reporting of MS and OEM to the EC/EEA

This is an intermediate option between Options 1 and 2: designated national authorities (national registration authorities most likely) would annually report individual HDV vehicle identification numbers ('VINs') of new registered vehicles to the Commission (or an EU designated agency such as the EEA). Based on the latter, the Commission or EEA would extract relevant monitoring information from vehicle manufacturers' data files. As in the two previous options the Commission would publish annual average values per vehicle type/manufacturer.

Member States' perspective

This section reveals the opinions of Member States and OEMs on the three options. Based on the interviews, Member States' preferences for one of the options, technical feasibility and perceived advantages and disadvantages are discussed.

Option 1: Member States responsible for reporting to the EC/EEA

Feasibility of digital registration system

Almost all interviewees reported that it would not be feasible to implement the monitoring system if the VECTO data would be submitted on paper or as pdf files (Option 1b). They indicate that monitoring can only be done digitally, given the large number of data. Registration through paperwork or pdf files would imply a too large administrative burden, and a risk of errors.
This implies that Option 1b is unwanted and unnecessary. It will not be further assessed in this report.

Some Member States proposed to adapt Directive 2007/46 for obligatory implementation of digital file transfer, instead of paper, in context of the need for harmonization of the digital CoC file (IVI). Some countries even stressed that they will only be able to collect and report the requested data if this is included in the vehicle e-CoC, since they have started a process to implement e-CoCs or have implemented this already. Only very limited technical information is currently included in the CoC. The Netherlands is frontrunner in the area of digital registration, but also Sweden, Finland and Germany currently run pilot projects aimed at using digital CoC files for HDV registration within a few years. Some of these countries already register vehicles having an e-CoC at small scale, which are mainly whole vehicle type approved vehicles.

Some countries have not started digitalisation programmes. In the United Kingdom, dealers manually enter registration data into the national registration database. The UK representative indicated that monitoring of a limited amount of data (25 data points, as for vans) could be implemented in the current registration processes. Monitoring up to 500 data points would not be feasible within the current registration system, and would require a completely new system that allows the exchange of digital data files between OEMs and the UK registration authority.

Slovakia does not use any form of digital registration for trucks. Although the monitoring of N1 vehicles is based on binding XML schemes, no digitalisation steps for HDVs are foreseen. Spain and Croatia specifically chose not to introduce a registration system based on e-CoC. A mandatory process would require a total redefinition of their registration processes.

Two interviewed representatives are confident that their MS would be able to set up a digital registration system within a few years. Four MS also think it is feasible, provided that all registration data are included in the e-CoC.
Two Member States are not planning to introduce a digital registration system yet. One of them argues that neither the TAA nor the RA actually has the capacity needed to implement the CoC document digitalization process.
In addition to the technical feasibility of including VECTO data into the national registration processes, the following advantages and disadvantages for MS monitoring were mentioned by the interviewees (Table 4).

Table 4 **Advantages and disadvantages of MS monitoring, mentioned by respondents**

Advantages	Disadvantages
– Credibility and consistency of reported information. – MS are already familiar with the existing monitoring process. It harmonises HDV data sets in MS registers. Mismatches of data sets are corrected in MS registries due to their natural relationship with TAA that allows checking the data. – Quality check: random check of values. We trust the OEMs, but they also know that the values are going to be checked. – All TA and registration data is in one hand (RDW, KBA), which matches with the current practice and allows use of the data for a broad range of purposes. – Data are collected from one system, that is centralised in the country. – Better understanding of CO_2 emission dispersion across different MS.	– Significant additional effort combined with limited resources. – The necessity of modifying all the processes. – Increased possibility of clerical (or informatical) errors. – Development of new data points in the registry will be needed – meaning costs and work time. Monitoring will add burden to authorities independent of the number of HDVs registered. – Construction changes (completion) of vehicles and installation of superstructures after OEM production line (MSV) may cause problems to compare data sets of OEM and MS.

Central EU database

Several interviewees indicated that a central EU database would be a helpful instrument of reporting and exchanging HDV CO_2 monitoring data. Amongst others, all vehicle type approval data and registration data in the EU should be added to such a database, including the CO_2 certification/monitoring data, but also information on traffic violations could be added. The type approval authorities would upload their data to this database, and the EU monitoring could be easily done on the basis of this database.

The option of creating such a central database with all registration data/type approval data has been considered and is under discussion in the EU for a long time. This option is, at least in the short term not feasible, according to some of the interviewees. According to the Vehicle Chain report (2014)[13] the implementation of a central e-CoC database for registration purposes and CO_2 monitoring, is specifically mentioned in the context of CO_2 monitoring, and preferred by some registration authorities.

At the moment, EUCARIS[14] is being used as a method for international exchange of data. EURARIS allows the exchange of data between national authorities and a central database can be seen as an extension of EUCARIS.

[13] The Vehicle Chain in Europe 2014, a survey of vehicle and driving license procedures, EReg, 2014.
[14] EUCARIS is the European CAR and driving license Information System. EUCARIS is a system that provides opportunities to countries to share their car and driving licence registration information and/or other transport related data. EUCARIS is not a database but an exchange mechanism that connects the Vehicle and Driving Licence Registration Authorities in Europe. www.eucaris.net/

Option 2: OEM 'self-reporting' to the EC /EEA

From a technical point of view, OEM reporting was identified as the most straightforward option by Member States. There are no technical implications for Member States since they have no active role in this scenario. Consequently, there is no need for investments. However, in the opinion of the majority of the interviewees some control from the Member States is needed.

During the interviews the following advantages and disadvantages were mentioned by the interviewees (**Table 5**).

Table 5 **Advantages and disadvantages of OEM self-monitoring, mentioned by respondents**

Advantages	Disadvantages
– No need to adapt the national vehicle register database (IT). – No costs for MS. – Less trouble and work for MS. Data shall be much more accurate with less risk of error.	– No information about developments on Member State level and no easy use of data by Member States. – Risk of credibility, transparency and consistency issues. – Validity of data needs to be checked by separate surveys regularly without MS database. – Risk of 'adjusted' results, especially in case legislation will be implemented. – CO_2 values are stored only in the EC/EEA's database and additional actions are needed if data is used for national purposes in some MS.

There was broad consensus on the fact that this option lacks the opportunity to consistently monitor developments at the national level. Therefore Member States rather preferred Option 3 over Option 2.

All but one respondent recognized the risk of credibility, transparency and consistency issues for the OEM monitoring option. These MS considered that MS should be definitely involved at some stage of the process for transparency reasons, by e.g. a mutual cross check of the monitoring data.

One country, however, does not consider the risk of fraud to be a disadvantage, because the TAAs are responsible for a check of the process of running the VECTO tool. This would be enough for this purpose, and the technical option of using digital signatures by TAAs. If the data is made publicly available as much as possible, in such a way that recalculations can be made, any wrong numbers will be discovered.

One MS explicitly argued that OEMs cannot be held responsible for the monitoring process: monitoring fundamentally is a task of registration authorities, since it concerns newly registered vehicles.

Option 3: Cross-reporting of MS and OEMs to the EC/EEA

The registration data (including VIN-number) collected by Member States is supplemented by OEM reported monitoring data. On the basis of the VIN-numbers the two datasets are combined in order to obtain monitoring data on a country level.

Member States replied that:

- this would be rather easy: all the vehicles that are registered are in the registration database and the RA would only have to make one extract for all registered heavy-duty vehicles;
- this is a much more efficient and precise way of monitoring because there are two independent parties involved;
- this is feasible to start without spending any new resources.

One respondent indicated that, on the short term, monitoring data could be reported by OEMs, while in a later stage, when the use of data for policy purpose becomes relevant, Member States could take over the monitoring as the credibility of the data becomes more important then.

The advantages and disadvantages of this option are largely comparable to those of OEM monitoring, since the effort for Member States is limited (see **Table 6**). However, in contrary to Option 2, it allows monitoring developments at a national level. It should furthermore be noted that this option does not take away the disadvantages linked to OEMs forwarding the data to EC/EEA directly.

Table 6 **Advantages and disadvantages of OEM self-monitoring, mentioned by respondents**

Advantages	Disadvantages
– No need to adapt the national vehicle register database (IT). – Limited costs for MS. – Less trouble and work for MS. Data shall be much more accurate with less risk of error.	– Risk of credibility, transparency and consistency issues. – Validity of data needs to be checked by separate surveys regularly without MS database. – Risk of 'adjusted' results, especially in case VECTO data will become a major buying criterion by vehicle purchasers. – CO_2 values are stored only in the EC/EEA's database and additional actions are needed if data is to be used for national purposes in some MS.

CO_2 data for policy needs

None of the interviewed Member States indicated that they already have plans for the introduction of national policy instruments based on HDV CO_2 data. Instead, it was indicated that the legislative process should be completed first and that the reliability and accuracy of the VECTO simulations should be clear. Few Member States representatives stated that OEM self-reporting might be a solution for monitoring but that would rule out utilisation of monitored CO_2 values for policy needs. The monitoring data would not be included in the MS registration data on the same level.

With Option 2, segregation on MS level is not available, and in Option 3 the MS segregation is made by matching VIN numbers (delivered by the MS) with the monitoring data. If the CO_2 monitoring data would need to be used by MS for policy purposes, it could be retrieved from the EC/EEA database.
More than half of the interviewees stated that it would be very likely that their Member States would use monitoring data for policy purposes in the future. Policy instruments mentioned were purchase subsidies, vehicle taxes and road tolls.

Some countries are, however, sceptical about using the VECTO data for policy purposes, as too many details are yet not clear enough for national policy makers, like the impact of the use of default values for MSVs. One country said that the quality of CO_2 values will become an important concern, meaning that policy makers need to have access to methods and input data. Another country stressed that CO_2 values simulated by OEM with some default factors behind the process may not be representative enough for application in national policy instruments.

OEMs' perspective

The interaction with the OEMs was performed in three steps:

1. ACEA answered a written questionnaire to the extent that common practice and point of views exist at the ACEA members.
2. The OEMs were asked more detailed questions in written form.
3. The questions under 2) were discussed in detail in oral interviews with some OEMs.

The involvement of ACEA and OEMs in the interview steps is listed in **Table 7**.

Table 7 OEMS participating in the interviews

OEM	Step 1	Step 2	Step 3
ACEA	x		
Scania		x	x
Daimler		x	x
DAF		x	
Volvo		x	

General aspects

ACEAs position is that the following aspects should be considered when identifying the suitable option for CO_2 monitoring and data collection:

- Avoid double/multiple reporting for vehicle OEMs by:
  - submitting data in one system/format only;
  - submitting data to one receiver only.
- Seek effective and reliable data handling by:
  - use digital data format when submitting data from vehicle OEMs;
  - minimize manual digitalization of data when transferring data at MS, to minimize risk of errors.

OEMs indicate that if the registration including the VECTO data is on paper (PDF) this may introduce a lot of mistakes and will create the need to check the data reporting of EEA. This is inefficient and not a good option:

- One OEM said: digitalisation by hand by registration authorities is not an option, as it would increase the risk of mistakes. A fully digital data transfer is a precondition.
- Another OEM added: As long as the standardised CoC in digital form exists, a separate file for CO_2 in XML format is preferred. Adding CO_2 information in a paper CoC is not reasonable and adds a lot of work.
- Again another OEM stated that adding CO_2 information in a paper CoC is not reasonable and adds a lot of work. It would be better if this could be an attachment to the current digital CoC.

Concerning the use of VECTO results in the certification process, ACEAs position is that there is no need to transfer VECTO result files for the specific vehicles to TAA. TAA can store information on specific vehicles if multiple/ parallel databases to the EEA database are set up for individual vehicles, which is normally not the responsibility of type approval authority (other specific vehicle information, such as the CoC, is not transferred to TAA).

According to ACEA Member States could have access to all certificates granted for checks at registration by request to the TAA. In the case of CO_2, the process certificate would ensure that OEMs have procedures in place to properly declare CO_2 for the vehicles. The VECTO files and specific CO_2 data values per vehicle will not be included in the CO_2 certificate(s), and are therefore not relevant for TAA storage. If wanted, the Member States could gain access to the specific CO_2 values in the EEA database.

ACEA notes that the responsibility of the vehicle OEM is limited to submitting monitoring data on the vehicles they produce, which can be complete or incomplete vehicles. A vehicle OEM cannot be made responsible for:

- Detailed information on when and where the specific vehicles are registered. This has to be reported by the Member States.
- Reporting obligation of other vehicle manufacturers, e.g. an n-stage vehicle manufacturer or a completed vehicle or bus.
- Checking that the information collected at Member State level is correct. This responsibility lies with the European Commission or Member States itself.

In all monitoring scenario's, the Member States have to be responsible for collecting information on the number of vehicles registered in each Member State.

Option 1: Member State responsible for reporting to the EC/EEA

The Options 1 a/b assume fully digitalized transfers of data from OEM. However, only a few Member States are currently working with fully digital systems. Therefore, ACEA believes that a transfer of data from paper (PDF) into a digitalized format will be needed in many Member States. Manual digitalization by MS or processing large amounts of data in paper format is not desired because results might be less reliable and costs are high.

Reporting by Member States, such as on the basis of CoC supplied from vehicle OEMs, is only suitable for monitoring a few parameters per vehicle and limited to vehicles which are registered by ECWVTA. ACEA considers such a scheme not to be optimal for HDV monitoring, taking into account the special conditions that apply to trucks and busses/coaches:

- The CO_2 results for HDV are expected to be more extensive than a few parameters, and more extensive than those of passenger cars and vans.
- Part of the registrations takes place without ECWVTA/CoC (for some countries ECWVTA is basically non-existing). Therefore, another additional format to the CoC would be needed to cover these vehicles.
- To a large extent the vehicle OEMs manufacture incomplete vehicles that are completed by a body builder (n-stage vehicle manufacturer). These decide what type of vehicle approval is used for registration (ECWVTA, small series and individual approval).

OEMs assume that there is a need to check the data compiled by MS and EEA and to provide feedback. In this way any mistake due to the digitalization at MS registration can be corrected and changes due to measures at n-stage vehicle manufacturer (i.e. addition of axles changing the market segment, etc.) can be considered.

Table 8 Advantages and disadvantages of MS reporting, mentioned by ACEA and OEMs

Advantages	Disadvantages
– MS can provide correct information on the registered vehicles, such as: • The exact numbers of vehicles that are registered in the MS and EU per year. • Which vehicle (VIN) was registered in the specific year (OEMs may not know in which MS registered the vehicle in many cases). • Information in case it is a special purpose vehicle that should be exempted from monitoring.	– Require new or extended formats and procedures to be developed by OEMs for reporting to MS, both in digitalized and paper (PDF) format. Existing CoC procedure/format is not sufficient. – Require procedures for submitting information to all EC Member States, instead of sending information to one receiver as in Option 2. – Digitalisation of a large amount of data may be needed at MS, since not all MS work with digital system today, involving the risk of introducing errors, etc. – Additional controls/feed-back required by OEM which would need more effort when data is distributed over many MS. Possibly in addition feedback could be required on the data compiled by EEA for entire EU. – OEMs may have to report to 28 individual Members States, with potentially 28 specific data requests to accommodate National programs.

Option 2: OEM self-reporting to the EC/EEA

According to ACEA Option 2 needs no consideration, since a link to national registrations is deemed to be crucial. Vehicle OEMs cannot take responsibility for correctness of the sales data of complete and incomplete vehicles. Therefore OEMs prefer Option 3 above Option 2.

Option 3: Cross-reporting of MS and OEMs to the EC/EEA

ACEA notes that the vehicle OEMs' responsibility is limited to submitting data to EEA for the vehicles that are produced for sale in the EU (complete and incomplete). This is similar to the comment made on Option 1.

ACEA provided the following general notes on Option 3:

– Option 3 is the preferred option for monitoring, provided that it does not involve parallel reporting of the monitoring data information to individual MS or TAA.
– If separate reporting to MS/TAA is required in parallel, the advantages of Option 3 are partly eliminated, since it would require most of the activities listed under Option 1.
– ACEA suggests to consider consequences in case of a future inclusion of bodybuilder as vehicle OEM (e.g. for busses). A standardized and simple format is thus needed.

Table 9 lists the advantages and disadvantages of Option 3 according to ACEA. MS shall annually provide information to EEA on when and where the specific vehicles are registered. Compiling the information from OEMs and MS shall be done in the database using the VIN number or by using the chassis number (last

digits of VIN) combined with the first manufacturer (in case the VIN is changed for MSV, which can be the case e.g. at bus builders).

Table 9 **Advantages and disadvantages of OEM self-reporting according to Option 3, mentioned by ACEA and OEMs**

Advantages	Disadvantages
– Simple, consistent and efficient way for vehicle OEMs to provide monitoring data by submitting monitoring information to one receiver (e.g. an ftp server). – Providing digital information directly to EEA reduces the risk of error, compared to manual transfer into a digital format at MS. The additional data needed from the MS/RA (vehicle registered) should be simple to transfer to EEA. – Reporting could be done at certain intervals, not necessary and not manageable to send one report per vehicle to EEA already before registration. – MS could get access to relevant parts of the EEA database for their monitoring purposes, instead of developing own separate databases. – EEA would have the data necessary for an efficient control of MS data vs. OEM data.	– MS may not have access to the CO_2 results at the moment of registration, depending on the lead times for OEM reporting to EEA, and/or the efficiency of EEA system (possibilities to instead set up on an interface to this retrieve from OEM could be discussed).

When VECTO data files are directly provided by OEMs to a central database (as in Option 3), default MSV CO_2 values can also be included in the monitoring system without special efforts from n-stage manufacturers. Due to different bodies (box, tippers, tank, etc.), the CO_2 data provided by VECTO for the generic norm bodies and trailers is not representing the absolute levels for all trucks correctly but may be a good indicator for the HDV efficiency.

The fact that many HDVs will not be equipped with the standard bodies and trailers in real operation is an issue for all HDVs (truck-trailer e.g.), not just for MSVs. How to deal with other possible changes at MSVs (e.g. adding axles and thus changing the vehicle class allocation) is also an open issue that requires further discussions.

Conclusion

Monitoring options

Taking into account the current practice in EU Member States regarding N1 monitoring, three main monitoring options have been identified for HDVs, with two variants for Option 1. Under all options, VECTO data is transferred to the European Environment Agency, but under Option 1 this data is submitted by Member States and under Options 2 and 3 the data is submitted by OEMs:

1. Monitoring responsibility for Member States only:
   a Only digital file submittal.
   b In a number of MS digital & paper data flows (variant).

2. Monitoring responsibility for OEMs only: based on sales data ('self-reporting').
3. Intermediate option between 1 and 2: designated national authorities annually report vehicle identification numbers ('VINs') of new registered vehicles to the Commission, which is used for the extraction of monitoring data from OEMs' files.

Method of data transfer

HDV CO_2 monitoring means that OEMs transfer VECTO data to the reporting authority. This can be done in various ways:

- as part of an extended vehicle CoC or type approval document (PDF) used for registration (Option 1);
- as part of a standardised XML file (IVI message file) that can replace the current CoC and type approval documents (Option 1);
- as an additional file (XML) that can either be added to the current registration documents (Option 1) or can be handed over directly by OEMs to European authorities (Option 2/3).

The use of paper documents would be expensive, as illustrated by TNO (2015), and it is not supported by Member States or OEMs. Therefore, this method is not analysed in this report.

The digitization of registration processes is ongoing in many countries, but the degree of digitalisation varies and digitalisation processes are not harmonized. From a technical point of view it would be possible to use the IVI message file that is developed by EReg. However, current digitalisation efforts are hardly based on this file. It is therefore unrealistic to assume that the registration process will be based on an extended IVI message file. It is rather expected that HDV CO_2 registration will occur:

- By the use of one harmonized XML file.
- Or by amendment and expansion of the existing and upcoming digital national registration processes. This would imply that OEMs and national registration authorities have to agree on the file structure.

Member States and OEMs' perspectives

Interviewed representatives from Member States rejected the use of paper or pdf files for the transfer of VECTO results to registration authorities because it would require too much work to enter the data in a digital system.

Of the twelve Member States, six countries favoured Option 3, four countries preferred Option 1 and two countries expressed no preference. The most important argument for Option 3 is that it will put less burden on MS and requires no additional investments in IT systems (vehicle registration).
The main argument made in favour of MS monitoring was related to data credibility and reliability, and parallels with the light-duty vehicle monitoring that is currently performed by Member States.

According to OEMs, information from VECTO on CO_2 should be processed in standardised electronic formats (XML) directly. It needs to be compatible with database systems. It is, however, unlikely that Member States will have introduced sufficient harmonized electronic data handling and registration procedures before 2018. This implies that OEMs would need to send the files to each of the national registration authorities instead. There is a risk of creating deviating data formats, which is already the case with digital registration.

Since Option 1 creates a high burden on OEMs, they prefer Option 3. OEMs do not necessarily know in which country vehicles are registered when the VECTO CO_2 results are produced on the production line.
This means that a link of CO_2 data to vehicle registration is crucial to ensure a good quality of data and to allow a MS related monitoring.

Multi stage vehicles

When VECTO data files are directly added by OEMs to a central EU database (Option 2/3), MSV CO_2 values (representing approximately 40% of the market) can also be included in the monitoring system if default values are used.
CO_2 data provided by VECTO only covers generic norm bodies and trailers. It will not represent the absolute CO_2 levels for all trucks correctly, due to different bodies (box, tippers, tank, etc.).

In case of Option 1, inclusion of MSVs can only be done if n-stage manufacturers are required to register MSVs along with the VECTO data. This may result in a significant additional administrative burden, since these companies are often small and medium sized companies.

Assessment of monitoring activities and costs

Introduction

In this chapter the costs of monitoring HDV CO_2 emissions are estimated in terms of required investments and amount of labour needed. Monitoring costs are defined as costs on top of certification. This means that costs until the stage of vehicle registration are excluded from the analysis. For example, costs of VECTO data storage are not regarded as a monitoring cost, since data storage is required for certification purposes.

The costs for Member States, OEMs and EEA (assuming the EEA shall be the EU agency in charge of this) are quantified. In case second stage certification is needed, second stage builders might also face costs of transferring the VECTO data (forwarded to them by OEMs). These costs are not quantified as the use default data is decided as the solution for the first period.

Since data transfer on paper is perceived as unrealistic by stakeholders, this option – while discussed previously - is not further assessed. Therefore, only the three main options will be considered.

Firstly, the cost assessment methodology is explained. Then the costs of each monitoring option are estimated, per actor and in total.

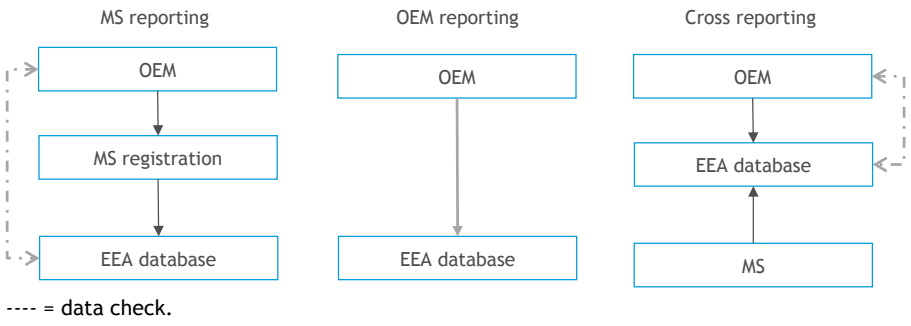
Definition of cost methodology

The monitoring costs will be estimated for the major actors, being Member States, OEMs and EEA. Three monitoring options are taken into account:

- Option 1: MS responsible for reporting to EC/EEA, various registration procedures in Europe; harmonised VECTO output in separate file or added to IVI file.
- Option 2: OEM responsible, self-reporting to EC/EEA.
- Option 3: Cross-reporting of OEM and MS to EC/EEA.

Figure 5 shows the major activities of MS, OEMs and EEA. The costs of those activities will be estimated.

Figure 5 Overview of the main activities of the three options



Description of activities

Option 1

HDV CO_2 monitoring data is forwarded as part of the registration data by or on behalf of OEMs to national registration authorities. Every year, Member States select the CO_2 monitoring data from their registration data and forward the data to EEA, using an extension of the system that is already in use for the CO_2 monitoring of van and passenger car. EEA processes the data and creates a publicly accessible database.

The monitoring activities of Member States consist of three steps:

1. Data transfer from each OEM to 28 MS, through the registration of each vehicle. The VECTO results are transferred in a predefined file to registration authorities as part of vehicle registration data transfer, by OEM or a mandated party (importer/dealer), but the registration procedure may differ per Member State.
2. Member States extract the monitoring data for each individual vehicle from their registration databases and forward these data to EEA through EEAs data management system. The data is stored in the CDR. This procedure is similar to the current process for vans (N1).
3. EEA, EC and OEMs correspond on the quality and correctness of the data forwarded by EEA.

It is assumed that if MS still require registration data on pdf/paper, a separate digital XML file with the necessary VECTO CO_2 data is added to the registration files (which is sent, for example per e-mail). This approach would be consistent with the view of most Member States. They also indicate that attaching a separate file to the registration would be preferred.

Option 2

OEMs forward the type approved monitoring data to the EEA on an annual basis. EEA processes the data as under Option 1.

Option 3

Option 3 is a mix of Options 1 and 2: Member States forward an extract of the vehicles registration database to EEA (VIN number) and EEA request the relevant CO_2 monitoring data from OEMs on the basis of these VIN numbers. OEMs forward the data to the EEA as described under Option 2.

Cost components

For all three options both one-off transition costs and recurring annual costs were assessed as listed in **Table 10**. All these cost components are quantified in the following sections.

Table 10 Cost components

Cost component	Sub-component description	Description	Relevant for actor under option		
			MS	OEM	EEA
Transition costs	Implementation costs	The implementation costs are defined as non-technical costs for organising the process, making arrangements between actors (between MS and OEM on registration procedure, between EEA and MS/OEM on reporting format). These costs are non-recurring costs.	1,3	1,2,3	1,2,3
	Database development/ IT investments	The technical implementation costs refer to investments in the development of needed databases and additional	1		1,2,3

Cost component	Sub-component description	Description	Relevant for actor under option		
			MS	OEM	EEA
		IT requirements. OEMs database costs are defined as certification costs and therefore not taken into account. These costs are non-recurring costs.			
Annual costs	Technical maintenance & IT costs	Data management costs concern the technical maintenance costs for IT systems and databases. These only apply when IT systems are in use for the sole purpose of HDV monitoring. OEMs database costs are defined as certification costs and therefore not taken into account. The data management costs are estimated at 10% of the technical investments.	1,3		1,2,3
	VECTO data transfer costs	VECTO data transfer costs apply only to monitoring option 1. In this option, not all Member States use a fully digitalised registration system, and additional costs will occur when registration procedure is extended for the sole purpose of HDV monitoring. This is the case for all registrations for the OEM and only for non-digitalised registrations for Member States.	1	1	
	Reporting costs	Reporting costs are defined as costs of transfer of data to EEA and management by EEA. These costs refer to the effort made by the responsible entity (MS in Option 1, OEM in Option 2 and both in Option 3) to perform the annual reporting. In case of EEA, this cost components represents the processing of the received datasets.	1,3	1,2,3	1,2,3
	Costs for making checks, answering questions	EEA and EC will perform several quality checks in order to evaluate the accuracy and the quality of the datasets. On the basis of the checks and the feedbacks from the responsible entity(ies) a preliminary database is published. Depending on the quality control system in each monitoring option, various actors will be able to give feedback on the datasets and notify the Commission of any errors in the data. The feedback is assessed and, when justified, taken into account for the final database.	1,3	1,2,3	1,2,3

Methodological notes

The transition costs are annualised by using the annuity method, a discount rate of 4%, in accordance with the impact assessment guidelines (EC, 2009)[15], and a 10 year depreciation period. The estimation of labour costs is based on an hourly rate of € 30/hour, which equals cost of € 60,000 for one working year. This value is deemed to be representative for experts representing the Member States, OEMs and EU institutions. The figure includes social charges and costs for pension (25%).

Costs per actor

Three major actors have been identified above, being Member States, OEMs and EEA. The EC is also involved in the last stage of quality checks. For each of these actors a detailed cost assessment is performed.

[15] European Commission, Impact Assessment guidelines, SEC(2009) 92, 15 January 2009.

Member States

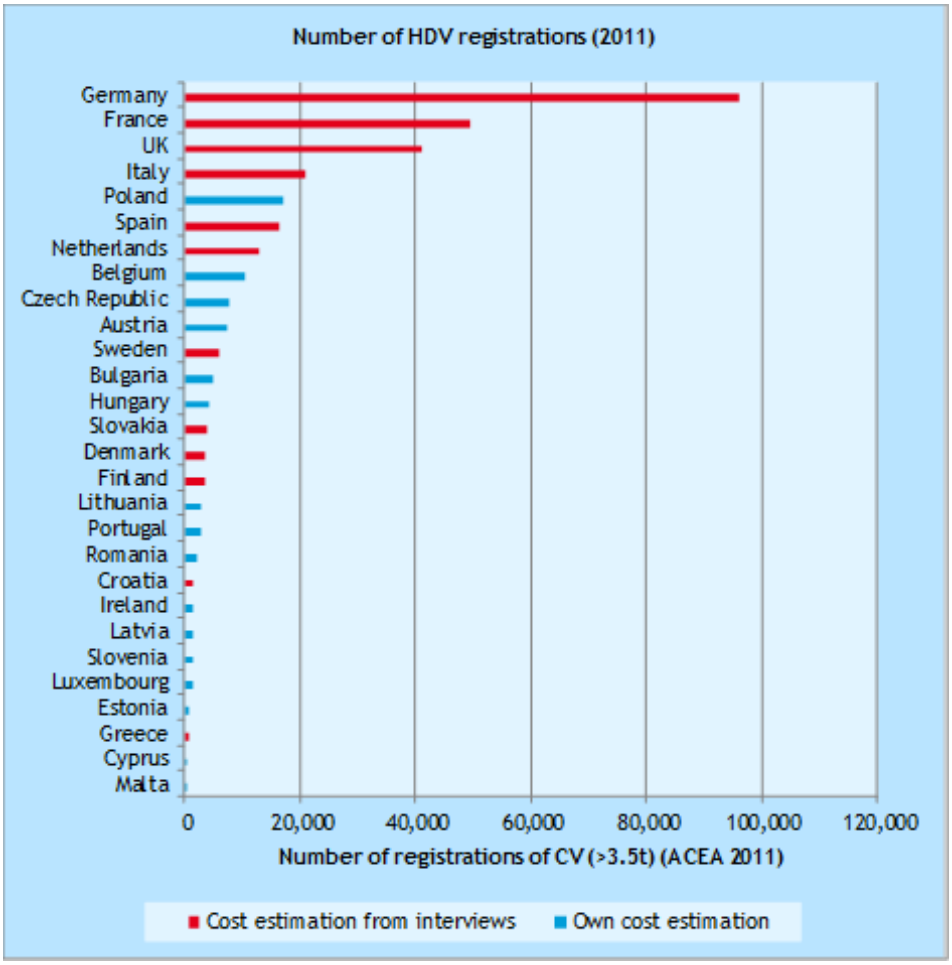
The costs for Member States differ strongly. Some Member States already have an advanced system of digitalised registration and are using or preparing the electronic CoC, while others (partly) use paperwork.

Analysis has been made for two groups: interviewed Member States and non-interviewed Member States. Most data was obtained via the interviews.

Option 1 - Interviewed Member States

For 13 MS both the transition costs and the annual costs are estimated on the basis of interviews (twelve countries) and the report on CO_2 data monitoring by EReg (2011)[16] on the costs of the current monitoring system for M1+N1 vehicles (Belgium). This group of Member States includes the four Member States with the highest number of registrations of HDV, and is displayed in red colour in **Figure 6**.

Figure 6 **Method of cost estimation per Member State as function of number of registrations**



Source: (ACEA, 2011).

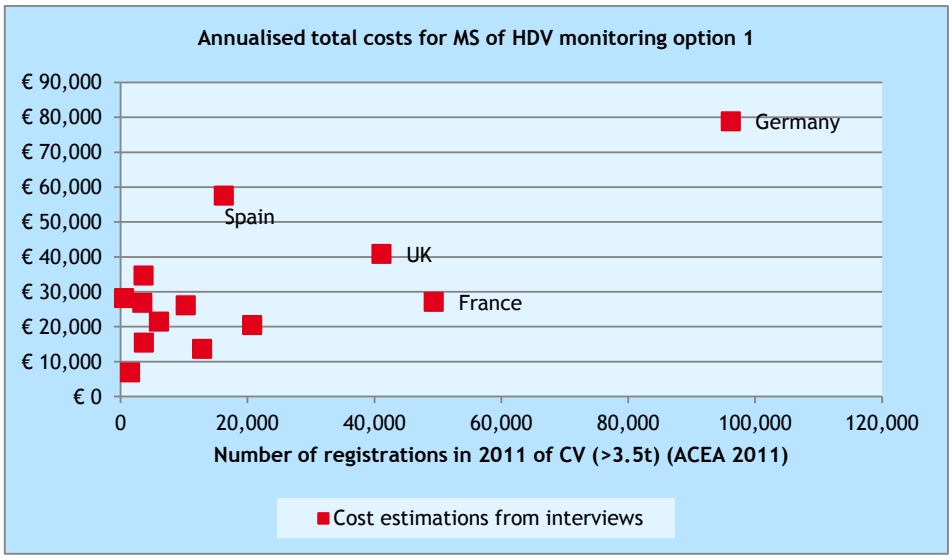
[16] EReg Topic Group IX on CO_2 Data Monitoring, final report, 07 April 2011.

The total annual costs for Member states can be divided into the following cost components:

- Transition costs:
  - database investment and development costs, summarised in 0;
  - implementation cost, € 16,500 per Member State for communication and aligning with OEMs on the needed registration format have been estimated;
  - technical maintenance & IT costs, which are 10% of the technical implementation costs.
- Annual costs:
  - VECTO data transfer costs;
  - annual costs for reporting and data checks, summarised in 0.

Figure 7 presents the total annual costs for monitoring Option 1. Member States mentioned a broad range of costs, representing the variation in the current registration practice and the number of actors involved in the monitoring of M1 and N1 vehicles. Transition costs range from 0 to € 100,000 and annual costs range from € 1,500 to € 80,000.

Figure 7 **Annualised total costs for interviewed Member States of Option 1**



Note: Germany, France, UK, Spain, Netherlands, Sweden, Slovakia, Denmark, Belgium Finland, Croatia and Greece are on the low/left of the axis. See Figure 6.

Non-interviewed Member States were grouped into two categories based on the degree of digitisation.

Option 1 - Non-interviewed Member States

Due to lack of data, for fifteen Member States a cost estimation must be made on the basis of thirteen Member States for which data is available from the interviews. The most important conclusions and assumptions are:

- The database development costs seem to be dependent on the specific situation of the Member State, but will probably be in the range of € 45,000-90,000. We have assumed an average € 67,500 per Member State.
- The VECTO data transfer costs depend on the rate of digitalised registrations. If the rate is low, many registrations will be processed via PDF files (by e-mail). The VECTO monitoring data will be included as an attachment (XML file) and we estimate 5 minutes of extra work for these

registrations. The rate of digitalised registrations was estimated from Table 3 and if unknown, a low rate of digitalisation was assumed.
In 0 these assumptions are summarised. Calculations are based on 10% (low digitisation) and 90% (high digitisation) rates.

– The annual reporting costs for each MS to EEA were estimated at € 3,500 per year in accordance with the interview results. Additionally, the Member States activities also include answering questions from EEA after the OEMs have commented on the provisional data. We estimate that this will cost on average 1 working day per OEM for every Member State (€ 1,750).

These assumptions are summarised in **Table 11**.

Table 11 Assumptions that were used for cost estimations of non-interviewed MS

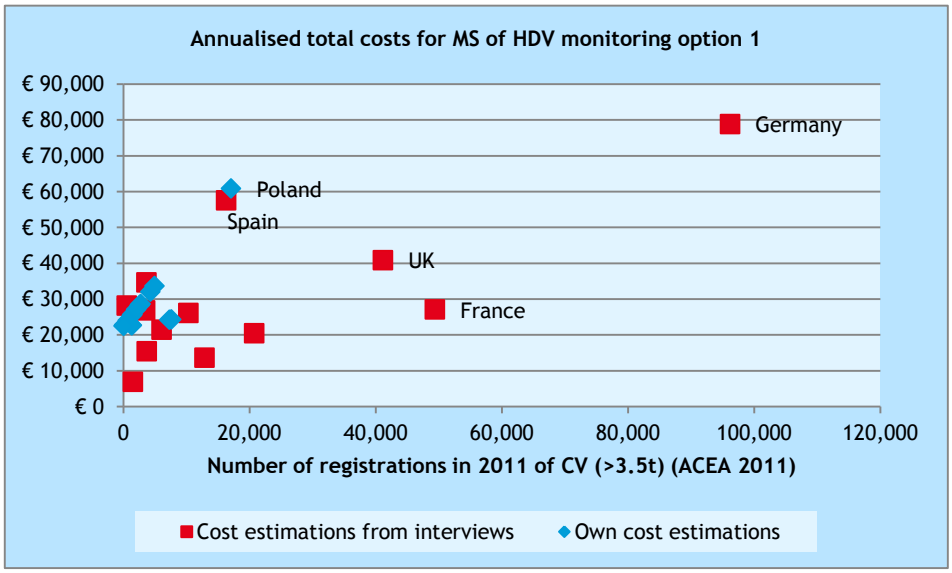
Cost component	Sub-component description	Low rate of digitalisation	High rate of digitalisation
Transition costs	Implementation costs	It was assumed that all MS will need € 16,500 to implement the new monitoring system (non-technical investments).	
	Database development/ IT investments	This depends on the specific situation of the MS. According to interviews in the range of € 50,000-90,000. Conclusion for all: € 67,500.	
Annual costs	Technical maintenance & IT costs	10% of technical implementation costs: € 6,750.	
	VECTO data transfer costs	Depends on rate of digitalisation and number of registrations: 5 min. per registration on paper (via XML attachment), 10% digital registrations.	5 min. per registration on paper (via XML attachment), 90% digital registrations.
	Reporting costs: MS to EEA	Fixed costs of € 3,500 per year	
	Costs for making checks, answering questions: MS to EEA and EC	1 day of work per OEM on average: € 1,750 per year.	

Option 1 – Annual costs for all MS

Based on the cost estimations provided in the interviews and the estimations for countries that were not interviewed, the total one-off transition costs for Member States for Option 1 are € 2.24 million and the annual costs for all EU Member States are € 534,000 per year.

When the transition costs are annualised, the total costs of HDV monitoring Option 1 are € 811,000 per year for all Member States. **Figure 8** shows this cost estimate in relation to the number of registrations.

Figure 8 Total annualised costs of monitoring Option 1 for all Member States



Option 2 and 3 – Annual costs for all MS

Option 2, in which OEMs will self-report the CO_2 monitoring data, implies no additional costs for Member States.

With respect to Option 3, all interviewed Member States indicated that extracting data from the registration database (on all registered HDVs in their country in one year) was relatively easy. Seven out of twelve countries stated that the annual costs are marginal or very small. Other provided cost estimates range from a few working days to a maximum of one month.

Our assumption is that, for all 28 MS, efforts to derive a set of VIN numbers of HDVs registered from their database is small and will cost about € 3,500 per year. No costs incur for making checks. Also, no transition costs would be needed.

In total, the annual costs of monitoring Option 3 are estimated at € 98,000 for all MS per year.

OEMs

In the first round of interviews, as illustrated in Table 7, little information on the costs of monitoring options was received. It is understandably difficult for OEMs to give an estimation, because monitoring actions are completely new to them. Therefore, we have sent a memo with a cost estimation for OEMs based on the Member State cost methodology to all the OEMs, and offered OEMs the opportunity to give feedback on our estimations. Two OEMs did so and their feedback was taken into account.

Option 1: Annual costs for all OEMs

Transition costs

A first important step is that each OEM will have to agree with all Member States how the registration procedure will be adapted due to the monitoring requirements. Setting up such a system would involve high transition costs, depending on the rate of standardisation of VECTO data exchange between OEMs and MS:

- if one standardised XML file can be agreed on, the transition costs would be limited and one central working group need to be installed;
- if each Member State requires different file structures from OEMs as part of the digital registration, the transition cost would be much higher and OEMs would need to negotiate with numerous Member States.

One OEM worries that deviations from the standard XML file for the CO_2 reporting would increase the costs of Option 1. Such deviations could be caused by individual Member States if they want to introduce a specific requirements for CO_2 for the registration in its country, e.g. for the purpose of following-up of national targets or taxation scheme, or if they for some reason decide they cannot handle the standardized XML format. Therefore coordination between Member States will be required. The cost for the initial implementation phase is estimated at € 250,000 for each OEM in the latter case and at € 125,000 in the first case. Since it is not known which of the two situations will occur, we decided to take an average of these two cost figures for calculation.

No additional database development costs/IT investments are needed in this scenario, since it was assumed that database development costs are upstream certification costs before monitoring takes place. One OEM explained that they already have a database with digital versions of the CoC, which may also track the additional information required by the various Member States.

Digital registration in the Netherlands

An example of the high implementation costs for OEMs is the development of a fully digitalised registration system in the Netherlands. This leads to an IT project for each OEM and only concerns one country. Such digitalisation projects happen uncoordinated at the moment, while a standard e-CoC has been agreed within EReg. To limit costs of CO_2 monitoring, it is important to set up a coordinated development of an agreed VECTO result file standard.

Annual costs

The annual costs will be high. One OEM indicates that costs will be very high if there is no standardisation of CoC and they are required to deliver MS specific digital files. Due to different national demands for registration (additional documents to CoC) this adds a lot of work and costs. Another OEM mentioned that high effort is needed when they have to submit initial VECTO data to 28 authorities.

When some MS still require reporting on paper, no extra data transfer system is required. A separate digital file will be attached to the existing registration. In case the digital VECTO data is sent along with PDF files, this would only add an additional data file to be included in an existing data exchange between OEM/dealer and registration authority. When we assume an additional extra work of 5 min. per vehicle (to include the necessary XML file into the existing

dataflow towards RA) the annual costs amount to € 75,000-180,000 per year, depending on the OEM (assumed is 5 min. per vehicle for € 30/h[17]).

After the provisional dataset is constructed by EEA, the OEMs will have the opportunity to check the data with their own databases. We estimate that the data checking costs are approximately three days per Member State: € 20,000 per year for each OEM.

The costs are summarised in **Table 12**.

Table 12 Cost of monitoring Option 1 per OEM

Cost component	Sub-component description	Option 1: Various registration procedures in Europe; harmonised VECTO output in separate file
Transition costs	Implementation costs	€ 125,000-250,000
	Database development/ IT investments	N/a
Annual costs	Data delivery costs: OEM to RA	€ 75,000-180,000 depending on the number of registrations
	Costs for making checks answering questions: OEM to EEA	€ 20,000

* No additional database is needed, as there is already a database in place for certification purposes.

Please note that the data delivery costs may occur at the distributer/dealer.

Option 2 and 3 – Annual costs for all OEMs

In these scenario's, OEMs are responsible for transferring VETCO data to the EEA. Option 2 implies that the OEMs are self-reporting without any other data flows involved. Option 3 includes cross-reporting from Member States (registered vehicles). However, only the costs for MS will differ. For OEMs both monitoring options imply the same costs and therefore *we do not distinct between Option 2 and 3*.

Self-reporting of OEMs requires, according to ACEA, that the production records of vehicles produced for the EU market need to be generated and periodically distributed. One OEM adds that data need to be submitted to the EEA and checked again before publication. This effort is quite limited compared to Option 1, in case only one single receiver is defined and VIN numbers are used.

The implementation cost for Option 2 and 3 are based on a simple IT solution, were the CO_2 data are automatically forwarded to the one entity (the EEA) without any additional handling/storage at the OEM. One OEM estimated that the implementing cost will be significantly lower than for Option 1.

The implementation costs are assumed to be similar to those of a medium Member State and as estimated to be around € 16,500 if the system is comparable to the current N1 monitoring system.

[17] This equals approximately € 60,000 per year and includes social charges, pension and overhead.

No database development nor IT investments will be needed as all the databases will be present at OEMs. The monitoring options elaborate on the VECTO databases of OEMs (which will be developed for certification purposes). Therefore, no additional monitoring costs will occur (these should be attributed to certification procedures).

The reporting costs arise when monitoring data for each individual vehicle needs to be extracted from their databases and is forwarded to EEA through EEAs data management system. This needs to be done once per year.
OEMs indicated that they would face significantly higher annual reporting costs than Member States. This is reasonable as the database per OEM is much larger than per MS (on average). Therefore we estimate these costs to be twice as high as for Member States: € 7,000.

The OEMs will receive some feedback from EEA based on the initial datasets, if there seem to be errors, or questions regarding the monitoring data. It is estimated that the OEMs will need about € 6,750 to process this, which corresponds to one day per Member State.

The costs are summarised in **Table 13**.

Table 13 Cost of monitoring Option 2 and 3 per OEM

Cost component	Sub-component description	2: Self-reporting	3: Cross-reporting
Transition costs	Implementation costs	€ 16,500	€ 16,500
	Database development/ IT investments	N/a	N/a
Annual costs	Reporting costs: OEM to EEA	€ 7,000	€ 7,000
	Costs for making checks answering questions: OEM to EEA	€ 6,750	€6,750

EEA and EC

EEA database development and data processing costs have been estimated on the basis of expert insights from the EEA and experience with the current monitoring system for N1/M1 vehicles.

The investment needed for setting up a new monitoring system for HDV will be around € 250,000 for EEA, depending on e.g. need to store complex data. When the monitoring requirements are clearer, the EEA will be able to make a better estimation. The number of data points (up to 500) is not a significant factor. One additional staff member (1 FTE) needs to be hired to manage the data(base) and correspond with stakeholders. The number of data flows (28 flows from the MS, or less flows from OEMs) is neither important, according to EEA. More important are: the number of registrations and checks that need to be made.

Additionally, the costs for the European Commission are estimated at 0,5 FTE.

It is estimated that the number of checks and the process of guiding this is not so different for the various options, from the perspective of EEA. The costs are summarised in **Table 14**.

Table 14 Costs of monitoring options for EEA

Cost component	Sub-component description	Option 1	Option 2	Option 3
Transition costs	Implementation costs	€ 250,000	€ 250,000	€ 250,000
	Database development/ IT investments			
Annual costs	Data management costs	€ 25,000	€ 25,000	€ 25,000
	EC staff costs	€ 30,000	€ 30,000	€ 30,000
	Reporting costs	€ 60,000	€ 60,000	€ 60,000
	Costs for making checks, asking questions			
Total annual costs		€ 145,000	€ 145,000	€ 145,000

Overall costs for the various monitoring options

The overall costs consist of the sum of costs identified for the various actors in the sections above, quantified for 28 Member States and 7 OEMs. **Figure 9**, **Figure 10** and **Figure 11** provide an overview the one-off transition costs, annually recurring costs and the total annualised costs.

Figure 9 **Comprehensive transition costs of monitoring and reporting options**

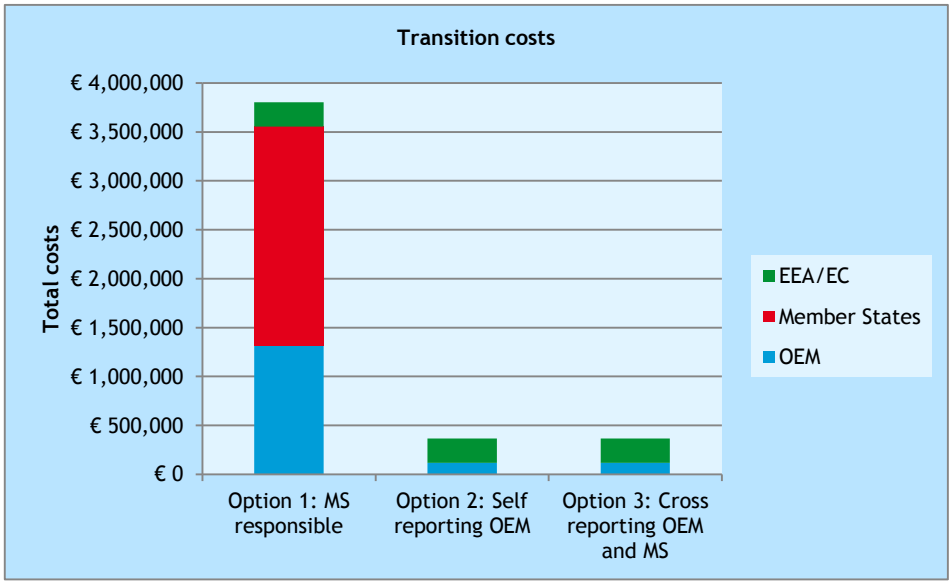


Figure 10 Comprehensive annual costs of monitoring and reporting options

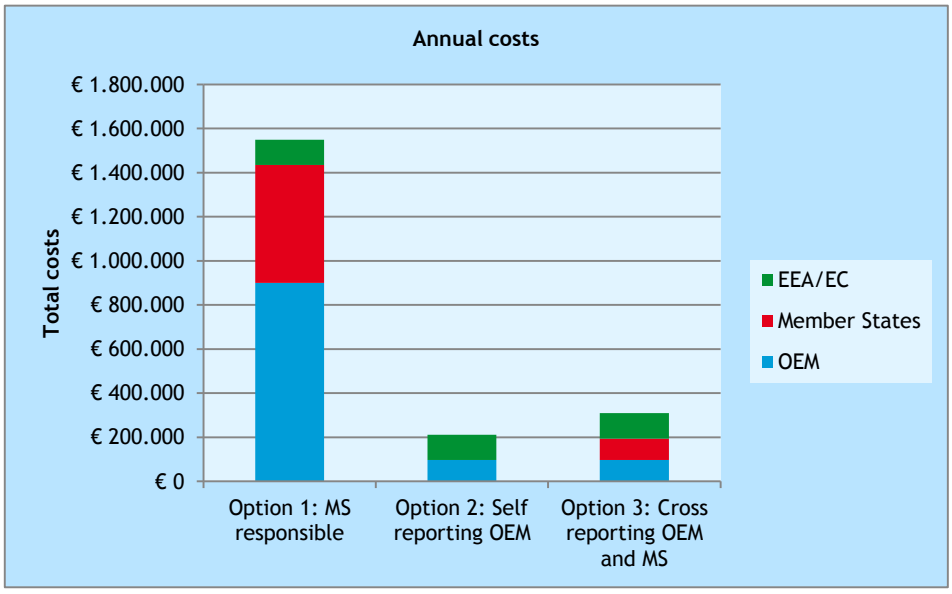
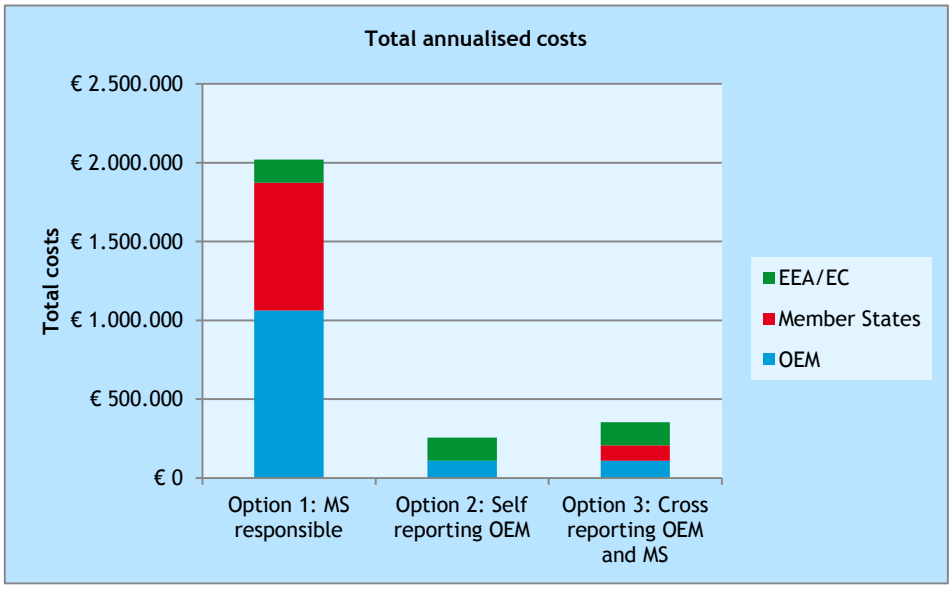


Figure 11 Comprehensive total annualised costs of monitoring and reporting options



The figures show that the costs of Option 1 are the highest, representing:

- the high transition costs for Member States and the high annual costs as a result of the development or adaption of databases and IT systems;
- the high annual costs for OEMs that are linked to the transfer of VECTO data to registration authorities.

Monitoring costs are between 1 (option 3) and 5 Euro (option 1) per vehicle registered in the EU.

In Scenario 1, Member States and OEMs bear the largest absolute costs while absolute costs are similar for EC/EEA in all options. Total costs are 8 times higher in Option 1 than in Option 2 and approx. 5.5 times higher than in Option 3.

Table 15 illustrates the costs for the various options per actor, used for creating the figures above.

Table 15 Resulting costs of different monitoring options

Actor	Cost component	Option 1: MS responsible	Option 2: Self-reporting OEM	Option 3: Cross-reporting OEM and MS
OEMs	Transition costs	€ 1,313,000	€ 116,000	€ 116,000
	Annual costs	€ 901,000	€ 96,000	€ 96,000
	Total*	**€ 1,062,000**	**€ 110,000**	**€ 110,000**
MS	Transition costs	€ 2,242,000	€ 0	€ 0
	Annual costs	€ 534,000	€ 0	€ 98,000
	Total*	**€ 811,000**	**€ 0**	**€ 98,000**
EC/EEA	Transition costs	€ 250,000	€ 250,000	€ 250,000
	Annual costs	€ 115,000	€ 115,000	€ 115,000
	Total*	**€ 146,000**	**€ 146,000**	**€ 146,000**
Overall	**Total***	**€ 2,019,000**	**€ 256,000**	**€ 354,000**

* Transition costs were annualised using a discount rate of 4% and a period of 10 years.

This study builds on the work that was done by TNO et al. (2015)[18], which also provided a cost estimation on the monitoring and reporting options.
The monitoring options in the TNO study and this study are not strictly comparable. This study does not make a cost assessment for reporting of non-digitalised data, comparison can only be made limitedly.
See 0 for more explanation.

The conclusions of this study have been presented at a stakeholder meeting in Brussels on October 17, 2016, and no major comments were received on the cost estimations.

[18] TNO 2015 R10150 Final report, Cost-benefit analysis of options for certification, validation, monitoring and reporting of heavy-duty vehicle fuel consumption and CO_2 emissions.

Conclusions

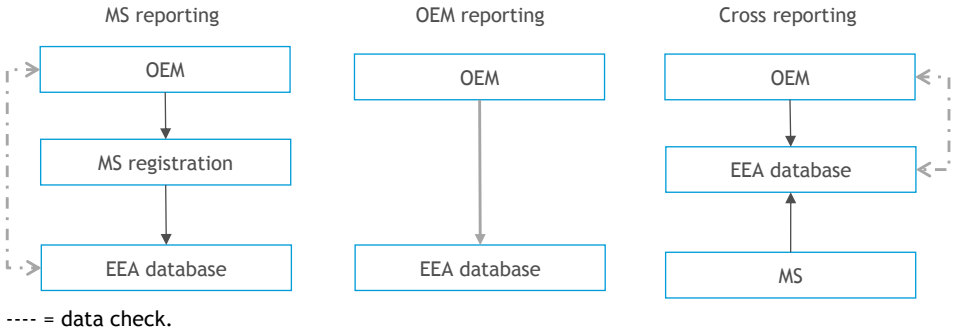
Options for monitoring actors

This report discusses the options for transferring HDV CO_2 monitoring data produced by OEMs to the European Commission, or an EU designated agency (such as EEA). The European Commission will publish a database and annual average values per vehicle type/manufacturer. Three basic options have been identified:

- **Option 1** is expected to mirror the monitoring procedure that is already carried out for light-duty vehicles' CO_2 emissions. Manufacturers report to national authorities, most of which are expected to be the national registration authorities, and national authorities report to the Commission. This means that registration-based data needs to be monitored. Subsequently, national registration authorities are a priori designated as the main potential national authorities in charge of submitting national data to the EU.
- **Option 2** would alternatively put HDV manufacturers in charge of the monitoring, with reporting to the Commission. The data that needs to be monitored in this case would be annual sales-based data in the possession of vehicle manufacturers.
- **Option 3** is an intermediate option between 1 and 2: designated national authorities - would annually report to the Commission individual HDV vehicle identification numbers ('VINs') of new registered vehicles. Based on the latter, the Commission or EEA would extract relevant monitoring information from vehicle manufacturers' data files. As in the two previous options the Commission would publish annual average values per vehicle type/manufacturer.

The options are graphically illustrated in **Figure 12**.

Figure 12 Overview of the main activities of the three options



Method of transfer of data

HDV CO_2 monitoring takes place via the transfer of VECTO data (up to 500 data points) from OEMs to the reporting authority. It can be done in different ways:

- as part of the vehicle CoC or type approval document (PDF) used for registration (Option 1);
- as part of the a standardised XML file (IVI message file) that can replace the current CoC and type approval documents (Option 1);
- as an additional file (XML) that can either be added to the current registration documents (Option 1) or can be handed over directly by OEMs to European authorities (Option 2/3).

The use of paper documents would be an expensive option as illustrated by TNO (2015). It is not supported by both Member States and OEMs and therefore not analysed in this report.

Many countries are digitalising their processes of registration, but the degree of digitalisation varies and digitalisation processes are not harmonized. From a technical point of view it would be possible to use the IVI message file that is developed by EReg. However, current digitalisation efforts are hardly based on this file. It is therefore unrealistic to assume that the registration process will be based on an extended IVI message file. It is rather expected that HDV CO_2 registration will occur:

- By the use of one harmonized XML file.
- Or by amendment and expansion of the existing and upcoming digital national registration processes. This would imply that OEMs and national registration authorities have to agree on the file structure.

Member States' and OEMs' perspectives

Option 3 was favoured by six out of twelve Member States, Option 1 was preferred by four Member States and two Member States have no preference. The most important argument for Option 3 is that it will put less burden on MS and requires no extra investments to IT systems (vehicle registration).

The main argument made for MS monitoring was related to data credibility and parallels to the current light-duty vehicle monitoring, which is also performed by Member States.

According to OEMs, standardised electronic formats (XML) need to be used to collect CO_2 data from VECTO. They should be compatible with database systems. It is, however, unlikely that Member States will have introduced sufficiently harmonized electronic data handling and registration procedures before 2018. This implies that OEMs would need to send the files to each of the national registration authorities, with the risk of deviating data formats. This is currently the case with digital registration.

Option 1 imposes a high burden on OEMs; Option 3 is their unanimously preferred solution. Option 2 is rejected since it does not allow monitoring national developments. The following arguments were mentioned favouring Option 3:

- this option allows monitoring of CO_2 values on MS level;
- this option reduces the risk of errors;
- reporting could be done using yearly intervals;
- this option could be implemented at lower costs compared to Option 1.

Costs of the monitoring options

The overall cost estimate consists of the sum of costs identified for the various actors and is quantified for 28 Member States and 7 OEMs. Figure 13 provides an overview the one-off transition costs, annually recurring costs and the total annualised costs.

Figure 13 Comprehensive total annualised costs of monitoring and reporting options

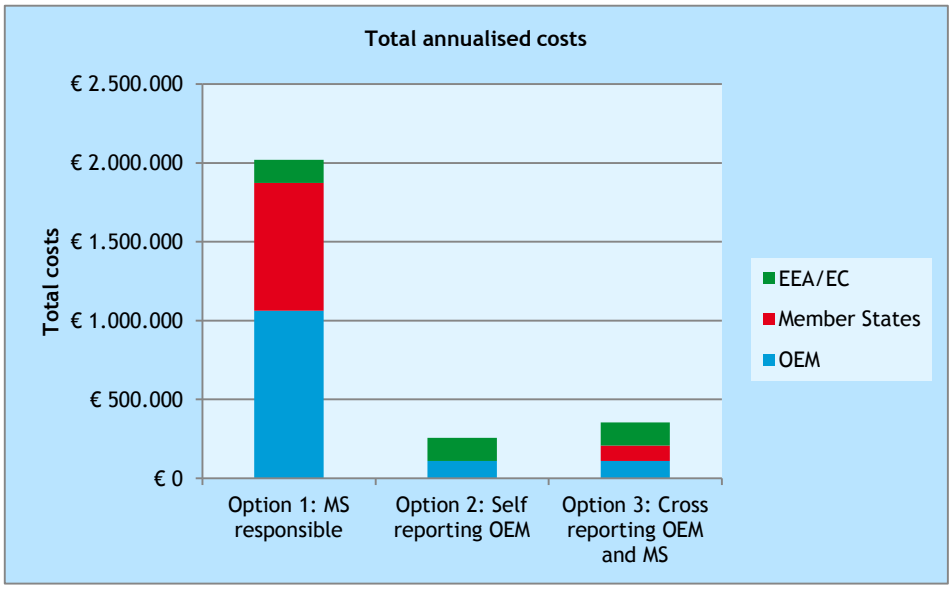


Figure 13 shows that the costs of Option 1 are the highest, representing:

- the high transition costs for Member States and the high annual costs as a result of the development or adaption of databases and IT systems.
- the high annual costs for OEMs that are linked to the transfer of VECTO data to registration authorities.

Monitoring costs are between 1 (option 3) and 5 Euro (option 1) per vehicle registered in the EU.

Recommendations

Since the use of a harmonized file by all national registration authorities would reduce the costs of reporting, it makes sense to install a working group were EReg members and OEMs agree on the data transfer procedures. This is especially relevant in the context of Option 1.

For Option 2 and 3, we recommend that digital signing of monitoring data at the vehicle level is explored. In order to prevent any discussion about the credibility of the monitoring data, this data should be 'secured' by type approval authorities in such a way that EEA can see if the data has been changed after securisation by the TAA. Digital signing is already used by the Dutch registration authority (exchange of digital CoCs).

Overview of cost estimations for MS of Monitoring Option 1

Table 16 Overview of cost estimations for MS of Monitoring Option 1

MS	Vehicle	1: Various registration procedures in Europe; harmonised VECTO output in separate file or added to IVI file		Description
		Transition costs	Annual costs	
Croatia	HDV	€ 0	€ 4,800	Estimation of transition costs to be negligible based on the interview. Estimation of annual costs based on 20 working days per year from interview.
Denmark	HDV	N/a	€ 12,531	Estimation of transition costs could not be made, and was estimated at € 90,000 in accordance with the estimated transition costs of Sweden and Finland.
				Estimation of annual costs are derived from the interview, based on 5-10 working days per year and 80,000 DKR for consultants and system adaptions.
Germany	HDV	€ 75,000-250,000	€ 60,000	Estimation of transition costs based on estimation from the interview, where € 250k refers to the initial implementation of M1 monitoring and € 75k refers to the elaboration of the monitoring system to M1+N1 monitoring. Transition costs for HDV monitoring depend on the degree of extra activities and IT investments needed.
				Estimation of annual costs based on one extra full time employee per year from interview.
Greece	N1	N/a	€ 15,000	Estimation of transition costs could not be made, and therefore was estimated at € 50,000 in accordance with the estimated transition costs in Italy.
				Estimation of annual costs based on 3 person months per year as was stated in the interview to be about 3 person-months per year (including IT support) for vans. Annual costs for option 3 (cross-reporting) were estimated at 1 person-month.
France	HDV	€ 45,000	€ 15,000	Estimation of transition costs based on 1,500 hours estimated in the interview.
				Estimation of annual costs based on 500 hours per year for M1+N1 vehicles from interview.
Finland	HDV	€ 100,000	€ 2,400	Estimation of transition costs of € 100,000 from the interview.
				Estimation of annual costs based on 10 working days per year from interview.
Italy	HDV	€ 50,000	€ 7,200	Transition costs were estimated (based on contact with the ICT provider) at € 50,000.
				Estimation of annual costs based on 30 working days per year from interview, which is an increase of 1/3 compared to current annual costs for M1+N1 vehicles.
Netherlands	HDV	€ 45,000	€ 1,500	Estimation of implementation costs based on 1,500 hours from interview.
				Estimation of annual costs based on 50 hours per year from interview.
Slovakia	HDV	N/a	€ 2,160	Estimation of transition costs could not be made, and therefore was estimated at € 50,000 in accordance with the estimated transition costs in Italy.
				Estimation of annual costs based on 4 controls of 1 working day and 1 week reporting per year from interview.

MS	Vehicle	1: Various registration procedures in Europe; harmonised VECTO output in separate file or added to IVI file		Description
		Transition costs	Annual costs	
Spain	HDV	€ 87,500	€ 36,000	The transition costs were estimated at about 75-100 k based on the interview. The registration processes have to be modified in order to fulfil the information required.
				Estimation of annual costs based on 150 man days per year from interview (which means that 3 people will be working for three weeks a year).
Sweden	HDV	€ 60,000	€ 6,000	Estimation of implementation costs based on 2,000 hours from interview.
				Estimation of annual costs based on 200 hours per year from interview.
UK	HDV	N/a	€ 16,474	No estimation was provided on the implementation costs, however in the interview the transition costs for M1+N1 vehicles were estimated to be one of the highest in the EU. Therefore we have taken the highest transition costs from other interviews: € 100,000.
				Estimation of annual costs based on 1 month per year for statistics and reporting from interview, and a 10% increase of work for paper registrations.
				Unfortunately, the estimations could not me affirmed.
Belgium	N1	N/a	€ 9,000	Estimation of transition costs could not be made, and was estimated at 1,500 hours in accordance with the estimated transition costs in the Netherlands, France.
				Estimation of annual costs based on 300 hours per year which was reported in EReg (2011).

Rate of digitalised registrations

The rate of digitalised registration was based on Table 17.

Table 17 Rate of digitalised registration (used for cost estimations of MS that were not interviewed)

Member State	HDV registrations (ACEA, 2011)	Rate of digitalised registration
Croatia	1,500	Cost estimation from interview
Denmark	3,658	Cost estimation from interview
Finland	3,430	Cost estimation from interview
France	49,366	Cost estimation from interview
Germany	96,161	Cost estimation from interview
Greece	547	Cost estimation from interview
Italy	20,747	Cost estimation from interview
Netherlands	12,854	Cost estimation from interview
Slovakia	3,691	Cost estimation from interview
Spain	16,300	Cost estimation from interview
Sweden	6,060	Cost estimation from interview
United Kingdom	41,125	Cost estimation from interview
Belgium	10,281	Cost estimation from literature
Austria	7,345	High
Bulgaria	5,000	Unknown (low is assumed)
Cyprus	200	Unknown (low is assumed)
Czech Republic	7,629	High
Estonia	746	Unknown (low is assumed)
Hungary	4,301	Low
Ireland	1,497	Unknown (low is assumed)
Latvia	1,390	Unknown (low is assumed)
Lithuania	2,762	Low
Luxembourg	1,337	Unknown (low is assumed)
Malta	50	Unknown (low is assumed)
Poland	17,105	Unknown (low is assumed)
Portugal	2,630	Unknown (low is assumed)
Romania	2,081	Low
Slovenia	1,382	High

Comparison of this study with the TNO study

This study builds on the work that was done by TNO et al. (2015)[93], which also provided a cost estimation on the monitoring and reporting options.
The monitoring options in the TNO study were defined as sub-options from the baseline, and each sub-option had another focus:

[93] TNO, 2015. R10150 Final report, Cost-benefit analysis of options for certification, validation, monitoring and reporting of heavy-duty vehicle fuel consumption and CO_2 emissions.

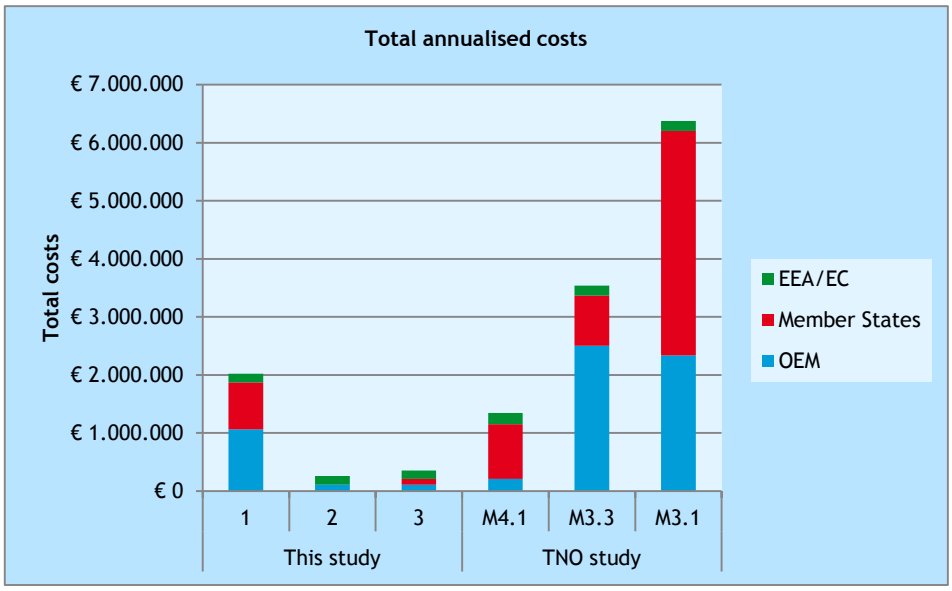
1. Baseline.
2. Sub options regarding quantity and subject of data.
3. Sub options regarding responsibilities for data collection and reporting.
4. Sub options regarding modernisation of the system.

Since this study does not make a cost assessment for reporting on non-digitalised data, comparison can only be made limitedly. We compared options M4.1, M3.3 and M3.1 with Option 1, 2 and 3 in this report respectively.

Table 18 **Comparison between monitoring options in TNO study and this study**

Option	Comparable option TNO study
Option 1: MS responsible, digitalised reporting	M4.1: Fully digitalised system (paperless via digital forms), MS responsible.
Option 2: OEM responsible	M3.3: Vehicle OEM self-monitoring (non-digital data transfer)
Option 3: Ross reporting of MS and OEM	M3.1: Hybrid monitoring (MS + Vehicle OEM) (non-digital data transfer)

Figure 14 **Total annualised costs of HDV monitoring options in both studies**



A fair comparison for Options 2 and 3 and the TNO options is not possible because of different assumptions on boundary conditions. The main differences are:

- All options in the TNO study besides option M4.1 and M4.2 assume paper data transfer, while in this study we have concluded that paper registration of VECTO is not feasible. Therefore the annual costs for OEMs in M3.3 and M3.1 and the annual costs for Member States in option M3.1 are very high in their assessment.
- For option 1 the transition costs for both OEMs and Member States have been estimated higher in this study. The main reasons are the implementation costs that were estimated in this study for communication and aligning between OEMs and Member States on the registration procedures.
- The annual costs for Member States are similar in both cost assessments.

– The annual costs for OEMs in Option 1 were estimated to be higher in this study. The explanation is that in the TNO study it was assumed that the registration would be to a high level automatized, while we have assumed a 5 min./vehicle extra work due to VECTO data transfer.

In conclusion, the monitoring options can hardly be compared with each other in a consistent way, mainly because of the different assumptions concerning paper registration. For Option 1 a comparison was possible and the costs were estimated higher in this study, due to additional work needed for the registration of vehicles in monitoring Option 1.