



Monitoring heavy-duty vehicles' CO₂ emissions and their costs

An assessment



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This report is prepared by:
Eelco den Boer, Maarten 't Hoen (CE Delft)
Stefan Hausberger (TU Graz)

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

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* 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	Heavy 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 CO₂ 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 CO₂ emissions in Europe. This strategy focusses on short term actions to certify, monitor and report HDV fuel consumption and CO₂ emissions.

The upcoming HDV CO₂ 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 CO₂ 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 CO₂ 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 cons². 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 CO₂ 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' CO₂ 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 CO₂ 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 EReg³, 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 CO₂ 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 CO₂ 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.

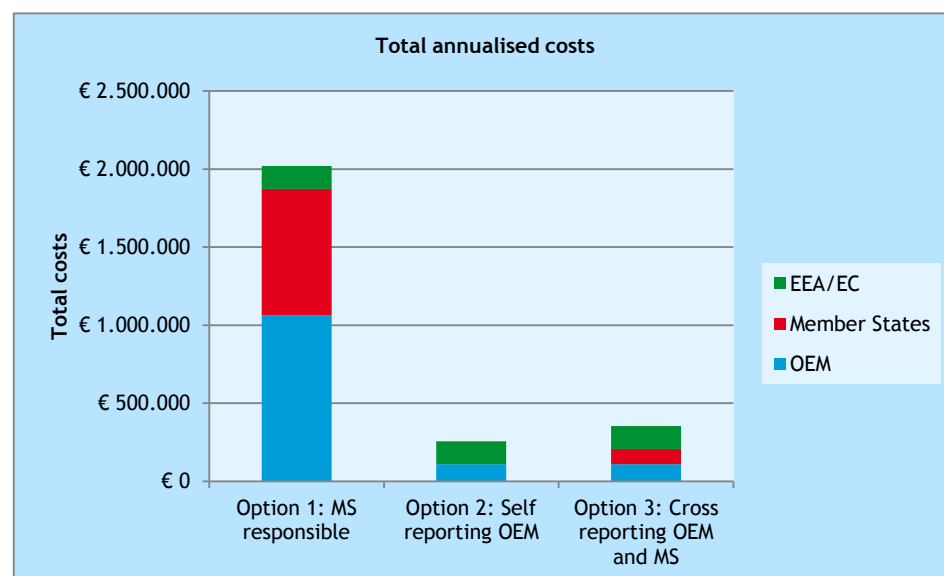
Multi stage vehicles

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

	Glossary	2
	Abstract	3
	Summary	4
1	Introduction	9
1.1	Background	9
1.2	Project objective and scope	10
1.3	Research structure	11
1.4	Research methodology	12
1.5	Report structure	13
2	Assessment of HDV monitoring options	14
2.1	Introduction	14
2.2	Vans (N1 vehicle) registration and monitoring	14
2.3	Current practice of heavy-duty vehicle type approval and registration in EU Member States	17
2.4	Monitoring options for HDVs	20
2.5	Member States' perspective	22
2.6	OEMs' perspective	27
2.7	Conclusion	30
3	Assessment of monitoring activities and costs	33
3.1	Introduction	33
3.2	Definition of cost methodology	33
3.3	Costs per actor	35
3.4	Overall costs for the various monitoring options	43
4	Conclusions	46
4.1	Options for monitoring actors	46
4.2	Method of transfer of data	47
4.3	Member States' and OEMs' perspectives	47
4.4	Costs of the monitoring options	48
4.5	Recommendations	48
Annex A	Overview of cost estimations for MS of Monitoring Option 1	49
Annex B	Rate of digitalised registrations	52
Annex C	Comparison of this study with the TNO study	53



1 Introduction

1.1 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 CO₂ emissions in Europe. This strategy focusses on short term actions to certify, monitor and report HDV fuel consumption and CO₂ emissions. This will require legislation on certifying, monitoring and reporting these emissions.

The upcoming HDV CO₂ 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 CO₂ 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 CO₂ 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.

1.2 Project objective and scope

The objective of the project is twofold:

- to better understand the various options for monitoring HDV CO₂ 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 CO₂ emissions per CO₂ 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 CO₂ values of the generic configuration. Subsequently, the CO₂ 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 CO₂ 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 CO₂ 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.

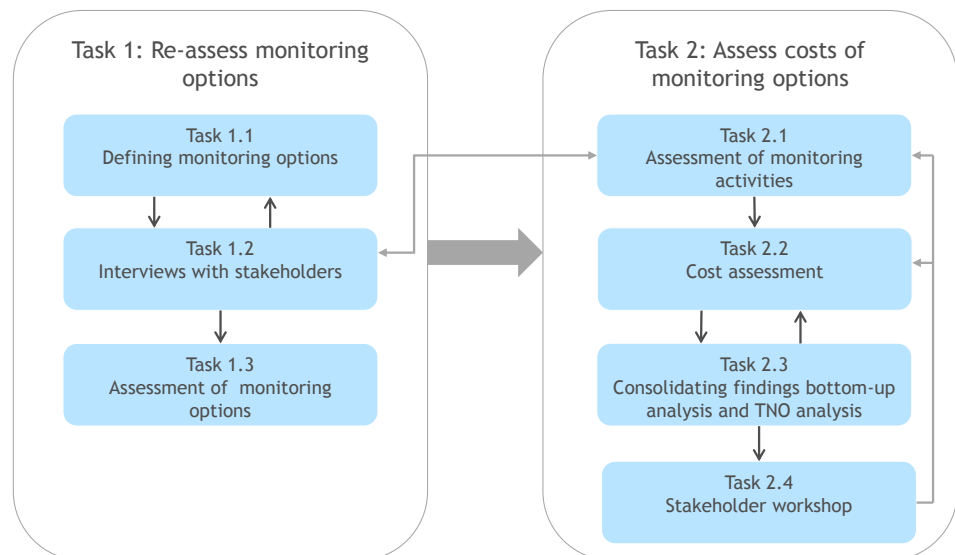
1.3 Research structure

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 CO₂ 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 CO₂ 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.

1.4 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 CO₂ certification and monitoring and have not started analysing the requirements for HDV CO₂ 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

1.5 Report structure

In Chapter 2, the concept of vehicle CO₂ monitoring is introduced with N1 vehicles (vans) as a reference. Subsequently, three monitoring options are identified and assessed. Chapter 3 covers a cost assessment of the various options. In Chapter 4, the main conclusions are drawn.

2 Assessment of HDV monitoring options

2.1 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.

2.2 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.

2.2.1 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.

2.2.2 N1 vehicle monitoring

Since 2012, N1 vehicle CO₂ 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 OEMs⁷);
- manufacturer name;
- type approval number;
- type, variant, version, make, commercial name;
- specific emissions of CO₂;
- 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:

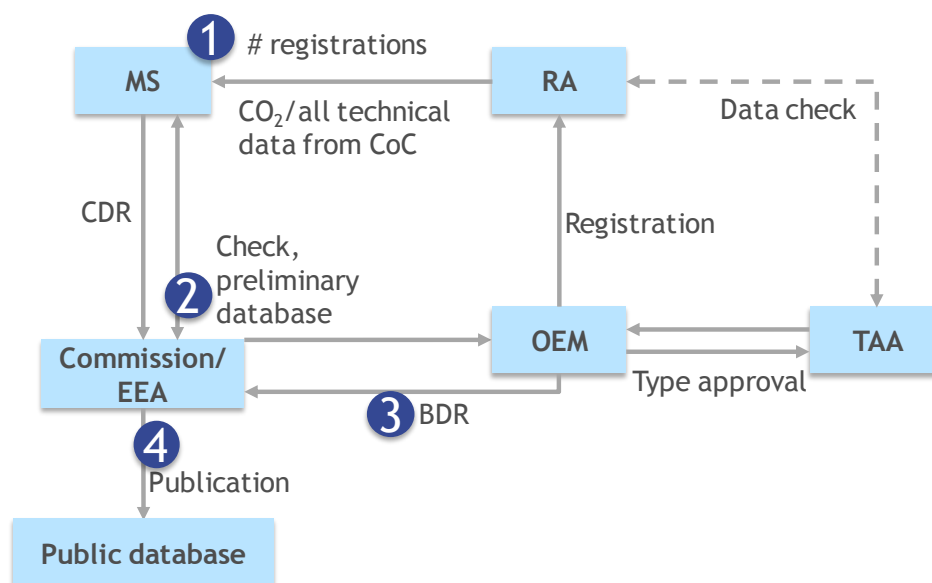
1. Member States record information for each new van registered in their territory and transmit this information to the Commission. Data are submitted to the Central Data Repository (CDR) managed by the EEA (<http://cdr.eionet.europa.eu/>). At the same time manufacturers submit a list of VINs and possibly 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 CO₂ 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 CO₂ 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.

2.2.3 Source of monitoring data

The documents used for vehicle monitoring also differ among Member States. Some countries use registration data for CO₂ 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 process⁸ 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.

2.2.4 EReg⁹ digitalisation efforts

In the context of Directive 2009/443 registration authorities have made significant efforts to implement CO₂ monitoring in the period 2009-2010. At that time, countries did not have a complete registration of the required characteristics.

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.

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 message¹⁰, can be used for the purpose of CO₂ 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/manufacture 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.

2.3 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.

¹⁰ www.ereg-association.eu/documents/subjects.php#



2.3.1 Type approval procedures for HDV in EU Member States

HDVs can be type approved by means of three methods: ECWVTA, NSSTA and IVA¹¹. 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 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/NS (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).

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



2.3.2 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, distributor 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 countries 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 2.2.4).

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 <i>paper</i> for registration (WVTA)	MS uses CoC <i>XML file</i> 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

2.4 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 CO₂ 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 points¹² will be monitored, which are direct inputs and outputs of the VECTO tool.

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

Member States gather HDV CO₂ 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 2.2.2). 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 CO₂ 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 CO₂ 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

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

view of the heterogeneous situation in Member States with regard to digitalisation (see Section 2.5).

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.

2.4.2 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 CO₂ 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.

2.4.3 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.

2.5 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.

2.5.1 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
<ul style="list-style-type: none"> – 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 CO₂ emission dispersion across different MS. 	<ul style="list-style-type: none"> – 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 CO₂ monitoring data. Amongst others, all vehicle type approval data and registration data in the EU should be added to such a database, including the CO₂ 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 CO₂ monitoring, is specifically mentioned in the context of CO₂ monitoring, and preferred by some registration authorities.

At the moment, EUCARIS¹⁴ 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/



2.5.2 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
<ul style="list-style-type: none">– 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.	<ul style="list-style-type: none">– 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.– CO₂ 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.

2.5.3 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
<ul style="list-style-type: none"> – 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. 	<ul style="list-style-type: none"> – 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. – CO₂ 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.

2.5.4 CO₂ 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 CO₂ 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 CO₂ 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 CO₂ 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 CO₂ values will become an important concern, meaning that policy makers need to have access to methods and input data. Another country stressed that CO₂ values simulated by OEM with some default factors behind the process may not be representative enough for application in national policy instruments.

2.6 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	

2.6.1 General aspects

ACEAs position is that the following aspects should be considered when identifying the suitable option for CO₂ 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 CO₂ in XML format is preferred. Adding CO₂ information in a paper CoC is not reasonable and adds a lot of work.
- Again another OEM stated that adding CO₂ 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 CO₂, the process certificate would ensure that OEMs have procedures in place to properly declare CO₂ for the vehicles. The VECTO files and specific CO₂ data values per vehicle will not be included in the CO₂ certificate(s), and are therefore not relevant for TAA storage. If wanted, the Member States could gain access to the specific CO₂ 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.

2.6.2 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 CO₂ 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
<ul style="list-style-type: none"> – MS can provide correct information on the registered vehicles, such as: <ul style="list-style-type: none"> • 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. 	<ul style="list-style-type: none"> – 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.

2.6.3 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.

2.6.4 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
<ul style="list-style-type: none"> – 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. 	<ul style="list-style-type: none"> – MS may not have access to the CO₂ 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 CO₂ 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 CO₂ 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.

2.7 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 CO₂ 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 CO₂ 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 CO₂ 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 CO₂ results are produced on the production line.

This means that a link of CO₂ 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 CO₂ values (representing approximately 40% of the market) can also be included in the monitoring system if default values are used. CO₂ data provided by VECTO only covers generic norm bodies and trailers. It will not represent the absolute CO₂ 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.



3 Assessment of monitoring activities and costs

3.1 Introduction

In this chapter the costs of monitoring HDV CO₂ 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.

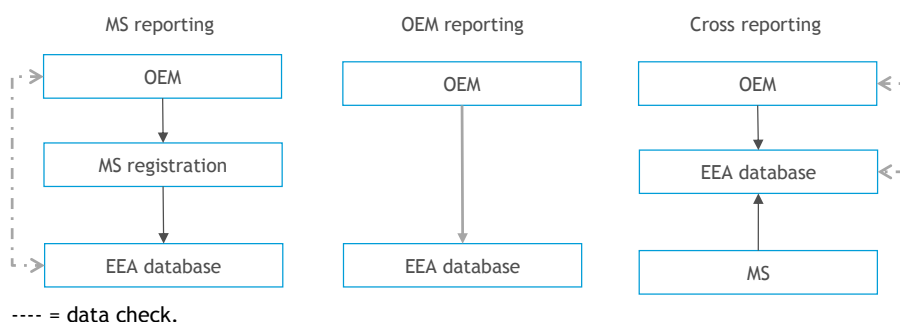
3.2 Definition of cost methodology

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



3.2.1 Description of activities

Option 1

HDV CO₂ 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 CO₂ 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 CO₂ 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 EEA's 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 CO₂ 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 CO₂ monitoring data from OEMs on the basis of these VIN numbers. OEMs forward the data to the EEA as described under Option 2.

3.2.2 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

3.2.3 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%).

3.3 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.



3.3.1 Member States

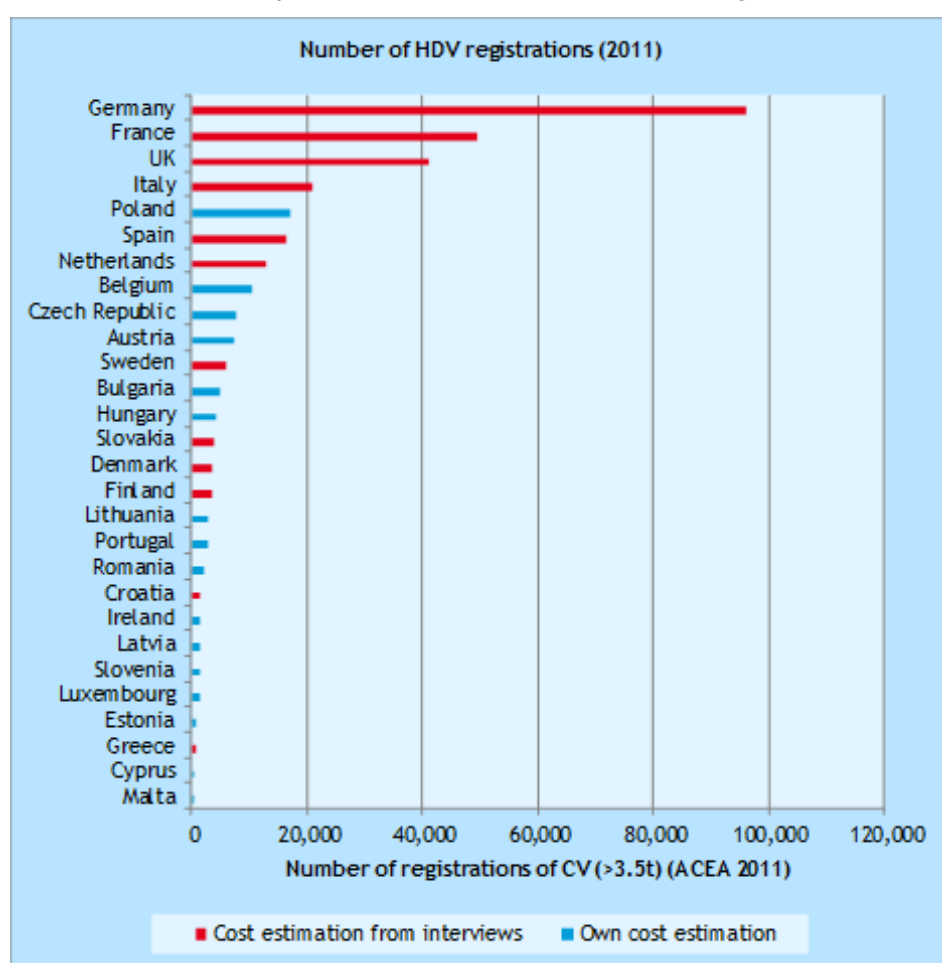
The costs for Member States differ strongly. Some Member States already have an advanced system of digitalised registration and are using or preparing the electronic CoC, while others (partly) use paperwork.

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 CO₂ 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).

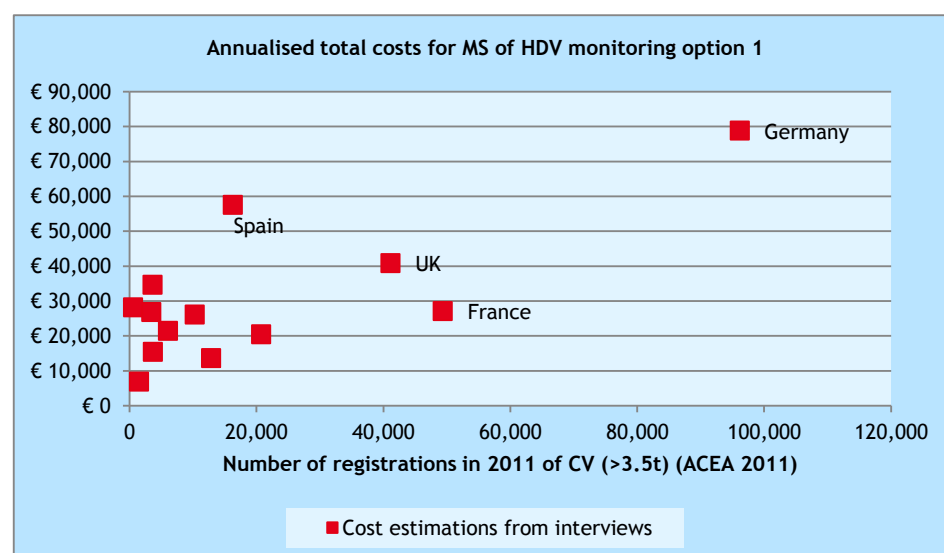
¹⁶ EReg Topic Group IX on CO₂ Data Monitoring, final report, 07 April 2011.

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

- Transition costs:
 - database investment and development costs, summarised in Annex A;
 - 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 Annex A.

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 Annex B 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

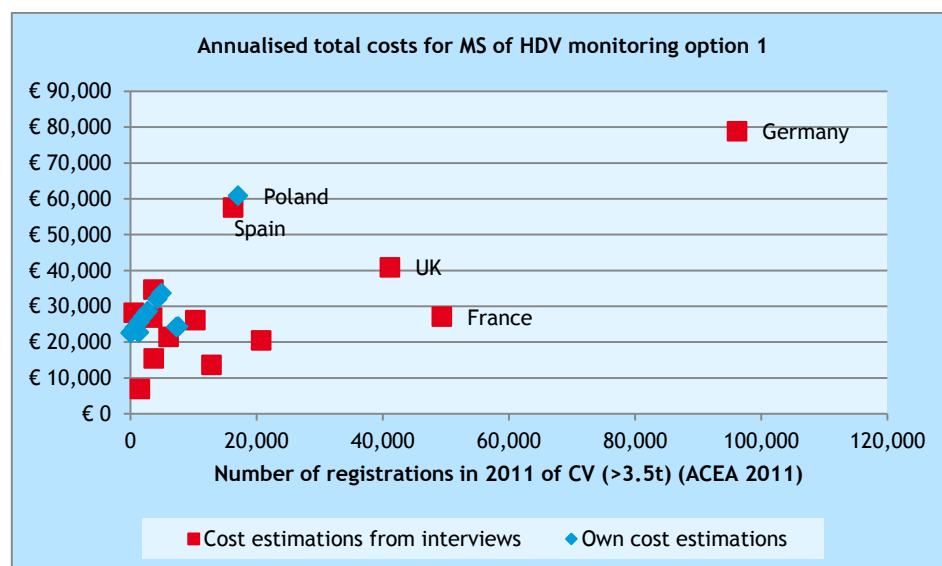
Cost component	Sub-component description	Low rate of digitalisation	High rate of digitalisation
Transition costs	Implementation costs	It was assumed that all MS will need € 16,500 to implement the new monitoring system (non-technical investments).	
	Database development/ IT investments	This depends on 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 CO₂ 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.

3.3.2 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 CO₂ 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 CO₂ 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 CO₂ 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/h¹⁷).

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 distributor/dealer.

Option 2 and 3 - Annual costs for all OEMs

In these scenario's, OEMs are responsible for transferring VECTO 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 CO₂ 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.

¹⁷ This equals approximately € 60,000 per year and includes social charges, pension and overhead.



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.

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

3.3.3 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

3.4 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

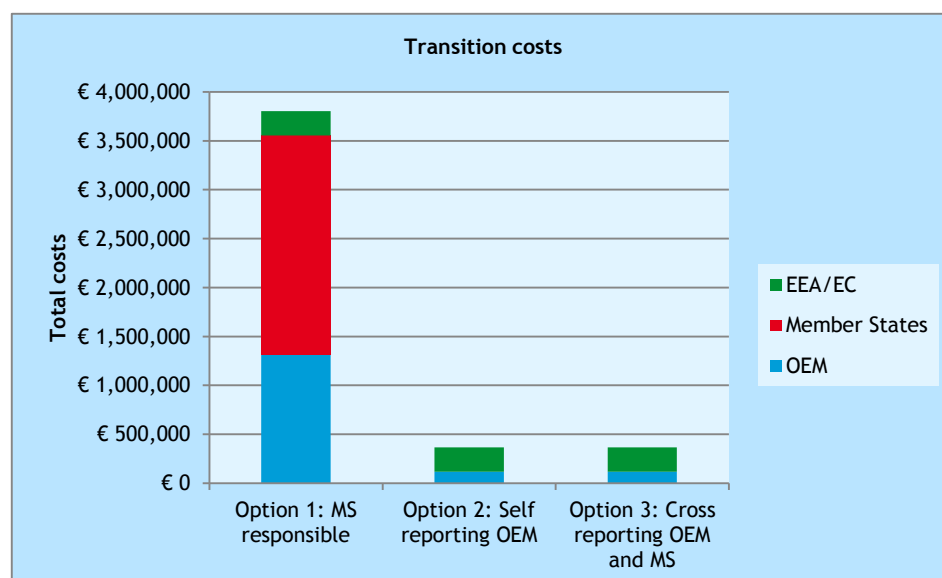


Figure 10 Comprehensive annual costs of monitoring and reporting options

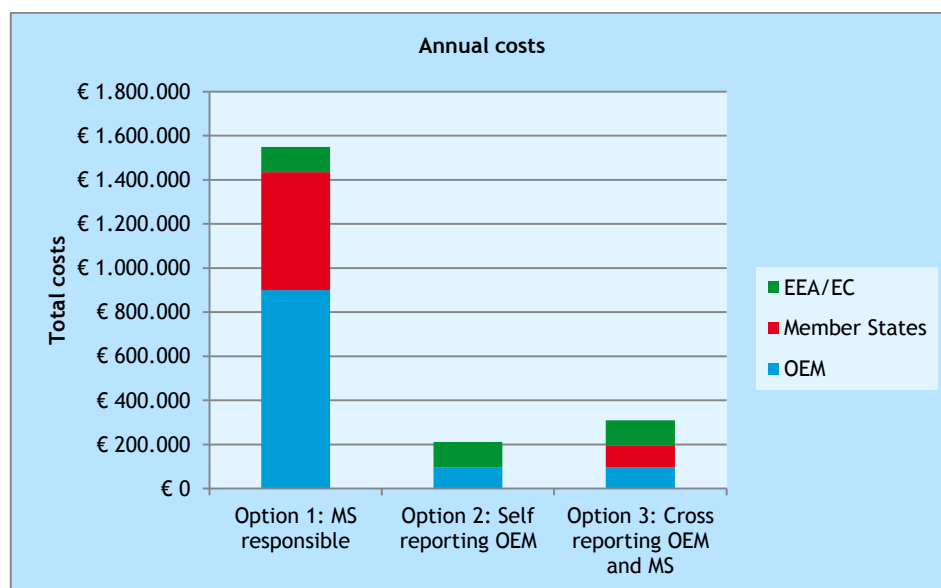
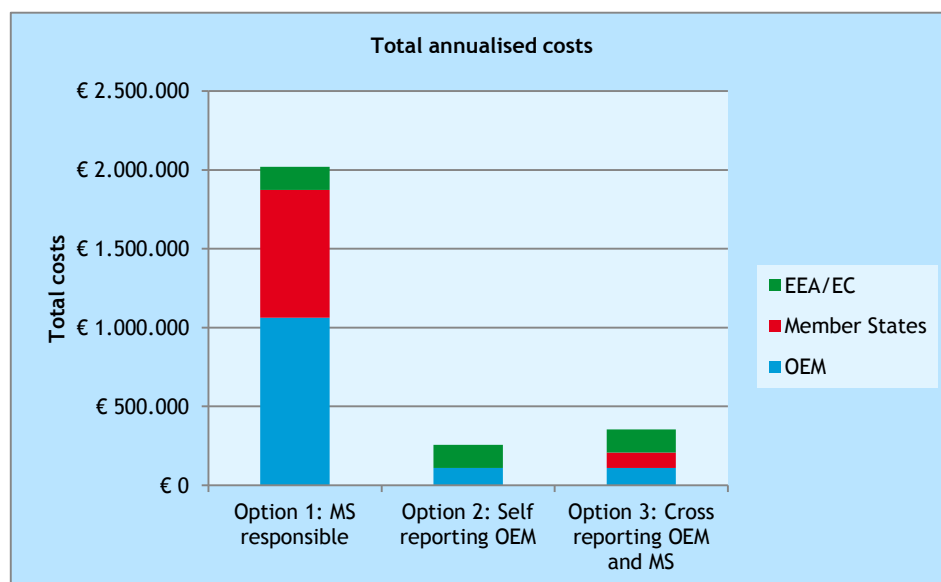


Figure 11 Comprehensive total annualised costs of monitoring and reporting options



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 Annex C 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 CO₂ emissions.



4 Conclusions

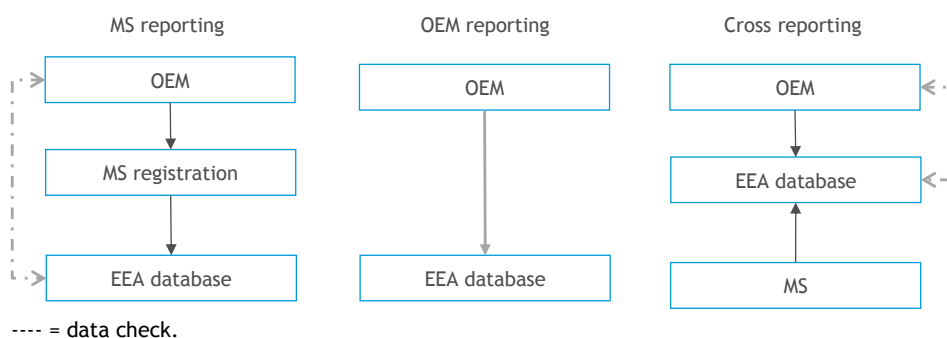
4.1 Options for monitoring actors

This report discusses the options for transferring HDV CO₂ 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' CO₂ 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



4.2 Method of transfer of data

HDV CO₂ 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 CO₂ 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.

4.3 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 CO₂ 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 CO₂ 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.

4.4 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

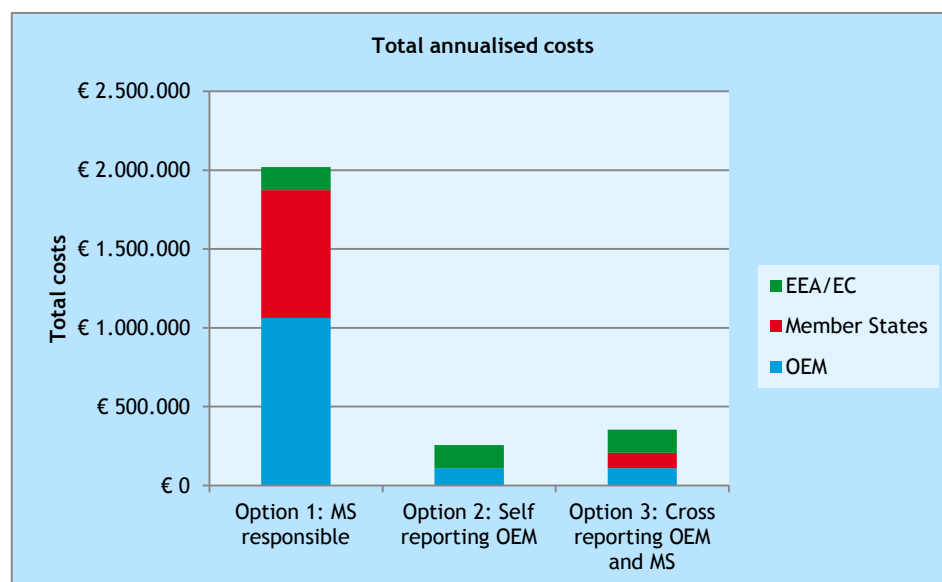


Figure 13 shows that the costs of Option 1 are the highest, representing:

- 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.

4.5 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).

Annex A 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 adaptations.
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 be 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).

Annex B 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



Annex C Comparison of this study with the TNO study

This study builds on the work that was done by TNO et al. (2015)¹⁹, 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:

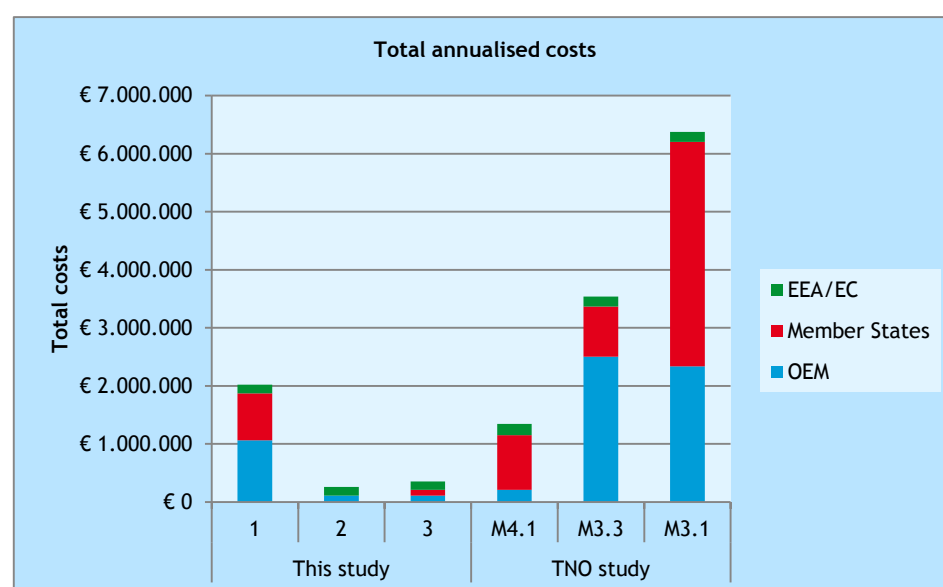
1. Baseline.
2. Sub options regarding quantity and subject of data.
3. Sub options regarding responsibilities for data collection and reporting.
4. Sub options regarding modernisation of the system.

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



¹⁹ TNO, 2015. R10150 Final report, Cost-benefit analysis of options for certification, validation, monitoring and reporting of heavy-duty vehicle fuel consumption and CO₂ emissions.

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.