Workshop input paper

Evaluation study on Speed Limitation Devices

SPECIFIC CONTRACT MOVE/A3/350-2010 IMPACT ASSESSMENTS AND EVALUATIONS (EX-ANTE, INTERMEDIATE AND EX-POST) IN THE FIELD OF THE TRANSPORT

Ex-post evaluation of Directive 92/6/EEC on the installation and use of speed limitation devices for certain categories of motor vehicles in the Community, as amended by Directive 2002/85/EC

European Commission
Directorate-general for Mobility and Transport
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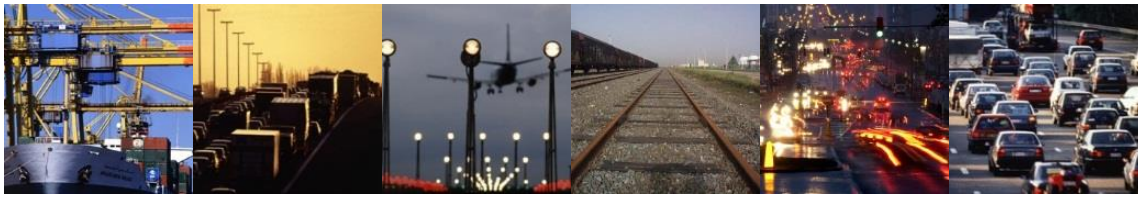

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Glossary

Average speed	This is the average speed of the traffic flow or an individual
HCV	Heavy Commercial Vehicles covering HGVs and buses as laid down in the Speed Limitation Directive. Refers to vehicle categories N2/N3 and M2/M3
HGV	Heavy Goods Vehicle, refers to vehicle categories N2 and N3
ISA	Intelligent Speed Assistance/Adaptation
LCV	Light Commercial Vehicle, refers to the vehicle category N1 and M1 that are commercially used
LGV	Light Goods Vehicle, refers to vehicle category N1
Speed Limitation Directive	Directive 92/6/EEC on the installation and use of speed limitation devices for certain categories of motor vehicles in the Community, as amended by Directive 2002/85/EC
Speed deviation	Statistical measure for the speed dispersion (standard deviation of speed)
Speed dispersion	Measure for the differences in speeds between individual vehicles that are part of the traffic flow or the variation in speeds for all vehicles over a road segment
Speed distribution	The arrangement of speeds driven according to their frequency of occurrence on the road
Speed profile	The variation in speed over time of a specific vehicle

Vehicle categories

Category M1	Vehicles designed and constructed for the carriage of passengers and comprising no more than eight seats in addition to the driver's seat
Category M2	Vehicles designed and constructed for the carriage of passengers, comprising more than eight seats in addition to the driver's seat, and having a maximum mass not exceeding 5 tonnes.
Category M3	Vehicles designed and constructed for the carriage of passengers, comprising more than eight seats in addition to the driver's seat, and having a maximum mass exceeding 5 tonnes.
Category N1	Vehicles designed and constructed for the carriage of goods and having a maximum mass not exceeding 3.5 tonnes.

Category N2	Vehicles designed and constructed for the carriage of goods and having a maximum mass exceeding 3.5 tonnes but not exceeding 12 tonnes.
Category N3	Vehicles designed and constructed for the carriage of goods and having a maximum mass exceeding 12 tonnes.

1 Project overview

1.1 Background

Limiting the vehicle speed of road vehicles by installing speed limitation devices constitutes an important measure to improve road safety, especially on motorways, and to reduce greenhouse gas emissions, pollutant emissions and traffic noise.

The first stage of an EU legislation on speed limitation devices was set by Directive 92/6/EEC which required speed limitation devices to be installed on N3 vehicles (heavy goods vehicles – HGVs - with maximum mass above 12 tonnes) and on M3 vehicles (buses) above 10 tonnes. In 2002, this Directive was amended by Directive 2002/85/EC, which obliged also N2 vehicles (smaller HGVs with maximum mass between 3.5 and 12 tonnes) and M3 vehicles (buses with more than eight seats + the driver's one with maximum mass exceeding 5 tonnes) to be equipped with speed limiters. Directive 2002/85/EC also requires the Commission to assess the road safety and traffic impacts of adjusting the speed limitation devices used by category M2 vehicles and by category N2 vehicles of 7.5 tonnes or less to the speeds laid down by the Directive.

In this context, the European Commission commissioned Transport and Mobility Leuven, CE Delft, TRT and TNO[1] to carry out an evaluation study on this topic. The results of this study will be used to decide whether a proposal for amendment is needed and if so, what type of amendment would be needed. Within this study, a stakeholder workshop will take place on June 10th. This paper is meant as input to this workshop.

1.2 Aim and scope of the study

The overall objective of the study is to assist the European Commission with the ex-post evaluation of Directive 92/6/EEC on the installation and use of speed limitation devices for certain categories of motor vehicles in the Community, as amended by Directive 2002/85/EC ("Speed Limitation" Directive) and to explore and assess options for revising the Directive (ex-ante evaluation). More specifically, the objectives of the study are:

1) To carry out an ex-post evaluation of the application of the Speed Limitation Directive.

2) To assess whether and how the Speed Limitation Directive could be amended to improve its effectiveness and efficiency.

The second objective includes assessment of options for changing the maximum speed applied for Heavy Commercial Vehicles (HCVs), extending the scope of the Directive to Light Commercial Vehicles (LCVs) and/or by application of various types of Intelligent Speed Assistance/Adaptation (ISA) systems for HCVs or LCVs.

[1] The study is carried out within the Framework Contract MOVE/A3/350-2010 Impact Assessments and Evaluations (Ex-Ante, Intermediate and Ex-Post) in the Field of the Transport.

1.3 Structure of this paper

This paper is structured as follows. In chapter 2, the methodology for the study is summarized. In chapter 3, the intermediate draft results of the ex-post evaluation are presented. The scenarios for the ex-ante evaluations are presented in chapter 4.

The draft results of the survey that has been carried out, are summarized in Annex A.

2 Methodology

2.1 Overview of the approach

The project is carried out in the following five work packages:

- WP1: Member State survey
- WP2: Ex-post evaluation of the Speed Limitation Directive (covering only HCVs)
- WP3: Exploring and assessing options for amending the Directive with respect to HCVs
- WP4: Exploring and assessing options for extending the scope of the Directive with LCVs
- WP5: Synthesis and stakeholder consultation

The first step of the project was a survey among Member States and stakeholders. It was aimed at gathering available data for both the ex-post and ex-ante evaluation. Next the ex-post evaluation of the Speed Limitation Directive is carried out. Then two main directions into which the Directive could be amended are explored: modifying speed limits for vehicle categories currently under the scope of the Directive and/or enlarging the scope to include LCVs. Options for this are identified and assessed, including the option of introducing ISA systems.

In both the ex-post and ex-ante evaluations, a broad range of impacts are analysed:

1) Vehicle speeds (average speeds, speed distribution and speed profiles[2]).
2) Traffic safety (numbers of accidents, injured and fatalities).
3) Fuel consumption and emissions (CO_2, PM and NO_x emissions).
4) Market impacts (vehicle design; shifts between vehicle categories, e.g. between HCVs and LCVs; fraud; administrative burden; costs of compliance/enforcement, SMEs).

Table 1 summarizes the methodologies used for the assessment of the various types of impacts.

Table 1: Summary of the methodologies used for assessing the various impacts

Type of impact	Methodology	
	Ex-post evaluation	**Ex-ante evaluations**
Speed	Literature review of vehicle speeds and data from Member State survey Modelling (using speed data from literature)	Literature review of vehicle speeds and data from Member State survey Modelling (using speed data from literature)
Traffic safety	Time series analysis of road accident statistics Modelling (using speed data and speed-accidents relationships from literature)	Modelling (using speed data and speed-accidents relationships from literature) For ISA: data from literature on the relationship between ISA and traffic safety
Fuel consumption and emissions	Modelling (using speed data and the VERSIT+ -model for speed-emissions relationships)	Modelling (using speed data and the VERSIT+ -model for speed-emissions relationships) For ISA: modelling data complemented with data from literature on the relationship between ISA and emissions
Market impacts	Qualitative assessment (based on literature review and survey)	Qualitative assessment (based on literature review and survey)

[2] The speed distribution is the arrangement of speeds driven to their frequency of occurrence. In reality a normal distribution around the mean is often observed. The speed profile shows the variation in speed for an individual vehicle over time.

The evaluation of impacts starts with an analysis of the impacts on vehicle speeds. Based on this, the impacts on traffic safety and emissions are quantified by applying relationships between speed and accidents and between speed and emissions, respectively. For the ex-post analysis also a time series analysis has been carried out on the relevant accidents statistics. Market impacts are assessed in a qualitative way using relevant literature. The data availability on all types of impacts is scarce. Therefore it is not always possible to obtain the necessary data to precisely estimate the effects.

2.2 Survey and literature review

The purpose of the survey is to collect the required data for the research. This consists of relevant information in relation to:

1. the impacts of the Speed Limitation Directive (first objective of the study), and
2. their opinions on its possible amendment (second objective).

The results of the survey feed the analytical work of the ex-post and ex-ante evaluations. The survey was targeted to the responsible offices within the Member States government departments and relevant stakeholders. At present 15 governmental contacts (Austria, Bulgaria, Estonia, Finland, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Poland, Romania, Slovakia, UK) and 19 stakeholders have provided the filled questionnaire, although not all entirely completed.

2.3 Ex-post evaluation

The objective of WP2 is to carry out an ex-post evaluation of the Speed Limitation Directive. More specifically, the objective is to establish the main results and impacts related to road safety, the environment – including fuel consumption and CO_2 emissions – and the level playing field of the measures set out in the Directive. The assessment takes into account all categories of HCVs. The evaluation builds on the survey and on a literature review and includes evaluation of the various impacts listed in section 2.1. The various elements of the approach are described below.

Literature review

The literature review is based on desk research of various relevant reports, scientific articles, data sources and own work performed previously by the researchers. Some of the literature was suggested by the stakeholders, others were selected by the researchers. Additional queries for data were made via e-mail and phone, when appropriate.

Impacts on speeds

The main driver of most other impacts of speed limiters are the result of their impacts on speed, or more specifically on the average speed and the speed distribution (needed for assessing the safety impacts) and the speed profile (needed for assessing the emission impacts). Speed distributions with and without a speed limiter are determined. This is done by analysing information on actual speed distributions for various EU Member States. Next, appropriate speed profiles have been selected for which the average speeds and speed dispersions match well with these speed distributions.

It should be noted that data on speed distributions is scarce. For HCVs there is particularly very few data on speed distributions in cases without speed limiters. Therefore, extrapolation of available data is needed.

Impacts on traffic safety by time series analysis

The data analysis consists of a time series analysis in which the evolution over time of accidents with HCVs is analysed, taking into account the evolution in traffic. The source for the accident data is the CARE database, while the vehicle-kilometres are based on Eurostat data – but corrected for the number of vehicles travelling in a country rather than driven by HCVs registered in a country.

Ideally this analysis is performed by comparing the evolution in accidents before the implementation of the Speed Limitation Directive and after. Unfortunately, there is not a single date of implementations as older vehicles received more time for the implementation, N2/M2 vehicles were later included in the Directive than N3/M3 vehicles and countries accessing the European Union at a later stage only implemented the Directive in a later stage. Moreover, in the same period also other Directives (e.g. on driving and rest times and on the digital tachograph) and national actions which influenced traffic safety were put in place. These imply serious limitations of this top-down approach for quantifying the impacts of the Directive. Therefore also an alternative approach is used (see below).

Calculation of the impacts on traffic safety by using changes in vehicle speed

Safety impacts are also analysed by comparing the situation of today – with speed limiters – with a theoretical situation in which there are no speed limiters. Given the speed distributions with and without speed limiters, the effect on road safety is calculated using the well documented relationships between speed and accidents.

In the literature the following data on the relation between speed and accident risk has been found:

- Relationships between changes in the average traffic speed and the accident rates, injury rates and fatality rates. The formulas for this relationship have been developed by Nilsson (1982) and Elvik (2009).
- Relationship between the individual vehicle speed and the accident risk for that vehicle. The formula for this relationship has been developed by Kloeden (2001).
- Relationship between the accident rate and average speed and speed deviation. The formula for this relationship has been developed by Taylor (2000).

For the ex-post evaluation the relationships developed by Nilsson and Elvik and the information on the impact on average speed are used to calculate the effects on the number of fatal accidents and accidents with serious injuries. This is done on a country level as speed limits and the shares of different vehicle types in vehicle-km and accident rates all play a role in the calculations.

Calculation of the impacts on emissions

Given the speed profiles without and with (simulated) speed limiter, the effect on emissions and energy use on a vehicle level is calculated using TNO's vehicle emission model VERSIT+. With the relations between speed and speed profile on the one hand and energy use and emissions on the other, the impacts on country scale can then be estimated with the policy assessment model TREMOVE. As the emissions in the reference situation depend on vehicle type and road type, these parameters are taken into account.

Market impacts

The evaluation of the market impacts is limited to a qualitative assessment, based on literature and the results of the survey.

2.4 Ex-ante evaluation

The methodology for the ex-ante evaluation is for the larger part similar to the methodology used for the ex-post evaluation. The main difference is that for the ex-ante analysis, no time series analysis on accident data can be applied. Therefore, the analysis of safety impacts fully rely on the changes in speed distribution and the speed-accidents relationships, as also described in the previous section.

The speed impacts are assessed in a similar as done for the ex-post evaluation. However for the ex-ante evaluation different maximum speeds for the speed limiters of HCVs are assumed and in the ex-ante evaluation for LCVs also speed distributions for LCVs with and without speed limiters are developed for various road types.

Furthermore, in the ex-ante evaluation, also scenarios are analysed with ISA systems instead of a regular speed limiter. The impacts of these scenarios require a slightly different approach:

- The safety impacts of ISA systems are more complex than they are for a regular speed limiter. The formulas that are used for quantifying the safety impacts of regular speed limiters are not suitable for estimating the safety impacts of ISA. However, there are some studies available on the specific relationship between ISA and various types of accidents. A study performed within the PROSPER project (Carsten & Tate[3]) offers a clear overview. Table 2 shows the reduction in accident rates that can be expected with various types of ISA systems. These estimates provide a suitable basis to estimate the safety impacts.

Table 2 – Safety impacts of various types of ISA systems

System type	Type of speed limit	Best estimate of reduction of injury crashes	Best estimate of reduction of fatal and severe injury crashes	Best estimate of reduction of fatal crashes
Advisory	Fixed	10%	14%	18%
	Variable	10%	14%	19%
	Dynamic	13%	18%	24%
Driver select (voluntary)	Fixed	10%	15%	19%
	Variable	11%	16%	20%
	Dynamic	18%	26%	32%
Mandatory	Fixed	20%	29%	37%
	Variable	22%	31%	39%
	Dynamic	36%	48%	59%

- To estimate the emission impacts of the ISA scenarios, the approach for regular speed limiters needs some adaptation. ISA results in a change in the average speeds which can be modelled in a similar way as this is done for regular speed limiters. In addition the changes in speed dynamics can result in additional impacts. These will be estimated with evidence from literature on the size and direction of these additional impacts.

[3] Carsten, O.M.J., & Tate, F.N. (2005). Intelligent speed adaptation: accident savings and cost-benefit analysis. Accident Analysis and Prevention, 37, pp 407-416.

3 Draft results of the ex-post evaluation on HCVs

3.1 Introduction

In this chapter the preliminary results of the ex-post evaluation of the Speed Limitation Directive are summarized. First the main findings of the literature review are briefly described. In the next sections the main results of the impacts on speeds (section 3.3), traffic safety (section 3.4) and emissions (section 3.5) are discussed. The final section (3.6) focusses on the possible market impacts.

3.2 Literature review

The literature review focussed on:

- Previous assessment of imposing a speed limiter for HCV – both ex-ante and ex-post;
- Studies focussing on the main crash types of trucks;
- Studies assessing the effect of equipping N1 vehicles with speed limiters.

Previous assessments

Up to now, the European Commission has not made a quantitative evaluation or impact assessment of the Speed limitation Directive. Also no national assessments were found or reported in the survey. In a summary report[4] from the European Commission it was concluded that the implementation would lower fuel consumption (from 3 to 11%), lower maintenance costs (tires, brakes, engine), increase road safety (fewer casualties) and lead to a more relaxed driving experience and reduced insurance premiums. The main negative aspect reported was the problem of speed limited trucks overtaking each other over many km, causing a traffic back log.

Transport Canada (2008a) planned the implementation of speed limiters for HCVs and made an international assessment to document the experiences of three participating jurisdictions (the UK, Australia and Sweden) and studied the safety implications of mandating speed limiters for large trucks (weight >11,794 kg) using a microscopic traffic simulation model. The main conclusions from the international assessments were that no country had performed an assessment before implementation or an ex-post evaluation and that the effect could not be seen directly from the safety statistics. Compliance and enforcement issues are centred on the high incidence of tampering, problems with testing equipment and the lack of enforcement personnel. According to the survey, fraud was not seen as a major problem by the interviewees.

The results of the traffic simulations showed that the maximum safety gains were obtained when the speed was set at 90 km/h. The CTBSSP Synthesis 16 (2008) examines and summarizes literature and industry information relating to speed limiters by the use of a survey and a literature research. 44% responded that speed limiters were successful or very successful in reducing tire wear and increased fuel economy (76%). Their literature review confirmed that there is a paucity of

[4] Report from the Commission to the European Union Parliament and the Council on the implementation of Council Directive 92/6/EEC of 10 February 1992 on the Installation and the Use of Speed Limitation Devices for certain Categories of Motor Vehicles in the Community – as quoted in Transport Canada (2008)

relevant published research on how speed limiters affect driving behaviour, especially in terms of safety.

Accident studies on HCVs

The most important study on accidents with trucks remains the European Truck Accident Causation (ETAC) Study. This study aimed at identifying the main causes of the accidents involving trucks based on an in depth investigation of over 600 truck accidents. It did not make an assessment of the influence of the Speed Limitation Directive, but if gives an insight in the order of magnitude (%) of accidents which can be influenced by the Speed Limitation Directive. In the top 3 of the main accident causes a non-adapted speed ranks first. The TRL (2009) report analyses whether or not there is likely to be any road safety risk involved in increasing the speed limit of HGVs exceeding 7,5 tonnes on single carriageway de-restricted roads from 40 mph to 50 mph (or possibly 45 mph). It was estimated that only a small proportion of the accidents would be affected by changing the speed limit.

Speed limiters for LCVs

With respect to extending the Speed Limitation Directive towards LCVs two relevant studies were found. CE Delft (2010) investigated the impact on safety and emissions of extending the scope of the Directive with N1 vehicles (LGVs). The potential reduction of CO_2-emissions of a speed limiter for LGVs was estimated at about 4-5% for a speed limiter set at 110 km/h and at about 6-7% for a speed of 100 km/h. Overall, limiting the top speed of LGVs in the EU to 100 and 110 km/h would reduce fatalities by about 190 and 110 per year, respectively.

The European Parliament (2009) report describes the collation and analysis of a wide range of disparate European data on the safety of light goods vehicles (<3,5 tonnes). An important finding of this study is the fact that data availability on LGVs is severely limited as many different definitions are used and as many Member States did not collect information on this type of goods vehicles. They also quote the result of the IMPROVER project in which it was shown that speed limiters for LGVs were not considered economically viable. Referring the UK data in which in only 2% of the cases exceeding the speed limit was seen as a contributory factor[5], the study for the European Parliament also concludes that introducing speed limiters such as those mandatory for HGVs are expected to prevent only a small proportion of the aforementioned 2%, as speed limiters would be set at the maximum speed permitted on the fasted roads. ISA would have greater potential but also greater costs.

Overall it can be concluded that there are not many relevant assessments available. This was also reflected in the results of the questionnaire. On a more detailed level there is a lot of literature linking speed to emissions and safety. This literature is discussed in the main report of this project within in the relevant sections.

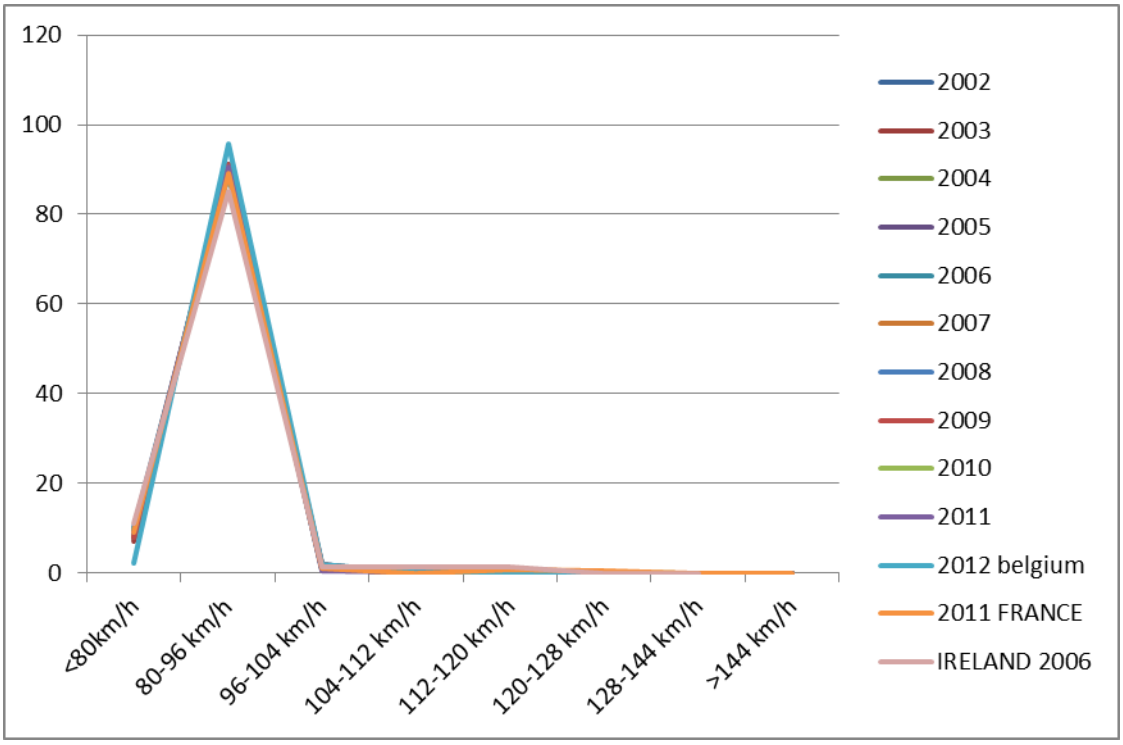
3.3 Impacts on speed

As explained previously, the main driver of the effects on safety and emission is through the change in speed and speed distribution. In order to determine the effect on the speed, an analysis was made of historical speed distributions. Only the UK has information on speed distributions, disaggregated according with respect to vehicle and road types over a long enough period. Unfortunately the

[5] Note that in 41% of the cases no contributory factor was attributed.

disaggregation with respect to speed classes is very rough. The figure below shows the speed distribution for the UK for the years 2002-2011 for the HGVs with 5 axles and the distribution for HGVs in France, Belgium and Ireland.

Figure 1: Distribution speed HGV- 5 axles UK and HGV Belgium, France, Ireland.



This graph seems to suggest that the speed limiter did not have an impact on the speed distribution, nor on the average speed. Hence, at the time of implementation, the Directive would probably not have had a large impact. This may have to do with the fact that according to these data, before mandatory introduction of speed limiters, the speed of almost all HGVs in the UK was yet below the speed set by the limiter.

Furthermore the question arises: what would be the speed distribution today? Today, the vehicles are much more powerful and more energy efficient while also the road infrastructure has improved.

Hence the remainder of the analysis will be based on more theoretical speed distribution. For the situation of today, with speed limiters two cases are relevant:

- A speed distribution for a country in which the posted speed limit[6] is higher or equal than the speed determined by the speed limiter (90 km/h for HGVs and 100 km/h for buses). This is the case in for example Belgium where the speed limit on motorways for HGVs is 90 km/h. In this case the speed limiter determines the maximum speed.
- A speed distribution for a country in which the posted speed limit is lower than the speed determined by the speed limiter. This is the case in Ireland where the posted speed limit on motorways for HGVs is 80 km/h. In this case the speed enforcement in a country will play an important role. The speed limiter will only limit the top offences.

[6] This is the speed limit for a road as posted on the traffic signs. These differ per Member State and road type.

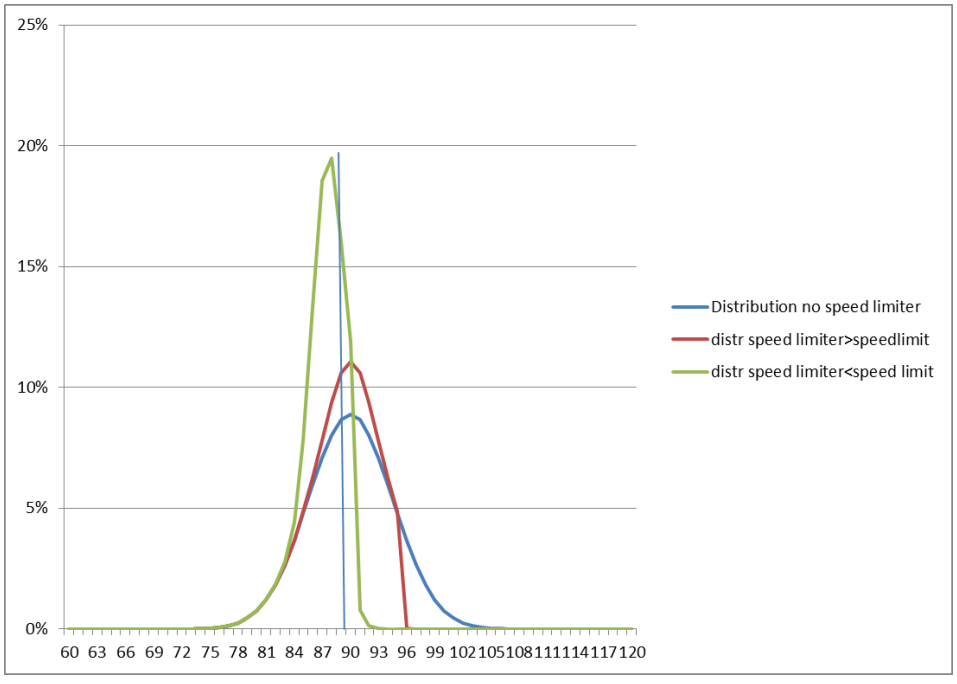
For the ex-post evaluation we need to compare the current speeds, with the theoretical case in which there would be no speed limiters. In this case we assume that the speeds would be normally distributed around the average speed, where the mean speed and a standard deviation are as shown in Table 3.

Table 3: Average speeds and speed deviations without a speed limiter

	Average speed (in km/h)			
Posted speed limit (in km/h)	**Car**	**LGV**	**HGV**	**Bus**
80			85	90
90	90	90	90	95
100	100	100	95	100
110	105	105	100	105
120	110	110		
130	115	115		
140	120	120		
Speed deviation (in km/h)	11	16.5	4.5	4.5

Hence, assuming a speed limit set at 90 km/h the blue line in Figure 2 shows the distribution in case there is no speed limiter; the red line shows the distribution if there is a speed limiter, but set at a speed of 100 km/h and the green line shows the distribution if the speed limiter is set at the level of the posted speed limit of 90 km/h.

Figure 2: speed distributions for HGVs in cases with and without speed limiter



Given the current speed limits in each country, we determined which of the speed distributions with a speed limiter was relevant. This distribution and the distribution without speed limiter are then centred around the average speed – which depends on the speed limit in place.

3.4 Safety impacts

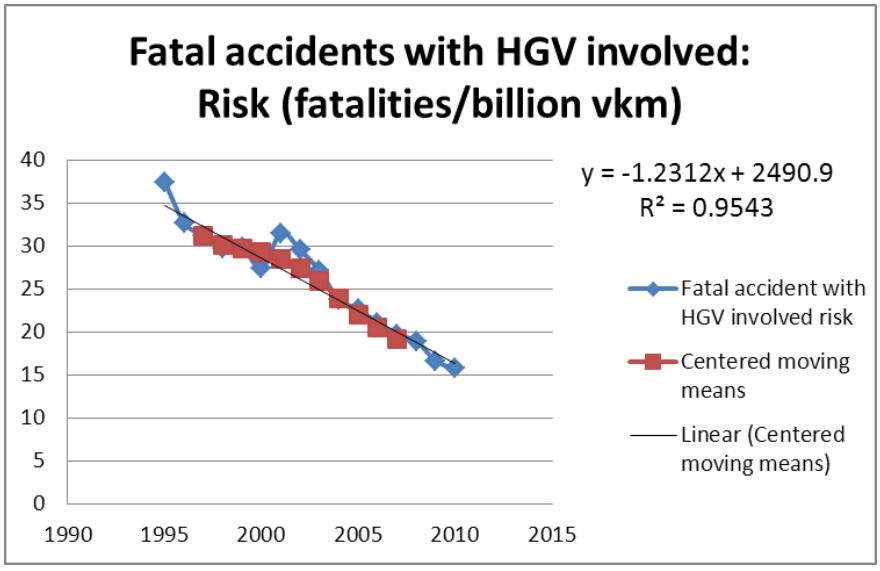
The safety impacts have been estimated by two approaches: time series analysis and changes in speeds and the relationship between speed and traffic safety.

3.4.1 Estimation of safety impacts based on time series analysis

In the first step an analysis is made based on the evolution over time (1995-2011 when possible) of the accident risk for fatal accidents where HGVs or "busses and coaches" are involved. By considering the accident risk[7] – defined as the absolute number of accidents divided by the total vehicle-km driven in a country by HGVs or buses respectively - the analysis corrects for trends which are due to the continuous increase in traffic. For both HGVs and buses we analysed the evolution of the accident risk and the centred moving means of the accident risk[8].

The analysis shown below focusses on the results for the EU15 composite for HGVs. The results for the buses and the individual countries will be included in the main report. Over the period 1995-2010, Figure 3 shows a reduction in the accident risk with HGVs involved. When controlling for temporal fluctuations by using the centred moving averages, a similar reduction is found.

Figure 3: fatal accident risk with HGVs involved



Source: own calculations based on CARE database and Eurostat.

A first order linear trend-line achieves an R^2 of 0.95, suggesting a strong linear effect over time[9]. This suggests that a maintained, yet stable reduction in the fatal accident risk per vehicle-kilometre has been achieved over the period of 1995 up to 2008.

[7] The full report also shows the analysis for the absolute number of accidents with fatalities where a HGV or a bus is involved.

[8] By using centred moving means the numbers are controlled for small yearly influences and the focus lies on the larger trends.

[9] R^2 provides a measure of how well observed outcomes are replicated by the model – the maximum value is 1.

Overall, there is no indication that within the period 2005-2007 one single element attributed to the continuous increase in traffic safety. Hence, purely looking at the accident data no safety effect can be attributed to the implementation of the Speed Limitation Directive.

3.4.2 Estimation of safety impacts based on changes in speed distributions

In this section we present the preliminary results of the second approach applied for assessing the safety impacts. The data on the number of accidents were retrieved from the CARE[10] database. Table 4 shows the accidents on motorways. The total number of accidents, fatal accidents and serious injury accidents are displayed. Not in every accident, a HGV or bus was involved. These numbers and percentages are also shown. The low number of accidents with buses on motorways makes this estimation uncertain.

Table 4: Accidents rates on motorways

Accidents from CARE database on motorways						
	Total accidents		Fatal accidents		Serious accidents	
		percentage of total		percentage of total		percentage of total
Total	52562	100%	1645	100%	9318	100%
HGV involved	9479	18%	491	30%	2100	23%
Bus involved	471	1%	27	2%	88	1%

The effects of the implementation of speed limitation devices for HGVs and buses were estimated from the speed impacts. For this a simulation was used, that simulates the speed distribution without a speed limiter in every Member State and the effect on speeds due to the speed limiter. The effect on the number of accidents is determined by the reduction in average speed. The change in average speed due to the implementation of the speed limiter depends on the initial speeds driven. This is shown in the tables below. These percentages have been calculated by applying the formulas from Elvik (2009) (see section 2.3). In the next phase of the project also the other two approaches (Kloeden and Taylor) will be applied.

[10] For the accident data the average number of accidents for the 4 most recent available years was taken, if there was data for 2 or more years available. Member States with insufficient data were left out of the analysis (BG, EE, IT, CY, LV, LT, MT)

Table 5: Impacts on accidents rates on motorways in Member States with high or low[11] posted speed limits (based on Elvik, 2009)

Average Member State with low speed limits		Average Member State with high speed limits	
Ex-post results		**Ex-post results**	
Trucks		Trucks	
change in average speed	- 0%	change in average speed	- 2%
Nilsson: Injury accidents - all	- 1%	Nilsson: Injury accidents - all	- 4%
Nilsson: Fatal crashes	- 2%	Nilsson: Fatal crashes	- 10%
Nilsson: Serious injury crashes	- 1%	Nilsson: Serious injury crashes	- 6%
Buses		Buses	
change in average speed	- 0%	change in average speed	- 2%
Nilsson: Injury accidents - all	- 1%	Nilsson: Injury accidents - all	- 4%
Nilsson: Fatal crashes	- 2%	Nilsson: Fatal crashes	- 9%
Nilsson: Serious injury crashes	- 1%	Nilsson: Serious injury crashes	- 6%

Amongst the EU Member States, the speed limits are very different for HGVs and buses (and also for cars). The results show that according to this analysis, speed limiter has little effect in a Member State where the posted speed limits are more than 10 km/h below the limit of the speed limiter.

The decrease in average speed in Member States with high posted speed limits on motorways was about 2% due to the implementation of the speed limiter. This resulted in a decrease of accidents.

This analysis was carried out for every Member State and the percentages were applied to the accident data per Member State with HGVs or buses involved. The aggregated results at the EU level are in Table 6.

Table 6: Impacts on the number of accidents on motorways (based on Elvik, 2009)

HGV involved			
	All injury accidents	Fatal accidents	Serious injury accidents
Number of accidents	9479	491	2100
Reduction due to decrease in speed	-152	-26	-58
% reduction	-2%	-5%	-3%

Bus involved			
	All injury accidents	Fatal accidents	Serious injury accidents
Number of accidents	471	27	88
Reduction due to decrease in speed	-14	-2	-4
% reduction	-3%	-8%	-5%

This analysis is sensitive for the input of speeds. This is also clear from the difference in effects between a Member State with high posted speed limits and a Member State with low posted speed

[11] The low posted speed limits are 80 km/h for HGVs and 90 km/h for buses on motorways, which means that the posted speed limit is was lower than the speed limiter. The high posted speed limits are 90 km/h for HGVs and 100 km/h for buses on motorways.

limits. Therefore a sensitivity analysis has been carried out, assuming that speeds without speed limiter are set 5 km/h higher than the ones listed in Table 3. The results of this assessment are shown in Table 7. It becomes clear that in that case, the effects of the speed limiters are more than 3 times larger than the base case shown in Table 6.

Table 7: Impacts on the number of accidents on motorways in Member States with higher assumed vehicle speeds for the case without speed limiter (based on Elvik, 2009)

	Results analysis		**Speeds 5 km/h higher**	
	Accident reduction	% reduction	Accident reduction	% reduction
All injury accidents	-166	-2%	-606	-6%
Fatal accidents	-28	-5%	-95	-18%
Serious injury accidents	-62	-3%	-224	-10%

Given the uncertainty in the vehicle speeds in the case when there would be no speed limiters, it is not possible to provide a precise estimate of the safety impacts of speed limiters. However, the results presented above provide a bandwidth that can be regarded as a reasonable estimate for the range.

The analysis carried out so far focuses on the impacts of changes in average speeds. In the final analysis also impacts of changes in speed dispersion will be included.

3.4.3 Synthesis

The results of the time series analysis do not provide evidence on impacts on traffic safety. This does not mean that the Directive did not have any safety effects, as the implementation covered several years and the impacts may be by blurred by the general trends in traffic safety.

The modelling based on changes in vehicle speeds and the relations between speed and traffic safety shows that a reduction in the number of fatal accidents on motorways with HCVs involved of -5% to -18% can be expected.

Unfortunately, it lacks sufficient data to be able to distinguish the road safety impacts of introducing speed limitation devices in vehicle categories N2 and M2, as required by legislator in Directive 2002/85/EC. For this, both traffic data and accident data differentiated to M2, M3, N2 and N3 would be needed. However, the differentiation between the smaller vehicle types (M2 and N2) and the larger ones (M3 and N3)can be made for neither traffic data nor safety statistics.

3.5 Impacts on emissions

As a result of the introduction of speed limiters, the average speed as well as the driving dynamics may change as explained in section 3.3. These changes affect the drag, rolling resistance and efficiency of the vehicle's engine, which on their turn affect the vehicles emissions. The impacts on emissions depend on the speed in the reference case. In Member States with relatively low posted speed limits (80 km/h for HGVs and 90 km/h for buses), the calculations show no significant impacts from the speed limiters for HCVs on emissions. The reason is that in those cases, the effect on the speed profile is assumed to be negligible.

However, in Member States with posted speed limits higher than the speed limitation speed, the first calculations show some impacts on emissions, in the range of 0.4 to 2% reduction. This analysis will be further developed and the results presented in the final report.

Also for emissions, it lacks sufficient data to be able to distinguish the impacts of introducing speed limitation devices in vehicle categories N2 and M2, as required by legislator in Directive 2002/85/EC.

3.6 Market impacts

The market impacts that can be attributed to the Directive and on the application of speed limitation devices can refer to different areas:

- shifts between vehicle categories, in particular HCV-LCV.
- compliance costs
- cost of transport
- vehicle design
- administrative costs, enforcement and fraud

The analyses reported here are based on the national data provided by the questionnaire respondents. The main focus is on the stock of registered vehicles in the period 1999-2012 per vehicle categories M and N in order to compare the growth trend of vehicles before and after the implementation of the Speed Limitation Directive and verify if the obligation of installing speed limiters led to a shift from heavy to light vehicles.

None of the respondents believe in a relation between Directive 2002/85/EC and the stock of vehicles: some (Bulgaria and Finland) denied it, others stated that they are not able to prove it. In fact, according to the analysis carried out, it seems that no certain or clear relation between the Directive implementation and the stock of registered vehicles has taken place. There are few countries (Bulgaria, Latvia, the UK) whose vehicles time series could be explained by a shift between vehicles categories driven by the implementation of Directive 2002/85/EC. Finally no discontinuities occur at the time of or close to the Directive implementation. However, like for accident rates, the impacts might be blurred by the impacts of many other factors.

As for the other issues such as compliance costs encountered by EU countries end data on frauds, few responses from governmental authorities have been received and few studies have been suggested. Further information is being collected through specific interviews with transport and logistics operators in order to understand whether they were influenced by the Speed Limitation Directive implementation in terms of vehicle choice, and if it affected the overall cost of transport. Up to now there is no evidence of this. However, this will be further explored in the next phase of the study.

4 Scenarios for the ex-ante evaluations for HCVs and LCVs

4.1 Introduction

In the ex-ante evaluations all together eight scenarios will be analysed: four scenarios with changes with respect to HCVs, four scenarios that extend the scope of the Directive to LCVs. In both cases two of the four scenarios will be with regular speed limiters, while the other two scenarios will cover mandatory application of selected ISA systems.

For the scenarios, a time horizon for implementation of about 5 years is relevant. Hence only technologies that could be applied within this period are relevant to consider. For speed limiters, this put no constraints, however for ISA this requirement limits the type of technologies that can be applied in the scenarios.

An ISA system typically consists of three components. These components can be built into the vehicle, or be provided as an after-market system.

- Speed and location monitoring system.
- Set speed information comparison.
- A feedback system.

The speed monitoring system is responsible for providing information on the current location of the vehicle as well as the speed that the vehicle is running at. This information is typically provided by a GPS system (location) in combination with vehicle data input (CANBUS or similar).

This information is compared to a set speed (the second component). This set speed can be provided through the combination of GPS coordinates with map information containing mandatory speed limits, vertical road sign recognition (speed signs) or other sources of information.

The driver receives information on the set speed through visual, auditory or haptic channels (the third component). A comparison between set speed and driven speed can take place before the feedback is presented.

Nine different types of ISA systems can be identified based on two characteristics:

1. System type:
    - Advisory/informing: speed limits are visually presented to the driver (mostly when changes in speed regimes are present). The driver is only informed on the speed limits. The driver is free to adjust his speed. This system is currently being offered as an option in some passenger cars.
    - Driver select (voluntary):
        - Warning (open): a warning is presented to the driver through visual or auditory means when the driven speed exceeds the posted speed limit. The driver is free to adjust his speed.
        - Intervening (half-open): the driver is presented with tactile feedback through the accelerator pedal when exceeding the speed limit. The driver experiences a higher pressure required on the operation of the accelerator pedal to increase driving speed.

- Mandatory (autonomous): the maximum speed of the vehicle is automatically limited to the posted (set) speed that is in force on that particular location. Remaining driver input is ignored. Additional feedback can be presented to the driver by limiting throttle input (strong haptic feedback or dead throttle).

2. Type of speed limit information:
   - Fixed: the basis for the speed comparison is the posted speed limit. The driver is informed thereof.
   - Variable: in addition to the fixed speed limits, the basis for the speed comparison is extended to variable speed information for special situations (road works, dangerous areas, black spots, etc.). The driver is informed thereof.
   - Dynamic: In addition to fixed speed limits, the basis for the speed comparison is extended to location specific situations (road works, traffic density, etc.) and time specific situations (weather, lighting, etc.). The driver is informed thereof.

For each of these systems, different levels of technological advancement and legislation need to be considered, making some systems more likely to be introduced on a large scale than others.

An inventory made of available technologies has shown that ISA systems that use dynamic speed limitation information are not expected to be mature enough. Therefore, such systems are not relevant for the scenarios. Furthermore, it should also be taken into account that digital road maps are an important condition for variable ISA systems to function and the maps would require regular updating. This means that a fixed system is more likely to be feasible than a variable system. Liability of the driver is also an issue, given that he should keep control over his vehicle. In this context it is not clear whether active ISA systems could be implemented as alternative to speed limiters or whether only supportive systems are a possible alternative. This means that also the mandatory systems fall out as an option.

Based on these considerations two types of ISA systems have been selected for the scenarios.

The scenarios and argumentation behind them are described in the next two sections.

4.2 Scenario definition for HCVs

For the ex-ante analysis for HCVs we propose the scenarios as shown in Table 8.

Table 8: Summary of the scenarios for the ex-ante analysis for HCVs

	Speed limiter HGVs	**Speed limiter buses**	**ISA system**
Reference	90 km/h	100 km/h	no
Scenario 1	80 km/h	90 km/h	no
Scenario 2	100 km/h	100 km/h	no
Scenario 3	90 km/h	100 km/h	Advisory/open – variable speed limit information
Scenario 4	80 km/h	90 km/h	Half-open – fixed speed limit information

The reasoning behind these scenarios is as follows. One scenario with an increase of the speed and one with a decrease of the speed has been chosen to assess a broad range of scenarios. The levels of 80 km/h for N2/N3 is a reasonable assumption as many countries have a speed limit on motorways set for this type of vehicles at 80 km/h. A lower speed limit is less likely to be possible

as in many Member States the minimum speed on motorways is 70 km/h.. An increase of the maximum speed for HGVs to 100 km/h decreases the differences in vehicle speed between the various vehicle types. Furthermore a speed of 100 km/h would be feasible for the HCV's of today.

The different EU27 countries however have different speed limits on their motorways and rural roads. Important for the analysis of these scenarios will be the assumption on what will happen with the national speed limits. A reasonable assumption may be that in all Member States the speed limits would be changed (if needed) in such a way that they would allow to drive at the maximum speed of the speed limiter.

It would be interesting to have scenarios that differentiate sped limits between M2 and M3 and/or between N2 and N3 vehicles. However, it lacks sufficient data for carrying out such an analysis. Therefore, such scenarios, although potentially relevant from the policy perspective, have not been selected.

For the ISA scenario 3, the technology is currently already being offered by several car manufacturers in the sense that visual or acoustic signals are being fed back to the driver. Haptic feedback (vibration) is currently not yet being offered as an option. However, it does not necessarily require significant adaptations to the principle. As such, the technology is already introduced to a sufficiently high level to be transposed on a heavy goods vehicles fleet. The informative nature of the system implies that no invasive actions are taken by the ISA system. The driver remains fully responsible for the eventual speed choice. This also means that from a liability perspective, it would be possible to combine this system with variable posted speed limit information. By keeping the speeds as they are today, this scenario allows to assess the pure effects of implementing this type of ISA for HCVs.

Also the technology needed for ISA scenario 4 is available. This system has been the subject of some research and field tests. It is currently not being offered as an option by vehicle manufacturers, but could be ready for the market within 5 years. Databases with speed limit information are up to a certain extent already available at both private and public level. Driver acceptance can sometimes be a problem for this type of system since a more explicit invasion takes place in relation to driver input (speed pedal pressure). As the system is more intrusive, from a liability perspective this system should be combined with fixed speed limit information as this type of information is most reliable. Many EU Member States already have a speed limit in place for HCVs which is lower than the current speed limiter. By combining a half open ISA system with a lower speed limit we expect that this scenario will have the highest safety impact and can serve as a comparison for the other three scenarios.

It should be noted that where regular speed limiters particularly have an impact on motorways, ISA systems have also impacts on trunk roads and urban roads. These are the road types with relatively high accidents rates, compared to motorways. Therefore, ISA systems can be regarded as complementary to the speed limiters. This is an important reason why scenario 3 and 4 have ISA systems on top of regular speed limiters.

4.3 Scenario definition for LCVs

For the ex-ante analysis for LCVs we propose the scenarios as shown in Table 8.

Table 9: Summary of the scenarios for the ex-ante analysis for LCVs

	Speed limiter LCVs (type N1)	ISA system
Reference	no	no
Scenario 1	110 km/h	no
Scenario 2	100 km/h	no
Scenario 3	no	Advisory/open – variable speed limit information
Scenario 4	no	Half-open – fixed speed limit information

The reasoning behind these scenarios is as follows. A speed limit of 110 km/h seems feasible and realistic. A set speed limit of 120 km/h was considered to have too small effects and therefore not useful to assess. Also a speed limit of 100 km/h seems feasible and realistic and is considerably lower than the limit in Scenario 1. A lower limit, for example of 90 km/h or lower, would result in relatively high differences in speed between N1 and M1 vehicles and is not deemed realistic.

The argumentation for the type of ISA systems that are assessed for LCVs is the same as for HCVs. Furthermore it should be noted that there is currently no mandatory application of speed limiters for LCVs. Scenarios with both speed limiters and ISA systems would therefore take two steps at once. The proposed scenarios with only ISA systems or speed limiters make it possible to compare the impacts of speed limiters with the impacts of ISA systems, as was also requested in the terms of reference for this study..

In all four scenarios for LCVs, the speed limits for all other vehicle categories are not changed and the set speed for speed limiters of HCVs remains the same. The current speed limit for N1-vehicles in many countries is the same as for cars, between 110 km/h and 130 km/h (or no limit as in Germany), so the effects of these scenarios will differ per country.

Preferably also scenarios in which commercially used M1-vehicles (mini busses) are subject to the obligation would be included. However, it may be difficult legal basis for distinguishing such vehicles from other types of M1-vehicles. Moreover, it lacks sufficient data with respect to vehicle-kilometres and safety data to distinguish commercially used M1-vehicles from other vehicles. Therefore, the scenarios defined and assessed are limited to N1-vehicles.

However, the final report of this project will discuss policy options for including some M1 vehicles as well. Also policy scenarios in which a subcategory of all N1 vehicles are subject to the obligation of installing speed limiters or ISA systems will be discussed. Several options could be considered, such as:

- Limiting the obligation for N1 vehicles to vehicles with a vehicle mass between 2610 and 3500 kilogrammes (using the same subcategories as used in Regulation EU/510/2011).
- Limiting the obligation for commercially used M1-vehciles to vehicles with 8-9 seats.

Annex A - Results of the Survey

Introduction

The survey was targeted to Member State and Stakeholders to gather relevant data and information on the application of the Directive. Data presented are obtained from 15 governmental offices and 19 stakeholders.

Implementation of the Speed Limitation Directive

With respect to the implementation of the Speed Limitation Directive, **no particular problems** have been encountered with few exceptions pointed out by Italy which highlighted the significance of both administrative and technical costs, Hungary and Greece which respectively faced high costs, administrative burdens and problems related to the manipulation of the speed limitation devices.

Checks on vehicles' compliance with the Speed Limitation Directive are normally carried out yearly with a few exceptions: Austria, Bulgaria and Romania perform checks on vehicle compliance with the Speed Limitation Directive every two years while in UK checks on vehicle compliance are carried out whenever vehicles are checked at the roadside.

Furthermore, EU countries comply with the Directive provisions regarding **the speed limits set in speed limitation devices**: 100 km/h for M2 and M3 vehicles, 90 km/h for N2 and N3 vehicles. Checks on the maximum speed used for speed limiters are mainly carried out during roadside inspections such as in Austria, Poland and Romania or roadworthiness tests such as in Ireland and Poland.

Impacts of the Speed Limitation Directive

In order to provide evidence on the impacts of the Directive, several studies have been suggested both by governmental contacts and stakeholders. Most of these regard the impacts of speed limitation devices on emissions, road safety and ISA systems. Governmental contacts have also indicated some additional national measures having impacts on emissions and road safety.

The relation between the application of **speed limiters and the stock of vehicles** seems to be rather weak and difficult to trace. The CNAE- the Spanish Confederation of Driving Schools - points out a relation between the installation of speed limitation devices and the trend of vehicles weighing more than 3,5 tons since 2005.The Norwegian Public Roads Administration comments that there could be a relationship between the implementation of Directive 2002/85/EC and the trend in vehicles stock, although, the trend in vehicles stock is also partly unintended result of changes in vehicle taxes. The contact from CERTH - Centre for Research and Technology Hellas believes that no relation between the two exists. The Slovenian Traffic safety Agency states that such a relation have not been observed.

The Norwegian Public Roads Administration provided also some relevant comments on the relation **average speeds and speed profiles.** In Norway the average speed for most of the speed limits have been slightly decreasing since 2004 but this reduction may have been influenced by other reasons than speed limitation devices such as several campaigns addressing the importance of appropriate speed. In addition, average speed cameras have appeared to be effective and are

achieving a significant reduction in driving speeds on stretches of road where the speed is initially higher than the speed limit.

With respect **to impacts on vehicle emissions**, the Ministry of Infrastructure and Transport of Italy states that in principle the limitation of the maximum speed should provide lower CO_2 and pollutants emissions. However, the need to keep an adequate commercial speed could imply extra energy consumption. On the other hand the market competition and the legislation on vehicle emissions have promoted the improvement in terms of CO_2 and pollutant emissions which are deemed to be more effective than the introduction of speed limiters.

The European Transport Safety Council states that fuel consumption and carbon dioxide emissions are a function of speed and that speed limitation is a very effective carbon abatement policy[12].

On the other hand VDA (Verband der Deutschen Automobilindustrie) thinks that there is no need to regulate the emissions by indirect technical devices such as speed limiters since the cost of equipping all vehicles with speed limiters are disproportionate to the CO_2-reductions.

As for **road safety impacts,** these are seen as a result of a combination of measures. According to the Norwegian Public Roads Administration, some commercial transportation companies have experienced a reduction in costs of fuel and cost of accidents thanks to the introduction of speed limitation devices.

As for **market impact** it is difficult to trace a clear relation between the obligation of installing speed limiters and the vehicle stock. According to VDA, the shifts between heavy goods vehicles and light commercial vehicles can be seen but a relation to speed limiters cannot be proved as different parameters have influence on the size of vehicle used for transport such as road charge, cargo weight etc. Moreover the increased number of light commercial vehicles in operation is due to changing customer demand (e.g. urban deliveries in connection with internet shopping).

According to Dekra Automotive Italy the extension of speed limiters to N2, M2 and M3 with maximum mass less than 10 tons lead to an increase of N1 category which could substitute N2 vehicles.

Possible amendments

Some possible amendments to the Speed Limitation Directive were proposed to Member States and stakeholders: the level of the speed limits applied to HCV's (i.e. keep or increase or decrease the current speed limits), the extension of speed limitation devices to light good vehicles, the introduction of the speed limiters to light passenger vehicles like minibuses/vans, the use of ISA (Intelligent Speed Assistance/Adaptation) systems for some or all commercial vehicles.

All the governmental contacts and most of the stakeholders (63%) responding to the relevant question agree to keep the current speed limits for heavy goods vehicles. More contradictory is the opinion on the application of speed limitation devices to light goods vehicles (N1) and to introduce speed limitation devices for light passenger vehicles like minibuses/vans; while 53% of the stakeholders consider this as positive measure, only 14% of the governmental contacts agree on this extension.

[12] ETSC's Policy paper" Managing Speed: Towards Safe and Sustainable Road Transport".

Almost all the stakeholders (79%) and nearly the half of the governmental contacts (43%) agree to introduce Intelligent Speed Assistance/Adaptation systems for all commercial vehicles (Luxembourg, Slovakia, Hungary, Ireland, Latvia and Romania) and the majority believes that an informative or supportive ISA system should be introduced as an alternative to speed limiters in the case of LCVs and on top of speed limiters for HCVs.