Speed limiters for vans in Europe

Environmental and safety impacts

Report
Delft, May 2010

Author(s):
Eelco den Boer
Femke Brouwer
In cooperation with TNO:
Richard Smokers
Maarten Verbeek

Publication Data

Bibliographical data:
Eelco den Boer, Femke Brouwer (CE Delft), Richard Smokers and Maarten Verbeek (TNO)
Speed limiters for vans in Europe
Environmental and safety impacts
Delft, CE Delft, may 2010

Vehicles / Speed / EC / Regulation / Environment / Safety / Effects

Publication number: 10.4218.39

CE-publications are available from www.ce.nl

Commissioned by: TNO.
Further information on this study can be obtained from the contact person Eelco den Boer.

CE Delft
Committed to the Environment

CE Delft is an independent research and consultancy organisation specialised in developing structural and innovative solutions to environmental problems. CE Delfts solutions are characterised in being politically feasible, technologically sound, economically prudent and socially equitable.

Contents

Summary

Background

Light goods vehicles contribute to the increase of greenhouse gas emissions of transport. Emission estimates illustrate an overall increase of 17% between 2010 and 2020, without additional measures. To curb the growth of emissions from light goods vehicles, the European Commission proposed CO_2 standards for newly sold vans. The proposal states that fleet average emissions per kilometre should be reduced to 175 grammes by 2016 and 135 grammes in 2020. A measure to reduce the CO_2 emissions of vans that is not covered by the Commission proposal is limitation of the top speeds of vans. This is already done at new trucks since the beginning of the nineties, and can be applied quickly, easily and without significant additional technology costs.

Effects on CO_2 emissions and fuel consumption

The potential GHG emission reduction of van speed limiting has been documented in several research studies and results from field tests. The estimated average reduction potential over all roads is:

- 4-5% CO_2 emission reduction for speed limiters at 110 km/h.
- 6-7% CO_2 emission reduction for speed limiters at 100 km/h.

The presented figures correspond with an emission reduction of 3-5 Mtonnes in the EU in 2010, assuming a speed limiter on all vehicles.

Both figures assume that the average engine power of vans stays the same after introduction of speed limiters. Customers might, however, choose for vans with less powerful engines, which would further increase the CO2 and fuel saving benefits of speed limiters. A first estimate is that the CO2 reduction could in that case be a few percentage points higher.

In addition, the effect of improved driver behaviour due to a possible limit on the maximum engine revolutions per minute (rpm), is not included in these figures. If this would be included, the CO_2 emission reduction would also be higher.

Effects on safety

The safety effects have been estimated on the basis of the widely used so called 'Nilsson formulas'. These formulas, based on statistical research, describe a fourth power function for the relation between speed changes and the number of fatalities, and a third power function between speed and the number of serious injuries. The formulas say, for example, that a speed reduction of 112 to 97 km/h results in a reduction of the number of fatalities and severe injuries of 44 and 35% respectively. The calculated safety rates have been applied to EU traffic safety data, extracted from the CARE database[1]. The number of deaths that has been allocated to vans has been estimated on the basis of intrinsic risks. This principle allocates victims in the car to the van in van-car accident and vice versa.

Speed limiting at 100 or 110 km/h will not only give benefits on motorways, but also on rural roads, where speeding is an important cause of accidents. The effects estimated on motorways and rural roads are tabled below (see Table 1). The relative effects presented relate to the road types mentioned.

[1] The CARE database is a Community database on Accidents on the Roads in Europe. The database is published by the European Commission on Mobility and Transport.

Table 1 **Overview of relative reduction of the number of casualties and injuries related to van-accidents in the EU**

	Casualties (%)	Severe injuries (%)	Slight injuries (%)
Motorways			
Speed limiter 110 km/h	31	24	20
Speed limiter 100 km/h	46	37	26
Rural roads			
Speed limiter 110 km/h	0-2.3	0-1.8	0-1.5
Speed limiter 100 km/h	2.0-3.6	1.6-2.9	1.1-2.0

Note: The numbers apply to deaths and injuries related to van-accidents that are allocated on the basis of intrinsic risks in this study.

As Table 1 shows, the share of deaths and injuries that can be allocated to vans strongly reduces on motorways due to speed limiting. Limiting top speeds to 100 km/h instead of 110 km/h increases the number of deaths saved by roughly half (46% vs. 31%).

The table shows that the percentage reduction of fatalities on rural roads is limited compared to motorways. However, on rural roads the number of victims is significantly higher.

Overall, limiting the top speed of vans in the EU to 100 and 110 km/h would reduce fatalities by approximately 190 per annum (of which 120 on motorways) and 110 per annum (of which 80 on motorways) respectively[2].

Cost-benefit analysis

A cost-benefit analysis has been performed to assess all costs and benefits to society for speed limiters at new vans. Two variants have been calculated, one without optimal power rating[3] and one with optimal power rating resulting from speed limitation. The cost-benefit analysis shows that the benefits balance the costs for the average of both variants calculated, since variant A results in small overall costs and variant B in small overall benefits. This shows that possible optimal power rating has a significant impact on the outcome of the cost-benefit analysis.

Additional travel time costs, lower vehicle purchase costs due to optimal power rating and reduced fuel costs are amongst the most important costs categories.

This study in the context of other studies

This study uses an approach that differs from other studies on speed limiters for vans on some aspects. The most important choices and differences with respect to the analysis of effects are:

- This study includes benefits of less speeding on rural roads.
- This study uses intrinsic risks as a rule for allocation of victims to vans.

Three other studies have been executed in the last decade on van speed limiting. In Table 2, we provide an overview of the most important methodological choices and the choices of individual studies.

2 The figures apply to an average of the 2006-2008 period.

3 The power of new vans is likely to be reduced, since speeding is not possible with van speed limiting. A lower power-to-weight ratio is called optimal power rating.

Table 2 **Overview of difference between studies performed**

	Rural roads included?	Victim allocation
CE Delft, 2010 (this study)	Yes	Intrinsic risks
CE Delft, 1998	No	All LGV involved
IMPROVER	No	All LGV involved
AVV, 2004	No	Unclear

AVV (2004) and CE Delft (1998) both apply to the Netherlands, but come to different conclusions. One of the reasons for this is that the studies calculate with different numbers of victims in accidents with LGVs involved. AVV (2004) is conservative in the estimation of the number of fatalities that can be prevented, compared to this study.

For the cost-benefit analysis, a number of methodological choices have been made that differ from a previously made cost benefit analysis in the IMPROVER study (Höhnscheid, 2006). In addition, different valuation figures were used in that study. The current study:

- Investigates the costs and benefits for new vans. For new vans, the costs of speed limit programming in the central computer can be regarded as zero, if applied on a large scale during vehicle production.
- Takes the benefits of purchasing vehicles with lower power to weight ratios into account, because high top speeds can not bring benefits to transport companies anymore.
- Corrects the value of time (VoT) for the share of taxes and social contributions.
- Bases the valuation figures on the recent IMPACT report (CE, 2008), which is the basis for the EU road pricing dossier.

The IMPROVER study, however, concluded that the benefits outweigh the costs with a factor of 1.65 for the existing vehicle fleet. This report concludes that for the average of the variants calculated, the difference between the costs and benefits is small.

1 Introduction

1.1 Background

Vans contribute to the increase of greenhouse gas emissions from transport. Emission estimates illustrate an overall increase of 17% from 2010 to 2020 (Tremove version 2.7). To curb the growth of emissions from vans, the European Commission proposed CO_2 standards for newly sold vans. The proposal states that CO_2 emissions per kilometre should be reduced to 175 grammes by 2016 and 135 grammes in 2020.

Another measure to reduce the CO_2 emissions of vans could be to limit their top speeds. The EU Directives 1992/6 and 2002/85 already limit the top speeds of lorries (> 3.5 tonnes) to under 90 km/h, for safety and environmental reasons. Vans are not yet covered by any such legislation.

In the next months, van emissions will be discussed by the Council of Ministers and the European Parliament. To inform its position, T&E asked CE Delft to investigate the potential effects of mandatory speed limiters on vans in the European Union.

1.2 Objectives

The aim of this report is:
– To provide an overview of the potential CO_2 emission reduction and safety rates of mandatory speed limiters that limit the speed of vans at 100 or 110 km/h.
– To estimate the overall effect on GHG emissions and safety on an EU scale.
– To estimate the cost-benefit ratio of speed limiters on newly sold vans in the EU.

In this report, a light goods vehicle (LGV or van) is defined as a commercial freight vehicle (N1 vehicle class in EU legislation) with a maximum weight (GVW) of 3.5 tonnes.

1.3 Report structure

Chapter 2 provides an overview of the GHG emissions of vans and the amount of van-related casualties and injuries in the EU. Furthermore Chapter 2 provides an overview of the history of speed limiting for trucks. Chapter 3 provides an overview of the methodology used to calculate the effects. Chapter 4 presents an overview of the potential reduction of GHG emissions and the number of deaths and injuries. In Chapter 5, we calculate the socio-economic costs and benefits of speed limiting for new vans. Finally, Chapter 6 summarises the main findings of the report.

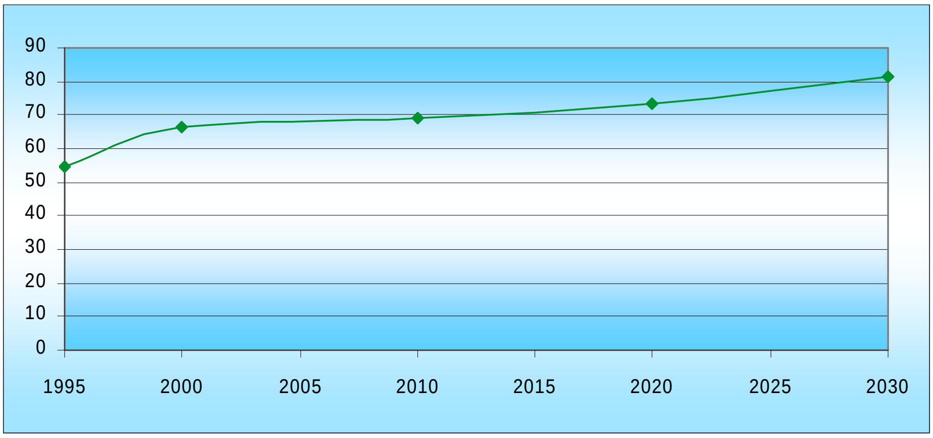
2 Background: speed limiters on vans

2.1 Use, emissions and safety impacts of vans

There has been a rise in van use in Europe in the last decade. The total stock of vans in EU-27 increased with 42% between 1995 and 2005 to 26.5 million vehicles (LAT, 2008). The vans sold in Europe have been gradually equipped by more powerful engines, allowing them not only to travel at higher speeds, but also with higher loads (TNO, 2010).

As a result of the increased use of vans, the emissions of vans increase as well. The overall CO_2 emissions of vans show a growth of 26% in the 1995-2010 period, see Figure 1. The emissions of vans represent around 7.5% of the total CO_2 emissions of road transport. In 2010, van emissions amount a share of 12% of the passenger car emissions (TREMOVE).

Figure 1 **CO_2 emissions from vans in the EU-27 according to TREMOVE (Mtonne, excl. WTT)**

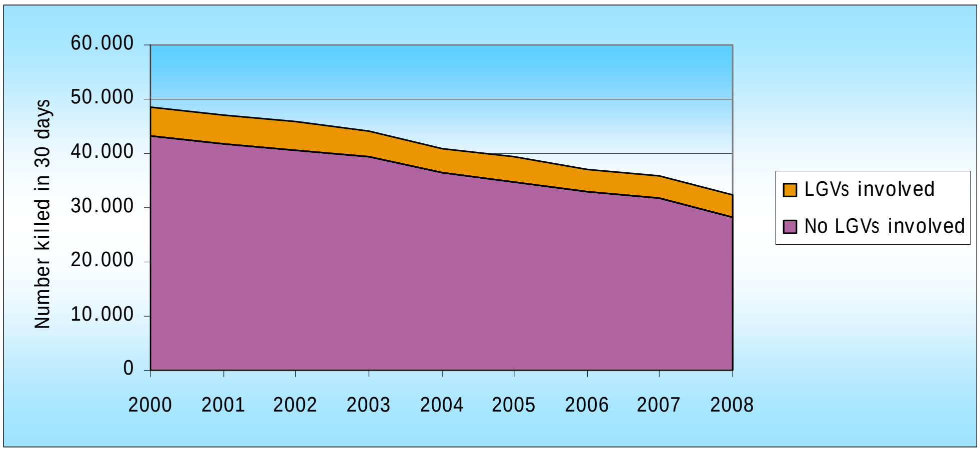


Source: CE, 2009 (TREMOVE).

Since 2000 traffic in the EU-27 has become safer. Although the total number of fatalities decreased by 34% in the 2000-2008 period, still almost 35,000 people died in traffic in the EU in 2008, in 3,779 cases there was a LGV involved in the accident.
If only accidents involving vans are taken into account, the reduction in the number of deaths is lower. The decrease in fatalities in accidents with vans involved was 26% for the same period, less than the 34% mentioned above. This implies that the safety performance of vans did not improve as much as for all other vehicles. Around 11% of all fatalities in road traffic can be linked to vans (see Figure 2). Figure 3 shows that most fatalities with vans occur at rural roads (67% in 2008). Only 8% of all fatalities occur on motorways[4].

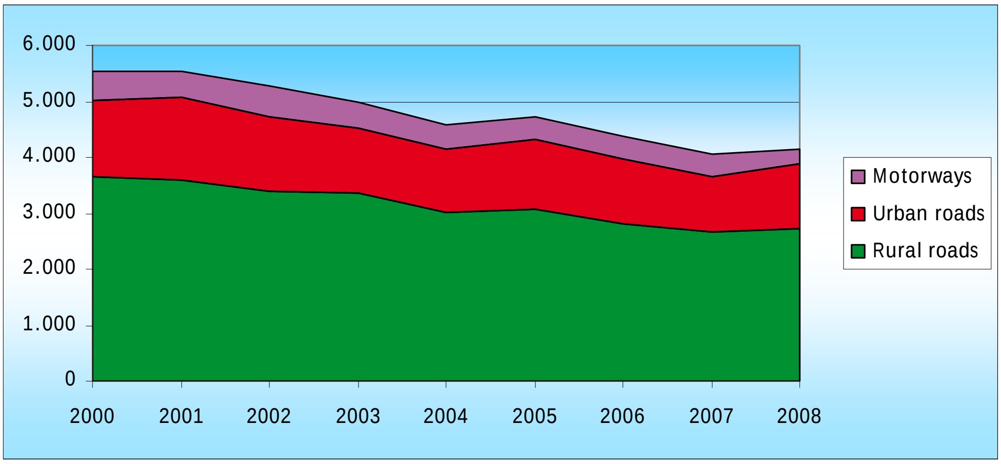
[4] Source: The EU CARE data base.

Figure 2 **Number of deaths in road traffic with and without vans involved in the EU-27**



Source: CARE database and own calculations (see textbox below).

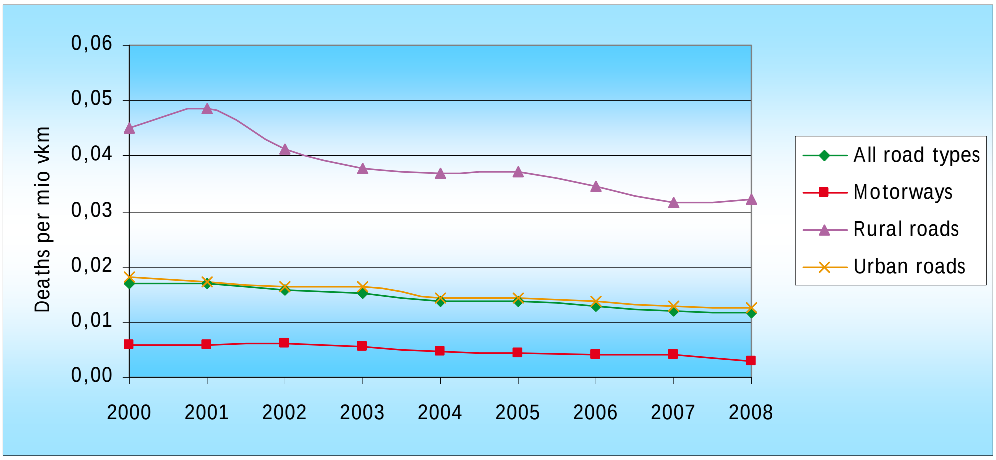
Figure 3 **Fatalities on different road types in accidents with LGVs involved in the EU-27**



Source: CARE database and own calculations (see textbox below).

In order to have a correct picture of safety performance of vans on different road types and over time, fatality rates are also shown. Figure 4 shows that fatality rates for vans decreased on all road types in the 2000-2008 period. The fatality rate is the highest for rural roads, which corresponds with the number of deaths shown in Figure 3.

Figure 4 **Fatality rates for accidents with vans involved on all road types**



Source: CARE database and own calculations (see textbox below).

The number of fatalities and injuries in EU-27

Data on fatalities and injuries were obtained from the CARE database. This database, however, did not include data for all countries in the EU-27, but only for two-third of the countries. To provide an overall picture we extrapolated data of countries which data was available for, to fill the data gaps. We used fatality and accident rates for the countries for which data was available and combined these rates with the vehicle kilometers from the countries for which accident data was not available.

Because safety rates differ over regions in Europe, we divided countries into two groups; a 'safer' group and a 'less safe' group. The division was made on the basis of data on road deaths per million inhabitants from the CARE database. If no data on safety in a country was available we used the overall accident rate in the EU-27.

Conclusion

The following conclusions can be drawn from the analysis presented above:

- Van fatality rates went down, but not as much as the other vehicle classes.
- Most van related fatalities occur on rural roads.

Since rural roads have the highest fatality rates, rural roads should be taken into account when analyzing the safety impacts of speed limiters. Although the percentage reduction in fatalities form limiting top speeds is likely to be small since most vans on rural roads do not drive at speeds above 100 km/h, there will be benefits due to less speeding.

2.2 History: speed limiters for lorries

Speed limiters for heavy lorries (>12 tonnes GVW) have been implemented by Directive 1992/6 between 1 January 1994 and 1 January 1995. Member States were required to 'take the necessary measures to ensure that' …. 'their speed cannot exceed 90 km/h'. Directive 2002/85 extended the scope of Directive 1992/6 to vehicles over 3.5 tonnes.

Experiences with lorries show that speed limiters contribute to better traffic safety. Over the period in which speed limiters for trucks have been in force, the accident rate has dropped by one third.

The most definitive results on the effectiveness of speed limiters comes from the United Kingdom. The crash involvement rate for speed-limited heavy trucks fell 26% between 1993 (when mandated) and 2005. However, the accident involvement rate on motorways (per hundred million vehicle kms) for *all* heavy goods vehicles (including 3.5-7.5 tonnes) increased from 18.5 in 1993 to 18.8 in 2005 in the UK[5]. These figures include accidents involving lorries between 3.5 and 7.5 tons which were not required to be fitted with a speed limiter. The data hence reflect an increase of fatality rates for the smaller lorries, without speed limiter, and a decrease of fatality rates for speed-limited lorries. Without speed limiters for heavy lorries the increase in overall crash involvement rate would have been significantly higher. UK authorities noted that other contributing factors may have influenced the decline, but concluded that speed limiters at least played a significant role (Bischop, 2008).

At the same time lower running speeds equal fuel savings and lower emissions. Fewer accidents may also cause less congestion. Road capacity is optimally utilised at an average speed of around 90 km/h (TNO, 2004). Limiting the speed of vans will therefore probably lead to improved traffic flow on motorways and consequently less congestion. On the other hand, lower speeds for vans may lead to increased change of lanes by passenger vehicles, which may hamper the traffic flow. The net effect of both is unknown, due to lack of data.

Some concerns are also raised. They include a lack of a consistent set of speeds and the inability of a speed-limited vehicle to accelerate in risky traffic scenarios. The UK results however show an overall improvement of the traffic safety situation, however. Besides that, lower speeds result in time losses, and the corresponding financial losses.

2.3 Options for speed limiting in vans

In new vehicles speed limiting (speed and revolutions per minute or rpm) can be included in the general programming of the central computer. For existing vans however, vehicles have to be retrofitted. Generally, fixed speed limiting can be done by reprogramming the engine computer or with applying retrofitting devices that are mechanically or electronically controlled.

Most older vans can be retrofitted by modifying engine management, i.e. without additional hardware. However, this is not the case for some vehicle brands and types, suppliers indicated. The costs for retrofitting of such vehicles depends on the used control technology. Prices between € 280 and € 1,000 excl. VAT were cited by different suppliers upon inquiry.

If speed limiting would become mandatory for new vehicles, the costs would be close to zero, experts stated. The programming of additional rules for speed limiting can be included in the general programming of the central computer.

The recent trend in more powerful engines might stop with mandatory speed limiters, since driving at speeds above the limits set is not possible anymore. This would save in addition to fuel costs also vehicle purchase costs.

5 This is significant, because traffic increased by 36% over the same period.

Speed limiting devices, also called Intelligent Speed Adaptation Systems (ISA systems) are available in different variants, ranging from informing devices to automatic control. Table 3 provides an overview of different options. This report mainly concerns the last category.

Table 3 Different speed limiting systems

Informing	Speed limit is displayed
Advisory dynamic	Display shows advisory maximum speed, dependent on conditions
Mandatory dynamic	Speed limited according to the conditions
Mandatory fixed	Speed limited to a fixed speed limit

3 Methodology used

3.1 Overall approach

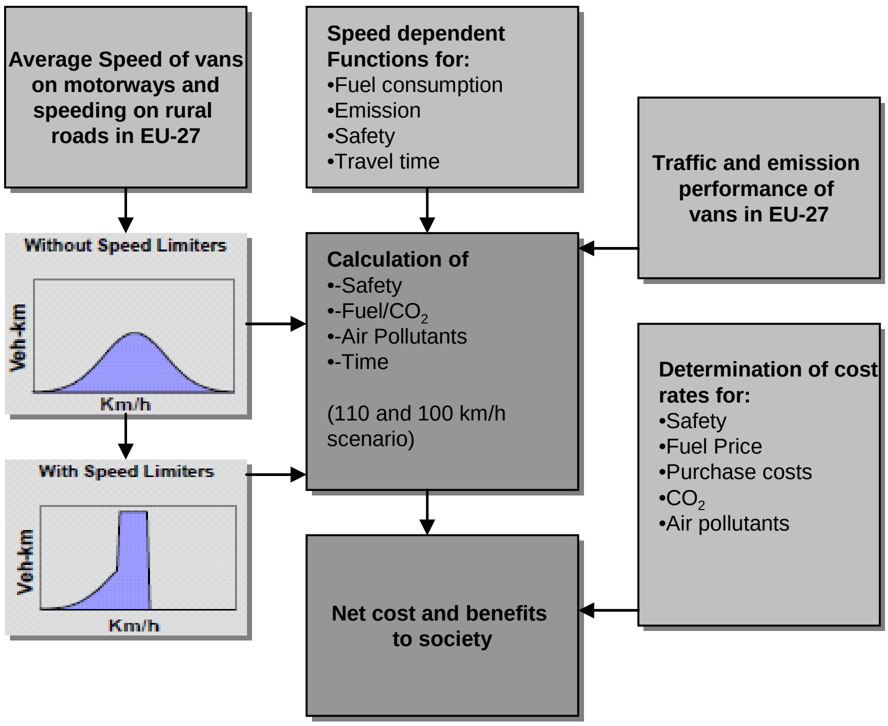
In this chapter, we describe the approach we used to estimate the climate and safety effects of speed limiters, and for the calculation of the cost-benefit ratio of this measure for new vehicles.

Emissions and safety effects of speed limiting for vans depend on the speed of the vehicles. Therefore, we first determined how speed limiters affect the average speed. Lowering of the speeds of vans will have the following effects:[6]
- Lower fuel consumption and CO_2 reduction (+).
- Lower air pollutant emission (+).
- Lower maintenance costs (+).
- Improved road safety (fatalities and severe injuries) (+).
- Additional time consumption (-).
- Speed limiter purchase costs (-).
- Lower vehicle purchase costs due to lower power to weight ratio's (+).

Additionally, data on the traffic and emission performance of vans is needed.

In Figure 5, the overall approach is illustrated.

Figure 5 Methodical approach for calculating the effects of speed limiters



Source: adapted from Höhnscheid et al. (2006) and CE (1998).

6 + indicates benefits and – indicate costs.

Below we discuss the methods used to calculate the effects on emissions and safety.

3.2 Effects on GHG emissions and traffic safety

3.2.1 Effects on GHG emissions

To obtain the effect of speed limiters on emissions, the following steps were followed:

1. Determination of the relative emission reduction when driving at a lower speed.
2. Estimation of the total emission reduction on a EU scale by the obtained reduction percentage and the traffic performance data from Tremove.

To obtain the reduction percentage of lower speeds (step 1) TNO calculated emission factors at different speeds, using the VERSIT+ model. We compared the results with results from literature, to determine a reliable reduction percentage.

3.2.2 Effects on traffic safety

Speed is an important factor in traffic safety. Speed often plays a role in traffic accidents. There is a direct relation between the severity of an accident and the collision speed. This relationship is based on the kinetic energy released during the collision. This kinetic energy is related to the mass of colliding vehicles and the square of the collision speed. A small change in the speed has therefore big effects.

Accordingly, speed reduction has significant benefits on traffic safety. If all road users would meet the speed limits set, fatalities and serious injuries would be reduced by 20 to 30% (AVV, 2004). The effect of speed limitation is additional to these figures.

Most studies find a power function or exponential relation for accident risks, while other report a linear relationship. An often cited relationship for calculating the effect of speed limitation is the formula of Nilsson (1982). He was one of the first that came with useful formulas for the effect of speed changes on traffic safety on the basis of empirical evidence. These formulas are the basis for many studies (SWOV, 2004).

Nilsson's formula

The data that Nilsson used for his study came from several studies executed in the framework of the speed limit changes in motorways in Sweden. The speed limit was changed from 110 km/h to 90 km/h. Nilsson used accident statistics from other roads (without a speed change) as control data. A reduction of the speed limits was found to be linked to a reduced accident rate and reduced severity of accidents, while at the other roads no changes could be observed. Nilsson calculated that the relative change in the number of severe injuries and the relative change in the speed limits were tied up with a third power relationship. The number of fatalities were linked with a fourth power relationship.

Nilsson used these formulas for both a reduction in speed limits as for the reduction of average speeds driven due to e.g. speed limiters.

Nilsson found the following formulas for the calculation of the reduction in severe injuries and fatalities:

$$\left(\frac{100\%}{\%\ severe\ injuries_{after}}\right) = \left(\frac{speed_{before}}{speed_{after}}\right)^3 \qquad (1)$$

$$\left(\frac{100\%}{\%\ fatalities_{after}}\right) = \left(\frac{speed_{before}}{speed_{after}}\right)^4 \qquad (2)$$

Joksch (1993) found evidence for the use of a fourth power function to relate the number of fatalities with changes in speeds. In his analysis he found values between 3.8 and 4.1. He concluded that the forth power rule is a good rule of thumb to estimate the effects speed changes on fatal accidents. Elvik (2004) confirmed this, however, he published exponents which are a bit different from the ones in the Nilsson formulas (4.5 for fatalities and 2.4 for sever injuries). In the current study we stick to the Nilsson formulas.

The above described method has been used to estimate the effects at motorways. In addition we estimated the effect of reduced speeds on rural roads on the basis of the number of deaths that can be linked with speeding on that roads.

A speed change of 15 km/h results in a reduction of the number of fatalities and severe injuries of 44 and 35%. For fatalities and severe injuries, this is 3 and 2.4% reduction per km/h of speed reduction. This value is lower than the 5% value used by Höhnscheid (2006).

For this study we can not simply apply the fatality and injury reduction rates as defined by Nilsson. The reason for this is that Nilsson estimates the effects when all vehicles reduce their speeds, while in this study only vans reduce their speeds. This implies that the energy released during a collision with a van is only partly lower than in a situation with general speed reduction. We do take this into account by applying the formulas only on the victims caused by vans. Reason for this is that only the number of those victims will reduce because of the speed limiters.

For allocation of victims to vehicles, we use the principle of intrinsic risks. This principle allocates victims in the car to the van in van-car accidents and vice versa. The principle is illustrated in Annex B.

Because Nilssons formulas are for overall speed reductions they do not take into account the effect of differences in speed. Speed limiters for vans result in speed differences between vans and passenger cars on motorways (on average). Those differences may cause a higher risk because passenger cars may change lanes more often. We estimate that the safety effect of this difference in speed is small compared to the extra safety of reduced speed. Therefore, this effect is not taken into account in the current study.

3.3 Socio economic costs benefit analysis

Chapter 5 outlines a socio economic cost benefit analysis on the introduction of mandatory speed limiters in newly sold vans. In a social perspective on cost effectiveness, it is the overall costs to society as a whole that are calculated. The social perspective is useful in the macro-economic context, when the focus is on impact on overall social welfare, irrespective of distribution effects. From the perspective of a given society:
- In principle, external (environmental) benefits do count.
- The effects of taxes and subsidies do not generally count, to the extent that these merely entail redistribution.
- Investments are generally written off over a longer period (i.e. a lower discount rate is assumed) than from the end user perspective.

Below, we briefly discuss the cost categories that play a role.

(In)direct expenditures
The direct expenditures of mandatory speed limiters can be broken down into two cost categories:
- Capital costs:
    - Speed limiter.
    - Reduced vehicle purchase cost as a result of optimal engine sizing[7].
- Operational costs:
    - Fuel.
    - Reduced maintenance costs as a result of reduced wear.

Welfare costs
Besides direct expenditures, introduction of mandatory speed limiters in vans will also affect people's welfare in non-financial ways. The most pronounced of these is the increased travel time of van drivers resulting from the average lower speed of their vehicles.

The welfare cost categories are:
- Increased travel times.
- Improved road safety.
- Pollutant emission reduction benefits.
- GHG emission reduction benefits.
- Congestion effects.

More detailed information and the cost data used is included in Annex C.

---

7 This is an indirect cost, that has never been covered by a cost benefit analysis before. We will therefore calculate with two variants, one with and one without this indirect cost category.

4 Effects on emissions and safety

4.1 Introduction

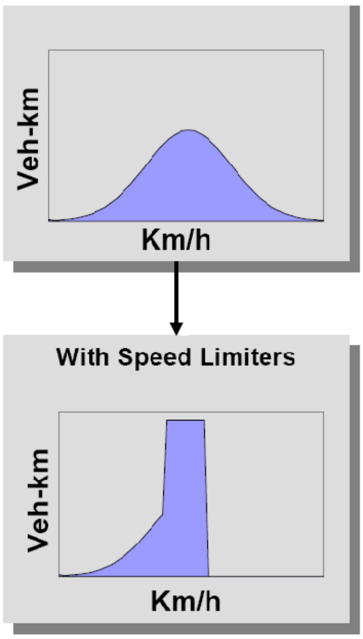
In this chapter, we firstly determine the effects of speed limiters on speed. We subsequently investigate how those changes in speed affect GHG emissions and safety.

4.2 Effects on speeds

The effect of speed limiters depends on the initial speed of vans. The average speed of the vehicles differs between road types and countries. Höhnscheid et al. (2006) presents the speed limits as well as the actual speed at motorways in all countries of the EU.

To obtain the speeds driven once speed limiters are installed, they assumed that the actual speed of vans is distributed over a normal distribution. The speed limiter cuts off the distribution at the respective speed limit. The share of the kilometres originally driven faster than that limit, has now a speed near the maximum possible speed. Figure 6 shows the assumed distribution of the speed of vans and the effect of speed limiters.

Figure 6 The assumed distribution of speed and the effect of speed limiters



Source: Höhnscheid et al., 2006.

Table 4 presents the speed limits, actual speeds and the derived speed once speed limiters are installed for the EU countries.

Table 4 **Speed limits, actual speeds and speeds once speed limiters are installed at 120 or 100 km/h (in km/h) for vans on motorways**

	Speed limit	Actual speed (average)	Speed limiters 120	Speed limiters 100
Germany	150	115	110	96.9
Austria, Czech, Italy, Luxembourg, Poland, Slovakia, Slovenia	130	114	110	96.3
Belgium, France, Greece, Hungary, Lithuania, Malta, The Netherlands, Portugal, Spain	120	112	108	95.3
Ireland, UK	113	106	104	94.2
Denmark, Finland, Latvia, Sweden	110	106	104	93.6
Cyprus, Estonia	100	98	97.3	91.7

Source: Höhnscheid et al., 2006.

A weighted average of the speeds of all countries is derived on the basis of vehicle kilometres of vans on motorways in each country to obtain the average speeds in the EU countries. Those speeds are presented in Table 5. Data available for Belgium from another study correspond with actual speeds driven presented below (TML, 2009).

Table 5 **Speed limit, actual speed and speeds once speed limiters are installed at 120 or 100 km/h for vans on motorways in the EU**

	Speed (km/h)
Average speed limit	125
Actual speed	112
Speed limiters 110 km/h	102
Speed limiters 100 km/h	96.5

The effect of speed limiters on driven speeds on rural roads is less, due to speed limits below 100 km/h.

4.3 Effects on GHG emissions

Because of differences in the speed and driving pattern, the fuel consumption and CO_2 emissions of vans differ between road types. On rural roads there will be little effect. Reason for this is that only the emissions of the speeding vans will be reduced. On the total emissions on rural roads this will only be a small reduction. On motorways the driving pattern will significantly change because, the maximum speed is lowered for all LGVs. The average emission factor of LGVs on motorways is therefore reduced.

The effect of speed limiters on the total emissions of vans can be determined in several ways. Below we determine the reduction potential in different ways and conclude on the most reasonable emission reduction.

Modelling emission factors using VERSIT+

A first method to obtain the reduction potential is by calculation of emission factors at different speeds. TNO used the model VERSIT+ to estimate emission factors for vans on motorways at different speeds. A standard driving pattern with a speed limit at 125 km/h (see Table 6) was used to obtain emission factors for the situation without speed limiters. A linear relation[8] was used to scale the driving pattern to lower speeds, while keeping the driving pattern unchanged. Table 6 presents the results of this exercise.

Table 6 **CO_2 emission factor for vans with and without speed limiters (VERSIT+) on motorways**

	Emission factor (g/km)	Emissions relative to no speed limiters
No speed limiters (125 km/h)	228	100%
120 km/h	221	97%
110 km/h	204	89%
100 km/h	192	84%

The driving pattern of vans with speed limiters on motorways in Europe was not explored. Therefore, the presented emission factors are only an indication for the real performance of those vehicles with speed limiters installed.

Literature

The effect of speed limiters in the Netherlands has been discussed in CE Delft (1998). They present the following reductions for CO_2 emissions:

- 3.8% reduction when the speed is limited at 110 km/h.
- 6.9% reduction when the speed is limited at 100 km/h.

These figures were projected for 2010 and count for the total CO_2 emissions of vans in the Netherlands on all roads. In those figures it is assumed that 30% of the vehicle kilometres are driven on motorways. In the Netherlands the legal speed limit is 120 km/h.

A study by AVV (AVV, 2004) mentions a reduction of 15%, but it is unclear whether this figure represents GHG emissions or air pollutants. This value is also not underpinned with other sources.

Field trials

Emission reductions were also investigated in field trials. In 1998, a field test with Ecodrive[9] speed limiters on 54 vans in the Netherlands was performed. Vehicles were speed limited at 120 km/h and a revolutions per minute (rpm) limitation of 3,200-3,700 rpm was applied, depending on the gear. The Ecodrive obliges good driver behaviour, within the speed limitations set by the Dutch authorities. If the driver exceeds the indicated rpm limitations, the maximum speed is limited with steps of 10 km/h until the driver shows good behaviour for 5 minutes. The Ecodrive leads to slower acceleration, lower maximum driving speeds and gear changes at lower rpm's.
The use of the Ecodrive has resulted in a fuel consumption reduction of 6%. This conclusion is based on two six months trials in the same season. One before the fitting of the Ecodrive systems and one after the fitting of the Ecodrive speed limiters.

---

8 100/125 and 110/125.

9 www.ecodrive.eu.

In 2002 another test with 177 vans was performed in the Netherlands. In this test with mandatory fixed speed limiters, the maximum speed was limited at 110 km/h. The six month experiment with a six month reference test concluded on 5% fuel consumption reduction.

Conclusions on the total emission reduction potential

Table 7 presents the potential emission reductions obtained from the sources mentioned above. All values are average CO_2 emissions of vans, taking al road types into account. For the modelled emission factors we assumed that the emission factors on roads other than motorways remain unchanged. This might be a slight underestimate, since speeds will be limited there as well to some extent.

Table 7 **Potential reductions of speed limiters in total fuel consumptions and CO_2 emissions according to different sources (average over all roads)**

	Modelled[2]	Field trials	Höhnscheid, 2006[2]	CE Delft, 1998
Assumed speed limit (km/h) in study	125	80-100-120	125	100-120
Effect of speed limiters 110 km/h	3%	5%	3%	4%
Effect of speed limiters 100 km/h	5%		5%	7%

2 Assumed that there is no effect on roads other than motorways.

Figures from the field trials and CE (1998) underestimate the potential relative emission reductions for the EU because they depart from the Dutch speed limit of 100-120 km/h on motorways instead of the average EU limit of 125 km/h limit. On the basis of the modelled emission factors we conclude that this results in an underestimation of less than 1% with respect to the average European speed limit of 125 km/h.

The modelled emission reductions and the reduction potential presented by Höhnscheid (2006) assume that there are no emission reductions on roads other than motorways. Although, there might be a decline in emissions, due to violation of the speed limits. This decline is however hard to estimate as there are no figures on the kilometres driven at such high speeds. The effect is, however, included in the results from the field trials. For this reason, the figures from field trials are the most relevant.

Taking the figures in Table 7 and the discussion above into account we conclude on the following emission reductions, taking all road types into account[10]:
- 4-5% CO_2 emission reduction for speed limiters at 110 km/h.
- 6-7% CO_2 emission reduction for speed limiters at 100 km/h.

The precise effects depends on the type of speed limiter. If the speed limiter also enforces a smooth and fuel-efficient driving pattern (see the Ecodrive example above), the effect would be higher than presented.

10 In the current study we did not take speed limiters of 120 km/h into account. On the basis of the modelled data we can however derive an CO_2 emission reduction of 1%, which is 0.7 Mton CO_2.

Based on the reduction percentages and the total emissions of vans on all road types in Europe from Tremove (version 2.7b), the total emission reduction is calculated. Table 8 shows that the introduction of mandatory speed limiters on vans reduces the greenhouse gas emissions of those vehicles by 2.8-3.5 Mton CO_2 for 110 km/h and 4.2-4.8 Mton CO_2 for 100 km/h in 2010.

Table 8 **Total van emissions of CO_2 under different speed limiter scenario's in the EU-27 (Mton) in 2010**

	CO_2
No speed limiters (125 km/h)	69.2
Speed limiter 110 km/h	65.8-66.5
Speed limiter 100 km/h	64.4-65.1

The forthcoming TNO study (TNO, 2010) indicates that the effect of lower power-to-weight ratio's will potentially also reduce the emissions of vans. Optimal power rating would save emissions with 5%. This implies that the overall effect of speed limiting could be higher than the figures presented above, if optimal engine sizing will be applied by the market. The effects of optimal engine sizing and speed limiting interact, and therefore the effect of both measures together is lower than the effect of the two single measures. A very rough estimate of the effect is 7% to 8.5%, for 110 and 100 km/h respectively. This figure assumes that 75% of the sum of effects remains if both are applied.

4.4 Effects on safety

4.4.1 Motorways

Nilsson's formulas

On the basis of the Nilsson formulas (Section 3.2.2), we provide the relative reductions for the proposed speed limits. The figures are calculated on the basis of reduced speeds driven, see Table 9. Although speed limiting at 120 km/h is not taken into account in the current study, the relative effect is shown as additional information.

Table 9 **Relative reduction in deaths and injuries under different van speed limiter scenario's in the EU-27 on motorways**

	Casualties (%)	Severe injuries (%)	Slight injuries (%)
Speed limiter 120 km/h	13	10	7
Speed limiter 110 km/h	31	24	20
Speed limiter 100 km/h	46	37	26

Source: On the basis of the Nilsson formulas and Table 5.

The Dutch study by AVV (AVV, 2004) calculates with a safety improvement that is more conservative than the figures used in this study. Consequently, the conclusion on the number of deaths that can be prevented is lower.

Field tests

It is not simple to determine the effect of speed limiters on traffic crashes. The proportion of vehicles equipped with speed limiters in the field trials performed was relatively small, while, in order to measure the effect on traffic crashes, a substantial number of speed limited vehicles is required.

However, Nilsson's formulas, which are based on statistical research, show that speed limiters would reduce the number of accidents and fatalities significantly.

Estimate of traffic safety effects

In the table below, the effects of speed limiters on vans in the EU are shown, using the Nilsson formulas (Table 9). The number of deaths and injuries were allocated to vans on the basis of intrinsic risks. The data presented are an average for the period 2006-2008. Due to deviation of the trend for individual years, the average over the three most recent years has been calculated.

Table 10 **Deaths and injuries under different van speed limiters scenario's in the EU on motorways that can be allocated to vans**

	Casualties	Severe injuries	Slight injuries
No speed limiters (125 km/h)	258	1,611	9,750
Speed limiter 110 km/h	178	1,224	7,800
Speed limiter 100 km/h	139	1,015	7,215

4.4.2 Rural roads

Speed limiters would not only have effects on motorways, but also on rural roads due to lower speeds driven there. Speed limit violation is one of the major causes of severe traffic accidents and the Nilsson formulas indicate higher fatality risks at higher speeds. Therefore, we give a first estimate of the effects to be expected.

At any given time from 15 to over 50% of vehicles in EU traffic are travelling at least 15 km over the posted speed limit (VTT, 2003). Several studies show that vehicles that drive considerably faster than average on that road have a higher crash rate. Rural roads have a much more complex design than motorways, which is the reason why they are not designed for higher speeds. In addition, speed differences between vehicles also play a role in accidents.

The above indicates that the installation of speed limiters on vans will also result in less accidents with vans involved on rural roads. An American study that includes data for six States concluded that on average 18%[11] of all casualties were due to exceeding of the posted speed limits (NHTSA, 2009). SWOV (2010) reports a value of 30% used in the context of urban areas, but indicates that their value is uncertain.

The question is which part of casualties due to speedy driving can be prevented by speed limiters limited at 100 or 110 km/h. To answer this question, we use a Dutch study by SWOV (SWOV, 2003). The Dutch rural road under study with a speed limit of 80 km/h shows a mean speed of 90 km/h with a standard deviation of 13 km/h (normal distribution). However, a mean speed of 90 km/h might be too high for a European average, therefore we also calculate the effects for an average speed of 82 km/h with a lower standard deviation.

11 The overall impact of speed is even higher, since driving too fast for conditions below the speed limits is another major cause of accidents that is not affected by the speed limiters studied here.

A mean speed of 90 km/h implies that on this road 22% of the vehicles drive at a speed above 100 km/h. The average speed of the vehicles with speeds above 100 km/h is 106 km/h. If these vehicles reduce their speed to 100 km/h, the number of deaths will reduce by 21%, the Nillson formulas dictate. We use this figure as an estimate for the reduction of the number of fatalities. This implies a 3.6% reduction of the number of casualties, starting from the 18% derived from the US study.

The same method was used to calculate the effects under a scenario of 82 km/h with a standard deviation of 8 km/h. The calculations have been made for a speed limit of 100 and 110 km/h.

Table 11 **Relative reduction of fatalities and injuries on rural roads**

Speed limit (km/h)	100		110	
Mean speed (km/h)	*82*	*90*	*82*	*90*
Standard deviation (km/h)	*8*	*13*	*8*	*13*
Reduction number of fatalities (%)	2.0	3.6	-	2.3
Reduction severe injuries (%)	1.6	2.9	-	1.8
Reduction slight injuries (%)	1.1	2.0	-	1.5

The results show that the number of fatalities on rural roads would reduce with 2-4% under a 100 km/h scenario and with 0-2% under a 110 km/h scenario. The figures presented above should be interpreted as a first estimate.

Just like for motorways the number of casualties on rural roads are allocated to vans on basis of intrinsic safety. Table 12 presents effects of speed limiters on rural roads on average for the period 2006-2008.

Table 12 **Deaths and injuries under different van speed limiters scenario's in the EU on rural roads**

	Casualties	Severe injuries	Slight injuries
No speed limiters (125 km/h)	2,489	12,792	52,686
Speed limiter 110 km/h			
82 km/h	2,489	12,792	52,686
90 km/h	2,430	12,560	51,891
Speed limiter 100 km/h			
82 km/h	2,439	12,588	52,096
90 km/h	2,399	12,422	51,614

4.4.3 Synopsis

The overall effect of van speed limiters on motorways and rural roads is presented in Table 13. The estimate is based on the intrinsic risk allocation principle.

Table 13 **Prevented deaths in the EU due to van speed limiting (2006/2007/2008 data)**

	100 km/h	110 km/h
Deaths		
Motorways	119	80
Rural roads	49-90	0-58
Severe injuries		
Motorways	596	387
Rural roads	204-370	0-232
Slight injuries		
Motorways	2,535	1,950
Rural roads	590-1,072	0-795

Overall, speed limiting avoids 80-119 deaths on motorways and 29-70 deaths on rural roads in the EU for speed limiting at 110 and 100 km/h respectively. This figure applies to an average of the years for which the most recent data is available: 2006-2008.

5 Socio economic cost benefit analysis of van speed limiting

5.1 Introduction and design

In this chapter we calculate the costs and benefits of mandatory speed limiters for new vehicles. Under the assumption of a final legislative proposal at early 2011, the date for implementation of speed limiters could be set at January 2012 so that from January 2012 onwards only speed limited vans would be sold. This short timeframe is possible, since the technology is available already. Speed limiting can be easily done by adapting of the central computing unit of a vehicle, at virtually no additional manufacturing costs.

When high speeds can not be driven anymore, the engine power of new vans can be reduced, since with speed limiters applied high power-to-weight ratios will not bring time benefits anymore. The effect of optimal power rating on the purchase costs is estimated between 0 and 10% according to TNO (2010). For this report we use an average value of 2-5% of the purchase costs in the case of 110 km/h and 3-6% in the case of 100 km/h.

Two variants of the CBA have been developed. Variant A without taking the effects of optimal power rating into account and variant B that accounts for the benefits of lower vehicle purchase costs due to optimal power rating and the accompanying fuel consumption benefits.

Safety figures for 2012 have been achieved by extrapolation of the trend in the safety performance of LGVs between 2000 and 2008. For the safety effects on rural roads, an average of the best and worst case scenario has been taken.

The costs and benefits presented apply to the year 2012.

5.2 Socio economic cost benefit analysis

In Table 14 and Table 15 all relevant costs and benefits are tabled at the vehicle level for a new vehicle. Variant A assumes no changes to vehicle power, while Variant B assumes that optimal power rating will occur due to the introduction of mandatory speed limiters.

Annex B holds an extensive methodological approach for this analysis and contains the base data used.

Table 14 **Variant A: Social cost-benefit analysis on a per vehicle basis of van speed limiting WITHOUT optimal power rating**

Speed limit (km/h)	110		100	
	Costs (€/year)	Benefits (€/year)	Costs (€/year)	Benefits (€/year)
Purchase of speed limiter	0		0	
Purchase of vehicle vehicle		0		0
Additional travel time		-143		-256
Fuel		45		64
Maintenance		6		16
Safety		20		36
Air pollution		36		45
CO_2		6		8
Overall benefits (€/year)		**-30**		**-86**

Table 15 **Variant B: Social cost-benefit analysis on a per vehicle basis of van speed limiting WITH optimal power rating**

Speed limit (Km/h)	110		100	
	Costs (€/year)	Benefits (€/year)	Costs (€/year)	Benefits (€/year)
Purchase of speed limiter	0		0	
Purchase of vehicle vehicle		49-123		74-148
Additional travel time		-143		-256
Fuel		69		84
Maintenance		6		16
Safety		20		36
Air pollution		36		45
CO_2		7		10
Overall benefits (€/year)		**47-121**		**10-84**

The cost-benefit analysis shows that the bandwidth of benefits is between € -86 and € -30, for speed limiting without optimal power rating. The benefit bandwidth is between € -15 and 121 for speed limiting with optimal power rating. Speed limiting at 110 km/h has better cost-benefit ratio than speed limiting at 100 km/h.

The benefits balance the costs on average over both variants, since variant A results in costs and variant B in benefits. Optimal power rating has, however, a significant impact on the outcome of the cost-benefit analysis.

Under scenario A, overall costs of speed limitation would amount € 60-190 million per year. In the case of scenario B, the benefits would be around € 100-180 million per year.

Increased travel time comprise the biggest cost category, while fuel and also reduced vehicle purchase costs are amongst the biggest benefits.

5.3 Sensitivity analysis

The various effects resulting from introduction of a mandatory speed limiter in vans is associated with all kinds of uncertainties. To acquire a better grasp of these uncertainties, in this section we perform a series of sensitivity analyses.

Value of time
As we have seen, the costs of additional travel time are a major component of the overall costs of a mandatory speed limiter in vans. However, the literature available agrees on the value to be used. The value of time has been lowered by 25% due to correcting for the taxes included in the figures. If we would apply the figures that are generally applied, the additional travel time costs would be 25% higher. This is between € 35 and 64.

Speed limiter costs
If speed limiters would cost € 150 as estimated in Höhnscheid (2006), the yearly costs would amount € 18.

Deaths and injuries on rural roads
Not calculating with deaths and injuries on rural roads would reduce the benefits with € 6-15.

Variation in fuel prices
Fuel prices are difficult to predict, but changes may have effect on the results. If the pre-tax fuel price would change with 20%, the overall benefits would be € 10-15 higher or lower.

6 Conclusion and discussion

6.1 Introduction

Speed limiting of vans is a measure to reduce the CO_2 emissions of vans and improve the safety situation on the European roads. This report estimates the effects of van speed limiting on climate and safety and offers a cost-benefit analysis that provides insights in all costs and benefits to society. UK research shows that speed limiting for lorries has brought significant improvement of the safety situation on the roads. It can be applied easy and without additional manufacturing costs.

6.2 Effects on safety and climate

The potential GHG emission reduction has been documented in several research studies and results from field tests. The estimated average reduction potential over all roads is:
- 4-5% CO_2 emission reduction for speed limiters at 110 km/h.
- 6-7% CO_2 emission reduction for speed limiters at 100 km/h.

The effect of improved driver behaviour due to limiting the maximum engine rpm, is not included in this figure. If this would be included, the effect would be higher. The presented figure corresponds with an emission reduction of 3-5 Mtonne in the EU in 2010, assuming a speed limiter on all vehicles.

The safety effects have been estimated on the basis of the widely used Nilsson formulas. These formulas, which are based on statistical research, describe a fourth power function for the relation between speed changes and the number of fatalities. The calculated safety rates have been applied to EU traffic safety data, extracted from the CARE database[12]. The number of deaths that have been allocated to vans have been estimated on the basis of intrinsic risks. This principle allocates victims in the car to the van in van-car accident and vice versa.

Speed limiting at 100 or 110 km/h will not only give benefits on motorways, but also on rural roads, where speeding is an important cause of accidents. The effects estimated on motorways and rural roads are tabled below (see Table 16). The relative effects presented relate to the road types mentioned.

[12] The CARE database is a Community database on Accidents on the Roads in Europe. The database is published by the European Commission on Mobility and Transport.

Table 16 **Overview of relative reductions in the number of casualties and injuries caused by van-related accidents**

	Casualties (%)	Severe injuries (%)	Slight injuries (%)
Motorways			
Speed limiter 110 km/h	31	24	20
Speed limiter 100 km/h	46	37	26
Rural roads			
Speed limiter 110 km/h	0-2.3	0-1.8	0-1.5
Speed limiter 100 km/h	2.0-3.6	1.6-2.9	1.1-2.0

Note: The numbers apply to deaths and injuries related to van-accidents that are allocated on the basis of intrinsic risks in this study.

As Table 16 shows, the share of deaths and injuries that can be allocated to vans strongly reduces on motorways due to speed limiting. The reduction in the number of deaths as a result of speed limiting at motorways at 100 km/h is 46%. This is significantly bigger than the reduction in the number of deaths as a result of speed limiting at 110 km/h, which is estimated at 31%.

The table shows that the relative effects on rural roads are limited compared to motorways, but the number of victims is significantly higher on rural roads. Overall, speed limiting would avoid 80-119 deaths on motorways and 29-70 deaths on rural roads for speed limiting at 110 and 100 km/h respectively in the EU[13].

6.3 Socio economic cost-benefit analysis

A cost-benefit analysis has been performed to assess all costs and benefits to society associated with mandatory application of speed limiters to new vans. Two variants have been calculated, one without optimal power rating and one with optimal power rating. The cost-benefit analysis shows that the benefits balance the costs on average over both variants calculated, since variant A results in costs and variant B in benefits. Optimal power rating has, however, a significant impact on the outcome of the cost-benefit analysis.

Additional travel time costs, lower vehicle purchase costs due to optimal power rating and reduced fuel costs are amongst the most important costs items.

6.4 Comparison with other studies

This study uses an approach that differs from other studies on speed limiters for vans on some aspects. The most important choices and differences with respect to the analysis of effects are:
- This study includes an estimate of the benefits at rural roads that are the result of less speeding.
- This study uses intrinsic risks as a rule for allocation of victims to vans.

13 The figures apply to an average of the 2006-2008 period.

For the cost-benefit analysis, a number of methodological choices have been made that differ from a previously made cost benefit analysis in the IMPROVER study (Hönscheid, 2006). In addition, different valuation figures were used in that study. The current study:

- Investigates the costs and benefits for new vans. For new vans, the costs of speed limit programming in the central computer can be regarded as zero, if applied on a large scale during vehicle production.
- Takes the benefits of purchasing vehicles with lower power to weight ratio's into account, because high top speeds can not bring benefits to transport companies anymore.
- Corrects the value of time (VoT) for the share of taxes and social contributions.
- Bases the external cost valuation figures on the recent IMPACT report (CE, 2008), which is the basis for the EU road pricing dossier.

The IMPROVER study, however, concluded that the benefits outweigh the costs with a factor of 1.65 for the existing vehicle fleet. This report concludes that for the average of the variants calculated, the difference between the costs and benefits is small. This implies that speed limiters could be applied at no costs to the society.

Literature

Bischop, 2008
R. Bishop et al.
Safety Impacts of Speed Limiter Device Installations on Commercial Trucks and Buses : A Synthesis of Safety Practice
Washington D.C. : Transportation Research Board, 2008
http://onlinepubs.trb.org/onlinepubs/ctbssp/ctbssp_syn_16.pdf

Carsten and Tate, 2005
O.M.J. Carsten and F.N. Tate
Intelligent speed adaptation : accident savings and cost–benefit analysis
In : Accident Analysis & Prevention, vol. 37, no. 3 (2005); p.407-416

CE, 2009
Eelco den Boer, Femke Brouwer, Arno Schroten, Huib van Essen
Are trucks taking their toll? : The environmental, safety and congestion impacts of lorries in the EU
Delft : CE Delft, 2009

CEC, 2009
Impact assessment : Accompanying document to the proposal for a Regulation of the European Parliament and of the Council, setting emission performance standards for new light commercial vehicles as part of the community's integrated approach to reduce CO_2 emissions from light-duty vehicles
COM(2009) 593 final
Brussels : Commission of the European Communities(CEC), 2009

Elvik, 2004
Rune Elvik
Speed, speed cameras and road safety evaluation research. A presentation given to the Royal Statistical Society
Oslo : Institute of Transport Economics, 2004

Höhnscheid, et al., 2006
Karl-Josef Höhnscheid, et al.
Impact assessment of measures concerning the improvement of road safety of light goods vehicles (LGV). IMPROVER, Subproject 2, Final report
http://ec.europa.eu/transport/roadsafety_library/publications/improver_final_report_sp2_060430.pdf

Joksch, 1993
H.C. Joksch
Velocity change and fatality risk in a crash : A rule of Thumb
In : Accident Analysis and Prevention vol. 25, nr. 1 (1993); p. 103-104

NHTSA, 2009
Cejun Liu and Chou-Lin Chen
An Analysis of Speeding-Related Crashes : Definitions and the Effects of Road Environments
Washington D.C. : U.S. Department of Transportation, National Highway traffic safety Administration (NHTSA), 2009

LAT, 2008
European Database of Vehicle Stock for the Calculation and Forecast of Pollutant and Greenhouse Gases Emissions with TREMOVE and COPERT
Thessaloniki : Aristotle University Thessaloniki, Lab. of Applied Thermodynamics (LAT), 2008

SWOV, 2003
J.J.F. Commandeur, drs. I.N.L.G. van Schagen and drs. S. de Craen
Sobere inrichting rurale gebiedsontsluitingsweg: effecten op het rijgedrag
Leidschendam : SWOV, 2003

SWOV, 2004
L.T. Aarts
Snelheid, spreiding in snelheid en de kans op verkeersongevallen
Leidschendam : SWOV, 2004

SWOV, 2007
SWOV Fact sheet Intelligent Speed Assistance (ISA)
Leidschendam : SWOV, 2007

SWOV, 2010
H.L. Stipdonk and L.T. Aarts
De onveiligheid van kleine snelheidsovertredingen : Een effectschatting voor het aantal verkeersslachtoffers binnen de bebouwde kom
Leidschendam : SWOV, 2010

TML, 2009
Impact van maximumsnelheid op autosnelwegen
Leuven : TML, 2009

TNO, 2004
Quick scan optimale snelheidslimiet op Nederlandse snelwegen
S.l. : TNO, 2004

TNO, 2008
Isabel Wilmink, Wiel Janssen, Eline Jonkers, et al.
eIMPACT Socio-economic Impact Assessment of Stand-alone and Co-operative Intelligent Vehicle Safety Systems (IVSS) in Europe
Deliverable D4 Impact assessment of Intelligent Vehicle Safety Systems, Version 2.0
Delft : TNO, 2008

TNO, 2010
Potential CO_2 reduction from engine downscaling for light commercial vehicles, (Draft, forthcoming)
S.l. : TNO, 2010

VTT, 2003
Tapani Mäkinen, David M. Zaidel and Gunnar Andersson, et al.
Traffic enforcement in Europe: effects, measures, needs and future, Final report of the ESCAPE consortium
S.l. : Technical Research Centre of Finland (VTT)

Annex A CARE safety data

Table 17 **Safety data for the EU-27, for 2000-2008 based on the CARE database. For 2012 figures are based on linear extrapolation (data concern victims allocated to vans on the basis of intrinsic risks)**

		2000	2002	2004	2006	2007	2008	2012
Killed at 30 days	Motorways	379	422	285	289	294	190	140
	Rural roads	3,228	2,960	2,752	2,567	2,415	2,484	1,990
	Urban roads	1,315	1,169	1,211	1,106	962	1,117	
	All road types	4,915	4,554	4,251	3,957	3,674	3,779	
Severely injured	Motorways	1,996	1,839	1,518	1,735	1,601	1,497	1,304
	Rural roads	15,105	13,683	12,230	13,400	12,756	12,220	11,100
	Urban roads	14,346	11,619	9,620	12,522	11,531	10,221	
	All road types	31,320	27,109	23,363	27,546	25,823	23,970	
Slightly injured	Motorways	10,561	10,730	9,473	10,296	9,797	9,159	8,885
	Rural roads	56,142	54,875	52,299	52,008	53,582	52,468	50,340
	Urban roads	87,766	86,667	74,667	76,718	78,088	75,380	
	All road types	154,541	152,629	136,622	139,038	141,530	137,176	

Annex B Allocation of victims in traffic accidents

The costs of the suffering due to lives lost and injuries incurred in traffic accidents place a serious burden on society. Given the weight and momentum of vans compared to other road users, accidents involving these vehicles can be particularly serious. To estimate the total number of fatalities and injuries arising in road accidents involving vans we distinguish between:
- Unilateral accidents.
- Multilateral accidents.

In the case of unilateral accidents involving a van, all the victims can plainly be attributed to this vehicle category. With multilateral accidents, however, the international literature provides no standard method for allocating the victims to the respective parties. There are essentially three allocation methods available:
- On the basis of accident involvement.
- On the basis of guilt.
- On the basis of intrinsic risk.

Allocation on the basis of accident involvement simply attributes the costs associated with the victims on an equal basis. The consequence of this choice is that in a collision between a bicycle and a van, with the cyclist the obvious victim, 50% of the costs will be allocated to the cyclist. As vans pose far more of a threat on roads than bicycles, however, this method will not be applied.

The second method allocates on the basis of guilt, assigning victims to the party causing the accident. We shall not apply this method, for the following main reason: responsibility for suffering does not lie solely with the party making a mistake, because *every* traffic participant poses an intrinsic danger.

Vehicles that are faster and heavier obviously pose a greater threat, an intrinsic risk that can be clearly derived from the statistics. In an accident involving a passenger car and a lorry, the driver of the former has a far smaller chance of survival than the lorry driver. Even though the latter may not be guilty of making a mistake, then, the mere presence of lorries on the roads creates a responsibility for the severity of the accidents they are involved in. The principle of intrinsic risks is also applied in the law as a means of protecting vulnerable road users like pedestrians and cyclists.

The third method takes the above mentioned intrinsic risk into account. The question now is how the notion of intrinsic risk can be used to derive a key for allocating costs across the various vehicle categories. Here, we have opted to allocate victims inside the van to the opposite party in multilateral accidents and vice versa.

Speed limiters will reduce the number of accidents, consequently the number of victims will reduce as well. Only part of the victims in accidents in which vans are involved, are caused by the vans. Because other road users do not slow down, not the total number of victims will be reduced, but only the part for which the LGV is responsible. It is the intrinsic risk of the vehicle that reduces, therefore only the victims allocated on the basis of this intrinsic risk will be reduced.

Safety data in the current study is obtained by application of this method on data from the EU CARE database.

Annex C Data used in socio economic cost benefit analysis

C.1 Introduction

In this annex, the cost data used for the cost benefit analysis is illustrated.

C.1.1 Direct and indirect expenditures

Capital costs
The speed limiter installation costs strongly depend on when the device is installed in the vehicle: during manufacture, or at a later date (retrofit). In the first case the costs are low for modern vehicle and will be virtually zero when applied at a large scale. Mechanical retrofitting for older vehicles is more expensive.

For the cost-benefit analysis, we assumed zero costs.

In addition to the capital costs of speed limiter also vehicle capital costs play a role. Because high speeds can not be driven anymore, the engine power of new vans are likely to be reduced since companies outweigh cost and benefits. The effect of optimal power rating on the purchase costs is estimated between 1 and 10% according to TNO (2010). For this study we use an average reduction of
2-5% (110 km/h) and 3-6% (100 km/h) of the purchase costs in case of optimal power rating. Other data used are depreciation period of 10 years, an average purchase costs of € 20,000 (excl. taxes) and an interest rate of 4%.

Fuel costs
In this analysis we assume a diesel price, excluding taxes of € 0.57 per litre. This corresponds with prices of end April 2010. We estimate these prices to be representative for 2012.

Reduced wear of tyres
The reduction in average van speed following installation of speed limiters also reduces the costs of tyre wear. Limiting vehicle speed to 110 or 100 km/h reduces these costs by 10-20% (CE, 1998). Tyre costs are € 0.01 per vkm[14]. The estimated costs reduction is € 0.001/vkm in the case of speed limiting at 110 km/h and € 0.002/vkm in the case of speed limiting at 100 km/h.

Reduced maintenance costs
Finally, a lower average vehicle speed will also lower the cost of engine and gearbox maintenance. For the reason of lack of data, however, these costs have not been included.

[14] These costs are € 100 per tyre and a lifespan of 40,000 kilometre.

C.1.2 Welfare costs

To estimate the welfare costs, we will use the value cited in the recently published IMPACT report CE Delft (2008a), which can be seen as a state-of-the-art handbook for calculating welfare costs of transport. To calculate price levels of 2000 into 2010, HCPI figures from Eurostat have been used and extrapolated for 2010-2012 period. The available data indicate price increases of 29% during the 2000-2012 period.

Increased travel times

For road journeys of a business nature, an hour of travel time (Value of Time, VoT) is worth € 23.8 (2002 price level) per person, according to the HEATCO project (CE, 2008). This figure is well in line with values used by UNITE.

However, these figures that are often used in socio economic cost benefit analyses, include also taxes, defined by the stated preference (SP) method used for valuation of non-monetary costs. The value of time is defined on the basis of questions to companies on the overall costs of additional travel time. Salaries of drivers include some 40% taxes and social security contributions. On the basis of discussion with several economists, we decided to correct the VoT figures for the share of taxes.

VoT figures exist for 53% of direct time costs (labour). The remaining costs are indirect costs, e.g. the vehicle, management, etc. Correcting for inflation and subtraction of a marginal tax burden of 40% in Europe over the direct time costs, results in a VoT of € 27 (2012 price) per hour per vehicle, taking an average vehicle occupancy of 1.1 persons per vehicle into account.

Increased travel times on different road types has been calculated using data on annual mileage and the division over different road types (see below). Valuation of Increased travel times has been applied for motorways as well as on rural roads, where speed limiters prevent speeding. The effect on rural roads is, however, limited.

Improved road safety

To assign a value to the number of traffic deaths requires monetary valuation of a 'statistical human life'[15]. The epithet 'statistical' indicates that this is a valuation of risk reduction, not of tangible human lives. After all, if tangible rather than statistical lives are involved, as with miners trapped underground, for example, society's willingness to pay soars to virtually infinity. When it comes to reducing risks, however, in practice people prove to be prepared to pay only a finite sum for further risk reduction, based on comparison with the benefits of alternative uses of the funds. Based on people's willingness to pay to reduce the risk of death in a range of situations, researchers have calculated the financial Value of a Statistical Life (VSL).

CE Delft (2008) reports cost figures that can be used to value the cost of traffic accidents. This figures are dominated by the costs of pain, grief and suffering of the average transport accident victim. For fatalities these costs can be estimated by using the value of a statistical life (VSL), for which an average value for Europe of € 1.5 million (2000 price level) is recommended. For severe and slight injuries these values are respectively 13% and 1% of the VSL. In addition to the costs of pain, grief and suffering, further direct and

[15] We are concerned here solely with the external costs, i.e. traffic deaths other than the occupants of the vehicles involved in an accident, for the risk of oneself perishing in traffic as a result of one's own actions is already accounted for.

indirect economic costs (medical costs, net production losses, administrative costs, etc.) have to be considered. For fatalities these economic costs are estimated at 10% of the VSL. Based on CE Delft (2008) it is estimated that for severe and slight injuries these percentages are 2% and 0.1% of the VSL, respectively.

On the bases of the total number of victims and the total numbers of kilometres driven by vans, costs are calculated per kilometre. By multiplying this by the kilometres driven by new vehicles, the total benefits of improved safety performance has been calculated.

GHG emissions
There is a vast amount of literature on the issue of valuing the impacts of CO_2 emissions. For this measure, calculating with prevention costs would be most appropriate, since the overall EU climate policy goals will not be altered. An important drawback of this method is the implicit assumption that the policy target is a perfect reflection of the preferences of individuals. Preference is therefore often given to valuing environmental effects using the damage cost approach. However, if the physical impacts of environmental effects are hard to estimate and if policy targets are available, then an avoidance cost approach may be preferable.

CE Delft (2008) provides an overview of available GHG cost figures.

The recommended values for 2010 in CE Delft (2008) is € 25 per tonne CO_2, based on the avoidance cost for the economy as a whole.

Air pollution
By lack of overall EU prevention costs, air pollution costs will be based on the damage costs approach. Air pollution costs are caused by the emission of air pollutants such as particulate matter (PM) and NO_x and consist of health costs and the costs associated with damage to buildings and materials, crop losses and damage to the ecosystem (biosphere, soil, water). Health costs (due mainly to PM and NO_x from exhaust emissions) constitute by far the most important cost category. The costs cited in CE Delft (2008) for NO_x are € 4,400 per tonne (2000 price level). For this study we will use an average value of € 55,000 (2000 price level) per tonne of pollutant for PM, representing the damage costs outside urban areas.

The estimated emission reduction per vehicle kilometre is 0.29–0.37 g/vkm for NO_x and 0.0024 to 0.0042 g/vkm for PM_{10} for speed limiting at 110 and 100 km/h respectively. These figures apply to Euro-5 vehicles and result from VERSIT+ simulation by TNO.

Reduced congestion
Road capacity is optimally utilised at an average speed of around 90 km/h (TNO, 2004). Limiting the speed of vans will therefore probably lead to improved traffic flow on motorways and consequently less congestion. On the other hand, lower speeds for vans may lead to increased change of lanes by passenger vehicles, which may hamper the traffic flow. The net effect of both is unknown, due to lack of data.

In addition, crashes on motorways are regularly accompanied by congestion, which is caused by the temporary reduction in road capacity (e.g. blocking of a lane on a motorway). Congestion leads to time losses. These costs are not covered under the assessment of the benefits of improved road safety.

TNO (2008) provides an overview of different studies and concludes on values of € 15,500 for congestions due to accidents with fatalities, € 5,000 for congestions due to accidents with personal injuries.

Because the values are low, congestion is not included in the cost-benefit analysis.

C.2 Other data used

The data used on traffic performance and fuel consumption that have been used for the CBA are tabled below.

Table 18 Data used for CBA calculations

		Source
Yearly mileage (km)	20,000	(CEC, 2009)
Share of vkm driven on MW	30%	Tremove
Share of vkm driven on rural roads	60%	“
Mio vkm MW (Tremove 2012)	82,837	“
Vkm rural (Tremove 2012)	155,602	“
Newly registred vans	2,157,105	
Fuel consumption (km/liter)	11.5	(CEC, 2009) with 20% correction for real world fuel consumption
CO_2 emission (g/vkm)	244	“