FINAL REPORT

Effects of adapting the rules on weights and dimensions of heavy commercial vehicles as established within Directive 96/53/EC

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Directorate-General Energy and Transport
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Executive summary

The current directive

Directive 96/53/EC regulates weights and dimensions of heavy commercial vehicles within the territory of the European Union. Now twelve years old, the directive may have reached its limitations, and risks to become a barrier to the natural growth of the freight transport market. This study was commissioned by the Directorate General for Energy and Transport, to investigate the possible effects of changing the directive to allow for longer and/or heavier vehicles in international transport. A number or alternatives were suggested, among which the modular concept.

The current regulation permits trucks of maximum 16.5 m (1 point of articulation) or 18.75 m (1 or 2 points) in length, 40 tonnes in weight and 4 m in height to circulate across European borders. For intermodal traffic, 44 t is the current maximum. The directive also sets limits for axle loads and overhangs. Countries are allowed to set the maxima at higher levels, but only on their own territory. The modular concept, with limits of 25.25 m and 60 t, has been in use for years in Sweden and Finland. Many countries have set their maximum load at 44 t instead of 40 t. The directive also covers passenger transport by coach. This study does not cover that domain, but instead focuses solely on freight transport.

Project scope and objectives

The aim of the project was to provide advice to the Commission on the optimal weights and dimensions of heavy vehicles. The advice focuses on the effects, both positive and negative, of the use of bigger and/or heavier vehicles, including the modular concept at various maximal dimensions and weight levels in and between adjacent and consenting Member States.

In this study, 4 LHV (*Long and heavy vehicles*) scenarios for 2020 have been studied.

1. *Scenario 1: "Business as usual"*. This first scenario assumes no changes to the road transport equipment constraints that were valid in 2000. The scenario takes into account projected economic developments and projected transport demand in Europe until 2020. All other scenarios take this one as the reference/base case.
2. *Scenario 2: "LHV Full option": Europe-wide permission of 25.25 m and 60 t trucks.* These LHVs trucks are allowed on all European motorways (i.e. backbone roads). The usage of LHVs on regional roads may be restricted.
3. *Scenario 3: "Corridor/Coalition": LHVs of 25.25 m and 60 t are allowed in some countries, while Europe-wide only 18.75 m and 40 t trucks are allowed.* This scenario is a mix of scenarios 1 and 2. There is a group of countries that permit LHVs on their motorways, possibly putting some restrictions for the usage of regional roads, while the rest stick to the current restrictions (40t 18.75m). We include into the coalition 6 European countries: Sweden, Finland, Denmark, Germany, The Netherlands and Belgium.
4. *Scenario 4: "Intermediate": Europe-wide permission of up to 20.75 m 44 t trucks.* This scenario represents a gradual increase in vehicle constraints, namely 10% of carrying capacity. The choice of dimensions and constraints is "realistic" and reflects wishes of car transporters and chemical industry.

Conclusions

<u>All scenarios give an overall positive effect on society compared to the reference</u>, with scenario 2 (the full option LHV) showing a greater benefit than scenarios 3 and 4. The main reason for this, is that society

has to spend less money for transporting the same (even slightly more) goods. LHV vehicles seem to be more cost-effective than current HGVs (*heavy goods vehicles*). They transport more tonne-km (+1 %) with less vehicle-km (-12.9 %). Even when some transport is shifted from rail (-3.8 % tonne-km) and inland waterways (-2.9 % tonne-km) to road, the road transport sector still grows.

Additionally, positive effects were predicted for safety and emissions, both mainly due to a reduction in road vehicle-km (-12.9 %), despite the fact that the individual LHV is more unsafe and more polluting than a regular truck.

The only negative impact is the high costs to road infrastructure. Higher investments in maintenance and bridges will be needed, though these investment costs are lower than the savings in the transport sector, and in society (emissions and safety).

Scenario 3's impact is very much the same as scenario 2's in the countries of the corridor. Outside it, results are mixed: while some countries will have more traffic as a result of cheaper transport in corridor countries, others, often transit countries "competing" with corridor countries for traffic, see a decline in volumes.

Scenario 4 has a much lower positive impact than scenario 2, as the smaller variant is not so efficient for the transport sector. Also, this type of truck is less beneficial for safety, and even has a negative impact on emissions, while the investment costs for maintenance and infrastructure are about as high as for the full size LHV. Any of such intermediate scenarios would also require new equipment.

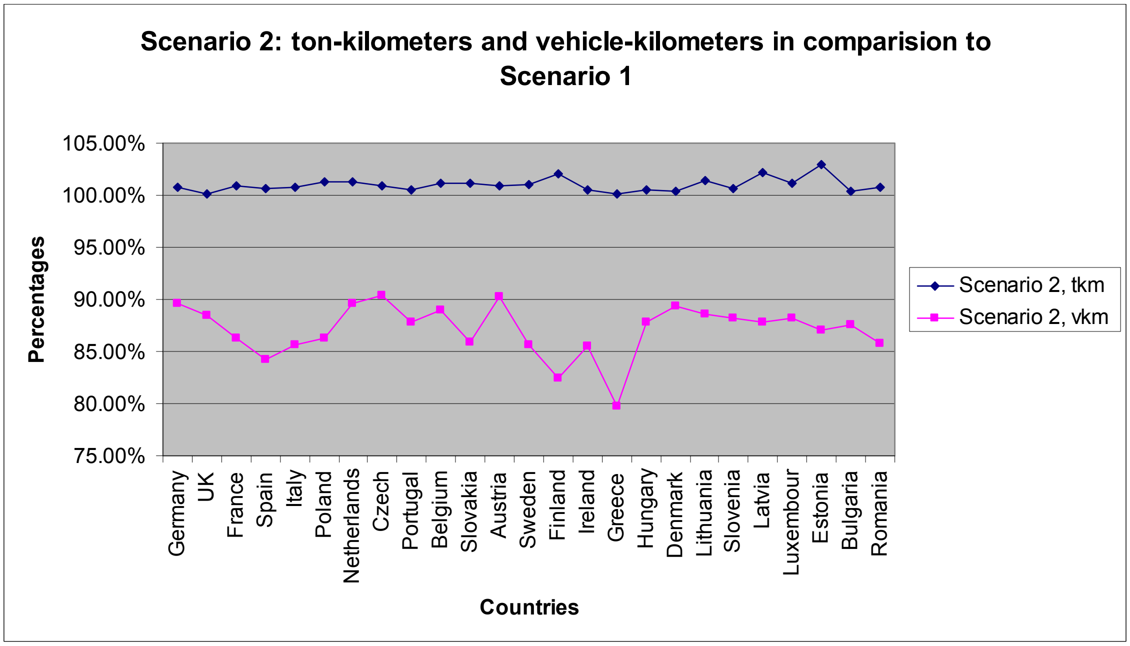
Though the costs and benefits for EU27 show a positive effect, huge differences between countries can occur.

The detailed analysis on transport demand and modal choice

In *scenario 2*, in which the LHVs of 25.25 metres long and 60 tonnes allowed in the whole of Europe, the total amount of tonne-km road transport volume rises by 0.99 % in comparison to the benchmark scenario 1 (price elasticity is -0.416). Approximately 30 % of heavy cargo traffic is carried out by LHVs, all according to the calculations with the TRANS-TOOLS model. On the other hand, we conclude that the number of vehicle-kilometres done by HGVs (LHV is a sub-class of heavy goods vehicles) declines by 12.9 %. It should be noticed that the decrease of vehicle-kilometres happens in heavy cargo traffic. There is a large variation in change of vehicle kilometres over the countries. The most affected countries are big and sparsely populated countries with clear aggregation of population and economical activity such as Spain, Finland and Greece.
Figure 1 below shows the evolution for all countries, the reference level (scenario 1) is 100%.

The total aggregate effect of LHVs on the European rail and inland waterway tonne volumes is a 3.8 % reduction in rail tonne-volumes and 2.9 % decrease in inland waterway tonne-volumes. This may be seen as an unwelcome effect. However, the rail volumes growth between 2005 and 2020 is projected to be much higher than 3.8%. In reality, this means that there is no downward spiral projected: rail will still grow and the growth rate will be only somewhat lower than in the case of no LHVs. We do not completely eliminate chances that on some lanes rail service could be severely damaged by LHVs, but this will not happen systematically. The growing transport demand will allow rail to continue growing.

Figure 1: Results of scenario 2 modelling on road transport volumes



Scenario 4 leads to an aggregate increase in road tonne-km volumes by 0.42 % and decrease in the number of vehicle kilometres by 3.4 %.

There is an interesting comparison between *scenarios 3 and 2*. The countries that are not included into the coalition/corridor are not noticeably affected. The road volumes and cargo traffic in countries that are included into the coalition respond differently. For instance, for the Netherlands there is almost no difference between scenarios 2 and scenario 3, while Belgium and Germany would witness bigger differences.

The detailed analysis on safety

The assessment of road safety aspects when adapting Directive 96/53/EC and permitting LHVs in road traffic did not reveal an inherent increase of safety risks in general.

However, there may be a higher risk for some LHV combinations regarding handling characteristics. Vehicles which are not (only) longer but just heavier may induce more severe accidents and casualties.
In general it can be stated that a slight increase of mass would not lead to a high decrease of road safety; and that from the safety point of view, there are no additional risks predicted if the longer semi-trailer is to be permitted. Generally, from the road safety assessment point of view it can be concluded that increasing the weight or increasing the dimensions would lead to only minor additional risks whereas an increase of both may increase the risks for road safety to a greater extent.

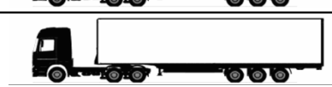
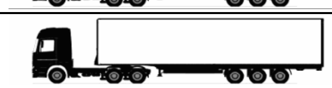
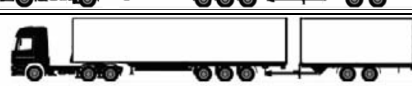
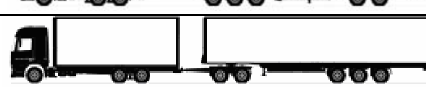
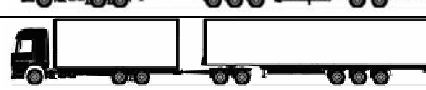
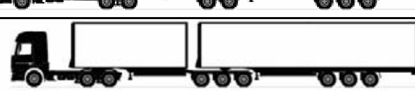
This has to be balanced with the potential reduction of the amount of lorries that LHVs may provide. As a reduction of the total amount of heavy duty trucks is predicted, safety will increase. This increase will completely balance out the increased risk factor of the individual vehicle. Moreover, counter measures are suggested if LHVs are introduced. Among them are more safety and control equipments and measures on these vehicles, e.g. on board weight control, improved ESP and stability control systems, or special training and survey of the drivers.

The detailed analysis on infrastructure

The main results are shown in the simplified table below. The reference is A40, the current standard of a 16.5m/40t truck on 5 axles.

Figure 2: Summary of the consequences on infrastructures, without countermeasures

[green] No consequences — [yellow] Moderate consequences — [red] Important consequences

Code	Shape	Pavement	Bridges: Extreme loads	Bridges: Fatigue
A40 (current vehicles)		1 [green]	[green]	[green]
A44		2.39 [red]	[yellow]	[yellow]
A48		>2.39 [red]	[red]	[red]
B40		1.22 [green]	[green]	[green]
B44		1.92 [red]	[yellow]	[yellow]
B48		>1.92 [red]	[red]	[red]
C40		1.02 [green]	[green]	[green]
C44		1.42 [yellow]	[yellow]	[yellow]
C48		1.85 [red]	[red]	[red]
D46		1.04 [green]	[green]	[green]
E50		0.55 [green]	[yellow]	[green]
F50		0.53 [green]	[yellow]	[green]
G50		0.42 [green]	[yellow]	[green]
E60		2.05 [red]	[red]	[red]
F60		2.07 [red]	[red]	[red]
G60		1.46 [yellow]	[red]	[red]

This table gives an overview of the impacts that result from the traffic of different combinations of vehicles, with different gross vehicle weight, driving on different kinds of pavements. <u>It clearly shows that in some cases (in red), important consequences have to be expected and that the corresponding combina-</u>

tions (A44, A48, B44, B48, C48, E60, F60 and G60) should be avoided. Particularly noteworthy is combination A44, which is already operational in a number of member states. If the Directive is revised and LHVs permitted, it is strongly suggested to avoid this combination A44 and to replace it by C44.

Appropriate countermeasures could help to decrease the impact on bridges, and hence change the result presented in the table above. It is therefore essential to define the relevant itineraries, to identify the problematic bridges and to decide on the appropriate measures that should be implemented. However, these three tasks require time and exhaustive expertise. A number of countermeasures are discussed in this report, along with proposals for further research work.

The detailed analysis on emissions and energy consumption

In summary, the energy consumption is predicted to go down when LHVs are introduced (*scenario 2*). The main reason for this is the fact that 60 t vehicles are up to 12.45 % more efficient in terms of fuel consumption per tonne-km performed. This effect is bigger than the predicted increase in tonne-km by road. NOx transport emissions will decrease with 4.03 %. For PM, the effect is even greater, as a drop of 8.39 % can be expected, mainly due to less non-exhaust PM: fewer kilometres driven cause less dust resuspension and mechanical wear.

In the "corridor/coalition" *scenario 3*, the effect is smaller, as only 6 countries allow LHVs.

In the "intermediate" *scenario 4*, there would be an increase of 0.61 % in emissions. This implies that the efficiency gain caused by the increase from 40t to 44t gross vehicle weight is insufficient to offset the extra emissions of the higher transport demand. Moreover, using a heavier vehicle (with one extra axle) removes even the smallest improvement in cost per tonne-km: it increases by 0.28 %. The extra load that can be carried does not offset the extra fuel consumption required to do so. The NOx emissions are up by 0.32 % compared to the "business as usual" scenario. PM emissions from transport are down however, by 1.85 %.

Table 1: Effect of the scenarios on emissions

	Scenario 2 vs. 1	Scenario 3 vs. 1	Scenario 4 vs. 1
CO2	-3.6 %	-0.7 %	0.3 %
NOx	-3.8%	-1.0%	-0.1%
PM	-5.0 %	-1.2 %	-0.9 %

Stakeholder consultation

As there is an enormous amount of stakeholders involved in the market, consultation of as many of them as possible was a major part of the task performed in this project. The results of the consultation were used in the calculation of the effects of introduction LHVs in Europe.

A first consultation round was organised to raise awareness for the study, followed by more elaborate exchanges between the consortium and various experts in the form of small regional workshops. Parallel with these moments of live interaction, an internet questionnaire was set up to allow the maximum number of stakeholder to contribute to the discussion. Live stakeholder consultation yielded varied results.

A large group of supporters was found in shippers, hauliers and manufacturers: all potential beneficiaries of the expected decrease in transportation costs that increased weights and dimensions may entail. Authorities of the few countries where the modular concept has been used or successfully tested have also shown a positive attitude towards a change in the directive.

Opponents of such a change are equally numerous. Governments of large countries such as France, Germany and UK, and of Alpine and Eastern European countries are reluctant to modify the current Directive, and above all to increase the weight and dimension limits. Operators or representative organisations of rail and inland waterways, which are at risk of losing volume as a result of a change, hold on firmly to prevent any disturbance in the current market situation. Environmental organisations, albeit with a different agenda, are generally opposed to a modification without compensation on other levels. A final group of opponents are authorities in charge of road infrastructure.

The main arguments cited as favourable to an increase of dimensions include:

- Decrease of operational costs due to greater loads
- Decrease of emissions (CO_2, NOx, PM)
- Positive impact on safety as less trucks are needed for the same amount of goods transported
- Driver shortage is alleviated

Supporters of the modular concept additionally claim that the flexibility of the system permit its introduction at a marginal investment from transporters. Other stakeholders state increased loads without any substantial changes to the current setup of the vehicle are possible as well.

Opponents to the system have an extensive list of objections, of which the most important are:

- Changes in competitive position (price) will push other modes out of contention, causing a domino effect (entire lines being lost), or at least will induce a transfer from less polluting and CO_2 emitting modes to the road, and thus have negative impact on environment.
- Reduced cost will generate more demand, causing increased emissions and congestion.
- Road, tunnel, bridge infrastructure could suffer greatly.
- If accidents occur, damage will be higher, and in numerous sections of the infrastructure, longer vehicles may induce unsafe situations for the other road users.

However, it seems that a large majority of stakeholders said that a volume increase is much more important than a weight increase. At least for infrastructures, it seems that a lorry of 25.25 m and 50 tonne would not be significantly more aggressive than the current 16.5 m and 40 tonne truck. It could be a compromise concerning the load limit, between the current 40 tonne and the Swedish 60 tonne limits. Such a vehicle could be an option if the EC decides to increase the current limits.

General recommendations on modifying Directive 96/53/EC

The general recommendation is that introducing LHVs in Europe can be done without harming European society in general.

However, some effects will need countermeasures:

1. Rail and inland waterway transport will grow somewhat less than expected, leading to a risk of local rail lines getting into difficulties.
2. The safety of the individual LHV is worse than that of a smaller truck.
3. Infrastructure investments need to be paid.

From a purely economical point of view, harmonisation is not necessary. In a scenario were the EC sets minimum standards, and countries can choose themselves to allow LHVs (scenario 3), benefits are substantial.

However, there is concern on timing. Introduction of a major change in weights and dimensions of heavy commercial vehicles needs to be announced well ahead. This accommodates the time needed to adapt infrastructures, and gives also the opportunity to monitor the effects on transport demand and modal choice, emissions and safety. Stepwise introduction is also an option, though the competitive position of smaller transporters could be at risk in this case.

Countermeasures on infrastructure

- A 44 tonne on 6 axles (or 50 tonne on 7 or more axles) does not create much extra damage. However, a 44 tonnes on 5 axles in the A44 combination (2 axle tractor and 3 axle tridem semi-trailer) is very bad for infrastructure, and should not be allowed (although a number of countries currently allow these vehicles).
- Precautions should be taken regarding access to certain roads or infrastructures which may not be able to handle LHVs. Examples of such roads are very common in many new member states. Bridges all over the European Union need to be examined. Regulation on minimal distance between vehicles and overtaking on bridges (to avoid high loads on individual supporting structures) is highly recommended.

Countermeasures on safety

- Strong limitations of LHVs overtaking would be needed.
- LHVs should be easily identifiable, at day and night, or in low visibility conditions, by clear markings (signs).
- A mandatory system to monitor the wheel and axles loads, the gross weights, and the load balance within the vehicles; such a system may either be based on roadside sensors or on-board sensors and equipments, or a combination of both.
- Minimal technical improvements (e.g. for suspension performances, stability control, braking efficiency, etc.) can be made mandatory for LHVs at higher standards than current HGVs.

Countermeasures on modal choice

- Several stakeholders have pointed to the fact that road freight transport does not pay its full cost at this moment as an argument against increasing weights and dimensions of heavy commercial vehicles. Although the argument of incomplete payment is not directly relevant to the discussion on dimensions, it should be accounted for in the total freight transport picture. Ideally, every cost that is the result of an action should be paid by the one performing the action. It should be noted that this reasoning does not solely apply to road transport. Fair competition can only be achieved when every mode is held accountable for all costs it causes.
- As done in Sweden, if LHVs are allowed, a taxation system can be introduced, both to partly compensate the gain of productivity (and share it between transport modes), and to finance bridge (and if needed pavement) reinforcement.
- As in the Netherlands, LHVs could only be permitted on some given routes, and/or during certain periods of the year/week/day. The route restriction would not only address road safety issues, but

also avoid a competition against the combined, railway or waterborne transport, and thus avoid any modal transfer.

- Alpine countries have already huge part of transport on rail and would not encourage LHV. However, they already plan to raise taxes on road transport.

45 foot containers

The 45 ft container currently does not fit within the maximum dimensions set by directive 96/53/EC. It would need an extra length of 12cm. Testing with a number of slightly longer vehicles (e.g. +1.30m) has not shown any practical issues with such a relaxation of regulation, as it does not affect its construction base and road behaviour.

As such, permitting 45 ft containers in international road transport would lead to a better harmonisation, but will only have a modest impact.

Enforcement

Many of the same stakeholders from the previous sections have also made the argument that the first priority should be to enforce current regulation, rather than making current regulation less restrictive.

This study has taken the assumption that legal limits and regulations are respected. Evidently, when infractions are common, the outcome of calculations for several of the effects could be entirely different (e.g. overloading causing more infrastructure damage, not respecting driving time or speed limits decreases safety, etc.). Enforcement is a key issue to maintaining a strong and credible freight transport system.

A particularly interesting concept in enforcement is the weigh-in-motion system, which can be used in a fully automated control system in the future, as done currently for speed enforcement.

I Project context and objective

1. General background

The growth of freight transport is threatening parts of the European transport system with congestion and the economic costs that this entails. The emission of pollutants and noise in the transport sector will increase, albeit unevenly across the European Union, there is increased concern about freight transport's contribution to greenhouse gas emissions and its dependence on imported supplies of fuel.

The 2006 revision of the Transport White Paper "Keep Europe Moving" concluded that the EU needs to establish a framework that encourages improvements to the individual modes of transport as well as their combinations in multi-modal transport chains for a sustainable transport system. Better utilisation of the transport infrastructure and a reduction of the negative environmental and social effects are the principal objectives of such a policy.

The key to achieving these objectives lies in the notion of co-modality: the efficient use of transport modes operating on their own or in multi-modal integration in the European transport system to reach an optimal and sustainable utilisation of resources.

The Commission considers that "the rules on the dimensions of vehicles and loading units should match the needs of advanced logistics and sustainable mobility" (COM(2006) 336 final – Communication on freight logistics).

Directive 96/53/EC sets out the maximum allowable vehicle and loading dimensions in national and international road transport in the EU. However, while the Directive harmonises across the EU the maximum dimensions of road vehicles and sets agreed levels for weights that would permit free circulation throughout the EU, it permits different national rules on the maximum dimensions. Member States may deviate from the maximum limitations in national transport in certain pre authorised circumstances, the "modular concept" being the most relevant example. Also, various industrial sectors have argued for an easement in the weights and dimension restrictions to accommodate more efficient loading (i.e. more pallets or passenger cars) or to carry a heavier payload.

Currently, several EU members have adopted legislation that allows for dimensions and weights exceeding the maxima set in directive 96/53/EC. In some cases, this legislation is valid all around. In other, it concerns trials for specified periods and/or trajectories.

The following tables contain detail on legislation throughout Europe.

Table 2: Maximum vehicle dimensions in Europe (Source: International Transport Forum, December 2007)

PERMISSIBLE MAXIMUM DIMENSIONS IN EUROPE					
COUNTRY	HEIGHT	WIDTH	LENGTH		
			Lorry or Trailer	Road Train	Articulated Vehicle
Albania	**4 m**	**2.50 m**	**12 m**	**18.35m**	**16.50 m**
Austria	**4 m**	**2.55 m** (3)	**12 m**	**18.75 m**	**16.50 m**
Azerbaijan	**4 m**	**2.50m**	**12 m**	**20 m**	
Belarus	**4 m**	**2.55 m**	**12 m**	**20 m**	**20 m**
Belgium	**4 m**	**2.55 m** (3)	**12 m**	**18.75 m**	**16.50 m**
Bosnia-Herzegovina	**4 m**	**2.50m**	**12 m**	**18 m**	**17 m**
Bulgaria	**4 m**	**2.55 m**	**12 m**	**18.75 m**	**16.50 m**
Croatia	**4 m**	**2.55 m** (3)	**12 m**	**18.35 m**	**16.50 m**
Czech Republic	**4 m**	**2.55 m** (3)	**12 m**	**18.75 m**	**16.50 m**
Denmark	**4 m**	**2.55 m** (3)	**12 m**	**18.75 m**	**16.50 m**
Estonia	**4 m**	**2.55 m**	**12 m**	**18.75 m**	**16.50 m**
Finland (1)	**4.20 m**	**2.60 m**	**12 m**	**25.25 m**	**16.50 m**
France	**not defined**	**2.55 m** (3)	**12 m**	**18.75 m**	**16.50 m**
FYR Macedonia	**4 m**	**2.50m**	**12 m**	**18 m**	**16.50 m**
Georgia	**4 m**	**2.50 m**	**20 m**		**20 m**
Germany	**4 m**	**2.55 m** (3)	**12 m**	**18.75 m**	**16.50 m**
Greece	**4 m**	**2.55 m** (3)	**12 m**	**18.75 m**	**16.50 m**
Hungary	**4 m**	**2.55 m** (3)	**12 m**	**18.75 m**	**16.50 m**
Iceland	**4.20 m**	**2.55 m**	**12 m**	**22 m**	**18 m**
Ireland	**4.25 m**	**2.50 m** (3)	**12 m**	**18.35 m**	**16.50 m**
Italy (2)	**4 m**	**2.55 m** (3)	**12 m**	**18.75 m**	**16.50 m**
Latvia	**4 m**	**2.55 m** (3)	**12 m**	**18.75 m**	**16.50 m**
Liechtenstein	**4 m**	**2.55 m**	**12 m**	**18.75 m**	**16.50 m**
Lithuania	**4 m**	**2.55 m** (3)	**12 m**	**18.75 m**	**16.50 m**
Luxembourg	**4 m**	**2.55 m** (3)	**12 m**	**18.75 m**	**16.50 m**
Malta	**4 m**	**2.55 m** (3)	**12 m**	**18.75 m**	**16.50 m**
Moldova	**4 m**	**2.50 m**	**12 m**	**20 m**	**16.50 m**
Netherlands	**4 m**	**2.55 m** (3)	**12 m**	**18.75 m**	**16.50 m**
Norway	**not defined**	**2.55 m** (3)	**12 m**	**19.50 m**	**17.50 m**
Poland	**4 m**	**2.55 m** (3)	**12 m**	**18.75 m**	**16.50 m**
Portugal (2)	**4 m**	**2.55 m** (3)	**12 m**	**18.75 m**	**16.50 m**
Romania	**4 m**	**2.55 m** (3)	**12 m**	**18.75 m**	**16.50 m**
Russia	**4 m**	**2.55 m** (3)	**12 m**	**20 m**	**20 m**
Serbia	**4 m**	**2.50 m**	**12 m**	**18 m**	**16.50 m**
Slovakia	**4 m**	**2.55 m** (3)	**12 m**	**18.75 m**	**16.50 m**
Slovenia	**4 m**	**2.55 m** (3)	**12 m**	**18.75 m**	**16.50 m**
Spain	**4 m**	**2.55 m** (3)	**12 m**	**18.75 m**	**16.50 m**
Sweden	**not defined**	**2.60 m**	**24 m**	**24 m**	**25.25 m**
Switzerland	**4 m**	**2.55 m** (3)	**12 m**	**18.75 m**	**16.50 m**
Turkey	**4 m**	**2.55 m** (3)	**12 m**	**18.75 m**	**16.50 m**
Ukraine	**4 m**	**2.65 m**	**12 m**	**22 m**	**22 m**
United Kingdom	**not defined**	**2.55 m** (3)	**12 m**	**18.75 m**	**16.50 m**

1. For vehicles registered in an EEA member country
2. Increased values are applicable for certain types of transport (i.e. containers, motorcars, etc.)
3. refrigerated vehicles = 2.60 m

Table 3: Maximum vehicle weights in Europe (Source: International Transport Forum, December 2007)

PERMISSIBLE MAXIMUM WEIGHTS IN EUROPE (in tonnes)							
Country	Weight per bearing axle	Weight per drive axle	Lorry 2 axles	Lorry 3 axles	Road Train 4 axles	Road Train 5 axles and +	Articulated Vehicle 5 axles and +
Albania	10		18	25	40	44	38
Austria	10	11.5	18	26	36	40	40
Azerbaijan	10				37	37	37
Belarus	10		18	25 (1)	36	38	38
Belgium	10	12	19	26	39	44	44 (2)
Bosnia-Herzegovina	10		20	26	40	40	40
Bulgaria	10	11.5	18	26 (1)	36	40	40
Croatia	10	11.5	18	26 (1)	36	40	40
Czech Republic	10	11.5	18	26 (1)	36	44 (1)	42 / 48
Denmark	10	11.5 (5)	18	26 (1) (5)	38	42 / 48	42 / 48
Estonia	10	11.5	18	26 (1)	36	40	40
Finland (3)	10	11.5	18	26 (1)	36	44	42 / 48
France	13	13	19	26	38	40	40
FYR Macedonia	10		16	22	36	40	40
Georgia	10	11.5			44	44	44
Germany	10	11.5	18	26 (1)	36	40	40
Greece	10	11.5	18	26 (1)	36	40	40
Hungary	10	11	20	24	36	40	40
Ireland	10	10.5	17	26 (1)	35	40	40
Iceland	10	11.5	18	26 (1)	37	40	44
Italy (4)	12	12	18	26 (1)	40	44	44
Latvia	10	11.5	18	26 (1)	40	40	40
Liechtenstein	10	11.5	18	26	36	40	40
Lithuania	10	11.5	18	26 (1)	36	40	40
Luxembourg	10	12	19	26	44	44	44
Malta	10.8	11.5	18	25	36	40	40
Moldova	10		18	24	36	40	40
Netherlands	10	11.5	21.5	33	40	50	50
Norway	10	11.5	19	26	37	46	44
Poland	10	11.5	18	26 (1)	36	40	40
Portugal (4)	10	12	19	26	37	40	40
Romania	10	11.5	18	26 (1)	36	40	40
Russia	10 (6)	10 (6)	18	25	36	38/44 (7)	38/40 (7)
Serbia	10		18	24	36	40	40
Slovakia	10	11.5	18	26 (1)	40	40	40
Slovenia	10	11.5	18	25		40	40
Spain (4)	10	11.5	18	26 (1)	36	40	40
Sweden	10	11.5	18	26 (1)	38	48/60 (10)	48/60 (10)
Switzerland	10	11.5	18	26 (1)	36	40	40
Turkey	10	11.5	18	25/26 (8)	36	40	40/44 (9)
Ukraine	10				38	38	38
United Kingdom	10	11.5	18	26 (1)	36	40	40 / 44

The countries in blue are those who have replied the questionnaire.

1. With air suspension or similar
2. 2 axles tractor + 3 axles semi-trailer: mechanical suspension = 43t ; pneumatic suspension = 44t
3. For vehicles registered in an EEA member country
4. Increased values are applicable for certain types of transport (i.e. containers, motorcars, etc.)
5. Weight per drive axle: national traffic = 10t; international traffic = 11.5t; Lorry 3 axles: national traffic = 24t; international traffic = 26t
6. About 10-12% of existing roads were constructed based on the axle weight 10t, other roads on the weight 6t. There is a recommendation of the Ministry of Transport to base all new federal road projects on the maximum axle weight of at least 11.5t
7. National: 38t; international: 40t, and 44t for 6 axles and + only.
8. With the conditions laid down in Regulation for type approval.
9. For vehicles engaged in combined transport.
10. 5 axles = 48t; 6 axles = 58t; 7 axles = 60t

The basic framework, as set by aforementioned directive, is a definition of vehicles subject to the limitations, followed by a number of exceptions and additional conditions. Among the exceptions is the modular system.

2. Problem analysis

The main criticism on the directive is its lack of harmonisation, a precondition for establishing a single market. When national legislation is less restrictive in some countries, it creates an imbalance between market positions of local and foreign service providers. Even though clear suggestions are made for those countries wishing to use the exceptions (the modular concept), this has not been sufficient to create the market competition envisioned.

Also, various industrial sectors have argued for an easement in the weights and dimension restrictions to accommodate more efficient loading (i.e. more pallets or passenger cars) or to carry a heavier payload. This should help to "match the needs of advanced logistics and sustainable mobility". On top of that, technological advances may have created opportunities that could not be foreseen in the current Directive.

3. Project objectives

The aim of the project was to provide advice to the Commission on the optimal weights and dimensions of heavy vehicles. The advice focuses on the effects, both positive and negative, of the use of bigger and/or heavier vehicles, including the modular concept at various maximal dimensions and weight levels in and between adjacent and consenting Member States.

In the form of a cost-benefit analysis, the consortium evaluated policy options and provides thorough feedback on each. The main research domains cover 6 topics on which adaptation of the directive will have an impact: road safety, energy efficiency, noxious emissions, infrastructure, modality and meeting demand.

II Stakeholder input

1. Literature

A great number of studies have been conducted with regards to the dimensions and weight of heavy commercial vehicles and the possibility of changing them. Some of them cover experiences of countries that have permanently or temporarily allowed lengths and weights exceeding the suggested maxima of Directive 96/53/EC. Others contain ex ante estimates of what bigger, heavier trucks would mean to the transport markets where they were not generally allowed before.

The first group of studies of course cover mainly the Swedish and Finnish markets, as well as the repeated trials that were conducted in the Netherlands. They are mainly very supportive of the modular concept with dimensions of 25.25 m and 60 t, stating decreased costs, environmental benefits, better opportunities for co-modality and better safety behaviour as the main advantages. In a look at the future, LHVs *(long and heavy vehicles)* are suggested to help in accommodating the ever growing demand for transport services in Europe. Efficiency gains are estimated to be in the range of 15-25 %.

However, a number of papers also present some very important remarks. A primary caveat is the demand generating effect that lower road transport costs will bring about. Price elasticities are the driving mechanism. Very few studies have worked on determining and calibrating these important parameters.

With respect to co-modality and intermodality, cross-elasticity plays an important role. The studies of TIM Consult and Kessel+Partner indicate that co-modality could decrease by up to 55 %, and increase trucking by 24 %.

Environmental effects depend greatly on load factor. A study of the German UBA states that the minimum load should be 77% of maximum capacity. This is confirmed by the study of MTRU.

Safety and infrastructure are big concerns for all parties. Real life experiences and trials have not shown drastic changes in safety risks. This could be due to the long existing history of the country (Sweden, Finland) or to the limited sample size and controlled setting. Same reasoning goes for infrastructure. No major problems have arisen, but in many countries, the impact can be significant. Particularly in the big three countries France, Germany and the UK, as well as the Alpine region, these are big concerns.

There are some reasons why it is difficult to extrapolate the experience from one part of Europe to another. Northern countries traditionally have a higher road safety level than most of the other European countries. Therefore, it is impossible to transpose the low (or negligible) influence of the LHVs on road safety to other countries. In Sweden, when introducing the LHVs, the government set up a tax on all the lorries to collect money and reinforce the bridges. Over a 10 year period (1996-2005), 400 million euro were collected and used for bridge reinforcement. This system is difficult to extend to larger countries, particularly those with a large proportion of international transit (e.g. France or Germany). In Germany, a cost of 7 to 11 billion euro was estimated to reinforce bridges in case of introduction of LHVs like in Sweden. Alpine countries have other concerns, mainly environmental issues and railway competitiveness, but also safety and infrastructure damage.

A study performed by VTI should receive a special mention. The institute researched what the consequences would be if Sweden were to limit trucks dimensions to the EU "standards" of 18.75 and 40t. Even with major investment in the rail network, costs to society would be significant. However, this study only applies to the Swedish conditions.

Technical aspects of the vehicles should be accounted for when evaluating a shift to new dimensions. Stability, swept path, off-tracking are characteristics that have to be adapted to the road. Several electronic systems have been developed; the question is whether they should be mandatory in LHVs. Other technical solutions may provide relief. The teardrop trailer with its improved aerodynamic specifications could improve fuel efficiency. Expanding the dimensions of current modules can be an option too.

Many stakeholders call for more clarity than the current legislative framework provides. Harmonisation is one point, but the need for regulation and enforcement on all aspects of HGV *(heavy goods vehicle)* and LHV *(long and heavy vehicle)* appears frequently in literature. Electronic systems could be an option, as could mandatory driver certification, limitation to certain roads, weight enforcement, etc.

2. Consultation & workshops

2.1. Organisation of the consultation with specialists and experts

In addition to the stakeholder meeting that took place in Brussels on March 4th, the consortium has organised several regional and local workshops, the details of which can be found in annex.

Through these regional workshops, the consortium aimed to collect the opinions and views of the different stakeholders, from industrials to research specialists. It was first thought that regional workshops could be organised with respect to the fields of expertise of the key specialists identified by the consortium members. Finally, the idea of cross-disciplinary meetings was retained and consequently, all matters of concern were tackled during each workshop.

Apart from the larger meeting in Brussels that had 90 participants, the other workshops have been quite successful with an audience ranging from 12 to 26 participants. Each of the workshops lasted a whole day and the consortium wants to show its gratitude towards stakeholders who have been very helpful in co-organising the four workshops.

The workshops were very similar in their structure. The first part of the day was dedicated to the expression of the different minds on the topic at stake. Participants were given the opportunity to show a few slides if they expressed the wish to do so. They were also offered the possibility to make a statement on behalf of their organisation, ministry, administration, company, etc.

2.2. Supporters and opponents

Although it would not make sense to produce statistics on a small sample of participants, it is nevertheless interesting to draw the map of opinions regarding the question of longer and or heavier vehicles.

During these workshops, different opinions were expressed by the participants about LHVs (long and heavy vehicles), depending on their fields of interest.

Opponents of LHVs are mainly:

- Rail & combined transport operators or associations;
- Governments or administrations in charge of transport and/or infrastructure;
- Associations defending the protection of the environment, directly or indirectly.

As to supporters of LHVs, they are essentially:

- Road hauliers (through their trade unions, if not hauliers themselves);
- Manufacturers (automobiles, telematics, tires, etc.);
- Shippers.

When it comes to comparing the positions of the various protagonists with reference to their country of origin, it may be interesting to observe that Europe can be roughly divided in three parts:

- *LHV supporters*

Northern European countries are rather in favour of LHVs. If not already users of LHVs, they (Denmark and Norway) are considering trials in a close future. Certain German regions and the Netherlands have already gathered experience concerning LHVs, thanks to their experiments and could therefore be associated to this first group of countries.

- *Cautious or opponents*

Central and Western Europe countries seem to be much more cautious regarding LHVs. Certain countries such as Austria and Hungary have made official statements to show their opposition to any adaptation of directive 96/53. Some Länder in Germany have experimented with longer and/or heavier vehicle combinations but on a Federal level, Germany has clearly expressed its opposition to LHVs on the German roads. For this reason, Germany also fits in the group of countries with reservations about LHVs. Since France has not yet made a decision on organising trials, it may be regarded as part of the group of "the cautious".

- *Undecided/unknown*

Despite the efforts to have experts from southern Europe participating in the various workshops, the consortium has been unable to collect opinions of these countries.

2.3. Datasets and inputs

During the different workshops, some studies were regularly quoted by the participants. The most recurrent of them were probably the studies performed by Kessel+Partner, TIM Consult, CE Delft and by the BASt. Their reviews and the reviews of other studies that are not mentioned here but were available to the consortium were added in the literature review part of this report (see Annex 1: Literature Review Sheets). Considering that certain studies were commissioned by stakeholders, reviews were performed with due caution.

2.4. The pros and cons of adapting directive 96/53 according to the stakeholders

The consortium was commissioned to collect the inputs and opinions of all experts and stakeholders in Europe, within a short period. This consultation enabled to list the main advantages and drawbacks regarding the possible adaptation of directive 96/53. Some arguments may seem contradictory. It was indeed expected, since the consortium, in this part of the study, had to list the pros and cons without ratifying the reasons advanced by the ones or the others.

2.4.1. Advantages

If longer and or heavier vehicles were allowed in Europe, defenders of LHVs state these advantages:

- **Fuel consumption and CO_2 emissions**: at least -10 %.
- **Road safety**: no impact or even beneficial when assuming that the number of trucks on roads decreases. No additional risks with LHVs driving on slippery roads. Stability tests prove that there is no extra risk. Since each single axle supports a lower weight, braking distances could be reduced. Experience shows that EMS integrates well into the traffic mix. They would not generate additional stress for drivers.
- **Road congestion**: efficient way to decrease congestion. 7 to 10 % fewer trucks on roads. 33 % fewer trips needed to transport the same amount of goods since 2 LHVs would replace 3 traditional trucks.
- **Transport costs**: -10 to -25 % depending on vehicle combinations.
- **Payload**: +30 to +50 %.
- **Modal shift**: no modal shift claimed; on the opposite, would encourage intermodality because existing intermodal units are used.
- **Road longevity and road wear**: +15 % road longevity, -22 % road wear.

In addition, it was stated that:
- No problem would occur with LHVs driving on existing infrastructure.
- LHVs would be a very relevant solution to the driver shortage.
- They would be a solution to the lack of capacity of rail transport.
- They would help overcoming the issue of volume limited transport operations.
- Huge space would not be needed to achieve coupling/decoupling of modules.

2.4.2. Disadvantages

Similarly, the inputs of the different experts and stakeholders may be summarised in a list of disadvantages set by the detractors of LHVs. One important argument focuses on the fact that making road transport cheaper will result in a **modal shift from rail, waterborne and combined transport to road**. Following this modal shift, negative impacts ranging from road insecurity to emissions would be triggered.

- **Fuel consumption and CO_2 emissions**: modal shift would cause an increase in fuel consumption and CO_2 emissions, from 5 to 10%. Empty runs with LHVs would worsen this problem. There would be a contradiction between these results and the EU targets for sustainable mobility.
- **Transport demand and road congestion**: road transport being more competitive, 3 smaller trucks would be replaced by 3 longer trucks; "Low-cost" road transport will generate extra demand and thus will not enable to reduce congestion.

- **Combined transport volumes**: -14 % to -55 % tonne-km according to studies; loss of market shares on long distance transport.
- **Single wagonload volumes**: -12 to -25 % tonne-km according to studies; single wagon transport services may be stopped.
- **Road safety**: the severity or even the number of accidents may increase with longer and heavier vehicles. LHVs may have longer braking distances and thus increase the probability of collision. LHVs may cause safety problems on steep roads because of their weight; and everywhere else by reducing the visibility of car drivers. They could be difficult to overtake outside motorways, and create some difficulties at the motorway exits or in intersections. LHVs will increase fire loads in tunnels and thus high investments would be required to address this issue. Investments for reinforced crash barriers would also be needed.
- **Infrastructure**: bridges and tunnels would be at risk. As road networks were not designed for more than 40t vehicles and/or underdeveloped in certain countries, allowing LHVs would require very large investments. It would overall reduce lifetime of bridges (in particular steel bridges and composite steel and concrete bearing structures) and increase life cycle costs. LHVs would decrease the longevity of road pavements and reduce their lifetime: pavement rutting may be increased by longer series of axles with short interspacing. The secondary road network would not be suitable for LHVs in all cases, but it is very likely that pressure would be put to extend the use of LHVs on all roads. Moreover, some junctions and roundabouts would need to be re-designed, with respect to turning difficulties of LHVs. Rest areas and parking spaces could be another matter of concern.
- **Country planning**: imbalances between territories where LHVs would operate and the others could occur. There could be competition to implement "swap" stations near the main roads. Space constraints for manoeuvring LHVs at existing warehouses and distribution centres may worsen the situation.

The only consequence following a possible generalisation of LHVs on which opponents and supporters agree, concerns the transports costs that are very likely to decrease.

2.5. Recommendations made by the stakeholders

Experts and stakeholders were deeply involved in making suggestions aiming at improving the current situation. Certain suggestions are recommendations, whereas others should rather be seen as requests.

As expected, some of their recommendations are conflicting. In this case, they are indicated one after the other, without trying to make them compatible.

Recommendations, as stated by the participants to the various workshops, are:

- **Experiment locally with LHVs** to know if they are suitable in each country and obtain helpful feedback to make decisions without extrapolating from a few experiments that may not be relevant to other countries.
- **Perform studies on different fields where knowledge is still not exhaustive** (infrastructure, road safety, enforcement, modal competition, social and economic analyses, social acceptance).
- **Harmonize and standardize on a European scale,** and prior to any political decision, the authorised European Modular System Vehicle combinations. This to ensure intra- and intermodal exchangeability of vehicles and units, regarding at least:
  - The dimensions of modules;
  - The combinations of modules;

  - The permissible overhang of trailers (in particular when 45 ft containers are used).
- **Impose countermeasures** if LHVs were to be authorised regarding:
  - Traffic management limitations (for instance, overtaking bans, minimum spacing or speed limits);
  - Compulsory safety equipments (lane departure warning systems, ESP, ABS, etc.);
  - Limited suitable network for driving LHVs (enforced with ITS such as Intelligent Access programs);
- **Reinforce controls** (in particular regarding weights, e.g. with tools like axle load measurement systems, weigh-in-motion controls).
- **Weights and dimensions:**
  - For almost all stakeholders, a volume increase is more useful than a weight increase.
  - Increase the weights and dimensions of vehicles suitable for international transport operations (increase of the height, length and weight) for reasons reminded previously. Many possibilities were expressed:
    - EMS combinations (25.25 m and 60 t);
    - 20.75 m instead of 18.75 m long road trains;
    - 17.80 m long vehicles formed of a tractor and a semi-trailer that is 1.30 m longer than the ones currently allowed, with a GVW *(gross vehicle weight)* of 40 t;
    - 44 t vehicles on 5 axles for the transportation of freight on road generally speaking and 48-50 t vehicles on 6 axles for intermodal transport operations;
    - 44 t vehicles on 6 axles;
    - 35 t vehicles on 4 axles, 2 of them being driving axles;
    - 45 ft containers for road transport in intermodal operations;
    - etc.
  - Do not increase the weights and dimensions for reasons mentioned previously.
  - A request also concerns the weights of touring coaches.
- **Directive 96/53** in itself:
  - Adapt directive to allow LHVs in international traffic between two countries that accept their use or in Europe overall.
  - Do not adapt the directive, for many reasons stated previously.
  - Adapt the directive to address the issue of uneven loading, annexes 1 and 2 of the directive should be adapted consequently.
  - Modify the calculation of vehicles' length (rear spoilers and FUPS[1] may not be included in the calculation of length).
  - Impose specific requirement on manoeuvrability, braking abilities, etc.
  - Look at Directive 96/53 and the other related directives as a whole and improve the coherence of the legal framework so as to satisfy the increasing demand for freight transport.

2.6. Conclusions from the expert consultation

The different workshops enabled the consortium to understand and measure the clash of interests between countries that have already allowed LHVs and the others and to identify the disagreement points. No doubt progress can be made to forecast the consequences that would follow the allowing of LHVs in Europe in a transparent and unbiased manner, and it is precisely the purpose of this study.

Considering the European geography, it seems hard to transfer the results from experiments that have taken place in a couple of countries to other countries with peculiar topographic and climatic characteris-

[1] FUPS = Front Underrun Protection System

tics. For that reason, there is no doubt that local experiments would be beneficial to countries that are investigating the possible consequences of LHVs on their road network.

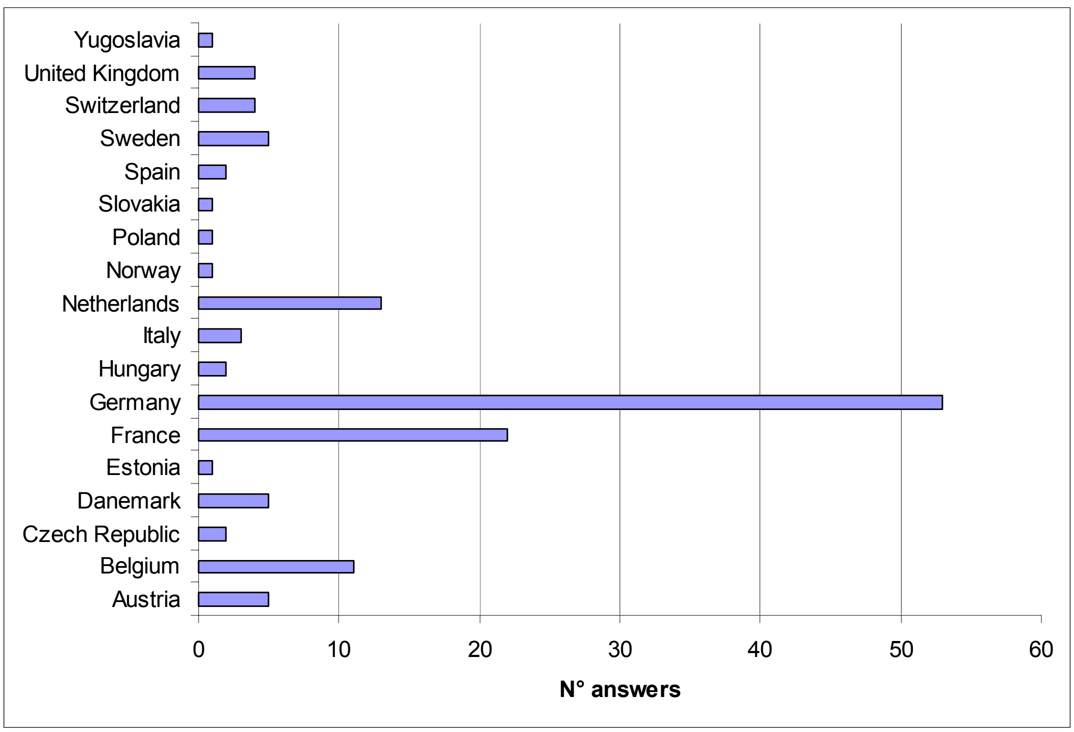
The workshops have been seen as an additional opportunity for certain countries to express their fears regarding LHVs. However, these countries are not opposed to other countries using longer and/or heavier vehicles. Therefore, it might be a solution to modify Directive 96/53 so that LHVs are allowed for international transport operations between countries where they are already authorised on a national scale.

3. Questionnaire

The web-questionnaire was online from 20 April until 28 May 2008. It was divided into 7 thematic parts. The questionnaire itself is added in annex 4 to this report.

About 320 stakeholders registered. There were 191 answers, of which 30 unidentified and 20 redundant (same company or sub-companies); so a total of 136 relevant answers have been processed. It was not required to answer to all parts of the questionnaire, which explains the different numbers of answers between parts. Most respondents were from Germany, France, Belgium, The Netherlands, UK, and Hungary, as can be seen in the figure below.

Figure 3: Questionnaire 136 answers by country.



Some comments were received about the fact that the questionnaire focused more on how LHVs could be implemented than on if they shall be implemented. That reflects the objectives of the DG/TREN contract which asked to investigate the potential positive and negative impacts of the introduction of LHVs. The consortium was not appointed to decide if LHV shall be permitted, which remains the decision of the Member State and the Commission.

3.1. Part 1: Economic, demand, logistics, intermodality

This part had 118 answers. The main findings were:

- Increase of the road traffic demand expected whatever the system of more than 10% with LHVs (according to 45% of answers).
- Decrease of 10 to 15% of the road transport cost expected (according to more than 50% of the answers)
- Undecided (50 – 50 %) on more/less trucks with LHVs.
- A modal shift is expected toward the road (5 to 20%).
- LHVs would be efficient on long distance.
- It will take time to equip the fleets with LHVs, and will impact fleet management (68% of respondents agree), but less the supply chain (42% answers).

Figure 4: Impact on transport mode: 65% negative impact - 35% positive impact

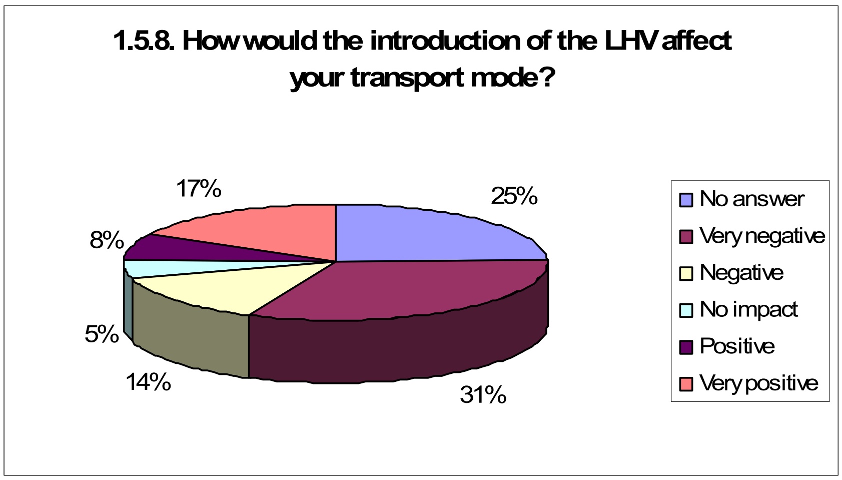


Figure 5: Impact of increased length: 60% positive - 40% negative

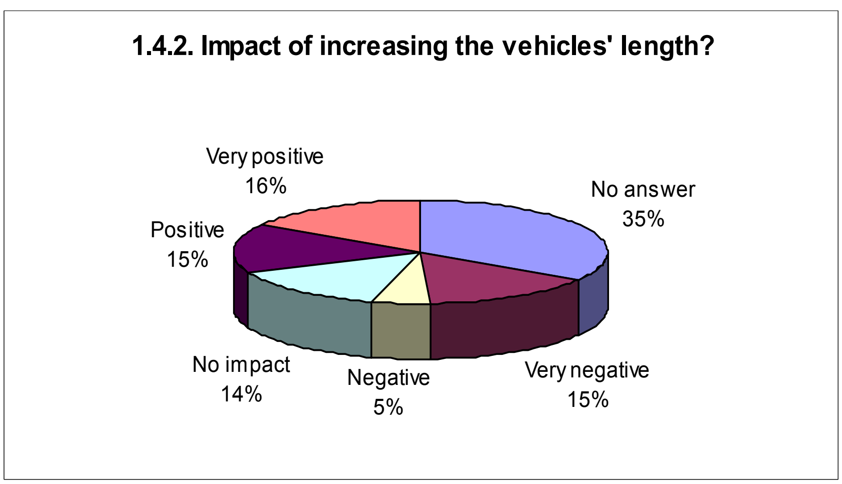
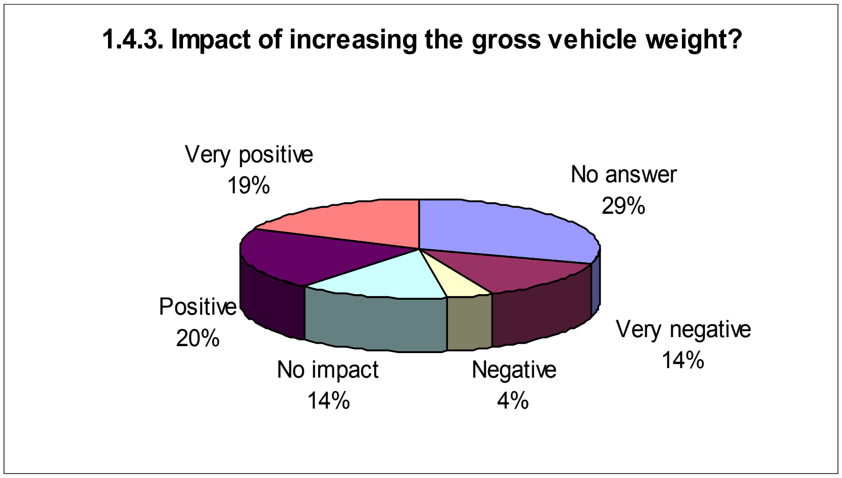


Figure 6: Impact of increased weight: 70% positive – 30% negative (up to 44 tonnes)



On the 45 ft container issues:

- Some 64% of the respondents are not satisfied with the current situation.
- Some 88% think that an EU harmonisation is needed.
- No agreement (50-50%) on cross border authorized on bilateral agreement.

3.2. Part 2: Technology, design (trucks, tires), engines

This part had 85 answers. The main findings were:

- Increase of motor power demanded by 40 % of the respondents (40 to 60 t).
- Air suspension should be mandatory.
- Longer vehicles with more axles.
- No major changes in the tyres needed.
- Safety equipment needed: ABS, EBS, ESP Additional, marks/signs for longer vehicles, on board WIM *(weigh-in-motion)* and enforcement using WIM was asked.
- Tests to be performed on infrastructure compliance (roundabout, slopes, turns, sleepy surfaces, railway crossings…).
- More frequent checks and specific checks.
- No specific driver information required.

3.3. Part 3: Environment, energy

This part had 42 answers. The main findings were:

- A few answers on fuel consumption and CO_2/NOx emission, noise and vibration, low relevant, no clear conclusions.
- No restriction wished on space and time for using LHVs (65% of answers).

3.4. Part 4: Infrastructure

This part had 95 (bridges) + 60 (pavements) answers. The main findings were:

- No major additional impacts on bridges up to 44 tonnes on 6 axles, or 50 tonnes on 7 or 8 axles.
- Some concerns about fatigue/lifetime.

- No major additional impact on pavement expected if additional weight carried by more axles and longer vehicles.
- Some increase of the maintenance cost expected, to be paid by the trucks (carriers, operators).

3.5. Part 5: Safety and operation (users)

This part had 78 answers. The main findings were:
- No specific speed limit, no allocated lane, no general time limitation.
- No agreement (50 – 50 %) for specific restrictions during peak hours (route, overtaking, stop…), for increased spacing whatever the time.
- Of the respondents, 65% ask to restrict or ban overtaking by LHVs.
- Of the respondents, 60% ask for specific driver instructions in adverse conditions.

3.6. Part 6: Driver training and control

This part had 74 answers. The main findings were:
- One fifth (20 %) of operators already use LHVs.
- No agreement (50 – 50 %) whether operators will modify their transport plan.
- Of the respondents, 65% said that less than 10% of the drivers can drive LHVs, 80% said that that a special training is required.
- Two thirds said that a safety certificate should be time-limited.
- No answer (50 – 50 %) to change the driver health control.

3.7. Part 7: PBS + questionnaire rating

This part had 71 answers. The main findings were:
- Europe is not yet ready for a PBS *(Performance Based Standards)* approach for a future Directive.
- Of the respondents, 76% rated the questionnaire (very) positive.
- However, some remarks:
  - Too much oriented to road transport carriers/operators.
  - Slightly biased questions (pro-LHVs).

Some comments were received about the fact that the questionnaire focused more on how LHVs could be implemented than on if they should be implemented. This reflects the objectives of the DG/TREN contract which asked to investigate the potential positive and negative impacts of the introduction of LHVs. The consortium was not appointed to decide if LHV will be permitted, which remains the decision of the Member States and the Commission.

4. Results of stakeholder input: SWOT

The SWOT analysis presented below shortly summarizes main strengths, weaknesses, opportunities and threats of LHVs, based on input from literature and stakeholder consultation. There are many factors that are influenced by and influence LHVs. Each section of the SWOT analysis is limited to five major issues.

<u>Strengths</u>
- **Lower transport cost expressed in euro per tonne-kilometre.** LHVs are bigger than normal trucks and can take more goods on board, thus fewer trips are necessary to carry out the same amount of

cargo. The transport price discount depends on the size of LHV and on how good a vehicle's capacity is unitized. For 25.25 metres and 60 tonne gross trucks we estimate the cost advantage to be 20 % (different estimates provide a range of 10 % - 31 %) and for 20.75 metres/44 tonne trucks we estimate the tonne-km cost discount to be 7 %.

- **Lower exhaust emissions related to tonne-kilometres of road freight transport.** The amount of energy to power trucks grows slower than the increase in vehicle capacity. It is estimated that LHVs of 25.25 metres and 60 tonne require some 10 - 15 % less energy per tonne-km of freight transport, in comparison to normal HGVs. This implies 10 - 15 % less CO_2 emissions and comparable reductions in other pollutants such as NOx, CO, fine particles, etc. Moreover, LHVs could lead to a substantial fleet renewal, while new vehicles would adhere to more stringent emissions standards, such as the Euro V standard.
- **More efficient way to meet increased demand**. As a result of the bigger cargo capacity of LHV, fewer trips are necessary to transport the same amount of cargo. Fewer trips translate into a smaller amount of vehicle-kilometres on motorways, and thus lighter load on infrastructure and less congestion. As the same amount of cargo transport can be done with a smaller number of trips, it is expected that there will be a decrease in the aggregate truck-driver hours needed. This leads to fewer truck drivers needed for the same amount of cargo transport.
- **Flexibility (same equipment can be used).** There are different implementations of LHVs; the modular concept is only one of them. Therefore, in some instances the existing truck fleet can be transferred into LHVs. Moreover, the concept allows assembling and disassembling of LHVs, such that LHVs can be used on motorways or permitted roads. The vehicles then can be disassembled into normal HGVs to travel over LHV-restricted areas.
- **LHVs can contribute to enhance the global competitive position of EU**. LHVs provide cheaper transport, translating it in a smaller share of transport cost in the whole economy. As transport is a vital economical facilitator, a smaller share of transport in the economy can be seen as a lighter taxation, thus stimulating other sectors of the economy. This taken together will improve the competitive position of the EU in the highly dynamic and competitive world economy.

Weaknesses

- **Need for new infrastructure and extra load on existing infrastructure.** First, existing infrastructure must allow passage of LHVs: sufficient bridge weight limit, sufficient turn radii, etc. Furthermore, rest areas must be redesigned (as existing rest areas must be made bigger to accommodate long vehicle and provide sufficient space and safety for manoeuvres), as well as decoupling points, loading terminals, etc. . Existing tunnels must provide sufficient safety for LHVs. LHVs can also cause more damage to the infrastructure: more wear and tear of road surface and pavement, more impact on bridges (metal fatigue).
- **LHV can only drive on a limited number of roads (not on minor roads or urban areas).** Small roads are not suited for LHVs mainly due to rotation radii and the fact that backward driving of LHVs is in most cases impossible. Therefore, they will be mainly used on motorways and many "feeder roads" will be out of reach for LHVs. This constraint limits the scope of LHV use.
- **In congested traffic, 3 becomes 2 is not valid; 3 becomes 2.9 is closer to reality.** In traffic jams, the space between vehicles is smaller then the one in free-flowing traffic. Thus, there is only a small difference whether there are 3 HGVs or 2 LHVs of 25.25 metres that stay in congestion. However, this does not apply to the free-flowing traffic, as safety distance between vehicles is substantially bigger than the lengths of the vehicles.
- **May lower incentives to invest in rail and inland waterway infrastructure.** As road transport becomes cheaper, there is less incentives to use rail or inland waterways, because cost of transport is one of the most important factors that determine which transport mode is used. Moreover, LHVs are

best used on longer distance routes that are often the realm of rail transport and inland waterways, so these transport modes can experience some reductions in transport volumes.

- **The need for some new equipment.** Usage of LHVs requires more powerful tractors, new requirements of safety technology, dollies, etc. This could be too expensive for small transport companies. As a result LHVs can be more-widely used by big companies, while smaller transport companies would experience harder competition. The response of the transport market could be more consolidation.

Opportunities

- **Application of new, safer and cleaner technology in road transport.** New technology can be made mandatory in these bigger trucks, be it new or retrofitted in older trucks. This would stimulate and speed up new technology penetration, because companies that really want use LHVs would be obliged to implement them.
- **Height can be harmonized as well as length and weight.** The change in 96/53/EC directive opens an opportunity for a comprehensive revision of other spatial dimensions of the HGV vehicles. For instance, they can be made to accommodate the Euro-pallet standard, or leave more responsibility to shippers regarding heights.
- **Introduction of LHV can be coupled with internalization of external cost (road pricing).** This gives opportunities to let the road sector pay for external costs in a politically acceptable way, as the increased burden of external costs will first affect users of LHVs, and cause less resistance from the sector. Further, this step would help levelling the playground with other modes, as rail and inland waterways are assumed to cause less external effects than the road mode.
- **LHV road innovation can spur innovation and cost reduction in other modes.** Bigger vehicles lead to decreases in road transport cost and more competitive pressure on other modes. This could urge innovation in techniques and business models by rail and inland waterways. The rail sector will be forced to make border crossings smoother and to increase customer service level to regain competitive position.
- **45 ft container can easily be introduced.** The cross-border transportation on road of 45ft containers that gain popularity in international transport is impossible with existing vehicle constraints. LHVs could accommodate this type of containers, thus facilitating European companies in participation in the world trade.

Threats

- **Loss of volume for rail and inland waterways could result in domino effect (losing entire lines).** There are some fears that LHVs can trigger a downward spiral in rail and inland waterway volumes. The cost advantage of LHVs could lead to reduction of rail and inland waterway traffic, which consequently would make loading unit transport cost higher. This cost increase could lead to lower rail and inland waterway volumes, therefore a typical example of positive feedback which within a few iterations would lead to cancellation of certain services. Combined transport and single wagon loads are said to be in jeopardy.
- **Increase in demand could make the environment worse off.** There is a potential generation effect: if road transport becomes cheaper, it will attract more cargo. Though the quantitative part of this study does not confirm a substantial generation effect, such a response of the inherently complex transport and economic system can not be eliminated. Substantially higher transport volumes could negate the traffic and environmental advantages of LHVs.
- **Quality of road & infrastructure is not equal all over Europe.** The usage of LHVs in less developed European regions, where road infrastructure is still undergoing development processes, could

lead to adverse affects. To prevent this, roads must be certified for the usage of LHVs through a sort of "infrastructure audit".

- **One increase could lead to a push for further increases.** The transport industry could demand ever increasing vehicle dimensions if it finds bigger vehicle capacity attractive. Thus, there could be a constant push to increase vehicle dimensions beyond those considered in this study.
- **How will increased weights, road limitations, etc. be enforced?** There are already some concerns that current weight limits are not strictly enforced and adhered to. LHVs can worsen the situation with weight limits, which is thought to be more dangerous than overloading a normal HGV. The same concern applies to enforcement of driving time regulations and other legislation. The decisive factor in these concerns is that LHVs can cause more damage during accidents.

III Scenario definition

1. General information and motivation on scenarios

To assess the economic and societal impact of LHVs *(long and heavy vehicles)* we will consider 4 scenarios for introduction. We clearly understand that these 4 scenarios cannot cover all possible combinations and future outcomes of LHV introduction. Therefore, the task on scenario definition has been to make them as clear and comprehensive as possible, while at the same time fulfilling objectives of the project. As more information was obtained over the course of the project (e.g. the stakeholders meeting, literature review, in-depth meetings with individual stakeholders and involved parties), it became clear that there is a number of possibilities in formulating scenarios, and these have been incorporated as much as possible.

The task on the scenario definition and choice did become even more complicated because six major effects had to be considered. For instance, the issues related to vehicle composition such as number of axles, weight distribution, etc. are more important for the assessment of risks and infrastructure issues, while they do not have a substantial impact on transport economics and issues that it entails. On the other hand, transport economics, modal split and transport demand are very sensitive to market behaviour of transport companies and manufacturers while more technical matters are mostly not.

Therefore, given the limited number of scenarios that we will use (mainly due to practicality of being able assessing them within the constraints of the project), the main questions that the 4 scenarios will answer are the following:

1. What will happen in 2020 if the 96/53/EC directive is not changed? The answer to this question will be used as a benchmark for assessment of other scenarios. It will give an estimation of transport demand growths in the period 2005-2020, giving the scope of magnitude for the challenging task of satisfying transport demand.
2. What if the 96/53/EC directive is amended in a harmonised way, such that all EU countries permit LHVs on their roads? Answering this question, it is possible to compare changes to the 2020 reference case: whether LHVs bring advantages in terms of pollution levels, safety, impact on infrastructure, etc.
3. What if there is no harmonisation, but some countries are allowed to press ahead with LHVs and conclude bilateral agreements with other (possibly neighbouring) countries? This will certainly have an effect on transport demand in countries involved. With an answer to this question it is possible to compare its outcome to the case if nothing changes and to the case of harmonized permission of LHV.
4. Given the concerns raised on modal split and transport generation effect of LHV, what if the directive 96/53/EC harmonizes vehicle constraints in a compromise way (no modular concept as it is in Sweden and Finland; weight and length is bigger than specified in 96/53/EC, but lower than those of the gigaliners; i.e. increasing dimensions of modules)?

The scenarios are aimed to answer above-described questions. The scenarios described below were designed mainly from the transport economics point of view, namely to look at satisfaction of current and future transport demand and to assess LHVs impact on different modalities and modal split. The assessment of other effects will be done using more specific assumptions on technological aspects such as number of axles, axle positioning, etc. For example for infrastructure, we have to deal with vehicle specifications which are more likely to be chosen by the industry, within the dimensions mentioned in the different scenarios. Therefore, we will use the TRANS-TOOLS model described in chapter IV to calculate the economic effects of LHV use in Europe.

2. Scenario description

Below, we have defined the 4 LHV scenarios in more detail. These scenario descriptions focus on making assumptions to study effects on meeting current and future transport demand and effects on combined and intermodal transport, while other issues will be addressed in other parts of the report. For all 4 scenarios, we will calculate these effects for the potential use of LHVs in the year 2020. The definition of scenarios below is conceptual; more details and modelling approach is provided in the section "Modelling issues".

5. **Scenario 1: "Business as usual"**. This first scenario assumes no changes to the road transport equipment constraints that were valid in 2000. It means that this scenario excludes any type of LHV from European transport networks; however, it includes national extensions on permitted weight, up to 44 tonne gross, which were applicable in 2000. The scenario takes into account projected economic developments and projected transport demand in Europe until 2020. All other scenarios take this one as the reference/base case.
6. **Scenario 2: "LHV Full option": Europe-wide permission of 25.25 m 60 t trucks**. These LHVs trucks are allowed on all European motorways (i.e. backbone roads). The usage of LHVs on regional roads may be restricted: the restriction does not have a big influence on economics of LHV operation, i.e. there is a limited set of roads where LHVs are forbidden. For this scenario we do not make distinction on technological aspects: we do not specify which type of equipment is allowed (e.g. Modular concept, EuroCombi); however we set a general permission for LHVs with constraints of 25.25m and 60t. Also, in a subscenario an approximation will be made for the use of a 50t truck option by extrapolation.
7. **Scenario 3: "Corridor/Coalition": LHVs of 25.25 m 60 t are allowed in some countries, while Europe-wide only 18.75 m 40 t trucks are allowed**. This scenario is a mix of scenarios 1 and 2. There is a group of countries that permit LHVs on their motorways, possibly putting some restrictions for the usage of regional roads, while the rest stick to the current restrictions (40t 18.75m). We include into the coalition 6 European countries: NL, BE, DE[2], SE, FI, DK. Possible extensions to France and Spain will be briefly discussed, without a similar elaborate quantitative analysis though.
8. **Scenario 4**: **"Intermediate": Europe-wide permission of up to 20.75 m 44 t trucks.** This scenario represents a gradual increase in vehicle constraints, namely 10% of carrying capacity. The choice of dimensions and constraints is "realistic" and reflects wishes of car transporters and chemical industry. The choice of these dimensions excludes "Gigaliners", at least in their currently implemented form, from considerations. At the request of the European Commission, we also provide an extrapolation for the situation where trucks of 50 tonne gross are allowed. We do not set up the model for these trucks: the results on meeting future demand and modal split are a linear combination of the scenarios 2 and 4 results.

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[2] We made the assumption that the coalition includes Germany to make a coherent set of countries, but according to our information this scenario remains rather unlike while the German government seems reluctant to change the current Directive.

In the scenarios defined above, we intentionally avoid selecting particular technological solutions like the modular concept and, particular implementations like EuroCombi. The idea behind scenarios is to benchmark particular constraints to the reference scenario in a clear and unambiguous way to see what would be the implications to the economics of transport and the impact on modal shift and rail transport market in particular. Scenarios are calculated on the aggregate level, dealing with transport streams in terms of tonne and tonne-kilometres volumes. Whenever indicated otherwise, we apply the same parameters to the whole of Europe. Nevertheless, for the assessment of other effects (safety and infrastructure), particular technological implementations will be taken into account. This includes a safety assessment of vehicle configurations of 25.25 m and a gross vehicle weight of 40 t as volume of freight plays a major role (e.g. one percent of Germans net domestic product is produced by transport of light but voluminous goods).

IV Assessing demand and modal split

The requirement for transport in the European economy is continuously growing. As the world economy, and the European economy in particular, grows, there is a need to transport more goods, in other words to make more tonne-kilometres. Assessments of future transport demand may differ in numbers; however they all predict a higher transport volume in Europe. The question is how this future demand can be satisfied, preferably in a way that brings a minimum of negative external effects.

Long and heavy vehicles are clearly an innovation that increases the productivity of the European road transport sector. In a competitive environment, if one technology brings substantial improvements, this improvement would certainly have an impact on competing technologies. In case of LHV use, there is a concern among some stakeholders that an increased use of LHVs in Europe will have a negative impact on the volumes in the rail transport sector. The inland waterways modality can also be affected; however, there is not much resistance from the inland waterways operators. The main explanation for this could be that inland waterway operators are normally smaller and less consolidated, as well as smaller representation by umbrella and lobby organizations.

In this section we look to see if introducing the concept of LHV could help satisfying ever growing transport demand, as well as a generation effect.

We also look at the effect on modal choice. The question of LHV impact on modalities is multi-faceted. If it is seen from a free-market perspective, improvements in the road sector must give a competitive stimulus to the rail sector. In practice however, the price decrease in the road sector due to LHV use might simply take away some volumes from rail, while the rail sector would not be able to react accordingly. Keeping in mind that rail transport has smaller negative externalities, this would not be desirable.

1. Methodology

Three approaches were used to reach a final set of data to be used in determining the effect of introducing LHVs in Europe. Before explaining them in detail, the concept of elasticities, one of the main determinants of modal split, is introduced. A rough analytical approach provides a first estimate. Using an extensive range of parameters, a more detailed calculation is then performed. Finally, a choice of parameters is made to develop a data set for further work.

In the case of measuring changes in European transportation and modal split, there are three main indicators. The first indicator is European transport demand measured in *tonnes transported*. This is a very basic measurement which is linked to transportation activities. The second indicator is *tonne-kilometre performed*. This measurement is linked very closely to the first one, but gives a better picture of the magnitude of transportation. The third indicator, *vehicle-kilometres* is applied for road transport. It is needed for the analysis of emissions, safety and congestion effects of LHVs. For the calculations on meeting future transport demand, we have looked at the annual tonne / tonne-km cargo volume transported per country (EU). Therefore, remaining at an aggregate level, we look at the impact of LHVs on the total transportation picture.

1.1. Analytical approach

An analytical calculation of the effects of LHVs on transport volumes has been made, using a few different elasticities. Using TRANS-TOOLS assumptions, plus literature data, a first approximation was used to calculate expected outcome of the transport situation in 2020.

1.2. Extensive calculation approach

A more extensive calculation has been made, using macroscopic variables to determine modal splits. In this approach, different LHV concepts were studied, using a broad set of elasticities based on literature.

1.3. Modelling approach

To be able to work with a final set of data for further calculations on the other effects of introducing LHVs, precise numbers were needed on the outcome in terms of volume, for each country and each mode. A choice was made among the ranges of parameters discussed in the previous approaches. The TRANS-TOOLS model was used for this. TRANS-TOOLS is a complex and comprehensive model that calculates transportation volumes in Europe between 300 regions, divided in road, rail and inland waterway transport. Transportation flows and modal split in Europe are projected for the year 2020, using a set of underlying assumptions that are generally used and accepted as sensible, as the model has been developed in the past few years for the European Commission by a consortium of leading R&D modelling organisations in Europe.

As this approach was the only one able to deliver output of sufficient detail - needed for further calculations - within the timeframe and budget of this study, only these results were used in the remainder of the document.

2. The concept of elasticities

As shifts in transport volumes, both within and between modes, are the key issue in assessing demand, this section will explain in detail how the mechanism of price elasticity works.

In transport economics, demand functions describe the relationships existing between the price of a transport service and the amount consumers are willing and able to purchase at that given price. Generally speaking, elasticities are used to indicate the responsiveness of one quantity to a change in another. Elasticities are a useful tool in transport economics, where small changes in transport costs are very common. In the previous context, direct price elasticity of demand for a transport service indicates the change in demand for this service following a change in its price. The elasticity of quantity q_a with respect to price p_a is the ratio:

$$\frac{p_a}{q_a} \cdot \frac{dq_a}{dp_a}$$

Similarly, cross elasticities measures the responsiveness of the quantity demanded of a good to a change in the price of another good. Within the given context, cross elasticities describe the relationship between the change in demand for a given transport service (in a given mode) and the change in the price of another mode.

Notation:

° refers to the reference situation

R refers to road transport

F refers to rail transport

W refers to inland waterways transport

$\varepsilon_{x/y}$ are elasticities of y with respect to x.

Remark: direct price elasticities correspond to x = y.

It can be assumed that the demand for freight transport and for each mode can be modelled as a linear demand[3] or an isoelastic demand[4]. Using these two specifications for the demand will give two values for modal split: an interval which contains the researched values.

In a context of competitiveness between road transport and railway transport, the isoelastic demand functions are formulated in the following manner:

Isoelastic demand

(1) $$q_R = q_R{}^{\circ}\left(\frac{p_R}{p_R{}^{\circ}}\right)^{\varepsilon_{R/R}}\left(\frac{p_F}{p_F{}^{\circ}}\right)^{\varepsilon_{R/F}}$$ and (2) $$q_F = q_F{}^{\circ}\left(\frac{p_R}{p_R{}^{\circ}}\right)^{\varepsilon_{F/R}}\left(\frac{p_F}{p_F{}^{\circ}}\right)^{\varepsilon_{F/F}}$$

In a context of competitiveness between road transport and inland waterways transport, the linear demand functions are formulated in the following manner:

Linear demand

(3) $$q_R = \frac{q_R{}^{\circ}}{\left(1+\varepsilon_{R/R}\left(\frac{p_R{}^{\circ}}{p_R}-1\right)+\varepsilon_{R/W}\left(\frac{p_W{}^{\circ}}{p_W}-1\right)\right)}$$ and

(4) $$q_W = \frac{q_W{}^{\circ}}{\left(1+\varepsilon_{W/R}\left(\frac{p_R{}^{\circ}}{p_R}-1\right)+\varepsilon_{W/W}\left(\frac{p_W{}^{\circ}}{p_W}-1\right)\right)}$$

This shows that direct price elasticities and cross elasticities are required to compute the impact of a change in road transport price on each mode.

[3] A linear demand function expresses the amount of goods or services consumers are willing to purchase as a linear function of the price of these goods or services.

[4] The demands for goods or services are called isoelastic when the corresponding elasticities are constant for any given combination of price and quantities.

Moreover, it is assumed that road price will instantaneously decrease, whereas prices will remain unchanged for all other modes. Considering equations (1) to (4), and that $p_R/p_R^\circ = 1$, the required elasticities and cross elasticities for calculations are: $\varepsilon_{R/R}$, $\varepsilon_{F/R}$ and $\varepsilon_{W/R}$.

Review of available values of direct price elasticities and cross elasticities[5]

A review of demand studies covering all modes of transport was compiled as World Bank Working Paper (Oum, Waters and Yong, 1990). It was based on estimates of demand elasticities for road and rail freight made in North America in the 1970s and 1980s. As the current market differs significantly from the US market of that era, it would not make sense to use the data in the table below, but they can be regarded as useful references.

Table 4: Elasticities of demand for rail and road freights (Friedlaender & Spady 1980)

TABLE 1D12 ELASTICITIES OF DEMAND FOR FREIGHT RAIL AND ROAD FREIGHT

	Own price elasticities		*Cross price elasticities*	
Commodity	*Rail*	*Truck*	*Rail wrt truck rates*	*Truck wrt rail rates*
Food products	−2.583	−1.001	−0.023	0.004
Wood & wood products	−1.971	−1.547	−0.050	−0.129
Paper, plastic & rubber products	−1.847	−1.054	0.007	0.003
Stone, clay & glass products	−1.681	−1.031	0.025	0.016
Iron & steel products	−2.542	−1.083	−0.053	−0.013
Fabr. metal products	−2.164	−1.364	−0.059	−0.099
Non-electrical machinery	−2.271	−1.085	−0.032	−0.010
Electrical machinery	−3.547	−1.230	−0.151	−0.061

Note Based on 5 regions in the USA for 1972.

Source Friedlaender & Spady (1980, table 2, p. 439).

In a 1994 report[6], Quinet provides some intervals for direct price elasticities and cross elasticities applicable for the transportation of freight by road and rail and for long distance transport services. These values are summarised in the table below.

Table 5: Elasticities of demand for rail and road freight (Quinet 1994)

Mode	Price	
	Railways	Road
Railways	-1	1.3
Road	0.5 to 0.7	-0.9 to –0.7

[5] Oum, T.H., W.G. Waters II and J.S. Yong (1992), Concepts of price elasticity of transport demand and recent empirical estimates*, Journal of Transport Economics and Policy,* May 1992 140-153

Ahdelwahab, W. (1998), Elasticities of mode choice probabilities and market elasticities of demnd: Evidence from a simultaneous mode/shipment size freight transport model, *Transportation Research E,* 34 (4), 257-266

Bröcker, J., (1995) Chamberlinian Spatial Computable General Equilibrium Modelling: A Theoretical Framework, Economic Systems Research, Volume 7, Issue 2 1995 , pages 137 - 150

[6] QUINET, E. (1994). Rapport Route-Air-Fer. Rapport pour le compte du Ministère des Transports

In 1995, a British Research Program[7] concludes that *for uniform changes in truck costs, the estimated cross elasticity for rail tonne-miles is 0.5*, which means:

$\varepsilon_{F/R} = 0.5$;

Moreover, a study by UBA[8] predicts that 20 % cost reduction in road transport would lead to a 38% loss of volume for rail, and 16 % loss for inland waterways, which is equivalent to:

$\varepsilon_{F/R}$ the elasticity of rail transport demand with respect to road price equals 1.9.

$\varepsilon_{W/R}$ the elasticity of inland waterways transport demand with respect to road price equals 0.8.

In a 2008 paper from TRL[9], it is indicated that allowing 60 tonne LHVs would result in an 8 – 18 % tonne-km shift from rail to road. Considering a 20 % discount in road transport price, it means that the rail/road cross elasticity equals 0.4 to 0.9:

$\varepsilon_{F/R} \in [0.4; 0.9]$

Some values were also given in a 2007 report[10] from Oxera. Considering volumes in tonne-km, direct price elasticities and cross elasticities were computed to assess the impact of introducing LHVs on volumes operated by the railway industry. They are:

$\varepsilon_{F/R} = 0.74$

$\varepsilon_{R/R} = -1.2$

Finally, Beuthe et al. (1999) developed a series of freight transportation demand elasticities using Belgian data[11]. They estimated direct and cross elasticity estimates of the demands for three freight transportation modes: rail, road and inland waterways. For their computation, they used a detailed multimodal network model of Belgian freight transports, as well as OD matrices and cost information. They assumed that companies would aim to minimise generalised cost and used NODUS software to calculate specific arc-elasticities, for Belgian traffics. However, they took into account the European context. In their model, the discount in road transport price was supposed to be instantaneous, while the other modes had no change in their price. In their paper, elasticities and cross elasticities are given for short distance and long distance freight transportation and for a small cost variation (5%).

Table 6: Elasticities of demand for rail, inland waterways and road freights (Beuthe et al. 1999)

Total cost variation						
Elasticities	Short distance			Long distance		
tonne-km	Road	Railways	Waterways	Road	Railways	Waterways
Road	-0.84	0.36	0.10	-1.64	0.71	0.09
Rail	2.08	-2.87	1.70	1.11	-0.64	0.43
waterways	2.60	1.66	-2.01	0.78	0.48	-1.59

7 Cambridge Systematics, Inc. 1995. Characteristics and changes in Freight Transport Demand : A Guidebook for Planners and Policy Analysts. National Highway Cooperative Rsearch Program Project 8-30.

8 Umweltbundesamt (2007). Hintergrundpapier „Länger und schwerer auf Deutschlands Straßen: Tragen Riesen-Lkw zu einer nachhaltigen Mobilität bei?

9 Knight, I. et al. (2008). Longer and/or Longer and Heavier Goods Vehicles (LHVs) – a study of the likely effects if permitted in the UK : final report.

10 Oxera (2007). The road, rail and external impacts of Longer, Heavier Goods Vehicles. Prepared EWS

11 BEUTHE, M. et al. (1999). Intermodality and Substitution of Modes for Freight Transportation: Computation of Price-Elasticities through a Geographic Multimodal Transportation Network Analysis. Paper presented at the 1999 conference of the European Regional Science Association.

A number of European models that are known to have been calibrated on EU transport statistics or equivalent data material also provide insight in the range of possible elasticities:

Table 7: Transport price elasticities

	Segment	Tonne/tonne-km	Elasticity
Scenes[12]	ALL	tonne	-0.12
Samgods[13]	<50 km	tonne-km	
	>50 km	tonne-km	-0.54
Nemo[14]	< 100 km	tonne-km	-0.08
	> 100 km	tonne-km	-1.55
WFTM[15]	< 100 km	tonne	-0.16
	> 100 km	tonne	-0.666
SISD[16]	< 250 km	tonne	-0.08
	> 250 km	tonne	-0.49
Trans-Tools MS model[17]	**All**	**tonne**	**-0.416**

3. Analytical approach

As a first approximation, an analytical study of the changes in European transport systems due to the introduction of LHVs was made. This allowed validation of the estimated impact of long and heavy vehicles on transportation demand and transportation flow, conceptualising the opportunities at the highest aggregate level. In essence, such a system on highly aggregated level has several degrees of freedom. In this analytical approach, we have identified the following most important factors that are of relevance for this study.

Below we briefly describe them:

1. Share of LHVs in total transportation, expressed as a number of tonne-km carried out by LHVs.
2. LHV cost discount. This variable compares cost of tonne-km carried out by a normal HGV truck to a LHV truck. Using knowledge we received at the stakeholder meetings, meetings with filed experts and literature study, we fix the discount factor at 20 %.
3. LHV extra capacity in comparison to HGV. We fix it at 50 % because we worked with a 60 t and 25.25 m LHV.
4. The rail transport demand price cross-sensitivity. This parameter does not reflect the sensitivity of rail transport demand to the price of rail services; however, it shows how rail transport demand is sensitive in respect to road transport cost. That is why we call it ‘cross-sensitivity’. This cross-sensitivity shows what happens with rail transport volumes as a result of change in road transport price.
5. Road transport price elasticity. This variable is responsible for generation of extra transport demand if price of transport decreases.

[12] Freight model of Sweden
[13] Freight model of Sweden
[14] Freight model of Norway
[15] Belgian Freight model
[16] Italian Freight model
[17] TRANS-TOOLS– Modal split model

3.1. Effect on road transport

The combinations of these parameters give a large freedom in scenario definition. That is why we fixed the LHV cost discount at 20% and LHV extra capacity at 50% (variables 3 and 4 in the list above). In this first approach, it reduces complexity and does not compromise calculation results because cost discount factor can be implicitly expressed through the assumed share of LHV in European road transport. Varying possible values of the share of LHV in total transport and road price sensitivity, we did make theoretical predictions on extra road transport demand and on infrastructure claim (congestion of roads). There are two effects at work: LHV cost discounts increases the use of road transport, while extra capacity of these vehicles decreases the number of trips. The calculations are made according to the following formulas.

$$\textit{Extra road transport demand (relative)} =$$

$$100 - 100 * \textit{Share of LHV}_{\%} * \textit{road price sensitivity} * \textit{LHV price discount}_{\%} / 10000 \quad (1)$$

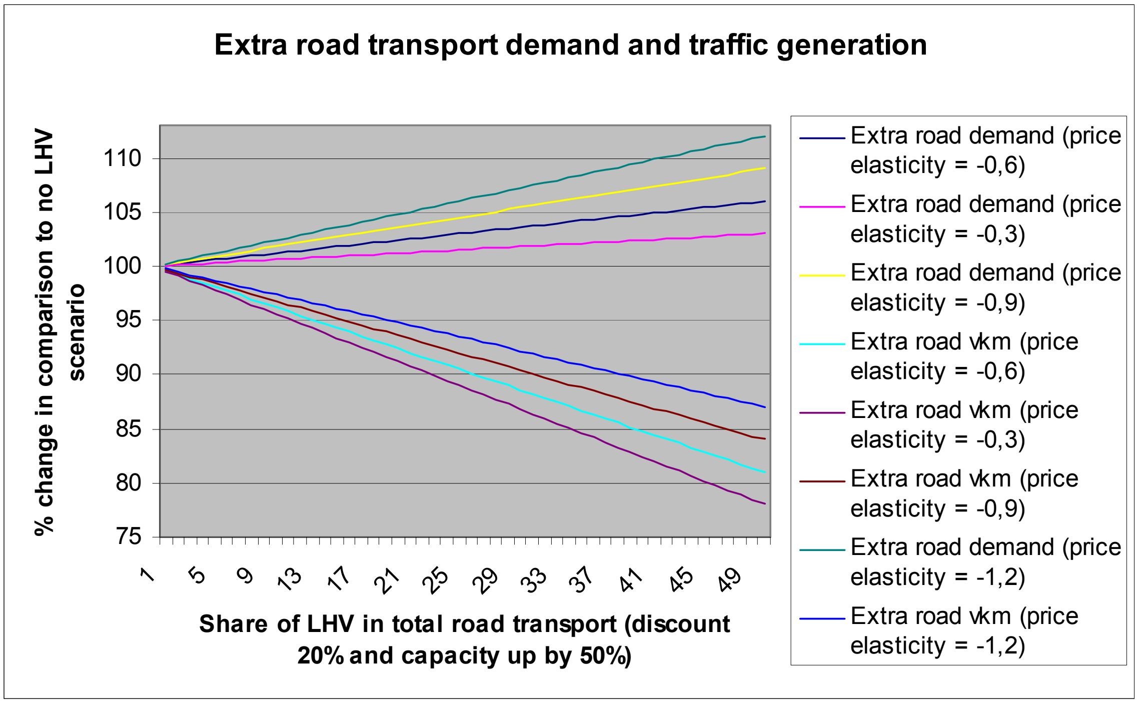
$$\textit{Extra road vehicle kilometres (relative)} =$$

$$100 - (100 * \textit{Share of LHV}_{\%} * \textit{road price sensitivity} * \textit{LHV price discount}_{\%} / 10000) -$$

$$- (100 * \textit{Share of LHV}_{\%} * \textit{LHV Extra Capacity}_{\%} / 10000) \quad (2)$$

The figure below illustrates the phenomenon of demand generation and impact on the infrastructure. The result of the figure should be read in the following way. We assume 100 % of road transport demand and vehicle kilometres made in case of zero LHVs on the roads. Values lower than 100 % represent decrease of a parameter and values of more than 100 % represent increase of a parameter. It should also be noted that road price demand elasticity is related to tonne-km of cargo transported (as opposed to volume expressed in tonnes). Generally road transport price elasticity is higher if it is expressed in tonne-km, while tonne-related transport volumes are less sensitive (i.e. price elasticity influences not only demand, but the average distance over which goods are transported).

Figure 7: Extra road transport demand and traffic generation



In the figure above, we have plotted on the X-axis the share of LHVs on the basis of tonne-km in total transport (variable 1 in the list above). On the Y-axis we plotted change in respect to transport demand expressed in tonne-km and claim on infrastructure expressed in vehicle kilometres. We selected 4 possibilities of road price sensitivity: -0.3; -0.6, -0.9 and -1.2, which is related to ton-kilometres. The LHV cost discount is set at 20% in comparison to HGV (thus 80 % of the cost) of tonne-kilometres and capacity of LHV is 50% bigger than that of HGV. The higher (in absolute terms) road price sensitivity, the more transport demand is generated. On the other hand, there is a substantial decrease in the total number of vehicle kilometres. There would be positive increase in the number of vkm only if price sensitivity is below -2.5. We do not expect such values to appear in the real world. Thus, the conclusion from this analytical exercise is that the use of LHVs would lead to more goods transported (up to 11% in the most extreme case), while at the same there will be fewer vehicle kilometres (down with 22 %) , in other words less traffic and less congestion.

Given the broad range of possibilities that appeared during our analysis of the influence of using LHVs on the European transport system, more refined results of TRANS-TOOLS model were indeed necessary. In the following subchapters we describe how the model has been set up and provide the reader with the TRANS-TOOLS modelling results.

3.2. Effect on rail

The impact of LHVs on the European modal split is assessed using the TRANS-TOOLS model runs. The output of the runs is the number of tons transported per country per mode in the year 2020. Before running the TRANS-TOOLS model, we have made a number of analytical assessments of impact of LHVs on modal split. In essence, such a system on a highly aggregated level has several degrees of freedom. The approach to calculating the effect of using LHVs on European modal split is very similar to one that is used for assessment of the effect on meeting future transport demand, which is described in the previous section of this report. To make an analytical assessment, we use the same variables as in the section on meeting future transport demand, plus rail transport price cross-sensitivity. The following is a list of variables taken into account to make the model split analysis.

1. The expected share of LHVs in total transportation, expressed as a number of tonne-kilometres carried out by LHVs.
2. The Road transport price elasticity.
3. The LHV cost discount. This variable compares cost of tkm carried out by a normal HGV truck to LHV. Given knowledge we gained during the stakeholder meeting, meetings with known experts and literature study, we fix the discount factor at 20%.
4. The LHV extra capacity in comparison to HGV. We fix it at 50% as considering 60t 25.25 m LHV.
5. The rail transport demand price cross-sensitivity. This parameter does not reflect the sensitivity of rail transport demand to the price of rail services; however, it shows how rail transport demand is sensitive in respect to road transport cost. That is why we call it ‘cross-sensitivity’. This cross-sensitivity shows what happens with rail transport volumes as a result of change in road transport price.

As in the case on meeting future transport demand, we fix the LHV cost discount at 20% and LHV extra capacity at 50% (variables 3 and 4 in the list above). Further, according to CE Delft research (1999) on transport price sensitivities, the rail transport demand price cross-sensitivity is approximately -3 times of road transport price sensitivity. Given these parameters, we can make an assessment on impact of road pricing on rail transport.

Varying possible values of the share of LHV in total transport and road price sensitivity and functionally-related rail price cross-sensitivity, we can make theoretical predictions on the impact of LHVs on rail volumes. The calculations are made according to the following formula:

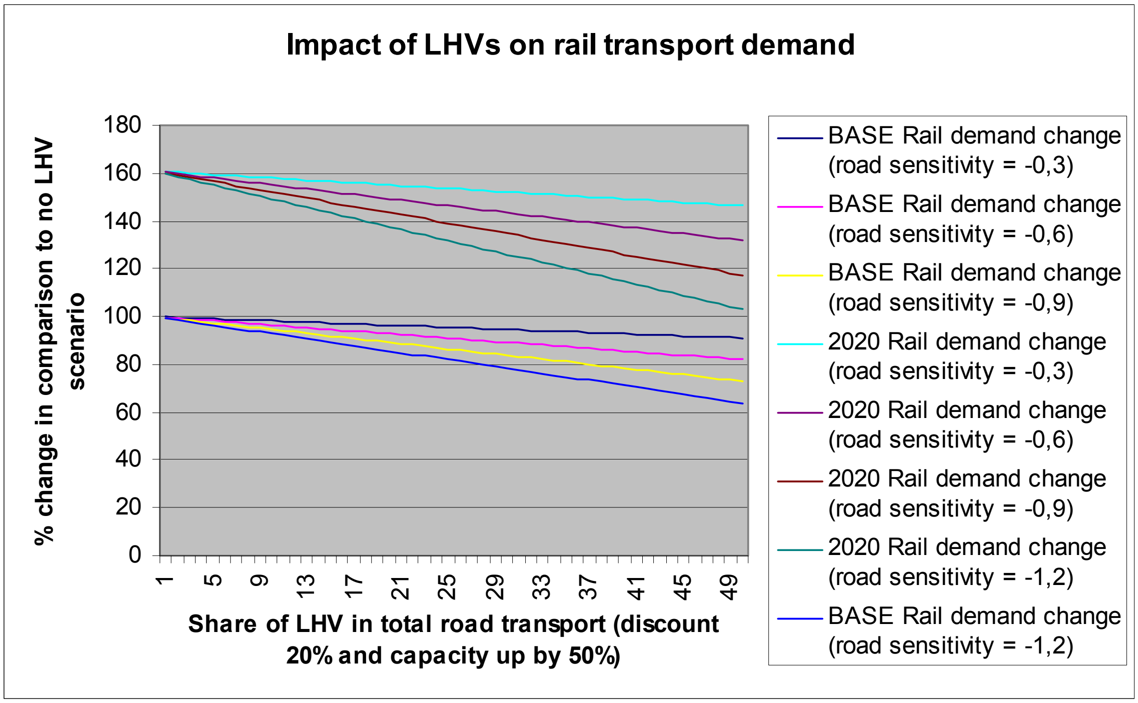
$$\textit{Extra rail transport demand (relative)} =$$

$$100 - 100 * \textit{Share of LHV}_{\%} * \textit{rail price cross\_sensitivity} * \textit{LHV price discount}_{\%} / 10000 \quad (3)$$

$$\textit{Rail price cross-sensitivity} = -3 * \textit{Road price sensitivity} \quad (4)$$

The figure below shows the dependency of rail transport demand, expressed in tonne-km (Y-Axis) on the share of road transport done by LHVs, given road price demand sensitivity and corresponding rail cross-sensitivity. LHV discount factor is set to 20 % (i.e. tonne-km of road transport carried out by an LHV costs 80 % of an equivalent tonne-km carried out by a normal HGV). LHV has 50 % more capacity than HGV. “BASE” refers to 2005 transport volume levels, “2020” starts from the increased volume in 2020, assuming a growth of total transport of just over 60%.

Figure 8: Impact of LHVs on rail transport demand, base year 2005 and future year 2020



As the figure above shows, the use of LHVs in Europe negatively influences European rail volumes. A reasonable range of impact is a 5 - 15 % decrease of tonne-km in rail transport in comparison to the situation with no LHVs. However, the reader should take into account that the TRANS-TOOLS model projects a growth of rail transport demand of 60.8 % between 2005 and 2020. If this growth factor is taken into account, then there will still be substantial growth of rail transport, even if LHVs are allowed throughout Europe. In practice, we talk about somewhat slowed-down growth of rail, from some 3 - 4 % per year without LHV to 2.5 - 3.5 % per year with LHV.

The cross-sensitivity factor has been set to -3 in this experiment. In other words, if road price goes down by 1 % and road transport price sensitivity is -0.6, then rail would lose 1.8 % of volume. These assumptions are conservative. Moreover, they assume that rail does not react competitively to changes in the road transport market segment. If the rail sector manages to improve its services, it would be able to decouple the segment quite substantially from the cross-sensitivity with road mode (in other words not trailing the road mode, but playing with it on equal terms). In this case, impact of LHV would be minimal, as cross-sensitivity factor would be getting close to 0.

4. Calculation of intra- and intermodal shifts on a macroscopic scale

A lot of studies have been conducted to estimate transport elasticities. This section lines them up and tries to estimate the range of outcomes for transport volume in 2020. The output is a set of transport volumes for all modes, based on a thorough analysis of all parameters.

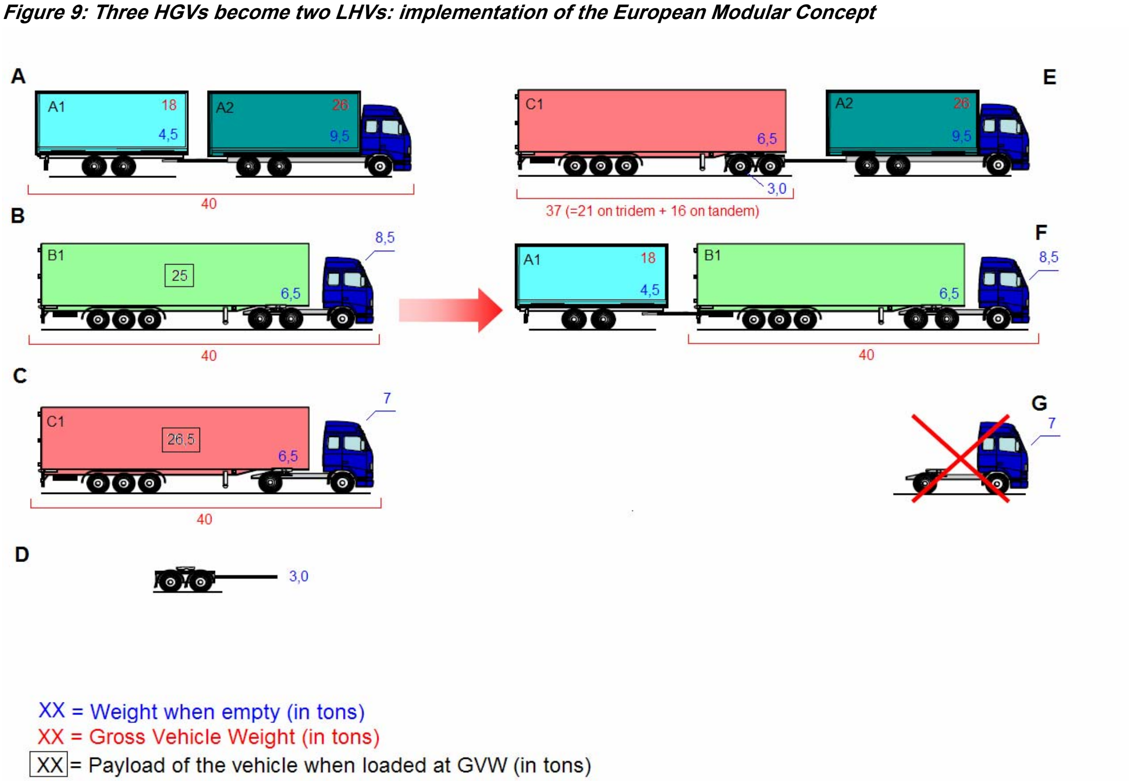
4.1. Considerations on vehicles' recombination

The aim of this part is to explore the use of the European modular concept in the new logistical organisation, specified below:

- Using three heavy goods vehicles (HGVs) of 40 t (shown as A, B and C on the scheme below) from the origin of the transport operation to a recombination area (distance may sometimes be zero) where dollies (D) are available.
- Recombining the 3 HGVs (A, B, C) plus a dolly D, in 2 LHVs E, F (plus a tractor G).
- Using 2 LHVs for the principal haulage until another recombination area where there are tractors (G), while G goes back in solo to the same or another point of origin.
- Recombining the two LHVs (plus a tractor G) in 3 new, "regular" HGVs.
- Using the 3 HGVs from the recombination area to the final point of the transport operation (distance may sometimes be zero).

At least one of the initial or final legs is performed by HGVs (door-to-door use of LHVs is not possible, because of limits due to infrastructure).

Figure 9: Three HGVs become two LHVs: implementation of the European Modular Concept



4.2. Objectives

In this section, 3 tasks have been performed:

- Determining the part of **the current road traffic** that fits with the proposed new logistical organisation.
- Determining the likely modal shift from other modes to road as a consequence of lower costs.
- Determining traffic generation resulting from lower road transport costs.

4.3. Calculation of permissible payloads in LHVs

The previous figure shows the principle of the recombination and shows figures that allow the calculation of payloads of A, B, C, E, F so that the weight of each combination is compatible with regulation.

To build this scheme, some data provided by a truck manufacturer have been used, after being checked with data provided on different truck companies' websites[18].

Table 8: Weight intervals for the various vehicle components of combinations

	Weight (in tonnes)	
	min	max
Long haul 4x2 tractor	7.0	8.0
Long haul 6x4 tractor	8.5	10.0
Long haul 6x4 truck	9.5	11.0
Semi trailer 3 axles	6.5	7.5
Dolly	2.5	3.0
2 centred-axle trailer	4.5	4.5

The mass of "x" is noted M(x). The total mass does not vary after recombination, which is equivalent to saying that:

(1): M (A+B+C+D) = M (E+F+G)

which can also be written:

(2): M (A+B+C) + M (D) = M (E+F) + M (G)

or:

(3): M (E+F) = M (A+B+C) – [M (G) – M (D)]

It is rational to determine M (E) and M (F) in the most favourable (from industry's point of view) conditions. Thus, assuming that the three vehicles A, B and C are loaded up to the maximum allowed limit (40 t) and their total mass is 120 tonnes. M (G) – M (D) is the minimum, thus equal to 4 tonnes.

Including those values in equation (3):

(4) M(E+F) = 120 – 4 = 116 tonnes

<u>First conclusion</u>: if Directive 96/53 is modified to allow road trains with a GVW of 60 t, <u>and</u> if the two LHVs are fully loaded, then the maximum weight of 40 t will be exceeded after recombining into 3 HGVs! As C weighs 40 tonnes and B's gross vehicle weight is 18 tonnes, F can not exceed 58 tonnes.

[18] DAF (www.daf.eu/FR/Trucks/product-Specification-sheets); MAN (www.man.co.uk) and (www.erf.com);SAMRo (www.samro.fr); SCANIA (http://www.scania.fr/Poids_lourds/scania_trucks/Fiches_techniques_porteurs/); FRUEHAUF (www.fruehauf.fr); LAMBERET (http://www.lamberet.fr/fr/frm.asp?ID_menu=m22&ID_ssmenu=ss_m221).

Thus, to make use of the European Modular Concept and to make sure that Directive 96/53 is respected in all cases, it is necessary to limit the gross vehicle weight of LHVs to 58t. Type F can reach 58t if the centre axle trailer is loaded at the maximum allowed weight (18t).

However, there is risk for errors in this new logistical organisation, when combining the various units.

The maximum payload compatible with the use of the described logistical organisation can be calculated for each vehicle:

A: 40 – (4.5 + 9.5) = 26.0 t
B: 40 – (6.5 + 8.5) = 25.0 t
C: 40 – (6.5 + 7) = 26.5 t

E: 58 – (6.5 + 3 + 9.5) = 39.0 t
F: 58 – (6.5 + 8.5 + 4.5) = 38.5 t

Second conclusion: the average payload of the three HGVs almost equals 26 tonnes (25.83…), while the payload of an LHV will almost equal 39 tonnes (38.75) i.e., logically, 50 % more.

Third conclusion: using a similar reasoning, one reaches to the conclusion that the number of pallets hauled by (or the volume of) E (or F) is 50 % higher than the average number of pallets hauled by (or the volume of) A, B and C.

Finally, using the described logistical organisation, allowing a GVW of 60t could lead to overloaded HGVs. It is therefore recommended to set the gross vehicle weight of LHVs at 58 tonnes.

4.4. Assessment of modal shifts

4.4.1. Transport econometrics

Method

By reducing the costs of road transport, LHVs will reinforce the competitiveness of this mode, to the detriment of the other modes. It is widely agreed that introducing LHVs will lead to a decrease of road transport costs of approximately 20 %. It is then interesting to compute the resulting modal shift from rail and inland waterways transport.

Elasticity and cross elasticities values retained for the computation of modal shifts

In reference to the data of paragraph 2, we have tried to achieve a balance between the values defended by all protagonists. Resulting from an arbitrary choice, they may be subject to criticism, but they are the ones that were available and they appear to be rather sensible. However, considering the important range of variation for each elasticity, two sets of values have been chosen. In a first set named 'low elasticities' in the table below, the absolute elasticity values are lower than in the second set, which means that the effects of a road price decrease would be less significant overall. By choosing two sets of values, we have intended to show what would be a “worst case” scenario regarding modal splits.

Table 9: Choice of elasticities for the assessment of modal shifts

	Total Road cost variation			
Elasticities	Short distance		Long distance	
tkm	Low elast.	High elast.	Low elast.	High elast.
Road	-0.7	-1.0	-1.0	-1.6
Rail	2.0	3.0	1.1	1.9
Waterways	2.6	4.0	0.7	0.8

4.4.2. Modal shift within road transport

The goals are to evaluate the share of road freight that will be shifted from HGVs to LHVs and to know the final proportion of LHVs in total traffic.

To shift from tonne-km (provided by statistics) to vehicle-km, the load factor has to be used.
The latest known average load factor on a European scale dates back 2005. Eurostat[19] estimates it at 13.1 tonnes per vehicle. Thus the calculations have to be done with reference to year 2005, when traffic was approximately equal to 1 800 billion tonne-km.

For the assessment of **the proportion of road freight that could be hauled by LHVs**, several factors need to be taken into account that will be listed below. Moreover, it is very likely that the impacts of these three factors will vary in time for many reasons. Thus, two sets of results will be produced. The first set corresponds to a **'static' approach** with initial values for the three following factors whereas the second set corresponds to a **'dynamic' approach** with new values for the three factors associated to changes achieved by the companies and upgrades of the road network.

- Company size effect: firms with less than 50 employees would probably not be able to shift to LHVs in the conditions described at the beginning, which would require advanced logistics abilities. According to French statistics, firms with more staff than 50 employees make about 40 % of the total turnover of the sector. It is assumed that these companies operate a similar proportion of all tkm, and that this value can be used at EU level. It is expected that the road transport sector will continue to concentrate since road companies tend to purchase competitors. From 0.4, it is assumed that this ratio will grow to reach 0.5.

- Logistic organisation effect: despite their bigger size, it cannot be assumed that these companies would be able to shift all their freight to LHVs especially for short distance transport operations or if the amount of goods to be carried on some routes is not sufficient. It is assumed that 30% of goods that are usually transported by these companies would not fit with the new logistics organisation. However, as they would get experience from using LHVs and the fleet would be gradually renewed, it expected that this ratio would decrease from 0.3 to 0.20.

- Infrastructure effect: all roads would not be suitable for LHVs, and therefore traditional trucks would perform some of the remaining traffic. It is assumed that 92% of the length of the actual routes would be suitable for LHVs and consequently they would only be allowed on this part of the road infrastructure. As the length of the road network that is authorised to LHVs is a factor to obtain tkm, this leads to the conclusion that 8% of the concerned traffic would be performed by HGVs and it is assumed that they would be fully loaded (cf. paragraph 4.3 of this chapter). It is then expected that some parts of the road network that were not suitable to LHVs will benefit from upgrades and consequently

[19] Statistics in focus, transport, n° 117/2007

would become suitable to LHV traffic. The proportion of road network suitable to LHVs would then increase from 92 to 94%.

Table 10: Calculation of the tonne-km done by HGVs and LHVs in the static approach

		with HGVs	with LHVs
2020 traffic (in tkm)	*Ratio*	X	0.00
1) Company size effect	*0.4*	0.60*X	0.40*X
2) Logistic organisation effect	*0.7*	0.6*X + 0.3*0.4*X	0.7*0.4*X
3) Infrastructure effect	*0.92*	0.6*X + 0.3*0.4*X + 0.08*0.7*0.4*X	0.92*0.7*0.4*X

Table 11: Calculation of the tonne-km done by HGVs and LHVs in the dynamic approach

		with HGVs	with LHVs
2020 traffic (in tkm)	*Ratio*	X	0.00
1) Company size effect	*0.5*	0.50*X	0.50*X
2) Logistic organisation effect	*0.8*	0.5*X + 0.2*0.5*X	0.8*0.5*X
3) Infrastructure effect	*0.94*	0.5*X + 0.2*0.5*X + 0.06*0.8*0.5*X	0.94*0.8*0.5*X

Furthermore, it seems interesting to calculate the parts of the freight traffic that will be performed by HGVs and LHVs. If the total freight traffic (tkm) in 2020 is noted X, and considering that the average load factor equals 13.1 tonnes/vehicle, then the freight traffic (vkm) performed by HGVs in 2020 would be equal to X/13.1. Next, if fully loaded HGVs are excluded from the vehicle sample, it is then possible to compute the average load factor of the remaining vehicles. Calculations show that the researched load factor is equal to 11.0 t. It will be noted $new.load.factor_{average}$.

These calculations enable to know the part of the tonne-km that could be done by LHVs. It can be assumed that this freight volume was formerly transported by fully loaded HGVs and that they would then be transported by fully loaded LHVs. The payload of HGVs is assumed to be approximately equal to 25.8 tonnes, whereas the LHV one is assumed to be equal to 38.7 t.

From the previous results, it can be found that:

- the part of freight traffic done by LHVs would be equal to $\frac{0.92 * 0.7 * 0.4 * X}{LHV_{payload}}$
- the part of freight traffic done by HGVs would be equal to the sum of :
  a) the traffic that could be performed by LHVs but that would be operated by HGVs because of infrastructure limits $\frac{0.08 * 0.7 * 0.4 * X}{HGV_{payload}}$
  b) the rest of the traffic that is operated by HGVs with the calculated average load (equal to 11.0 tonnes), that is equal to $\frac{0.6 * X + 0.3 * 0.4 * X}{new.load.factor_{average}}$ and
  c) the solo trips of empty tractors that would be necessary to operate the freight when infrastructure limits occur on an itinerary and that would approximately be equal to the mileage done by HGVs (the same value as in a). This is of course only valid in the calculation of veh-km, not tonne-km.

4.4.3. Impact on road transport price

Once, the share of road volumes that are operated by LHVs and by HGVs is known, it is possible to calculate the impact that the introduction of LHVs would have on the road transport price overall.

If x% of road volumes in tonne-km are operated by HGVs at a price $p_{R°}$ and y% by LHVs at a price p_R, and if $p_R = w.\ p_{R°}$ then the average new price of road transport, p_R' will be equal to:

$$p_R' = x.p_{R°} + y.\ p_R = x.p_{R°} + y.\ w.\ p_{R°}$$

and thus $p_R'/p_{R°} = x + y.w = x + (1 - x)*w$

4.4.4. Impact on the other modes

Then using the ratio $p_R'/p_{R°}$ and the methodology that was introduced in transport econometrics paragraph, the changes in freight volumes can be calculated, in tonne-km, operated by each mode, assuming that:

- road price will immediately decrease for transport operations done by LHVs, while the price of other modes will remain unchanged (-20 % for road transport operations performed by LHVs in scenarios 2 and 3 and –7% for the ones in scenario 4);
- the demand functions for each mode are linear or isoelastic;
- the elasticities and cross elasticities for short distance & long distance equal the values indicated in the transport econometrics paragraph.

However, as mentioned earlier, elasticities are not to be used in a context of significant changes in transport costs. For that reason, demand functions were introduced so as to make calculations on a larger scale. These demand functions, linear or isoelastic, make use of direct price elasticities and cross elasticities. Although, their use in the considered context may not be appropriate from an economic point of view, this method is very useful and convenient when it comes to finding interesting marks.

4.5. Modal shifts for the different scenarios

4.5.1. Example: scenario 2

The same methodology is used for all calculations in scenario 3 and 4. Whether we deal with a static or a dynamic approach, or with 'low' elasticities or 'high' elasticities, the only difference consists in the number of countries that are considered in each scenario and the kind of vehicles that are introduced. Therefore, only scenario 2 is extensively calculated as an example, before summarizing all results in a few tables.

Scenario 2 consists in allowing 25.25 m long vehicles with a weight of 60 t, in all European countries. In a first step, we will calculate the market shares of HGVs and LHVs in Europe if LHVs were to be introduced. Considering that 2343 billion tkm would be operated by road transport in Europe in 2020 (reference scenario), and using the methodology described previously, LHVs and HGVs will respectively operate the volume and traffic proportions given in Table 12. In the present case, we will use a static approach and the set of elasticities and cross elasticities that we have named 'low elasticities'.

Table 12: Scenario 2 market shares of HGVs and LHVs – static approach

		Billion tkm		Billion vkm	
		with HGVs	with LHVs	HGV	LHV
2020 traffic	*Ratio*	2 343.20	0.00	178.87	0.00
Company size effect	*0.4*	1 405.92	937.28		
Logistic organisation effect	*0.7*	1 687.10	656.10		
Infrastructure effect	*0.92*	1 739.59	603.61		
Solo trips				0.68	
Total		1 739.59	603.61	156.09	15.58
Share of LHVs and HGVs (%)		**74.24**	**25.76**	**90.93**	**9.07**

Given that HGVs will operate 74.24 % of all tkm and LHVs will operate 25.76 % and that LHVs would provide a 20 % discount on transport price, it is calculated that the ratio *[average new price of road transport] / [former price of road transport]* will be equal to:

$$0.7424 + 0.2576*0.8 = 0.9485$$

which means that overall, road transport price will decrease by 5.15 % and that freight volumes, in tkm, operated by each mode, would vary in the following proportions, as can be seen in the table below.

Table 13: Scenario 2: changes in freight volumes (tkm) operated by each mode- static approach

	Linear demand		Isoelastic demand		Average
ROAD	5.0	to	5.3	%	5.1
RAIL	-6.0		-5.9		-6.0
Waterways	-5.8		-5.7		-5.8

Considering that the previous volumes for rail and inland waterways are transferred to road, it is possible to calculate the extra road volumes, uniquely due to the decrease in road transport costs in the table below.

Table 14: Scenario 2: generated volumes transported by road – static approach

	Isoelastic demand		Linear demand	Average
Road transport growth (%)	5.3	to	5.0	5.1
Road freight volumes (Gtkm)	2466.9		2460.4	2463.6
Generated volumes (Gtkm)	85.1		91.9	88.5
Proportion within total increased volumes (%)	3.6		3.9	3.8

Related to the current road volumes, these extra volumes would represent 3.8% of freight volumes transported by road in 2020. Generated volumes are equal to the total road freight volumes (after application of the calculated growth factor) minus the freight volumes that are shifted from railways and inland waterways to road transport.

If we consider now a dynamic approach, we would find that LHVs and HGVs would respectively operate the volumes (in tkm and vkm) given in the table below:

Table 15: Scenario 2 market shares of HGVs and LHVs – dynamic approach

		Billion tkm		Billion vkm	
		with HGVs	with LHVs	HGV	LHV
2020 traffic	*Ratio*	2 343.20	0.00	178.87	0.00
Company size effect	*0.5*	1 171.60	1 171.60		
Logistic organisation effect	*0.8*	1 405.92	937.28		
Infrastructure effect	*0.94*	1 462.16	881.04		
Solo trips				0.73	
Total		1 462.16	881.04	130.72	22.74
Share of LHVs and HGVs (%)		**62.40**	**37.60**	**85.18**	**14.82**

Given that HGVs will operate 62.40 % of all tkm and LHVs will operate 37.60 % and that LHVs would provide a 20 % discount on transport price, it is calculated that the ratio *[average new price of road transport]* / *[former price of road transport]* will be equal to:

$$0.6240 + 0.3760*0.8 = 0.9248$$

which means that overall, road transport price will decrease by 7.52 % and that freight volumes, in tkm, operated by each mode, would vary in the following proportions, as can be seen in the table below.

Table 16: Scenario 2: changes in freight volumes operated by each mode – dynamic approach

	Linear demand		Isoelastic demand		Average
ROAD	7.5	to	8.1	%	7.8
RAIL	-8.7		-8.6		-8.7
Waterways	-8.4		-8.3		-8.4

Considering that the previous volumes for rail and inland waterways are transferred to road and applying the average growth for road transport that has been computed previously, it is possible to calculate the freight volumes that would be operated by road and extra road volumes, uniquely due to the decrease in road transport costs in the table below.

Table 17: Scenario 2: generated volumes transported by road – dynamic approach

	Isoelastic demand		Linear demand	Average
Road transport growth (%)	7.5	to	8.1	7.8
Road freight volumes (Gtkm)	2518.5		2533.5	2526.0
Generated volumes (Gtkm)	128.7		144.2	136.4
Proportion within total increased volumes (%)	5.5		6.2	5.8

Related to the current road volumes, these extra volumes would represent 5.8% of freight volumes transported by road in 2020.

In addition, regarding the transportation of freight by rail and waterways, an extreme scenario could be added. Indeed, rail freight segments can be split in full train (in competition with barges), single wagon and combined transport (both in competition with road). According to the study by McKinsey[20], 35 % of the total rail freight is hauled by full trains. LHVs would obviously compete with the remaining modalities of using rail (single wagon load and combined transport). Calculations show that roughly a significant de-

[20] The Future of Rail Freight in Europe: a perspective on the sustainability of Rail Freight in Europe.

crease of 6% could be expected for rail volumes. This could pose a risk for certain rail services, as one of the major rail protagonists defends that combined transport operators have a benefit that is equal to 5.6 % of their turnover.

In that case, two thirds of 413.4 billion tonne-km (rail freight traffic in 2005), which equals 272.8 billion tonne-km could shift from rail to road.

Similarly, in the year 2005 the total traffic of freight on inland waterways was equal to 138 billion tonne-km for EU27 (the same as in 2006). According to Inland Navigation Europe, the repartition by commodity was:

- Agricultural products 28%
- Coal 6%
- Petroleum products 15%
- Iron, steel and metal products 12%
- Building material 24%
- Chemicals 5%
- Manufactured goods and containers 8%

The last commodity is probably the only one for which LHVs would severely compete with. If it is assumed that LHVs would retrieve all freight of this kind, then 8% of 138 billion tonne-km, which equals 11.04 billion tonne-km, would shift from waterways to road.

Despite these assumptions come from real data, it cannot be claimed that things would occur this way. Therefore, it is worth noticing that the advanced conclusions result from a theoretical thought process.

4.5.2. Additional information on scenarios 3 and 4

Scenario 3 consists in allowing 25.25 m long vehicles with a weight of 60 t, in six European countries: Belgium, Denmark, Germany, the Netherlands, Finland and Sweden. For the calculation of modal shifts in these countries, we have taken into account the fact that Finland and Sweden already make use of the European Modular Concept. Bearing in mind that the 2020 freight forecasts were computed in 2005 when there were no LHVs in the Netherlands, we have considered that LHVs were not allowed in the 2020 reference situation in the NL. As in scenario 2, LHVs bring a 20% cost reduction in road transport when they are used instead of HGVs.

Scenario 4 consists in allowing 20.75 m long vehicles with a weight of 44 t, in all European countries. These LHVs would bring a 7% cost reduction in road transport when they are used instead of HGVs. In countries were longer and or heavier vehicles are already allowed, we assume that these LHVs would not introduce any change since it is likely that vehicles of this type are already used, despite we do not give any information here on the silhouette of these vehicles. However, we assume that an additional axle, weighing approximately 1 tonne would be required (6 axles instead of 5 axles for traditional HGVs) and thus that the maximum payload of these LHVs would be equal to 28.8 t (instead of 25.8t for traditional HGVs).

4.5.3. Comparison of the four scenario results

The results are summarised in the following tables.

Table 18: Shares of freight volumes and traffic performed by HGVs and LHVs for all scenarios – set of 'low' elasticities

Shares of freight volumes and traffic performed by HGVs and LHVs for all scenarios		Set of 'low' elasticities					
		Static approach			Dynamic approach		
		HGVs	LHVs	Total	HGVs	LHVs	Total
Ref scenario 2020	Billion tonne-km	2 343.20	0.00	2 343.20	2 343.20	0.00	2 343.20
	Share (%)	*100.00*	*0.00*	*100.00*	*100.00*	*0.00*	*100.00*
	Billion veh-km	178.87	0.00	178.87	178.87	0.00	178.87
	Share (%)	*100.00*	*0.00*	*100.00*	*100.00*	*0.00*	*100.00*
Scenario 2	Billion tonne-km	1 829.01	634.63	2 463.64	1 576.21	949.77	2 525.98
	Share (%)	*74.24*	*25.76*	*100.00*	*62.40*	*37.60*	*100.00*
	Billion veh-km	164.11	16.38	180.49	140.91	24.51	165.42
	Share (%)	*90.93*	*9.07*	*100.00*	*85.18*	*14.82*	*100.00*
Scenario 3 (European scale)	Billion tonne-km	2 213.07	160.50	2 373.57	2149.11	240.19	2389.29
	Share (%)	*93.24*	*6.76*	*100.00*	*89.95*	*10.05*	*100.00*
	Billion veh-km	175.13	4.14	179.27	169.26	6.20	175.46
	Share (%)	*97.69*	*2.31*	*100.00*	*96.47*	*3.53*	*100.00*
Scenario 4	Billion tonne-km	1 769.30	613.92	2 383.22	1 499.06	903.28	2 402.35
	Share (%)	*74.24*	*25.76*	*100.00*	*62.40*	*37.60*	*100.00*
	Billion veh-km	158.06	21.32	179.38	133.27	31.36	164.64
	Share (%)	*88.12*	*11.88*	*100.00*	*80.95*	*19.05*	*100.00*

Table 19: Shares of freight volumes and traffic performed by HGVs and LHVs for all scenarios – set of 'high' elasticities

Shares of freight volumes and traffic performed by HGVs and LHVs for all scenarios		Set of 'high' elasticities					
		Static approach			Dynamic approach		
		HGVs	LHVs	Total	HGVs	LHVs	Total
Ref scenario 2020	Billion tonne-km	2 343.20	0.00	2 343.20	2 343.20	0.00	2 343.20
	Share (%)	*100.00*	*0.00*	*100.00*	*100.00*	*0.00*	*100.00*
	Billion veh-km	178.87	0.00	178.87	178.87	0.00	178.87
	Share (%)	*100.00*	*0.00*	*100.00*	*100.00*	*0.00*	*100.00*
Scenario 2	Billion tonne-km	1 883.00	653.37	2 536.37	1 647.47	992.71	2 640.18
	Share (%)	*74.24*	*25.76*	*100.00*	*62.40*	*37.60*	*100.00*
	Billion veh-km	168.95	16.86	185.81	147.28	25.62	172.90
	Share (%)	*90.93*	*9.07*	*100.00*	*85.18*	*14.82*	*100.00*
Scenario 3 (European scale)	Billion tonne-km	2226.65	165.22	2391.87	2 167.03	250.99	2 418.02
	Share (%)	*93.09*	*6.91*	*100.00*	*89.62*	*10.38*	*100.00*
	Billion veh-km	176.35	4.26	180.61	170.86	6.48	177.34
	Share (%)	*97.64*	*2.36*	*100.00*	*96.35*	*3.65*	*100.00*
Scenario 4	Billion tonne-km	1 786.48	619.88	2 406.36	1 520.63	916.28	2 436.91
	Share (%)	*74.24*	*25.76*	*100.00*	*62.40*	*37.60*	*100.00*
	Billion veh-km	159.60	21.52	181.12	135.19	31.82	167.00
	Share (%)	*88.12*	*11.88*	*100.00*	*80.95*	*19.05*	*100.00*

The freight volumes in t-km with respect to the reference scenario (2020) are summarized in the following table and then represented in three bar graphs, one graph per scenario.

Table 20: Evolution of freight volumes (t-km) w.r.t. to reference scenario 2020 (in %)

		Set of 'low' elasticities		Set of 'high' elasticities	
		Static approach	Dynamic approach	Static approach	Dynamic approach
Scenario 2	Road	5.1	7.8	8.2	12.7
	of which generated traffic	*3.8*	*5.8*	*6.1*	*9.7*
	Rail	-6.0	-8.7	-9.8	-14.1
	Waterways	-5.8	-8.4	-7.6	-10.8
Scenario 3 (on a European scale)	Road	1.3	2.0	2.1	3.2
	of which generated traffic	*0.7*	*1.1*	*1.2*	*2.0*
	Rail	-1.5	-2.2	-2.5	-3.6
	Waterways	-4.7	-6.7	-6.0	-8.6
Scenario 4	Road	1.7	2.5	2.7	4.0
	of which generated traffic	*1.2*	*1.8*	*1.9*	*2.9*
	Rail	-2.1	-3.1	-3.5	-5.1
	Waterways	-2.1	-3.0	-2.8	-4.0

Figure 10: Evolution of freight volumes (tkm) in scenario 2 w.r.t. reference scenario 2020 (%)

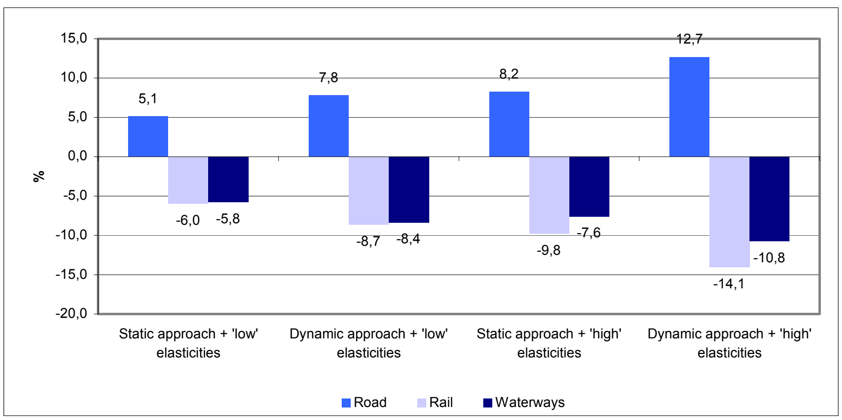


Figure 11: Evolution of freight volumes (tkm) in scenario 3 w.r.t. reference scenario 2020 (%)

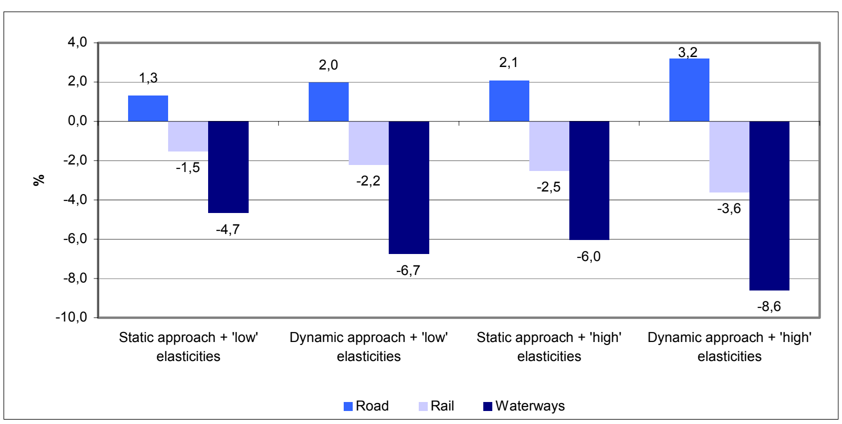
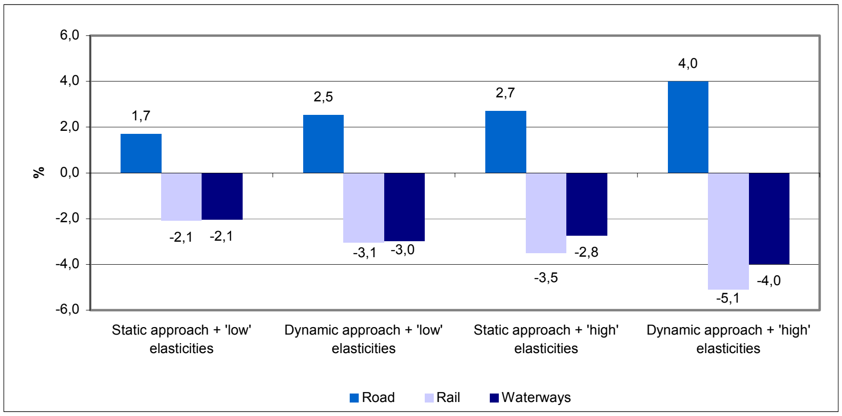
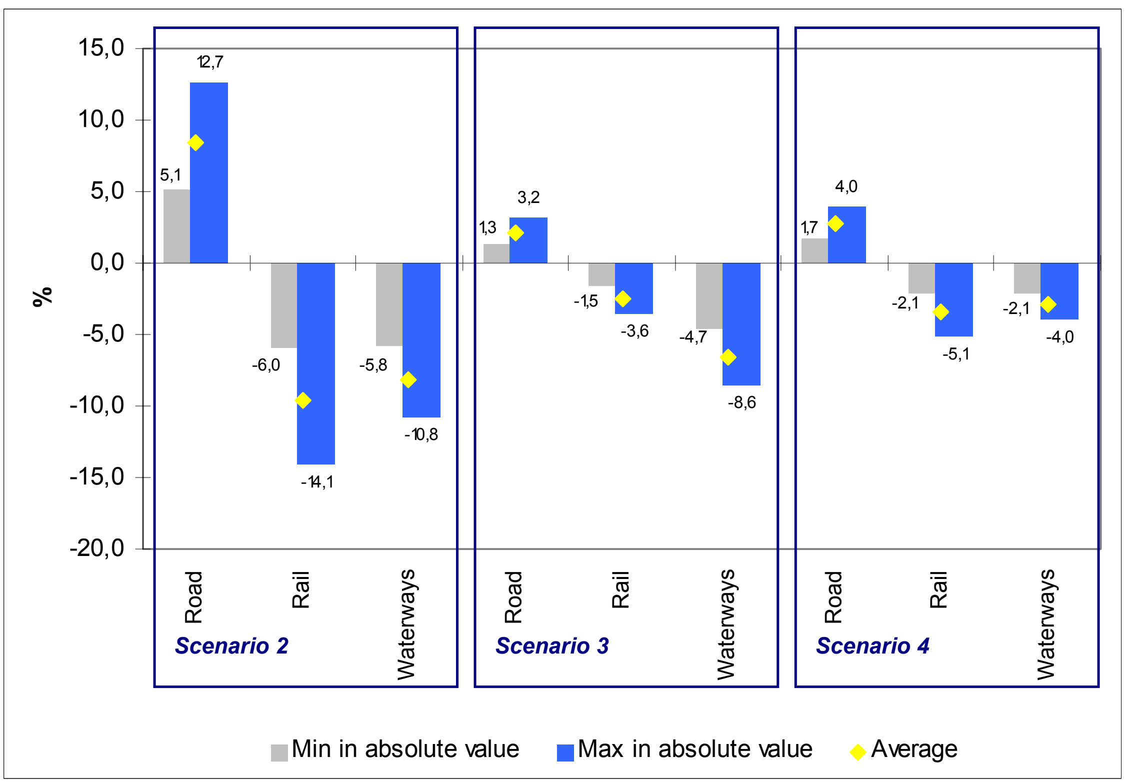


Figure 12: Evolution of freight volumes (tkm) in scenario 4 w.r.t. reference scenario 2020 (%)



These various results show that the slightest evolutions of freight volumes occur for each scenario in the case of a static approach when a set of 'low' elasticities is used for the calculations. On the opposite, the most significant evolutions of freight volumes are observed when a set of 'high' elasticities is used for the calculations and in a context of a dynamic approach. Consequently, to sum up these results, we can draw a new graph that shows for each scenario and for each mode the minimum and the maximum evolutions of freight volumes that could be expected.

Figure 13: Minimum and maximum evolutions of freight volumes (tkm) for all scenarios w.r.t. reference scenario 2020 (%)



The previous graph shows for each scenario and each mode of freight transport the minimum and maximum changes in freight volumes with respect to our 2020 reference scenario. On this graph is indicated for each mode and for each scenario the average value of the changes in freight volumes. These averages are computed after the four values of changes in freight volumes (dynamic/static approaches & low/high elasticities).

The previous graphs show that the most significant changes in the freight volumes operated by each mode would occur in scenario 2. Road volumes could increase by 13% at most while rail and waterways volumes could respectively decrease by –14% and –11%.

Scenario 3, which is similar to scenario 2 apart from the number of countries concerned by the use of LHVs underlines the prominent role of inland waterways transport of freight in the six concerned countries, in particular Germany and the Netherlands. Considering the proportion of all European waterborne transport operations performed in these two countries, it is therefore not surprising to notice that inland waterways transportation of freight could decrease by almost 9% in scenario 3.

Last, scenario 4 shows more moderate changes in the evolution of freight volumes transported by each mode. While volumes operated by road would increase between 1.7 and 4.0 %, volumes operated by rail and inland waterways would roughly decrease by 2 to 5 %. In absolute value, the intensity of changes would be lower in scenario 4 than in scenario 2, whatever the mode of transport.

Similarly, we can focus on the evolution of road freight traffic with respect to the reference scenario 2020. Road traffic in veh-km can be compared for each scenario and within each scenario, between the different approaches (static/dynamic) and for different sets of elasticities ('low' / 'high').

Table 21: Evolutions of road freight traffic (veh-km) w.r.t. to reference scenario 2020

		Set of 'low' elasticities		Set of 'high' elasticities	
		Static approach	Dynamic approach	Static approach	Dynamic approach
Scenario 2	Traffic evolution (in veh-km)	1.6	-13.4	6.9	-6.0
	Evolution (%)	*0.9*	*-7.5*	*3.9*	*-3.3*
Scenario 3 (European scale)	Traffic evolution (in veh-km)	0.4	-3.4	1.7	-1.5
	Evolution (%)	*0.2*	*-1.9*	*1.0*	*-0.9*
Scenario 4	Traffic evolution (in veh-km)	0.5	-14.2	2.2	-11.9
	Evolution (%)	*0.3*	*-8.0*	*1.3*	*-6.6*

The evolutions (in %) of the road freight traffic in each scenario with respect to our reference scenario can be summarised as below in a single graph. On this graph, we can observe that for each scenario, the road freight traffic may increase or decrease according to the approach that is considered and the set of elasticities that is chosen. In all cases, the most significant decreases and changes in absolute-value take place for a set of 'low' elasticities when used within a dynamic approach. On the opposite, it is calculated that a road traffic increase may happen but on a lower magnitude. This may occur in the context of calculations performed within a static approach.

Figure 14: Evolutions of road freight traffic (vkm) for all scenarios w.r.t. reference scenario 2020 (%)

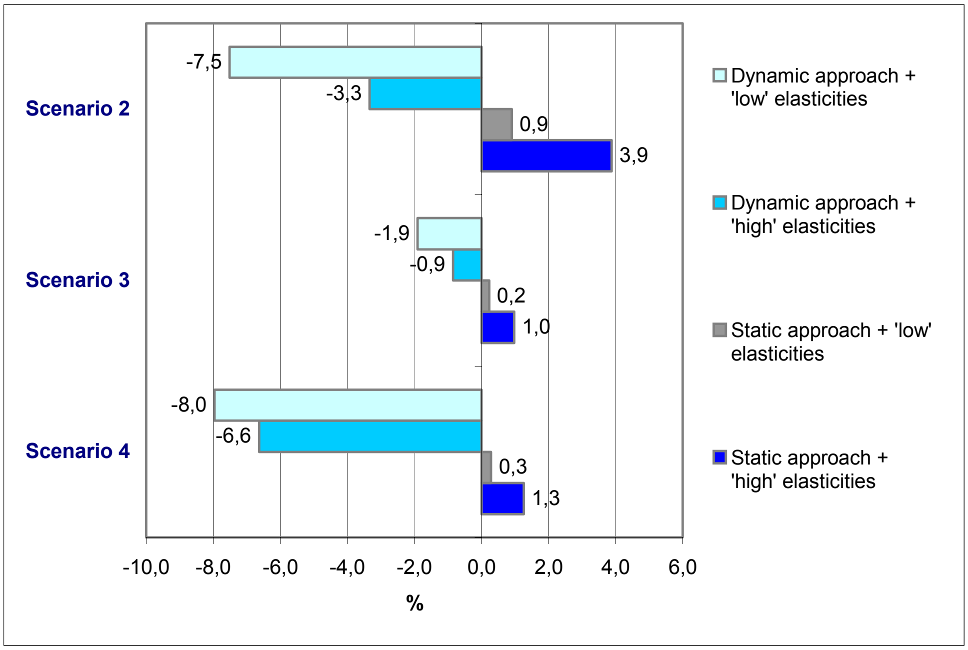
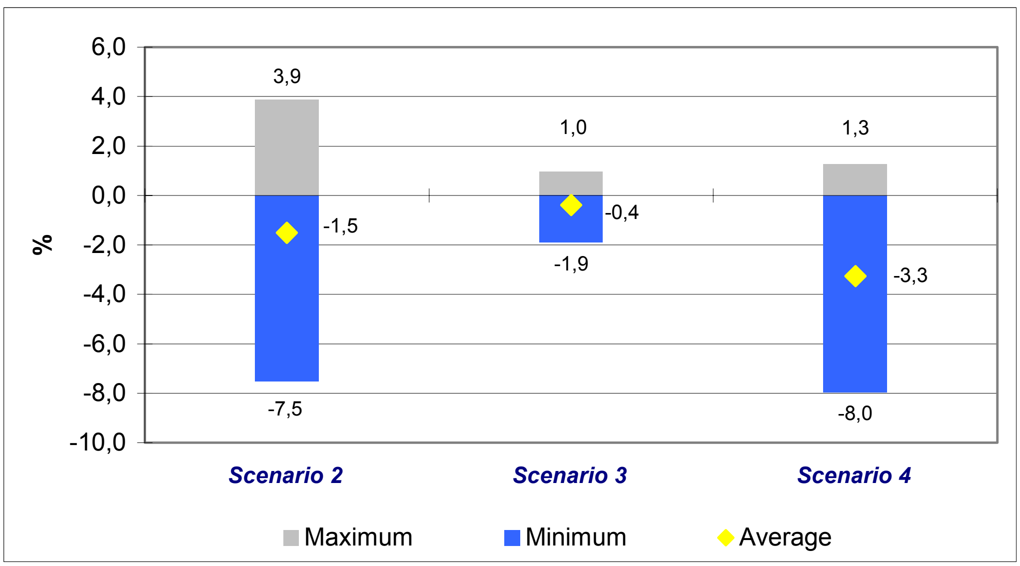


Figure 15: Minimum, maximum and average evolutions of road freight traffic w.r.t. reference scenario 2020 (%)



The interest of the previous graph lies in its synthetic representation of the trend that would be followed by road freight traffic in each scenario. In addition to the maximum and minimum changes in road freight traffics, it indicates the average values of the changes in road freight traffics computed after the four values related to the set of elasticities and the approach type that have been chosen. Although, the average value cannot be considered as the change in road freight traffic that would indeed occur, it highlights the fact that the magnitude of change would certainly stand somewhere between the minimum and maximum values that are shown on this graph. In all cases, the sign of the average values is negative, which would tend to prove that road freight traffic would overall decrease whatever the scenario.

Scenario 2 is the scenario for which there is most uncertainty about the changes that could occur for road freight traffic. Being the scenario applied on the largest scale and thus the most considerable traffic, it is not surprising to observe that the choice of hypotheses regarding the set of elasticities of the approach type (static/dynamic) would result in the most different results as far as road traffics are concerned. Consequently, the magnitude of changes is less important for scenario 3. Regarding scenario 4, it is interesting to notice that it could result in the significant decrease road freight traffic reduction (up to –8%). It can be explained by the large intra modal shift from HGVs to LHVs but the minor intermodal shift that would occur from the other modes to road due to the lower cost reduction in road transport. Thus, scenario 4 appears as an intermediate scenario which would have the advantages of a significant decrease in road freight traffic and a lower modal shift from inland waterways and railways to road.

5. Modelling approach

In this third and final approach, a choice of parameters from the sections above is made, in agreement with the European Commission, and used in the TRANS-TOOLS model to obtain detailed results on transport volumes. With these data, further calculations can be made on the impacts of introducing LHVs in Europe.

5.1. Model description

The TRANS-TOOLS model forecasts the macro (or meso) transport flows in Europe base on global economic trends. To model the impact of LHVs on transport demand, we have decreased road transport price (expressed in euro per tonne-km transported). With this change, we have used the TRANS-TOOLS model to re-calculate European transport economics (thus probably generating more output and more transport demand), and increasing transportation demand. The outputs of the model are new transportation requirements, expressed in tonnes transported per country and per mode.

5.1.1. Output

The output of the TRANS-TOOLS model is in the form of tonnes of cargo volume shipped per transport mode and per O/D relationship. In the model, Europe is divided into approximately 300 regions at NUTS2 level. Each region has a "centre of gravity", to which all outbound and incoming shipments are attached. So the flow is defined on a matrix of approximately 60 000 records; each record represents a flow between origin and destination per transport mode. It should be noted that, at the moment, Sweden and Finland allow LHVs on their roads. The model does not take this into account, as load factors are commodity-specific and not country-specific. We performed calculations as if Sweden and Finland did not allow LHVs. Therefore, we suggest that the impact of LHVs on these countries would be much more modest, as only international traffic would be affected.

The output of the TRANS-TOOLS model is given in tonnes of transport volume. The distance between O/D nodes is known, so it is not difficult to calculate the total tonne-km flow. However, the routes of the transport volume (i.e. the path over which goods are transported) is not defined in the TRANS-TOOLS model. Consequently, if we want to know transport volumes in tonne-km per country, this information cannot be concluded from the model. This is not a problem for domestic transport as all tonne-km are performed in one country. However, for international transport, it is not possible to assign parts of flow to different countries. To solve this problem, we have used the RESPONSE™ model, which is developed by the consortium partner TNO. This model calculates road path between arbitrary points, so assignments of tonne-km volumes to individual countries becomes possible. In this way we have translated road tonne volumes into road tonne-km volumes and road vehicle-kilometres for assessment of changes in traffic.

5.1.2. Calculating LHV scenarios in TRANS-TOOLS

The results for *scenario 1* will be calculated using the TRANS-TOOLS model *reference scenario*. This calculation is based on forecasted European economic behaviour and other parameters. Thus, the scenario does not account for any changes to the 96/53/EC directive and will be used as a benchmark. Other scenarios will also be calculated through with the model.

By its nature, the TRANS-TOOLS model does not deal with vehicle parameters such as dimensions and weight directly, though these parameters influence the model through changes in transport cost. Therefore, all effects associated with LHVs are external for the model. In essence, we have 3 parameters that influence transport demand and modal split in the model:
1. Transport demand price sensitivity
2. The share of goods carried by LHVs (in terms of tonne-km)
3. The transport cost discount that LHVs bring (in terms of tonne-km)

During extensive literature study and communication with the stakeholders, we found that there is a great uncertainty over the actual values of the above mentioned factors. Our literature study for scenarios 2 and 3 shows the following ranges for them:

1. Road transport price sensitivity ranges from -0.12 (European model SCENES, elasticity value applied to ton volumes) up to -1.55 (Nemo, CGE, Norway, elasticity value applied to ton/km volumes)
2. Share of goods carried out by LHVs: from 6% of HGV *(heavy goods vehicle)* vehicles being LHV (Arcadis, NL) up to 74% of tonne-km by LHV in Sweden.
3. Transport cost discount: range from 10% to 31%. The discount factor highly depends on load factor (utilization of vehicles). Some reports say that with utilization of less than 75% there is no cost advantage in comparison to normal HGVs. We fix the cost advantage factor at 20%.

5.1.3. Assumptions put into the TRANS-TOOLS model

The TRANS-TOOLS model is applied for 4 LHV introduction scenarios. The first scenario, “Business as usual”, is not discussed here, since it is the reference scenario for transport situation in 2020, which does not include LHVs. The computations for 2020 have been done outside the scope of this project (in 2006/2007 for the TRANS-TOOLS project itself) and are taken by the consortium as they are. The TRANS-TOOLS model is verified and validated by a number of independent research bureaus and the European Commission; therefore we leave the discussion on the 2020 base projections out of the scope of this report. The base 2020 scenario 1 is the reference scenario in the sense that scenarios 2, 3 and 4 are compared to it; the results of comparison are expressed in relative (percentages) terms.

To set up the model, the base set up parameters have been taken from scenario 1. Here we describe only the changes put into the model that relate to calculating the effects of LHV usage on the transport system. The parameters are very similar for scenarios 2 and 3, except the scope of LHVs: in scenario 3 they are limited to 6 countries. Scenario 4 often has different parameters: if it is the case then we described these explicitly; otherwise we mean the same parameters for all 3 scenarios.

1. **Road transport demand price elasticity**. The TRANS-TOOLS modal-split model is a basic multinomial LOGIT model, which uses the choice probabilities of the available modes per commodity group for every OD relation. The cost elasticities of the Modal Split model are compared with cost elasticities of different modeling and literature sources as have been presented in Table 7.

In the TRANS-TOOLS model the price elasticity is based on recent European research and set to -0.416, as the average of various research results. The road price demand elasticity is related to total ton volume transported. The TRANS-TOOLS elasticity parameter is used to define modal shift as a function of transport price; the generation effect is not taken into account in the modal split model, as it dealt with the economics sub-model.

The generation effect is built up from two components: 1) the GDP effect, generating additional production or consumption and 2) the trade effect, generating longer trade and thus transport relations. We used the Trans-Tools economic module CGEurope to derive the effects in these areas. The CGEurope model is a state-of-the art Spatial Computable General Equilibrium model tailored to the European regions. It includes a full account of the European economy for appr. 1300 regions and makes use of the latest data available. The model is described in detail in Bröcker (1995) and Bröcker et al (2003).

2. **Commodity groups**. The TRANS-TOOLS model includes transportation in the following 11 European commodity groups in the table below.

Each of the commodity groups has its intrinsic properties. In the context of LHVs, each of the commodity groups has been assigned an "LHV saturation" value. The meaning of this parameter is the following: if all LHV requirements are satisfied (e.g. infrastructure, safety, sufficient volume and distance, etc), the parameter is the percentage of the commodity that is transported by LHV. Some commodities, such as "Machinery & other manufacturing" are less suitable for LHVs due to, for instance, smaller transport batch sizes than oil and petroleum products. The following table shows LHV saturation values, expressed in maximum percentages of LHV use (given that all other factors allow and favour LHVs). The values of Maximum share of LHV in total transport are based on expert opinion of the consortium members.

Table 22: Maximum share of LHV in total road (LHV commodity saturation values)

Code	Commodity group	Maximum share of LHV in total road (%)
0	Agricultural products	80
1	Foodstuffs	50
2	Solid mineral fuels	90
3	Crude oil	100
4	Ores, metal waste	90
5	Metal products	80
6	Building minerals & material	60
7	Fertilizers	100
8	Chemicals	100
9	Machinery & other manufacturing	50
10	Petroleum products	100

3. LHV extra capacity: for scenarios 2 and 3, it is assumed that LHV have 50 % more capacity in terms of both volume and weight. For scenario 4, LHVs have 10 % more capacity (volume and weight). The TRANS-TOOLS model works with weights of goods, i.e. tonnes of cargo transported, while spatial volume of goods is not taken into account. The values of extra capacity reflect a general consensus on changes in vehicle capacity.

4. **LHV transport cost discount**. The cost of driving LHVs is higher than driving HGVs *(heavy goods vehicle)*, in the context of this report a "normal" 40 tonne gross and up to 18.75 m long vehicle. Due to bigger carrying capacity, the cost of transport done by LHVs is lower in comparison to HGVs. If measured in cost of tonne-kilometre, we assumed that

- For *scenarios 2 and 3* the cost reduction of LHV is 20 %. In other words, the cost of tonne-km of cargo transport is 80 % of the one of HGV.
- For *scenario 4* the cost reduction is 7 %; i.e. LHV cost is 93 % of tonne-km cost of HGV.

For more information on the choice of cost reduction factors, we refer the reader to the earlier sections on modelling issues and scenario definition.
No assumptions are made on changing price levels of oil. High oil price would certainly create a price advantage for the rail due to two factors: even diesel rail traction is less energy intensive than road transport (measured as energy consumption per ton-kilometre) and due to electrical traction. However, we cannot make firm conclusions over direct consequences for the rail market.

5. **Average vehicle load factors**. The TRANS-TOOLS model translates transport requirements into the number of vehicle trips (and consequently the number of tonne shipped and number of tonne-km is concluded). It should be noted that vehicles are not always loaded up to their load limits: the model uses average load factors that combine FTL *(full truckload)* and LTL *(less than a full truckload)* shipments as well as empty trips. The model employs the following load factors for HGV, which depends on commodity type and trip type.

Table 23: TRANS-TOOLS load factors (in tonnes) of normal trucks (HGV)

commodity	International load factor	Domestic load factor	Intrazonal load factor
Agricultural products	10.7	8.5	7
Foodstuffs	10.3	8.3	6.5
Solid mineral fuels	10.8	9	8
Crude oil	11.9	10	9
Ores, metal waste	10.8	9	8
Metal products	11.6	9	8
Building minerals & material	11	9	8
Fertilisers	11.7	9	8
Chemicals	11.3	9	7.5
Machinery & other manufacturing	8.8	7	5.5
Petroleum products	11.9	10	9
AVERAGE	11.0	8.9	7.7

These general load factors are translated into scenario-specific load factors. The table above shows load factors for scenario 1 and for countries that are not part of the coalition of six in scenario 3. For scenario 2 and for countries that are part of coalition in scenario 3 the load factors are increased by 50 %, only for the fraction of flow done by LHVs. For scenario 4 the load factors are increased by 10 % (applicable for LHV fraction of flow).

6. **Determination of share of LHVs in total road transport**. The realization of the European LHV potential in road cargo transport on O/D *(origin/destination)* level depends on distance class between the origin and destination and available goods flow.

Table 24: Maximum probability that LHV is used as a function of distance and flow factors

Flow size between particular pair O/D, in tonne	Distance between particular pair of O/D, kilometres		
	>=0 and <300 km	>=300 and <500 km	>=500 km
< 50K	0 %	0 %	25 %
50-100K	0 %	25 %	50 %
100K-200K	25 %	50 %	75 %
> 200K	50 %	75 %	100 %

The table above shows the part of transport volume flows performed by LHVs as a function of distance and flow classes. This table does not directly imply the share of LHVs in the flow, but sets an upper boundary on it. In other words, there would be a share of LHV in road transport volumes as given in the table if other factors permit a 100 % usage of LHV. The LHV commodity saturation rates are also a constraining factor on the share of LHV in road transport. The values of the table are the expert opinion of the project consortium.

5.2. TRANS-TOOLS model results

In this section we describe in detail the output of the model in respect to road transport volumes, while in the following section of the report we look at the volumes in other modalities. The model was run 4 times: the first run is to define base scenario 2020 (scenario 1) and three other runs for the same model, but with modified parameters.

In this section of the report we present the main findings of the TRANS-TOOLS modelling exercise. More detailed information on the model output can be found in the annex to this report, road tonne-km volumes and traffic. In the annex, we specify the absolute number of tonne-km and vehicle-kilometres per scenario, per country, road type, and vehicle type. All graphs presented below compare base scenario 1 with other scenarios; in other words results are presented relative to scenario 1 (scenario 1 = 100 %).

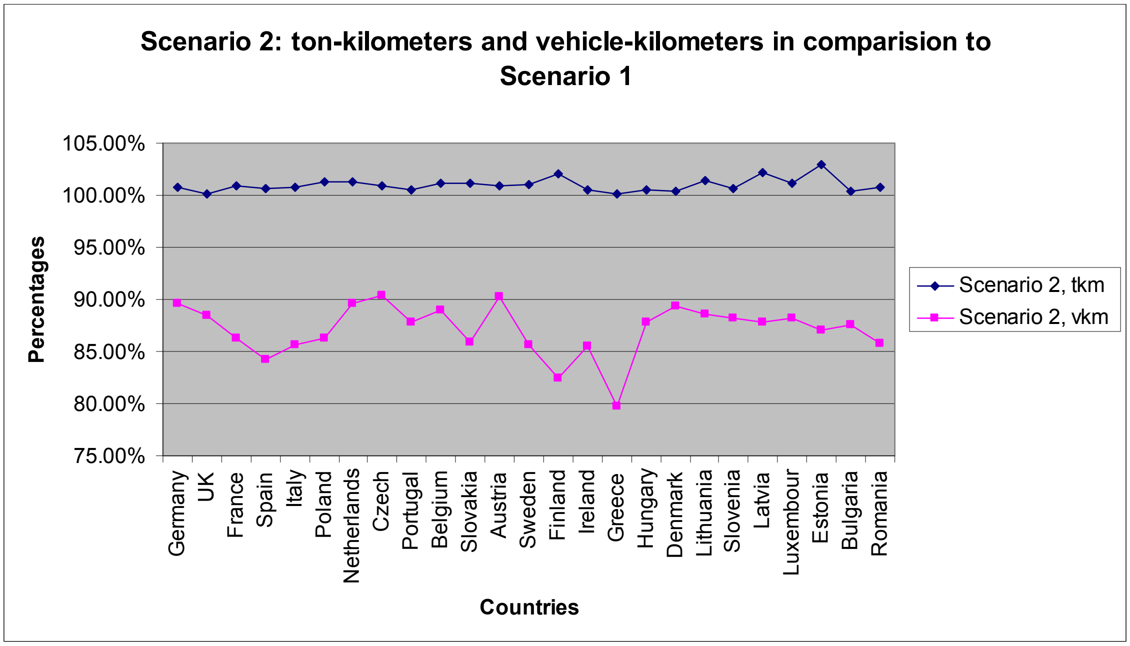
5.2.1. Scenario 2

a. Effect on road transport volumes

In scenario 2, in which the LHVs of 25.25 metres long and 60 tonne allowed in the whole Europe the total amount of tonne-km road transport volume rises by 0.99 % in comparison to the benchmark scenario 1. Therefore, we see only a relatively modest increase in the road transport as a result of allowing LHVs on the European road. On the other hand, we conclude that the number of vehicle-kilometres done by HGVs (LHV is a sub-class of heavy goods vehicles) declines by 12.9 %. It should be noted that the decrease of vehicle-kilometres happens in heavy cargo traffic. There are no indications that light road cargo traffic is substantially affected (e.g. effect on light vehicles such as vans). These are the main conclusions of the modelling exercise; other scenarios show only more subtle effects in what-if changes cases.

There is no contradiction between the observed modest increase in the road transport volumes and the substantial decrease in vehicle kilometres when using LHVs. The reason is that LHVs take more cargo per trip, thus if the amount of cargo does not grow much, the number of trips necessary to carry the cargo decreases.

Figure 16: Results of scenario 2 modelling on road transport volumes



A more detailed look at the figure above shows that there is no substantial variation in changes of road volumes between countries (only Latvia and Estonia would have an increase in road tonne-km volume of more than 2%). There is a bigger variation in change of vehicle kilometres. The most affected countries are big and sparsely populated ones; or countries with a clear aggregation of population and economical activity. So, Spain, Finland, Greece would enjoy the most of the benefits of reduced road cargo traffic. This phenomenon is easy to explain: due to concentration and big distances, these countries are most suitable for the use of LHVs. LHVs will transport more cargo traffic in these countries than in other.

Therefore, our conclusion from the "clear-cut" scenario 2 is that road transport volumes are only modestly affected by LHVs; there will be a substantial decline in traffic since approximately 13% of HGV trips become redundant. The following graph summarizes all scenarios in respect to tonne-km.

The TRANS-TOOLS model results show a rather low impact of LHVs on European transport demand in comparison to analytical study results. For this phenomenon, we have a number of arguments that explain the difference and confirm the result. The range of possible values for the road price elasticity that can be found in the literature is from -0.12 to -1.55. If applied directly to road tonne-km volumes, they would lead to a 1 % - 5.6 % of road tonne-km increase, given that 20 % - 30 % of the tonne-km is carried out by LHVs. The TRANS-TOOLS model shows an aggregate increase of 1% of road transport, thus on the lower edge of the range.

The main reason for this is that TRANS-TOOLS shows almost no generation effect as a consequence of price decrease; extra road volumes mainly come as a substitution from rail and inland waterways. Because this effect is somewhat counter-intuitive, we have double checked the (almost) absence of the volume generation effect: first analytically (see section 3) and then using the CGEurope model[21]. In both cases, it is estimated that the transport generation effect is very small.

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[21] The CGEurope model is a spatial computable general equilibrium model of goods transport and business passenger flows. It has been developed by the University of Kiel. The CGEurope model is a component of the TRANS-TOOLS model.

The analytical approach divided effect of elasticity into 3 components: (1) substitution (volumes from other modes through cross-elasticities), (2) impact on production (a link between price of transport and production volumes) and (3) intrinsic road price elasticity. Substitution was shown to be the most profound component of road price elasticity; changes in production play a smaller role and intrinsic road price elasticity is small, it is certainly lower than -0.1.

The CGEurope model confirms this small generation effect. We applied a road price decrease to see whether this decrease would change economic activity and trade relations. As a result of two runs, the CGEurope gave very small changes in trade, depending on the calculation method used in the range of 0.02%-0.75% increase of trade, and hence, transport volumes. From economic activity point of view, the result is intuitively comprehensible. As transport costs account to ca 10% of GDP and its cost decreases by 5%, it means that the economy experiences unload of 0.5% of the burden, which translates into almost negligible increase in trade.

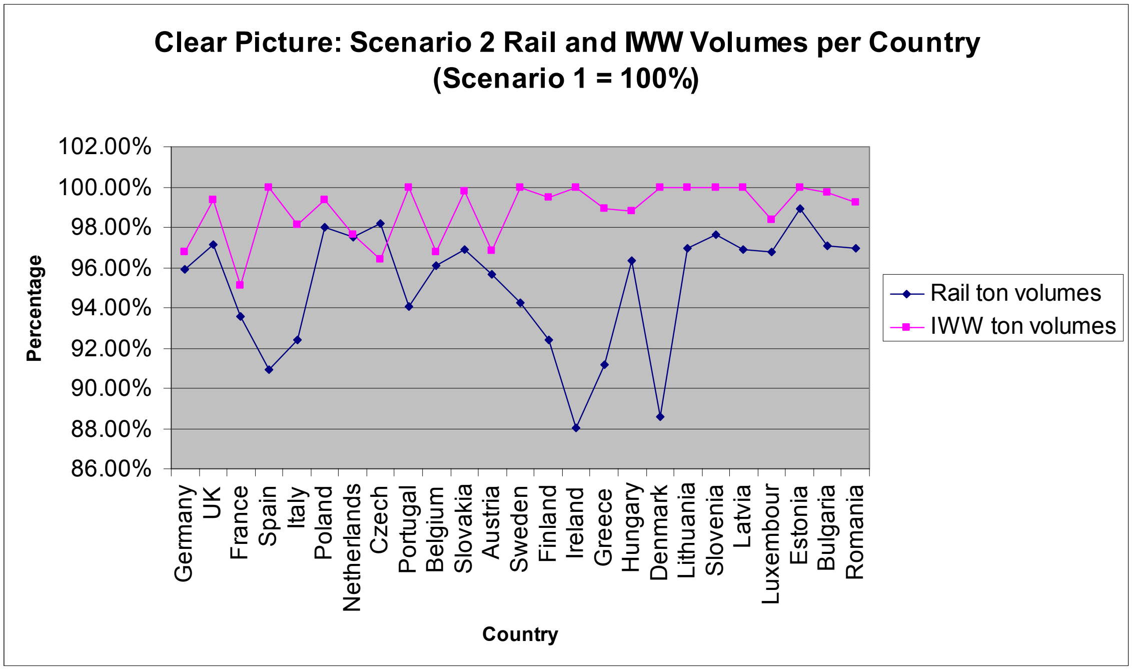
The substitution effect is larger; however, its application scope is geographically limited. Modal shift is only possible if there are other modes available, which is not always the case. Moreover, even if other modalities are present in a route, their relative volumes might be small in comparison to road volumes.

Thus, we have obtained a relatively small increase in road volumes with the TRANS-TOOLS model due to the introduction of LHVs in Europe. The change in the number of vehicle-kilometres is in line with the one predicted by analysis. As the cargo capacity of vehicles increases by 50 %, they can take 50 % more goods. The only factor which influences the number of vehicle-km is the proportion of LHVs in cargo transport. The modelling results and analytical results are converging on a 10 % - 15 % decrease in "traditional" HGV *(heavy goods vehicle)* vehicle-km.

b. Effect on rail and inland waterways

In this section of the report we present the main findings of the TRANS-TOOLS modelling exercise in respect to changes in modal split. More detailed information on the model output on rail and inland waterway tonne volumes per scenario and per country can be found in the annex "Rail tonne volumes" and annex "Inland waterways tonne volumes". All graphs presented bellow compare base scenario 1 with other scenarios; in other words results are presented relative to scenario 1 (scenario 1 = 100 %).

Figure 17: Results of scenario 2 modelling: impact on modal split



Please note that the countries such as Spain, Portugal and some other do not have noticeable IWW transport. For these countries, the share of IWW does not change (i.e. the change is from negligible to negligible).

The figure above illustrates the impact of LHV use on the use of other transport modes in scenario 2: LHVs of 25.25 metres long and 60 tonne gross are allowed throughout Europe. The total aggregate effect of LHVs on the European rail and inland waterway tonne volumes is a 3.8 % reduction in rail tonne-volumes and 2.9 % decrease in inland waterway tonne-volumes (weighted average). The impact of LHVs is not the same in each country. The biggest transport markets, which are on the left side of the figure, are affected somewhat more than average in respect to rail: of the largest 5 European markets, only in the UK is rail affected less than the average of 3.8 %. Big countries with clear aggregation centres such as Spain, Italy and Finland are affected more than smaller and more uniformly developed ones (in terms of geographical distribution of economic activity).

The model results show rather small aggregate impact of the potential use of LHVs on European modal split; however the impact is within margins of our analytical examination. The main explanation for this is that we compare an aggregate response of the transport system (3.8 % decrease of rail volumes predicted by TRANS-TOOLS for the whole Europe) with a theoretical application of cross-elasticities. The explanation of this phenomenon is that rail transport volumes are substantially lower than the road ones and rail links do not exist everywhere. So, for some rail links with intensive traffic the impact of LHV is substantially higher than 3.8 %, while for rail links with smaller volumes the impact is smaller than 3.8 %. The smaller impact can be attributed to several factors. The main factor is at play if between a pair of specific origin and destination there is no big LHV flow, due to, for instance, insufficient volumes and / or less appropriate commodities for LHV. In this case, rail volumes would be hardly affected. The second factor is attractiveness of the links. In the case of small volumes, the likelihood of a regular competing LHV service is also small due to unattractiveness and vested interests; therefore, the chance of modal shift is also small.

Obviously, the reduction of rail volumes will not be welcomed by the sector. However, first of all, the rail volumes growth between 2005 and 2020 is projected to be much higher than 3.8%. In reality it means that there is no downward spiral projected: rail will still grow and the growth rate will be only somewhat slower than in the case of no LHV. We do not completely eliminate chances that on some lanes rail service could be severely damaged by LHVs, but this will not happen systematically. The growing transport demand will allow rail to continue growing.

5.2.2. Scenario 3 and 4

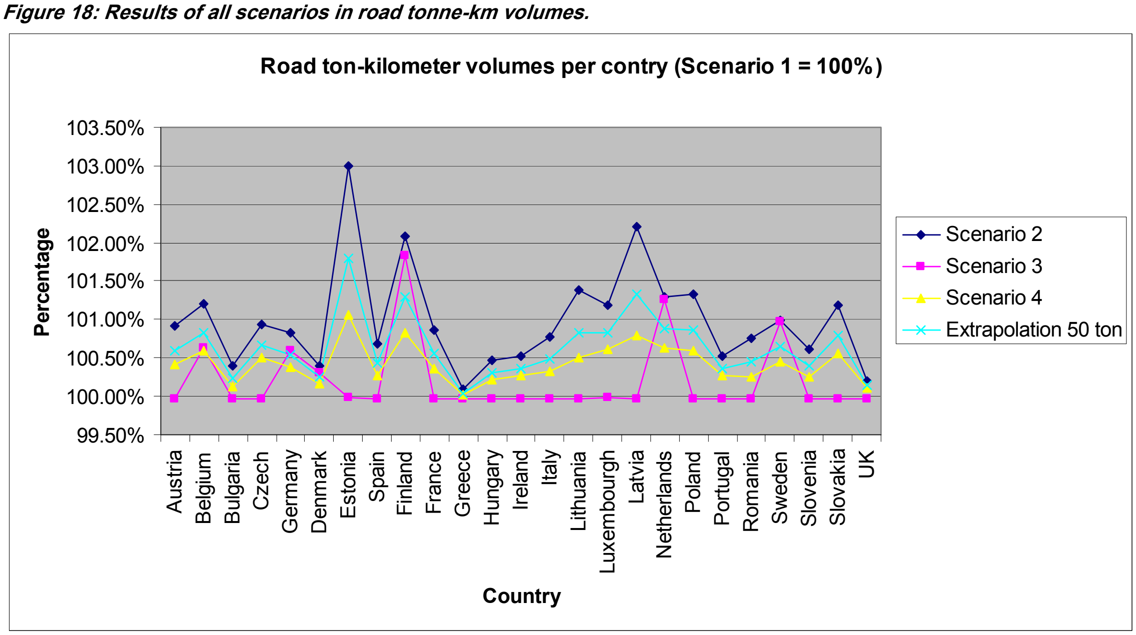
a. Effect on road transport volumes

Scenario 4 leads to an aggregate increase in road tonne-km volumes by 0.42 % and decrease in the number of vehicle kilometres by 3.4 %. The volume change difference between the scenarios 2 and 4 is 5 times (50 % against 10 % vehicle capacity increase). So the change in road volumes does not have a linear character, while decrease in vehicle-kilometres, though still non-linear, is closer to linearity.

There is an interesting comparison between scenarios 2 and 3. Obviously, the countries that are not included into the Coalition are not noticeably affected (they experience 0.03 % decrease in road tonne-km volumes and 0.21% decrease in vehicle kilometres). The road volumes and cargo traffic in countries that are included into the coalition respond differently. For instance, for the Netherlands there is almost no difference between scenarios 2 and scenario 3, while Belgium and Germany would witness bigger differences.

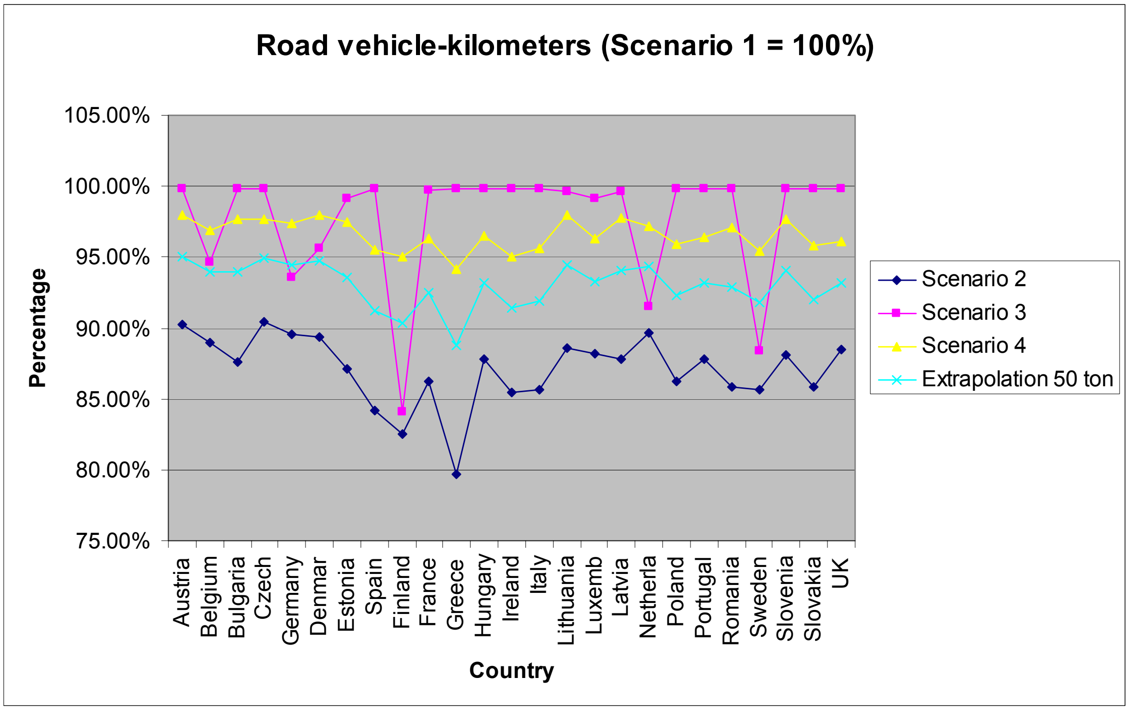
This phenomenon can be explained by two factors. The major factor is geography. The Netherlands is surrounded in scenario 3 by the countries that allow LHVs, so it would be able to conduct most of the international transport without limitations on LHVs (however not necessarily by LHVs: here we only point out to the fact that major trading partner countries permit them). On the contrary, Germany is surrounded by countries that do not allow LHVs, such as Poland, Czech Republic, Austria, and France. This limits the scope of international LHVs traffic in comparison to the scenario 2.

Figure 18: Results of all scenarios in road tonne-km volumes.



At the Commission's request, we have also made a linear approximation for the trucks of 50 tonne. 50 tonne trucks are assessed in the same way as it has been done for the scenarios 2 and 4, assuming that the directive 96/53/EC is harmonized in a way that allows usage of these trucks throughout Europe. The model has not been used to calculate the effect of 50 tonne trucks; we used a linear combination of scenarios 2 and 4 to get estimates for 50 tonne trucks. Therefore, the impact of 50 tonne trucks is somewhere in-between those of the 44 tonne and 60 tonne trucks.

Figure 19: Results of all scenarios in road vehicle-kilometre volumes.

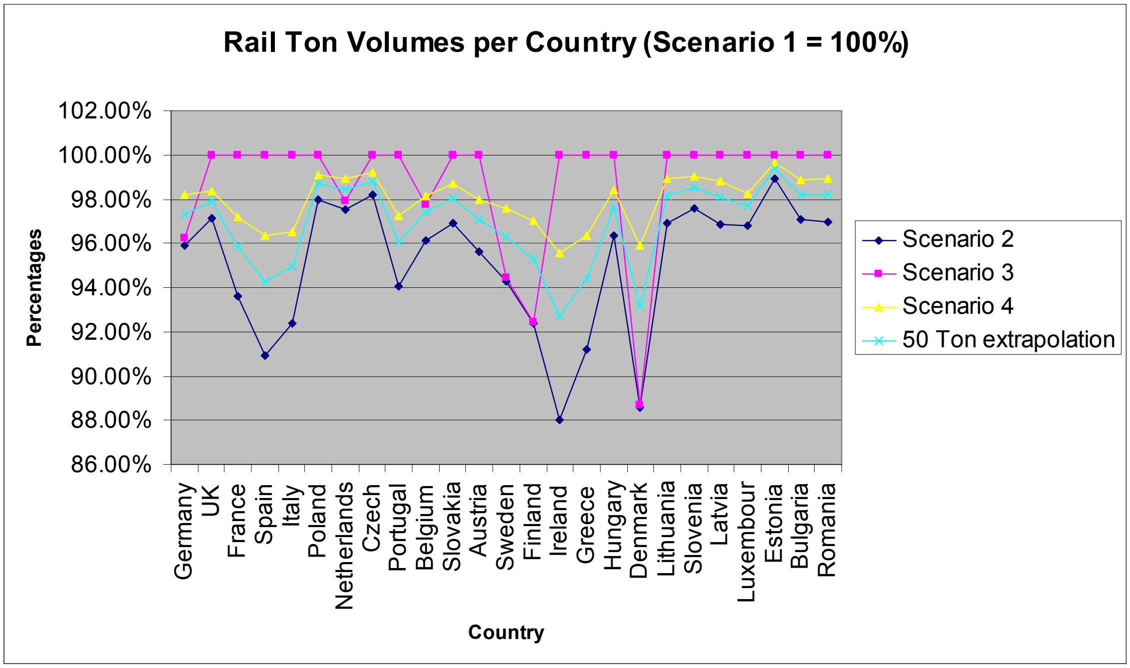


All scenarios in which an increase in vehicle capacity is considered lead to the same conclusion: there would be less road vehicle traffic, but this traffic would be more economically efficient. For scenario 2, approximately 30 % of heavy cargo traffic is carried out by LHVs, while the road volumes grow only by 1 %. Therefore, the number of trips and vehicle kilometres declines, as bigger trucks take more goods in one trip. The bigger share of LHV in road transport, the bigger is the decrease in the number of vehicle kilometres in heavy traffic. Greece, Finland and Spain would see the biggest reduction in traffic as geography and consolidation of economically-active areas favour LHVs.

b. Effect on rail and inland waterways

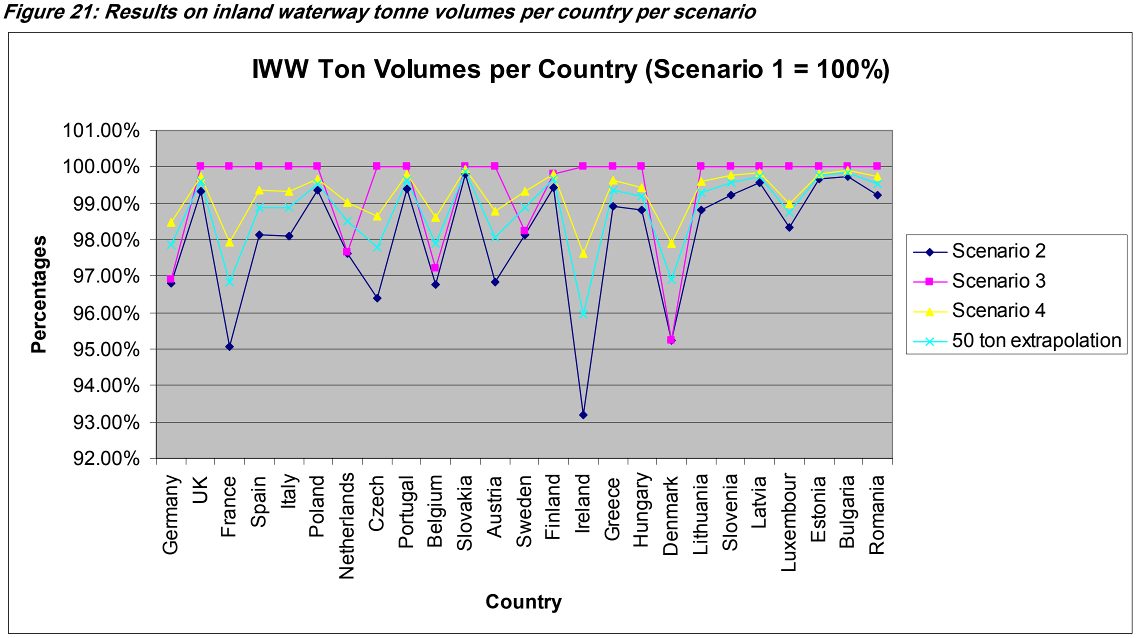
As it can be seen from the figure below, in scenario 3 the reduction in rail volume due to LHV use in 6 countries almost coincides with scenario 2 for those 6 countries that are in the coalition. In scenario 3 there is no noticeable reduction in rail volumes in comparison to the base scenario 1. The size of impact on rail follows non-linearly extra capacity of LHV: scenario 2: 96.2 % of scenario 1 rail volumes and scenario 4: 98.3 % of scenario 1 rail volumes.

Figure 20: Results on rail tonne volumes per country per scenario



The relative decrease of inland waterway tonne volumes when LHVs are used in Europe is smaller than in case of rail. The reason is that inland waterways have a smaller scope; some countries do not have an extensive inland waterway system, so the volumes cannot go down. The biggest impact is observed in Ireland, Denmark, Spain and France, though these countries do not have big inland waterway flows. Scenario 3 inland waterway volume reduction almost coincides with scenario 2 for those countries that are in the coalition. The impact on inland waterways generally follows the pattern of impact on rail mode, but it is smaller.

Figure 21: Results on inland waterway tonne volumes per country per scenario



6. Conclusions

The analytical approach first revealed trends to be expected for more detailed calculations: the introduction of LHVs is expected to reduce the road transport cost by 15 to 20% in comparison to normal HGV trucks (depending on the scenario and on some external factors, e.g. fuel cost). As a result, road tonne-km volume grows, while vehicle-kms go down. Rail volumes can also be expected to decrease, although it is very unlikely that any decline will occur: growth will merely be somewhat slower.

This trend was confirmed by the other approaches.
In scenario 2, the modelling approach showed that road volumes are expected to increase by 0.99%, while rail and waterway volumes would respectively decrease by 3.8% and 2.9%.
However, using the assumption of a more price-sensitive market in the calculation approach, a road transport growth of 13% could be reached, while rail and inland waterways would decline by 14% and 11% respectively. Approximately 30 % of heavy cargo traffic would be carried out by LHVs.

On the other hand, the number of vehicle-kilometres done by HGVs (LHV is a sub-class of heavy goods vehicles) declines by 13 %. It should be noticed that the decrease of vehicle-kilometres happens in heavy cargo traffic. There is a large variation in change of vehicle kilometres over the countries. The most affected countries are big and sparsely populated countries with clear aggravation of population and economical activity, such as Spain, Finland and Greece.

The figures with scenario 3 are similar, except for the waterway decrease which would be almost 9%, because the concerned regions are have the most developed waterborne transport operations. With scenario 4, the changes would be less, with an increase of road volume by 1.7 to 4% (or +0.4% with the modelling approach) and a decrease by rail and waterway by –2 to –5% (and a decrease in the number of vehicle kilometres by 3.4 % with the modelling approach).

There is an interesting comparison between scenarios 3 and 2. The countries that are not included into the coalition/corridor are not noticeably affected. The road volumes and cargo traffic in countries that are included into the coalition respond differently. For instance, for the Netherlands there is almost no difference between scenarios 2 and scenario 3, while Belgium and Germany would witness bigger differences.

V Effect on safety

1. General introduction

The assessment of effects on road safety by adapting the directive 96/53/EC throughout the study was examined in accordance with the scientific approach of Seiffert[22]. Road safety in general can be divided into the following columns:

- Human / safety of road users
- Vehicle / safety of means of transport
- Environment / safety of traffic routes

Each column was discussed in two dimensions. First dimension was the primary or active safety (branch A in the figure below) which refers to systems to prevent crashes from occurring.

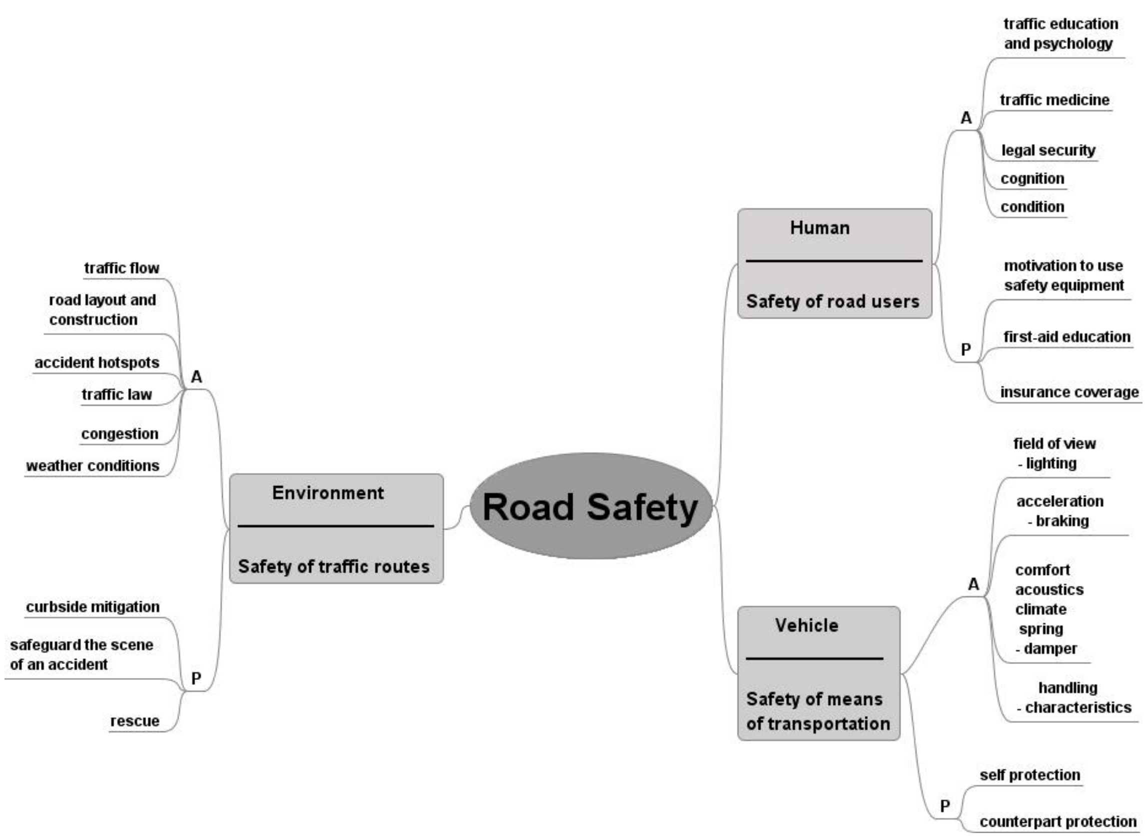


Figure 22: Three columns of road safety according to Seiffert (1992)

Secondary or passive safety (branch P) was the other dimension and refers to systems which prevent or minimize injury after an accident has happened. Figure 22 gives an overview of the detailed columns of road safety in a Mind Map.

[22] Seiffert, U. (1992): 11

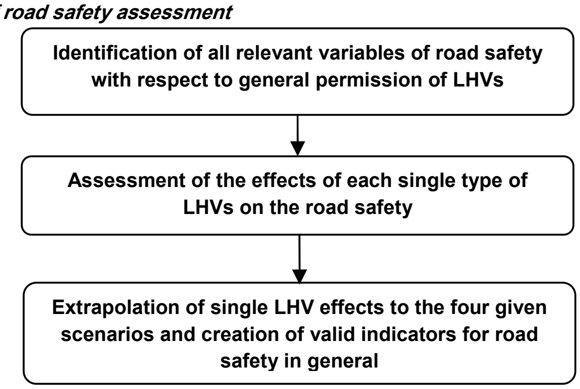
To balance the future development of road safety this section also discusses state-of-the-art safety technologies which are in a mature phase but not yet established all over. These technologies are in addition to effects which may occur when adapting weights and dimensions within Directive 96/53/EC. However, their future use will have a major impact on road safety as well.

The first step of the safety assessment was to identify all relevant variables which are affected by the introduction of longer and/or heavier vehicles (LHVs) across Europe within this scientific model of road safety. This effort was conducted in close ties with experts from truck manufacturers and scientific researchers from automotive research institutes to ensure the quality of this process. In this step also the impact quality of each variable on road safety was examined in terms of increasing/decreasing safety or no effect on safety at all.

The second step correlates the various detected variables with the different types of LHVs and thus a matrix of effects can be drawn. By this, each array of the matrix combines a discrete LHV with a specific variable of road safety. Content of those arrays is the result of the conducted literature review, expert workshops within the study, e.g. a safety workshop in Stuttgart, individual interviews and calculations on vehicle dynamics, accident statistics, etc. Result is an assessment of road safety effects on a micro level. This level is described by the impact of one discrete LHV on road safety and on the safety of the vehicle itself.

In the third step of the assessment the results of step one and two were brought to a macro level. Therefore the effects of single LHV safety were correlated with the four scenarios, and it was researched, how the different use cases affect road safety in terms of accident costs as input for the cost benefit analysis. Figure 23 below summarises the methodology of the safety assessment.

Figure 23: Methodology of road safety assessment

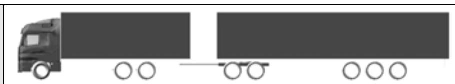
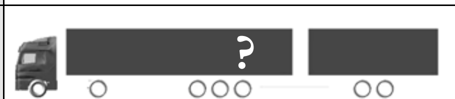


2. Vehicle safety assessment

2.1. Introduction

The expected impacts of LHVs will be discussed in this chapter in detail for the above mentioned vehicle safety issues (cf. Figure 22) However, only those causing a differing risk potential to standard heavy duty vehicles are summarized below. The vehicle safety issues to be discussed in-depth are *field of view – lighting*, *braking – acceleration*, *handling characteristics (like manoeuvrability and vehicle dynamics)* and *counterpart protection*. They were proposed during the stakeholder consultations. Prior to the assessment results, Table 25 below provides an overview of the researched vehicle configurations within the study. These combinations are the most proposed concepts to be used across Europe and recent research provides scientifically robust data for an assessment. The range varies from a vehicle length of 17.8 m to 25.25 m and a GVW *(gross vehicle weight)* of 40 t to 60 t. At the end of the vehicle safety assessment chapter some state-of-the-art safety technologies (e.g. advanced driving assistance systems) will be discussed and their ability to prevent risks will be described.

Table 25: Vehicle configurations within the road safety assessment

		vehicle concept[23]	gross vehicle weight	scenario
1		6 x 4 lorry with semi-trailer on dolly (25.25 m)	60 t	2 & 3
2		6 x 4 lorry with two drawbar trailers (25.25 m)	60 t	2 & 3
3		B-Double, tractor with interlink semi-trailer + semi-trailer (25.25 m)	60 t	2 & 3
4		4 x 2 tractor with semi-trailer and drawbar trailer (25.25 m)	48 t	2 & 3
5		4 x 2 tractor with longer semi-trailer of 14.92 m (17.8 m)	40 t	4
6		not yet defined future option with length of 25.25 m	40 t	2 & 3

LHV type 1, 2 and 3 have a GVW of 60 t and a length of 25.25 m. They differ only in the mechanical construction which means different combinations of standard commercial vehicle parts. Thus these concepts are in line with the European Modular System (EMS). LHV type 1 is a standard 6 x 4 lorry with semi-trailer on dolly, LHV type 3 is a 6 x 4 lorry with two drawbar trailers and LHV type 4 is tractor with so-called interlink semi-trailer and an additional semi-trailer.

LHV type 4 consists of a 4 x2 tractor with semi-trailer and drawbar trailer. This configuration has a GVW of 48 t and a total length of 25.25 m and is also an example for an EMS. If this version would be equipped with a 6 x 4 tractor it could reach a GVW of 60 t due to the required load ratio on the driving axle. However, the discussed version is introduced to tackle market's demand for higher volume capacity without increasing the GVW dramatically.

LHV Type 5 marks a longer semi-trailer combination without changed GVW. The semi-trailer length is extended to 14.92, thus the total length amounts to 17.8 m. This combination is chosen for scenario 4 as it seems there are hardly any other combinations researched yet which fit more to the given limits of 20.75 m and 44 t.

LHV type 6 describes a future option of advanced vehicle combination. It meets the demand for an increased volume capacity without any extended GVW. Hence all predicted negative effects of heavier commercial vehicles either on road safety or on infrastructure may be avoided.

[23] LHV type 1-4 present concepts according the European Modular Concept, LHV type 5 represents a proposed concept by Kögel Fahrzeugwerke GmbH

Figure 24below provides an overview of the different innovation strategies of LHVs. The different LHV types from Table 25 are indicated via numbers in the red bubbles, the blue bubbles represent standard commercial vehicle concepts. In general, there are three possibilities to adapt the Directive 96/53/EC. First strategy is an increase of dimensions only. Examples are a longer semi-trailer as well as EMS. An increase of weight only marks the second strategy, e.g. are pre- and post-haulages of the combined transport. Third option is an increase of both variables. The following assessment balances the effect on road safety of these strategies compared to today's level of safety.

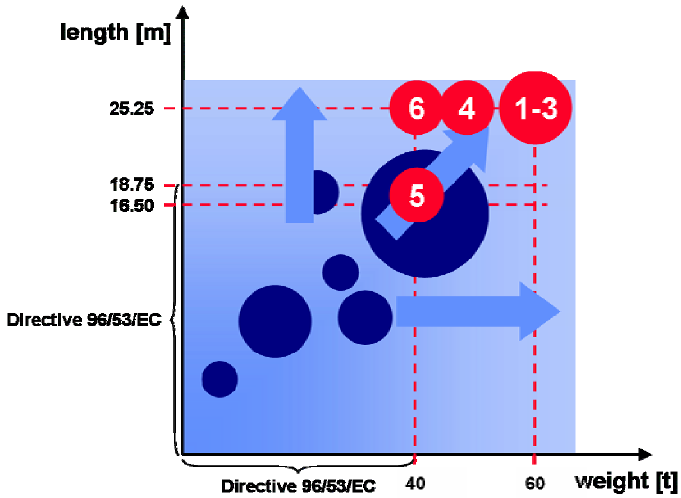


Figure 24: Innovation strategies of LHVs

The assessment itself was conducted separately for each configuration whereas the risk factors for the cost benefit analysis in section VIII present an aggregated average value to balance the impact of LHVs on accident costs. The average values are to process the data from TRANS-TOOLS in a proper way.

2.2. Field of view

In the context of vehicle design the field of view is defined as all areas the driver can either see directly or indirectly via mirrors or other supporting devices. As cabins of LHVs are expected to be designed similar to or even the same way as standard commercial vehicles the direct view will remain unchanged. This means that introducing LHVs would not lead to worse field of direct view than for current vehicles (with all still existing problems, e.g. the view to the passenger side of the cabin). Regarding indirect vision directive 2003/97/EC sets up requirements for the equipment of all new heavy vehicles with corresponding devices. However, many old vehicles have not to be retrofitted and thus do not comply with these requirements. This might be of importance if for the introduction of LHVs no additional requirements are set up for the tractor/lorry pulling the vehicle combination.

As general conclusion of the field of view topic it can be stated (cf. Knight et al. 2008) that:

- The field of view in straight ahead manoeuvres will not be decreased for LHVs compared to standard vehicle configurations.
- All assessed LHVs would suffer additional blind spots during cornering manoeuvres and the front trailer or the rigid vehicle would prevent vision of the front area of the rear trailer. This leads to a slightly increased risk associated with cornering compared to standard vehicle configurations. Just the B-Double with fixed axles on the interlink semi-trailer is slightly safer due to no existing exposed wheels out of the drivers view.

- Regarding the longer semi-trailer there will be no additional safety risk associated with the field of view.

The 25.25 m combination with a GVW of 40 t seems to be not yet investigated. Changes in the field of view depend strongly on the chosen configuration as described above.

The field of view of the other road users (e.g. cars, motorcycles, etc.) would be reduced by LHVs which may induce additional risks. However at this stage, there is a lack of knowledge to quantify this phenomenon. Additional studies would be required to assess the visibility issues induced by LHVs and to quantify the additional risk. In any cases, if LHVs would be accepted, they must have clear signs to be easily identified by the other road users, at day and night and whatever the visibility conditions.

2.3. Acceleration – braking

The road safety especially on motorways is related to a proper traffic flow. This can be diminished by commercial vehicles with undervalued engine power. Typical situations where this appears are uphill sections of roads or ingress ramps where under motorized commercial vehicle's velocity slows down. Consequently, this can cause rear-end-collisions due to overtaking manoeuvres of faster commercial vehicles or by inattentive car drivers. To avoid such risks, some vehicle manufacturers with experiences in LHV design have suggested a minimum engine power of 480 hp[24] for vehicle combinations up to 60 t, while others recommend 650 hp. It is obvious that for combinations which do not exceed the current level of GVW *(gross vehicle weight)* the current power level would be adequate and hence longer semi-trailer combinations which do not exceed current weight limits either would not cause any additional risks.

Along with the mandatory introduction of ABS for commercial vehicles throughout ECE-13 and 71/320/EC under or over braked axles might not occur any longer during braking manoeuvres and thus stability and directional control is improved. To benefit from this, it is necessary that all components of the likely permitted LHVs comply with these current braking regulations albeit there are still older vehicles in use which are not equipped with ABS or other driver assistance systems. Besides ABS other safety technologies regarding braking manoeuvres are in a mature phase and a mandatory use via EU regulation is to be recommended. The effectiveness of additional safety measure was demonstrated by Daimler AG with a fleet comparison of 500 trucks (tractor/semi-trailer 40 t GVW) equipped with and 500 trucks without assistant systems. This trial led to a reduction of accidents up to 50 % within the part of the fleet equipped with safety measures especially the frequency of rear-end collisions. The used driver assistant systems included proximity control but not yet an active brake assistant which is able to initiate full braking with maximal performance. However, his trial provides an outlook on what is feasible today. Nevertheless, such driving assistant systems are not yet in exhaustive use, because they are just optional equipment. An approach which may increase the motivation to use safety equipment (a passive safety variable from the human column of road safety in Figure 22) is discussed below in chapter 3. Based on the findings above an active brake assistance system should be compulsory for LHVs.

Another issue regarding road safety is the requirement to minimize stopping distance to avoid crashes from occurring. The brake system response time is a reasonable factor to estimate the braking performance. As commercial vehicles are usually equipped with pneumatic brake systems it is obvious that the transport mode of the braking signal from the driver to the various brake chambers has an influence on

[24] *Knight, I., Newton, W., McKinnon, W. et al.* (2008): Longer and/or Heavier Goods Vehicles (LHVs) – a Study of the Likely Effects if Permitted in the UK. TRL Limited. UK: 98

the response time. By using air the relatively low pressure wave propagation rate leads to a short time gap which can be reduced substantially by using electrical signals, e.g. via Electronically Braking Systems (EBS). According to manufacturers from the safety workshop in Stuttgart such EBS would be technically available for LHVs in the close future. Tests by the Daimler AG carried out on test tracks in Sweden and Germany have proofed the high braking performance of LHVs. Compared with a conventional truck trailer combination a LHV (type 1 from Table 25) could decrease the braking distance on dry surface up to 5 % and on slippery surface up to 17 %. LHVs have a reduced axle load due to more axles and a bigger footprint. Thus higher brake forces can be transmitted. The amount of more axles may also improve the control algorithm of the ABS. This has to be evaluated in further research. However, it would be recommended that the EBS technology is available by several manufacturers and generalized prior allowing LHVs.

The discussion above has focussed only on LHVs as for longer semi-trailers there is no change neither in the braking system itself nor in the braking performance. For LHV type 6 an improved braking behaviour may be predicted as more axles might be expected and thus the axle load compared to a standard 40 t vehicle would be reduced.

2.4. Handling characteristics

The assessment of the handling characteristics was divided in two main parts which are *manoeuvrability* and *vehicle dynamics*. In the first part of this chapter the manoeuvrability examination will be discussed.

The additional 6.5 m length of LHVs type 1 to 4 might tend to a decrease of manoeuvrability and thus potentially increases the accident risk. Risks can occur from additional road space required when turning. In order to tackle the existing requirements LHVs have to comply with Directive 97/27/EC on out-swing limits and Regulation 96/53/EC on swept path limits. Out-swing in this context is described as the lateral distance that a given point of a vehicle moves outwards as a turn commences. Directive 97/27/EC determines for that situation an out-swing limit up to 800 mm. Geometrical considerations indicate that out-swing depends on the amount of the rear overhang and the wheelbase of a vehicle whereas the trailer coupling position plays a minor role. Hence LHV types 1 to 4 comply with the requirement. This is true for an extended semi-trailer of 14.92 m, too (cf. Bachmann 2007)[25]. For other concepts of longer semi-trailer steered axles are mandatory to achieve this limit. Consano and Werner (2006)[26] propose in their research that articulated vehicles should not exceed a length of 17.8 m according to achieve the requirements of out-swing as well as swept path.

To comply with Regulation 96/53/EC vehicle combinations must be able to navigate a circle with an outer radius of 12.5 m and an inner radius of 5.3 m. This leads to a swept path of 7.2 m in which vehicle combinations have to turn. Recent studies allocate that all LHV types from Table 1 assessed could meet the required limits if equipped with steered axles or dollies. Otherwise type 1 to 4 would not comply with European standards but with a 10.5 m swept path as permitted in Sweden and Finland. For only a 90° turn the difference of the swept path would decrease significantly according to Pilskog et al. (2006)[27]. In the study this 90° turn is proposed as much more representative for real driving situations.

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[25] *Bachmann, C.* (2007): Gutachten. Wissenschaftliche Begleitstudie zum Feldversuch des verlängerten Aufliegerkonzepts (Eurotrailer). ika Bericht 63140. Aachen. Germany

[26] *Consano, L.; Werner, J.* (2006): An optimized transport and safety concept for tractor-semitrailer combination. DEKRA/VDI Symposium Safety of commercial vehicles, October 12-13th 2006. Neumünster. Germany

[27] *Pilskog, L., Aurell, J. and Avedal, C.* (2006): Experience from the European Modular System in Scandinavia. DEKRA/VDI Symposium Safety of commercial vehicles, October 12-13th 2006. Neumünster. Germany

The second part of the handling characteristics assessment was the evaluation of the vehicle dynamics and the stability of LHVs. Stability consists of directional and roll stability. The reduction of either one or both of these aspects can cause serious accidents. As today's state of the art trailer have an equipment rate for active rollover prevention systems of up to 100 % static rollover stability of LHVs is not considered to vary from standard heavy duty vehicles. However, it shall be underlined that most of the existing roll-over prevention systems are not fully efficient because they act too late. Some accident studies carried out in France (LCPC) show that the roll-over is the first cause of accident of trucks alone, above all for the type 5. Moreover, it was shown that the higher the gravity centre, the higher the roll-over risk. Therefore, it may be anticipated that LHVs could be exposed to roll-over with more severe consequences than the current trucks. In such a case, they also would be more difficult to remove from the road. The side-wind effects on longer vehicles, especially EMS, seem to be not yet assessed in a scientifically robust manner. Bachmann (2007) refers to a driver survey of longer semi-trailer which draws the conclusion that the effects are equal or slightly worse compared to standard combinations. The directional stability can be assessed via standardised driving manoeuvres on test tracks or in simulations according to ISO 14791 and 14792. Typical manoeuvres are steady state circular tests, sinusoidal steering and lane change manoeuvres.

The results of recent handling characteristics research is presented in Table 27 (cf. Knight et al. 2008 and Wöhrmann 2008)[28]. Arrows or a flash respectively are used to describe the different tendencies of the behaviour of LHVs. To interpret the findings in the right way Table 26 presents the meaning of the arrows orientation and of the flash.

Table 26: Evaluation scale for the handling characteristics of LHVs according to Wöhrmann (2008)

Assessment of handling characteristics at the limits	
↗	equivalent or better behaviour than standard heavy duty vehicles
↘	slightly inappropriate behaviour than standard heavy duty vehicles
↘	unfavourable behaviour compared to standard heavy duty vehicles
↓	significant unfavourable behaviour compared to standard heavy duty vehicles
⚡	not acceptable

During the examination LHV type 1 shows stable driving dynamics in general like standard commercial vehicles. Precondition is a lockable steering axle mechanism for the straight ahead position at higher speed levels for the trailer. Without locked steered axles the trailer needs to build up a higher attitude angle to produce the required lateral forces when cornering. The steered axles of the dolly must not be lockable from the driving dynamics point of view.

The combination with two drawbar trailers pulled by a lorry is just limited advisable. It has a good behaviour regarding the steady state circular test but all other stability criteria are at least significantly unfavourable. Even with the discussed avoidance strategy the damping rate can not be increased adequately. Reducing the GVW *(gross vehicle weight)* to 40 t may lead to more acceptable handling characteristics as the eigen-

[28] *Wöhrmann, M.* (2008): Fahrdynamische Analyse innovativer Nutzfahrzeugkonzepte - Abschlussbericht. Forschungsvereinigung Automobiltechnik (FAT) e. V. Frankfurt. Germany

frequency of the vehicle is shifted to higher values and thus the moment of inertia is reduced. However, the low damping ratio of the system still exists.

Table 27: Assessment results of the handling characteristics according to Knight (2008) and Wöhrmann (2008)

	concepts \ manoeuvre	Gross Vehicle Weight	steady state circular test	sinusoidal steering	single lane change manoeuvre		manoeuvra-bility	Scenario
			behaviour	behaviour	required space	yaw damp-ing	behaviour	
1		**60 t**	↗	↗	↘	↗	↘	2 & 3
2		**60 t**	↗	↯	↓	↯	↘	2 & 3
3		**60 t**	↗	↗	↘	↗	↘	2 & 3
4		**48 t**	↗	↘	↘	↓	↘	2 & 3
5		**40 t**	↗	↗	↗	↗	↗	4
6		**40 t**	further research is needed to assess the driving dynamics and the manoeuvrability of this future option					2 & 3

The B-Double has almost the same characteristics compared to the standard combinations with respect to driving dynamics. Only the required space for the lane change manoeuvre is increased slightly. Thus, the LHV type 3 is advisable concerning stability aspects.

The results of LHV type 4 are more diverse for the different manoeuvres carried out. Whereas the steady state circular behaviour is equivalent to recent vehicle combinations the other indicators are slightly worse. Significantly is the low yaw damping rate. This is generated by high vehicle reactions of the drawbar trailer in the region of its eigen-frequency. To avoid critical situations active brake systems can be used to compensate the low damping rate, i.e. the rollover prevention system of today's trailer can eventually compensate the increased risks.

The longer semi-trailer concept is advisable to be permitted concerning driving dynamics as it behaves at least like standard trailers. The increased wheelbase may cause an increased level of safety regarding rearward amplification and directional stability. As the precise vehicle combination of LHV type 6 is not yet defined, there seems to be no results on driving characteristics available.

The assessment above was focused only on active safety issues and the possible impacts LHVs might have on it. This sub chapter is about the passive safety aspects of vehicle safety. Figure 22 defines two qualities, the self protection and the counterpart protection. As car occupants are the majority of fatalities in accidents involving heavy duty vehicles the counterpart protection is of superior meaning. Nevertheless, increased vehicle weights require increased crashworthiness of the truck's cabins to ensure driver's survivability. The proportion of truck occupant fatalities is some 9 % from accidents involving heavy duty vehicles. As the structure of the truck cabin can not be designed as stiff as needed for higher closing speeds and collisions with other heavy vehicles or stationary obstacles an increase in mass increases the risk for the occupants.

For the impact severity evaluation on other road users (i.e. car drivers) there are two main factors of relevance, the closing speed at which the vehicles collide and the different masses of the vehicles. In a car-truck accident higher closing speeds lead to higher changes in velocity for the car involved and thus to a higher likelihood that car occupants will be killed during the collision. The other factor is the difference of masses. The change in velocity sustains to a higher fraction by the lighter vehicle. But if the mass ratio is sufficiently large, the energy to dissipate in a collision becomes insensitive to the mass of the truck (as the factor is defined as $m_1 + m_2 / m_1 x m_2$). This is already true for mass ratios from 10:1 upward. According to this introducing LHVs would not perceptibly increase the impact severity. An exception of this finding is given when there are other obstacles in the path of the post primary collision trajectory. So the impact severity in collisions between trucks driving behind a car is dependent on the situation ahead the car. Most relevant example is a rear-end collision in traffic jam situations.

In general an improved under run protection was demanded during several stakeholder consultations. Especially the front under run protection (FUP) is of concern due to rear-end collisions when LHVs with an extended mass are the hindmost vehicle. Current protection systems are rigid and the energy absorbing capability is limited on a low level. A recent study by Krusper and Thomson (2008)[29] came to the conclusion that current FUP systems according to ECE Regulation 93 are not always sufficient. In this context Avedal and Svenson (2002)[30] have proposed a deformation zone concept to absorb more of the impact energy. The authors estimated that this concept could save 12.000 serious ore fatal injured people across Europe each year. However, this device would require additional space/length at the front side of the truck and it would influence the weight distribution of the axles.

2.5. State-of-the-art safety technologies

Not only adapting the rules on weight and dimensions influences road safety but also the availability and large-scale use of future safety technologies. Especially for LHVs this was confirmed by stakeholders in the questionnaire. Roughly 80 % of the subscribers voted for an extend effort on advanced safety features for LHVs. At a very basic level these extended efforts may be by stakeholders requested shorter intervals for technical inspections as well as specific checks for LHVs. But mainly active safety technologies, i.e. advanced driving assistance systems, were requested.

Some of these systems are well introduced; others are in a mature phase or still under development. However, currently there is a misfit between availability and use. Today, several safety devices are optional and not mandatory (e.g. equipment ratio of ESP is some 10 %). Driving management systems, adaptive proximity and cruise control and electronic lane guard systems are state-of-the-art. The benefits for road safety of these equipments were demonstrated by a fleet trial of the Daimler AG (see above). Further available devices are active brake assistance systems to avoid or at least mitigate collisions, improved blind spot detection/bend off assistance, etc. Hence, such equipment could be made compulsory via regulation for LHVs. In this context a strategic roadmap for driving assistance systems could be introduced to bundle efforts on road safety improvements by the manufacturers. Such roadmap could be divided into the parts safe traffic flow, risk avoidance, collision avoidance, self- and counterpart protection and rescue manage-

[29] *Krusper, A., Thomson, R.* (2008): Crash compatibility between heavy goods vehicles and passenger cars: Structural interaction analysis and in-depth accident analysis. International Conference on Heavy Vehicles HV Paris 2008. Paris. France
[30] *Avedal, C.; Svenson, L.* (2002): Accidents with trucks in Scandinavia – an overview of the current situation. DEKRA/VDI Symposium Safety of commercial vehicles, October 12-13th 2006. Neumünster. Germany

ment and it would correlate safety technologies with safety risks. Another positive side effect of mandatory safety equipment for LHVs could be a high likelihood for increasing safety of all heavy duty vehicles. To obtain the flexibility to use a tractor in any combination – LHV or standard – an additional number of trucks would be fitted by the operators. Thus, more safe trucks than LHVs would be on road.

An extra consideration should be given to countries that have already successfully deployed LHVs on their territory. Setting standards for technical equipment within the EU exceeding the ones in SE, FI and NL could prevent cross-border use of existing combinations.

However, as most of the recommended countermeasures refer to the tractor (e.g. lane departure warning, active brake assist, etc) and not to the combination itself, existing rigs can be used except for some tractors. Taken into account an average amortization period of three years for long distance tractors, freight forwarders should be able to tackle this situation, on the condition that a long enough transition period is foreseen. Today's safety features work modular, which means oriented either to the tractor or to the trailer, but not to both. As such, equipment can be mixed. Most of the Scandinavian combinations are lorries with semi-trailer on dolly. These combinations have a high longitudinal driving stability. Thus, such combinations would not create additional risks.

Additionally, road safety depends strongly on road type. Current users such as SE, FI and NL have very similar road networks (few hills) and weather conditions (wind, precipitation, temperature). However, countermeasures were addressed for more dense, hilly or winding roads than in these countries, to balance the European wide road network situation. Nevertheless, permitting LHVs with countermeasures could be an advantage for countries using them already, even when they have to invest more in safety equipment.

3. Assessment of human and environmental factors of safety

3.1. Accident occurrence

One significant parameter regarding traffic safety and accident occurrence is the number of vehicles on the road. LHVs are able to counter this, if assuming that the total volume/mass of freight on the road remains constant. The usage of LHVs can reduce the number of trucks on the road and relieve the traffic density by ferrying the same amount of goods. Thus, the traffic flow can be improved. Concerning this, road safety is not necessarily negatively affected and growing vehicle dimensions do not cause new accident typologies. But modified vehicle dimensions might change the accident frequency and accidents severity. The following parts are thus divided into the dimensions: accidents frequency and accident severity. Within this dimensions relevant road safety issues concerning LHVs from Figure 22 are discussed. Road layout issues have been presented within the manoeuvrability sub chapter above. The section regarding effects on infrastructure describes the risks of LHVs in terms of road construction issues, e.g. restrain systems. As both secondary safety parts of human and environmental road safety do not depend on specific vehicle configurations they were not investigated. Exception is the insurance coverage. Special initiatives like German “Safetyplus Truck” may foster the use of safety equipment to reduce number and consequences of accidents by favourable insurance premiums. Therefore, such initiatives are strongly to recommend.

It is noteworthy that heavy duty vehicles account only for approximately 6 % of all vehicle traffic performance. However, 18.3 % of all road accident fatalities occur in accidents involving commercial vehicles. An IRU study (2007) has investigated that and detected that the main cause for accidents is linked to human error (85.2 % of all cases). Hence, the human column of road safety marks a major role. To balance this issue, especially when allowing LHVs, stakeholders have requested during the safety workshop to introduce special driver training and at least five years of driving experience. All activities of manufacturers carried out to support the driver's condition and cognition and to balance driver's malpractice via advanced driving assistance systems as described in section 2 must be mandatory in LHVs.

Another aspect is the driver education. As human error is the major cause of accident, it is obvious that special vehicle combinations need special attention. To train future drivers of LHVs without any negative effects on the safety of all road users, such education may use modern practices like driving simulators which are standard in pilot's education. Another stakeholder concern[31] was the psychological impacts LHVs have on other road users. They argued that a late perception especially of car drivers whether the other vehicle in the traffic flow is standard or a LHV can cause critical driving situations (e.g. for overtaking manoeuvres). Therefore it would be essential that LHVs carry some marks to be easily identified, at day and night. Related to that issue is the general acceptance of LHVs by society. There is hardly any scientifically robust data available. In the past surveys and interviews were carried out prior and accompanying field trials in the Netherlands and Germany. They show differing results from against or in favour for LHVs. To evaluate the driver's strain in traffic situations with LHVs the total number of LHVs in the past trials, e.g. in Germany or the Netherlands was much too small. Therefore future research should focus on potential accident occurrence risk changes in such critical situations. To avoid any risk within such investigations they can be conducted via driving simulator examinations.

3.2. Accident frequency

In terms of the traffic flow, in particular on motorways, new or aggravating problems are rather improbable, except close to exits. Whereas in subordinated road networks as intersections, level crossings or two-lane rural roads, negative effects might be expectable.

Relating to the action and assessment of longer and heavier trucks and based on large-scaled studies, the following accident configurations were the most frequent in occurrence and mark accident hotspots. In this classification vehicles (resp. pedestrian) and trucks were involved:

- Accidents at intersections and junctions (27 %),
- Accidents in queues (20.6 %) resp. rear-end collisions,
- Accidents due to lane departure (19.5 %),
- Accidents during an overtaking manoeuvre or changing lane (11.3 %),
- Single truck accidents (7.6 %).

The accident configurations listed above were identified from the IRU (2007)[32]. Even in other reports this scenarios were mentioned[33]. In addition to this studies of the Federal German Highway Research Institute

[31] Interview with T. Hessling, ADAC
[32] *IRU* (2007): A Scientific Study. „ETAC" – European Truck Accident Causation. O.O.: 41
[33] *Akerman, I.; Jonsson, R.* (2007): European Modular System for road freight transport - experiences and possibilities. Stockholm. Sweden: 43 f.

(Glaeser et al. 2006) and the German automobile club (ADAC 2007)[34] gleaned some more relevant and potential accident scenes:

- Accidents at motorway accesses or motorway exits,
- subordinated road networks,
- Rest areas.

Drawing on the example of *accidents in intersections* the main accident causes are failures in observing intersection rules no matter if the truck driver causes the accident or the driver of another vehicle. The second reason is that the drivers – equally truck drivers and drivers of other vehicles – do not adapt their speed. A third cause pertained to truck drive's arises from improper manoeuvres in the process of turning. In an accident in intersections the main impact of the trucks is the front impact (59 %), the main impact of the other road users is the side impact (46 %)[35].

In driving situations like *overtaking manoeuvres* or changing lane nearly 54 % of the truck drivers cause the accidents in contrast to 43% of the other road users[36]. The main causes for these accidents initiated by trucks were improper manoeuvres in the process of overtaking or changing the lane followed by inattention resp. over fatigue. For the other road users the situation is similar: improper manoeuvres when overtaking or changing the lane is the first reason, followed by "non-adapted speed" as the second cause.

In this context, a Swedish study (1976) stated that there is no statistical interrelation between an increased accident rate due to overtaking manoeuvres and vehicles of excess length[37]. According to this the aspect *length of a truck* and as a consequence the increased time of the overtaking process are not essential. Contrary to these findings some 30 years later German studies (Glaeser et al. 2006 and ADAC 2007) stress the point, that overtaking manoeuvres require much more time and an additional sight distance and hence retrieving a higher safety risk. The additional risk from overtaking manoeuvres strongly depends on the grade to which roads are trafficked. However, a much more critical situation may be expected from overtaking manoeuvres processed by LHVs among themselves. Due to the small relative velocity and the increased length the overtaking time rises significantly. In this context the required engine power as mentioned above may be counter additional risks. That supports the proposal of stakeholders to put strong limitations on the overtaking by LHVs.

Even in the subordinated road network the accident occurrence can be biased negatively. Problems may appear on non-signalized junctions, two-lane rural roads, during turning off and passing level crossings. Relating to the clearance interval in conflict areas in intersections the length of a truck is a relevant factor[38]. Moreover, at a high merging-scale and high utilization-grades the number of critical driving manoeuvres on two lane carriageways increased by 1/3[39]. Furthermore the access road to rest areas on motorways is currently already used as parking space, so the accident risk is incremented.

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[34] *ADAC* (2007): Die Supertrucks – Belastung statt Entlastung. ADAC Positionspapier. München. Germany

[35] IRU (2007): 46f.

[36] ibid.:58f.

[37] *Backman, H.; Ralf N.* (2002): Improved Performance of European Long Haulage Transport. TFK Report. Stockholm. Sweden: 26f.

[38] *Glaeser, K.-P.; Kaschner, R. et al.* (2006): Auswirkungen von neuen Fahrzeugkonzepten auf die Infrastruktur des Bundesfernnetzes. Bast. Bergisch Gladbach. Germany: 97f.

[39] ibid.:89

3.3. Accident severity

The consequences originated in longer and heavier vehicles must be distinguished in consequences resulting from an increased weight and such resulting from a bigger overall length. With regard to the severity accidents in queues and traffic jam just as rear-end accidents require special attention[40]. In this accident configuration a truck is more often impacted by another vehicle driving behind, than the other way round. The accident main causes are insufficient safety distance, non-adapted speed and lack of attention no matter if the truck impacts another road user or vice versa[41].

Independent from the accident configuration and the vehicles involved – accidents with heavier trucks might be in average more fatal as the deformation energy rises with rising masses. This fact from physics shows the potential of LHV type 6. Albeit the volume capacity is increased, the GVW *(gross vehicle weight)* and thus the accident energy remain on standard 40 t level. Another counter measure to avoid an increased accident severity could be the use of active brake assistant systems as discussed above in chapter 2. However, in the context of accident severity it has to be stated that according to manufacturers of such devices current active brake assistant system are not able yet to detect stationary obstacles. But this use case is of significant importance to avoid rear-end collisions at the tail end of traffic jams. Thus, there is an urgent need to develop technologies in the close future to counter this weakness of active brake assistant systems.

3.4. Interim conclusions of accident frequency/severity

Table 28 below provides an overview of predicted main consequences from the use of LHVs correlated to the above mentioned four main accident configurations. Also, it gives – according to the proposed road map for advanced driving assistance systems – some first technology recommendations to counter additional risks.

Table 28: Main consequences introducing LHVs

main cause \ consequence	Increase of accident frequency	Increase of accident severity	Technological countermeasures
Accidents at intersections and junctions	X		Turning/intersection assistance system
Accidents in queue, respectively rear-end collisions		X	Active brake assist
Accidents during overtaking or lane change manoeuvre	X		Lane departure warning
Accidents due to lane departure	X		Blind spot detection/lane guard

As the increase of accident frequency relates to extended dimensions and the increase of accident severity relates to extended weights the above mentioned innovation strategies can be assessed. Table 28 leads to the conclusion that increasing both variables may induce the highest risks on road safety whereas increasing only one variable may induce just slight changes in road safety.

[40] *Glaeser, K.-P.; Kaschner, R. et al.* (2006): Auswirkungen von neuen Fahrzeugkonzepten auf die Infrastruktur des Bundesfernnetzes. Bast. Bergisch Gladbach. Germany:100
[41] *IRU* (2007): A Scientific Study. "ETAC" – European Truck Accident Causation. O.O.:49f

3.5. Literature review results versus experiences

The preceding chapters have pointed out that the main causes due to the accident configurations named above were non-adapted speed, failure in observing intersection rules and inattention. This implies that not technical errors, infrastructure or other circumstances causes the accidents but human errors are responsible for these.

If the traffic volume significantly decreases thanks to LHVs, the accident rate will theoretically decrease. But the increased weight may provide that a higher accident severity may cease. However, experiences from countries using LHVs already have stated that LHVs do not increase accident frequency as predicted based on the IRU (2007) study. To what extend this may be extrapolated to other European countries with more trafficked roads and less safe driver behaviour is not yet researched.

In the Scandinavian countries, Australia, Canada and USA LHVs are – on specified routes – an integral part of the everyday freight transportation. In this context Potter[42] postulates that the ratio major accident claims to freight task (tonne-km) is much better for LHV concepts than for semi-trailer combinations. Results of a Netherland's study pointed out that the action of LHV brought no aggravating problems[43]. A survey regarding the perception of LHVs in the traffic roads stated that other road users do not notice the LHVs. But whether these statements can be transferred to other countries is currently not predictable, since e.g. the Dutch experiences with less than 200 LHVs cannot be generalized.

4. Conclusion

The assessment of road safety aspects above when adapting Directive 96/53/EC and permitting LHVs in road traffic did not reveal an inherent increase of safety risks in general. However, there may be a higher risk for some LHV combinations regarding handling characteristics and for some accident configurations, with longer vehicles and above all with an extended mass of the commercial vehicle. According to results of the handling characteristics assessment (cf. Table 27) LHV type 1 and 5 are favourable to be permitted whereas for LHV type 6 further research is urgently needed. In general it can be stated that a slightly increase of mass would not lead to a high decrease of road safety and that from the safety point of view there are no additional risks predicted if the longer semi-trailer is to be permitted. In general, further research on side-wind effects on longer combinations is needed. This has to be balanced with the potential reduction of lorries LHVs may provide. Calculations within this study have indicated a reduction of vehicle-km if LHVs were to be permitted. Regarding road safety in general this effect may overweigh the induced higher risk of individual LHVs. However, this depends strongly on the real changes in vehicle kilometres travelled in the future.

To balance the aspects above, stakeholder concerns on road safety should be taken seriously if LHVs were to be permitted. This includes mandatory counter measures to avoid extra risks of LHVs. Along these safety measures there should be proximity control (i.e. adaptive cruise control), lane departure warning assistants, stability control systems (i.e. advanced anti roll-over systems more efficient than the current ones), electronic braking systems (EBS), emergency active brake assistants for collision avoidance/mitigation, identification tags or marks for other road users and lockable steered axles of the trailer/dolly. A regulated engine power may counter the mentioned risks of increased weights. A special

[42] *Potter, J.* (2007): Safety, Environment and Amenity. Regulating Heavy Vehicles for Safety and Amenity: Australia as a Case Study. Paris. France.
[43] *Aarts, L.* (2007): European Modular System. Die niederländischen Erfahrungen aus der Praxis. Rotterdam. Netherlands

driver education for LHVs and cargo securing as well as minimum driving experiences should accompany the technical safety measures. Some strong limitations of overtaking by LHVs shall also be considered.

Generally, from the road safety assessment point of view it can be stated that increasing the weight up to 44 t/48 t or increasing the dimensions up to 25.25 m only would just lead to slight additional risks whereas an increase of both may increase the risks for road safety.

VI Effect on infrastructure

1. Bridges

1.1. Summary of the conclusions

The following tables summarize the effects of the principal configurations of heavier and / or longer vehicles (LHV) on various types of bridges for the main structural aspects. These conclusions are explained in the paragraphs that follow and are valid only for bridges in good condition.

The restraint systems are covered in the last paragraph of this chapter.

Caption:

C = Reinforced and prestressed concrete bridges

S = Steel and steel-concrete composite bridges

[green] = No effect

[yellow] = Moderate effect

[red] = Important effect, need of studies on this topic

Table 29: Impact on bridges of 44 tonnes – 5 axles vehicles (16.50 m or 18.75 m)

Spans		Extreme loads		Fatigue	
		Local effects	General effects	Local effects	General effects
Short	C	[yellow]	[yellow]	[green]	[green]
	S	[yellow]	[yellow]	[yellow]	[yellow]
Medium	C	[yellow]	[yellow]	[green]	[green]
	S	[yellow]	[yellow]	[yellow]	[yellow]
Long	C	[yellow]	[yellow]	[green]	[green]
	S	[yellow]	[yellow]	[yellow]	[green]

- Configuration possible, but more aggressive than the current configurations and can cause additional costs of monitoring, of maintenance and preventive strengthening specific to each country.
- Time required to identify the bridges with problems and to take appropriate measures (tonnage limitations, strengthening, etc.).

Table 30: Impact on bridges of 48 tonnes – 5 axles vehicles (16.50 m or 18.75 m)

Spans		Extreme loads		Fatigue	
		Local effects	General effects	Local effects	General effects
Short	C	[red]	[red]	[green]	[green]
	S	[red]	[red]	[red]	[red]
Medium	C	[red]	[red]	[green]	[green]
	S	[red]	[red]	[red]	[red]
Long	C	[red]	[red]	[green]	[green]
	S	[red]	[red]	[red]	[yellow]

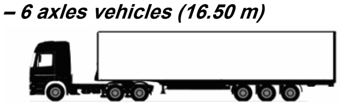
- Configuration to avoid as very aggressive and causing significant additional costs of monitoring, of maintenance and preventive strengthening specific to each country.
- Requires increasing axle load limits.

Table 31: Impact on bridges of 44 tonnes – 6 axles vehicles (16.50 m)

Spans		**Extreme loads**		**Fatigue**	
		Local effects	General effects	Local effects	General effects
Short	**C**				
	S				
Medium	**C**				
	S				
Long	**C**				
	S				

- Configuration possible, but more aggressive than the current configurations and can cause additional costs of monitoring, of maintenance and preventive strengthening specific to each country.
- Time necessary to identify bridges with problems and take appropriate measures (tonnage limitations, strengthening, etc.).

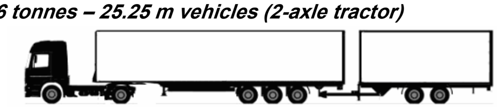
Table 32: Impact on bridges of 48 tonnes – 6 axles vehicles (16.50 m)



Spans		**Extreme loads**		**Fatigue**	
		Local effects	General effects	Local effects	General effects
Short	**C**				
	S				
Medium	**C**				
	S				
Long	**C**				
	S				

- Configuration very aggressive and thus causing additional costs of monitoring, of maintenance and preventive strengthening specific to each country.
- Important preliminary studies are indispensable before considering an authorization.

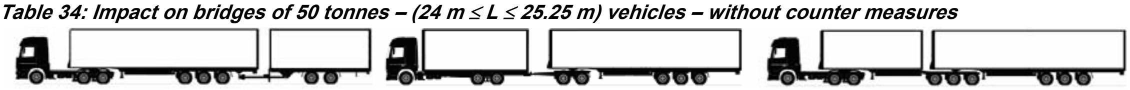
Table 33: Impact on bridges of 46 tonnes – 25.25 m vehicles (2-axle tractor)



Spans		**Extreme loads**		**Fatigue**	
		Local effects	General effects	Local effects	General effects
Short	**C**				
	S				
Medium	**C**				
	S				
Long	**C**				
	S				

- Configuration bit aggressive and not causing additional costs of monitoring, of maintenance and preventive strengthening.
- Compliance with the requirement of Article 4.1 of Annex I to Directive 96/53/EC.

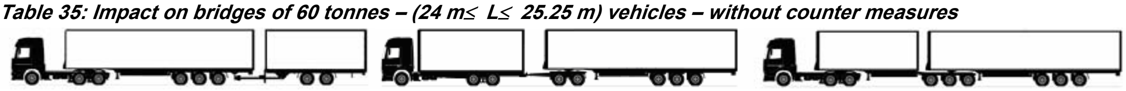
Table 34: Impact on bridges of 50 tonnes – (24 m ≤ L ≤ 25.25 m) vehicles – without counter measures



Spans		Extreme loads		Fatigue	
		Local effects	General effects	Local effects	General effects
Short	C	(green)	(green)	(green)	(green)
	S	(green)	(green)	(green)	(green)
Medium	C	(green)	(yellow)	(green)	(green)
	S	(green)	(yellow)	(green)	(green)
Long	C	(green)	(green)	(green)	(green)
	S	(green)	(green)	(green)	(green)

- Configuration bit aggressive and causing few additional costs of monitoring, of maintenance and preventive strengthening specific to each country.
- Compliance with the requirement of Article 4.1 of Annex I to Directive 96/53/EC
- Minimal spacing between 2 LHV
- Minimal length to impose about 24 meters overall, or minimal wheelbase of about 20 meters

Table 35: Impact on bridges of 60 tonnes – (24 m≤ L≤ 25.25 m) vehicles – without counter measures



Spans		Extreme loads		Fatigue	
		Local effects	General effects	Local effects	General effects
Short	C	(green)	(yellow)	(green)	(green)
	S	(green)	(yellow)	(green)	(yellow)
Medium	C	(green)	(red)	(green)	(green)
	S	(green)	(red)	(green)	(red)
Long	C	(green)	(yellow)	(green)	(green)
	S	(green)	(yellow)	(green)	(yellow)

- Aggressive Configuration and causing additional costs of monitoring, of maintenance and preventive strengthening specific to each country.
- Authorizations limited to specific routes
- Compliance with the requirement of Article 4.1 of Annex I to Directive 96/53/EC
- Minimal length to impose about 24 meters overall, or minimal wheelbase of about 20 meters
- Time necessary to define the routes, to identify the bridges with problems and take appropriate measures (tonnage limitations, strengthening, etc.)
- Respect of the limits on the constituent elements

Table 36: Impact on bridges of 60 tonnes – (24 m≤ L≤ 25.25 m) vehicles – with counter measures

Spans		Extreme loads		Fatigue	
		Local effects	General effects	Local effects	General effects
Short	C				
	S				
Medium	C				
	S				
Long	C				
	S				

- Configuration moderately aggressive and can cause additional costs of monitoring, of maintenance and preventive strengthening specific to each country
- Accompanying measures effective in limiting the aggressiveness of vehicles (minimal spacing between 2 LHV, no overtaking, on-board load measuring systems, authorizations limited to specific routes, etc.)
- Compliance with the requirement of Article 4.1 of Annex I to Directive 96/53/EC
- Minimal length to impose about 24 meters overall, or minimal wheelbase of about 20 meters
- Respect of limits on the constituent elements
- Time necessary to define the routes, to identify bridges with problems and take appropriate measures (tonnage limitations, strengthening, etc.).

1.2. General points

1.2.1. Diversity of the European bridge stock

The European bridge stock is a particularly heterogeneous unit:

- Bridges have very different ages; some are over 100 years old. For example in France, on the national road network 9% of the bridges were built before 1940.
- Bridge maintenance policies vary between countries.
- Inside each country, the bridges have been designed with regulations that have evolved what can lead to varying safety levels. For example, in France 9 loading rules have succeeded since 1852.

This heterogeneity is increased by the differences between the national regulations.

It is noteworthy that the arrival of Eurocodes will contribute to homogenize the performances of future bridges. Two cases will be distinguished thereafter:

- Existing structures, which represent several hundreds of thousands of bridges in Europe.
- Bridges that will be built in the future on the basis of Eurocodes.

1.2.2. General principle of the report

Despite this diversity, and unless stated otherwise (limitation of tonnage), these bridges are deemed able to support the traffic in conformity with Directive 96/53/EC. Given this diversity, and in order that the findings of this report are valid for all European countries, reference to national regulations will not be made hereafter. The approach will thus primarily consist in comparing the effect of the traffic resulting from the application of the Directive 96/53/EC and the effect of the traffic that would result in a modification of this Directive.

However, the few studies on the subject already carried out in different European countries, which most often refer to national regulations, will be taken into account insofar as it can illuminate for particular cases the general principles. *But it is clear that these results apply to a country and generally cannot directly be extrapolated to the others.*

1.2.3. Points to be considered

To assess the impact of an evolution of the traffic on a particular bridge several points must be considered:
1. Its ability to support the passage of maximum intensity traffic (extreme load).
2. Its ability to withstand the repeated passage of traffic (the phenomenon of fatigue).
3. The increase in the costs of monitoring, of maintenance and strengthening which result.

There are some studies carried out in Europe on the extreme load, on the other hand fatigue, monitoring, maintenance and strengthening costs have been little discussed so far.

a. Extreme loads

Generally, aggressiveness for bridges depends of course on the gross weight and the axle loads, but also the longitudinal distribution of load. The longitudinal distribution of load is a fundamental concept for bridges.

Figure 25: Longitudinal distribution of load and mid-span bending moment

For example, the two vehicles below have the same gross weight (72 tonnes) but have very different aggressiveness for the 15 meters long span considered because of their differences in compactness.

Vehicle A – 72 tonnes semi-trailer: 14.40 m wheelbase | *Vehicle B – 72 tonnes crane: 9.6 m wheelbase*

M_A = *129 t.m* | M_B = *165 t.m (aggressiveness: + 28%)*

Mid-span bending moment

As a result, for example:
- Insofar as vehicles of 60 tonnes and 25.25 m long are significantly longer than the vehicles of 40 tonnes and 16.50 m long, it is not possible to say a priori if they are more aggressive for bridges.
- It is necessary to impose a maximum density of charge, i.e. a minimum length of the vehicle.

b. Fatigue

Fatigue is the gradual deterioration of intimate material structures subject to fluctuating or repeated loads. It concerns mainly steel and steel-concrete composite bridges and leads to the emergence and development of cracks, which can then lead to ruin by brutal rupture if the cracks are not detected in time under the monitoring.
The consequence of an increase in the weight of vehicles on the fatigue of the structures is variable depending on the bridges. The principal beams are not very sensitive, and less sensitive for the larger spans. The most sensitive steel beams are those of small bridges.

c. Bridge lengths

We consider in this report 3 categories of bridges:

- *Short bridges* (longer span less than 10 to 20 meters in length)
  These bridges are mainly sensitive to axle and group of axle (tandem and tridem) loads, and not too much to the gross vehicle weight, above all for long vehicles exceeding the span length. While it is not envisaged to increase the axle load limits, these bridges are not considered here."
- *Medium span bridges* (longer span length to about 50 to 60 meters).
  It is the range of lengths which was most analyzed in the few studies on bridges already carried out in Europe for longer and/or heavier vehicles. Contrary to the short bridge case, the case of the bridges with several continuous spans will be also studied. Indeed, the question of the bending moment near a support when the adjacent spans are loaded seems the most delicate point. In all the consulted studies, only continuous bridges with 2 identical spans are considered. This very synthetic approach is relevant, and the conclusions thus obtained can directly be extrapolated with the other types of bridges with continuous spans.
- Long span bridges (with a main span length above 60 to 90 m)
  Except for local or semi-local effects, which are similar to the general effects of short or medium span bridges, the long span bridge loading is governed by an accumulation of heavy vehicles close each to the other all along the span. The EUDL (Equivalent Uniform Distributed Load) is the key factor. If the heavy vehicle length increase proportionally to its weight, the EUDL or UDL does not significantly increase, but because of the vehicle spacing. However, the long span bridges are generally well designed, either with high safety factor and/or because the design codes are rather conservative for long spans. In addition, for some specific long bridges, it may be possible to install a load control system prior to the bridge to monitor the total load on the bridge and to limit it. This was already done in UK.

1.2.4. Configuration of vehicles

a. Vehicles of the same length as current vehicles but heavier

The vehicles a priori involved are configurations with 5 or 6 axles and 44 or 48 tonnes. In the case of configurations with tractors they may have 2 or 3 axles. Some 44 tonnes configurations are already authorized by Directive 96/53/EC for combined transport for ISO containers of 40 feet. Similarly, these configurations are more generally authorized in some countries (United Kingdom with 3-axle tractor, The Netherlands, France for combined transport, or in certain areas (150 km around the main harbours), or for log transport, etc). Lastly, it is noteworthy that a significant percentage of 5-axle overloaded vehicles have already reached 44 tonnes.

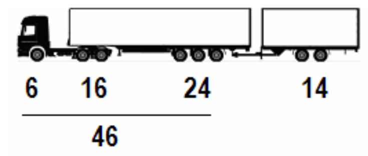
b. Vehicles longer and/or heavier than the current vehicles

The vehicles a priori involved are 25.25 m long configurations. Several gross weights are possible. The studied configurations are 46 tonnes, 50 tonnes and 60 tonnes. The configuration of 60 tonnes appears as a limit in this study and the heaviest configurations have not been studied. The TRL study[44] confirms that with more than 60 tonnes the consequences of the authorization would be much more important for the bridges.

[44] TRL June 2008 - LHVs - a Study of Likely Effects if permitted in the UK: Final Report, page 199.

The studied configurations have loads properly distributed. Indeed, for the same gross weight configurations much more aggressive, because with loads badly distributed, would be considered.
For example, by only observing the conditions of the axle weight, configuration below would be correct.

However, the tractor and semi trailer reach 46 tonnes over 16.50 m, which is not acceptable.



Other conditions must be imposed to avoid these configurations with loads badly distributed.
The configurations studied for these vehicles:

- Take into account the current limits on the constituent elements.

- Take systematically into account the requirement of Article 4.1 of Annex I to Directive 96/53/EC, which currently only concerns the international traffic. This article indicates, *"the weight supported by the drive axle or axles of a motor vehicle or a combination of vehicles shall not be less than 25% of the gross weight of the vehicle or combination of vehicles, when used in international traffic ".*

In addition, the conclusions of this report are valid only for lengths similar to those modelled. A minimal wheelbase about 20 meters long, or a minimal overall length of about 24 meters, is necessary to ensure that the conclusions drawn for vehicles of 25.25 m can still be considered valid. A minimal 18 m wheelbase is advocated in The Netherlands[45]. Insofar as the Dutch bridges are able to support the trucks of 50 tonnes and 16.50 meters long, it is normal that the condition used for an extrapolation to other European countries, 20 meters, is more restrictive than the condition used in The Netherlands, 18 meters.

1.2.5. The modelling of vehicles

The modelling of vehicles, and more generally the modelling of the traffic, requires making numerous assumptions that may be subject to discussion:

- % LHV in traffic;
- deviation on the weight of trucks;
- minimum spacing;
- % trucks in violation;
- dynamic factor;
- % lorries on the second lane;
- modelling of the traffic jams;
- safety factor;
- etc.

The results are very sensitive to the assumptions finally selected. The various studies cited in the report show a great variety in the assumptions and methods of calculation envisaged in different countries.

45 TNO of April 7, 2008.

1.3. Local effects – extreme loads and fatigue

1.3.1. General points

The local effects of new configurations can be seen without taking into account the bridges lengths and the vehicles lengths.

1.3.2. Extreme loads

a. Vehicles of the same length as current vehicles but heavier

If we consider that the current limitations of the axle weights are kept, these vehicles are not more aggressive than currently authorized vehicles for the local effects.

5 axles:
For the 44 tonnes the respect of these conditions leads to very precise configurations and is rather difficult to meet, above all in most of the European countries where the single axle load is limited to 11.5 tons (in France and Spain it is 13 tons). The second axle of the tractor is very often overloaded, up to 14 tons. For the 48 tonnes, the respect of these conditions is not possible and an authorization would thus require an increase in the limits of axle loads.

6 axles:
Current limitations of the axle weights could be kept.

b. Vehicles longer and/or heavier than the current vehicles

If we consider that the current limitations of the axle weights are kept, these vehicles are not more aggressive than currently authorized vehicles for the local effects, except the 44 ton articulated truck with 5 axles.

1.3.3. Fatigue

This paragraph concerns mainly steel and steel-concrete composite bridges.

a. Vehicles of the same length as current vehicles but heavier

5 axles:
The 5-axle configurations that lead to a heaviness of the axle loads can cause or worsen a local phenomenon of fatigue for certain steel bridges, in particular for the steel orthotropic decks. A French study of 2005 showed that the generalization of the 44 tonnes with 5 axles led to a very significant lowering of the lifespan of the "orthotropic deck" and at high costs of repairing or protection. This type of bridges represents however only a very small part of the stock, except in The Netherlands where there are a few hundreds of them, above all movable bridges. A Dutch study[46] shows a considerable reduction from the lifespan from the steel bridges due to an increase from the axle loads. On 48 tonnes no studies on the subject were done, though a study is necessary before being able to consider an authorization.

[46] Interaction of effect of likely traffic loads and bridge details to fatigue – Leendertz de Boer 2008.

6 axles:
On the other hand the 6-axle vehicles, in fact primarily the vehicles with 3-axle tractors, are very beneficial for the secondary elements that are sensitive to the local effects, insofar as the weight of the currently heaviest axle would appreciably decrease. No study on the subject was brought to our attention for 6 axles. Such a study would be very interesting to appreciate the effect on the lifespan of these bridges in the absence of preventive measures and the cost of these measures. In the absence of studies on the subject, and taking into account the improvement brought by an additional axle, we regard the evolution of aggressiveness due to the taking into account of the 44 tonnes as negligible and the evolution of aggressiveness due to the taking into account of the 48 tonnes as moderate in a 6-axle configuration.

b. Vehicles longer and/or heavier than the current vehicles

These configurations do not lead to a heaviness of the axle loads and are not likely to cause or worsen a local phenomenon of fatigue for the steel bridges (for a constant global payload).

1.4. General effects – extreme loads

1.4.1. General points

To estimate the general effects of new configurations of vehicles, it is necessary to take into account the bridges lengths and the vehicles lengths.

1.4.2. Vehicles of the same length as current vehicles but heavier

a. Short and medium existing bridges

Firstly we consider single span bridges less than 20 meters. Such bridges represent a large proportion of existing bridges (for example, about 2/3 of bridges on the French national road network). Given the bridges length and the studied vehicles length, we cannot consider more than one vehicle on each lane. It is then easy to compare for each lane the effects of vehicles currently authorized by Directive 96/53/EC and the effects of other vehicles.

The case of bridges less than a dozen meters in length can quickly be treated. Indeed for these bridges, the 5 or 6 axles of the 44 or 48 tonnes vehicles cannot be present at the same time on the bridge. As a result, and if we consider that the limits of axle loads are not modified, these vehicles are not more aggressive than currently authorized vehicles for the general effects. The TRL study[47] shares this conclusion for bridges less than 10 meters.

For longer bridges, and insofar as the length of the vehicle is not modified, we can consider that an increase in gross weight of X % results in an increase in the stresses due to the vehicle of X %.
For the principal beams:

- A vehicle of 44 tonnes is thus 10% more aggressive than a vehicle of 40 tonnes of the same length.
- A vehicle of 48 tonnes is thus 20% more aggressive than a vehicle of 40 tonnes of the same length.

If we consider moreover that the traffic loads represent to the more 50% of the total loads supported by a bridge, then the increase in the resulting stresses remains lower than 5% for one 44 tonnes and 10% for

[47] TRL June 2008 - LHVs - a Study of Likely Effects if permitted in the UK: Final Report, page 198.

one 48 tonnes. It is also advisable to note that the circulation of vehicles of 44 tonnes is already authorized by directive 96/53/EC for the transport of ISO container of 40 feet for combined transport.

The case of the 44 tonnes
An increase of aggressiveness lower than 5 % remains moderate and in general acceptable. However a generalization of the authorization must be carried out with prudence. Indeed, these considerations are valid only for the relatively recent bridges (less than 50 years old), which constitute the main part of the European stock. Certain older bridges, in particular out of the main network, can need specific analysis, for example the bridges already presenting structural insufficiencies and the "brittle" bridges. If this configuration is authorized, a period of preliminary analysis will have thus to be left to the various owners in order to identify the bridges with problem (pathological bridges, brittle bridges, old bridges, etc) and to take appropriate measures (limitations of tonnage, repair, strengthening, etc). It is also advisable to note that the majority of these bridges support already overloaded vehicles exceeding 44 tonnes. However, we do not have elements to appreciate the overloading that would be practiced compared to a limit with 44 or with 48 tonnes.

The case of the 48 tonnes
For the 48 tonnes, the increase in aggressiveness is definitely more appreciable and appears too brutal so that a general measure can be considered without important preliminary studies. Dutch studies[48] realized for a truck of 16.50 meters and 50 tonnes gives results favourable compared to the Dutch design codes *but can not be generalised to other countries.* We are not informed of another study on this subject. For the 48 tonnes in particular a study on the subject appears necessary before being able to consider an authorization.

b. Long existing bridges

To replace the 40 tonnes vehicle by 44 tonnes vehicle increases the load supported by the bridges. However in a first approximation, and in a very simplified way, let us consider a long span of which 50% of the traffic load is due to vehicles of 40 tonnes. If we consider that all these vehicles are replaced by 44 tonnes with the same lengths then the increase in the traffic load is 5%. Considering the weight of the structure it is noted that the increase in aggressiveness remains weak.

1.4.3. Vehicles longer and/or heavier than the current vehicles

a. Short existing bridges

For spans up to 20 meters, the 25.25 meters long vehicles are not entirely on the bridge, and as a result they are less aggressive. Ongoing French studies comparing the aggressiveness of a LHV with the aggressiveness of configurations currently authorized (40 tonnes on 15.50 m, 4-axle vehicles of 32 tonnes with 2 steering axles) for one-span bridges with lengths varying between 10 m and 50 m show an increase in aggressiveness reaching to the maximum 15 % for the 60 tonnes, which is of the same order of magnitude as the increase in aggressiveness due to the vehicle of 44 tonnes and 16.50m.

In the absence of restrictive countermeasures, the conclusions obtained for the 44 tonnes in paragraph the paragraph above are thus also valid. For the 50 tonnes, there is no increase in aggressiveness. If we consider moreover effective countermeasures to avoid overloaded vehicles, then we can consider that the aggressiveness of a vehicle of 60 tonnes is appreciably reduced and close to the aggressiveness of an over-

[48] TNO of April 7, 2008 and Oranjewoud of August 2007.

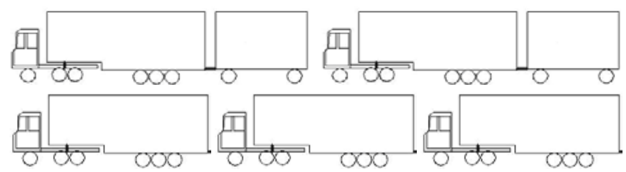
loaded vehicle of 40 tonnes. The TNO study concludes that for medium span bridges, the vehicle of 60 tonnes and 25.25m long has almost the same aggressiveness as the vehicle of 50 tonnes and 16.50m long provided the load is sufficiently distributed. This results in a minimal wheelbase equal to 18 meters, and the circulation of the 60 tonnes checking this condition is considered acceptable in The Netherlands.

Insofar as the Dutch bridges are ready to support the 16.50 meters long trucks of 50 tonnes, it is normal that the condition retained for an extrapolation with the other European countries, 20 meters, is more restrictive than that the condition retained in The Netherlands, 18 meters.

b. Medium existing bridges

It is the most discussed topic of the European studies on LHV. The approaches adopted in these studies are very varied, some considering some bridges considered to be representative, others carrying out parameterized studies. In addition, some of these studies are based on measurements of traffic and others on "deterministic" vehicles. *The majority of these studies refer to the national regulations however, which prevents any generalization of their results to the other European countries.*

In first approach if we consider an accidental situation of jam, the linear densities of load of vehicles of 60 tonnes or vehicles of 40 tonnes are very close.



If we consider an average length of 15.50 m for the 40 tonnes (maximum authorized 16.50 m for the semi trailers) and a spacing of 2 m between bumpers the longitudinal density is:
60/(25.25 + 2) = 2.20 T/ml for the "60 tonnes"
40/(15.5 + 2) = 2.28 T/ml for the "40 tonnes"

It should be noted that this situation is in general not considered by the design codes in particular on the medium and large spans and that thus the bridges are not all ready to support it.

Ongoing French studies show that in the case of frequent situation of traffic, the trucks are alone and aggressiveness on a support of one LHV of 60 tonnes for a bridge with two identical spans with lengths varying between 10 and 50 m is with more about 40% higher than aggressiveness of one 40 tonnes. It is with more about 20% for the 50 tonnes. This simplified approach confirms the conclusion of the German study, namely the sensitivity of the bending moment about support for the configurations of 60 tonnes and 25.25m. *The simplifications carried out suppose comparable overloading for the 40 tonnes and the 60 tonnes; the conclusions thus do not apply more in the event of effective measures making it possible to limit the load of the 60 tonnes. In the same way, a minimal spacing between LHV would make it possible to reduce this aggressiveness appreciably.*

An Irish study[49] relates to the bridges of small and medium spans. It was carried out on the basis of measurements of traffic carried out in The Netherlands on a road supporting an extremely heavy traffic and in particular special permit trucks such as cranes or low-loaders (a 165 tonnes vehicle was observed).
This study, carried out for a one-span bridge of 35 m and for a bridge with 2 identical spans of 35 meters, concludes that the dominant loads for the determination of the characteristic effects are the cranes and the other very heavy special vehicles and that this result will be influenced little by modifications made to the

[49] O' Brien and al - Implication of Future Heavier Trucks for Europe' S Bridges - TRA Ljubljana 2008

configurations of the heavy vehicles most current. *However, this study carried out for bridges supposed to support an extremely heavy traffic, cannot be generalized with all the bridges.*

The BASt 2007 study relates to 2 configurations of vehicles, a LHV of 60 tonnes and 25.25 m long, a LHV of 58 tonnes and 25.25 m long. The study was carried out for bridges of medium and large spans (single spans from 10 to 50 meters and 2 continuous spans from 10 to 80 meters). A flow of traffic comprising a share of heavy vehicles with 20% or 40% of LHV was generated on the basis of measurement of traffic taken on the German highway A61. Values characteristic of stresses were extrapolated and compared with the effects of the loads of the loading rules. This study analyzes the bridges according to the German regulations used at the time of the design and concludes that some of them would require a strengthening preliminary to the circulation of LHV. It should be noted that according to this study a share of these bridges requires strengthening even in the absence of LHV. The study also shows an increase from stresses due to the LHV compared to the current traffic in particular on support.
Two assumptions have to be underlined in order to specify the field of validity of these conclusions. The regulations used in the comparisons are the German regulations what do not make it possible to generalize the conclusions with the other European countries. The study was undertaken by considering an average weight of 60 tonnes (equal to the authorized maximum loading) and an important standard deviation.

Two Dutch studies[50] compare for medium span bridges (single span of 25 meters or 3 continuous spans of 30 m) aggressiveness of the semi trailer of 50 tonnes and 16.50 m long with 5 axles allowed in The Netherlands and a 60 tonnes and 25.25 m long LHV. The comparison with the loads of the Dutch loading rules is also carried out. These studies conclude that for medium span bridges, the vehicle of 60 tonnes has almost the same aggressiveness as the vehicle of 50 tonnes and 16.50 m provided the load is sufficiently distributed. This results in a wheelbase at least equal to 18 meters, and the circulation of the 60 tonnes checking this condition is considered acceptable in The Netherlands. *For possible future configurations with a lower wheelbase than 18 meters report suggests compensating by a reduction in the gross weight. These conclusions are based on the comparison with the loads of the Dutch loading rules and on the comparison with the semi trailer of 50 tonnes already authorized in The Netherlands and are thus not directly able to be extrapolated with the other European countries. However if we consider that the 50 tonnes of 16.50 m and the 60 tonnes of 25.25 m have the same aggressiveness, we can carry out easily by preserving the same length to determine the weight of a vehicle of 25.25 m which would have same aggressiveness as a vehicle of 40 tonnes with 5 axles, that is to say 60 x 40/50 = 48 tonnes.*

The TRL study[51] considers several configurations of LHV of 44 T, 60 T and 82 tonnes. The study is undertaken for one-span bridges with length varying from 5 to 100 meters. Only one lane is considered. An overloading factor of 1.4 for the spans between 5 and 10 meters then varying linearly from 1.4 to 1 between 10 and 60 meters is taken into account, and the axle most charged is affected of a dynamic factor equal to 1.8. The effect of the LHV alone on its lane is compared with the effect of the loads of the English loading rules. According to this study the 82 tonnes would pose problems on 25% of the bridges of the principal network, among oldest. For 60 tonnes the report considers that the limitations and strengthening would be appreciably lighter. Lastly, the report indicates that it is not very probable that a configuration to 50 tonnes and 25.25 m would have an unfavourable impact. *These conclusions are based on the comparison with the loads of the English loading rules and are thus not directly able to be extrapolated with the other European countries, more especially as the 44 tonnes of 16.50 m is already authorized in England.*

In conclusion, it appears that the configuration with 60 tonnes without countermeasures appears aggressive mainly for the bending moment on support of the medium span bridges. Countermeasures compris-

[50] TNO of April 7, 2008 and Oranjewoud of August 2007
[51] TRL June 2008 – LHVs – a Study of Likely Effects if permitted in the UK: Final Report.

ing the control of the gross weight by effective measures and the obligation of a minimal spacing between 2 vehicles of 60 tonnes would make it possible to reduce this aggressiveness very appreciably.

c. Long existing bridges

To consider the aggressiveness of a vehicle alone is a relevant approach for the short span bridges, for the longer spans, it is appropriate to reason no more with LHV alone but with LHV in the traffic, i.e. considering the LHV inserted in their environment of vehicles. Indeed, the LHV present on a bridge are not simultaneously all filled with their maximum authorized weight. Reciprocally, it should be noted that some could exceed these limits.

The road traffic measured on the A6 highway in France was applied to a lane of a 162 meters length real simple supported span. This traffic was modified beforehand in the following way: removal of the light vehicles, creation of a jam situation (heavy vehicles brought closer with a distance 5 meters between the last axle a vehicle and the first axle the following vehicle), and a random replacement of part of the vehicles with 5 axles by LHV (30% of the 5-axle vehicles with of total weights ranging between 30 and 50 tonnes, which accounts for 20% of the 5-axle vehicles).
The study on the span of 162 m was undertaken for 2 types of LHV of 25.25 m, 50 tonnes and 60 tonnes. In both cases, it was considered that these values correspond to the average value (and not maximum) of the LHV present on the span, which makes it possible to take into account in a simplified way a distribution around the authorized maximum loading thus including overloading. The measured and generated values even include a light dynamic increase due to measurement. For the bending moment at mid-span, the aggressiveness for the situations of jams with LHV and for the situations of jams without LHV are comparable.

The BASt 2007 study relates to 2 configurations of vehicles, a LHV of 60 tonnes and 25.25 m long, a LHV of 58 tonnes and 25.25 m long. The study was carried out for bridges of medium and large spans (single spans from 10 to 50 meters and 2 continuous spans from 10 to 80 meters). This study analyzes the bridges according to the German regulation used at the time of the design and concludes that some of them would require a strengthening preliminary to the circulation of LHV. It should be noted that according to this study some of these bridges requires strengthening even in the absence of LHV. The study also shows an increase from stresses due to the LHV compared to the current traffic in particular on support. *Two assumptions have to be underlined in order to specify the field of validity of the conclusions. The regulations used in the comparisons are the German regulations, which does not make it possible to generalize the conclusions with the other European countries. The study was undertaken by considering an average weight of 60 tonnes and an important standard deviation.*

The TNO study approaches also the case of the great bridges. By considering a large span charged with a distributed load with 1.6 T/ml in the middle of which one put either one 50 tonnes of 16.50 m or one 60 tonnes of 25.25 m, TNO observes that the differences in bending moments obtained according to 2 assumptions are very weak.

For the large spans the increase in aggressiveness due to the taking into account of the LHV thus appears less important than for the medium span.

1.5. General effects – fatigue

1.5.1. General points

To estimate the effects of new configurations of vehicles, it is necessary to take into account the bridges lengths and the vehicles lengths.

1.5.2. Vehicles of the same length as current vehicles but heavier

a. Short and medium existing bridges

The increase in the aggressiveness of very current heavy vehicles can cause or worsen the phenomenon of fatigue for certain steel bridges. See on this subject the paragraph hereafter. The conclusions of the simplified study which is developed there are also valid for these vehicles of 44 and 48 tonnes. No study on the subject was brought to our attention. Such a study would be very interesting to appreciate the reduction in the lifespan of these bridges in the absence of preventive measures and the cost of these measures. For the vehicle of 48 tonnes in particular a study on the subject appears necessary before being able to consider an authorization.

In the absence of studies on the subject, we regard the evolution of aggressiveness due to the taking into account of the 44 tonnes as moderate and the evolution of aggressiveness due to the taking into account of the 48 tonnes as important. A study on the aggressiveness of the 48 tonnes with respect to fatigue appears necessary.

b. Large existing bridges

The conclusions of the paragraph before still apply, but the bridges become less sensitive to this phenomenon with the increase in the span length.

1.5.3. Vehicles longer and/or heavier than the current vehicles

a. Short existing bridges

See on this subject the paragraph hereafter. The conclusions of the simplified study that is developed in this paragraph are also valid for these bridges. In the absence of studies on the subject, we regard the evolution of aggressiveness due to the taking into account of the 60 tonnes as moderate and the evolution of aggressiveness due to the taking into account of the 50 tonnes as negligible.

A study on the aggressiveness of the 60 tonnes with respect to fatigue appears necessary. All in all, the loads increase will result in an increase in the maintenance costs, whose amount will remain moderate, subject carrying out certain work of preventive strengthening. It will be advisable in particular to reinforce the steel bridges most sensitive to avoid premature fatigue cracks. To clarify this opinion, we will indicate that the number of bridges potentially concerned must represent less than 2% of the bridges of the national road network in France.

The TNO study more generally tackles the problem of the fatigue of the steel bridges. Estimating that the 60 tonnes would represent 2 000 vehicles against 80 000 semi trailers, it regards as marginal the phenomenon of fatigue. *However this conclusion relates to a country which authorizes already the 50 tonnes on 16.50m, and the proportion of 60 tonnes in the other countries would be probably definitely more important.*

If we consider moreover of the effective countermeasures to avoid overloaded vehicles, then we can consider that the evolution of the aggressiveness of the traffic due to the 60 tonnes is negligible or moderate.

b. Medium existing bridges

In the absence of a detailed study, a simplified approach makes it possible to define orders of magnitude that show that in the absence of specific measures the lifespan of a steel bridge subjected to a strong traffic of trucks of 60 tonnes can be appreciably reduced.

Let us consider a distributed load p, applied over a length L, at mid-span on a simple supported span length L. The bending moment at mid-span is M = pl/4 x (L - L/2)
40 tonne truck: length loaded l_{40} = 16 m and p = 2.5 tonne/ml
60 tonne truck: length loaded l_{60} = 24 m and p = 2.5 tonne ml unchanged
M_{60}/ M_{40} = 1.5 x (L-12) / (L-8) from where for simple supported spans varying from 30 to 60 meters:

L (m)	30	40	50	60
M_{60}/ M_{40}	1.23	1.31	1.36	1.38

It is the effect of the passage of a truck alone on the bridge that determines the fatigue life. Calculation above shows that this effect will increase significantly if the traffic of the vehicles of 60 tonne is generalized. The assumption is made that the average effect will increase half of the value computed above i.e. 10 to 20 %.

If we consider that the bridge is optimized with fatigue with respect to the current trucks and that the damage is proportional to the power fifth of the stress, then:
- An increase in the average effect of 10% results in an increase of 1.15 = 1.6 of the average damage, i.e. a reduction of the total lifespan equal to 40%
- An increase in the average effect of 20% results in an increase of 1.25 = 2.5 of the average damage, i.e. a reduction of the total lifespan equal to 60%

However it should be noted that the steel and steel-concrete composite bridges are not all concerned. Those for which fatigue was not dimensioning at the time of the design have a reserve of resistance with respect to this aspect. It is in particular the case of the very great spans. In the same way are not concerned those which are not subjected to a very important heavy truck traffic (majority of the bridges out of the main network).

A study on the aggressiveness of the 60 tonnes with respect to fatigue appears very necessary. All in all, the increase in the loads will result in an increase in the maintenance costs, whose amount will remain moderate subject carrying out certain work of preventive strengthening. It will be advisable in particular to reinforce the steel bridges most sensitive to avoid premature fatigue cracks. Solutions exist to improve the behaviour with fatigue of the welded joints (shot-blasting) and they will have undoubtedly to be considered on the much circulated bridges. To clarify this opinion, we will indicate that the number of bridges potentially concerned must represent less than 2% of the bridges of the national road network in France.

c. Large existing bridges

The conclusions of article 5.3.2 still apply but the bridges become less sensitive to this phenomenon with the increase in the span length.

1.6. Future bridges

Contrary to the existing bridges that were designed according to very varied regulations, the bridges that will be built in the future will be designed according to a single European code, the Eurocodes. The theoretical traffic loads of this code were calibrated on the basis of measurements of traffic carried out on the principal European highway networks in the Eighties. It will result a better homogeneity of the designs in the European countries. The homogeneity will however not be total because the values of the theoretical traffic loads defined in Eurocode can be balanced in the national appendices corresponding.

The question that arises then is to know if the theoretical traffic loads of this code are sufficient to authorize LHV. The answer cannot be general because of the variations that can appear in the coefficients of the national appendices.

Taking into account the noted and foreseeable evolutions of traffic, international reflections are in progress on the relevance of a new calibration of these theoretical traffic loads with respect to the extreme loads and with respect to the fatigue. Possibly by recalibrating the current coefficients, it is thus possible to design bridges able to support the LHV. With regard to the extreme loads, the French studies carried out during the development of the French national appendix of Eurocode 1 showed that the theoretical class 1 loads cover the vehicles of 44 tonnes (the French national appendix of traffic has 2 classes). With regard to fatigue, studies on the subject are necessary.

1.7. Cost of monitoring, maintenance and strengthening

1.7.1. General points

The increase in the cost of monitoring and maintenance, even the need for preliminary strengthening strongly depends from:

- Nature of the authorizations (tonnages, minimal lengths, number of axles, limitations on the weights by groups of axles according to configurations, etc.).
- Routes considered (defined routes, all the territory).
- Possible countermeasures (larger spacing, prohibition to overtake, on-board load measuring systems, etc.).
- National specificities (loading rules used at the time of the design, state of the bridges stock, strengthening works already completed, etc.).

For the configurations more aggressive than the currently authorized configurations only national studies taking into account local specificities can thus answer the question.

On the other hand, for the configurations that are not more aggressive, we can consider that the increase in the costs of monitoring and maintenance would be weak even null. The TRL study[52] indicates "It has

[52] TRL - June 2008.

not been possible to accurately monetize the effect of LHVs on bridges and so this will be considered as a risk factor in terms of the final analysis of costs and benefits".

1.7.2. Vehicles of the same length as current vehicles but heavier

For these vehicles, overall, the increase in the loads will result in an increase in the maintenance costs, whose amount will remain moderate in the case of the 44 tonnes subject carrying out certain work of preventive strengthening.

It will be advisable in particular to strengthen the most sensitive steel bridges to avoid premature fatigue cracks. To clarify this opinion, we will indicate that the number of bridges potentially concerned in France must represent less than 2% of the bridges of the national road network.

On the 44 tonnes, there is only one study: the French study of 2005 on the "orthotropic plates". For the 48 tonnes no study was brought to our attention. National studies are necessary to estimate the impact in term of cost.

1.7.3. Vehicles longer and/or heavier than the current vehicles

For the 60 tonnes LHV overall, the increase in the loads will result in an increase in the maintenance costs, whose amount will remain moderate subject carrying out certain work of preventive strengthening. These costs will be strongly reduced if countermeasures are taken (with effective measures to limit the overloading, spacing between 2 vehicles of 60 tonnes, prohibition to overtake, on-board load measuring systems, etc.).

It will be advisable in particular to strengthen the most sensitive steel bridges to avoid premature fatigue cracks. To clarify this opinion, we will indicate that the number of bridges potentially concerned in France must represent less than 2% of the bridges of the national road network.

In Sweden in the 1990's many bridges were already strengthened to authorize the LHV of first 56 tonnes, then 60 tonnes. Currently 90 % of the roadway systems and 94 % of the Swedish national network are accessible to the 60 tonnes LHV. This required a monitoring, a strengthening and an adaptation of roads and bridges.

The Bast 2007study estimates at 4 to 8 billion € the requirements in strengthening to authorize the 60 tonnes on the bridges of the German freeways for which it is advisable to add 3 billion € for the bridges on highways. However, this study that was undertaken by considering the German loading rules used when designing the bridges cannot be extrapolated with the other countries. In addition it does not take into account the costs pulled by the fatigue of the steel bridges. In the same way, this study does not take into account the impact of countermeasures. For example, the standard deviation retained on the gross weight could be appreciably reduced if adapted measures are imposed to control this one.

The TNO study[53] considers that insofar as the configurations with 60 tonnes are not more aggressive than the configurations with 50 tonnes already authorized, there is no reduction in the lifespan of the bridges to fear. However, this study cannot be extrapolated with the other countries.

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[53] TNO of April 7, 2008

For the 50 tonnes LHV, the impact in term of cost of monitoring of maintenance and strengthening is weak with the configurations considered.

1.8. Safety barriers

For a speed and an angle of incidence given, the aptitude of a restrain system to retain a vehicle strongly depends on the mass of this one. There are thus interrogations on the capacity of the current barriers to retain the LHV. Studies, even of tests could be necessary to appreciate the increase in the level of risks. In addition, on the bridges to be built, the characteristics of the devices to be implemented as well in term of barrier as in term of anchoring on the structure to take account of a possible circulation of the LHV would be to examine.

2. Pavements

For pavements, the Alizé software has been used. This software models the road and determines the stresses due to loaded axles of different vehicle shapes.

2.1. Methodology

Using the work done by COST333 and COST 323[54], four kinds of road structures, which are representative of the European roads, are selected:

- Flexible pavement, intended to support a weak traffic (5 million of 8 t standard axles)
- Bituminous pavement, conceived to support a moderate traffic (10 million of 8 t standard axles)
- Bituminous pavement, conceived to support heavy traffic (100 million of 8 t standard axles)
- Semi-flexible pavement, conceived to support heavy traffic (100 million of 8 t standard axles)

Table 37: Physical characterization of pavements

Traffic intensity	Weak	Moderate	Heavy	Heavy
Asphalt thickness (mm)	100	200	330	280
Asphalt Young's modulus (MPa)	7 500			
Asphalt Poisson's ratio	0.4			
Granular layer thickness (mm)	300	250	200	-
Young's modulus of granular material (MPa)	200			
Granular layer Poisson's ratio	0.3			
Cement bound base layer thickness (mm)	-			200
Cement bound base Young's modulus (MPa)				10 000
Cement bound base Poisson's ratio				0.2
Subbase Young's modulus (MPa)	70			
Subbase Poisson's ratio	0.3			

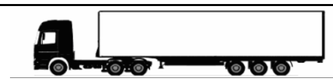
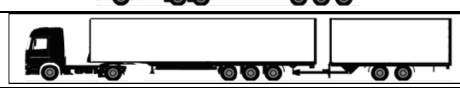
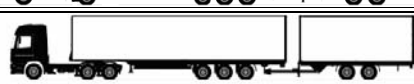
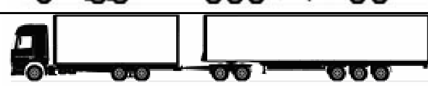
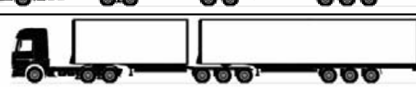
[54] COST – European Cooperation in the field of Scientific and Technical Research – is a European instruments supporting cooperation among scientists and researchers across Europe and is the first and widest European intergovernmental network for coordination of nationally funded research activities. COST 323 was aimed at defining pan-European requirements for weighing vehicles while in motion, and for the development of associated systems. COST 333 aimed at developing a coherent, harmonised and cost-effective European road pavement design method, which was to open new possibilities for industry to collaborate in the field of pavement design and construction.

2.2. Heavy goods vehicles considered

Data on tyres prints (contact area between tyre and pavement) are needed to calculate the stresses into the pavement structure. Once again, COST results are used, assuming that the driving axle and the axles with twin tyres use 315/80 tyres while single non-driving axle use 385/65 large tyres.
To be coherent with the work done on bridges, the same vehicle shapes as before are used (cf. table below).

NOTE: afterwards, vehicle combinations are named after their shape and their maximum allowed mass. The first letters refer to the shape, while the number refers to the maximum allowed mass. Hence, A40 represents a vehicle formed of a tractor and a semi-trailer, with a GVW *(gross vehicle weight)* of 40 tonnes. This shape is used as the reference shape for the aggressiveness' calculations.

Table 38: Classification of vehicle combinations

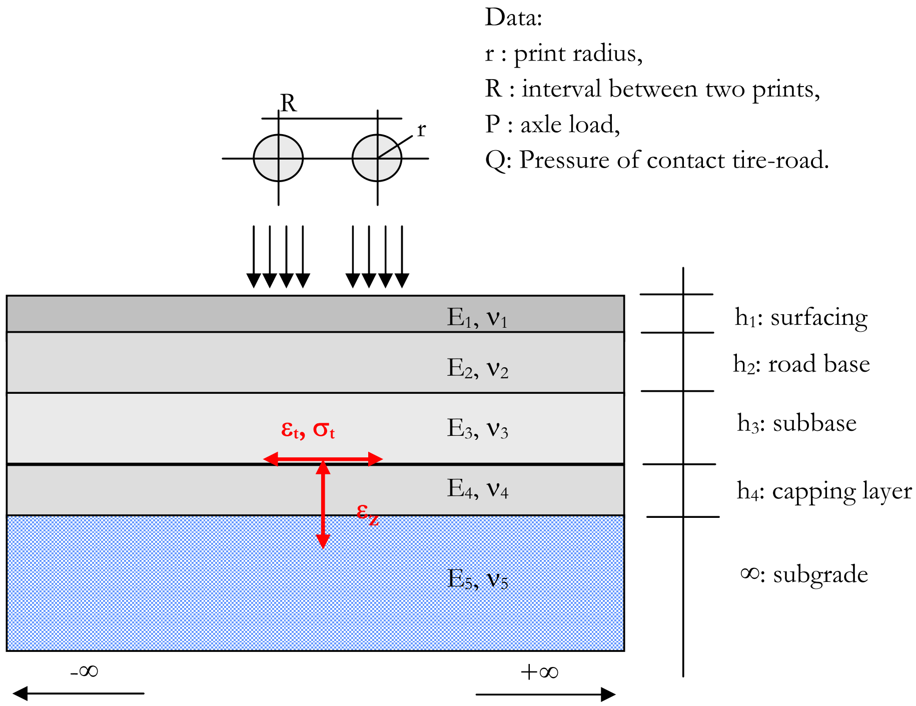
Internal code	Shape
A40	
A44	
B44	
C40	
C44	
C48	
D46	
E50	
F50	
G50	
E60	
F60	
G60	

2.3. Methodology for the aggressiveness' calculation

The Alizé software determines the stresses produced by traffic on each layer of the road. It uses the Burmister's theoretical model. Road structure is supposed to be made of overlapping layers with constant thickness, and to have an elastic, linear and isotropic behaviour.

Figure 26: Description of the pavement structure

With:



- E_i : Young's modulus of layer "i";
- ν_i : Poisson's ratio of layer "i";
- h_i : thickness of layer "i";
- ε_t : Transverse strain on the base of the layer of connected materials;
- σ_t : Transverse stress on the base of the layer of connected materials;
- ε_z : Vertical strain at the top of the layer of unbound materials and/or of the subgrade.

The aggressiveness A_i of an axle "i" towards a specific layer is calculated as follows $A_i = \left(\frac{s_i}{s_{réf}}\right)^{\alpha}$

where:

s_i : stress on the base of the layer, under the axle "i" considered, due to all the simulated axles;

$s_{réf}$: stress on the base of the layer due to the reference axle;

a : Coefficient of fatigue depending on the material of the layer

Once calculated the aggressiveness of each axle, they are all added to obtain aggressiveness of the vehicle.

$$A_{vehicle} = \sum_i A_i$$

2.4. Calculations

Calculations were done assuming full compliance of maximum axle loads to directive 96/53/CE (but for A44):

- Driving axle 11.5 t
- Single non-driving axle 10.0 t
- Tandem axles of motor vehicle 19.0 t
- Tandem axles of trailer or semi trailer 18.0 t
- Tri-axles of trailer or semi trailer 24.0 t
- The weight borne by the driving axle or driving axles of a vehicle or vehicle combination must not be less than 25 % of the total laden weight of the vehicle or vehicle combination.

As a result of the last indent, a vehicle can not have a single driving axle when total allowed mass is mayor than 46 t. A44 is an exception because if limits are respected for the tri-axles (24 t) and driving axle (11.5 t), then they are 8.5 t left for the first axle, and manufacturers limit its load to 8 t.

Calculations show that the way a vehicle is loaded has a very important effect on its aggressiveness towards the pavement. When the loading is done as to minimise the aggressiveness, the vehicle is said to be ideally loaded. The table below compares the aggressiveness of each combination with a reference one: A40 ideally loaded. Columns "best" refer to ideally loaded combinations while columns "worst" refer to the most aggressive way one can load a vehicle complying with regulation.

Table 39: Comparison of each combinations aggressiveness with a reference aggressiveness (A40)

	Flexible pavement		Bituminous pavement		Thick bituminous		Semi-flexible pavement	
Code	Best	Worst	Best	Worst	Best	Worst	Best	Worst
A40	***1***	***1,07***	***1***	***1,18***	***1***	***1,23***	***1***	***2,43***
A44	1,53	1,63	1,59	1,67	1,53	1,68	2,85	4,28
B44	1,54	1,57	1,6	1,61	1,36	1,4	2,44	2,83
C40	0,62	0,99	0,56	1,07	0,57	1,08	0,31	2,33
C44	1,03	1,27	0,89	1,23	0,86	1,21	1,6	2,37
C48	1,37	1,51	1,25	1,42	1,21	1,48	2,04	3,15
D46	0,84	1,22	0,69	1,2	0,65	1,22	0,51	1,88
E50	0,67	1,04	0,67	0,86	0,59	0,72	0,2	0,47
F50	0,6	0,83	0,63	0,8	0,58	0,71	0,2	0,43
G50	0,42	0,79	0,37	0,79	0,35	0,71	0,04	0,43
E60	1,51	2,03	1,39	1,86	1,33	1,66	2,05	3,56
F60	1,38	1,69	1,59	1,74	1,49	1,6	2,47	3,17

The same calculations, related to a tonne of transported goods, are presented in the following table:

Table 40: Comparison of each combination's aggressiveness with a reference aggressiveness (A40's), when related to a tonne of transported goods

		Flexible pavement		Bituminous pavement		Thick bituminous pavement		Semi-flexible pavement	
Code	**Average load (t)**	min.	max.	min.	max.	min.	max.	min.	max.
A40	25	1.00	1.10	1.00	1.13	1.00	1.24	1.00	2.47
A44	29	1.33	1.42	1.39	1.46	1.43	1.57	3.18	4.77
B44	30	1.30	1.32	1.34	1.36	1.22	1.27	2.63	3.05
C40	24	0.64	1.17	0.55	0.97	0.53	1.03	0.20	2.10
C44	28	0.84	1.15	0.74	1.11	0.74	1.17	0.57	2.74
C48	32	1.08	1.19	0.99	1.13	1.02	1.25	1.68	3.18
D46	27	0.79	1.14	0.65	1.12	0.65	1.22	0.61	2.25

		Flexible pavement		Bituminous pavement		Thick bituminous pavement		Semi-flexible pavement	
Code	**Average load (t)**	min.	max.	min.	max.	min.	max.	min.	max.
E50	30	0.57	0.87	0.57	0.72	0.53	0.65	0.22	0.50
F50	30	0.50	0.70	0.53	0.67	0.52	0.64	0.22	0.46
G50	29	0.37	0.68	0.32	0.69	0.33	0.66	0.04	0.48
E60	40	0.90	1.28	0.88	1.20	0.85	1.19	0.79	2.88
F60	40	0.80	1.07	0.81	1.26	0.77	1.29	0.59	3.07
G60	39	0.56	0.97	0.59	1.02	0.59	1.08	0.39	2.63

It is also possible to compute the ideal load repartition per axle. It depends of the considered pavement, hence the four tables below. In theses tables, "e 1" stands for first axle, "e 2" for second group of axles and so on.

Table 41: Ideal load repartition per axle for each type of pavement – Flexible pavement

Code	e 1	e 2	e 3	e 4
A40	7.5	10	22.5	-
A44	8.5	11.5	24	-
B44	8	18	18	-
C40	7	14	19	-
C44	7.5	15	21.5	-
C48	8	17	23	-
D46	6	11.5	16	12.5
E50	7	15	22	16
F50	6	16	15	23
G50	6	12.5	15.5	16
E60	7	15	22	16
F60	7	17	14	22
G60	6	15	20	19

Table 42: Ideal load repartition per axle for each type of pavement – Bituminous pavement

Code	e 1	e 2	e 3	e 4
A40	8	11	21	-
A44	8.5	11.5	24	-
B44	7.5	18.5	18	-
C40	7	15	18	-
C44	7.5	17	19.5	-
C48	8	18.5	21.5	-
D46	6	11.5	16	12.5
E50	6	12.5	17	14.5
F50	6	12.5	11.5	20
G50	6	12.5	15.5	16
E60	7	17	20	16
F60	7	17	14	22
G60	7	16	18	19

Table 43: Ideal load repartition per axle for each type of pavement – Thick bituminous pavement

Code	e 1	e 2	e 3	e 4
A40	8	11	21	-
A44	8.5	11.5	24	-
B44	8	18	18	-
C40	7.5	15	17.5	-

Code	e 1	e 2	e 3	e 4
C44	8	17	19	-
C48	8	18.5	21.5	-
D46	6	11.5	16	12.5
E50	6	12.5	17	14.5
F50	6	12.5	14.5	17
G50	6	12.5	15.5	16
E60	8	17	19	16
F60	8	18	14	20
G60	8	16	18	18

Table 44: Ideal load repartition per axle for each type of pavement – Semi-flexible pavement

Code	e 1	e 2	e 3	e 4
A40	8	11	21	-
A44	8.5	11.5	24	-
B44	8	18	18	-
C40	8	14	18	-
C44	8	16	20	-
C48	8	18	22	-
D46	6	11.5	16	12.5
E50	8	12.5	15	14.5
F50	6	12.5	14.5	17
G50	6	12.5	15.5	16
E60	8	16	20	16
F60	8	17	15	20
G60	8	16	18	18

2.5. Sensitivity analysis

The following paragraph will present the method at work to compare the aggressiveness of the different combinations of vehicles.

Data regarding the load repartition of current A40s is not available. Nevertheless, a range of aggressiveness for current A40s can be specified: between the reference (1) and the maximum (or present worst) value calculated for A40. Two horizontal segments surround this area on the graphics below. It has then be decided to use the calculated median value (in yellow) for each combination to range them from least to most aggressive, showing at the same time the extreme values. Each kind of pavement has been considered separately. Combinations shown on the left of A40 on the graph below are less aggressive than the actual full loaded 5 axles 40 t. The most aggressive combination is shown on the extreme right side of the graph. The shape order with respect to aggressiveness would change if one decides to use the best or worst values as classification criterion.

Please note that the scales of the graphs are different.

Figure 27: Aggressiveness of each vehicle combination toward flexible pavements, supporting a low traffic

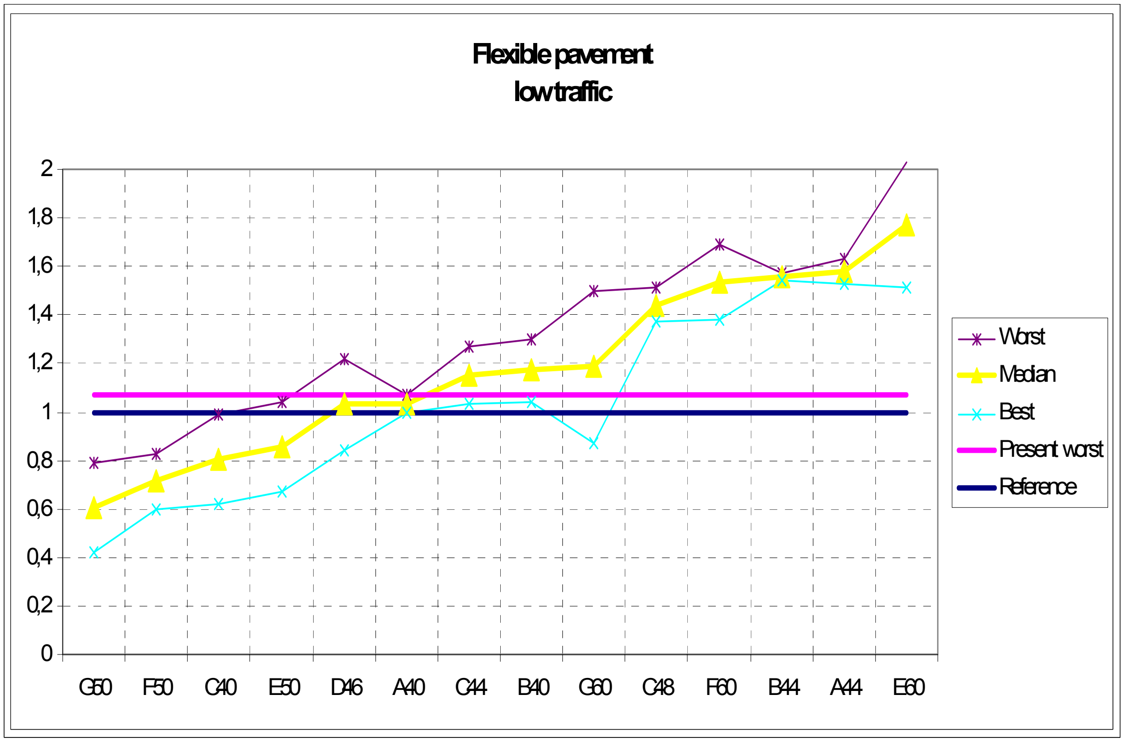


Figure 28: Aggressiveness of each vehicle combination toward bituminous pavements, supporting a moderate traffic

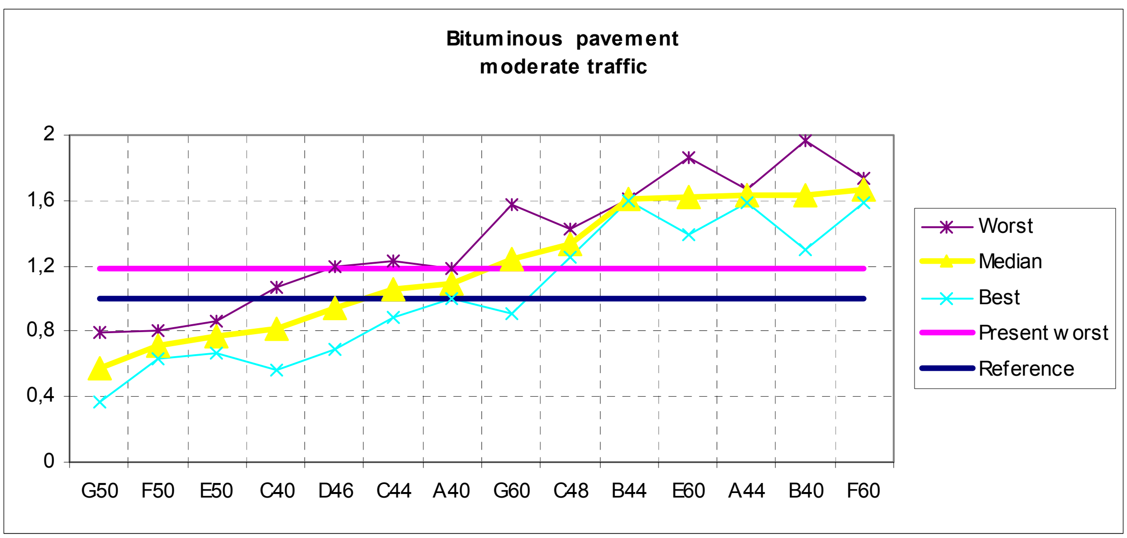


Figure 29: Aggressiveness of each vehicle combination toward bituminous pavements, supporting an heavy traffic

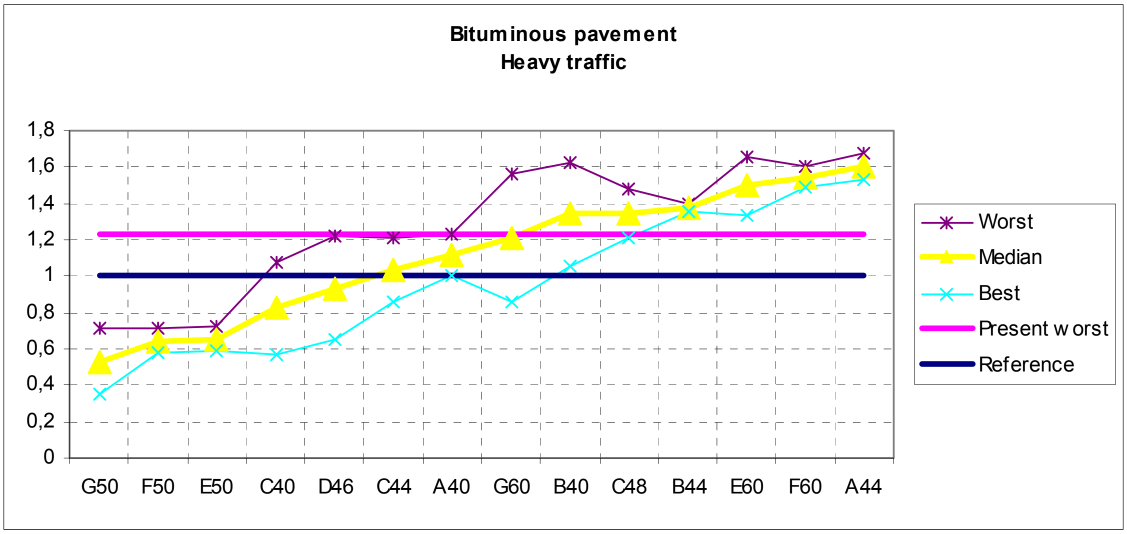
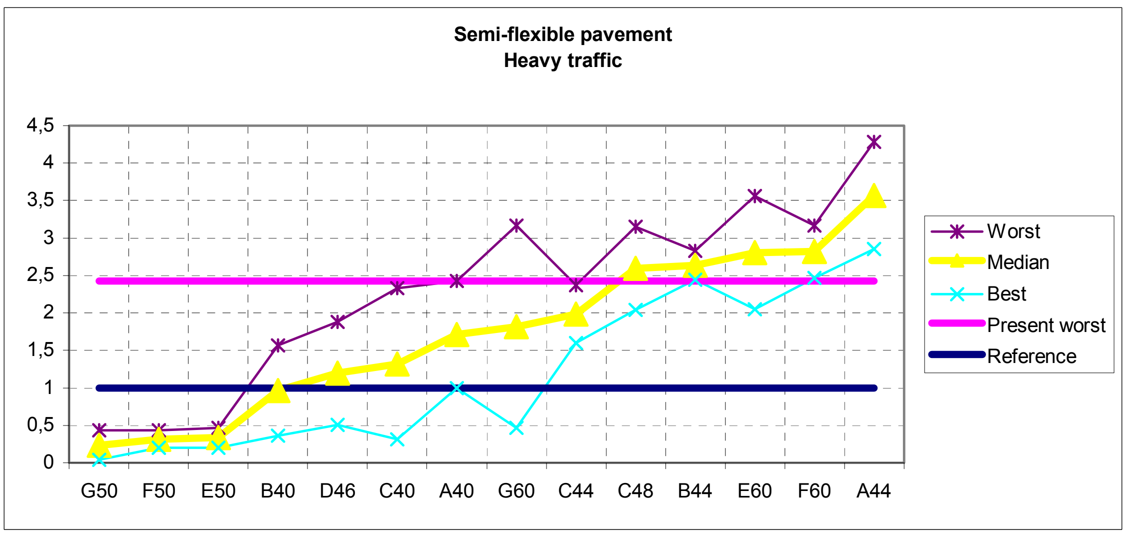


Figure 30: Aggressiveness of each vehicle combination toward semi-flexible pavements, supporting a heavy traffic



These graphs show that:

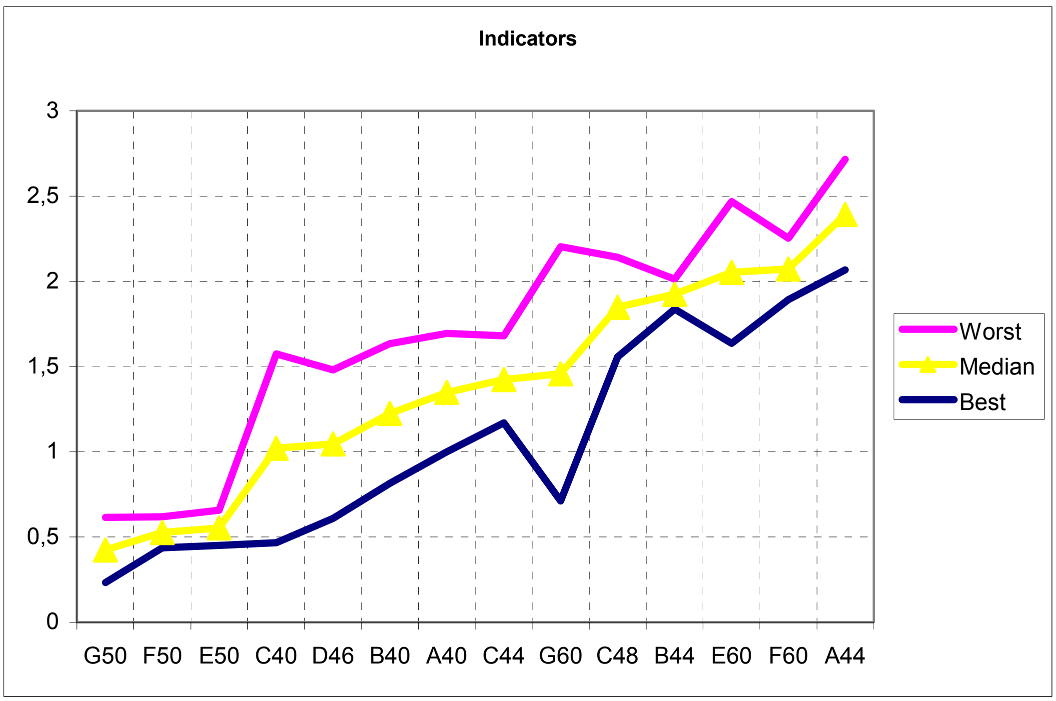
- Semi-flexible pavements with heavy traffic are the most sensitive to axles' load (with the highest calculated aggressiveness) and to load repartition (aggressiveness amplitude between best and worst cases).
- G50 and F50 are far better than the current situation, for all kind of pavements. They are followed by E50, C40, and D46.
- B40, which complies with current directive, is sometimes better and sometimes worse than A40, our reference.
- Aggressiveness of combination C44 is very close to the one of the reference truck (twice less, twice more).
- G60 seems as acceptable as C48, but it is probably because of the low value of its relative aggressiveness, when ideally loaded.
- For the two cases related to heavy traffic (thick bituminous and semi flexible), we find the same order: B44, E60, F60 and A44 (semi trailer, 44 t, five axles, which is also the second worst for the other two cases).
- Ranking is different for the low traffic and moderate traffic cases.

2.6. Indicators

It seems feasible to define a global aggressiveness indicator once we know the composition of the network where the LHVs are allowed.

Attention must be paid to the fact that using the median value does not enable to observe the large variation in aggressiveness values that depends upon the way vehicles are loaded (for example G60 versus C48). Some research should be done to have a more accurate knowledge on the existing load repartition. To compute the relevant indicators, a representative network is modelled, that is made up of 5 % of low traffic – flexible pavement, 15 % of moderate traffic – bituminous pavement and 40 % for each other kind of roads. Then, the aggressiveness due to the traffic of different kinds of combinations is calculated; depending on the manner vehicles are loaded. The three values given for each vehicle combination correspond to the load scenarios, that is to say: best-loaded, worse-loaded and a median load.

Figure 31: Aggressiveness of each vehicle combination toward a "representative" modelled pavement



It can be observed that:

- LHVs with a weight limit of 50 t are better for pavements than the reference (present semi-trailer 5 axles 40 t), their aggressiveness being approximately the half of the one of the reference.
- A semi-trailer 5 axles 44 t is the most aggressive vehicle (some 2.4 more aggressive than the reference).
- Two LHVs with a weight limit of 60 t are twice as aggressive as the reference while the third (shape G: three axles tractor, a little semi-trailer plus a big semi-trailer) is "only" 1.4 more aggressive than the reference, thus in the same range of the median value for A40 between the extreme load cases.
- In the case of G60, the ideal way of loading leads to an aggressiveness that is 30% lower than the reference one: it is very important to explain which is the ideal way of loading, even if it depends on the road structure. But the chapter dealing with bridges shows that "countermeasures" are essential.

Ideal loads

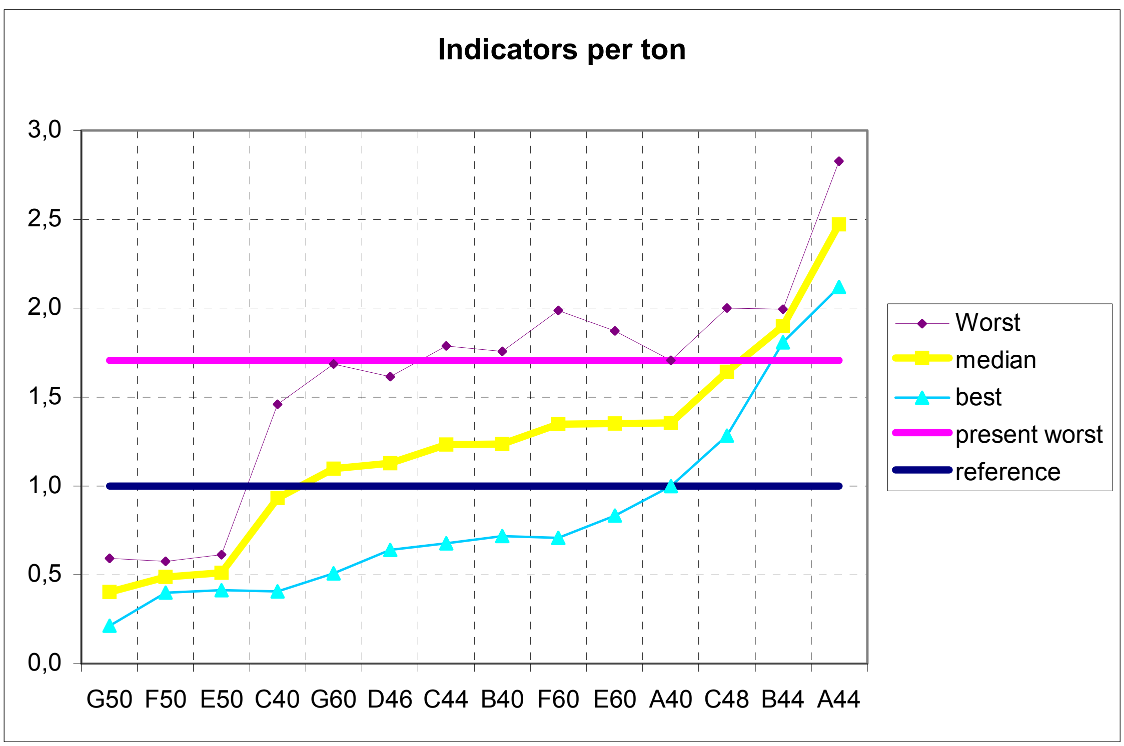
For the considered network (5% of low traffic – flexible pavement, 15% of moderate traffic - bituminous pavement and 40 % for each other kind of roads), and using an approximation to the nearest half tonne, it is interesting to calculate the axle load that would overall minimise the aggressiveness on pavements (knowing that the situation will be suboptimal for any kind of pavement in particular).

Table 45: Axle loads minimising the aggressiveness of each vehicle combination on a "representative" modelled pavement

Code	e 1	e 2	e 3	e 4
A40	8	11	21	-
A44	8.5	11.5	24	-
B44	8	18	18	-
C40	7.5	14.5	18	-
C44	8	16.5	19.5	-
C48	8	18	22	-
D46	6	11.5	16	12.5
E50	7	12.5	16.5	14
F50	6	13	14	17
G50	6	12.5	15.5	16
E60	8	16.5	19.5	16
F60	8	17.5	14	20.5
G60	8	16	18	18

Another important indicator could be the relative aggressiveness per tonne carried. With the same network, the aggressiveness per tonne of goods carried is shown on the graphic below.

Figure 32: Aggressiveness of each vehicle combination toward a "representative" modelled pavement, related to a tonne of transported goods



There are only three shapes worse than the reference one: C48, B44 and, the worst, A44.

Financial overall idea

French experts calculated in 2003 what would be the extra cost of maintenance if A44 or C44 were allowed. The calculations only considered three levels of traffic, without considering the actual structure, for the French national road network.

Table 46: Calculation of extra maintenance costs for France in 2003

Number of HGV *(heavy goods vehicle)* per day and per direction	A44	C44
750 to 2000	14%	10%
300 to 750	17%	12%
150 to 300	20%	15%

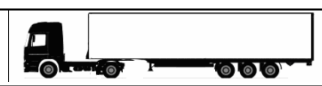
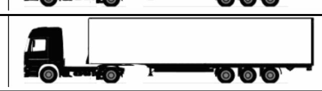
Once again, we reach to the conclusion that A44 and C44 would generate extra road maintenance costs, A44 being worse than C44 and should therefore be avoided.

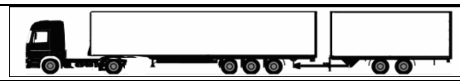
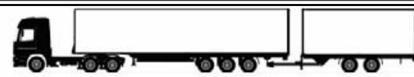
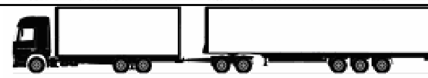
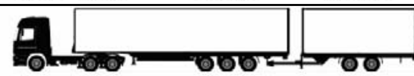
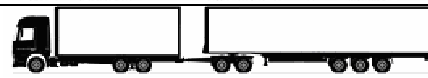
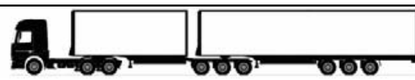
3. Conclusions on infrastructure

Summarising the whole chapter, and indicating in the pavement column the median value of the indicator calculated previously (relative aggressiveness on a network made up of 5 % of low traffic – flexible pavement, 15 % of moderate traffic - bituminous pavement, 40 % of heavy traffic – thick bituminous pavement and 40 % of heavy traffic – semi-flexible pavement), the main results are shown in the simplified table below.

Figure 33: Summary of the consequences on infrastructures, without countermeasures

No consequences | Moderate consequences | Important consequences

Code	Shape	Pavement	Bridges	
			Extreme loads	Fatigue
A44		2.39		
A48		>2.39		
B40		1.22		
B44		1.92		
B48		>1.92		
C40		1.02		
C44		1.42		
C48		1.85		

Code	Shape	Pavement	Bridges	
			Extreme loads	Fatigue
D46		1.04		
E50		0.55		
F50		0.53		
G50		0.42		
E60		2.05		
F60		2.07		
G60		1.46		

This table gives an overview of the impacts that result from the traffic of different combinations of vehicles, with different GVW *(gross vehicle weight)*, driving on different kinds of pavements. Using a basic colour code, it allows a rough comparison of all cases. It clearly shows that, in some cases (in red), important consequences have to be expected and that the corresponding combinations (A44, A48, B44, B48, C48, E60, F60 and G60) should be avoided. The 44 tonnes on 5 axles (A44 combination, 2 axle tractor and 3 axle tridem semi-trailer) is very bad for the infrastructures, bridges and pavements. If the Directive is modified in the future, this configuration should best be avoided in all EU State Members, even those which already authorized this configuration (e.g. France, Belgium, Italy).

It must be reminded that appropriate countermeasures could help to decrease the impact on bridges, and hence change the result presented in the table above. Among these countermeasures could be mentioned:

- Training the industry about the best way to load a lorry.
- Minimal spacing between two LHVs.
- No overtaking.
- On-board load measuring systems.
- Authorisations limited to specific routes.

It is therefore essential to define the relevant itineraries, to identify the problematic bridges and to decide of the appropriate measures that should be implemented. However, these three tasks require time and exhaustive expertise. Some possible countermeasures will be discussed later in this report, along with proposals for further studies.

VII Effect on energy efficiency, CO_2 and noxious emissions

1. Description of emissions

Energy efficiency of freight transport is measured in terms of energy consumption per tonne-km. For road transport, this is generally equivalent to fuel consumption, more specifically diesel fuel. As such, improving energy efficiency is closely linked to decreasing operational costs.

For rail the picture is somewhat more complex. Some 20 % of freight trains are diesel powered. The propulsion force of the other 80 % is electricity. In order to account for the total emissions generated by freight transport, the complete energetic cycle needs to be examined, from well to wheels. Power plants in European countries tend to vary: electricity produced in France will generate few emissions, as close to 80% originates from nuclear plants. About 55 % of Austrian electricity comes from hydropower; nonetheless, fossil fuel plants are still a major source of power in many European countries.

CO_2 emissions are directly related to fuel consumption. For each litre of diesel fuel that is consumed, 2.62 kg of CO_2 is emitted into the air.[55]

NOx is a generic term for mono-nitrogen oxides (NO and NO_2). Ground-level (tropospheric) ozone (smog) is formed when NOx and volatile organic compounds (VOCs) react in the presence of sunlight. Children, people with lung diseases such as asthma, and people who work or exercise outside are susceptible to adverse effects such as damage to lung tissue and reduction in lung function. Ozone can be transported by wind currents and cause health impacts far from original sources. Other impacts from ozone include damaged vegetation and reduced crop yields.

PM or particulate matter are tiny particles of solid or liquid suspended in a gas. It is generally classified based on its diameter, ranging from 10 µm to smaller than 0.1µm. The external costs of PM are due to its impact on human (and animal) health. Inhalation of the bigger particles (between 2.5 µm and 10 µm) can cause pulmonary diseases such as asthma or lung cancer. Emissions of traffic are mainly PM below 2.5 µm. Inhaling particles of that size can also lead to cardiovascular problems. The road transport sector contributes with both vehicle exhaust particles and resuspension of road dust.

2. Methodology

The COPERT IV methodology[56] has been used to calculate fuel consumption and CO_2 emissions. COPERT is a software program aiming at the calculation of air pollutant emissions from road transport. The development of COPERT has been financed by the EEA. COPERT IV estimates emissions of all

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[55] Formula: $[CO_2] = \frac{44.011 * DENS * FC_v}{12.011 + (1.008 * RHC)}$,

with $[CO_2]$ = the weight of CO_2 exhausted, DENS = fuel density (g/l; for diesel, this is 835), FC_v = fuel consumption in litre, and RHC the ratio of hydrogen and carbon atoms in the fuel (for diesel, this is 2).

[56] http://lat.eng.auth.gr/copert

major air pollutants (CO, NOx, VOC, PM, NH_3, SO_2, heavy metals) produced by different vehicle categories (passenger cars, light duty vehicles, heavy duty vehicles, mopeds and motorcycles) as well as greenhouse gas emissions (CO2, N_2O, CH_4). In this study, the COPERT formulas for LHV were used for PM, NOx, and CO_2.

The composition of the truck fleet (age classes, Euro classes) was derived from the TREMOVE model[57]. TREMOVE is a policy assessment model to study the effects of different transport and environment policies on the emissions of the transport sector. The model estimates the transport demand, modal shifts, vehicle stock renewal and scrappage decisions as well as the emissions of air pollutants and the welfare level, for policies as road pricing, public transport pricing, emission standards, subsidies for cleaner cars etc. The model covers passenger and freight transport in 31 countries and covers the period 1995-2030.

The output of the scenario calculations are tonnes transported, vehicle kilometres and tonne kilometres, disaggregated based on

- truck type,
- truck technology,
- region (urban/motorway/rural road),
- timing (peak/off peak),
- load factor.

For each class, data from the demand calculations served as the input for the calculation.
Trucks are distinguished in TREMOVE based on their GVW *(gross vehicle weight)*. In the standard model, four types exist:

- 3.5 t - 7.5 t (HDT1)
- 7.5 t - 16 t (HDT2)
- 16 t - 32 t (HDT3)
- 32 t - 40 t (HDT4)

While this is sufficient for the base case, the other scenarios require modelling greater gross vehicle weights. For that, two types are added:

- 40 t - 50 t (HDT5)
- 50 t - 60 t (HDT6)

COPERT IV works with a different set of truck types. These are:

- Rigid
  - 3.5 t - 7.5 t (HDT_RIGID1)
  - 7.5 t - 12 t (HDT_RIGID2)
  - 12 t - 14 t (HDT_RIGID3)
  - 14 t - 20 t (HDT_RIGID4)
  - 20 t - 26 t (HDT_RIGID5)
  - 26 t - 28 t (HDT_RIGID6)
  - 28 t - 32 t (HDT_RIGID7)
  - 32 t + (HDT_RIGID8)
- Articulated
  - 14 t - 20 t (HDT_ARTIC1)
  - 20 t - 28 t (HDT_ARTIC2)
  - 28 t - 34 t (HDT_ARTIC3)

[57] http://www.tremove.org

- 34 t - 40 t (HDT_ARTIC4)
- 40 t - 50 t (HDT_ARTIC5)
- 50 t - 60 t (HDT_ARTIC6)

A link exists between these classifications. The column "proportion" shows the share of the COPERT type in the TREMOVE type:

Table 47: TREMOVE-COPERT link for vehicle types

TREMOVE	TREMOVE description	COPERT	COPERT description	value
HTD1	heavy duty truck 3.5-7.5t - diesel	HDT_RIGID1	RT <=7.5t	1
HTD2	heavy duty truck 7.5-16t - diesel	HDT_RIGID8	RT >7.5-12t	0.25
HTD2	heavy duty truck 7.5-16t - diesel	HDT_RIGID2	RT >12-14t	0.25
HTD2	heavy duty truck 7.5-16t - diesel	HDT_RIGID3	RT >14-20t	0.25
HTD2	heavy duty truck 7.5-16t - diesel	HDT_ARTIC1	TT/AT >14-20t	0.25
HTD3	heavy duty truck 16-32t - diesel	HDT_ARTIC1	TT/AT >14-20t	0.1
HTD3	heavy duty truck 16-32t - diesel	HDT_ARTIC2	TT/AT >20-28t	0.16
HTD3	heavy duty truck 16-32t - diesel	HDT_ARTIC3	TT/AT >28-34t	0.16
HTD3	heavy duty truck 16-32t - diesel	HDT_RIGID3	RT >14-20t	0.1
HTD3	heavy duty truck 16-32t - diesel	HDT_RIGID4	RT >20-26t	0.16
HTD3	heavy duty truck 16-32t - diesel	HDT_RIGID5	RT >26-28t	0.16
HTD3	heavy duty truck 16-32t - diesel	HDT_RIGID6	RT >28-32t	0.16
HTD4	heavy duty truck >32t - diesel	HDT_ARTIC4	TT/AT >34-40t	0.25
HTD4	heavy duty truck >32t - diesel	HDT_ARTIC5	TT/AT >40-50t	0.25
HTD4	heavy duty truck >32t - diesel	HDT_ARTIC6	TT/AT >50-60t	0.25
HTD4	heavy duty truck >32t - diesel	HDT_RIGID7	RT >32t	0.25

In this study it is assumed the intramodal shift to LHV only comes from HDT4. The COPERT IV methodology allows establishing functions that will link speed with fuel consumption for all classes. To achieve a flexible automated calculation tool, the COPERT IV functions that are in TREMOVE are programmed into an Access database.

A major parameter in determining exhaust emissions is the load factor of trucks. It is calculated as the average load of a truck, divided by its maximal capacity. The average load is based on the scenario output, as [number of tonne-km]/[number of vehicle-km]. The average maximum capacity is displayed in Table 48.

Table 48: Load capacities per truck type

Truck type	Load capacity (tonne)
HDT1	3.5
HDT2	8.5
HDT3	14
HDT4	26
HDT5	29
HDT6	39.5

Five formulas are established to calculate fuel consumption. Fourteen formulas are used to calculate NOx, while nine are used for PM, depending on the emission profile by each subclassification. They vary between truck types, truck technologies and load factors. The parameters of the formulas are vehicle speed, plus a number of COPERT specific data. For details, we refer to the TREMOVE[58] and COPERT IV[59] websites.

[58] http://www.TREMOVE.org

3. Calculation

Using the methodology described above, detailed calculations were made for each scenario. The full well-to-wheels cycle is considered, to allow for comparability between modes. Data are presented in tabular form, grouped by country and truck type. Highly detailed numbers are presented. Of course, these are subject to the same caution that was given in the previous chapters, and depend very much on demand data as described in chapter IV.

3.1. "Business as usual" scenario

In the reference scenario, with only Finland and Sweden using 25.25 m/60 t LHVs, a total of 40 729.26 million litres of diesel fuel is consumed during transport using heavy trucks. The average fuel consumption of HDT4 is close to 30.28 l/100 km. Fuel efficiency in terms of consumption (litre) per tonne-km is equal to 0.02567 l/tonne-km . This is equivalent to 67.2554 g of CO_2 per tonne-km.

Table 49: Scenario 1 transport energy consumption

Country	Truck type	Fuel consumption (tonne)	Fuel consumption (million litre)	CO_2 (tonne)
AT	HDT4	489 420	586	1 535 601
BE	HDT4	1 438 054	1 722	4 512 025
BG	HDT4	362 792	434	1 138 292
CZ	HDT4	968 494	1 160	3 038 739
DE	HDT4	6 896 051	8 259	21 636 994
DK	HDT4	294 407	353	923 728
EE	HDT4	118 262	142	371 057
ES	HDT4	5 852 937	7 010	18 364 127
FI	HDT4	105 477	128	330 942
FR	HDT4	5 069 512	6 071	15 906 059
GR	HDT4	489 361	586	1 535 416
HU	HDT4	441 853	529	1386 353
IE	HDT4	208 243	249	653 382
IT	HDT4	2 983 493	3 573	9 360 984
LT	HDT4	221 477	265	694 904
LU	HDT4	43 648	52	136 949
LV	HDT4	135 925	163	426 477
NL	HDT4	855 024	1 024	2 682 715
PL	HDT4	2 035 487	2 438	6 386 528
PT	HDT4	259 182	310	813 207
RO	HDT4	1 136 225	1 361	3 565 012
SE	HDT4	154 700	185	485 385
SI	HDT4	124 628	149	391 032
SK	HDT4	223 434	268	701 044
UK	HDT4	2 438 284	2 920	7 650 339
FI	HDT6	266 952	324	837 587
SE	HDT6	391 094	468	1 227 092
TOTAL		**34 004 414**	**40 729**	**106 691 971**

[59] http://lat.eng.auth.gr/copert/

During the production process of the fuel, energy is consumed as well. The CO_2 emitted during this production process (well-to-tank emissions) should also be taken into account. This adds another 19.4 % to the total.

Table 50: Scenario 1 well-to-tank CO_2 emissions

Country	Truck type	CO_2 well-to-tank emissions (tonne)
AT	HDT4	298 546
BE	HDT4	877 213
BG	HDT4	221 303
CZ	HDT4	590 781
DE	HDT4	4 206 591
DK	HDT4	179 588
EE	HDT4	72 140
ES	HDT4	3 570 292
FI	HDT4	64 341
FR	HDT4	3 092 402
GR	HDT4	298 510
HU	HDT4	269 530
IE	HDT4	127 028
IT	HDT4	1 819 931
LT	HDT4	135 101
LU	HDT4	26 625
LV	HDT4	82 914
NL	HDT4	521 564
PL	HDT4	1 241 647
PT	HDT4	158 101
RO	HDT4	693 098
SE	HDT4	94 367
SI	HDT4	76 023
SK	HDT4	136 295
UK	HDT4	1 487 353
FI	HDT6	162 841
SE	HDT6	238 567
TOTAL		**20 742 693**

In the base case, NOx emissions are 483 062 tonne. About 11 511 tonnes of particulate matter are exhausted, of which 44 % does not originate from burning fuel, but from other sources such as resuspended dust and mechanical abrasion (tyre, brake and road surface wear).

Table 51: Scenario 1 Noxious emissions

Country	Truck type	NOx exhaust emissions (tonne)	PM exhaust emissions (tonne)	PM non-exhaust emissions (tonne)
AT	HDT4	6 818.381	90.806	69.520
BE	HDT4	16 085.501	162.330	231.011
BG	HDT4	5 288.467	74.565	49.794
CZ	HDT4	15 186.191	254.057	132.844
DE	HDT4	110 582.596	1 514.628	1 142.790
DK	HDT4	3 630.315	39.397	42.810
EE	HDT4	1 704.598	25.509	18.580
ES	HDT4	80 647.597	1 084.994	769.833
FI	HDT4	1 331.203	20.052	12.812
FR	HDT4	70 094.316	829.952	832.011

Country	Truck type	NOx exhaust emissions (tonne)	PM exhaust emissions (tonne)	PM non-exhaust emissions (tonne)
GR	HDT4	7 454.406	117.933	65.488
HU	HDT4	6 657.538	114.869	60.264
IE	HDT4	3 307.188	59.548	23.884
IT	HDT4	41 654.313	528.135	457.533
LT	HDT4	3 229.191	46.373	33.519
LU	HDT4	558.458	6.912	5.826
LV	HDT4	1 978.297	28.259	20.333
NL	HDT4	10 310.473	117.842	115.067
PL	HDT4	30 832.327	490.379	276.248
PT	HDT4	3 969.699	71.811	36.199
RO	HDT4	16 879.463	243.368	155.700
SE	HDT4	2 158.127	27.997	21.005
SI	HDT4	2 089.314	39.982	14.186
SK	HDT4	4 069.654	57.987	32.402
UK	HDT4	27 819.512	276.274	392.068
FI	HDT6	3 336.075	46.452	23.907
SE	HDT6	5 389.270	65.171	39.554
TOTAL		**483 062.470**	**6 435.583**	**5 075.187**

Noxious emissions from the fuel production process are clearly following a different pattern than the emissions from transport. Well-to-tank PM emissions are nearly at the same level as emissions from fuel consumption, whereas NOx emitted in production is only 1/8 of the total nitrous oxide emitted in the fuel life cycle.

Table 52: Scenario 1 Well-to-tank noxious emissions

Country	Truck type	NOx well-to-tank (tonne)	PM well-to-tank (tonne)
AT	HDT4	994.884	153.722
BE	HDT4	2 923.247	451.678
BG	HDT4	737.476	113.949
CZ	HDT4	1 968.735	304.194
DE	HDT4	14 018.155	2 165.981
DK	HDT4	598.464	92.470
EE	HDT4	240.400	37.145
ES	HDT4	11 897.733	1 838.349
FI	HDT4	214.411	33.129
FR	HDT4	10 305.203	1 592.283
GR	HDT4	994.764	153.704
HU	HDT4	898.189	138.781
IE	HDT4	423.313	65.407
IT	HDT4	6 064.786	937.085
LT	HDT4	450.214	69.564
LU	HDT4	88.727	13.709
LV	HDT4	276.306	42.693
NL	HDT4	1 738.075	268.554
PL	HDT4	4 137.698	639.326
PT	HDT4	526.859	81.406
RO	HDT4	2 309.696	356.877
SE	HDT4	314.471	48.590
SI	HDT4	253.341	39.144
SK	HDT4	454.191	70.178

Country	Truck type	NOx well-to-tank (tonne)	PM well-to-tank (tonne)
UK	HDT4	4 956.494	765.841
FI	HDT6	542.655	83.847
SE	HDT6	795.007	122.839
TOTAL		**69 123.494**	**10 680.447**

3.2. "Full option" scenario

The full option scenario allows LHVs of 25.25 m and 60 t to circulate throughout the European Union. In spite of a volume (tonne-km) increase of 0.76 %, fuel consumption is down by 3.58 %. When the extra goods transported are accounted for, the efficiency gain (amount of fuel per tonne-km) is 4.31 %. Fuel consumption per vehicle-km does increase by 9.34 % on the total.

When LHVs of 25.25 m and 60 t operate in Europe under the same terms as classic heavy goods vehicles (outside of urban areas), they show themselves to be 12.45 % more efficient in terms of fuel consumption per tonne-km performed.

Table 53: Scenario 2 transport energy Consumption

Country	Truck type	Fuel consumption (tonne)	Fuel consumption (million litre)	CO_2 (tonne)
AT	HDT4	403 645	483	1 266 472
BE	HDT4	961 857	1 152	3 017 915
BG	HDT4	225 032	270	706 059
CZ	HDT4	678 236	812	2 128 028
DE	HDT4	4 693 983	5 622	14 727 803
DK	HDT4	204 631	245	642 050
EE	HDT4	66 973	80	210 135
ES	HDT4	2 993 905	3 586	9 393 651
FI	HDT4	107 654	130	337 775
FR	HDT4	2 890 630	3 462	9 069 616
GR	HDT4	199 725	239	626 657
HU	HDT4	277 196	332	869 727
IE	HDT4	204 470	245	641 544
IT	HDT4	1 687 075	2 020	5 293 353
LT	HDT4	138 857	166	435 675
LU	HDT4	32 342	39	101 474
LV	HDT4	80 368	96	252 161
NL	HDT4	577 163	691	1 810 901
PL	HDT4	1 149 764	1 377	3 607 490
PT	HDT4	163 029	195	511 520
RO	HDT4	681 604	816	2 138 596
SE	HDT4	156 206	187	490 110
SI	HDT4	79 154	95	248 352
SK	HDT4	122 664	147	384 870
UK	HDT4	2 038 758	2 442	6 396 791
AT	HDT6	76 618	92	240 395
BE	HDT6	427 254	512	1 340 548
BG	HDT6	125 046	150	392 342
CZ	HDT6	270 044	323	847 288
DE	HDT6	1 960 260	2 348	6 150 494
DK	HDT6	80 680	97	253 140
EE	HDT6	48 120	58	150 980

Country	Truck type	Fuel consumption (tonne)	Fuel consumption (million litre)	CO_2 (tonne)
ES	HDT6	2 602 013	3 116	8 164 056
FI	HDT6	272 495	330	854 979
FR	HDT6	1 939 781	2 323	6 086 241
GR	HDT6	260 181	312	816 341
HU	HDT6	149 470	179	468 975
IE	HDT6	3 405	4	10 683
IT	HDT6	1 150 437	1 378	3 609 602
LT	HDT6	76 472	92	239 939
LU	HDT6	10 544	13	33 084
LV	HDT6	52 411	63	164 444
NL	HDT6	258 740	310	811 820
PL	HDT6	827 981	992	2 597 866
PT	HDT6	86 034	103	269 938
RO	HDT6	414 585	497	1 300 797
SE	HDT6	394 896	473	1 239 022
SI	HDT6	41 670	50	130 745
SK	HDT6	93 493	112	293 342
UK	HDT6	348 636	418	1 093 879
TOTAL		**32 786 184**	**39 270**	**102 869 662**

Well-to-tank emissions show the same pattern, as they are 100 % correlated to fuel consumption. The amount of CO_2 emitted during fuel production is down 3.58 % to 19 999 572 tonnes.

NOx transport emissions will decrease somewhat more than CO_2 emissions, by 4.03 % to 463 593 tonnes for all countries. For PM, the effect is even greater, as a drop of 8.39 % can be expected, mainly due to less non-exhaust PM: fewer kilometres driven cause less resuspension and mechanical wear.

As they are linked directly to fuel consumption, well-to-tank emissions of NOx and PM are down by 3.58 % in comparison to the “business as usual” scenario.

Tables for NOx and PM are added in the annex to this report

3.3. “Corridor/coalition” scenario

In the corridor/coalition scenario, only a select number of countries are assumed to allow LHV on their roads.
Demand will not be stimulated to the same extent as in the previous scenario, yet the fact that a number of industrial centres and distribution hubs are located within the corridor/coalition scenario, combined with national demand growth, still make for significant increases in road volumes in these countries.

The resulting effect on energy consumption is moderate in comparison to the reference scenario. Fuel consumption decreases by 0.58 %, while tonne-km go up by 0.18 %. The average net efficiency gain per tonne-km is 0.76 %.

Compared to the full option scenario, LHVs have a slightly smaller cost advantage to classic HGVs *(heavy goods vehicles)*, at 11.14 %. Main reason for the difference is a marginally lower average load factor in the corridor/coalition countries.

Table 54: Scenario 3 transport energy consumption

Country	Truck type	Fuel consumption (tonne)	Fuel consumption (million litre)	CO_2 (tonne)
AT	HDT4	488 926	586	1 534 049
BE	HDT4	1 186 198	1 421	3 721 805
BG	HDT4	362 176	434	1 136 360
CZ	HDT4	966 810	1 158	3 033 456
DE	HDT4	5 718 603	6 849	17 942 643
DK	HDT4	257 342	308	807 435
EE	HDT4	117 232	140	367 827
ES	HDT4	5 843 047	6 998	18 333 097
FI	HDT4	107 393	130	336 955
FR	HDT4	5 059 501	6 059	15 874 647
GR	HDT4	488 533	585	1 532 816
HU	HDT4	441 102	528	1 383 998
IE	HDT4	208 229	249	653 337
IT	HDT4	2 978 211	3 567	9 344 410
LT	HDT4	220 816	264	692 832
LU	HDT4	42 771	51	134 198
LV	HDT4	135 500	162	425 142
NL	HDT4	620 930	744	1 948 226
PL	HDT4	2 031 881	2 433	6 375 213
PT	HDT4	258 734	310	811 803
RO	HDT4	1 134 298	1 358	3 558 963
SE	HDT4	156 178	187	490 022
SI	HDT4	124 418	149	390 372
SK	HDT4	223 061	267	699 873
UK	HDT4	2 436 094	2 917	7 643 468
BE	HDT6	227 795	273	714 726
DE	HDT6	1 050 375	1 258	3 295 648
DK	HDT6	33 658	40	105 606
FI	HDT6	271 823	329	852 870
NL	HDT6	219 296	263	688 062
SE	HDT6	394 825	473	1 238 800
TOTAL		**33 805 755**	**40 491**	**106 068 658**

Total well-to-tank emissions in this scenario amount to 20 621 510 tonnes.

Well-to-tank NOx and PM emissions decrease by the same level as CO_2 emissions. NOx emissions will again decrease somewhat more than CO_2, by 0.68 %. Around 479 796 tonnes of NOx would be emitted as a consequence of freight transport with heavy trucks. PM emissions go down by 1.27 %.

Tables for NOx and PM are added in the annex to this report.

3.4. “Intermediate” scenario

Under the assumptions of scenario 4, there would be an increase of 0.61 % in emissions. This implies that the efficiency gain caused by the increase from 40 t to 44 t gross vehicle weight is insufficient to offset the extra emissions of the higher transport demand. Moreover, using a heavier vehicle (with one extra axle) proves to be lethal to even an improvement in cost per tonne-km: it increases by 0.28 %. The extra load that can be carried does not offset the extra fuel consumption required to do so. From a CO_2 emissions point of view, 44 t on 6 axles would thus not be beneficial. Due to the small margin, this result may not be very robust.

Table 55: Scenario 4 transport energy consumption

Country	Truck type	Fuel consumption (tonne)	Fuel consumption (million litre)	CO_2 (tonne)
AT	HDT4	414 780	497	1 301 409
BE	HDT4	877 025	1 050	2 751 746
BG	HDT4	264 996	317	831 450
CZ	HDT4	665 823	797	2 089 081
DE	HDT4	4 804 222	5 754	15 073 686
DK	HDT4	228 396	274	716 613
EE	HDT4	75 379	90	236 508
ES	HDT4	2 789 560	3 341	8 752 501
FI	HDT4	39 180	47	122 930
FR	HDT4	2 731 738	3 272	8 571 080
GR	HDT4	171 656	206	538 588
HU	HDT4	258 007	309	809 521
IE	HDT4	203 355	244	638 046
IT	HDT4	1 469 946	1 760	4 612 089
LT	HDT4	160 874	193	504 757
LU	HDT4	29 203	35	91 628
LV	HDT4	91 765	110	287 920
NL	HDT4	552 091	661	1 732 237
PL	HDT4	1 024 564	1 227	3 214 662
PT	HDT4	150 412	180	471 930
RO	HDT4	805 479	965	2 527 266
SE	HDT4	74 458	89	233 618
SI	HDT4	87 705	105	275 183
SK	HDT4	103 536	124	324 853
UK	HDT4	1 899 298	2 275	5 959 221
AT	HDT5	75 463	90	236 771
BE	HDT5	566 524	678	1 777 520
BG	HDT5	100 076	120	313 998
CZ	HDT5	313 765	376	984 466
DE	HDT5	2 105 026	2 521	6 604 712
DK	HDT5	67 077	80	210 460
EE	HDT5	44 250	53	138 837
ES	HDT5	3 130 870	3 750	9 823 393
FI	HDT5	68 626	83	215 322
FR	HDT5	2 351 604	2 816	7 378 373
GR	HDT5	323 019	387	1 013 503
HU	HDT5	187 860	225	589 427
IE	HDT5	4 968	6	15 588
IT	HDT5	1 523 228	1 824	4 779 267
LT	HDT5	62 442	75	195 916
LU	HDT5	14 945	18	46 891
LV	HDT5	45 867	55	143 912
NL	HDT5	312 950	375	981 911
PL	HDT5	1 045 539	1 252	3 280 476
PT	HDT5	110 213	132	345 804
RO	HDT5	339 559	407	1 065 399
SE	HDT5	82 279	99	258 158

Country	Truck type	Fuel consumption (tonne)	Fuel consumption (million litre)	CO_2 (tonne)
SI	HDT5	37 988	45	119 192
SK	HDT5	123 661	148	387 997
UK	HDT5	537 437	644	1 686 259
FI	HDT6	269 155	326	844 499
SE	HDT6	392 779	470	1 232 381
TOTAL		**34 210 619**	**40 976**	**107 338 956**

Well-to-tank emissions are 20 868 477 tonnes for scenario 4.

COPERT calculations have shown that also for NOx emissions, scenario 4 would not be beneficial for the environment. In scenario 4, they are up by 0.32 % compared to the "business as usual" scenario. PM emissions from transport are down however, by 1.85 %. The main reason is the lower amount of vehicle-km, resulting in a 3.27 % reduction of non-exhaust PM emissions. Just like fuel consumption, well-to-tank emissions of both NOx and PM are up by 0.61 %.

Tables for NOx and PM are added in Annex 6: Emission calculation tables to this report.

3.5. Rail and inland waterway transport

Data for the business-as-usual scenario were calculated using the TREMOVE base case. For each country, using the modal shift data from chapter IV, the change in CO_2 emissions of the full energy cycle are calculated (well-to-wheels). Additionally, to guarantee comparability between different modes, numbers are provided on the total energy consumption during the transport process (expressed in Ktoe, kilotonnes of oil equivalent).[60]

Inland waterways are predicted to perform 178 673 million tonne-km in 2020 for the reference scenario. The total CO_2 emission for this transport (including well-to-tank emissions) is 6 640 346 million tonnes. The CO_2 emission per tonne-km is 37.16 g/tonne-km, just over half that for "business as usual" road transport (67.2 g/tonne-km).

Table 56: Scenario 1 inland waterway energy consumption

Country	Total CO_2 (tonne)	Energy consumption (ktoe)
AT	130 765	35
BE	479 697	130
BG	50 799	14
CZ	5 886	2
DE	2 668 123	721
FR	368 631	100
HU	35 487	10
NL	2 423 623	655
PL	11 634	3
RO	414 538	112
SK	51 163	14
TOTAL	**6 640 347**	**1 793**

[60] Conversion of ktoe to tonnes of diesel fuel: 1 ktoe=990.099018567 tonne diesel (TREMOVE calculation based on 2004 and 2005 EU Transport in Figures statistical pocketbook)

An energy consumption of 1 793 ktoe *(kilotonne oil equivalent)* is equivalent to 1 775 486 tonnes of diesel fuel.

Table 57 shows the predicted emissions and energy use for freight transport by electric train. Unlike for inland waterways, great differences in emissions exist between countries here, due to the use of renewable (water, wind, …) or nuclear sources for electricity generation. The average is 22.09 g/tonne-km, with France, Sweden and Finland all at less than 9 g/tonne-km. However, when the total energy balance is considered, average country values are much closer together. Total freight transport by electric trains amounts to approximately 318 727 million tonne-km. This is of course one of rail's main advantages over road: lower carbon emissions, as the energy required for transported can be generated in more climate friendly ways. It should be noted that no assessment is made for the external costs of these alternatives. This refers mainly to nuclear power and the radioactive waste it produces.

Table 57: Scenario 1 rail (electric) energy consumption

Country	Total CO_2 (tonne)	Energy consumption (ktoe)
AT	206 724	83
BE	99 045	30
BG	101 501	21
CH	2 375	2
CZ	286 804	49
DE	2 708 363	437
DK	27 932	6
ES	219 460	71
FI	59 204	22
FR	299 565	233
GR	40	0
HU	141 892	29
IE	14	0
IT	1 309 369	308
LU	6 608	2
NL	100 443	23
NO	6 118	14
PL	891 411	107
PT	56 533	13
RO	188 230	39
SE	143 188	78
SI	65 351	14
SK	47 023	12
UK	61 127	15
TOTAL	**7 019 827**	**1 590**

The energy consumption of freight transport by diesel train is shown in Table 58. This segment is responsible for little over a quarter of total rail freight tonne-km. Its efficiency in terms of CO_2 exhaust is 27.76 g/tonne-km. With the entire fuel life cycle covered here, rail can still claim a significant advantage in energy efficiency.

Table 58: Scenario 1 rail (diesel) energy consumption

Country	Total CO_2 (tonne)	Energy consumption (ktoe)
AT	107 612	29
BE	33 885	9
BG	34 596	9
CZ	115 095	31
DE	468 223	126
DK	73 462	20
EE	101 995	27
ES	85 073	23
FI	118 138	32
FR	153 911	41
GR	19 533	5
HU	68 428	18
IE	19 145	5
IT	35 253	10
LT	168 241	45
LU	8 202	2
LV	213 602	58
NL	46 307	12
PL	249 562	67
PT	76 778	21
RO	137 148	37
SE	25 965	7
SI	32 245	9
SK	21 161	6
UK	938 680	253
TOTAL	**3 352 242**	**903**

For other scenarios, estimates were only made for volume (tonnes) lifted. The assumption is made that rail and inland waterways are able to optimise their transports in accordance with "business as usual" volumes. As such, emission estimates are based on the most efficient (in terms of volume optimisation) scenario for these modes. Should certain segments of their business disappear or become unprofitable, they will be terminated and could also shift to other modes. This is the aforementioned "domino effect", which could be particularly risky for single wagon loads. Given the projected growth in comparison to current transport levels, it is unclear how this will play out in reality.

For this study, Table 59 contains the estimated CO_2 emissions for rail and inland waterways, for all scenarios.

Table 59: CO_2 emissions for rail and Inland waterways

		Scenario 1	Scenario 2	Scenario 3	Scenario 4
Inland waterways	CO_2 (tonne)	6 640 347	6 455 900	6 488 168	6 558 573
	Energy Cons (ktoe)	1 793	1 743	1 752	1 771
	Difference		***-2.78%***	***-2.29%***	***-1.23%***
Rail	CO_2 (tonne)	10 372 069	9 915 089	10 212 305	10 169 207
	Energy Cons (ktoe)	2 493	2 375	2 459	2 441
	Difference		***-4.41%***	***-1.54%***	***-1.96%***

Calculated results for PM and NOx are in Table 60. The decrease for inland waterways in scenario 3 is greater than for rail. This is due to the fact that most of the countries with a significant inland waterway network are in the corridor/coalition, and thus see a greater decline. Due to less stringent regulation on fuel quality for inland waterways, its exhaust of by-products (caused by fuel impurities) is substantially higher for each unit of fuel consumed.

Table 60: Noxious emissions for rail and inland waterway

		Scenario 1	Scenario 2	Scenario 3	Scenario 4
Inland waterways	NOx (tonne)	110 267	107 204	107 740	108 909
	Difference		*-2.78 %*	*-2.29 %*	*-1.23 %*
	PM (tonne)	7 577	7 367	7 403	7 484
	Difference		*-2.78 %*	*-2.29 %*	*-1.23 %*
Rail	NOx (tonne)	57 951	55 673	57 303	56 937
	Difference		*-3.93 %*	*-1.12 %*	*-1.75 %*
	PM (tonne)	4 882	4 703	4 842	4 805
	Difference		*-3.66 %*	*-0.81 %*	*-1.58 %*

4. Conclusions

In summary, the energy consumption is predicted to go down when LHVs are introduced. The main reason for this is the fact that 60 t vehicles (HDT6) are 12.45 % more efficient in terms of fuel consumption per tonne-km performed. This effect is bigger than the predicted increase in tonne-km by road.

In the “corridor/coalition” scenario 3, the effect is smaller, as only 6 countries allow LHVs.

In the “intermediate” scenario 4, there would be an increase of 0.61 % in emissions. This implies that the efficiency gain caused by the increase from 40 t to 44 t gross vehicle weight is insufficient to offset the extra emissions of the higher transport demand. Moreover, using a heavier vehicle (with one extra axle) proves to be lethal to even an improvement in cost per tonne-km: it increases by 0.28 %. The extra load that can be carried does not offset the extra fuel consumption required to do so.

Table 61: Effect of the scenarios on CO2 emissions

CO2	Scenario 2 vs. 1	Scenario 3 vs. 1	Scenario 4 vs. 1
Road (transport)	-3.6 %	-0.6 %	0.6 %
Road (well-to-tank)	-3.6 %	-0.6 %	0.6 %
Rail (electric)	-4.7 %	-1.7 %	-2.1 %
Rail (diesel)	-3.9 %	-1.1 %	-1.7 %
Inland waterways	-2.8 %	-2.3 %	-1.2 %
Total emissions	**-3.6 %**	**-0.7 %**	**0.3 %**

When 25.25 m/60 t LHV are allowed to circulate in all European countries, NOx transport emissions will decrease with 4.03 %. For PM, the effect is even greater, as a drop of 8.39 % can be expected, mainly due to less non-exhaust PM: fewer kilometres driven cause less resuspension and mechanical wear.

In scenario 3, the effect is obviously smaller: a decrease by 0.68 % for NOx and 1.27 % for PM.

In scenario 4, the NOx emissions are up by 0.32 % compared to the “business as usual” scenario.
PM emissions from transport are down however, by 1.85 %. The main reason is the lower amount of vehicle-km, resulting in a 3.27 % reduction of non-exhaust PM emissions.

Table 62: Effect of the scenarios on NOx emissions

NOx	Scenario 2 vs. 1	Scenario 3 vs. 1	Scenario 4 vs. 1
Road (transport)	-4.0%	-0.7%	0.3%
Road (well-to-tank)	-3.6%	-0.6%	0.6%
Rail (electric)	-4.2%	-1.0%	-1.8%
Rail (diesel)	-3.9%	-1.1%	-1.7%
Inland waterways	-2.8%	-2.3%	-1.2%
Total emissions	**-3.8%**	**-1.0%**	**-0.1%**

Table 63: Effect of the scenarios on PM emissions

PM	Scenario 2 vs. 1	Scenario 3 vs. 1	Scenario 4 vs. 1
Road (transport)	-8.4 %	-1.3 %	-1.8 %
Road (well-to-tank)	-3.6 %	-0.6 %	0.6 %
Rail (electric)	-3.2 %	-0.1 %	-1.2 %
Rail (diesel)	-3.9 %	-1.1 %	-1.7 %
Inland waterways	-2.8 %	-2.3 %	-1.2 %
Total emissions	**-5.0 %**	**-1.2 %**	**-0.9 %**

5. Sensitivity analysis

Aerodynamical improvements, such as the teardrop trailer, are likely to have close-to-linear effects on road transport emissions and do not require extra calculations; i.e. if a certain concept is advertised to reduce emissions by 10 %, it will probably do so no matter the load. Each concept should be evaluated on its own merit (e.g. using a PBS – "performance based standards" approach).

Sensitivity has been investigated for scenario 2 and 3 where not 60 t but 50 t would be the maximum weight. For scenario 4, an evaluation was made for using 48 t instead of 44 t.

With the modified load factors, CO_2 emissions for the 25.25 m / 50 t truck decrease by 5.09 % per vehicle-km. However, per tonne-km, they increase by 13.72 %. Under the simplified assumptions of this study, LHVs of those dimensions would even be more expensive per tonne-km than classic HGVs (on average 1.72 %).

The HGV of max 20.75 m/48 t would emit 6.02 % less CO_2 per tonne-km than the 44 t variant. This type of LHV is 4.64 % more fuel efficient per tonne-km compared to classic HGVs.

A very important caveat: as load factors are based on weight, volume goods do not quite fit within the logic described above. The capacity increase of 25 %, down from 50 % of 60t LHVs, would not be valid. The efficiency gain to 40 t HGVs would likely be closer to the 12.45 % mentioned in 3.2, as the volume capacity increase remains at 5.0 %.

A 25.25 m LHV at max 50t would emit 13.95 % more NOx per tonne-km than the 60 t version, and 15.14 % more PM. Emissions would be even marginally higher than for classic HGVs, yet the same precaution as with CO_2 is valid here: emissions factors are based on load factor in terms of weight. Volume-limited transports would likely show a pattern similar to 60 t weight-limited moves.

48t trucks in scenario 4 are 5.31 % more efficient than 40 t vehicles in terms of NOx exhausted, and even 6.31 % for PM. It should be noted that these estimates only account for exhaust emissions, implying that gains for PM are even higher when the reduced amount of vehicle-km are accounted for.

VIII Cost-benefit analysis

In this chapter, the six effects are aligned and compared. The base case scenario, where no changes to Directive 96/53/EC are made, is the reference for evaluation. The output of the cost-benefit analysis is a table listing absolute and monetised results of a change in policy, based on the six effects proposed by the Commission.

Scenario 1 serves as the baseline. The costs mentioned for this table may not reflect the total costs for each of the effects, but they do however contain all relevant costs relevant for this study.

The numbers for the other scenarios are displayed as an increase or decrease of costs in comparison to the base case. A positive number means that there is a cost decrease, while values less than zero imply a deterioration of the situation. The valuation of each of the effects is described in the relevant chapter. Lower and upper bounds were set where available. This allows for a broad range of evolutions in the market situation to be evaluated. For each effect, one leading number was chosen to represent the most likely outcome, based on current conditions.

For all effects, amounts were based on best available data, either in existing research or calculated in the previous chapters of this document. As such, they are valid under the conditions as used in these data sources. As such, the numbers presented give orders of magnitude rather than exact valuations. Within the assumptions made in this study, the results are however a good indication of the expected outcome of the 4 scenarios.

1. Transport demand and modal split

1.1. Road transport

We apply CBA analysis based on the costs of vehicle operation per country. It means that the analysis takes the side of people or companies that exploit transport, but not, for instance, a societal perspective.

The costs of vehicle operation are different per country of operation. The COMPETE project Annex 1 presents data on costs of heavy duty vehicle operation. These costs are in the form of costs per kilometre driven per country, they can be found in the column HDV / Specific costs in euro/vehicle-km in the table below.

Table 64: Light duty vehicles (LDV) and heavy duty vehicles (HDV): Specific costs per vehicle-km, total costs and total costs per GDP (data for 2005)

	LDV			HDV		
	Specific costs (in EUR/veh-km)	Total operating costs (in Mio. EUR/a)	Operating costs in relation to GPD (in %)	Specific costs (in EUR/veh-km)	Total operating costs (in Mio. EUR/a)	Operating costs in relation to GPD (in %)
Belgium	1.11	3'824	1.33%	1.34	6'896	2.39%
Czech Republic	0.40	2'307	2.66%	0.52	3'882	4.47%
Denmark	1.17	3'703	1.89%	1.39	3'826	1.95%
Germany	0.89	13'374	0.60%	1.10	50'784	2.29%
Estonia	0.29	n.d.a.	n.d.a.	0.39	n.d.a.	n.d.a.
Greece	0.50	3'601	2.15%	0.62	2'120	1.27%
Spain	0.68	34'621	4.13%	0.84	20'966	2.50%
France	1.04	72'708	4.41%	1.26	50'388	3.06%
Irland	0.75	824	0.55%	0.92	1'716	1.16%
Italia	0.75	19'448	1.44%	0.94	24'556	1.82%
Cyprus	0.62	n.d.a.	n.d.a.	0.77	n.d.a.	n.d.a.
Latvia	0.21	n.d.a.	n.d.a.	0.30	n.d.a.	n.d.a.
Lithuania	0.24	n.d.a.	n.d.a.	0.34	n.d.a.	n.d.a.
Luxembourg	1.24	314	1.22%	1.40	686	2.67%
Hungary	0.36	776	0.96%	0.50	1'567	1.93%
Malta	0.56	n.d.a.	n.d.a.	0.70	n.d.a.	n.d.a.
Netherlands	1.14	95	0.02%	1.35	7'773	1.59%
Austria	1.15	667	0.28%	1.39	5'693	2.40%
Poland	0.32	3'404	1.67%	0.43	6'366	3.12%
Portugal	0.58	887	0.62%	0.75	1'630	1.15%
Slovenia	0.50	161	0.62%	0.63	293	1.12%
Slovakia	0.30	540	1.63%	0.43	1'101	3.32%
Finland	1.23	9'757	6.52%	1.36	6'175	4.12%
Sweden	1.25	5'498	1.95%	1.43	7'162	2.54%
United Kingdom	0.94	32'113	1.87%	1.18	28'596	1.67%
USA	0.87	707'797	7.50%	1.00	363'936	3.86%
Switzerland	1.07	383	0.13%	1.61	5'092	1.76%
EU 25 *	0.85	208'622	2.01%	1.03	232'176	2.24%
Western EU **	0.89	201'433	2.04%	1.11	218'966	2.21%
Eastern EU ***	0.34	7'190	1.67%	0.46	13'209	3.07%

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For our computation, we equal HGV to HDV, i.e. they are classified as trucks of 18.75 meters and 40 tonne gross. The cost of 60 tonne 25.25 meter LHV operation is 20 % more expensive than that of normal HGV[61].

Thus, to calculate costs of scenario 1, we multiply the number of vehicle kilometres per country by the country-specific cost of vehicle kilometre.

For scenario 2, we do similar computations: for the HGV part of the flow we multiply the number of HGV vehicle-km per country by the country-specific cost of vehicle-km. For the LHV part of the flow, multiply the number of the LHV vehicle-km per country by the country-specific cost of vehicle-km times 1.2, as we assumed the cost of LHV vehicle-km to be 20 % more.

Scenario 3 is similar to the scenario 2, except for the fact that LHVs of 25.25 meter and 60 tonne are only allowed in the "coalition/corridor" countries.

61 Reference: Bolk Transport, choice of the higher boundary.

Scenario 4: for the HGV part of the flow we multiply the number of HGV vehicle-km per country by the country-specific cost of a vehicle-km. For the LHV part of the flow, multiply the number of LHV vehicle-km per country by the country-specific cost of vehicle kilometre times 1.04, as we assumed the cost of LHV 44 tonne LHV vehicle-km to be 4% more.

Summing up costs of HGV and LHV we get the scenario 2 road transport costs. The following table presents results of the calculations:

Table 65: Total expenditures, 2020

S1 total expenditures:	329 146 million euro
S2 total expenditures:	305 155 million euro
S3 total expenditures:	324 029 million euro
S4 total expenditures:	322 586 million euro
S2 Difference, %	7.29 %
S3 Difference, %	1.55 %
S4 Difference, %	1.99 %
S2 Difference, abs:	23 991 million euro
S3 Difference, abs:	5 117 million euro
S4 Difference, abs:	6 560 million euro

The conclusion is that the total road transport expenditures in scenario 2 is some 7.3 %, for scenario 3 it is 1.55% and scenario 4 is 1.99 % cheaper than the road costs in scenario 1. This is logical, because in scenario 2 there are some 13 % less vehicle-kilometres made, however 1/3 of them are done by LHVs, which are 20 % more expensive in operation.

Important note: The CBA road transport calculations are done with 2005 road transport costs, but applied to road transport requirements of 2020.

1.2. Rail transport

There is no straightforward way to make CBA analysis based on the TRANS-TOOLS output, since the model produces tonne volumes, instead of tonne-kilometre volumes. To overcome this problem, we used Eurostat data on rail tonne-km per EU country, as well as the COMPETE project assessment of the cost of tonne-km transportation per country.

Table 66: Railways: Average costs per passenger-km (rail passenger) and tonne-km (rail freight) (data for 2005), COMPETE Annex 1.

	Rail: Average costs per pkm and tkm	
	Rail passenger (in EUR/pkm)	Rail freight (in EUR/tkm)
Belgium	0.35	0.12
Czech Republic	0.04	0.08
Denmark	0.16	0.35
Germany	0.16	0.13
Estonia	n.d.a.	n.d.a.
Greece	0.22	0.25
Spain	0.12	0.07
France	0.20	0.06
Irland	0.22	0.29
Italia	0.20	0.10
Cyprus *	–	–
Latvia	n.d.a.	n.d.a.
Lithuania	n.d.a.	n.d.a.
Luxembourg	0.39	0.36
Hungary	0.04	0.11
Malta *	–	–
Netherlands	0.25	0.23
Austria	0.23	0.10
Poland	0.03	0.05
Portugal	0.08	0.04
Slovenia	0.08	0.07
Slovakia	0.03	0.06
Finland	0.10	0.04
Sweden	0.09	0.04
United Kingdom	0.25	0.32
USA	0.11	0.01
Switzerland	0.21	0.23
EU 25 *	0.17	0.11
Western EU **	0.19	0.12
Eastern EU ***	0.03	0.06

To get the 2020 tonne-km rail transport volumes, we have indexed Eurostat tonne-km 2005 volumes by the factor of 1.61. This factor is used in TRANS-TOOLS to assess the future rail transport demand in Europe. Coupled together with rail costs per country, we obtained scenario 1 costs. Consequently, for scenarios 2, 3 and 4 we applied difference factor, calculated during scenario runs. The following table presents calculation results

Table 67: Rail expenditures, 2020

Scenario	Rail expenditures	Absolute difference S1	Difference, %
S1	64 897 million euro		
S2	62 221 million euro	2 676 million euro	4.12%
S3	63 823 million euro	1 075 million euro	1.66%
S4	63 696 million euro	1 201 million euro	1.85%

Important note: The rail volumes are extrapolated according to Eurostat 2005 data. The costs are calculated with 2005 euro costs and applied to 2020 volumes. The costs do not include terminal operation and transshipment costs.

1.3. Inland waterway transport

As it is the case with the rail transport mode, there is no straightforward way to make CBA analysis based on the TRANS-TOOLS output, since the model produces tonne volumes, instead of tonne-km volumes. Similarly to rail CBA, we used Eurostat data on aggregate European inland waterway volumes. We did not distinguish individual countries because there is no inland waterway cost data available on country level. The COMPETE report provides the European average inland waterway transport cost, which amounts to 0.008 euro/tonne-km.

Therefore, to make comparison between the costs of scenarios, we calculated volumes of scenario 1: it Eurostat aggregate 2005 European tonne-km volume times 1.61 (growth factor). Inland waterway transport tonne-km volumes of scenarios 2, 3, 4 were based on scenario 1 volume, adjusted according to TRANS-TOOLS scenario results. The following table shows the resulting costs.

Table 68: Inland waterway expenditures, 2020

Scenario	Inland waterway expenditures	Absolute difference S1	Difference, %
S1	1 773 million euro		
S2	1 723 million euro	50 million euro	2.85%
S3	1 733 million euro	41 million euro	2.29%
S4	1 751 million euro	22 million euro	1.23%

Important note: The inland waterway volumes are extrapolated according to Eurostat 2005 data. The costs are calculated with 2005 euro costs and applied to 2020 volumes. The costs do not include terminal operation and transshipment costs.

1.4. Total transport

The CBA of all transport modes under consideration concerns a cost comparison of the total transport scenario costs. The following table summarizes the computations.

Scenario	Total road expenditures	Total inland waterway expenditures	Total rail expenditures	Total expenditures	Absolute diff. to S1	Relative diff to S1, %
S1:	329 146 million euro	1 773 million euro	64 897 million euro	395 816 million euro		
S2:	305 155 million euro	1 723 million euro	62 221 million euro	369 099 million euro	-26 719 million euro	-6.75%
S3:	324 029 million euro	1 733 million euro	63 823 million euro	389 585 million euro	-6 233 million euro	-1.57%
S4:	322 586 million euro	1 751 million euro	63 696 million euro	388 033 million euro	-7 783 million euro	-1.97%

The last column represents relative cost saving in comparison to scenario 1: scenarios 2, 3 and 4 are all cheaper than scenario 1. The absolute cost difference, expressed in $euro_{2005}$ is between 8 and 27 billion euro, according to the scenario.

2. Safety

For safety issues a lot of indicators exist in literature. They start with biomechanical limit values like the HIC (Head Injury Criterion), go over to maximum lateral and longitudinal acceleration and steering behaviour and end with accident severity (Maximum Abbreviated Injury Scale, etc.) or fatal accidents per vehicle kilometre. Within the safety part of the study several calculations were conducted. The conclusive indicators for road safety of LHVs according input to the cost benefit analysis are aggregated risk factors. These risk factors are imposed to balance the findings below and to describe the impact of LHVs on accident occurrence. The risk factors present the change of road safety by percentage, i.e. a factor bigger one marks a higher risk and thus higher accident costs. According to research results the accident risk varies significantly to road types and hence they are different for all four road types of the used TRANS-TOOLS data. As the literature review hardly provides any data on accident costs for different LHV types this approach appears to be the most feasible.

The formula to calculate the total accident costs for the four scenarios within the following cost benefit analysis is presented below. The average accident costs are taken from Banfi et al. (2000)[62] and Viert et al.

[62] *Banfi, et al.* (2000): External Costs of Transport-Accident, Environmental and Congestion Costs in Western Europe. INFRAS/IWW. Zuerich/Karlsruhe. Switzerland, Germany

(2008)[63]. HDT 1 to 4 are different mass classes of standard heavy duty vehicles according to TRANS-TOOLS data as used in the cost benefit analysis.

$$accident\ costs_{Scenario_i} = \sum_{j=HDT1}^{HDT4} m_{i,j} \cdot \alpha_j + m_{i,LHV} \cdot \alpha_{LHV} \cdot \vartheta_r$$

Although the figures are aggregated and present estimated accident costs per vehicle-km /tonne-km [64] the calculations can show the tendency if LHVs would be permitted. The single variables within the formula are described below.

$$m_{i,j} = Mileage\ for\ each\ scenario\ and\ vehicle\ [km_{tkm/vkm}]$$
$$\alpha_j = Accident\ costs\ for\ existing\ vehicles\ [\frac{€}{km_{tkm/vkm}}]$$
$$\alpha_{LHV} = Accident\ costs\ of\ LHV\ [\frac{€}{km_{tkm/vkm}}]$$
$$\vartheta_r = Risk\ factor\ for\ LHV\ accidents \approx f(LHV_{type}, road_{type}, traffic)$$

The risk factors in the formula are estimated on the base of results from Knight et al. (2008) and findings from the safety workshop in Stuttgart. Knight et al. have introduced casualty rates to compare the different LHV configurations to standard vehicle combinations. However, the authors have stated that they have predicted these casualty rates for LHVs higher than they would occur in reality. To balance this results with findings on vehicle safety below the risk factors are estimated via an approximately 10 % reduction of the average value from Knight et al. (2008) on all assessed LHV types. The risk factors for LHVs as used in the calculations are presented in Table 1 below.

HDT type 5 describes LHVs with 40 t – 50 t GVW *(gross vehicle weight)* and HDT type 6 stands for LHVs with a GVW of 50 t – 60 t according to the vehicle classes as used in the TRANS-TOOLS and TREMOVE calculations. PK is the abbreviation for peak hour traffic (four busiest hours per day) and OP is for off peak traffic. Metropolitan road refers roads in capital cities and Ourban road refers roads in other urban areas. These descriptors are also taken from the TREMOVE data format.

Table 69: Risk factors for the accident cost calculation

	ϑ_r (HDT 5)	ϑ_r (HDT 6)
Motorway off-peak	1.1	1.125
Motorway peak	1.15	1.175
Rural road off-peak	1.2	1.225
Rural road peak	1.225	1.25
Metropolis road off-peak	1.3	1.35
Metropolis road peak	1.35	1.375
Other urban road off-peak	1.25	1.25
Other urban road peak	1.275	1.275

Even though the risk factors are estimated they provide an outlook on the development of accident costs within the four investigated scenarios of the cost benefit analysis. For each scenario, costs were estimated with the standard risk factors shown in the table above, as well as for a risk factor 30% lower, which gives

[63] *Vierth, et al.* (2008): The effect of long and heavy trucks on the transport system; report on a government assignment. VTI rapport 605a. VTI, Sweden
[64] vehicle-km refers vehicle kilometres and tkm refers tonne kilometres

an indication of risks when an array of electronic countermeasures is made mandatory. The high and low ranges of costs are based on calculation method (based on vehicle-km or tonne-km).

Table 70: Costs of safety: overview

		Scenario 1	Scenario 2	Scenario 3	Scenario 4
HIGH	Standard risk factor	31 920 million €	30 429 million €	31 714 million €	31 107 million €
	Reduced risk factor	31 885 million €	29 706 million €	31 578 million €	30 108 million €
LOW	Standard risk factor	18 363 million €	17 948 million €	18 320 million €	17 804 million €
	Reduced risk factor	18 302 million €	16 811 million €	18 110 million €	16 634 million €

3. Infrastructure

3.1. Maintenance

The traffic scenarios used in this study give the vehicle-km and tonne-km on the European road network, while useful data, as far as aggressiveness' calculation is concerned would be either the number of vehicle by class and by structure of pavement, or the number of tonnes carried, also by class and by structure of pavement.

Thus, the number of vehicle-km has to be turned into proportion of vehicles by class. The method used is to calculate $X_i = \frac{x_i}{\sum_j x_j}$, where:

x_i is the number of vehicle-km of the class HDT_i

X_i is the proportion of vehicles of the class HDT_i

Then, the percents of vehicles by class has been turned into percents of vehicles equivalent in matter of aggressiveness, multiplying the share of each class by the relative aggressiveness of the vehicle representative of the class: 40 t for HDT4, 44 t for HDT5 and average of 60 t combinations for HDT6.

Scenario 1 is the reference one. The last line of each table shows the variation of aggressiveness from scenario 1 to each scenario. To be as exhaustive as possible, scenario 4 is split in two cases, depending of the number of axles allowed for the compromise vehicle (5 or 6 axles). The results can be found in the tables below.

Table 71 Flexible pavement

	Scenario 1		Scenario 2		Scenario 3		Scenario 4 version 44 t 5 axles		Scenario 4 version 44 t 6 axles	
	% veh.	% veh. equivalent	% veh.	% veh. equivalent	% veh.	% veh. equivalent	% veh.	% veh. equivalent	% veh.	% veh. equivalent
HDT4	22.04	22.04	13.61	13.61	21.49	21.49	13.48	13.48	13.48	13.48
HDT5	-	-	-	-	-	-	7.67	12.59	7.67	9.84
HDT6	0.39	0.68	5.59	9.83	0.58	1.02	0.39	0.68	0.39	0.68
TOTAL		22.72		23.45		22.51		26.76		24.01
Difference to scenario 1				3.17 %		-0.95 %		17.74 %		5.64 %

Table 72 Bituminous pavement

	Scenario 1		Scenario 2		Scenario 3		Scenario 4 version 44 t 5 axles		Scenario 4 version 44 t 6 axles	
	% veh.	% veh. equivalent	% veh.	% veh. equivalent	% veh.	% veh. equivalent	% veh.	% veh. equivalent	% veh.	% veh. equivalent
HDT4	22.04	22.04	13.61	13.61	21.49	21.49	13.48	13.48	13.48	13.48
HDT5	-	-	-	-	-	-	7.67	12.96	7.67	9.57
HDT6	0.39	0.68	5.59	9.84	0.58	1.02	0.39	0.68	0.39	0.68
TOTAL		22.73		23.45		22.51		27.13		23.74
Difference to scenario 1				3.19 %		-0.95 %		19.36 %		4.46 %

Table 73 Thick bituminous pavement

	Scenario 1		Scenario 2		Scenario 3		Scenario 4 version 44 t 5 axles		Scenario 4 version 44 t 6 axles	
	% veh.	% veh. equivalent	% veh.	% veh. equivalent	% veh.	% veh. equivalent	% veh.	% veh. equivalent	% veh.	% veh. equivalent
HDT4	22.04	22.04	13.61	13.61	21.49	21.49	13.48	13.48	13.48	13.48
HDT5	-	-	-	-	-	-	7.67	12.96	7.67	9.57
HDT6	0.39	0.68	5.59	9.84	0.58	1.02	0.39	0.68	0.39	0.68
TOTAL		22.73		23.45		22.51		27.13		23.74
Difference to scenario 1				3.19 %		-0.95 %		19.36 %		4.46 %

Table 74 Semi-flexible pavement

	Scenario 1		Scenario 2		Scenario 3		Scenario 4 version 44 t 5 axles		Scenario 4 version 44 t 6 axles	
	% veh.	% veh. equivalent	% veh.	% veh. equivalent	% veh.	% veh. equivalent	% veh.	% veh. equivalent	% veh.	% veh. equivalent
HDT4	44.86	44.86	27.34	27.34	41.12	41.12	26.56	26.56	26.56	26.56
HDT5	-	-	-	-	-	-	16.77	92.83	16.77	51.47
HDT6	0.44	2.00	12.26	55.64	2.97	13.49	0.44	2.01	0.44	2.01
TOTAL		46.86		82.98		54.61		121.39		80.04
Difference to scenario 1				77.08 %		16.54 %		159.04 %		70.80 %

The table below shows the resulting variations.

Table 75: Variation from scenario 1

Kind of pavement	Scenario 2	Scenario 3	Scenario 4 (5 axles)	Scenario 4 (6 axles)
Flexible	3.17 %	-0.95 %	17.74 %	5.64 %
Bituminous	3.19 %	-0.95 %	19.36 %	4.46 %
Thick bituminous	7.57 %	1.65 %	26.86 %	8.08 %
Semi-flexible	77.08 %	16.54 %	159.04 %	70.80 %

This table shows clearly that:

- A 44 t, five axles vehicle would lead to the worst scenario since each cell of the column contains the highest value of its row. Once again, aggressiveness' expectations plead to avoid this kind of vehicle.
- Scenario 3 appears to be the one with minimum added aggressiveness.
- Semi-flexible pavement with heavy traffic is the most sensitive structure, since each cell of the row contains the highest value of its column.

This also leads to two proposals:

- Totally ban 44 t, five axle vehicles, although this means to do very strict and frequent controls.

- Avoid, as much as possible, itineraries which contain semi-flexible pavement with high traffic.

It is assumed that nowadays situation of traffic will lead, in average, to adding each year[65] the amount of pavement below:

- 0.5 cm of asphalt for flexible pavement and light traffic (0.58 if moderate traffic);
- 0.58 cm of asphalt for bituminous pavement and moderate traffic (0.676 if heavy traffic);
- 0.676 cm of asphalt for thick bituminous pavement and heavy traffic (0.58 if moderate traffic);
- 0.7 cm of asphalt, for semi-flexible pavement and heavy traffic (0.56 if moderate traffic).

Assuming that the extra number of asphalt centimetres required between two successive classes[66] of traffic is due to the fact that traffic is doubled, one can consider that the evolution of the value on maintenance is approximately the result of the product of the increase of aggressiveness by this extra number of asphalt cm. If traffic is doubled, the maintenances costs will wary as shown in the table below.

Table 76: Maintenance costs variation when traffic is doubled

		For 100% variation	
Kind of pavement	Previous number of asphalt cm per year	Extra centimetres / year	%
Flexible	0.5	0.080	16.00 %
Bituminous	0.58	0.096	16.55 %
Thick bituminous	0.676	0.096	14.20 %
Semi-flexible	0.7	0.140	20.00 %

Combining those values with relative aggressiveness variations, one obtains the maintenances costs variations in each scenario.

Table 77: Maintenances costs variations in each scenario

	Variation from scenario 1 to scenario n°			
Kind of pavement	2	3	4 (5 axles)	4 (6 axles)
Flexible	0.25 %	-0.08 %	1.42 %	0.45 %
Bituminous	0.31 %	-0.09 %	1.86 %	0.43 %
Thick bituminous	0.73 %	0.16 %	2.58 %	0.78 %
Semi-flexible	10.79 %	2.32 %	22.27 %	9.91 %

For the considered network (5 % of low traffic – flexible pavement, 15 % of moderate traffic - bituminous pavement and 40 % for each other kind of roads), one can build a rough indicator for each scenario of the variations of maintenance costs, in percentages.

Table 78: Additional road maintenance costs due to the introduction of LHV

Scenario 2	4.67 %
Scenario 3	0.97 %
Scenario 4 five axles	10.29 %
Scenario 4 six axles	4.36 %

Based on a total road maintenance cost of 16.8 billion euro (yearly) in EU27[67], the absolute values can be calculated.

[65] Annex to the French ministry's Circular n° 89-46 of August 8th, 1989
[66] T0 = light traffic, T = moderate traffic, T2 = heavy traffic.
[67] Source: ERF European Road Statistics., chapter 4.

Table 79: Yearly road maintenance costs due to the introduction of LHV

	Relative increase	Absolute increase
Scenario 2	4.67%	784.56 million euro
Scenario 3	0.97%	162.96 million euro
Scenario 4 five axles	10.29%	1 729.00 million euro
Scenario 4 six axles	4.36%	732.48 million euro

3.2. Bridges

For the effect on the investment costs in bridges, only a rough estimate could be made.

The BASt 2006 study[68] stated that for Germany, approx. 4 to 8 billion euro would have to be raised for the federal motorways for replacements or reconstruction of bridges. An extrapolation to EU27 based on the tonne-km[69] would give a cost of 22.9 to 45.8 billion euro.

Sweden invested in total 5.65 billion SEK between 1988 and 1998 in bridges. Not all of this investment was meant to accommodate for LHVs. An extrapolation of this number to EU27 based on the tonne-km[70] would give a cost of 26.7 billion euro. The 10-year long full Swedish bridge investment is thus on the low side of the projected German investment.

Also, one has to take into account the investment period (depreciation period). For bridges, this is 20 tot 40 years. Thus, a high and low range for the necessary bridge investments can be calculated. The result can be found in the table below.

Table 80: High and low scenario 2 for the investment costs in bridges

	Investment cost	Period (years)	Yearly investment
HIGH	45.757 billion euro	20	2.288 billion euro
LOW	22.879 billion euro	40	0.572 billion euro

Scenarios 3 and 4 were derived linearly equivalent with the pavement calculations.

4. CO_2 and noxious emissions

In this paragraph, a value is attributed to the CO2 emissions of transport. The abatement cost for 1 tonne CO_2 is estimated to vary between 20 € and 200 €[71] in 2020. Costs are estimated for both values, as well as for an intermediate value, set at 90 €.

The results of CO_2 emission and cost calculations are summarised in Table 81. Well-to-tank emissions are included, but not the other costs generated by alternative energy sources (to generate electricity).

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68 Effects of new vehicle concepts on the infrastructure of the federal trunk road network, Bast - Federal Highway Research Institute , Ulf Zander, et al., 2006

69 Germany had 17.48 % of all EU27 tonne-km on its territory.

70 Sweden had 2.11 % of all EU27 tonne-km on its territory.

71 At price level of 2000

Table 81: CO_2 emissions and costs: overview

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Road (transport)	106 692	102 870	106 069	107 339
Road (well-to-tank)	20 743	20 000	20 622	20 868
Rail (electric)	7 020	6 693	6 898	6 875
Rail (diesel)	3 352	3 222	3 314	3 294
Inland waterways	6 640	6 456	6 488	6 559
Total Emissions (kilotons)	**144 447 kt**	**139 240 kt**	**143 391 kt**	**144 935 kt**
Total cost (20 €)	*2 889 k€*	*2 785 k€*	*2 867 813 k€*	*2 899 k€*
Total cost (90 €)	*13 000 k€*	*12 532 k€*	*12 905 k€*	*13 044 k€*
Total cost (200 €)	*28 889 k€*	*27 848 k €*	*28 678 k€*	*28 987 k€*

Disaggregated emissions for NOx and PM (in tonnes) are monetised based on the CAFE programme valuations. Ranges (low value – high value) are established to cover uncertainty in the evolution of prices (see Table 82 and Table 84).

Unlike for CO_2, these values differ per country. As stated in the introduction, pollutants such as NOx and PM tend to have local and/or regional effects, rather than general impact on climate.

Table 82: Marginal external cost of NOx (in €-2000)

Country	Low value	High value
AT	8 700	24 000
BE	5 200	14 000
BG	5 400	15 000
CY	840	1 900
CZ	7 300	20 000
DE	9 600	26 000
DK	4 400	12 100
EE	810	2 200
ES	2 600	7 200
FI	750	2 000
FR	7 700	21 000
GR	840	1 900
HU	5 400	15 000
IE	3 800	11 000
IT	5 700	16 000
LT	1 800	5 000
LU	8 700	24 000
LV	1 400	3 700
MT	670	1 700
NL	6 600	18 000
PL	3 900	10 000
PT	1 300	3 200
RO	5 400	15 000
SE	5 900	5 900
SI	6 700	18 000
SK	5 200	14 000
UK	3 900	10 000

In each of the alternative scenarios, NOx emissions and the costs they entail are lower than in the reference case. The difference is smallest in scenario 4, where only 400 fewer tonnes are emitted. This is mainly due to the decreased volume for inland waterways, as the exhaust from road transport (both well-to-tank and tank-to-wheels) is notably higher with this setup.

Table 83: NOx Emissions and costs: overview

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Road (transport)	483 062	463 593	479 796	484 615
Road (well-to-tank)	69 123	66 647	68 720	69 543
Rail (electric)	6 365	6 095	6 302	6 250
Rail (diesel)	51 586	49 579	51 001	50 687
Inland waterways	110 267	107 204	107 740	108 909
Total emissions	**720 404 t**	**693 117 t**	**713 559 t**	**720 004 t**
Total cost (low value)	*8 685 k€*	*8 516 k€*	*8 628 k€*	*8 674 k€*
Total cost (high value)	*23 364 k€*	*22 904 k€*	*23 209 k€*	*23 334 k€*

PM emissions have been attributed a value based mainly on expected health costs. More densely populated regions like Germany, the Netherlands and Belgium are thus more vulnerable to an increased exhaust, and show remarkably higher external costs for particulate matter than for example Finland or Estonia.

Table 84: Marginal external cost of PM (in €-2000)

Country	Low value	High value
AT	37 000	110 000
BE	61 000	180 000
BG	25 000	72 000
CY	8 600	25 000
CZ	32 000	91 000
DE	48 000	140 000
DK	16 000	48 000
EE	4 200	12 000
ES	19 000	54 000
FI	5 400	16 000
FR	44 000	130 000
GR	8 600	25 000
HU	25 000	72 000
IE	15 000	42 000
IT	34 000	97 000
LT	8 400	24 000
LU	41 000	120 000
LV	8 800	25 000
MT	9 300	27 000
NL	63 000	180 000
PL	29 000	83 000
PT	22 000	64 000
RO	25 000	72 000
SE	12 000	34 000
SI	22 000	64 000
SK	20 000	58 000
UK	37 000	110 000

Costs of PM are lower in each of the alternative scenarios, much like NOx emissions. The "intermediate" scenario shows the most remarkable trend again. Emissions from road transport decrease, as fewer vehicle kilometres are made and less non-exhaust PM is produced. However, it was demonstrated in the previous chapter that CO_2 emissions is expected to increase with a limitation of 44t. Hence, well-to-tank emissions (by-products of fuel production) also go up. The decrease of the other elements of total PM emissions is sufficient to compensate the higher fuel consumption.

Table 85: PM emissions and costs: overview

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Road (transport)	11 511	10 545	11 365	11 298
Road (well-to-tank)	10 680	10 298	10 618	10 745
Rail (electric)	1 585	1 534	1 583	1 565
Rail (diesel)	3 297	3 169	3 260	3 240
Inland waterways	7 577	7 367	7 403	7 484
Total emissions	**34 650 t**	**32 912 t**	**34 229 t**	**34 332 t**
Total cost (low value)	*2 465 k€*	*2 401 k€*	*2 443 k€*	*2 452 k€*
Total cost (high value)	*7 161 k€*	*6 975 k€*	*7 098 k€*	*7 122 k€*

5. Conclusions

To conclude, all costs and benefits were added in one table. Positive numbers indicate a benefit to society, negative numbers a cost. The table indicates the EU27 effect for the year 2020, with current price levels.

All scenarios give an overall positive effect on society, with scenario 2 (the full option LHV) showing a greater benefit than scenarios 3 and 4. The main reason for this, is that society has to spend less money for transporting the same (even slightly more) goods. LHV vehicles seem to be more cost-effective than current heavy goods vehicles. They transport more tonne-km (+1 %) with less vehicle-km (-12.9 %). Even when some transport is shifted from rail (-3.8 % tonne-km) and inland waterways (-2.9 % tonne-km) to road, the road transport sector still saves money.

Additionally, positive effects were predicted for safety and emissions, both mainly due to a reduction in road vehicle-km (-12.9 %), despite the fact that the individual LHV is more unsafe and more pollution than a regular truck.

The only negative impact is the high costs to road infrastructure. Higher investments in maintenance and bridges will be needed, though these investment costs are lower than the savings in the transport sector, and in society (emissions and safety).

Scenario 4 has a much lower positive impact than scenario 2, as the smaller variant is not so efficient for the transport sector. Also, this type of truck is less beneficial for safety, and has even a negative impact on emissions, while the investment costs for maintenance and infrastructure are about as high as for the full size LHV.

A remark has to be made on the scope: the table indicates the costs and benefits for EU27. Huge differences between countries can occur.

Table 86: CBA overview

		Scenario 2 vs. 1	Scenario 3 vs. 1	Scenario 4 vs. 1
Benefits of operating costs	Total road expenditures	23 991 million €	5 117 million €	6 560 million €
	Total rail expenditures	2 676 million €	1 075 million €	1 201 million €
	Total inland waterway expenditures	51 million €	41 million €	22 million €
Road Safety	Low cost/standard risk	415 million €	43 million €	559 million €
	Low cost/reduced risk	1 492 million €	192 million €	1 668 million €
	High cost/standard risk	1 491 million €	207 million €	814 million €
	High cost/reduced risk	2 180 million €	307 million €	1 777 million €
Infrastructure – maintenance	Low value	-785 million €	-163 million €	-733 million €
	High value	-785 million €	-163 million €	-1 729 million €
Infrastructure – bridges	Low value	-572 million €	-119 million €	-534 million €
	High value	-2 288 million €	-475 million €	-5 041 million €
CO2 emissions	Low cost	104 million €	21 million €	-10 million €
	Medium cost	469 million €	95 million €	-44 million €
	High cost	1 041 million €	211 million €	-98 million €
Noxious emissions: NOx	Low cost	169 million €	57 million €	11 million €
	Medium cost	460 million €	155 million €	30 million €
Noxious emissions: PM	Low cost	64 million €	22 million €	13 million €
	Medium cost	186 million €	63 million €	39 million €
CBA total	**LOW value**	24 397 million €	5 737 million €	1 587 million €
	HIGH value	29 228 million €	6 687 million €	8 265 million €

IX Conclusions and recommendations

1. Conclusions

a. The current directive

Directive 96/53/EC regulates weights and dimensions of heavy commercial vehicles within the territory of the European Union. Now twelve years old, the directive may have reached its limitations, and risks to become a barrier to the natural growth of the freight transport market. This study was commissioned by the Directorate General for Energy and Transport, to investigate the possible effects of changing the directive to allow for longer and/or heavier vehicles in international transport. A number or alternatives were suggested, among which the modular concept.

The current regulation permits trucks of maximum 16.5m (1 point of articulation) or 18.75m (1 or 2 points) in length, 40 tonnes in weight and 4m in height to circulate across European borders. For intermodal traffic, 44t was the maximum. The directive also sets limits for axle loads and overhangs. Countries are allowed to set the maxima at higher levels, but only on their own territory. The modular concept, with limits of 25.25m and 60t, has been in use for years in Sweden and Finland. Several countries have set their maximum load at 44t instead of 40.

The directive also covers passenger transport by coach. This study does not cover that domain, but focuses solely on freight transport.

b. Arguments of the stakeholders

As there is an enormous amount of stakeholders involved in the market, consultation of as many of them as possible was a major part of the task performed in this project. A first consultation round was organised to raise awareness for the study, followed by more elaborate exchanges between the consortium and various experts in the form of small regional workshops. Parallel with these moments of live interaction, an internet questionnaire was set up to allow the maximum number of stakeholder to contribute to the discussion.

Live stakeholder consultation yielded varied results. A clear distinction in background could be made between participants.

A large group of supporters was found in shippers, hauliers and manufacturers, all potential beneficiaries of the expected decrease in transportation costs that increased weights and dimensions may entail. Authorities of the few countries were the modular concept has been used or successfully tested have also shown a positive attitude towards a change in the directive.

Opponents of such a change are equally numerous. Governments of large countries such as France, Germany and United Kingdom, and of Alpines and Eastern European countries are reluctant to modify the current Directive, and above all to increase the weight and dimension limits (see annex 3b). Operators or representative organisations of rail and inland waterways, which are at risk of losing volume as a result of a change, hold on firmly to prevent any disturbance in the current market situation. Environmental organisations, albeit with a different agenda, are generally opposed to a modification without compensation on other levels. A final group of opponents are authorities in charge of road infrastructure.

The main arguments cited as favourable to an increase of dimensions include:

1. Decrease of operational costs due to greater loads
2. Decrease of emissions (CO_2, NOx, PM)
3. Positive impact on safety as fewer trucks are needed for the same amount of transported goods
4. Driver shortage is alleviated

However, the first argument is also used by the opponents to assess the risk of an increase of the whole demand and a transfer from the rail and waterborne back to road.
The third argument contained high uncertainty, as it had not been proven that fewer but longer vehicles would be safer. This is one of the main topics addressed in this study.

Supporters of the modular concept additionally claim that the flexibility of the system permit its introduction at a marginal investment from transporters. Other concepts state increased loads without any substantial changes to the current setup of the vehicle are possible as well.

Opponents to the system have an extensive list of objections, of which the most important are:

- Changes in competitive position (price) will push other modes out of contention, causing a domino effect (entire lines being lost), or at least will induce a transfer from less polluting and CO_2 emissive modes to the road, and thus have negative impact on environment.
- Reduced cost will generate more demand, causing increased emissions and congestion.
- Road, tunnel, bridge infrastructure could suffer greatly.
- If accidents occur, damage will be higher, and in numerous sections of the infrastructure, longer vehicles may induce insecurity to the other road users.

However, a large majority of stakeholders claim that a volume increase is much more important than a weight increase. At least for infrastructures, it seems that a lorry of 25.25 m and 50 or 52 ton would not be significantly more aggressive than the current 16.5 m and 40 tonne lorry. A compromise concerning the load limit between the current 40 tonne and the Swedish 60 tonne is a possibility.

c. Scenarios and Assessments by Criteria

In conjunction with and based on stakeholder consultation as well as discussion with the European Commission, the scenarios were defined. The year to be investigated was set at 2020.

Four LHV scenarios for 2020 have been studied:

- *Scenario 1: "Business as usual"*. This first scenario assumes no changes to the road transport equipment constraints that were valid in 2000. The scenario takes into account projected economic developments and projected transport demand in Europe until 2020. All other scenarios take this one as the reference/base case.
- *Scenario 2: "LHV Full option": Europe-wide permission of 25.25 m 60 t trucks*. These LHVs trucks are allowed on all European motorways (i.e. backbone roads). The usage of LHVs on regional roads may be restricted.
- *Scenario 3: "Corridor/Coalition": LHVs of 25.25 m 60 t are allowed in some countries, while Europe-wide only 18.75 m 40 t trucks are allowed.* This scenario is a mix of scenarios 1 and 2. There is a group of

countries that permit LHVs on their motorways, possibly putting some restrictions for the usage of regional roads, while the rest stick to the current restrictions (40t and 18.75m). We include into the coalition 6 European countries: NL, BE, DE, SE, FI, DK.

- *Scenario 4: "Intermediate": Europe-wide permission of up to 20.75 m 44 t trucks*. This scenario represents a gradual increase in vehicle constraints, namely 10% of carrying capacity. The choice of dimensions and constraints is "realistic" and reflects wishes of car transporters and chemical industry.

d. Transport Modality and Modal Shift

The introduction of LHVs is expected to reduce the road transport cost by 15 to 20% in comparison to normal HGV trucks (depending on the scenario and on some external factors, e.g. fuel cost). A lot also depends on the penetration of LHVs in the heavy vehicle stock. As a result of the decreased costs, demands shift may occur. The modal shifts expected if LHVs are introduced are assessed in chapter IV, using three approaches.

In scenario 2, the road volumes are expected to increase by 0.99%, while rail and waterway volumes would respectively decrease by 3.8% and 2.9%. However, using the assumption of a very price-sensitive market, a road transport growth of 13% could be reached, while rail and inland waterways would decline by 14% and 11% respectively. Approximately 30 % of heavy cargo traffic would be carried out by LHVs.

On the other hand, the number of vehicle-kilometres done by HGVs (LHV is a sub-class of heavy goods vehicles) declines by 13 %. It should be noticed that the decrease of vehicle-kilometres happens in heavy cargo traffic. There is a large variation in change of vehicle kilometres over the countries. The most affected countries are big and sparsely populated countries with clear aggravation of population and economical activity, such as Spain, Finland and Greece.

The figures with scenario 3 are similar, except for the waterway decrease which would be almost by -9% because the concerned regions are the most performant for waterborne operation. With scenario 4, the changes would be less, with an increase of road volume by 1.7 to 4% (or +0.4% with the TRANS-TOOLS approach) and a decrease by rail and waterway by –2 to –5% (and a decrease in the number of vehicle kilometres by 3.4 % with the TRANS-TOOLS approach).

There is an interesting comparison between scenarios 3 and 2. The countries that are not included into the coalition/corridor are not noticeably affected. The road volumes and cargo traffic in countries that are included into the coalition respond differently. For instance, for the Netherlands there is almost no difference between scenarios 2 and scenario 3, while Belgium and Germany would witness bigger differences.

Beside that, a too quick or too broad introduction of LHVs would also deeply affect the small and medium size road transport companies, which would be unable to invest in a short term period on new longer vehicles and more powerful tractors, and then could highly suffer from the large company's competition and the decrease of the transport cost.

However, despite the risk of more intense competition between road, rail and waterborne, the growing transport demand (expected to grow by 1.5 to 2% per year in the future) will allow rail and waterways to continue growing. There is no downward spiral projected. Any volume decline could even be alleviated with the appropriate countermeasures and road pricing implementation.

e. Road Safety

The assessment of road safety aspects when permitting LHVs in road traffic did not reveal an inherent increase of safety risks in general. First, LHVs are expected to be newly designed and well equipped vehicles, with the latest safety technologies. Moreover, their drivers are expected to be chosen among the most experienced and the safest ones. Finally, the experience of Sweden is difficult to generalize, because this country has a low traffic density compared to continental Europe and is one of the safest countries with respect to the driver behaviour. The Dutch experience with less than 200 LHVs is also very difficult to generalise because of this very limited number of vehicles. However, there may be a higher risk for some LHV combinations regarding handling characteristics. Vehicles which are not (only) longer but just heavier may induce more severe accidents and casualties. In general it can be stated that a slight increase of length or mass would not lead to a high decrease of road safety and that from the safety point of view there are no additional risks predicted if the longer semi-trailer is to be permitted. Any extra risk would certainly be carried by the other users (cars, motorbikes and pedestrians), rather than by the LHVs themselves.

This has to be balanced with the potential reduction of lorries that LHVs may provide. If a reduction of the total amount of heavy duty trucks is effective, safety will increase. This increase would balance out the increased risk factor of the individual vehicle.

The risk increase could be controlled and even avoided by a proper signalling of the LHVs in all circumstances, by some safety driving rules (e.g. minimum spacing, route limitation, etc.), and a sufficient teaching of the other road users. The issue of speed differences with the HGVs in slippery roads and on ramps shall be investigated to avoid congestion.

f. Infrastructure

The impacts that result from the traffic of different combinations of vehicles, with different gross vehicle weights, driving on different kinds of pavements and bridges were assessed in chapter VI. Compared to the current 5 or 6-axle lorry (2 or 3-axle tractor and a semi-trailer with a tridem axle), it was shown that some configurations are very aggressive and should be avoided, while some other do not induce significantly more damage to infrastructure.

In brief, the 5-axle tractor with semi-trailer with 44 tonne or more is at least twice as aggressive for pavements, and also more damaging for bridges. It also cannot comply with the maximum axle load limitation of 11.5 tonne of the Directive.

A 44 t 6-axle tractor with semi-trailer (scenario 4) only would have moderate additional impact on infrastructures, above all if its length is increased compared to the current one of 16.5 m.

The long EMS (25.25m) with a gross weight up to 50 or 52 t do not show more aggressiveness for road infrastructure such as pavements and bridges. With a gross weight up to 60 t, some bridge lifetimes would be affected and higher investments in bridge maintenance and replacement will be needed. The impact on pavement rutting and fatigue would require more investigations, above all with a better knowledge of the effects of a series of close axles (boogies and series of axles of the same vehicle).

In any cases, heavier vehicles would require some investments for infrastructure safety equipment, such as safety barriers, bridge pier protection, emergency stopping lanes in the downhill road sections, etc. A significant impact on the design and operation of lorry parking lots is also expected, with a reduction of the number of available slots and some redesign of accesses. Because in many European countries there is already a lack of lorry parking slots, this issue shall be investigated in more details, above all with road and motorway operators.

However, infrastructure investment costs could be lower than the savings in the transport sector, and in society (emissions and safety), and could also be paid, as done in Sweden for bridge maintenance and repair, by specific taxes on lorries.

g. CO_2 and noxious emissions

If 3 HGVs are replaced by 2 LHVs, there would a benefit in terms of CO_2 and other gas emission per tonne-km, even if the engine powers are slightly increased. This increase will be balanced by more advanced standards and technologies of vehicles and engines.

The energy consumption is predicted to go down when LHVs are introduced (scenario 2). The main reason for this is the fact that 60 t vehicles are 12 % more efficient in terms of fuel consumption per tonne-km performed. This effect is bigger than the predicted increase in tonne-km by road. CO_2 transport emission would decrease by 3.5%, NOx transport emissions by 4 %, and PM by 5 %, mainly due to less non-exhaust PM: fewer kilometres driven cause less resuspension and mechanical wear.

In the scenario 3, the effect is almost 4 times smaller, as only 6 countries allow LHVs.

In the scenario 4, there would be an increase of 0.6 % in emissions. This implies that the efficiency gain caused by the increase from 40 t to 44 t gross vehicle weight is insufficient to offset the extra emissions of the higher transport demand. Moreover, using a heavier vehicle (with one extra axle) proves to be lethal to even an improvement in cost per tonne-km: it increases by 0.3 %. The extra load that can be carried does not offset the extra fuel consumption required to do so. The NOx emissions are up by 0.3 % compared to the scenario 1 (“business as usual”). PM emissions from transport are down however, by 1.8 %.

h. Cost Benefit

According to the cost-benefit analysis (CBA) performed in this study, all scenarios give an overall positive effect on society, with scenario 2 showing a greater benefit than scenarios 3 and 4. The main reason for this, is that society has to spend less money for transporting the same (even slightly more) goods. LHV vehicles seem to be more cost-effective than current heavy goods vehicles. They transport more tonne-km (+1 %) with less vehicle-km (-12.9 %). Even when some transport is shifted from rail (-4 to -15 % tonne-km) and inland waterways (-3 to -11 % tonne-km) to road, the road transport sector still saves money. However, the CBA analysis results highly depend on the model and above all its parameters such as the elasticities. Within this study, limited in time and budget, it was not possible to perform several calculations and thus the conclusions should be taken with care. The assumptions made on the elasticities and provided by a literature study require complementary calculations with other assumptions to reinforce or balance the conclusions.

i. General Conclusions

The concept of LHVs and EMS (European Modular System) may clearly provide some beneficial solutions to the main issues encountered in freight transport in Europe:

- quick increase of the freight transport demand, and of the lorries on the road network,
- more and more road congestion, in relation with the slow expansion of the road networks under the pressure of environmental constraints and public budget cuts,
- the need to reduce the CO_2 and other noxious emissions from road transport,
- a lack of lorry drivers all across Europe,
- the slow increase of the other mode transport offer, mainly rail and waterways.

The most advanced technologies seem to provide effective and safe enough vehicles to be operated in longer and heavier combinations than specified in the current Directive 96/53EC. Even if the experience of a few Northern countries, or of small scale experiments in the Netherlands and a few other countries cannot be generalized to the whole Europe, and above all to large and heavy trafficked countries such as France, Germany and United Kingdom, or to the Alpine and Eastern countries, there is no evidence of strong negative impacts of LHVs on road safety and infrastructures, if the relevant investments are done. Though the costs and benefits for EU27 show a positive effect, huge differences between countries can occur.

However, LHVs could have a significant impact on the road transport costs, which could be beneficial for the clients or the largest road transport companies, but could also affects the competition with other transport modes, mainly rail and waterways, and the SMEs in road transport. That may induce an increase of the whole transport demand and a modal transfer from rail and waterways to road. While the cost benefit analysis and the modality study highly depend on the chosen models and parameters, such as elasticities and also on external factors (energy cost, PIB growth, etc.), it is extremely difficult to accurately predict such effects. In any case, if LHVs are introduced in Europe, on a general level or only for willing countries, a careful follow up should be made by the European Commission to survey the modal shift in both directions (road to other modes and reversely and transport cost), and if needed, some financial mechanisms (taxation or others) planned to counter any negative effect.

Most of the negative effects on infrastructures and road safety may be accounted for or avoided if appropriate counter measures are taken (see the recommendations below), and if the relevant investments are done on infrastructures, vehicle safety equipment and signs, driver training, including motorbike and car drivers, and pedestrian information. Also a progressive introduction of LHVs would be suitable with route or time of operation limitations, and some measures to avoid a too fast and strong competition with rail or waterways lines under developments or not saturated.

Among the proposed scenarios, the scenario 4 (44 tonnes on 6 axles) does not fulfil all the expected benefits, above all on the environment. However, it could be a short term answer for some industry (e.g. chemical good transports or heavy goods), with a little risk vs. all the criteria. If this vehicle may be slightly extended in length to welcome the 45 ft containers, it would also be a valuable solution to develop intermodal container transport. In any cases, the 44 tonnes and 5-axle lorry should be strictly prohibited as much more aggressive for bridges and pavements, and not complying with the maximum axle load limitation of 11.5 t. A transition period for adaptation could be allowed for countries which already allowed these lorries (e.g. France, Belgium, Italy).

Because most road transport operators expressed more concerns on the volume limitation than on the load limitation, the scenario 2 could be suggested with EMS of 25.25m but with a gross weight limitation of 50 or 52 tonnes in a first step. Scenario 3 could eventually accept the 60 tonnes upper limit on a joint agreement of the concerned countries. Increased infrastructure costs could be covered by a road pricing system to be developed.

Intermediate steps with LHVs of 20 to 22 m and up to 48 or 50 tonnes were also envisaged, but it is obvious that not using the current modules (trailers and semi-trailers) would lead to huge investments for transport companies, a waste of material, while the railway companies and intermodal operators already designed and invested a lot of money in wagons adapted to the current module lengths.

2. Recommendations

2.1. General recommendations

The general recommendation is that introducing LHVs in Europe can be done without harming European society as a whole.

However, some effects will need countermeasures:

- Rail and inland waterway transport will grow somewhat less than expected, leading to a risk of local rail lines getting into difficulty.
- The safety of the individual LHV may be worse than of a smaller truck, mainly for other users and in case of an accident.
- Infrastructure investments need to be paid.

In a scenario were the EC sets minimum standards, and countries can choose themselves to allow LHVs (scenario 3), benefits are substantial.

However, there is concern on timing. The vehicle length increase, if approved, cannot be done on a step-by-step basis, because: (i) the modular concept (EMC) based on new combinations of the existing units seems to be the only economical modus operandi; it would be a waste of money and material, to change all the trailers and semi-trailers to gain 1 or 2 m in length; (ii) increasing the length in more than one step would lead to design and market new units (trailers and semi-trailers) for a limited period of time.
As such, the choice will be between scenario 1 (no change) and an increase up to 25.25 m, which should be announced well in advance, in order to allow for stakeholders to make the necessary changes in vehicle stock and counter measures to be implemented.

However, any weight limit increase could easily be implemented step by step. First allowing for example 48 or 50 tons for LHVs of 25.25 m would attenuate the negative effects on infrastructures and some of them on road safety, as well as avoid a too strong competition between road transport and other modes. Moreover, the demand of most of the stakeholders is mainly on more volume, rather than more weight. After collecting a number of years of experience, a new assessment of costs and benefits can be made with more accurate figures. Depending on the outcome of that CBA, loads could easily be set at a higher level, e.g. 55 tons or 60 tons.

2.1.1. Countermeasures

a. Countermeasures on infrastructure

- A 44 tonne on 6 axles (or 50 tonne on 7 or more axles) does not create much damage. However, a 44 tonnes on 5 axles is very bad for infrastructure, and should not be allowed.
- LHVs should be equipped with advanced (or future) anti roll-over systems, which better anticipate the phenomenon.
- Eastern European countries are worried about the quality and design of their road network. They may be not prepared to welcome LHV. Certification of roads for LHV might be the solution, not suitable road may have restrictions for LHVs. The renewal of the road network should be encouraged.
- On long span bridges (e.g. span longer than 50 m), a minimum spacing could be imposed to all the lorries above a given gross weight, e.g. 50 m above 40 tonnes. The same would apply on motorways and highways close to the exits.
- On some bridges (with a reduced load capacity), lorry overtaking could be forbidden for all heavy commercial vehicles (i.e. more than 3.5 tonnes), or for some of them (above a given gross weight). Moreover, some crossing monitoring and control systems could be installed on some bridges, as developed in Heavyroute.
- Bridge WIM monitoring systems would also provide useful tools to survey the traffic loads and load effects on particular bridges.

b. Countermeasures on safety

- Strong limitations of LHVs overtaking would be needed.
- A minimum (increased) spacing between LHVs shall be required in some road sections for the other road users' safety and comfort, such as on motorways and highways close to the exits, or on slippery roads.
- LHVs should be easily identifiable, at day and night, or in low visibility conditions, by clear marks (signs).
- A mandatory on-board system to monitor the wheel and axles loads, the gross weights, and the load balance within the vehicles with an electronic record (as for the driving time).
- Air suspensions with periodical mandatory checks should be used.
- EBS *(electronic braking system)*, spacing control systems, lane departure warning systems should be installed and in operation on LHVs.
- Eventually a specific qualification for LHVs driver.
- The design of LHVs engines should avoid too large speed differences with other HGVs in slippery roads, which could lead to more congestion.

c. Countermeasures on modal choice

- Several stakeholders have pointed to the fact that road freight transport does not pay its full cost at this moment as an argument against increasing weights and dimensions of heavy commercial vehicles. Although the argument of incomplete payment is not directly relevant to the discussion on dimensions, it should be accounted for in the total freight transport picture. Ideally, every cost that is the result of an action should be paid by the one performing the action. It should be noted that this reasoning does not solely apply to road transport. Fair competition can only be achieved when every mode is held accountable for all costs it causes.

- As done in Sweden, if LHVs are allowed, a taxation system can be introduced, both to partly compensate the gain of productivity (and share it between transport modes), and to finance bridge (and if needed pavement) reinforcement.
- As in the Netherlands, LHVs could only be permitted on some given routes, and/or during certain periods of the year/week/day. The route restriction would not only address road safety issues, but also avoid a competition against the combined, railway or waterborne transport, and thus avoid any modal transfer.
- Alpine countries have already huge part of transport on rail and would not encourage LHV. However, they already plan to raise taxes on road transport.

All these (and may be other) countermeasures could help to decrease the negative impacts on infrastructures, road safety and unwished modal shift. Some possible additional countermeasures should be investigated later, along with proposals for any Directive changes.

2.1.2. 45 ft container

The 45 ft container currently does not fit within the maximum dimensions set by directive 96/53/EC. It would need an extra length of 12cm. Testing with a number of slightly longer vehicles (e.g. the concept of the Kögel company) has not shown any practical issues with such a relaxation of regulation

It is important for several industrial sectors to get lorries which can carry 45 ft containers. A limited increase of the current vehicle length could accommodate that, but only on 6-axle lorries if the gross weight is more than 40 tons. As such, permitting 45 ft containers in international road transport would lead to a better harmonisation, but will only have a modest impact.

2.2. Other points

2.2.1. Road pricing

Several stakeholders have pointed to the fact that road freight transport does not pay its full cost at this moment as an argument against increasing weights and dimensions of heavy commercial vehicles. This study has demonstrated that different types of external costs do not behave uniformly when such a change is made. Demand generation and modal split greatly determine which of the effects will dominate.

Although the argument of incomplete payment is not directly relevant to the discussion on dimensions, it should be accounted for in the total freight transport picture. Ideally, every cost that is the result of an action should be paid by the one performing the action. These external costs include emissions, congestion, infrastructure, accidents, etc. In road transport, this implies that road pricing system should be instated that 1) calculates the exact cost generated by a move of freight; and 2) allows the charging of this cost to the mover. Such systems exist already in a number of European countries, although not as elaborate as desirable.

It should be noted that this reasoning does not solely apply to road transport. Fair competition can only be achieved when every mode is held accountable for all costs it causes. The valuation of external effects is not an easy process however, and might be the subject of a tense political discussion.

2.2.2. Enforcement

Many of the same stakeholders from the previous section have also made the argument that the first priority should be to enforce current regulation, rather than making current regulation less restrictive.

This study has taken the assumption that legal limits and regulations are respected. Evidently, when infractions are common, the outcome of calculations for several of the effects could be entirely different (e.g. overloading causing more infrastructure damage, not respecting driving time or speed limits decreases safety, etc.). Enforcement is a key issue to maintaining a strong and credible freight transport system.

The most interesting concept in enforcement is the weigh-in-motion system, which even can become automated in future.

Therefore, any change (increase) of the permitted load (and length) of heavy commercial vehicle should be accompanied by a better control of overloading and oversizing, as well as overspeeding, to avoid an unfair competition with the other transport modes or between road transport companies. That would also contribute to balance any negative effect on road safety and infrastructure durability. While the ITS technologies quickly progress, it is recommended to impose on future lorries, first on LHVs and then on all HGVs.

It is thus recommended to develop automatic systems for overload (and overspeed) screening and enforcement, using both road side and on-board sensors and equipments (including Weigh in motion: WIM). Efficient and automated WIM systems shall be developed and implemented to strictly avoid overloads of LHVs and even reduce the general overloading rate, to compensate the effects of these new vehicles.

2.2.3. Implementation mechanism

If the directive 96/53 EC is modified, and the concept of LHV (EMC) is implemented in EU member states, it would be recommended to do so respecting the necessary delays, on a win-win agreement between the involved parties.

A scenario for that could be to propose a list of specifications which have to be met by the carriers which apply to get a licence to operate LHVs. These specifications could contain:

- a list of safety equipments to be installed and operated in the LHVs,
- a detailed list (map) of the itineraries and periods of time on which the LHVs can be operated,
- a list of monitoring and survey equipments (e.g. on-board WIM, GPS…) with the data to be recorded and transmitted on real time to a concessionary operator, in charge of checking that the LHVs operation comply with all the specified rules.

The carriers which fully satisfy the specifications and sign a chart to respect them will get a licence (e.g. temporarily for a test period first, and then, after a given amount of time without violation report, permanent).

The concept would be that all the LHVs are remotely monitored by a concessionary independent company or independent organisation (as done in Germany for the truck tolling system), which ensures that all the rules are respected; which reports any violation to the governmental authorities; and which may suspend or cancel the licence of the violators.

The licences could be given for a limited number of LHVs by company fulfilling the required specifications, and then progressively increased if the experience is satisfying regarding all criteria of evaluation. In such a way the competitiveness of the SMEs (carriers) will not be too much affected by a quick transfer from current HGVs to LHVs, as well as the railway, waterway and combined transport sectors. It will give time to them to adapt and improve their technology and competitiveness.

The concessionary company or organisation in charge to operate the system is placed under the control of the member states, with representatives of the main professional unions or organisations involved.
If the scenario 2 is adopted, each member state could then sign an agreement with the concessionary company or organisation on a voluntary basis to join the set of countries in which LHVs are accepted.

2.2.4. Heights

Heights have not been a major part of discussion in this study. One of the stakeholders has made a strong push to abandon all height regulations, as is already the case in a number of countries. For car transporters, working with loads outside the net dimensions of the transport vehicle, significant gains can be made. Effort will however need to be made to map all bridges and other infrastructure where height may be an issue.

2.2.5. Noise

Noise emissions have not been considered in this study. The point can however be made that noise production is closely related to vehicle-kilometres, number of axles and axle load. The effect on human beings and the rest of the environment (noise perception) is not linearly related to actual noise level.
The overall effect is likely to be small compared to the base case situation.

2.2.6. Coaches

This study was solely directed at researching the freight transport market. However, directive 96/53/EC also contains regulation on weights and dimensions of coaches, for passenger transport. Some stakeholders have made the request to study this topic.

2.3 Further actions needed

If a decision would be taken to allow a form of LHV in Europe, we strongly recommend a complementary study on technical aspects carried out by a group formed by all stakeholders. This study should focus on the details on how to change the directive and which counter measures to take and implement. Also, a common test throughout Europe can be performed. A likely adapted frame of such a process could be a COST transport action.

Additionally, due to the very short timeframe this study has been conducted in, only a specific set of assumptions could be checked. While the consortium for this study has attempted to balance the maximum amount of stakeholder opinions, a selection of assumptions had to be made in coordination with DG TREN.

Mainly in the matter of determining demand and modal split, a broad range of possibilities in elasticities has been available. To provide a clear view of the outcome in different circumstances than those that were assumed in this study, a thorough analysis needs to be performed. Chapter IV, paragraph IV4 already contains a first step towards the setup of this extended research. Ideally, all parties involved in the transport market should agree on the data sets to be used.

Annex 1: Literature Review Sheets

Title:	**Working group on heavy vehicles: regulatory, operational and productivity improvements, ToR**		
Year:	2007	Language:	ENGLISH
Authors:	Affiliation:		
OECD, ITF			
Web link:			
Scenario	No		
Opinion	No		
Data	**Summary:** this document is the draft terms of reference of a joint ITF / OECD Transport Research Committee on Heavy Vehicles. This working group intends to investigate the recent safety performance of heavy vehicle operations in member countries. The tasks will consist in: • Examining the safety and environmental impacts of current heavy vehicle operations procedures; • Making an inventory of regulatory measures and enforcement practices; • Assessing the effects of changing the vehicles' weight and dimensions, articulations and technologies on their safety, the environment, the compatibility with the road infrastructure and the acceptance by the other road users; • Evaluating the potential effects of improved regulatory and controlling measures. EMS do not form the core issue of this study but could be addressed a separate issue. Most information will come from a few benchmarking studies undertaken across the working group's member states.		
Experts identified:	Affiliation:		
Reviewer's remarks:			
A performance based standard study on the vehicles allowed in each country will necessarily deal with longer and heavier vehicles. This study will compare all kind of vehicle combinations with regard to many parameters, but unfortunately its results were not available on time for our study.			

<table>
<tr><td>Title:</td><td colspan="4">Een quick scan bij drie bedrijven naar de mogelijkheden voor een eerste stap op weg naar een landelijke netwerk goederenvervoer, De inzet van road trains voor Campina Melkunie, Laurus and Technische Unie (A quick scan at three companies into the opportunities for a first step towards a national network for freight transport, the use of road trains for Campina Melkunie, Laurus and Technische Unie)</td></tr>
<tr><td>Year:</td><td colspan="2">2000</td><td>Language:</td><td>Dutch</td></tr>
<tr><td colspan="2">Authors:</td><td colspan="3">Affiliation:</td></tr>
<tr><td colspan="2">Matthieu van der Heijden and Mirjam Iding</td><td colspan="3">TNO</td></tr>
<tr><td>Web link:</td><td colspan="4"></td></tr>
<tr><td>Scenario</td><td colspan="4">This report gives the results of a quick scan at three companies in the Netherlands in the year 2000. The objective of the quick scan was to analyse the opportunities for using road trains in the national distribution networks of:

• Campina Melkunie, one of the major Dutch dairy manufacturers
• Laurus, one of the major Dutch supermarket chains
• Technische Unie, one of the major wholesaler of technical-electronic equipment

For this research, only the most promising transport flows were analysed, and these were the Full Truck Loads (FTL). The most important criterion for analysing the advantages was the difference in total transport cost between road trains and traditional road haulage.</td></tr>
<tr><td>Opinion</td><td colspan="4">Because Campina had much more volume than either Laurus or Technische Unie, it would be best to start here with a pilot. For Laurus, cooperation with other supermarket chains would be especially advantageous. Also, next to the average distance for transport (when the distance is longer, road trains become more attractive), the density of the network is important. The denser the network of roads that can be used, the more attractive road trains are to especially Laurus. The total operational transport cost benefit of using road trains would be in the 10-25% range for each of the three companies.

TNO advises to aim for a national network for road trains, because only in this way companies can possibly simultaneously operate double transport flows. The larger companies in the Netherlands should be contacted to measure their interest, and the focus should be on FTL.</td></tr>
<tr><td>Data</td><td colspan="4">First of all, it was calculated how long the trailers have to be in order to be cost efficient for more than 50% of all FTL to be transported by road train:
• Technische Unie: with a road train with 2 trailers, about 80% of all road haulage FTL kilometres would be cheaper
• Laurus: with a road train with 3-5 trailers, about 50% of all road haulage FTL kilometres would be cheaper
• Campina Melkunie: with a road train with 2-3 trailers, about 75% of all road haulage FTL kilometres for fresh milk would be cheaper</td></tr>
<tr><td colspan="5">Reviewer's remarks:</td></tr>
<tr><td colspan="5">Looking back, we can state that this project from 2000 has shown the opportunities for the use of road trains in distribution networks in the Netherlands, and in this was a frontrunner for the later LHV-pilots from 2004-2006.The report focuses on economic results, and does not go into the technical and legal possibilities.</td></tr>
</table>

Title:	**Analysis of potential optimization in a road network by including the European Modular Concept (EMS)**		
Year:		Language:	German
Authors:	Affiliation:		
Claas Schneider	Department of materials handling and warehousing, university Dortmund		
Web link:	http://www.flw.mb.uni-dortmund.de/en/index.html		
Scenario			
Opinion			
Data	Objective of this diploma thesis was to analyze whether the EMS could be feasible in Germany or not based on potential financial and ecological benefits of the logistic service provider UPS. This investigation is undertaken with regard to following restraints: road wear, bridges, safety. The main structure of the thesis consists of: Introduction regarding transport mode road and EMS in general Potential applications of EMS for UPS Results and perspective In detail, data to evaluate the implementation of EMS is calculated by means of the recent line road network of UPS in Germany. Therefore connections between the several sort centres are examined and used storage and transport container as well as used vehicles of UPS are assessed against the modular concept to evaluate whether they fulfil requested criteria. By this eleven routes of UPS in Germany were evaluated. Results of the thesis are a savings potential for UPS of 1.15 Mio € annually on this routes as well as a decrease of CO_2-Emissions by 20 %. Potential changes in the whole network were analyzed with an internal Network Optimization tool and the result was an achievable reduction of the transport cost by 13.9%.		
Experts identified:	Affiliation:		
Reviewer's remarks:			
Examination of the modular concept from a haulier point of view.			

<table>
<tr><td>Title:</td><td colspan="3">The Modular Concept for Europe and for Spain</td></tr>
<tr><td>Year:</td><td>2007</td><td>Language:</td><td>ENGLISH</td></tr>
<tr><td colspan="2">Authors:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2">Anders Lundström</td><td colspan="2">SCANIA</td></tr>
<tr><td>Web link:</td><td colspan="3"></td></tr>
<tr><td>Scenario</td><td colspan="3">No</td></tr>
<tr><td>Opinion</td><td colspan="3">Based upon Dutch trials
• Environment benefits of modular concept shown in theory and practice
• As safe as other heavy / long combinations
• Special drivers' permit is a possibility
• Excellent compatibility with other modes.
• No effect on short bridges
• Reduced or unchanged road wear
• Road space is a minor problem (turning circle, cornering)
• Volume limit matters more than loading limit
• European harmonisation desirable sooner or later</td></tr>
<tr><td>Data</td><td colspan="3">• 4 possible modular combinations
• Basic load dimensions of today trucks:
o Loading length 13.6 m → 33 pallets, 90m3, 2 TEU
o Loading length 7.82 m → 19 pallets, 50m3, 1 TEU or a CEN swap-body</td></tr>
<tr><td colspan="2">Experts identified:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2">Anders Lundström,
Head of feasibility studies</td><td colspan="2">SCANIA</td></tr>
<tr><td colspan="4">Reviewer's remarks:</td></tr>
<tr><td colspan="4">• Good plea for EMS, but probable lack of objectivity.
• Clearly based uniquely on Dutch trials.
• Seems to minimize effects on bridges (only the short ones are considered) and road wear, on road space. DOES NOT examine the eventual modal shift.</td></tr>
</table>

<table>
<tr><td>Title:</td><td colspan="3">EMS for road transport</td></tr>
<tr><td>Year:</td><td>2007</td><td>Language:</td><td>ENGLISH</td></tr>
<tr><td colspan="2">Authors:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2">Ingemar Åkerman
Rikard Jonsson</td><td colspan="2">TFK - Institutet för transportforskning
TFK - Institutet för transportforskning</td></tr>
<tr><td>Web link:</td><td colspan="3"></td></tr>
<tr><td>Scenario</td><td colspan="3">No</td></tr>
<tr><td>Opinion</td><td colspan="3">No</td></tr>
<tr><td>Data</td><td colspan="3">This study is based on a project conducted by the authors as a master thesis and in cooperation with Swedish Road Haulage Associated, Volvo Trucks and Scania. The aim was to evaluate the experiences of using LHVs in Sweden and Finland and to compare these findings with the trial in the Netherlands. Also, effects of increased vehicle dimensions on traffic safety and economy are examined. Information for the study was gathered using the following methods: Literature survey, interviews, inquiry and a case study.</td></tr>
<tr><td colspan="2">Experts identified:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="4">Reviewer's remarks:</td></tr>
<tr><td colspan="4">Interesting study on experiences of Sweden and Finland using LHVs and some comparisons to recent trials across Europe</td></tr>
</table>

<table>
<tr><td>Title:</td><td colspan="3">Vehicle combinations based on the modular concept</td></tr>
<tr><td>Year:</td><td>2007</td><td>Language:</td><td>ENGLISH</td></tr>
<tr><td colspan="2">Authors:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2">John Aurell and Thomas Wadman</td><td colspan="2">Nordiska Vägtekniska Förbundet (Nordic Road Association)
Volvo Trucks</td></tr>
<tr><td>Web link:</td><td colspan="3">http://www.ptl.fi/NVFnorden/imageblob/54_1_2007.pdf</td></tr>
<tr><td>Scenario</td><td colspan="3">No</td></tr>
<tr><td>Opinion</td><td colspan="3">Largely in favour of the EMS generalization, for technical and environmental reasons as well as for facing congestion and an increasing demand for transport.</td></tr>
<tr><td>Data</td><td colspan="3">This report describes the development of weights and dimensions of heavy vehicles in Europe. It illustrates the background to the modular concept (EMS) and explains the advantages with the modular concept. The report provides an extensive analysis of the performance of a large number of conventional and modular vehicle combination types. The different European vehicles combinations, as allowed by directive 96/53 and modular vehicle combinations are compared, with regards to many parameters:
• Stability (rearward amplification);
• Swept path;
• Road wear;
• Offtracking.

The results are summarized as follows:
• The modular concept has a large environmental impact with a minimum of 18% reduction of the fuel consumption and the emission of CO_2 and other harmful gases;
• Long modular vehicle combinations contribute to ease the congestion problem on
• European motorways;
• The modular concept creates prerequisites and facilitates for intermodal transports on railroads (with no other explanation);
• The road wear from current modular vehicle combinations and in particular from suggested prospective combinations is typically less than with current European vehicle combinations;
• Modular combinations have better dynamic stability than many conventional European combinations;
• For good dynamic stability, the coupling should be moved forward. Couplings for centre axle trailers shall have a coupling distance of not less than 1.5 m. Combinations with two centre-axle trailers shall have a coupling distance of not less than 1.9 m;
• For all vehicle combinations, there is a contradiction between good stability and small low-speed offtracking;
• When performance-based standards on swept path width are used, a 90-degree turn
• on a 12.5 m outer radius is recommended;
• Three-axle tractors are necessary in order to avoid overloading of the driving axle,
• both for conventional European combinations and for modular combinations;
• In order to secure traction, tandem-driving axles may be necessary, when the GCW (Gross Combined Weight) exceeds 46 t.

It is also recommended that long modular vehicle combinations are not to be driven on the whole road network, but on roads suited for this type of vehicle combinations.</td></tr>
</table>

Other interesting data:

- In 1968, the Swedish Road and Transport Research Institute published an extensive report on dynamic stability of a large number of vehicle combinations;
- An extensive program of analytical and experimental studies of the dynamic stability of vehicle combination started at Volvo during the 1980's (especially on snow and ice surfaces);
- After having increased the authorized combination weight, the accident rate with truck – full trailer combinations increased in Norway in 1987;
- Volvo had carried out extensive analyses and tests of the dynamic stability of current EU vehicle combinations and modular combinations. A paper on the modular concept was presented at the Fourth International Symposium on Heavy Vehicle Weights and Dimensions in 1995.

Road Space comparison (with a safety distance of 70 m)

Combination type	Total road space (m)	Number of palettes	Road space per palette (m)	Relative road space
2 tractor-semitrailer and 1 truck-trailer	262	104	2,52	1,00
2 modular combinations	191	104	1,83	0,73

Experts identified:	Affiliation:
TFK Confederation of Swedish Enterprise	

Reviewer's remarks:

The article deals with the EMS topic with a **very technical approach**. All vehicles are compared and assessed with regards to different physical parameters. The statements concerning intermodal transport, the environmental impact and the benefits in terms of road safety are not justified but references are provided to approve them.

<table>
<tr><td>Title:</td><td colspan="3">Improved Performance of European Long Haulage Transport</td></tr>
<tr><td>Year:</td><td>2002</td><td>Language:</td><td>ENGLISH</td></tr>
<tr><td colspan="2">Authors:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2">Haide Backman
Rolf Nordström</td><td colspan="2">TFK - Institutet för transportforskning
TFK - Institutet för transportforskning</td></tr>
<tr><td>Web link:</td><td colspan="3">http://sn.svensktnaringsliv.se/sn/publi.nsf/Publikationerview/1B20A63C883A84FDC1256C620039DB77/$File/PUB200210-008-1.pdf</td></tr>
<tr><td>Scenario</td><td colspan="3">No</td></tr>
<tr><td>Opinion</td><td colspan="3">No</td></tr>
<tr><td>Data</td><td colspan="3">• Description of a case study (2001) with some limitations:
• International transports
• Full truck loads (FTL)
• On highways
• Non-stop (direct) transports
• 2 Dutch, 1 Danish company
• Result of study: -32% trips, -15% fuel consumption, -23% costs
• Congestion: estimated 20% less heavy vehicles
• Road Wear: decrease of 15 to 25% due to distribution over more axles
• Road Safety: no proper data, only quoting another paper: no statistically proven change in safety</td></tr>
<tr><td colspan="2">Experts identified:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2">Haide Backman
Rolf Nordström</td><td colspan="2">TFK - Institutet för transportforskning
TFK - Institutet för transportforskning</td></tr>
<tr><td colspan="4">Reviewer’s remarks:</td></tr>
<tr><td colspan="4">• Useful as example, but may not be representative (limited sample)
• Clear presentation</td></tr>
</table>

Title:	**Monitoring of weights and dimensions of loading units in intermodal transport**		
Year:	2007	Language:	ENGLISH
Authors:	Affiliation:		
Economic Commission for Europe. Inland Transport Committee			
Web link:	http://www.unece.org/trans/wp24/wp24-inf-docs/24infdocs.html#9		
Scenario	No		
Opinion	No		
Data	The Inland transport committee of the Economic Commission for Europe monitors the weights and dimensions of loading units in intermodal transport by surveying each member of the 56 UNECE member countries. The survey is formed of 4 questions: • Is road transport of 45 ft ISO containers permissible? • Is road transport of 45 ft pallet-wide containers permissible? • Are exceptions allowed? • Are there plans for modification of maximum permissible dimensions? So far, not all members have replied. For the first three questions, answers show that countries are shared among the different options. The answers to the last question are more homogeneous. Most countries do not plan to modify the maximum permissible dimensions. The few countries that intend to do so are Albania, Belgium, Hungary, the Netherlands, Serbia and the United-Kingdom. The Netherlands replied that 45 ft long containers cause difficulties in enforcement in case of older types of containers and chassis. As to Belgium, an expert group is studying the issue of 45 ft containers by applying the modular concept. Norway is thinking of experimenting EMS on some limited parts of its network for a limited period.		
Experts identified:	Affiliation:		
Reviewer's remarks:			
The issue of the 45 ft ISO container is not directly linked to the EMS concern. However, this issue paves the way the way for thinking about the maximum permissible dimensions in each country. In some countries, it may trigger a broader reflection.			

Title:	**Letter to Bernard Van Houtte, DG TREN, Modular Concept: technical expertise for the Commission's Study**		
Year:	2007	Language:	English
Authors:	Affiliation:		
Ivan Hodac	ACEA		
Web link:			
Scenario	No		
Opinion	The modular concept should be seriously explored, as it would allow up to 50% more goods to be transported with one vehicle. ACEA offers its help to consultants, mainly regarding technical expertise.		
Data	No		
Experts identified:	Affiliation:		
	ACEA		
Reviewer's remarks:			
Useful knowledge for safety, road wear and emissions.			

Title:	**Ecocombis in combined transport**		
Year:	2007	Language:	Dutch
Authors:	Affiliation:		
André Pluimers	Bolk Transport		
Web link:	LHV pilot, economics of LHV		
Scenario	The presentation describes a pilot project carried out by Bolk Transport using oversized Ecocombi equipment. Bolk transport operates a transport service between Rotterdam (NL) and Hengelo (NL) over the distance of 200km, where 80% of the containers are transported by barge and 20% by truck. Annually the company transports 32000 containers. The usage of truck is determined by such factors as closing times, peak shaving and speed.		
Opinion	**Expected benefits**: Reduced road congestion, CO2 reduction, Facilitation of growing demand **Predictions**: according to the presentation, Ecocombis • will not structurally increase haulers' profits; • will not cause a backward modal shift; • can finance infrastructural improvements when a high weight limit is used • are necessary for solving capacity shortage and congestion and emission problems		
Data	Bolk Transport operates 2 Ecocombi's since June 2004, while the company operates 20 trucks in total. The Ecocombis do 7 round trips per week, in total 140 000 km per year. The Ecocombis allow transportation of two containers: 20' + 40'-containers. Bolk Transport reports no problems on operation of Ecocombis. The presentation shows substantial financial gains: Extra investment: € 38.000 Extra fuel consumption: 15% Total yearly extra cost: € 20.000 (+15-20%) Total yearly benefits: 140.000 TEU-km (+50%) Additional benefits: 60 tons (30%) CO2 reduction per unit per year According to the presentation, the **financial benefits** will be distributed over stakeholders depending on the introduction phase of LHVs: **Phase** — **Beneficiary** Pilot phase — Haulers Introduction phase — Forwarders Adoption phase — Industry End phase — Consumers		
Experts identified:	Affiliation:		
André Pluimers	Bolk Transport		
Reviewer's remarks:			
The presentation reports on the results of a pilot project. The party (Bolk Transport) shows satisfaction with LHVs and give a detailed analysis. The report should be treated as an account of a successful application of the technology			

<table>
<tr><td>Title:</td><td colspan="4">Monitoringsonderzoek vervolgproef lzv resultaten van de vervolgproef met langere of langere en zwaardere voertuigcombinaties op de Nederlandse wegen</td></tr>
<tr><td>Year:</td><td colspan="2">2006</td><td>Language:</td><td>Dutch</td></tr>
<tr><td colspan="2">Authors:</td><td colspan="3">Affiliation:</td></tr>
<tr><td colspan="2">Unknown</td><td colspan="3">ARCADIS (Dutch Consultancy). ARCADIS has conducted the study as an assignment on behalf of the Dutch Ministry of Transport, Public Works and Water Management</td></tr>
<tr><td>Scenario</td><td colspan="4">The report presents a study conducted by request of the Dutch Ministry of Transport, Public Works and Water Management over the impact of pilot projects that involved usages of LHVs in the Netherlands. Thus, the study looked at actual exploitation cases of LHVs on the Dutch roads.

The study has answered 5 broad research questions: the presented below 5 study questions and main conclusions are taken from the report and represent meaning of the organization that conducted the study. Moreover, the results are only relevant for the Dutch environment.</td></tr>
<tr><td>Opinion</td><td colspan="4">1. What market size can be expected if the present limitations regarding the number of participants and vehicles are lifted?
Depending on the level of the preconditions, 7 to 31% of the regular truck rides with a loading capacity of over 20 tons will be replaced by LHVs. There will be 6000-12000 LHVs that will replace 8000 – 16000 regular combinations.

2. What would be the impact on the inter-modal transportation market?
The introduction of LHVs causes only a limited modal shift. Transport by road increases 0.05 to 0.1%, depending on the preconditions by which LHVs are allowed. This decreases the inland navigation transport by 0.2 to 0.3% and rail transport by 1.4 to 2.7%.

3. Will the large scale use of LHVs influence the traffic safety (both subjectively and objectively)?
Based on the experiment there is no reason to assume that a LHV has a higher safety risk compared with a regular vehicle combination. Since LHVs reduce the number of mileages, the traffic safety can increase. The expected decrease in fatal accidents amounts to 4 to 7 and the decrease of injuries to 13 to 25. However, the study cannot conclude the safety-related question with statistics data: the size of the experiment is insufficient to draw statistical conclusions on safety.

4. What will be the effects of the large scale use of LHVs on a macro level on environment (emission, noise), traffic (congestion, effective use of capacity, number of rides), costs (for labour, per ride and per freight unit) and competitive position?
The use of LHVs reduces the number of rides and thereby the total mileages of inland road transport. As a result the fuel consumption of LHVs is lower, compared to regular trucks in case they transport an equal amount of freight. The use of LHVs can reduce congestion by 0.7 to 1.4%. The cost price per mile for LHVs will increase with approximately 6.5%, but thanks to the reduction of the number of rides, the total cost reduction in road transport will amount to 1.8 to 3.4% (depending on the preconditions). The modal shift caused by the introduction of LHVs is merely limited.

5. What consequences do LHVs have in daily life of logistic (planning) processes?
The study shows that participants are able to fit in LHVs – with regard to logistics - flexibly.</td></tr>
</table>

	Big changes in logistical planning are not required. Some logistical innovations have been noted, but these do not cause big shifts in logistical processes.
Reviewer's remarks:	
The study seems to be neutral in respect to assessment quality. Nevertheless, it is very positive regarding LHVs introduction and wide-scale use.	

Title:	**Note to IRF, statement by ASFiNAG on permitting 60-tonne trucks in Austria**		
Year:	2007	Language:	English
Authors:	Affiliation:		
	ASFINAG		
Web link:			
Scenario			

Opinion	ASFINAG "Autobahnen- und Schnellstrassen- Finanzierungs- Aktiengesellschaft" (AT) is strictly against any increase of the maximum authorized total weight and length.
	4 reasons:
	• Negative impact on road wear and safety
	    o 300+km of bridges: lifetime shortened
	    o more maintenance needed: traffic jams
	    o Junctions and roundabouts not designed with long vehicles in mind (secondary road network)
	    o Availability of rest areas
	• Road safety:
	    o Tunnels: fire + breakdown bays
	    o Accidents related to breaking distance
	• Fear of modal shift rail to road
	• Reduction of special approvals for heavy transport		

<table>
<tr><td>Title:</td><td colspan="3">Performance Based Standards</td></tr>
<tr><td>Year:</td><td>2007</td><td>Language:</td><td>English</td></tr>
<tr><td colspan="2">Authors:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2">Ted Vincent</td><td colspan="2">Vic roads</td></tr>
<tr><td>Web link:</td><td colspan="3">http://www.vicroads.vic.gov.au/Home/HeavyVehicles/RoutePermitInformation/PerformanceBasedStandards.htm</td></tr>
<tr><td>Scenario</td><td colspan="3"></td></tr>
<tr><td>Opinion</td><td colspan="3"></td></tr>
<tr><td>Data</td><td colspan="3">This presentation summarizes the efforts of a reform in Victoria, a federal state of Australia, to improve the efficiency and safety of freight vehicles by allowing innovative vehicle proposals to be evaluated against performance standards rather than prescriptive limits. These limits were seen as restricting the innovation potential. The Performance Based Standard focuses on how the vehicle behaves on the road. Weights and dimensions are in so far not crucial for an operating licence.

This aim is achieved throughout a set of 15 approved safety (s) and infrastructure (i) standards. These standards are as follows:

• Startability (s)
• Gradeability (s)
• Acceleration (s)
• Tracking ability on a straight path (s)
• Low speed swept path, frontal and tail swing (s)
• Steer tyre friction demand (s)
• Static rollover threshold (s)
• Rearward amplification (s)
• High speed transient offtracking (s)
• Yaw damping coefficient (s)
• Directional stability under braking (s)
• Pavement vertical loading (i)
• Pavement horizontal loading (i)
• Tyre contact pressure distribution (i)
• Bridge loading (i)

Vehicles shall be assessed against the described standards to pass and obtain an operating licence. Within this assessment there are four Levels, starting from general access to type 2 road train. During a case study conducted by Pilkington the feasibility of this approached has been evaluated.</td></tr>
<tr><td colspan="2">Experts identified:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="4">Reviewer's remarks:</td></tr>
<tr><td colspan="4">Interesting point of view on how to handle responsibilities of legislator in contradiction to demands of freight forwarders.</td></tr>
</table>

<table>
<tr><td>Title:</td><td colspan="3">Effects of new vehicle concepts on the infrastructure of the federal trunk road network</td></tr>
<tr><td>Year:</td><td>2006</td><td>Language:</td><td>German</td></tr>
<tr><td colspan="2">Authors:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2">Ulf Zander, et al.</td><td colspan="2">Bast - Federal Highway Research Institute</td></tr>
<tr><td>Web link:</td><td colspan="3">http://www.bast.de/EN/e-Home/e-homepage__node.html?__nnn=true</td></tr>
<tr><td>Scenario</td><td colspan="3">EMS is examined only in 60 t version</td></tr>
<tr><td>Opinion</td><td colspan="3"></td></tr>
<tr><td>Data</td><td colspan="3">The following text summarizes the several documents of the German Federal Highway Research Institute as given within the literature list.

The research on the effects of new types of tractor-trailer combinations on the infrastructure, traffic flow and road safety assigned by the Federal Ministry of Transport, Building and Urban Affairs (BMVBS) was completed by BASt in November 2006.

The investigations by the working group of the Federal Highway Research Institute (BASt) focus exclusively on technical issues. The main results are:
• An increase in road damage due to the new vehicle types with eight axles is not to be expected. As a result of the predicted general increase in transporting capacity, however, this effect will be of a limited duration.
• Stress on bridges will be clearly increased by 60 ton tractor-trailer combinations, which will make replacements or reconstruction necessary. As regards the federal trunk road network, approx. 4 to 8 billion euro would have to be raised for the federal motorways for this purpose.
• The consequences of fires in tunnels on federal trunk roads could be much graver due to the clearly larger loading volume, resulting in increased requirements to safety equipment.
• Problems of driveability of roundabouts, road crossings and intersections as well as parking spaces in parking lots will be a result of the longer vehicle lengths. These can be partially reduced using additional technical fixtures such as trailing axles, however the use of new types of tractor-trailer combinations within cities and towns cannot be considered.
• Based on present experiences in other countries, sufficiently motorised transport vehicles with reliable brake systems do not pose any serious problems with respect to traffic flow and road safety on motorways. Negative effects of tractor-trailer combinations can be expected on subordinate road networks (country, district and municipal roads in particular) on both, road safety as well as the efficiency of roads. Thus, for example, longer overtaking paths and longer clearance times when turning and at railway crossings are to be expected.
• The present protective and restraint systems have not been designed for 60 ton tractor-trailer combinations. Due to the higher vehicle weights the severity of accidents in the case of head-on collisions could increase considerably. Modern driver assistance systems (Lane keeping assistant as well as brake assistant with interval radar) could, however, make a basic contribution in reducing both the risk and the severity of accidents.

The full report is structured as follows:
• Effects on road wear
• Effects on approximated daily heavy vehicle traffic by implementing LHVs</td></tr>
</table>

	• Effects on bridges and tunnels • Trafficability of recent road infrastructure • Effects on traffic flow • Road safety • Additional technical equipment and aptitude of drivers for new vehicle concepts • Experiences of foreign countries
Experts identified:	Affiliation:
Reviewer's remarks:	
Important and a deep scientific complete study. Disadvantage is the focus on the 60 t version of EMS	

Title:	**Working group on longer and heavier goods vehicles (LHVs): a multidisciplinary approach to the issue**		
Year:	2007	Language:	English
Authors:	Affiliation:		
W.Debauche, D.Decock	Belgian Road Research Centre		
Web link:			
Scenario			
Opinion			
Data	This is a Belgian perspective on the LHV discussion. Some scenarios are suggested, experiences of other countries (SE, FI, DE, NL) and legal aspects. LHV are theoretically evaluated and modal shift risks are proposed based on NL experience. A survey among Belgian carriers was performed, with many respondents stating LHVs are no valid alternative. Of those who were in favour, most showed interest in routes to and from the port of Antwerp. The problem regarding infrastructure could be severe. In SE and FI, the road network was designed with LHV in mind; not so in the rest of Europe. A discussion on axle weights of different truck types is included. Charges: eurovignette based on EU directive, no flexibility. Social: driver training required. A trial conducted under strict constraints is advised, although it would remain difficult to estimate long term effects.		
Experts identified:	Affiliation:		
Reviewer's remarks:			
Lots of facts on the Belgian market, which could be a base for evaluating other countries. Links to many other documents.			

Title:	**Monster trucks to foil EU's climate policy** **Letter to transport Commissioner** **Press Release**		
Year:	2007	Language:	ENGLISH
Authors:		Affiliation:	
CER		Community of European Railway and infrastructure companies	
Web link:	http://www.cer.be/index.php?option=com_publications&task=view&id=199&Itemid=71		
Scenario	No		
Opinion	A significant increase of CO_2 emissions would result from a general authorisation for monster trucks on European roads. The decrease in road unit costs would lead to a significant increase or road transport at the detriment of combined transport. Based on: K+P study I (R40 – 2006) TIM Consult study (R56 – 2006) dealing with the potential return to the road of today combined transport traffic Outcome: Joint letter to Mr. BARROT (with CER, UIP and UNIFE) 21 march 2007 (S71)		
Data	• Modal shift to road: about 7 billion tkm in Germany. • Additional trucks journeys: 400000		
Experts identified:		Affiliation:	
		K+P transport Consultants TIM Consult	
Reviewer's remarks:			
Interesting study of TIM Consult. Lobby against EMS			

Title:	**Continuous carriage of 45' containers in national road transport**		
Year:		Language:	English
Authors:	Affiliation:		
N.N.	EU Commission staff working group		
Web link:			
Scenario			
Opinion			
Data	This document of an EU Commission working group regarding road freight transport is dealing with the continuous carriage of 45' containers in national road transport after the end of a temporary derogation in directive 96/53/EC. Until 31.12.2006 it was allowed for vehicles registered or put into circulation before the implementation of 96/53/EC to exceed those maximum dimensions of the directive. Even though the fleet of 45' containers were only approximately 2 % of the total global fleet in 2006, the Commission have undertaken examination to answer stakeholders request whether it would be possible to continue carrying such containers. Finding of this investigation, which was conducted without any prejudice to the final outcome, has been that 45' containers are able to continue circulating under Article 4(3) of 96/53/EC (special permits or similar non-discriminatory arrangements) as 'indivisible loads' provided that the Member States concerned to decide and put in place the necessary administrative arrangements on a non-discriminatory basis. As well 45' containers are able to continue circulating under Article 4(4), in particular 4(4)(b) of Directive 96/53/EC provided that the Member States concerned apply Article 4(4) on a non-discriminatory basis, accept the 'modular concept' in their respective territories, and inform the Commission of the measures taken pursuant to the paragraph. The staff working document mentioned that these interpretations do not effect on the maximum weights stipulated in 96/53/EC. It also postulates that for carriage between member states intermodality should be used		
Experts identified:	Affiliation:		
Reviewer's remarks:			
Example on how to interpret EU directives and adopt it on changing situations without the need of changing the directive itself.			

Title:	**Denby Eco-Link**		
Year:	2007	Language:	English
Authors:	Affiliation:		
	Denby Transport LTD		
Web link:	http://www.denbytransport.co.uk/ecoLink.asp		
Scenario			
Opinion			
Data	The video summarizes the Denby point of view regarding the advantages of LHVs, especially type B. Therefore it presents the manoeuvrability of the vehicle and its command steer system. The video also shows the braking performance and other driving manoeuvres on a test track like the standard vehicle turning cycle. Furthermore, the additional safety equipment like rear view cameras, etc. is explained. In addition to technical measures the economic advantages are given, too. These data consists of the well known points like replacing 3 commercial vehicles by 2 LHVs, an overall fuel consumption of up to 15 % and a reduction of CO_2 emission by the same level. To proof the given data the video refers to field trials in the Netherlands and the experiences of Sweden and Finland.		
Experts identified:	Affiliation:		
Reviewer's remarks:			
This video is a company presentation on their proposal for an EMS (type B) to be used on British roads.			

Title:	**M&S cuts carbon with teardrop trailers**		
Year:	2007	Language:	ENGLISH
Authors:	Affiliation:		
	Don-Bur (Bodies & Trailers) Ltd.		
Web link:	http://www.donbur.co.uk/gb/products/aerodynamic_teardrop_trailer.shtml		
Scenario			
Opinion			

Data

This presentation on the homepage of Don-Bur a British trailer company introduces a new trailer design. By inventing a teardrop shaped trailer Don-Bur turns the adjustment screw a trailer manufacturer can take care off regarding fuel consumption.

Technical background is an aerodynamic optimized trailer. As a vehicle passes through air, it creates drag. These drag forces include pressure, surface friction and turbulence. Turbulence is created when laminar airflow travelling over a surface leaves that surface (separation point) due to sharp corner or rapid shape change (relative to the speed of the air) and flows unnaturally, creating vortices and eddies. The teardrop is an excellent aerodynamic shape and reduces the coefficient of drag (cd-value). The decrease of fuel consumption by using such an innovative trailer concept is up to 10.14 %. In a field test conducted by Marks & Spencer the ecological potential was verified. The fuel saving combined with 16 % additional load volume for the Marks % Spencer fleet causes a fleet reduction of 20 % CO_2 emissions.

Some key figures at a glance (internal calculations by Don-Bur):

	Standard Trailer	**Teardrop Trailer**	**% Variance**
Cd-value	0.7	0.4	- 42.86
Width	2.55 m	2.55 m	
Height	4 m	4.5 m	
Frontal Area	10.2 m^2	11.48 m^2	12.5
Fd	2742.08 N	1762.77 N	- 35.71
Total Force	5742.08 N	4762.77 N	- 17.06

Following successful controlled testing of a prototype Marks & Spencer uses 140 teardrop trailers in it fleet at present. The Teardrop trailers will be used on trunking operations for general merchandise, transporting stock between M&S suppliers and Distribution Centres.

Experts identified:	Affiliation:
David Burton	Don-Bur
Simon Ratcliffe	Marks & Spencer

Reviewer's remarks:

Quite interesting trailer concept, but the trailer is neither longer nor heavier than a conventional one.

<table>
<tr><td>Title:</td><td colspan="3">The use of Ecocombis in cross-border transport in Europe</td></tr>
<tr><td>Year:</td><td>2007</td><td>Language:</td><td>English</td></tr>
<tr><td colspan="2">Authors:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2">Iozia, et al.</td><td colspan="2">EU section for Transport, Energy, infrastructure and the Information Society (EESC)</td></tr>
<tr><td>Web link:</td><td colspan="3">http://www.eesc.europa.eu/</td></tr>
<tr><td>Scenario</td><td colspan="3"></td></tr>
<tr><td>Opinion</td><td colspan="3"></td></tr>
<tr><td>Data</td><td colspan="3">This “draft opinion” of the section for Transport, Energy, infrastructure and the Information Society, which was discussed on 6 November 2007, summarizes several aspects of the use of EMS in cross-border transport in Europe.

After the introduction the report gives an overview on the following issues:
• European transport policy
• Legal framework
• Cross-border aspects
• Evaluation of numerous studies

Opinions of the EESC as mentioned in the report are:
• The Directive 96/53/EC should be amended in such a way as to permit the use of these combination vehicles in international transport
• The EESC recommend to lose no time adopting the directive with a view to authorising cross-border transport operations between states in which the use of Ecocombis is permitted
• The EESC takes the view that steps must also be taken to preclude a situation whereby combination vehicles from a given Member State in which Ecocombis are authorised are not allowed to use the road network of another Member State where Ecocombis are likewise authorised as they are not in conformity with the national requirements of the latter state.</td></tr>
<tr><td colspan="2">Experts identified:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2">Henk A. Kramer</td><td colspan="2"></td></tr>
<tr><td colspan="4">Reviewer’s remarks:</td></tr>
<tr><td colspan="4">Good state of the art overview on the modular concept and the efforts across Europe to evaluate its feasibility and potentials with respect to increasing freight demand, ecological and economical aspects and impacts on society.</td></tr>
</table>

<table>
<tr><td>Title:</td><td colspan="3">CEPI presentation</td></tr>
<tr><td>Year:</td><td>2007</td><td>Language:</td><td>English</td></tr>
<tr><td colspan="2">Authors:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2"></td><td colspan="2">CEPI, Confederation of European Paper Industries</td></tr>
<tr><td>Web link:</td><td colspan="3"></td></tr>
<tr><td>Scenario</td><td colspan="3"></td></tr>
<tr><td>Opinion</td><td colspan="3">CEPI supports harmonisation of the modular system.</td></tr>
<tr><td>Data</td><td colspan="3">Many good arguments in favour are stated:
• Volume is limiting factor rather than weight
• Less road space for same transport volume
• Cost effective: savings could go up to 10% for cross border
• Future needs: 55% increase, only 12% extra road volume
• Fuel efficiency: 15% better than 40T trucks
• Safety:
o Braking distance no problem
o Stability could be an issue, depending on configuration
o Road wear: lower axle load (7% less)
o Sweeping area: not commented, but data show possible difficulties
o Overtaking: no problems since long vehicles will be marked (?)
Need for terminals where combination can be recoupled. Modular system supports comodality (but this seems to be a difficult argument to make).
Some other points are added regarding road transport: effective charging, comodality.
Weight range: 44T min, 60T max, but 60T may not be advisable for all countries.</td></tr>
<tr><td colspan="2">Experts identified:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="4">Reviewer's remarks:</td></tr>
<tr><td colspan="4">Somewhat oversimplified, clearly not taking all circumstances into account. Some useful points (e.g. terminals for recombining), and a clear opinion in favour of EMS. No sources mentioned.</td></tr>
</table>

Title:	**Position paper European Shippers' Council on Road transport reduction through the European Modular System, the challenges for European transport markets**		
Year:	2007	Language:	English
Authors:	Affiliation:		
	ESC, European Shippers' Council		
Web link:			
Scenario	ESC is in favour of extended use of the Modular system in the EU. Several researches are used, yet none explicitly mentioned. KSF of policy: movement of the freight is key (with regards to intermodality), i.e. door-to-door. The condition for implementation of EMS is that modular vehicles are only allowed on the primary road network, not on smaller roads.		
Opinion	Advantages are again discussed, citing fewer trips, lower emissions, reduced costs, no statistical decrease of safety, limited infrastructure investment. No legislative barriers exist, since the current directive already allows for longer vehicles. An interesting approach is formulated: modular vehicles will allow for increased competition. The longer trucks will enable mode shippers to use road freight, as the same units are used in maritime and rail transport. As a result, these units will be used more often, and greater possibilities for intermodality arise. The application in Sweden and Finland is cited as an example. Mention is also made of the trials in several other countries with "overwhelmingly positive experiences and benefits".		
Data			
Experts identified:	Affiliation:		
Nicolette van der Jagt Secretary General	European Shippers' Council		
Reviewer's remarks:			
Benefits are highlighted, hardly any mention made of disadvantages (safety).			

<table>
<tr><td>Title:</td><td colspan="3">ECG Comments on policy orientations in the Commission's Communication: 'Freight Logistics in Europe – key to sustainable mobility'</td></tr>
<tr><td>Year:</td><td>2006</td><td>Language:</td><td>English</td></tr>
<tr><td colspan="2">Authors:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2"></td><td colspan="2">ECG, Brussels</td></tr>
<tr><td>Web link:</td><td colspan="3"></td></tr>
<tr><td>Scenario</td><td colspan="3">The document presents a 4-page reaction on policy orientation issued by the EC "Freight logistics in Europe – key to sustainable mobility". The document covers various logistics-related topics, which are of interest for an organization that represents interests of transporters of automotive products (the ECG is an umbrella organization that represents interests of transporters active in outbound transportation of Automotive products). The main topics of the document are loading standards, logistics training, network of rail services, ICT, identification of bottlenecks and their solutions, promotion and simplification of multinational chains, and other topics. The issue of LHV appears under the heading of 'Loading standards'.</td></tr>
<tr><td>Opinion</td><td colspan="3">ECG believes that a very important need of advanced logistics is longer trucks as well as harmonization of maximum authorized dimensions of loaded vehicles involved in international traffic. The members of ECG highlight the fact that there is lack of harmonization in all areas of vehicle and load dimensions, automotive transport companies encounter serious operational problems such as fines, prohibition of vehicles, uncertainty due to complex, differing national legislation, etc when transporting vehicles from one Member State to another.</td></tr>
<tr><td>Data</td><td colspan="3"></td></tr>
<tr><td colspan="2">Experts identified:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="4">Reviewer's remarks:</td></tr>
<tr><td colspan="4">The opinion of ECG is strongly in favour of LHV; the organization wants the standard on LHV to be pan-European such that its members can use the same equipment throughout whole Europe.</td></tr>
</table>

Title:	**Parliament favourable to 60-tonne lorries under strict conditions**		
Year:	2007	Language:	English
Authors:	Affiliation:		
Eric van Puyvelde	Newspaper article, the EUROPOLITICS newspaper		
Web link:			
Scenario	In a small article, the newspaper gives an account for the new European Directive that authorizes, under conditions, 60-tonne US-style lorries in the EU, as is already the case in Sweden and Finland. The article underscores that the debate showed that the MEPs were much divided on the issue; some of them thought that authorizing 60-tonne lorries would induce a definitive imbalance in favour of only one mode of transport and would have a serious impact on the environment. The article underscores that the new directive authorizes LHVs to be used only at the national level, and under certain conditions: the LHVs are already in use in Sweden and Finland, and pilot tests are underway in Germany and the Netherlands, while Denmark is expected to follow suit, with a pilot test starting in January 2008. The European Commission is not yet talking about amending Directive 96/53 to allow large-scale use of the vehicles at EU level, but an impact study is under way.		
Opinion	The article also presents the point of view of the Transport Commissioner, Jacques Barrot. He said that that regarding pan-European permission for LHVs, the European Commission would take a decision after a study taking account of experience with lorries heavier than 60 tonnes and only after a thorough exchange of views on this issue with all the concerned stakeholders.		
Data			
Experts identified:	Affiliation:		
Jacques Barrot	Transport Commissioner, EC		
Reviewer's remarks:			
The article seems to be pretty neutral on the subject of LHV. There is no inclination in favour or against LHVs: it just informs the reader over the subject, gives an account of state-of-the-art and presents dominant the point of view of the commissioner.			

Title:	**Letter to John Berry, DG TREN, Report on effects of introduction of 60 tonne lorries**		
Year:	2007	Language:	English
Authors:	Affiliation:		
	Freight on Rail, UK		
Web link:			
Scenario	No		
Opinion	Freight on rail is against 60 tonne lorries. They request to be consulted during the research. Arguments: • More road tkm because of lower cost • At the expense of rail freight transport • Safety issues • Environmental benefits rely on load factor; to be beneficial, this needs to be above currently achieved levels • Heavy trucks can not be limited to primary network; they will also drive on local roads. • Current situation of compliance with regulation needs to be set straight before any progress can be made		
Data	No		
Experts identified:	Affiliation:		
Philippa Edmunds (Campaigner/Lobbyist)	Freight on Rail, UK		

Title:	**Oversize Trucks: Dangers Confirmed** **Press Release**		
Year:	2007	Language:	English
Authors:	Affiliation:		
UIRR	Union Internationale des sociétés de transport combine Rail / Route		
Web link:	http://www.uirr.com/?action=page&page=47&title=N%2FP%2FA+CATEGORIES&categorie=2&year=2007&item=53		
Scenario	No		
Opinion	Disastrous environmental effects would result from a general authorisation for oversize trucks on European roads Based upon: K+P study I (R40 – 2006) Tim Consult study (R56) dealing with the potential return to the road of today combined transport traffic. Outcomes: Joint letter to Mr. BARROT (with CER, UIP and UNIFE) 21 March 2007 (S71)		
Data			
Experts identified:	Affiliation:		
	K+P transport Consultants TIM Consult		

Title:	**Letter to Mr. Fotis KARAMITSOS**		
Year:	2007	Language:	English
Authors:	Affiliation:		
UIC, CER, EIM, UIRR, UNIFE, ERFA			
Web link:			
Scenario	No		
Opinion	• The decrease in road unit costs would lead to a significant increase in road transport. • Another effect would be a modal shift from rail to road. • Need for road infrastructure enhancements. • Significant increases of CO_2 emissions, congestion, accidents would result from a general authorisation for mega trucks on European roads. Based upon EWS study (S36 –2007)		
Data	Rail-based combined transport is currently enjoying significant growth annually averaging 6.8% in Europe.		

<table>
<tr><td>Title:</td><td colspan="3">Innovative trailer concept: the BIGMAXX by Kögel</td></tr>
<tr><td>Year:</td><td>2007</td><td>Language:</td><td>German</td></tr>
<tr><td colspan="2">Authors:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2">N.N</td><td colspan="2">Kögel Fahrzeugwerke GmbH</td></tr>
<tr><td>Web link:</td><td colspan="3">http://www.big-maxx.com/</td></tr>
<tr><td>Scenario</td><td colspan="3">No</td></tr>
<tr><td>Opinion</td><td colspan="3">No</td></tr>
<tr><td>Data</td><td colspan="3">The concept of the Big-MAXX consists of a conventional semi trailer, which was extended by only 1.3 m. This complies with an increase of the shipping volume of 10 m³. Thus, it possesses of over 37 instead of 33 pallet storing positions. However, with its total length of 17, 80 m it is still shorter than an articulated train. Further changes of geometry are the increased front overhang radius of 2.04 m as well as the gap of kingpin and the backmost limitation of 13.30 m instead of 12.00 m. According to estimations of the producer this concept could lead to a relief of the traffic of approximately 8% with heavy utility vehicles.
Currently there is a large scale test (300 semi trailers in Germany, Poland and the Czech Republic indefinite number) that is supposed to prove the sustainability of the concept and that takes until the year 2012. Until April 2007 it had been accompanied by the Institut für Kraftfahrwesen at the RWTH. In a short statement Professor Wallentowitz gives an absolute recommendation for a general approval of the concept, which is also called Eurotrailer. The Big-MAXX is capable of passing the BO-KRAFTKREIS without steering axle; it does not constitute an additional obstacle and adheres to the valid total weight of 40 t. Hence, no separate investments into the infrastructure are necessary. Moreover, existing traffic circles and parking lots can be used without restrictions.
First calculations regarding the efficiency of the Eurotrailer assume an additional charge of 5.200 €. Applying this to the estimated annual profit of a semi trailer of 160.000 € the use of the 10% bigger shipping volume results in a gain of 16.000 €. If this surplus is divided up between loader and carrier, the Eurotrailer can amortize already after 8 months. Furthermore, savings in matters of processing costs (loading, unloading, freight documents etc.) of approximately 10% will arise. Application areas of the Big-MAXX are as megatrailers in intermodal transport for 48“-containers or two 7.45 m long swap trailers as well as for steal transportation.</td></tr>
<tr><td colspan="2">Experts identified:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2">Prof. H. Wallentowitz</td><td colspan="2">Institut für Kraftfahrwesen Aachen (ika) der RWTH Aachen</td></tr>
<tr><td colspan="4">Reviewer’s remarks:</td></tr>
<tr><td colspan="4">Interesting innovation enlarging the trailer within legal requirements</td></tr>
</table>

Title:	**Letter to the commissioner for Transport Mr. Jacques Barrot**		
Year:	2007	Language:	English
Authors:	Affiliation:		
	The confederation of Danish commercial transportation and service industries		
Web link:			
Scenario	No		
Opinion	Danish haulers do not express their preference for LHV explicitly, but they request the Commission to bring clarity through a uniform regulation. General opinion seems to be pro (less congestion, lower CO_2 emission).		
Data	No		
Experts identified:	Affiliation:		
Bjarne Palstrom Michael Svane			

<table>
<tr><td>Title:</td><td colspan="4">Heavier lorries and their impacts on the economy and the environment</td></tr>
<tr><td>Year:</td><td colspan="2">2007</td><td>Language:</td><td>English</td></tr>
<tr><td colspan="2">Authors:</td><td colspan="3">Affiliation:</td></tr>
<tr><td colspan="2"></td><td colspan="3">MTRU</td></tr>
<tr><td>Web link:</td><td colspan="4">MTRU.com</td></tr>
<tr><td>Scenario</td><td colspan="4"></td></tr>
<tr><td>Opinion</td><td colspan="4"></td></tr>
<tr><td>Data</td><td colspan="4">From Executive summary:
This report considers three key questions:
• Do bigger and heavier lorries reduce traffic?
• Does cheaper HGV travel encourage more of it?
• How important are the largest HGVs in producing greenhouse gas?
After examining the most reliable sources of national statistics, the conclusions are:
• Rather surprisingly, there is no direct evidence of larger or heavier lorries leading to reductions in the numbers of HGVs or total HGV traffic (measured as vehicle kilometres).
• Despite several increases in maximum weight and volume, the average payload has fallen instead of rising.
• One likely reason for the predicted benefits not arising is the bunching of almost all new vehicles at the maximum permitted weight, rather than a range of weights suited to actual loads.
• The sensitivity of HGV vehicle kilometres to changes in cost in the UK appears to have been seriously underestimated, particularly taking mode transfer into account.
• HGV traffic is an important source of greenhouse emissions from transport, second only to cars and vans and to international aviation.
• Emissions from HGV traffic have grown significantly since 1990, by 25-30%, the latest revised DEFRA assessment appears substantially correct.
• A combined approach, transferring mode, reducing the amount that goods have to travel and improving vehicle fuel efficiency, could reduce CO2 emissions by 27% in a 10-15 year period.</td></tr>
<tr><td colspan="2">Experts identified:</td><td colspan="3">Affiliation:</td></tr>
<tr><td colspan="2"></td><td colspan="3"></td></tr>
<tr><td colspan="5">Reviewer's remarks:</td></tr>
<tr><td colspan="5">This document contains some useful numbers from practical experience, yet is focussed only on the British situation, i.e. with maritime transport as an alternative for Modular vehicles. As this situation is unique in Europe, this document can be used only when discussing the UK.</td></tr>
</table>

<table>
<tr><td>Title:</td><td colspan="3">Rapport Evaluatie beleid Langere en Zwaardere Vrachtwagens</td></tr>
<tr><td>Year:</td><td>2006</td><td>Language:</td><td>Dutch</td></tr>
<tr><td colspan="2">Authors:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2">J.A.M.Hendrikx</td><td colspan="2">Overlegorganen Verkeer en Waterstaat</td></tr>
<tr><td>Web link:</td><td colspan="3"></td></tr>
<tr><td>Scenario</td><td colspan="3">The report under consideration is a policy advice to the Ministry regarding LHVs in order to help with taking of the definite decision.</td></tr>
<tr><td>Opinion</td><td colspan="3">• The usage of LHVs does not seem to bring extra traffic safety issues.
• Among the available report there is lack of study on LHVs road safety issues in inhabited areas.
• The advantages of LHVs become stronger if they are used in international transportation, thus the advice to the Dutch government is to stimulate usage of LHVs in international transport. The initial ambition should be concentrated in reaching agreements with Germany, Belgium and France. The Dutch transport sector has already approached neighbouring countries via branch organization and now needs help of the government.
• It is important that reports by Arcadis and TNS-NIPO are made more accessible on the international level.
• The European dimension of LHVs is more important in international transportation because its advantages become clearer with bigger distances
• Shippers and transport companies prefer 'Scenario 3' (loading capacity up to 60 tones) over the 'Scenario 4' (loading capacity up to 70 tones) because they deem the 'Scenario 3' to be more feasible.
• During pilots it became obvious that road-rail crossing points cannot be used by LHVs. Thus, on certain routes, and depending on local situation, the rail crossing should be made possible
• The ANWB thinks that LHVs are less applicable for transportation within inhabited areas (cities and villages). This is due to the perception that LHVs are not safe.
• The impact of LHVs on safety of cyclists and pedestrians are not studied. This is because there is little experience in practical use of them.
• There should be educational programs for drivers and other measure taken in order to improve safety, not only in respect to LHVs, but in general. For instance, there is a need of study on the impact of extra mirrors.
• The studies show that there is very limited impact of LHVs on modal choice. It is expected that there will be no substantial changes in transportation mode due to introduction of LHVs. However, the LHVs can bring shift in usage of rail and inland waterways on certain routes.</td></tr>
<tr><td>Data</td><td colspan="3"></td></tr>
<tr><td colspan="2">Experts identified:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="4">Reviewer's remarks:</td></tr>
<tr><td colspan="4">This report presents a short summary of reports and workshop given over LHVs. The issuing body, Overlegorganen Verkeer en Waterstaat (OGV), is an independent organization which provides platform for discussions over socially significant issues under the umbrella of the Dutch Ministry of Transport, Public Works and Water Management. Thus, it can be treated as an independent assessment.</td></tr>
</table>

<table>
<tr><td>Title:</td><td colspan="3">The road, rail and external impacts of Longer, Heavier Goods Vehicles Longer, Heavier Road Vehicles Study by TRL / Heriot-Watt University. A response by English Welsh & Scottish Railway</td></tr>
<tr><td>Year:</td><td>2007</td><td>Language:</td><td>English</td></tr>
<tr><td colspan="2">Authors:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2">Graham Smith (letter)</td><td colspan="2">English Welsh & Scottish Railway, Oxera</td></tr>
<tr><td>Web link:</td><td colspan="3"></td></tr>
<tr><td>Scenario</td><td colspan="3">The document presents the point of view of English Welsh & Scottish Railway on introduction of LHVs in Britain. The railway has conducted a study on impact of LHVs together with Oxera (an independent consultancy).</td></tr>
<tr><td>Opinion</td><td colspan="3">The main conclusions (arguments) of the study are the following:
• The introduction of LHVs will create additional external costs in excess of £900m a year
• Rail freight will be seriously damaged. Our analysis focuses on bulk freight where nearly half of existing rail traffic in commodities such as Aggregates will transfer to road if LHVs are introduced
• We understand that other studies that focus on the intermodal market demonstrate even more severe consequences for rail. This is reinforced by our Confidential case studies
• The introduction of LHVs will only generate minimal environmental benefits compared with existing road fleets
• Any benefits from LHVs is strongly influenced by the utilization of the vehicles – loading below capacity will remove those benefits
• International studies do not support the introduction of LHVs and those studies that purport to justify LHVs do so from a very small sample base
• The introduction of LHVs, the resulting loss of existing rail freight business and the choking of any rail freight growth runs counter to the recent reports by Sir Rod Eddington, Sir Nicholas Stern and the Intergovernmental Panel on Climate Change
• for those companies that purchase road freight transport, LHVs offer lower haulage prices
• LHVs offer modest benefits in external cost reduction by replacing some HGV use
• For the UK economy and society as a whole, these modest benefits are outweighed by the extra external costs incurred by the switch of freight from rail to road
• The net external cost of road freight will further increase very substantially when more lorry-kilometres are generated by the market force of lower haulage rates. The net cost of LHVs to the UK as a whole will exceed £900 million per annum
• Continental European experience of LHVs sends mixed messages to the UK and cannot be used as a reliable analogy
• Several significant practical issues must be addressed before LHV can be used on UK roads

The report also presents Oxera's findings in respect to costs and scenario analysis in respect to business shift from rail to road as a result of LHVs introduction

Costs per tonne-kilometre of freight moved by LHV
<table><tr><td>Type of LHV</td><td>60-tonne</td><td>84-tonne</td></tr><tr><td>Cost reduction</td><td>14.2-15.3%</td><td>22.9%</td></tr></table>
• These cost reductions apply to several sectors of the bulk freight market (solid and liquid commodities such as cement, aggregates, semi-finished and finished steel and petroleum</td></tr>
</table>

	products) which are core business for rail, and between them, comprise 43% of all bulk freight moved by rail • Substantial amounts of this core business would shift from rail to road…. • Over 40% of rail business in the bulk construction material market sectors would switch to road if larger, heavier combinations of LHVs were permitted • Over 20% of rail business in the bulk construction material market sectors would shift to road even if the smaller LHV weight / length combinations were permitted • Nearly 17% of rail business in the bulk metals market sector would shift to road if larger, heavier combinations of HGV were permitted • LHVs offer modest benefits over 44-tonne lorries in some external cost groups but these are not enough to overtake those of rail: moving freight by train will continue to generate lower external costs than if it were moved by road – even if using LHVs • The increase in external costs caused by modal switch to road from rail will more than outweigh any savings made by the switch from 44-tonne lorries to LHVs • The external costs of freight transport are further increased by LHVs due to the impact of new traffic generated by step-change reduction in road transport costs to end-users • Overall, the introduction of LHVs would cause an increase in the external costs of freight transport of over £800 million per year	
Data		
Experts identified:		Affiliation:
Reviewer's remarks:		
The result of the study is strongly against introduction of LHVs. The main argument is that heavy vehicles would eat up rail transportation market, taking goods flows from the rail mode to roads. Thus, the railway is concerned with highly negative impacts of LHVs on its business performance, at the same time giving conclusions that external costs of LHVs would amount to 900 million pounds.		

Title:	**ESC reinforces support for Long Road Vehicle Combinations**		
Year:	2007	Language:	English
Authors:	Affiliation:		
Nicolette van der Jagt	European Shippers' Council, ESC		
Web link:			
Scenario			
Opinion	In more detail, the release states the following. The ESC's support for the LHVs, in the words of the organization, is in recognition of the mounting evidence from studies and pilot tests that the operation of such vehicle combinations generated significant economic and environmental benefits – completely counter to the arguments used by opponents of the modular system. According to Nicolette van der Jagt, 'There are absolutely no grounds to the argument that these longer vehicle combinations would make any noticeable difference to rail freight's fortunes. It is time the rail freight sector and its supporters stopped trying to stop others from becoming more efficient and better at what they do and instead focused on how they could raise their own game. According to Nicolette van der Jagt, LHVs should not be looked at purely modal terms. It should be seen more as a freight transport innovation that improves the efficiency of freight transport and increases the utilization of the existing transport infrastructure. Growing levels of congestion in the EU and growing transport flows emphasize the need for every single transport mode to increase its efficiency. The modular concept (LHVs) presents greater opportunities for co-modal (intermodal) logistics operations due to the standard loading units being the same as are used in maritime and rail freight distribution, so increasing the possibilities for loading the units from trucks to other modes where possible.		
Data			
Experts identified:	Affiliation:		
Reviewer's remarks:			
This is a highly opinionated press release that is strongly in favour of LHVs and more deregulation / competition in transport sector. The document also underscores that it is not a right way of improvement of rail transportation by decreasing competitiveness of other transportation modes.			

Title:	**Road trains for Europe-how to realize them**		
Year:	2001	Language:	German
Authors:		Affiliation:	
Neunzig, D., et al.		Institut für Kraftfahrwesen Aachen (ika) der RWTH Aachen	
Web link:			
Scenario	No		
Opinion	No		
Data	There are two possible scenarios how the increasing freight traffic can be faced. First scenario is through a raise of the average speed to 100 km/h and second scenario is through an increase of the loading capacity and/ or the shipping volume. The discussed Road train comprises both approaches. It consists of an ordinary tractor with a semi trailer plus another semi trailer, which is coupled via a special middle link. The increase of the road haulage can not be adequately compensated by a shifting onto tracks or by the present realization of the Federal Network Transport Plan (BUNDESVERKEHRSWEGEPLAN). Thus, new ways for the future road haulage are necessary. One way could be the implementation of so called Road trains. There are three objectives for the increase of the transportation capacity on the road. First the assurance/acceleration of the average cruising speed, second the avoidance of disturbances of the traffic flow and third the quick dissolving of bottlenecks due to infrastructure and the overload that comes along with this. The solution that is considered in the report (besides FRACHTBÖRSEN and assistance systems for the dissolving of traffic jams) introduces the Road train, which has a maximum total weight of 56t. Three aspects were analyzed: *Cornering ability and handling:* By means of ADAMS different concepts for steering axles were tested: NACHLAUFACHSE, ACHSSCHENKELACHSE and DREHSCHEMELLENKUNG. The results of the simulation show that a safe and feasible realization of the concept is possible. The demand of §32d StVZO can be met with controllable semi trailer axes. From a driving safety point of view the critical components are the KOPPELANHÄNGER as well as the second semi trailer. However, all concepts reach a cross acceleration of at least 3.9 m/s^2 at the steady-state skid pad testing, before the vehicle breaks away. *Fuel consumption* The potential for fuel savings of the Road train was determined by means of the traffic flow program PELOPS. It was evaluated for the speeds 80 km/h and 100 km/h. In comparison with a standard trailer truck, the fuel consumption relating to one ton actual load was taken as a basis operand. It appeared that the fuel consumption of the Road train is 26% (100 km/h) and 23% (80 km/h) respectively lower than the fuel consumption of the standard trailer truck. In some stationary handling points improvements of even 35% can be demonstrated. No significant losses in the driving performances have to be accepted. *Traffic load* The simulation with PELOPS considered both a medium and a high TRAFFIC LOAD. The proportion of trucks accounted for 25%. The results were that the average speed of all traffic		

	participants increases in the middle scenario by 10% to 120 km/h and with a high load even by 14% to 117 km/h.

Title:	**Traffic economic effects using innovative truck concepts**		
Year:	2006	Language:	German
Authors:		Affiliation:	
N.N.		K+P Transport Consultants	
Web link:			
Scenario	No		
Opinion	No		
Data	This study deals with the following problems regarding Germans inland freight transportation in the year 2015 by using figures of the Federal Network Transport Plan: • Effects on bimodal traffic (road – rail) with containers and swap bodies (inland traffic) • Effects on rail transport in the seaports hinterland (maritime traffic) • Effects on inland waterway traffic with respect to containers • Involvement of selected cross-border transport Methodological approach to answer these questions is a detailed view on shifting reactions from the co-modal to the road freight transport with respect to its price ratio. Therefore elasticity[72] is defined as follows: $$elasticity = \frac{changing\ of\ the\ co\text{-}modal\ quantity}{changing\ in\ difference\ between\ co\text{-}modal\ and\ road\ traffic\ prices}$$ Basis for the evaluation of these changes is the use of time series analyses. To ensure that all relevant data is included, the study defines more than one elasticity, e.g. one elasticity for maritime international transport with respect to capacity and another one with respect to weight. With this input several case studies on different transport routes are conducted regarding four alternatives: • Co-modal transport of freight with conventional commercial vehicles in the pre- and post carriage • Co-modal transport with LHV in the pre- and post carriage • Transport solely on road with conventional commercial vehicles • Transport solely on road with LHV After analyzing all this data the core statement of the study is summarised as follows: • Regarding the co- modal inland freight transportation without crossing the Alps there will be a decrease in co-modality of 14 % under solely consideration of alteration of prices due to LHV • Combined with the effects by a reduction of train capacity utilization due to shifting from co-modality to road transport there will be a decrease of 32 % Regarding the total co-modal inland freight transport the decrease will be 7 % or 15 %, respectively.		

[72] For example, an elasticity of one presents 10 % changing of prices induces 10 % changing of quantities

Title: **Verkehrswirtschaftliche Auswirkungen von innovativen Nutzfahrzeugkonzepten II**

Year: 2007 | Language: German

Authors: N.N.

Affiliation: K+P Transport Consultants

Web link:

Scenario

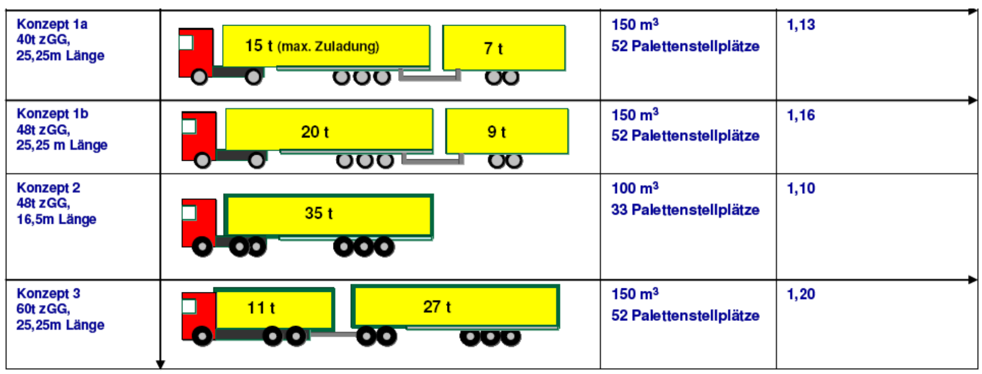
Opinion

Data

This report is an extension to the 2007 report on effects using innovative commercial vehicle concepts on the traffic economy. Therefore it examines the following points:

- Effects using the EMS on conventional rail freight services
- Netting out effects of intra-modal displacements with respect to CO_2 Emissions and savings of mileage
- Extensions to the former study like trans-Alps traffic, accessibility of EMS to terminals of the combined transport, effects using a 14.9 m trailer, etc.
- Others

The study researches the effects of four different concepts of EMS as represented below:



General finding with respect to freight issues is that there will be shifts from rail to road transport services due to a decrease in road transport costs. But there will be at least a small reduction in road congestion. The intra-modal shift (conventional commercial vehicle to LHV) over-compensates the inter-modal shift (rail to road).

With respect to CO_2-Issues the report concludes a CO_2 reduction of 1.1 % to 7.3 %.

For the accessibility to terminals of the combined transport the study expects complications.

Using the EMS in trans-Alps traffic would imply no advantages with respect to cost reduction and also there will be no shift from rail to road.

Experts identified:

Affiliation: IFEU Institute in Heidelberg for CO_2-Issues

Reviewer's remarks:

This report provides a detailed overview and a sound methodology. Nevertheless it should be taken into account that this report is conducted in coalition with the research foundation pro combined transport.

Title:	**Longer and heavier lorries (LHLs) and the environment**		
Year:	2007	Language:	English
Authors:		Affiliation:	
		European Federation for Transport and Environment - T&E	
Web link:	http://www.transportenvironment.org/Downloads-req-getit-lid-453.html		
Scenario			
Opinion	The federation states the continent wide introduction of Gigaliners is only acceptable when certain conditions are met: • Correct Road user charges • Stricter and more frequent enforcement • Ex ante impact assessments (our study), including CBA • Max weight: 50T • Compatibility with alternative modes		
Data	Environmental • Gains only exist with loads under 50T, optimising loading capacity is key • Under current conditions, a UBA study concludes that introducing Gigaliners would have a negative net effect, because of modal shift Adaptation required to bridges, tunnels and junctions Safety: best suited for high volume transport Cost reduction by 20-25% for light goods, but greater demand Price elasticity: -1% price road transport = • -1.8% rail demand • -0.8% IWW demand		
Experts identified:		Affiliation:	
Nina Renshaw		T&E	
Reviewer's remarks:			
Some very useful points, underlying studies can add value.			

Title:	**Menace de cacophonie dans le débat sur les écocombis**		
Year:	2007	Language:	FRENCH
Authors:	Affiliation:		
Philippe Van Dooren	Transport Echo Magazine		
Web link:			
Scenario	No		
Opinion	Considering that EMS become more and more popular, there is a risk that each country modifies its national regulation on its own to allow the traffic of longer trucks. In this way, directive 96/53/EC that intended to harmonize weights and dimensions of road vehicles in Europe will result in a superposition of national regulations about longer and heavier vehicles.		
Data	After joining the European Union in 1995, Finland and Sweden were supposed to comply with directive 96/53/EC. With the help of environmental arguments (and the lobbying of the Scandinavian ecologists), an agreement was found on the European level to let them use longer and heavier vehicles (hence Art. 4, §4) in the directive. At this time, the Swedish Ministry of Transport (Vägverket) claimed that a strict adoption of directive 96/53 without the tolerance introduced in art 4 would have had the following consequences for Sweden: • CO_2 emissions: + 16%; • NOx emissions: +21%; • Transportation cost for the Swedish economy overall: +20%.		
Reviewer's remarks:			
This article helps to understand how the Art 4 -4 of directive 96/53 came into being and how it served to enable the beginning of the experiments in the Netherlands. Directive 96/53 is not accompanied with particular conditions on the vehicles and the drivers, hence a risk that each individual country decides on its own particular conditions for the use of longer and heavier vehicles.			

Title:	**A real danger for Combined Transport: the Megatruck** **Newsletter 4**		
Year:	2006	Language:	English
Authors:	Affiliation:		
UIRR			
Web link:	http://www.uirr.com/?action=page&page=47&title=N%2FP%2FA+CATEGORIES&categorie=4&year=2006&item=30		
Scenario	NO		
Opinion	• The decrease in road unit costs would lead to a significant modal shift from rail to road. • The journeys by trucks would increase. • Investments done for CT would be greatly devaluated. • Need for road infrastructure enhancements. • Specific problems to the servicing of cities. Based upon TIM Consult study (S56 – 2006) dealing with the potential return to the road of today combined transport traffic.		
Data	• 55% of railroad combined transport traffic would return to the road. • Journeys by trucks would increase 24%		
Experts identified:	Affiliation:		
	TIM Consult		

<table>
<tr><td>Title:</td><td colspan="3">European Modular System: a root to more efficient transportation</td></tr>
<tr><td>Year:</td><td>?</td><td>Language:</td><td>English</td></tr>
<tr><td>Authors:</td><td colspan="3">Affiliation:</td></tr>
<tr><td></td><td colspan="3">Volvo Trucks</td></tr>
<tr><td>Web link:</td><td colspan="3"></td></tr>
<tr><td>Scenario</td><td colspan="3"></td></tr>
<tr><td>Opinion</td><td colspan="3">It is mentioned that transport volumes will grow at least by 50% during coming 15 years. Thus, EMS will allow doing more transport using the same number of vehicles. EMS means that existing units can be combined in a more efficient way. Today's trucks, trains and ships can continue to be used without any major modifications. The only thing that is new is the way in which the load carriers are combined. EMS allows reaching capacity of 3 trucks by two EMS systems. This means that much of the expected volume increase on the roads would be possible to move with the same number of vehicles that are on the roads today.

The starting point for EMS is the existing standard for load carriers: 7.82 and 13.6 meters. One way of EMS implementation is to combine two load carriers measuring 7.82 and 13.6 meters respectively. The load carriers used for road transport can also be transferred to and from railways and ships. The EMS approach favours intermodal transportation.

The EU does not object to broad-based implementation of EMS in Europe. EMS is encompassed in EU vehicle directive 96/53/EC. In those countries where EMS is being used or tested, the results are excellent. Sweden and Finland have applied the system since the mid-90s. Calculations reveal that the efficiency of cargo transportation there has improved by 30%. In brief, EMS has the following main advantages.

• More efficient transportation: 50% higher load capacity with the same number of vehicles
• Less congestion: fewer truck rigs take less space on the roads
• Co-modality: interaction between various transport modes is improved
• Intermodality: the same load carrier can be used for trucks, trains and ships
• Lower accident risk: with fewer vehicles on the roads, the risk of accidents is lower
• Lower fuel consumption: fuel consumption per ton-kilometre is cut by 15-20%
• Standard solution: EMS makes use of already existing load carriers
• Lower transport costs per tonne-kilometre
• Less road wear because the weight of load is distributed between more axles
• Modal shift: experiences from Sweden, Finland and the Netherlands show that EMS does not cause any market shift from other modes to the road mode.</td></tr>
<tr><td>Data</td><td colspan="3"></td></tr>
<tr><td colspan="4">Reviewer's remarks:</td></tr>
<tr><td colspan="4">The brochure is an advertisement of Volvo's European Modular System (EMS) concept of LHV. It is indeed very positive about EMS, underlining that LHVs in the form of EMS is the solution for the growing transport demand.</td></tr>
</table>

<table>
<tr><td>Title:</td><td colspan="3">Letter to Lucien Vogel about Interpretation by Member States of Directives 96/53/EC and 97/27/EC on the definition of trailer length</td></tr>
<tr><td>Year:</td><td>2007</td><td>Language:</td><td>English</td></tr>
<tr><td>Authors:</td><td colspan="3">Affiliation:</td></tr>
<tr><td>Ben Van Houtte</td><td colspan="3">DG TREN</td></tr>
<tr><td>Web link:</td><td colspan="3"></td></tr>
<tr><td>Scenario</td><td colspan="3"></td></tr>
<tr><td>Opinion</td><td colspan="3"></td></tr>
<tr><td>Data</td><td colspan="3">Lucien Vogel, quality director at LOHR industries, has reported in a letter dated 22/06/2007 that misinterpretation of directive 93/53/EC, annex I, point 1.1 and Directive 97/27, annex I, point 2.4.1has led to different transpositions of these directives into national law. The key point is whether or not coupling devices of trailers (whose maximum length was set at 12.00m by former directive) have to be taken into account. Added to this letter are some examples of Finnish, French, British and German law texts, indeed stating differences in maximum lengths.
In response, Ben Van Houtte confirmed that these coupling devices should not be taken into account when determining dimensions. Furthermore, he stated that should an infraction against either directive occur, a formal procedure should be started.</td></tr>
<tr><td>Experts identified:</td><td colspan="3">Affiliation:</td></tr>
<tr><td>Lucien Vogel</td><td colspan="3">LOHR</td></tr>
<tr><td colspan="4">Reviewer’s remarks:</td></tr>
<tr><td colspan="4">How directives are transposed to national legislation should not be a topic of discussion. At first sight, applicable directives seem to be clear enough.</td></tr>
</table>

Title:	**European Truck Accident Causation**			
Year:	2007		Language:	ENGLISH
Authors:		Affiliation:		
N.N.		EU and International Road Transport Union		
Web link:	http://www.iru.org/index/bookshop-display-action?id=169			
Scenario	No			
Opinion	No			
Data	Objective of this study was to fill in the lack of knowledge regarding statistics on accidents involving trucks and its main causes. The main cause is the cause which has made the greatest contribution to the fact that the accident happened. The detailed objectives can be summarized as follows: • To develop a scientific, widely accepted and internationally benchmarked methodology, • To develop a European homogeneous database, • To have expert teams investigate over 600 truck accidents in seven European countries (France, Germany, Hungary, Italy, the Netherlands, Slovenia, Spain) • To identify the main cause and the causal sequence of accidents involving trucks, • To recommend actions to various stakeholders which contribute to the improvement of road safety by targeting the main causes of accidents involving trucks, • To make the results available to the research community and other relevant parties. During the study 624 accidents across Europe were investigated. Outcome is that the main accident cause is linked to human error (85.2 %). However, among these accidents 75 % are caused by other road users versus 25 % by the truck drivers. Other factors such as weather and infrastructure conditions, or technical failures played a minor role. The accidents were distinguished between single truck and multi-vehicle accidents and within this in several categories. Indeed, 85.8 % are covered by one of the configurations below: • Accident at intersection • Accident in queue • Accident due to lane departure • Accident during an overtaking manoeuvre • Single truck accidents The evaluation of all data gathered during the study produced a list of recommendations to various stakeholders. The main categories are namely: 1. Non-adapted speed 2. Failure to observe intersection rules 3. Improper manoeuvre when changing lanes The recommendations are addressed to manufacturers, infrastructure providers/developers, governments, truck drivers, other road users and media. As an overall conclusion to mention is special attention to the human factor.			
Reviewer's remarks:				
Useful study regarding road safety				

<table>
<tr><td>Title:</td><td colspan="3">Mega-trucks versus rail freight?
What the admission of Mega-trucks would really mean for Europe</td></tr>
<tr><td>Year:</td><td>2007</td><td>Language:</td><td>English</td></tr>
<tr><td colspan="2">Authors:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2">UIC, CER, EIM, UIRR, UNIFE, ERFA</td><td colspan="2"></td></tr>
<tr><td>Web link:</td><td colspan="3"></td></tr>
<tr><td>Scenario</td><td colspan="3"></td></tr>
<tr><td>Opinion</td><td colspan="3">They DO NOT agree with the opinion of one part of road-sector stakeholders:
• increased transport capacities (payloads) made available for a minimal extra financial outlay;
• a more rational use of road and motorway capacities, hence a reduction or stabilisation of the number of conventional trucks on the roads (though this would only be true at constant traffic levels, an unlikely scenario);
• road unit costs (cost per tonne-kilometre) reduced by 20-25% over long-haul runs. This would only be true if these trucks were to always carry their maximum load;
• a further claim is that the same freight volumes can be moved using fewer road vehicles. This would, nonetheless, require more logistics centres to distribute the goods brought in by these trucks (deflating the second argument above).
In their opinion, allowing EMS would lead to:
• the need of expensive road infrastructure enhancements
o new roads have to be constructed to a different, more costly specifications,
o eventually, a dedicated extra lane for Mega-Trucks will have to be provided for on the busiest motorways,
o the widening of roundabouts, access lanes, etc., would be required,
o at the road / rail interfaces: upgrading of level-crossings (design, dimensions, safety equipments), road-over-rail bridges,
o many motorways, parking areas would have to be enlarged (in Germany, for example, they already have reached the point of saturation in many places),
o most terminals and logistics platforms on the outskirts of population centres would have to be restructured, not to mention all the work needed on the access roadways.
o this would additionally imply the costly upgrading of many civil engineering structures (experts have mentioned the risks posed by bridges built in the 70s and 80s, based on extremely different load scenarios).
• a major impact on transport safety:
o the co-existence of long, heavy road vehicles and private-car traffic (with a strong speed differential),
o necessity to dedicate slow lanes to Mega-Trucks (which virtually implies depriving slower cars of one lane),
o overtaking risks (overtaking between 'conventional' trucks and Mega-Trucks, cars and other truck types, etc.),
o risks intrinsic to the behaviour of these Mega-Trucks in road traffic: sensitivity to cross winds when moving, handling difficulties (even with specific assistance systems), braking distances, visibility problems, generally and specifically in terminals or parking zones,
o safety at level-crossings and more generally at all road / rail interfaces (road-</td></tr>
</table>

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<tr><td></td><td>
over-rail bridges, etc.),
o increased gravity rate (fatalities) of road accidents involving longer and/or heavier trucks.
• creating more imbalance between transport modes in the freight market and increasing even more the "true costs" of transport (i.e. increasing external costs)
• a contradiction with current objectives of transport policy and sustainable mobility
• "unfair" competition with rail mode, unless rail freight has first been freed of its infra-structure constraints. And prior to that, a number of issues must be resolved, including:
o the introduction of a genuine infrastructure 'user fee', set at a suitable level for road transport,
o more globally: the internalisation of external costs,
o the harmonisation of working conditions, such as between transport modes, and the effective monitoring of their application by road transport operators,
o the technical preparation (in terms of capacity, authorised train lengths and loads, interoperability, path-allocation and train-working priorities) of a freight-prioritising European railway infrastructure.
Based upon:
Tim Consult study (R56 – 2006)
K+P study I (R40 – 2006)
T&E policy paper (TML41, April 2007)
BASt study (R09, November 2006)
Allianz pro Schiene (see website, March 2007)
INFRAS / IWW External costs of transport (October 2004)
CRR (TML17 English version, S69 French version – March 2007)
TRL / Heriot – Watt University (TNO36 – May 2007)
</td></tr>
<tr><td>Data</td><td>
• National standards for road transport vehicles (length and weight) in Europe
• Average external costs freight 2000
• Total external costs of transport in Western Europe (650 billions euro without congestion costs
• Growth of domestic combined transport by country 2005/2015
• Perspectives for combined transport by rail
</td></tr>
</table>

Title:	**Potential of high productivity vehicles**		
Year:	2007	Language:	English
Authors:	Affiliation:		
Anders Lundström	SCANIA		
Web link:	http://www.internationaltransportforum.org/jtrc/infrastructure/ParisSep2007/07Lundstrom9.pdf		
Scenario	No		
Opinion	• Need for harmonizing road class definitions and "bridges formulae". • Need for harmonizing road design, especially round about • Need for harmonizing and improving freight statistics. • Need for harmonizing standards to road – vehicle communications • European harmonisation desirable sooner or later		
Data	• Proposal for a "key performance indicator" = SPEED (km/h) x PAYLOAD (tonnes) / FUEL (litres) • SP/F (1909) = 0.1 SP/F (1990) = 10 SP/F (2010) = 20 • 1 kg of fuel = 3 kg of CO_2. • 4 possible modular combinations • Basic load dimensions of today trucks: o Loading length 13.6 m → 33 pallets, 90m3, 2 TEU o Loading length 7.82 m → 19 pallets, 50m3, 1 TEU or a CEN swap-body		
Experts identified:	Affiliation:		
Anders Lundström	Head of feasibility studies SCANIA, Sweden		
Reviewer's remarks:			
• Good ideas to show where the state of the art and the legislation could progress. • Valuable data.			

Title:	**Competitive effects on combined traffic launching LHVs**		
Year:	2006	Language:	ENGLISH
Authors:		Affiliation:	
N.N.		TIM Consult	
Web link:			
Scenario	No		
Opinion	No		
Data	This presentation was held on a press conference by kombiverkehr and UIRR and summarizes the results of a study regarding competitive effects on intermodal (rail-road) traffic after launching LHVs. Key finding is a calculated decrease of intermodal traffic up to 55 % with LHVs on the road. Methodology of the study was an examination of 388 real door-to-door transports in the following four market segments: container transport national, container transport international, continental transport national and continental transport international. Based on different transport chains a model calculation was conducted. This analysis has presumed a use of LHVs only on designated highways; the authors reasoned their decision by claiming this as the worst case for LHVs. The approximated average decrease of 55 % in intermodal traffic as mentioned above results from a decrease in the ratio of road-intermodal traffic (from 41 % road and 59 % intermodal to 73 % road to 27 % intermodal). Figures of decrease in intermodal traffic for the four market segments are as follows: • 44 % container traffic national • 17 % container traffic international • 27 % continental traffic national • and 81 % continental traffic international Besides these figures the study predicts an increase of 24 % for overall trucking albeit there is a capacity decrease of 50 % using LHVs. In addition to the evaluation results the presentation gives an outlook on further questions regarding the use of LHVs. In detail these questions are: • increase of traffic space due to changing locations (LHVs only on designated routes) • increase of vehicle congestion due to fluctuation from close-up range to changing locations • noticeable congestion in urban traffic by LHVs			

<table>
<tr><td>Title:</td><td colspan="3">EuroCombi: Efficient, Economical, Ecological, European</td></tr>
<tr><td>Year:</td><td>2006</td><td>Language:</td><td>English</td></tr>
<tr><td>Authors:</td><td colspan="3">Affiliation:</td></tr>
<tr><td>Prof. Dr. Bernd Gottschalk</td><td colspan="3">VDA (German Association of the Automotive Industry)</td></tr>
<tr><td>Web link:</td><td colspan="3"></td></tr>
<tr><td>Scenario</td><td colspan="3"></td></tr>
<tr><td>Opinion</td><td colspan="3">The following are the most important statements / conclusions mentioned in the presentation.
• Due to rising customer demands all over Europe the use for road haulage is expected to increase substantially in the coming ten years. It is vital that the road infrastructure is used more efficiently to cope with this rising demand.
• New vehicle concepts should be developed to use the road infrastructure efficiently. These new concepts should be compatible with intermodal transport, comply with road safety, have a broad based social acceptance and give return on investments for the automotive industry.
• The VDA wants to start a discussion about the use of EuroCombis, with safety as a top concern. Other important elements would be road infrastructure and especially bridges (should not be taxed too much).</td></tr>
<tr><td>Data</td><td colspan="3">• The proposed vehicle concept is long (up to 25.25 meters) and heavy (to 60 tonnes). If 23% of all trips of conventional trucks in Germany were made with EuroCombis, 2.2 billion vehicle kilometers would be saved. The savings in the German economy would account to 6%. If it would be possible to use these EuroCombis in the entire EU, the savings would be 10% for the German economy.
• From a business perspective, the savings would be 16% on operational cost when using EuroCombis instead of 40-ton conventional trucks.</td></tr>
<tr><td colspan="4">Reviewer's remarks:</td></tr>
<tr><td colspan="4">The document presents a point of view of the German Association of the Automotive Industry on the EuroCombi concept, in which LHVs are possible. The document is very positive on EuroCombi (a type of LHV) and can be seen as an advertisement of a particular type of equipment (and consequently of the LHV concept).</td></tr>
</table>

<table>
<tr><td>Title:</td><td colspan="3">EuroCombi: more goods with less traffic</td></tr>
<tr><td>Year:</td><td>?</td><td>Language:</td><td>English</td></tr>
<tr><td colspan="2">Authors:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2">Prof. Bernd Gottschalk</td><td colspan="2">German Association of the Automotive Industry</td></tr>
<tr><td>Opinion</td><td colspan="3">
The new vehicle concepts (LHV) can raise the volumes transported by up to 50% per vehicle
EuroCombi causes less damage to the road surface
EuroCombi is an offer from the automotive industry to conduct a broad dialog amongst all parties concerned on the possibilities, framework conditions and requirements for introducing longer and/or heavier commercial vehicles for long-distance traffic. The objective does not be the general introduction of a 60-ton maximum, but the search for efficient solutions within the realms of what is technically feasible.
Trucks account for approximately 70% of ton-kilometres in Germany. That number is not going to change in the longer term; the EC even expects the portion of goods carried out by trucks in Europe to increase slightly
Trucks are the best means (for online commerce), since most of today’s road freight consists of small-volume, high-quality products. They can be transported most efficiently and quickly by commercial vehicles. Trucks therefore offer transportation that customers appreciate – customer-oriented, high-quality, flexible, safe, fast and offering good value.
The automotive industry presents the EuroCombi as a concept for the future in two variations
Volume-oriented variation: a standard two-axle tractor tows a standard semi-trailer 13.62 meters long. A tandem axle trailer 7.82 meters long is coupled to it, resulting in a total length of 25.25 meters. This variation has a total weight of 48 tons.
Weight-oriented variation: a tractor unit with 3 axles, two of which are driven axles, and a fixed body up to 7.82 meters long are coupled via a two-axle dolly to a standard semi-trailer 13.62 meter long. This variation is 25.25 meter long and has maximum total weight of 60 tons.
Current investigations by Kessel & Partner on behalf of the German Association for Research in Automotive Technology assume that around 2.2 billion vehicle-kilometres can be saved annually by EuroCombi. That means that in Germany alone there would be savings for the national economy, including both ecological and economical effects, amounting to 6% as compared to transportation solely by 40-tons trucks. If EuroCombi was used for cross-border transport, the savings would exceed 10%.
The modular structure of EuroCombi allows the operators of vehicle fleets to use the different parts of the truck-tractor combination flexibly in various combinations and does not require large-scale new investment. Existing vehicles can still be used in the logistics network.
The fully loaded EuroCombi enjoys 15% fuel saving per ton-kilometre in comparison to 40-ton commercial vehicle.
EuroCombi are safe and can be equipped with advanced passive and active driver assistance systems
</td></tr>
<tr><td colspan="4">Reviewer’s remarks:</td></tr>
<tr><td colspan="4">The document presents a point of view of the German Association of the Automotive Industry on EuroCombi – a type of equipment used to make LHVs. The document is very positive on EuroCombi (a type of LHV) and can be seen as an advertisement of a particular type of equipment (and consequently of the LHV concept).</td></tr>
</table>

Title:	**The B-train - interlinked semi-trailers(?)**		
Year:	?	Language:	English
Authors:		Affiliation:	
John Dickson-Simpson (?)		TPS Design(?), Denby Transport	
Web link:	http://www.tmleuven.be/temp/20080130Tim/B-Train_Report_by_John_Dickson-Simpson.pdf		
Scenario	The report is an engineering and economic appraisal of the B-train combination of doubled trailers. The project has been privately funded by Lincoln logistics company Denby Transport. The fuel consumption study was supervised by the British Transport Advisory Committee. B-train is long established in Australia, Canada and South Africa has two semi-trailers coupled together. When the wheels of the intermediate semi-trailer steers, B-train tracks within the turning corridor specified in European regulations.		
Opinion	Assuming full payloads and a reasonable requirement to move 6000 tonnes of cargo per year, a B-train would do 160 trips when a conventional 44-tonne articulated truck would require 213 trips. In other words, there would be, with B-trains, 25% less vehicles to move a given quantity of freight. Put another way, a B-train could carry 32.5% more tonnage over equivalent time.		
Data	Overall average deceleration maximum of the B-train is 0.73g B-trains could reduce the number of heavy vehicle trips by 25% in terms of weight and by 50% in terms of volume There are some concerns about roll stiffness, braking and lateral stability under critical conditions, and the tracking of the outfits does not as a rule lie within the corridor of circles of 5.3. and 12.5 m radiuses required by the EC directive 96/53 In comparison to normal heavy trucks, the fuel consumption of B-trains is 29.76% more, while increase in gross weight is 43% and increase in payload weight is 41% Road wear factors determined from summation of the fourth powers of laden axle weights, are for the B-train prototype 45% worse then those of a 4-tonne six-axle articulated lorry. In relation to payload moved, the road wear index of the B-train tested is 11.6% worse than that of a six-axle 44-tonner		
Experts identified:		Affiliation:	
Reviewer’s remarks:			
The study appears to be a good technical account of the B-train performance and characteristics. The study reports in detail positive and negative aspects of B-train performance, as well issues related to compliance to the EC directive.			

<table>
<tr><td>Title:</td><td colspan="3">Le poids lourd de 60 tonnes</td></tr>
<tr><td>Year:</td><td>2007</td><td>Language:</td><td>FRENCH</td></tr>
<tr><td colspan="2">Authors:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2">André Peny</td><td colspan="2">French Ministry of Transport</td></tr>
<tr><td>Web link:</td><td colspan="3"></td></tr>
<tr><td>Scenario</td><td colspan="3">No</td></tr>
<tr><td>Opinion</td><td colspan="3">Observing and learning from the others' experiments could help French deciders to prepare an experiment in France, rather undergoing when too late.</td></tr>
<tr><td>Data</td><td colspan="3">This short paper describes the situations in Sweden, the Netherlands, Estonia and Germany.

• Sweden:
o According to the Swedish National Road Administration, decreasing the GCW from 60 to 40 t would result in: CO_2 -> +16%, NO_x -> +21%, Transport costs -> +20%;
o Impact on rail transportation and modal shifts are negligible;
o Infrastructure (roads and bridges) must be adapted and looked after. A long term investment programme was decided for that purpose. They are jointly financed by the Swedish state and the Swedish industry.
• The Netherlands:
o First results (at the time of the writing) show that 7 to 31% of trips operated by trucks with a GCW higher than 20 t are transferred to LHV, hence a decrease of the number of trucks running on Dutch roads overall;
o No real effect on the modal balance;
o Decrease in the number of people killed on the roads (-4 to -7%) due to a reduction in the number of trucks (–13 to –25% for the injuries);
o TNS NIPO Consult has investigated the behaviour of drivers when faced to LHVs and has produced some recommendations as for the 'generalization' of LHVs on Dutch roads.
• Estonia: EMS experiment not allowed because:
o Difficulties in overtaking long vehicles;
o Difficulties in operating vehicles across the Russian border.
• Germany: very divided opinion on the EMS
o Advantages demonstrated from the Swedish, Finnish and Dutch experiments;
o But other studies mention the damages to roads and bridges, bad results in road safety, investments to adapt parking areas, etc.;
o Positive effects of the EMS to deal with congestion are not proven: risk that transport demand increases because of the EMS, to the detriment of the other modes.
• France:
o The European framework has a word to say and rather that denying the problem, France should rather take the bull by the horns and get a dialogue going with all stakeholders, in order to launch an experiment;
o Experimenting the use of LHVs would enable all players to be aware of the consequences of having LHVs on French roads;
o The Dutch experiment (especially its methodology) could usefully inspire the French deciders.</td></tr>
</table>

Experts identified:	Affiliation:
	Swedish National Road Administration TNS NIPO Consult Estonian Logistics Association
Reviewer's remarks:	
This is a very general article informing of the different situations in Europe. Some details are given but most sources are omitted. As a conclusion, the writer highlights the interest of anticipating a European decision by allowing an experiment ASAP.	

Title:	**Seasonal speed limits and heavy vehicles (p. 22)**		
Year:	2005	Language:	English
Authors:	Affiliation:		
Jukka Räsänen, Harri Peltola	VTT, Finland		
Web link:			
Scenario			
Opinion			
Data	Articulated vehicles do the majority of road transport in Finland. Computer simulation suggests full trailer trucks (22m) are more unstable than semi-trailer trucks (25.25m).		
Experts identified:	Affiliation:		
Jukka Rasanen Harri Peltola	VTT Finland		
Reviewer's remarks:			
Application of extra safety measures (decreasing speed limits during winter), but not specific for Gigaliners.			

Title:	**The role of seasonal speed limits in speed management**		
Year:		Language:	English
Authors:	Affiliation:		
Harri Peltola	VTT, Finland		
Web link:			
Scenario			
Opinion			
Data	Accident statistics on Finnish roads, and the influence of seasonal speed limits on them.		
Experts identified:	Affiliation:		
Harri Peltola	VTT		
Reviewer's remarks:			
Not much useful information, as this is not specific to trucks, let alone big trucks.			

Title:	**Impact sur le transport combiné de la généralisation du 44 t**		
Year:	2005	Language:	FRENCH
Authors:		Affiliation:	
Olivier Rolin		French Ministry of Transport	
Web link:			
Scenario	Impact of the generalization of 44 t vehicles on French combined transport.		
Opinion	Hard to quantify but will jeopardize combined transport for sure		
Data	**Summary:** This paper refers to a few studies to propose a computation of the impact of generalizing 44 t vehicles on combined transport. The hypotheses are : • The fares proposed by combined transport companies do not change, in spite of a reduction of road transport costs; • In spite of a modal shift from combined transport to road, the combined transport network remains unchanged, which may be questioned for certain lines that know the most significant modal shifts; • 20 to 25 % of all swap bodies are used with a gross weight of 29 t (maximum weight). They are first concerned by a possible increase of the GVW to 44 t. (the associated volume equals 4.3 billions of t-km per year in France at this time). Under these conditions: • Increasing the GVW to 44 t would result in a reduction of the road transport costs of roughly 14%; • As a result, between 21 and 31 % of the swap bodies that are operated at a gross weight of 29 t will be transferred to road only (which represents between 0.9 and 1.3 billion of t-km per year in France at this time).		
Experts identified:		Affiliation:	
Reviewer's remarks:			
The author underlines a very important point: If combined transport terminals do not operate large enough volumes, this may cause their closing down. It is a kind of vicious circle.			

Title:	**Impact sur les émissions de GES de la généralisation du 44 t**		
Year:	2005	Language:	FRENCH
Authors:	Affiliation:		
Olivier Rolin	French Ministry of Transport		
Web link:			
Scenario	Impact of the generalization of 44 t vehicles on the greenhouse gas production.		
Opinion	Depends on the calculation of the traffic changes for each mode.		
Data	**Summary:** from the results of paper S67 on all kinds of traffics (road, combined transport, rail and river transport), the effect of increasing the permitted gross weight are calculated. Once the traffics are calculated, the results concerning greenhouse gas depend upon the hypotheses that are used. Here are the main hypotheses: • The elasticity of unit fuel consumption of the trucks to loading: 0.3; • The unit consumption of trains (between 0.6 and 2.4 g CO_2/t-km); • The unit consumption of river transport (27.2 g CO_2/t-km).		
Experts identified:	Affiliation:		
Reviewer's remarks:			
The results in this paper are directly linked to the hypotheses used in another paper. The loading effect being the most prominent, the paper states a serious decrease in the greenhouse gas production.			

<table>
<tr><td>Title:</td><td colspan="3">Impact sur les trafics de la généralisation du 44 t</td></tr>
<tr><td>Year:</td><td>2005</td><td>Language:</td><td>FRENCH</td></tr>
<tr><td colspan="2">Authors:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2">Olivier Rolin</td><td colspan="2">French Ministry of Transport</td></tr>
<tr><td>Web link:</td><td colspan="3"></td></tr>
<tr><td>Scenario</td><td colspan="3">Impact of the generalization of 44 t vehicles on traffics and modal shares</td></tr>
<tr><td>Opinion</td><td colspan="3">Less trucks on the roads overall in spite of the modal shifts from the other modes to road transport</td></tr>
<tr><td>Data</td><td colspan="3">In this paper, the author computes the effects of generalizing the 44 t on goods transport on the whole. The results show that the number of trucks will decrease overall. There are 3 effects at stake:
• A "loading" effect: trucks would be more loaded, which would reduce their number on roads;
• A "modal split" effect: decreasing the cost of road transport would lead to increase its competitiveness and encourage modal shift from the other modes (combined transport, rail transport, river and maritime transport) towards road transport;
• A transit effect: some trucks with a 44t gross weight would now be able to cross France.
These effects do not head toward the same direction. They are assessed separately.

Among the important hypotheses, it should be noted that:
• The loading effect mainly applies on trucks which are formed of a tractor and a semi-trailer and among these vehicles. Besides 22% only of them already carry 40 t;
• For combined transport, the traffic of swap bodies whose weight equals 29 t is most likely to a shift to road transport only;
• For the other modal shifts concerning the traffics operated on railways and waterways, the elasticity of the demand to costs is calculated;
• The transit effect is computed thanks to traffic data related to traffics operated between neighbour countries that allow 44 t vehicles.</td></tr>
<tr><td colspan="2">Experts identified:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2">ADEME
CNR</td><td colspan="2"></td></tr>
<tr><td colspan="4">Reviewer’s remarks:</td></tr>
<tr><td colspan="4">Data are provided for France but are quite approximate, due to the many hypotheses that are necessary for the calculations. However, the methodology can be easily adapted to other countries, after having discussed the different hypotheses.</td></tr>
</table>

Title:	**Longer and heavier on German roads, do LHVs foster sustainability**		
Year:	2007	Language:	ENGLISH
Authors:	Affiliation:		
Döpke A., et al.	Umweltbundesamt		
Web link:			
Scenario	The considered modular scenario is realized with a permissible total weight of only 60 t.		
Opinion	The utility vehicles, which are called "giant trucks", do not make a contribution to sustainable traffic development.		
Data	The focus of the report is on the response to questions as for the use of longer or/and heavier trucks regarding environmental pollution. These questions are partitioned as follows: fuel consumption as well as production of air pollutants and noise; effects on other carriers; required space and risk of traffic jams; infrastructure. *Effects on fuel consumption as well as pollutants and traffic noise:* The specific consumption that refers to the volume declines by up to 25%, since almost 50% more freight can be carried. However, this gain only refers to a capacity utilization of more than 77%[73]. The same applies for the air pollutant emissions. They only decline during maximum capacity utilization. Noise emission increases as a result of heavier motorization as well as a higher number of axes. Relating to the transported amount of goods, the contribution to the decrease of traffic noise also depends on the degree of utilization. With utilization similar to conventional trucks they do not make a contribution. *Effects on other carriers:* Due to the greater load possibilities the costs per ton of freight decrease by up to 25 %[74]. For this reason the competitive situation switches in favour of the road. With a road haulage that is at a reduced rate of one percent, the goods transported by rail decrease by 1.8% and those transported by water transportation by 0.8 %[75]. According to estimations of the UIRR 55 % of today's combined traffic would be shifted to the road in the future through the admission of bigger trucks. *Effects on required space and infrastructure* With optimal capacity utilization two oversized trucks substitute three conventional trucks. This results in reduced space requirements of 44%[76]. However, the parking space capacity at motorway service stations is reduced by 20 %[77]. Oversized trucks particularly affect bridges and traffic centres and have a negative impact on durability and maintenance. Special traffic facilities like smaller roundabouts cannot be passed with longer and/or heavier trucks. With regard to traffic accidents the heavier weight brings about severe consequences. Moreover, they make higher demands on safety equipments (tunnels, guard rails, ...)		
Experts identified:	Affiliation:		
Gohlisch G.	Umweltbundesamt		

[73] Federal Environment Agency
[74] Internationales Verkehrswesen 11/2005 and Federal Environment Agency
[75] Study CE Delft, 2000
[76] Federal Environment Agency
[77] Study Federal Highway Research Institute, 2006

Title:	**Des véhicules plus longs et plus lourds (VLL): une approche multidisciplinaire de la problématique en Belgique**		
Year:	2007	Language:	French
Authors:		Affiliation:	
Wanda DEBAUCHE		BRRC	
Web link:	ftp://ftp2.autoroute411.be/autorout/Centre_de_Recherches_Routieres_les_VLL.pdf www.autoroute411.be/download.php?op=mydown&did=82		
Scenario	No		

Opinion	• How to address the issue
	• Important data missing to make up one's mind about this issue, on:
	  o Road safety
	  o Mobility
	  o Environment.		

Data	• Brief summaries of some European experiments with VLL • Belgian legal aspects • Mobility and environment: data missing • Economical aspects • Infrastructure issues • Road safety: data missing • Fiscal and social aspects		
Experts identified:		Affiliation:	
Wanda DEBAUCHE		Mobility division, Belgian Road Research Center, Belgium	
Reviewer's remarks:			
Very good proposal for a methodology to deal with the issue.			

Title:	**Letter to M. Barrot, 21 March 2007**		
Year:	2007	Language:	ENGLISH
Authors:	Affiliation:		
Johannes Ludewig Rudy Cole Wolf Gehrmann Michael Clausecker	CER (Community of European Railway and Infrastructure Companies) IURR (International Union of combined Road-Rail transport companies) UIP (International Union of Private Wagons) UNIFE (European association for the railway supply industry)		
Web link:			
Scenario	Supersized road vehicles on a European-wide basis		
Opinion	Supersized road vehicles would cannibalise rail transportation.		
Data	**Summary:** this letter warns the European Commission of the high risk that would come from allowing LHVs in Europe. On the basis of 2 studies (achieved by K+P Transport Consultants and Tim Consult), **fore-cast consequences for the German transport industry** are laid out in order to support the fears of the rail industry. It is stated that the consequences of the introduction of EMS in Germany on combined rail-road transport would be (in a year): • 7 billion tonne-kilometres would shift from rail to road; • which means 400 000 additional trucks journeys. These figures probably underestimate the consequences, because the effects on Single Wagon Load are not taken into account. Thus, allowing LHVs would have **side effects:** decreasing road unit costs would lead to an increased use of road transport at the detriment of combined transport, which would mean **more CO_2 emissions**.		
Experts identified:	Affiliation:		
Matthias Ruete K+P Transport Consultants TIM Consult	Director General DG TREN Carried out the evaluation commissioned by the German Government		
Reviewer's remarks:			
Allowing longer and heavier vehicles in Europe will reinforce the competitiveness of road transportation to the detriment of rail transport. The premium is put on modal shift in this article and the environmental impact. Rail industry is not questioned in this article.			

<table>
<tr><td>Title:</td><td colspan="4">The effects of long and heavy trucks on the transport system</td></tr>
<tr><td>Year:</td><td>2008</td><td>Language:</td><td colspan="2">English</td></tr>
<tr><td colspan="4">Authors:</td><td>Affiliation:</td></tr>
<tr><td colspan="4">Inge Vierth, Hakan Berell, John McDaniel, Mattias Haraldsson, Ulf Hammarström, Mohammad Reza-Yahya, Gunnar Lindberg, Anre Carlsson, Mikael Ögren, Urban Björketun</td><td>VTI</td></tr>
<tr><td>Web link:</td><td colspan="4"></td></tr>
<tr><td>Scenario</td><td colspan="4">This study has investigated the consequences of reverting to current EU maxima of 18.75m and 40t on the Swedish transport industry, which has been using the longer vehicles since the mid 90’s. It is in fact the reverse of our study on continent wide implementation of LHV, in the typical setting of Sweden.
4 scenario’s are presented:
A. Reference: current legislation and volumes are upheld
B. Revert to current EU maxima, no extra investments in rail infrastructure (=short term consequences)
C. Revert to current EU maxima, with extra investments in rail infrastructure (=long term consequences)
D. Current W&D levels, with extra investments in rail infrastructure (so that scen B+scen D=scen C)
Models used:
• SAMGODS (Swedish freight transport model): modal shift
• ARTEMIS: Emissions
• HARMONOISE: noise
Going back to smaller trucks would mean:
• 37% more trucks needed
• 24% increase in operational costs
• No major modal shift without investments (Scen B): for each commodity, there is a preferred mode. This translates to 24% more vkm for road freight in scen B, and 14% in scen C.
• If the smaller trucks have 7 axles, road wear would decrease. If they have 5, it would increase. Formula: change in wear = $(\text{new axle load}/\text{old axle load})^4$
• A deterioration of safety: heavier, but less trucks results in less casualties than lighter, but more trucks
• More congestion
• More emissions in scen B, less emissions in scen C
• More noise

Some characteristics of the Swedish transport market:
• Most of the road infrastructure, including bridges, tunnels, roundabouts and rest stops, were designed with LHV in mind
• Geography and the types of goods that are transported make Swedish rail more competitive than in the rest of Europe
• A lot of the international transport is rail. Swedish rail would suffer more if LHV would be allowed all over Europe than if they would be forbidden in SE.

Conclusion: Neither Scenario B nor scenario C would be beneficial for the Swedish society.</td></tr>
</table>

Opinion	None	
Data	See scenario	
Experts identified:		Affiliation:
Inge Vierth		VTI
Reviewer's remarks:		
Very interesting case study to show the opposite side of the problem. A number of very useful considerations: • When costs of road modification, apparently necessary, are sunk, benefits of LHV outweigh costs in the Swedish market. • When road freight prices increase because of increased operational cost of smaller trucks, railshippers' profit increases more when they increase their prices as well, as opposed to increasing their volume. Price and substitution elasticities are obviously important.		

Title:	**Nadere toelichting op eisen aan de LZV vrachtautocombinatie**			
Year:	?		Language:	Dutch
Authors:		Affiliation:		
		RDW, the Dutch Government		
Web link:				
Scenario	This document presents the requirements for LHVs (LZV in Dutch) according to the RDW. The RDW is a Dutch organization responsible for vehicle and owner's registration, vehicle safety, MOT registration, incident registration and vehicle type approval. The RDW facilitates the use of LHV as long as they comply with the requirements (for details see document). The most important (additional) limitations are: • The total length of the combination <= 25.25 meter • Under all circumstances stable • The vehicle should by equipped with an anti-lock braking system • Total weight of the combination <=60 ton • Point of rotation maximum two • The vehicle should by equipped with side protection between the axles • Left side steering • The engine should have at least 5×10^{-3} kW per kg maximum total weight.			
Opinion				
Data				
Experts identified:		Affiliation:		
Reviewer's remarks:				
The document is factual about the detailed legal requirements on the actual use of LHVs on the Dutch road networks, and does not give an opinion.				

Title:	**Reacties op Lange Zware Vrachtwagens (LZV's) in het verkeer**		
Year:	2005	Language:	Dutch
Authors:	Affiliation:		
	TNS-NIPO Consult, AVV Transport Research Centre		
Web link:			
Scenario	AVV Transport Research Centre (part of the Dutch Ministry) requested TNS NIPO Consult as an independent research organization to conduct a study on the effects of LHVs on other road users, the central issue was what "civilians claim they would do". Besides obtaining insight into the effects of freight traffic on the perception of road safety, AVV wanted to form a notion of attitude towards and image of freight traffic in general and LHVs in particular. It seems that there is no significant difference in behaviour and safety feeling between interaction with regular freight transport or LHVs.		
Opinion	The following are the most important conclusions and recommendations mentioned. Conclusions • In general motorists feel safe on the road. • There appears to be no significant difference between the motorists' feeling of safety while interacting with LHVs and their feeling of safety while interacting with regular freight traffic. • Motorists choose less risky behaviour for interaction with freight traffic or LHLs than for interaction with passenger cars. This indicates a greater feeling of insecurity about freight traffic or LHVs compared to passenger cars. There are no differences between behaviour comparing interaction with freight traffic or LHVs. • The type of vehicle involved affects the assessment of danger and controllability. This difference shows when comparing passenger cars to freight vehicles, but not when comparing regular lorries to LHVs. • There is a small difference in perception in terms of danger and controllability between LHVs and regular lorries concerning a specific manoeuvre, like turning right. This is considered to be the most dangerous manoeuvre for LHVs. For cars and regular lorries, motorists consider merging with traffic to be the most dangerous act. • The most important indicator of danger influencing the perception of safety is the length of a LHVs • Motorists do not perceive road safety different when it comes to interacting with LHVs or regular freight traffic. A disadvantage is that motorists anticipate to and interact with LHVs the same way as with regular freight traffic. • No real efforts need to be made to create support for the introduction of LHVs. There appears to be substantial support for a general allowance of LHVs. Recommendations • It would be fruitful to increase the general level of knowledge and awareness regarding freight traffic and to remove a number of misperceptions. • It is important to distinguish the differences between LHVs and regular freight transport, for instance swerving. • It should be made mandatory for LHVs to occupy both lanes of a dual carriageway when turning right. Drivers of LHVs (and lorries) already tend to do this out of safety concerns. This is not always understood by other road users, who unjustly consider this rude behaviour. It is equally important to clearly communicate new legislation and the motiva-		

	tion behind it to motorists, to remove a possible lack of understanding. • Haulers should be encouraged to colour their LHVs in very light shades and to load them as evenly as possible.	
Data		
Experts identified:	Affiliation:	
Reviewer's remarks:		
This report is in favour of LHVs if the Dutch government concentrates its efforts on a policy of measures accompanying the new LHVs legislation. Such as a campaign to increase the general level of knowledge and awareness regarding freight traffic (including LHVs).		

<table>
<tr><td>Title:</td><td colspan="3">Gigaliners… des Hyper Poids Lourds sur nos autoroutes</td></tr>
<tr><td>Year:</td><td>2008</td><td>Language:</td><td>French</td></tr>
<tr><td colspan="2">Authors:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2">Yves LAUFER</td><td colspan="2">GETC (European organisation for combined transport)</td></tr>
<tr><td>Web link:</td><td colspan="3"></td></tr>
<tr><td>Scenario</td><td colspan="3">No</td></tr>
<tr><td>Opinion</td><td colspan="3">
Modal shift (to road) will be very high
Probably more trucks.
Car-drivers feel yet in danger, it will be worse
Road safety will be worse
What if EU allows and Switzerland does not?
D96/53 should get the “status of sanctuary”.
D96/53 should be in force even at national level
Eventual experiments should be driven by EC
EC should boost rail freight
Some essential conditions to an experiment:
To exclude EMS from built up areas
To prohibit EMS to overtake
To limit to 70 Km/h their speed limit, even when unloaded
Absolute control in real time
Special driver license, for 3 years
Technical control of trucks every 3 years
Higher taxes
Traffic ban on week-ends and the days of traffic peaks
</td></tr>
<tr><td>Data</td><td colspan="3">
Some kind of combinations
Maximum noticed weight of 90 tons, in NL
Disparity of traffic density in (FIN, N, S) versus (D, F, I)
Landscapes are different
Freight and persons pass in transit through D and F
E, F and I are very touristic regions
Space consumption by a pallet row (1.2 m in the lorry):
1.49 m for 25.25 m
1.50 m for 16.50 m
1.56 m for 18.75 m
Today, a truck needs 5 km or so to overtake another one, on a motorway, (speed 100 and 110 km/h)
</td></tr>
<tr><td colspan="2">Experts identified:</td><td colspan="2">Affiliation:</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="4">Reviewer’s remarks:</td></tr>
<tr><td colspan="4">Good ideas. Clearly against EMS, but open minded.</td></tr>
</table>

<table>
<tr><td>Title:</td><td colspan="3">Impact EMS on intermodal transport. Getting too heavy?</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Year:</td><td>2007</td><td>Language:</td><td>English</td></tr>
<tr><td>Authors:</td><td colspan="3">Affiliation:</td></tr>
<tr><td>Chris Kampfraath</td><td colspan="3">Ministry of Transport, Public Works and Water Management, Netherlands</td></tr>
<tr><td>Web link:</td><td colspan="3">http://www.unece.org/trans/wp24/wp24-presentations/documents/pres07-04.pdf</td></tr>
<tr><td>Scenario</td><td colspan="3">No</td></tr>
<tr><td>Opinion</td><td colspan="3">• Dutch vision on goods transport
• The shift to co-modality
• Only relatively short distance intermodal transport is interesting market for EMS
• Heavy goods travel often on rail or inland shipping
• Every mode has its own captive markets, which will not be influenced by EMS
• EMS is option for efficient logistics in traditional road transport goods</td></tr>
<tr><td>Data</td><td colspan="3">• History of the experiment
• No significant modal shift
• Average mass per m² loading surface in road transport: 300 kg
• Average loaded mass 16 tons
• Average mass EMS in trial: 36 tons
• Payloads:
o EMS 60T → 40 tons
o Regular NL 50T → 35 tons
o 44T: → 29 tons
o 40T: → 25 tons
• 40' containers are usually used for lighter goods than 20' ones.
• Needed payload for average
o 3 x 20': 51 tons (GCW: 71T)
o 20' + 40' 36 tons (GCW: 71T)
• NL strong in 20' If more 40', more influence on intermodality</td></tr>
<tr><td>Experts identified:</td><td colspan="3">Affiliation:</td></tr>
<tr><td></td><td colspan="3"></td></tr>
<tr><td colspan="4">Reviewer's remarks:</td></tr>
<tr><td colspan="4">It is a presentation done fore UNECE in April 2007, WP on intermodal transport. This is a very general article informing of the different situations in Europe. Some details are given but most sources are omitted. As a conclusion, the writer highlights the interest of anticipating a European decision by allowing an experiment ASAP.</td></tr>
</table>

<table>
<tr><td>Title:</td><td colspan="4">Response to Transport and Mobility Leuven research on behalf of DGTREN Logistics and Co-modality on Directive 96/53 adapting weights and dimensions</td></tr>
<tr><td>Year:</td><td colspan="2">2008</td><td>Language:</td><td>English</td></tr>
<tr><td colspan="2">Authors:</td><td colspan="3">Affiliation:</td></tr>
<tr><td colspan="2">Philippa Edmunds</td><td colspan="3">Freight on Rail</td></tr>
<tr><td>Web link:</td><td colspan="4"></td></tr>
<tr><td>Scenario</td><td colspan="4"></td></tr>
<tr><td>Opinion</td><td colspan="4">FoR is against increasing weights or dimensions of heavy commercial vehicles. Basic arguments are:
• Past experience with increases: more trucks driving around less full
• Demand stimulation
• External costs increase
• Impossible to keep these vehicles away from urban areas
• Safety
• Road freight kms will increase due to cost reduction, but also due to the relative improvement in cost position vis-à-vis rail, causing modal shift (mobile warehousing).
• Current vehicle capacity can be increased with more extensive use of IT
• Public opinion is opposed
• Lorries do not pay their full external cost
Comments are provided on each of the 5 aspects:
• Safety
  o Longer and heavier means more damage in case of accident
  o Stability of trucks is put in doubt
  o Foreign trucks on British roads could cause more problems
  o Enforcement/Compliance with regulation (loads, roads, speeds)
  o Bigger vehicles are not suitable for all roads (turning circles)
• CO_2 and emissions
  o Increasing dimensions will not result in less lorries
  o Lower load factor, more unused capacity
  o Rail has far lower exhaust per tkm (CO_2 factor 5, others up to factor 15)
• Infrastructure
  o More road vkm means more damage
  o Risk for bridges
  o Who pays for modification?
• Combined transport
  o Road and rail have some market in common (e.g. deep sea containers)
  o When road cost goes down, rail can not compete
  o Rail is a valid alternative for road
• Meeting demand
  o Trend: more freight, greater distances
  o Predictions from Royal & Sun Alliance and UK Dept. of Transport
  o Rail has the support of governments
  o Rail is reliable</td></tr>
<tr><td>Data</td><td colspan="4">Comments on statements made during the first stakeholder meeting of 04/03/2008</td></tr>
</table>

<table>
<tr><td>Title:</td><td colspan="4">Study by Freightliner on the effects on modal share in the deep sea container market of the introduction of longer heavier vehicles (LHVs)</td></tr>
<tr><td>Year:</td><td colspan="2">2008</td><td>Language:</td><td>English</td></tr>
<tr><td colspan="2">Authors:</td><td colspan="3">Affiliation:</td></tr>
<tr><td colspan="2">Tom Jones</td><td colspan="3">Freightliner</td></tr>
<tr><td>Web link:</td><td colspan="4"></td></tr>
<tr><td>Scenario</td><td colspan="4"></td></tr>
<tr><td>Opinion</td><td colspan="4">A study performed by Freightliner to support their arguments against LHVs.
Market concerned is that of Deep Sea containers in the UK. Several options are considered: increasing current semi trailer length to 16m, 25.25/60t, 30m/82t. This specific market is has high price elasticity. One of its main problems regarding road transport is that the average container weight is above the average allowed weight for trucks.
It is assumed that fuel costs per truck increase by 15%, and fixed costs by 11%. On the other hand, utilisation increases by 24%, resulting in a net cost decrease of 15% per container shipped (mainland Europe: up to 2x that amount).
At an elasticity of 2.5, rail would lose 27% of its market. At elasticity=6, this could be up to 66%.
The UK government subsidises rail. In 2005, this was around £15 mio. Allowing LHV would increase that to up to £39 mio/annum by 2010.
Another problem is loss of critical mass, leading to price increases for rail, and less flexibility in service (less regular lines).
Safety: overtaking – changing lane to the right is the main concern, especially for foreign trucks.
Like in the Freight on Rail argument, lack of enforcement is not seen as an indication of current legislation not being fit for purpose, but as what could happen in case law is relaxed.
GPS is not made for HGV, overloading and speeding is very frequent.
Overall, the suitability of the UK road network for LHV is probably not up to par.</td></tr>
</table>

Annex 2: Stakeholder list

Name	Name	Country	Company
Elsinger	Julia	AT	
Feige	Lydia	AT	
Avenoso	Antonio	BE	ETSC
Berrry	John	BE	European Commission
Billiet	Marc	BE	International Road Transport Union (IRU)
Breemersch	Tim	BE	TML
Claeys	Bram	BE	BBLV
Cocu	Xavier	BE	BRRC
De Ceuster	Griet	BE	TML
De Maegt	Isabelle	BE	FEBETRA
De Somere	Petra	BE	Promotie Binnenvaart Vlaanderen vzw
Debauche	Wanda	BE	BRRC
Decruyenaere	Kathleen	BE	Federal Government
Ey	Frank	BE	Austrian Federal Chamber of Labour
Fouquet	Marie	BE	Michelin
Hertogs	Beatrice	BE	ETF Europe
Janin	Olivier	BE	CLECAT
Janitzek	Timmo	BE	ETSC
Lambrechts	Paul	BE	Promotie Binnenvaart Vlaanderen vzw
Luksic	Oliver	BE	DEKRA
Lundström	Anders	BE	Scania EU Affairs
Maillard	Henry	BE	Federal Government
Maître	isabelle	BE	FNTR
Mievis	Laurent	BE	MET
Olivier	Marguerite	BE	Federal Government
Peetermans	Eric	BE	NMBS Holding
Pitnick	Alfred	BE	ÖBB
Saile	Dirk	BE	Bundesverband Güterkraftverkehr, Logistik und Entsorgung (BGL)
Tilling	Cristina	BE	ETF Europe
van de Paer	Erik	BE	European Chemical Transport Association (EPCA)
Van Herbruggen	Bart	BE	TML
Van Houtte	Ben	BE	European Commission
Vanhoegaerden	Chris	BE	UPS
Verlinden	Jos	BE	European Chemical Industry Council (Cefic)
Winters	Gijs	BE	European Rail Infrastructure Managers (EIM)
Yarsley	Chris	BE	UK's Freight Transport Association
Claessens	Kethy	BE	Barco N.V. BarcoView
Coppens	Carine	BE	Santens nv
Corduant	Véronique	BE	DPWN
Damar	Christelle	BE	Hill & Knowlton International Belgium
De Fauw	Alex	BE	Santens NV/SA
Dehaes	Joris	BE	Louis Dreyfus Cotton Int. N.V.
Escoyez	Louis	BE	O.T.M.

Isaksson	Karl	BE	Scania EU Affairs
Lambrechts	Valentin	BE	OTM
Laureys	Carla	BE	OTM
Lievens	Joke	BE	
Lombard	Bernard	BE	CEPI
Maillard	Henri	BE	Service public fédéral Mobilité et Transports
Meert	Didier	BE	T.L.M.
Panneels	Gretel	BE	
Raes	Yvan	BE	OTM
Schmidt	Philippe	BE	O.T.M.
Serruys	Baudouin	BE	MET
Van den Bossche	Roger	BE	O.T.M. Belgian Shippers'Council
van der Jagt	Nicolette	BE	European Shippers Council
Van Houtte	Tom	BE	Concordia N.V.
van Wettere	Julien	BE	OTM
Vansnick	Marc	BE	Kabinet Leterme
Versnick	Marc	BE	Federale cel mobiliteit
Wijbenga	Reinout	BE	EEA
Deiters	Oliver	BE	DEKRA
Hunter	Joanne	BE	representing the paper industry
Dings	Jos	BE	Transport & Environment (T&E)
Marmy	Jacques	BE	International Road Transport Union (IRU)
De Munck	Liesbet	BE	VIL
Vannieuwen-huyse	Bart	BE	VIL
Angelova	Anita	BG	
Papayianni	Anthi	CY	
Friedrichs	Max	DE	RTWH Aachen
Bleck	Arnulf	DE	MEYER & MEYER Internationale Spediteure GmbH & Co. KG
Bonati	Corinna	DE	Deutsche Bahn AG
Dicke	Bernhard	DE	VDA
Fabian	Thomas	DE	Bundesverband der Deutschen Industrie (BDI)
Geissler	Andreas	DE	Allianz pro Schiene e.V.
Glaeser	Klaus-Peter	DE	BAST
Gosse-Vehne	Klemens	DE	Kögel Fahrzeugwerke GmbH
Keuchel	Stephan	DE	University of Applied Sciences Gelsenkirchen
Klingender	Max	DE	RTWH Aachen
Lacroix	Jacqueline	DE	Deutscher Verkehrssicherheitsrat e.v. (DVR)
Mertel	Rainer	DE	Kombiverkehr KG
Scherer	Michel	DE	Kögel Fahrzeugwerke GmbH
Schmidt	Jörg	DE	Railion Deutschland
Schoch	Dieter	DE	Daimler AG
Schwarz	Roger	DE	Bundesverband Güterkraftverkehr, Logistik und Ent-sorgung (BGL)
Seidelmann	Christoph	DE	Allianz pro Schiene e.V.
Dr. Preisser & Prof.	Pflug	DE	*FAT/vda*
Fried	Joachim	DE	Deutsche Bahn AG

Gohlisch	Gunnar	DE	Umweltbundesamt
Hausherr	Herbert	DE	COTRANS LOGISTIC GmbH & Co. KG
Herbrand	Wolfgang	DE	Thüringen Ministry of Transport
Heuschen	Stephan	DE	Ministerium für Bauen und Verkehr
Kunz	Anja	DE	Secretary UIRR
Schaller	Karl Viktor	DE	MAN-Heavy Trucks, Munich, Germany
Stempfle	Paul	DE	Kögel Fahrzeugwerke GmbH
Wallentowitz		DE	Institute of Automotive Engineering (IKA), RWTH Aachen
Wieczorek	Johannes	DE	
Zander	Ulf	DE	Bundesanstalt für Straßenwesen (BASt)
Richter	Cornelia	DE	University of Applied Sciences Gelsenkirchen
Hessling	Thomas	DE	Allgemeiner Deutscher Automobil Club e.V.
Hahn	Wolfgang	DE	German Ministry of Transport, Building and Urban Affairs
Berner	Ulrich	DE	German Ministry of Transport, Building and Urban Affairs
Larsen	Soren	DN	Danish Transport and Logistics Association (DTL)
Gade	Karsten	DN	Danish Transport and Logistics Association (DTL)
Moppel	Anti	EE	
Simons	Jan	EESC	
Ayala Sender	Inès	EP	
Fernandez-Balbin	Matilde	ES	Ministerio de Fomento
Martinez Sans	Fuensanta	EU	ACEA
Kulesza	Patrycja	EU	ECG - The Association of European Vehicle Logistics
Kwantes	Denise	EU	CER
Larsson	Stefan	EU	ACEA
Ludewig	Johannes	EU	CER
Pype	Rose-Marie	EU	European Chemical Transport Association (EPCA)
Burkhardt	Martin	EU	UIRR
Dirand	Jacques	EU	CER
Perkins	Stephen	EU	OECD
Renshaw	Nina	EU	The European Federation for Transport & Environment
Paci	Giovanni	EU	Association of European Vehicle Logistics
Grohn	Jari	FI	
Laufer		FR	Groupement Européen pour le Transport Combiné (GETC)
Morcheoine	Alain	FR	Agence de l'Environnement et de la Maîtrise de l'Energie (ADEME)
Arki	Hervé	FR	SETRA
Averseng	Antoine	FR	French Ministry for Ecology, Sustainable Development and Spatial Planning
Babé	Francis	FR	FNTR
Bereni	Matthieu	FR	SETRA
Feypell	Veronique	FR	OECD/ITD Joint Transport Research Centre
Fline	Claude	FR	Ministry of Transport, Division for Sciences and Research (DRAST, MEDAD)

Gaeta	Francesco	FR	French Ministry for Ecology, Sustainable Development and Spatial Planning
Gauthier	Gilbert	FR	Michelin
Jacob	Bernard	FR	LCPC
Mazieres	Jacques	FR	CARCOSERCO
Bichot	Lionel	FR	Ministry of Transport (DSCR, MEDAD)
Bomier	Joel	FR	ASF
Bourgeois	Guy	FR	INRETS
Boussuge	Jacques	FR	Association of motorway companies (ASFA)
Brehier	Régine	FR	Ministry of Transport (MEDAD)
Bursaux	Daniel	FR	Ministry of Transport (MEDAD)
Cabanes	Ariel	FR	Michelin
Cambournac	Hugues	FR	AXA Assurance
Charbonnier	Loic	FR	Ministry of Transport (DGMT, MEDAD)
Delsey	Jean	FR	INRETS
Durand	Grégoire	FR	Ministry of Transport (MEDAD)
Favre	Bernard	FR	Renault Trucks
Frémont	Guy	FR	SANEF
Gehenot		FR	UIC
Guiraud	Hervé	FR	Ministry of Transport (MEDAD)
Janin	Jean-François	FR	Ministry of Transport (MEDAD)
Leroy	Christine	FR	Union des Syndicats de l'Industrie Routière Française (USIRF)
Lévèque	Stéphane	FR	French Federation of Logistics and Transport
Parise	Patrice	FR	Ministry of Transport (MEDAD)
Petit	Cécile	FR	Ministry of Transport (MEDAD)
Ray	Michel	FR	EGIS
Rose	Christian	FR	French Association of Road Transport Users
Roudier	Jacques	FR	LCPC
Savy		FR	Ecole Nationale des Ponts et Chaussées
Rose	Christian	FR	Association des utilisateurs de transport de fret (AUTF)
Bouldouyré	Muriel	FR	French Ministry for Ecology, Sustainable Development and Spatial Planning
Borsu	Mathias	FR	French Ministry for Ecology, Sustainable Development and Spatial Planning
Langlais	Gérard	FR	Arkema
Branellec	Gildas	FR	
Chapulut	Jean-Noel	FR	
Apostolinas	Dimitrois	GR	
Gecse	Gergely	HU	
Russo	Francesco	IT	
Kaucikas	Nerijus	LT	
Butuzuva	Anna	LV	
Caruana	Anthony	MT	
Sutton	David	MT	
Chen	Ming	NL	TNO
Davydenko	Igor	NL	TNO

Kramer	Henk	NL	Transport en Logistiek Nederland
Otter	Dany	NL	CTT
Salet	Martin	NL	Ministry Of Transport
Smit	Ambro	NL	Transport en Logistiek Nederland
Verweij	Kees	NL	TNO
Aarts	Loes	NL	Ministry Of Transport
de Kievit	Eric	NL	Ministry Of Transport
de Vlieger	Jan-Jaap	NL	TNS NIPO
Hagen	G.	NL	Arcadis
Kampfraath	Chris	NL	Ministry Of Transport
Leferink	Chris	NL	TPG Post
Nijhof	Marjolein	NL	TNS NIPO
Pauwelussen	Joop	NL	HAN
Philips	Max	NL	RailCargo
Pluimers	Andre	NL	Bolk Transport
Rosenberg	Freddy	NL	Arcadis
Schoon	Chris	NL	SWOV
Uttien	Max	NL	RDW
Wesbeek	Wouter	NL	European Shippers Council (ESC)
Beer	Maarten	NL	
Donski-Lesiuk	Jakub	PL	
Nawracki	Janusz	PL	
Correia	Carlos	PT	
Bontea	Raluca	RO	
Ehrning	Ulf	SE	Volvo
Karvonen	Seppo	SE	Volvo
Ericson	Johan	SE	
Ingelsson	Maria	SE	
Novak	Simon	SI	
Marusinec	Pavol	SK	
Denby	Peter	UK	Denby Transport Ltd
Edmunds	Philippa	UK	Freight on Rail
Gillingham	Steve	UK	UK Department for Transport
Jones	Tom	UK	Freight on Rail
Adam	Jill	UK	Department of Transport
McKinnon	Alan	UK	Heriot-Watt University
Smith	Gordon	UK	EWS
Hayes	Paul	UK	
Christensen	Jorgen		Vejdirektoratet Denmark
Colle	Rudy		UIRR
Buitenkamp	Willem		Sun Chemical
Temmerman	Chris		Ansell Healthcare Europe
Vlietinck	Dirk		Packo Inox N.V.
Sennewald	Heiko		Ewals Cargo Care
Kienzler	Hans-Paul	DE	K&P Transport Consultants

Annex 3: Workshop minutes

1. Stakeholder meetings

1.1. Stakeholder meeting 04/03/08, Brussels

Minutes by: Igor Davydenko, Matthieu Bereni, Tim Breemersch

Chair: Griet De Ceuster

Project Presentation

9:45 **Outline of the day**

9:50 **Project objectives**

Ben Van Houtte and John Berry *(Directorate-General Transport & Energy)* present the objectives of the study that was launched at the end of 2007. In a context of increasing transport demand and an evolution towards a more sustainable mobility, the Commission has committed itself to the option of adapting Directive 96/53 to take account of technological developments and changed transport requirements, in particular as regards the possibility to allow heavier and/or longer vehicles. It is reminded that the study should focus on the effects, both positive and negative, of the use of bigger and/or heavier vehicles, in and between adjacent and consenting Member States. The effects will be on road safety, on energy efficiency and CO2 emissions per tonne-km and per veh-km, on noxious emissions, on road infrastructure, on combined transport and other Intermodal transport operations and on meeting current and future freight transport demand.

10:00 **Project methodology and work plan by the project team**

The problems due to the directive in its current form are first underlined. In a nutshell, the current directive allows many exceptions; hence an update, and possibly EU harmonisation, is envisioned to satisfy current market needs.
Then, the five members of the consortium in charge of the study are presented. They are: TML, TNO, Sétra, RWTH Aachen and LCPC. The option to adapt directive 96/53/EC will be addressed through four steps: a) Literature study and stakeholder/expert consultation b) Assessment of four scenarios according to c) Six effects and d) computation of a Cost-Benefit Analysis. The four scenarios are:

Scenario A: Business as usual • Exceptions only in national traffic; • 40t max in international transport; • 44t for 40ft ISO container; • 45ft container with 12cm overhang only in national transport; • No harmonized requirements on the size	Scenario B: Adapt directive, EC defines restrictions and maximums in international traffic restrictions could include: • Routes; • Road pricing; • Vehicle standards (dimensions, overhangs); • Driver qualifications;

of a fully loaded vehicle.	• Maximum load/load per axle.
Scenario C: Adapt directive, Member States defines restrictions and maximums in international traffic	Scenario D: as B, but no modular vehicles in international traffic

The final report is due 27/07/08. Until the end of March, the consortium members would be grateful for all stakeholders' inputs in order to take into account all needs and opinions.

In response to a question, it is specified that the road safety side of the study will be undertaken for all kinds of road networks.

10:30 **Stakeholders survey**

Stakeholders will be surveyed through different processes that are: a) regional workshops, b) interviews and c) a web-based questionnaire. This will enable to collect facts and data from the main stakeholders, in different regions of Europe. The overall methodology is shortly presented to the attendees, who are invited to visit the dedicated website for more information.
http://ecstudy.hvwd.free.fr
On May 19-22, a conference on heavy vehicles is organised in Paris by LCPC.

Keynote presentations

10:45 **Jorgen Christensen (project leader OECD/JTRC project)**

OECD has acquired a good experience of heavy vehicles and their related topics through many studies, from 1983 till now. The Joint Transport Research Centre (OECD/ITF) is currently leading a project on heavy vehicles dealing with regulatory, operational and productivity improvements. With the help of the country members, the study will consist of:

- examining the safety, environmental and productivity impacts of HGV operations;
- making an inventory of regulatory measures and enforcement practices;
- assessing the effects of changes on compatibility with infrastructure and other road users;
- evaluating how needs for increased road transport productivity can be achieved while.

Publication of the final report is planned for September 2009.
As far as the relationship with our DG TREN study is concerned, it is anticipated that these studies will be complementary and some common inspirations will not lead to contradictory conclusions. The OECD project will use Australia an example of the effect of bigger trucks. This caused a reaction from CER: did the group seriously consider Australia and Europe comparable? The Australian example was only quoted as an illustration of the use of performance based standards for defining the permissible dimensions of HGVs. Last, all points of view are represented in this working group. Names of members can be communicated on demand. No CBA will be conducted by the JTRC project; it can be done by member states individually.

11:00 **Martin Salet (Dutch Ministry of Transport)**

For many reasons that range from a congested road network to the necessity of reducing emissions, the Dutch Ministry of Transport has decided to experiment since 1999 with the European Modular system, also known as Gigaliners or Ecocombis. Different configurations can be used in the EMS framework. The main argument in favour of the EMS is that two longer vehicles carry the same amount of goods as three usual trucks, which also tends to decrease fuel consumption. So far, no decrease of traffic safety has been measured despite certain safety issues have already been identified. Moreover, the circulation of these vehicles is limited to certain parts of the road network and only a minor modal shift from other modes to road has been observed. The Dutch government now intends to pursue the experiment but on a larger scale. Although The Netherlands have invested a lot of money in modal shift policies, the effect was only marginal, as 80% of trips are 100km or less.

Responding a few questions, Martin Salet explained that only EMS combinations have been experimented in the Netherlands. Other possibilities, such as non-EMS vehicles whose weight would be more than 50t but less than 60t have not been investigated. Concerning the infrastructure, there have been some political discussions and technical debates about allowing 60t or not. Finally, it has been decided to limit the experiment to 50t combinations. Hopefully, the dimensions of these vehicles enable an easy controlling of their movements, particularly on roads where they are not allowed.

11:35 **Jos Dings (Transport & Environment)**

A cheaper and faster road transport (which forced rail to follow) has led to a dramatic growth in freight transport volume. This trend is not supposed to change in the future. Netherlands Economic Institute and CE Delft investigated price elasticities of road transport. Their results are the following:

- Elasticity of road freight to price of road transport: –0.6 to –0.9
- Elasticity of rail freight to price of road transport: +1.8 to +3.0

This shows that rail freight is significantly sensitive to fluctuating road price variations. Also, this could lead to a situation where three classic lorries are replaced by almost three longer and/or heavier lorries. Furthermore, the issues of the impact on the infrastructure, on safety and the enforcement of circulating on specific roads remain unresolved. For all these reasons, T&E do not believe that longer and/or heavier vehicle constitute an appropriate response. The first initiative that should be taken is road pricing systems.

11:50 **Stefan Larsson (ACEA)**

ACEA points out the need for an increased road capacity. Increasing the size of loading units and the dimensions of the vehicles is one of the solutions. ACEA supports a wider EU application of EMS mainly because of their beneficial environmental impact, their ability to reduce road congestion, and the fact that they are currently allowed in directive 96/53/EC. Besides, EMS allows efficient logistics and supports intermodality by using existing standard modules. Regarding road safety, fewer trucks on roads would mean a reduced accident risk. EMS having the same braking capabilities – as each axle can brake its own load - they do not present an additional risk. Their stability is also described as equal to present EU vehicles. It must be added that EMS will create a

more stable situation with respect to the lifetime of standardised load units and related handling equipment: "better and longer use of what we already have".
Quoting different studies from the NL, Sweden and the UK, Stefan Larsson specifies that, on the one hand, rail and road transport carry different kinds of goods; on the other hand, the distances travelled by road and rail are not the same. Hence there is no real competition between modes and the allowing longer and/or heavier vehicles will not contribute to stimulate the demand for road transport significantly.

12:05 **Rudy Colle (UIRRR) and Rainer Mertel (Kombiverkehr KG)**

It is reminded that EMS increase truck capacity by at least 50 % and at the same time enable to decrease road transport costs by 20 – 25 %. A study undertaken by TIM Consult shows that the cost advantage of EMS changes modal competition substantially (potential of shifting up to 55 % of combined transport volumes to road and thus +24% more truck movements on motorways). There is also a risk that minor shifts from rail to road lead to cancelling full trains and thus preventing rail operators to keep their train service.
It is also highlighted that EMS only save one towing vehicle, but do need the same length (since it is well known that safety distance are overall not respected). Some other issues concern:

- The need for swap stations near the main roads, which could be difficult for companies that are far from the main roads;
- A likely political pressure to extend rules on Gigaliners to all roads in the longer term;
- Possible space constraints for manoeuvring Gigaliners vehicles at warehouses and distribution centres?

A comprehensive economic and social analysis of increased vehicle weights and dimensions is therefore most required. A number of countermeasures were suggested: speed harmonisation (car and truck), right hand side overtaking, ITS.

<u>Afternoon session</u>

13:40 Dr. Johannes Ludewig, CER Executive Director, presents "Mega-trucks: a mega risk for the railways."

The presentation begins with a reminder that current EU transport policy emphasizes CO_2 abatement (referring to the general EU emissions reduction target of 20% GHG emission reduction by 2020 from the base 1990 level); co-modality and shifts to the environmentally friendlier transport modes.

Looking at 'introduction of Mega-trucks', Dr. Ludewig estimates that 25.25m long and up to 60 ton trucks would achieve road haulage cost decreases of 20-25%. Referring to the studies by Kessel + Partner and TIM Consult, Dr. Ludewig expects that introduction of such trucks would lead to a reduction of up to 32.3% (Kessel + Partner) and up to 55% (TIM Consult) of the market for Combined Transport. The Single Wagonload Transport market would loose 12.2% if 25.25m / 40t trucks are allowed and 25% if 25.25m / 60t trucks are allowed.

According to the presentation, combined transport is vulnerable to competition from mega-trucks, because rail would compete with them in the sector of long distance haulage, where currently it has a price advantage.

Dr. Ludewig acknowledges that longer and heavier trucks represent a productivity gain as a result of an innovation. The point is that due to road efficiency gains, the rail sector would loose volumes, as a dynamically spiralling process. Marginal loses of rail cargo would lead to higher marginal transportation costs for remaining cargo, which in turn would lead to even more shift to road and less rail cargo. This is illustrated as a feed-back loop with diminishing rail volumes.

In the presenter's opinion, lower road haulage prices would lead to an increase in road transport demand, thus 'less means more' statement. As an illustration, an impact assessment of low-cost airlines on air passenger traffic has been given: 55% increase of intra-EU passenger traffic between 1995 and 2004. The increase in road traffic volumes causes intensified negative effects of road transport in various areas such as emissions, road safety and infrastructure. The presenter expects more CO2 emissions from the transport sector in case if 'mega-trucks' are allowed. Referring to the UK Oxera's study, it is estimated that there would be 934 million Pounds extra external costs if 'mega-trucks' are allowed.

The presentation is concluded with a statement that 'Mega-trucks are incompatible with the EU policy on co-modality, CO2 reduction, and combined transport'.

After the presentation, there were a number of questions from the audience.
Question: Sweden has allowed longer and heavier trucks, however at the same time the country enjoys the highest share of rail transport. How can it be explained? *Answer*: Geography of Sweden explains this phenomenon. It is a big country, with big distances and it is not densely populated.

Question: Is there some spare rail capacity to cope with growing transport volumes? *Answer*: If 20-30% of the annual road infrastructure investments are redirected to rail infrastructure, the rail capacity can be increased by 60-70%.

Question: What does the rail sector do in order to improve its competitive position? For instance, passenger trains have priority over goods trains, there is rail congestion and other negative effects in rail transport. *Answer*: The road and rail modes compete in the long haulage transportation market segment. Liberalization of railways and new IT technology are aimed at improvements in the rail sector. There is some work on common control and signalling systems. Deutsche Bahn started a common production system for cross-border rail transportation.

Note from the audience: the Oxera study (to which the presentation refers) on impact of longer and heavier vehicles on rail transport and assessment of external costs has been ordered by the rail sector, therefore, it is not an independent research of the UK government.

Question: Supposing that there is no cost advantages in road transport (LHVs are not allowed), would you remain competitive to road transport? *Answer*: With rather small investments in rail infrastructure, one can substantially improve rail capacity.

13:55 Jacques Marmy (IRU) presents "The Harmonization of European Modular Concept to Promote Co-Modality".

The presenter is affiliated with IRU, International Road Union, which counts 180 members from 72 countries. IRU represents interests of cargo and passenger road transportation companies, aiming at stable and harmonious development of the world economy. In broad sense, IRU deals with innovation, incentives and infrastructure, developing effective technical measures and operating practices to reduce environmental impact; encourages faster introduction by transport sector of the best available technology; encourages investments into infrastructure to remove bottlenecks and missing links, and to optimize the usage of existing infrastructure.

IRU emphasises advantages of the modular concept. In opinion of IRU, it will decrease the number of trips by 32%, reduce transport costs by 23%, reduce fuel consumption and CO2 emissions by 15%, and contribute to longevity of the roads by 5%.

The modular concept promotes co-modality when semi-trailers and swap body units or containers are used. One system can transport 2 loading units: 7.82 m and 13.8 m long. However in the presenter's opinion, to efficiently promote EU co-modality, the European modular concept needs to be harmonized by the EU. Moreover, the modular concept can promote co-modality by offering better transport, rather than simply more transport. There is a clear need for harmonization and standardization of various combinations of equipment to allow intra- and inter- modal exchangeability of vehicles and transport units.

The forthcoming revision of the 96/53/EC directive provides an excellent opportunity to adapt weights and dimensions of buses and coaches as well. These revisions should open the way to adjustments of the 97/27/EC directive.

There were no questions raised by the presentation.

14:10 Jos Verlinden presents "CEFIC Position on Authorized Weights in International Transport Directive 96/53/EC"

The presenter is associated with CEFIC, European Chemical Industry Council. The EU chemical industry generates 30% of the world output, counts 27000 companies, employs 1.5 million people, with sales of EUR475 billion. The Cefic has 500 business members, of which 40 major international companies.

Efficient and competitive transport is vital for the industry, while safety is a major attention point. There are some challenges that the industry faces: congestion, shortage of drivers, obstacles in usage of intermodal transport, pressure to reduce emissions and fuel costs. Cefic thinks that "Increasing the authorized vehicle weights in Europe would contribute to a solution for many of these issues".

The weight limitations are important because for international transports the chemical industry is limited by the lowest authorized vehicle weight on the route. Because several industry sectors transport mainly heavy goods, these sectors are impacted most by the weight limitations (for both bulk and packed transport). There should be an EU-wide increase of authorized weights to at least 44 tons for road transports and at least 48 – 50 tons for intermodal transports. This will result in decrease / reduction of road journeys, number of trucks, number of drivers needed, congestion, fuel consumption, emission, transport costs, and improved competitiveness of the industry.

Concluding, the presenter describes the wishes of the industry: there should be Europe-wide permission to use 5-axle 44 ton vehicles for road transport and 6-axle 48/50 ton vehicles for intermodal transport.

Question: What if dynamic is brought into consideration, for instance, after 10 years why the industry and other shippers will be satisfied with 44 ton limit, while intermodal transport allows 50 ton? *Answer*: it is difficult to predict future, "no one has a crystal ball".

Question: Don't you think that 44 ton limit for road transportation is not big enough? *Answer*: we can work with 44 ton limit; it is realistic, because aiming at higher weights would scare the public off. The chemical cargo is perceived to be dangerous by public and there would be more resistance if the limit is higher.

14: 25 Giovanni Paci of ECG (European Association of Vehicle Logistics) presents the view of vehicle transporters on forthcoming change of the 96/53/EC directive.

ECG has 95 members in 24 European countries, which operate 387 car carrying ships, 18000 trucks, and 16300 rail wagons. The members employ 53000 people and generate EUR 13 billion of turnover. According to the presenter, because ECG members operate all transport modes, the opinion of ECG is unbiased.

The environment, in which the industry operates, faces environmental challenges. Given 20% emission reduction target, between 1990 and 2004 the EU transport emissions rose by 26%. There is a possible extension of Emissions Trading System to sea and road freight transport after 2012, which puts some extra pressure on the industry to cut emissions.

Thus, to reduce emissions and to improve efficiency, ECG wants to increase the length limit by 2 m from 18.75 m to 20.75. For car transporters the maximum permitted length has importance, while the maximum allowed weight has no importance: a full truck load carrying cars barely reaches 35 ton of gross weight. On the other hand, Absence of any harmonization on Maximum Dimensions means more Car Transporters on the European Roads, more CO2 emissions and road congestion, lower safety.

The increase of allowed length to 20.75 m would increase the average number of transported cars by a truck from 7 to 9, at the same time if EURO IV/ V standards applied, such length extension would reduce average CO2 emissions from 156.9 g/km to 126.0 g / km, thus saving 18.5% in CO2 emission and fuel. No harm to the road safety is expected and much lower traffic congestion is foreseen.

Question: If LHV improve efficiency by 25%, why do consumers not see prices going down? *Answer*: The price pressure from the automotive sector (manufacturers) is such that there are very small margins in car transport. If there is a cost advantage of LHVs, it would be immediately squeezed put by the industry, and in the end passed out to the consumer.

Question: What is the average distance per mode, i.e. how long is the average distance covered by road mode and by rail mode? Answer: in short, road should be used for short-distance transport and rail for long-distance one. The presenter does not possess the numbers; however, they might be looked up in the database.

Panel discussions

15: 00 Panel 1: Demand and logistics

Arnulf Bleck of Meyer & Meyer opened the discussion with a short presentation of the trials that were conducted in North Rhine – Westphalia. On the trajectory Duisburg-Nuremberg-Duisburg, the potential annual savings of using the EuroCombi amount to 121.500€.
Andreas Geissler of Allianz Pro Schiene (a collection of environmental and rail organizations) stated that increasing dimensions would not help in meeting EU targets for sustainable mobility. Phillipa Edmunds of Freight on Rail made remarks on the level of internalization of costs of road transport. First priority is to improve this from the current level of 60%, and to improve efficiency within the current dimension framework.
Ambro Smit of TLN repeated that Ecocombis can provide a valid solution for meeting demand in an ecological way, while limiting the effects of congestion. Safety will also improve, as fewer trucks are needed. No modal shift of significance has occurred in NL, it supports comodality. Jacques Mazières of CARCOSERCO is in favour of LHVs for already mentioned reasons. He does acknowledge that infrastructure is an important concern. The organization will lobby with the French government to allow trials following the Dutch example.

Kees Verweij then asked which dimensions of heavy vehicles were preferred by panellists. Andreas Geissler remarked that over 90% of German trailers are not suitable for combined transport. He did not think it was necessary to change dimensions. Ambro Smit would like an increase of the height to 4m10, and increasing dimensions allowed for international transport to 25.25m. Weight should be increased to at least 44T on 5 axles. Jacques Mazières would also prefer an increase to 25.25m.

Kees' second question was whether or not dimensions should be harmonized by the EC, or be left to the choice of national authorities. Ambro Smit commented on harmonizing the overhangs of trailers. Phillipa Edmunds stressed that road conditions need to support higher weights, which is not the case everywhere. 44T would be acceptable (currently allowed in the UK).
The third question referred to scenario definition: would it be a good idea to research small increases instead of just the maximum? Anders Lundstrom of Scania brought the argument that Loading Unit length is the real subject of discussion, so smaller than 25.25 would not help much. Height should be liberalized according to him, and be left to operator and driver responsibility. Another audience member also said maximum dimensions needed to be investigated most. Johannes Ludewig asked what criteria would be used to evaluate the options. Kees replied that the 6 criteria mentioned in the study description would be used. Martin Salet said a practical approach should be taken, like was done in NL. Rainer Mertel remarked that in some important transit countries, 40T is the current limit. Liesbeth De Munck of VIL made a remark on dimensions of loading capacity versus total length (cabin length is the difference). Stefan Larsson of ACEA replied that differences between the US and Europe were too big to make good comparisons. Steve Gillingham commented on weight per axel and turning circle, which would be addressed in panel 2.

15:45 **Panel 2: Infrastructure and Safety**

Wanda Debauche of BRRC opened with a question that needs to be addressed before 25.25m/60T could be introduced. It consisted of a number of items:

- Infrastructure:
  - Entry and exit lanes to highways
  - Overtaking distance
  - Distance between vehicles
  - Weather conditions (lack of enforcement)
  - Parking
  - Extra space required for manoeuvring
- Drivers: training
- Vehicles
  - Braking system
  - Equipment (blind spot mirror)
  - Stability
  - Hazardous goods
- Routes (not urban, slow traffic, railway crossing)

According to Francesco Gaeta of the French Ministry, total length, total weight and weight per axle determine fatigue effects on infrastructure. 50T needs to be taken into account next to 40T and 60T. 44T leads to 20% extra maintenance costs, which in turn also leads to extra emissions.

Klaus-Peter Glaeser presented a study performed by BAST. 60T should be transported on 8 axles, not 7, with equal loads. Weigh-in-motion axle loading should be implemented. Overloading should be input to the engine. Bridges and tunnels are a risk. Accidents with this type of truck could have very serious consequences. Turning circle problems make LHVs unsuitable for certain trajectories. Correct taxation is important. Safety: several solutions exist and should be used: Lane departure warning, ESP, ABS, Adaptive cruise control. Industry should take the lead in defining standards.

Jorgen Christensen agreed. He further commented on Danish trials, scheduled for late 2008. Recommendations have been made on infrastructure adaptations. Not many are needed, only in rest areas and some roundabouts. Increased dimensions are no problem for pavement if loading is correct.

Anders Lundstrom came back to earlier remarks on the comparability of Australia to Europe. It is very urbanized and should not just be seen as a desert country. Turning circle limitations in the directive are old German criteria, based on more than a full circle turn. A highway criterion may be a better way to go. Uneven loading (leading to overloading of one axle) is a bigger problem than just higher loading. Annex 2 of the directive is outdated (on suspension). Annex 1, 4.1, 25% of total axle weight should be on powered axle. This rule has not been tested for a long time.

Bernard Jacob added comments on bridges. Extreme loads are an important issue especially during overtaking/crossing moments. Fatigue is another point.

Tom Jones of Freight on Rail said that compliance is a major problem. Better compliance and enforcement should come before new rules are allowed. This is confirmed by Ben Van Houtte. The reason of non-compliance is also important: is it because of lack of enforcement, or because old rules are not enough anymore? Anders Lundstrom added that overloading is generally not the full load, but just one axle. Johannes Ludewig indicated increased competition as the main reason; market pressure is what makes people cross the limits. Stefan Larsson remarked that single axle load is not harmonized across Europe.

Jorgen Christensen added a final personal remark; again referring to Australia, where functional compliance based approval is the guiding principle. Operators have to prove the security of the transport. He also brought the question what would happen if the US and China start supporting the 53ft container. New limits may not last as long as the old ones.

16:30 **Panel 3: Environment and technology**

Bram Claeys of BBLV said that the expansion of transport is a real problem, but increasing dimensions is not the solution. Road pricing – internalizing external costs - is the primary tool to address the issue by limiting demand. Competition with other modes (rail, IWW) should not suffer by allowing LHVs.

Michel Scherer of Kögel suggested their BigMaxx could be of help. 80% of transports are volume limited, so increasing dimensions (without increasing weight) could contribute to a solution. Intermodality is also covered by this concept. Mr Scherer added that when the modal concept is concerned, 26.55 m would be best (25.25 + extra length of Big Maxx).

Bernhard Dicke of VDA offered the results of studies performed by VDA/FAT to the consortium. He explained the concept of EuroCombi. It is designed for the European market, and is suitable for combined transport. He hopes the EC will allow 25.25/60T in international traffic.

Ulf Ehrning of Volvo trucks stated that one of the big advantages of the modular concept is exactly the possibility to recombine to smaller vehicles (long when possible, short when necessary). The issue is harmonizing the dimensions of modules.

Bart Van Herbruggen asked if harmonising regulation all over Europe would make it easier to construct safer and cleaner trucks. Ulf Ehrning said that it would. Especially harmonizing the modules would allow for more efficient transport.

Phillipa Edmunds inquired on the extra conditions attached to the concept and to harmonization. Bart Van Herbruggen replied that there could be many of those, e.g. special driver licences. Bernhard Dicke added that the EuroCombi contains a number of standard safety equipment technologies. Kögel's Eurotrailer has the same characteristics as any of the current semi-trailers (turning circle, axle weight,…)

Ben Van Houtte concluded the meeting.

Table 87: List of people explicitly invited to the 4 March meeting

Name	Name	Company	Invitation date
Aarts	Loes	Ministry Of Transport	unknown
Adam	Jill	Department of Transport	unknown
Angelova	Anita	Bulgarian Government	20080218

Apostolinas	Dimitrois	Greek Government	20080218
Arki	Hervé	SETRA	unknown
Avenoso	Antonio	ETSC	unknown
Averseng	Antoine	French Ministry for Ecology, Sustainable Development and Spatial Planning	unknown
Ayala Sender	Inès	European Parlement	20080218
Babé	Francis	FNTR	unknown
Beer	Maarten		20080218
Bereni	Matthieu	SETRA	unknown
Berner	Ulrich	German Ministry of Transport, Building and Urban Affairs	20080303
Berry	John	European Commission	unknown
Bichot	Lionel	Ministry of Transport (DSCR, MEDAD)	20080220
Billiet	Marc	International Road Transport Union (IRU)	20080219
Bleck	Arnulf	MEYER & MEYER Internationale Spediteure GmbH & Co. KG	unknown
Bomier	Joel	ASF	20080220
Bonati	Corinna	Deutsche Bahn AG	unknown
Bontea	Raluca		20080218
Borsu	Mathias	French Ministry for Ecology, Sustainable Development and Spatial Planning	unknown
Bouldouyré	Muriel	French Ministry for Ecology, Sustainable Development and Spatial Planning	20080220
Bourgeois	Guy	INRETS	20080220
Boussuge	Jacques	Association of motorway companies (ASFA)	20080220
Branellec	Gildas	Ministry of Transport (MEDAD)	20080218
Breemersch	Tim	TML	unknown
Brehier	Régine	Ministry of Transport (MEDAD)	20080225
Buitenkamp	Willem	Sun Chemical	20080220
Burkhardt	Martin	UIRR	unknown
Bursaux	Daniel	Ministry of Transport (MEDAD)	20080220
Butuzuva	Anna		20080218
Cambournac	Hugues	AXA Assurance	20080220
Caruana	Anthony		20080218
Chapulut	Jean-Noel	Ministry of Transport (MEDAD)	20080218
Charbonnier	Loic	Ministry of Transport (DGMT, MEDAD)	20080220
Chen	Ming	TNO	unknown
Christensen	Jorgen	Vejdirektoratet Denmark	unknown
Claeys	Bram	BBLV	unknown
Cocu	Xavier	BRRC	20080220
Colle	Rudy	UIRR	unknown
Coppens	Carine	Santens nv	20080220
Corduant	Véronique	DPWN	unknown
Correia	Carlos		unknown
Correia	Alain	SNCF	20080218
Damar	Christelle	Hill & Knowlton International Belgium	unknown
Davydenko	Igor	TNO	unknown
De Ceuster	Griet	TML	unknown
De Fauw	Alex	Santens NV/SA	20080220
de Kievit	Eric	Ministry Of Transport	unknown
De Maegt	Isabelle	FEBETRA	unknown
De Somere	Petra	Promotie Binnenvaart Vlaanderen vzw	unknown
de Vlieger	Jan-Jaap	TNS NIPO	unknown
Debauche	Wanda	BRRC	unknown
Decruyenaere	Kathleen	Federal Government	unknown
Dehaes	Joris	Louis Dreyfus Cotton Int. N.V.	20080220
Deiters	Oliver	DEKRA	unknown

Delsey	Jean	INRETS	20080220
Denby	Peter	Denby Transport Ltd	20080219
Dicke	Bernhard	VDA	unknown
Dings	Jos	Transport & Environment (T&E)	unknown
Dirand	Jacques	CER	unknown
Donski-Lesiuk	Jakub		20080218
Dr. Preisser & Prof. Pflug		*FAT/vda*	unknown
Durand	Grégoire	unknown	unknown
Edmunds	Philippa	unknown	unknown
Ehrning	Ulf	unknown	unknown
Elsinger	Julia		20080218
Ericson	Johan		20080218
Escoyez	Louis	O.T.M.	20080220
Ey	Frank	Austrian Federal Chamber of Labour	unknown
Fabian	Thomas	Bundesverband der Deutschen Industrie (BDI)	20080221
Favre	Bernard	Renault Trucks	unknown
Feige	Lydia	AT Department of Transport	20080218
Fernandez-Balbin	Matilde	Ministerio de Fomento	20080218
Feypell	Veronique	OECD/ITD Joint Transport Research Centre	unknown
Fline	Claude	Ministry of Transport, Division for Sciences and Research (DRAST, MEDAD)	20080220
Fouquet	Marie	Michelin	unknown
Frémont	Guy	SANEF	20080220
Fried	Joachim	Deutsche Bahn AG	unknown
Friedrichs	Max	RTWH Aachen	unknown
Gade	Karsten	Danish Transport and Logistics Association (DTL)	20080220
Gaeta	Francesco	French Ministry for Ecology, Sustainable Development and Spatial Planning	unknown
Gauthier	Gilbert	Michelin	unknown
Gecse	Gergely		20080218
Gehenot	Sandra	UIC	20080220
Geissler	Andreas	Allianz pro Schiene e.V.	unknown
Gillingham	Steve	UK Department for Transport	20080219
Glaeser	Klaus-Peter	BAST	20080220
Gohlisch	Gunnar	Umweltbundesamt	20080226
Gosse-Vehne	Klemens	Kögel Fahrzeugwerke GmbH	unknown
Grohn	Jari		20080218
Guiraud	Hervé	Ministry of Transport (MEDAD)	unknown
Hagen	G.	Arcadis	unknown
Hahn	Wolfgang	German Ministry of Transport, Building and Urban Affairs	20080303
Hausherr	Herbert	COTRANS LOGISTIC GmbH & Co. KG	unknown
Hayes	Paul		20080218
Herbrand	Wolfgang	Thüringen Ministry of Transport	unknown
Hertogs	Beatrice	ETF Europe	unknown
Hessling	Thomas	Allgemeiner Deutscher Automobil Club e.V.	unknown
Heuschen	Stephan	Ministerium für Bauen und Verkehr	unknown
Hunter	Joanne	representing the paper industry	20080228
Ingelsson	Maria		20080218
Isaksson	Karl	Scania EU Affairs	unknown
Jacob	Bernard	LCPC	unknown
Janin	Olivier	CLECAT	unknown
Janin	Jean-François	Ministry of Transport (MEDAD)	20080220

Janitzek	Timmo	ETSC	unknown
Jones	Tom	Freight on Rail	unknown
Kampfraath	Chris	Ministry Of Transport	unknown
Karvonen	Seppo	Volvo	unknown
Kaucikas	Nerijus		20080218
Keuchel	Stephan	University of Applied Sciences Gelsenkirchen	unknown
Kienzler	Hans-Paul	K&P Transport Consultants	unknown
Klingender	Max	RTWH Aachen	unknown
Kramer	Henk	Transport en Logistiek Nederland	unknown
Kulesza	Patrycja	ECG - The Association of European Vehicle Logistics	unknown
Kunz	Anja	Secretary UIRR	20080218
Kwantes	Denise	CER	unknown
Lacroix	Jacqueline	Deutscher Verkehrssicherheitsrat e.v. (DVR)	unknown
Lambrechts	Paul	Promotie Binnenvaart Vlaanderen vzw	unknown
Lambrechts	Valentin	OTM	20080220
Langlais	Gérard	Arkema	20080219
Larsen	Soren	Danish Transport and Logistics Association (DTL)	20080227
Larsson	Stefan	ACEA	unknown
Laufer	Yves	Groupement Européen pour le Transport Combiné (GETC)	20020220
Laureys	Carla	OTM	20080220
Leferink	Chris	TPG Post	unknown
Leroy	Christine	Union des Syndicats de l'Industrie Routière Française (USIRF)	20080220
Lévèque	Stéphane	French Federation of Logistics and Transport	unknown
Lievens	Joke	Mobiel Vlaanderen	20080218
Lombard	Bernard	CEPI	20080227
Lowenhamm	Johan	Green Cargo, railroad and road transport	unknown
Ludewig	Johannes	CER	unknown
Luksic	Oliver	DEKRA	unknown
Maillard	Henri	Service public fédéral Mobilité et Transports	unknown
Maître	isabelle	FNTR	unknown
Marmy	Jacques	International Road Transport Union (IRU)	unknown
Martinez Sans	Fuensanta	ACEA	unknown
Marusinec	Pavol		20080218
Mazières	Jacques	CARCOSERCO	unknown
McKinnon	Alan	Heriot-Watt University	unknown
Meert	Didier	T.L.M.	20080220
Mertel	Rainer	Kombiverkehr KG	unknown
Mievis	Laurent	MET	unknown
Moppel	Anti		20080218
Morcheoine	Alain	Agence de l'Environnement et de la Maîtrise de l'Energie (ADEME)	20080220
Nawracki	Janusz	Ministry of Transport	20080218
Nijhof	Marjolein	TNS NIPO	unknown
Novak	Simon		20080218
Olivier	Marguerite	Federal Government	unknown
Otter	Dany	CTT	20080220
Paci	Giovanni	Association of European Vehicle Logistics	20080228
Panneels	Gretel		20080218
Papayianni	Anthi		20080218
Parise	Patrice	Ministry of Transport (MEDAD)	20080225
Pauwelussen	Joop	HAN	unknown
Peetermans	Eric	NMBS Holding	unknown
Perkins	Stephen	OECD	unknown

Petit	Cécile	Ministry of Transport (MEDAD)	20080225
Philips	Max	RailCargo	unknown
Pitnick	Alfred	ÖBB	unknown
Pluimers	Andre	Bolk Transport	unknown
Pype	Rose-Marie	European Chemical Transport Association (EPCA)	20080219
Raes	Yvan	OTM	20080220
Ray	Michel	EGIS	20080219
Renshaw	Nina	The European Federation for Transport & Environment	unknown
Richter	Cornelia	University of Applied Sciences Gelsenkirchen	unknown
Rose	Christian	French Association of Road Transport Users	unknown
Rosenberg	Freddy	Arcadis	unknown
Roudier	Jacques	LCPC	20080220
Russo	Francesco		20080218
Saile	Dirk	Bundesverband Güterkraftverkehr, Logistik und Entsorgung (BGL)	unknown
Salet	Martin	Ministry Of Transport	unknown
Savy		Ecole Nationale des Ponts et Chaussées	20080220
Schaller	Karl Viktor	MAN-Heavy Trucks, Munich, Germany	unknown
Schmidt	Jörg	Railion Deutschland	unknown
Schmidt	Philippe	O.T.M.	20080220
Schoch	Dieter	Daimler AG	20080219
Schoon	Chris	SWOV	unknown
Schwarz	Roger	Bundesverband Güterkraftverkehr, Logistik und Entsorgung (BGL)	unknown
Seidelmann	Christoph	Allianz pro Schiene e.V.	unknown
Sennewald	Heiko	Ewals Cargo Care	unknown
Serruys	Baudouin	MET	unknown
Simons	Jan		20080218
Smit	Ambro	Transport en Logistiek Nederland	unknown
Smith	Gordon	EWS	unknown
Stempfle	Paul	Kögel Fahrzeugwerke GmbH	unknown
Sutton	David		20080218
Temmerman	Chris	Ansell Healthcare Europe	20080220
Tilling	Cristina	ETF Europe	unknown
Uttien	Max	RDW	unknown
van de Paer	Erik	European Chemical Transport Association (EPCA)	20080219
Van den Bossche	Roger	O.T.M. Belgian Shippers'Council	20080220
van der Jagt	Nicolette	European Shippers Council	20080227
Van Herbruggen	Bart	TML	unknown
Van Houtte	Ben	European Commission	unknown
van Wettere	Julien	OTM	20080220
Vanhoegaerden	Chris	UPS	unknown
Verlinden	Jos	European Chemical Industry Council (Cefic)	20080219
Versnick	Marc	Federale cel mobiliteit	unknown
Verweij	Kees	TNO	unknown
Vlietinck	Dirk	Packo Inox N.V.	20080220
Wallentowitz		Institute of Automotive Engineering (IKA), RWTH Aachen	unknown
Wesbeek	Wouter	European Shippers Council (ESC)	unknown
Wieczorek	Johannes	German Ministry of Transport, Building and Urban Affairs	20080218
Wijbenga	Reinout	EEA	unknown
Winters	Gijs	European Rail Infrastructure Managers (EIM)	unknown
Yarsley	Chris	UK's Freight Transport Association	20080227
Zander	Ulf	Bundesanstalt für Straßenwesen (BASt)	unknown

“Unknown” usually indicates that these persons got the invitation forwarded, or that they contacted us themselves.

Pre-announcement on 14/02/2008.

1.2. Final stakeholder meeting 10/07/2008, Brussels

Pre-announcement on 04/03/2008.

Table 88: List of people explicitly invited to the 15 April workshop

Name	Name	Company	Invitation date
Aarts	Loes	Ministry Of Transport	20080617
Abraham	Claude		20080617
Adam	Jill	Department of Transport	20080619
Ahola	Hans	Ahola Transport	20080617
Angelova	Anita	Bulgarian Government	20080617
Apostolinas	Dimitrois	Greek Government	20080617
Arki	Hervé	SETRA	20080617
Asplund	Göran	carrier Finland-Sweden	20080617
Aurell	John	Volvo	20080619
Aust	Rainer	ERTRAC	20080626
Avenoso	Antonio	ETSC	20080617
Averseng	Antoine	French Ministry for Ecology, Sustainable Development and Spatial Planning	20080617
Ayala Sender	Inès	European Parlement	20080617
Babé	Francis	FNTR	20080617
Bachmann	Christian	Forschungsgesellschaft Kraftfahrwesen Aachen	20080619
Back	Stefan	Swedish Transport Industry Association	20080617
Backlund	Sakari	Finnish Hauliers Association	20080617
Barbero	Francesca	Iveco	20080617
Beer	Maarten		20080619
Bereni	Matthieu	SETRA	20080617
Berner	Ulrich	German Ministry of Transport, Building and Urban Affairs	20080619
Berry	John	European Commission	20080619
Beuthe	Michel	Catholic university of Mons (FUCAM)	20080617
Bichot	Lionel	Ministry of Transport (DSCR, MEDAD)	20080619
Biddle	Steven	Road Haulage Association (RHA)	20080617
Billiet	Marc	International Road Transport Union (IRU)	20080617
Bleck	Arnulf	MEYER & MEYER Internationale Spediteure GmbH & Co. KG	20080619
Blum	Albert	BSH Bosch und Siemens Hausgeräte GmbH	20080617
BLUMENSTEIN	Wulf	Vertretung Land Niedersachsen bei der EU	20080619
Bomier	Joel	ASF	20080617
Bonati	Corinna	Deutsche Bahn AG	20080619
Bontea	Raluca		20080619
Boqvist	Pär	Swedish International Freight Association and The Transport Group (SIFA)	20080617
Bordewijk	George	RDW	20080617
Borsu	Mathias	French Ministry for Ecology, Sustainable Development and Spatial Planning	20080617
Bouldouyré	Muriel	French Ministry for Ecology, Sustainable Development and Spatial Planning	20080617
Bourgeois	Guy	INRETS	20080619
Boussuge	Jacques	Association of motorway companies (ASFA)	20080617
Branellec	Gildas	Ministry of Transport (MEDAD)	20080619
Breemersch	Tim	TML	20080617
Brehier	Régine	Ministry of Transport (MEDAD)	20080617
Brutin	Emmanuel	UNIFE	20080617

Buitenkamp	Willem	Sun Chemical	20080619
Burkhardt	Martin	UIRR	20080617
Bursaux	Daniel	Ministry of Transport (MEDAD)	20080617
Butuzuva	Anna		20080619
Cabanes	Ariel	Michelin	20080617
Cambournac	Hugues	AXA Assurance	20080619
Caruana	Anthony		20080617
Cemat	President	CEMAT (Combined European Management and Transportation)	20080617
Cerezo	Véronique	French Ministry for Ecology, Sustainable Development and Spatial Planning	20080617
Chapelon	Jean	Ministère de l'Ecologie	20080617
Chapulut	Jean-Noel	Ministry of Transport (MEDAD)	20080619
Charbonnier	Loic	Ministry of Transport (DGMT, MEDAD)	20080619
Chen	Ming	TNO	20080617
Christensen	Jorgen	Vejdirektoratet Denmark	20080619
Claeys	Bram	BBLV	20080617
Cocu	Xavier	BRRC	20080617
Colle	Rudy	UIRR	20080619
Coppens	Carine	Santens nv	20080617
Corce	Pietro	University of Pise	20080617
Corduant	Véronique	DPWN	20080619
Correia	Carlos		20080619
Correia	Alain	SNCF	20080617
Cox	Liz	Transport UK	20080619
Croccolo	Fabio	Transport Italy	20080619
Cullum	Peter	Road Haulage Association (RHA)	20080617
CUNIN	Rémi	Syntec	20080619
Damar	Christelle	Hill & Knowlton International Belgium	20080619
Damm	Rune	Norwegian Hauliers Association	20080617
D'AUBREBY	Marc	Ministère de l'Ecologie	20080619
Davydenko	Igor	TNO	20080617
Dawes	Pauline	SOMI Trailers LtD	20080617
De Ceuster	Griet	TML	20080617
De Fauw	Alex	Santens NV/SA	20080619
de Kievit	Eric	Ministry Of Transport	20080617
De Maegt	Isabelle	FEBETRA	20080619
De Munck	Liesbet	VIL	20080619
De Ridder	Maarten	RDW	20080617
De Schepper	Karin	Inland Navigation Europe	20080619
De Somere	Petra	Promotie Binnenvaart Vlaanderen vzw	20080619
de Vlieger	Jan-Jaap	TNS NIPO	20080617
DEÁK	János	EU-UNECE Vehicle Development	20080617
Debauche	Wanda	BRRC	20080617
Decré	Marie-Hélène	CARCOSERCO	20080619
Decruyenaere	Kathleen	Federal Government	20080617
Défossé	Carole	ASECAP	20080617
Dehaes	Joris	Louis Dreyfus Cotton Int. N.V.	20080617
Deiters	Oliver	DEKRA	20080617
Delsey	Jean	INRETS	20080617
Denby	Dick	Denby Transport Ltd	20080617
Denby	Peter	Denby Transport Ltd	20080617
Devos	Christ	Barco N.V. BarcoView	20080617
Dicke	Bernhard	VDA	20080617

Dickson-Simpson	John	TPS Design	20080617
Dings	Jos	Transport & Environment (T&E)	20080619
Dirand	Jacques	CER	20080617
DOMINGUEZ	Pedro	Equimodal	20080619
Dongiovanni	Leonardo	European Rail Infrastructure Managers (EIM)	20080619
Donski-Lesiuk	Jakub		20080617
DOUAUD	André	CCFA	20080619
Dr. Preisser & Prof. Pflug		*FAT/vda*	20080617
Durand	Grégoire	Ministry of Transport (MEDAD)	20080617
Dybowski	Piotr	CTL Logistics SA	20080617
Dyrelund	Peter	Ministry of Transport	20080619
Edmunds	Philippa	Freight on Rail	20080619
Egri	Istvan	TUV Nord Hungary	20080619
Ehrning	Ulf	Volvo	20080617
Elsinger	Julia		20080617
Ericson	Johan		20080617
Escoyez	Louis	O.T.M.	20080619
Estévez Macarro	Eduardo	Berge Automotive Logistics	20080617
Ey	Frank	Austrian Federal Chamber of Labour	20080617
Fabian	Thomas	Bundesverband der Deutschen Industrie (BDI)	20080617
FALEMPIN	Michel	Syntec	20080617
Farkas	Balazs	Magyar Kozut (Hungarian Roads Management Company, Directorate for Road Network Protection)	20080617
Favre	Bernard	Renault Trucks	20080617
Feige	Lydia	AT Department of Transport	20080619
FERENC	Ignácz	IbB-Hungary	20080617
Fernandez-Balbin	Matilde	Ministerio de Fomento	20080619
Ferrari	Sandra	Ferrovie dello Stato	20080619
Feypell	Veronique	OECD/ITD Joint Transport Research Centre	20080617
Fline	Claude	Ministry of Transport, Division for Sciences and Research (DRAST, MEDAD)	20080619
Fouquet	Marie	Michelin	20080617
Frémont	Guy	SANEF	20080617
Fried	Joachim	Deutsche Bahn AG	20080617
Friedrichs	Max	RTWH Aachen	20080617
Gade	Karsten	Danish Transport and Logistics Association (DTL)	20080619
Gaeta	Francesco	French Ministry for Ecology, Sustainable Development and Spatial Planning	20080617
Gauthier	Gilbert	Michelin	20080619
GAUVIN	Bernard	Ministère de l'Ecologie	20080619
Gecse	Gergely		20080617
Gehenot	Sandra	UIC	20080619
Geissler	Andreas	Allianz pro Schiene e.V.	20080619
Giacomuzzi	Nicolo		20080626
Gillingham	Steve	UK Department for Transport	20080619
Giraudeau	Céline	France Nature Environnement (FNE)	20080617
Glaeser	Klaus-Peter	BAST	20080617
GLAISTER	Stephen	IC London (Uni Research)	20080619
Gohlisch	Gunnar	Umweltbundesamt	20080617
Gosp	Gregory	UIRR	20080619
Gosse-Vehne	Klemens	Kögel Fahrzeugwerke GmbH	20080617
GRAHAM	Daniel	IC London (Uni Research)	20080617
Grealy	Joe	THERMO KING Europe	20080619
Greening	Paul	Transport UK	20080617

Grindberg	Bjoern	Railion Deutschland	20080617
Grohn	Jari		20080617
Guiraud	Hervé	Ministry of Transport (MEDAD)	20080617
Hagen	G.	Arcadis	20080619
Hahn	Wolfgang	German Ministry of Transport, Building and Urban Affairs	20080617
Hallams	Bo	Schenker	20080619
Hasler	Jürgen	Imperial Logistics International GmbH	20080617
Hausherr	Herbert	COTRANS LOGISTIC GmbH & Co. KG	20080619
Hayes	Paul		20080617
HELLUNG-LARSEN	Martin	Danish Road Transport Agency	20080617
Herbrand	Wolfgang	Thüringen Ministry of Transport	20080617
Hermansson	Marie	Swedish International Freight Association and The Transport Group	20080617
Hernefjord	Gina	Volvo Logistics	20080619
Hertogs	Beatrice	ETF Europe	20080617
Hessling	Thomas	Allgemeiner Deutscher Automobil Club e.V.	20080617
Heuschen	Stephan	Ministerium für Bauen und Verkehr	20080617
Hoogendoorn	Richard	GE Equipment Services	20080617
Hummel	Aloïs	Fahrzeugwerk Bernard Krone	20080619
Hunter	Joanne	representing the paper industry	20080619
Huschebeck	Marcel	PTV	20080619
Ingelsson	Maria		20080619
Isaksson	Karl	Scania EU Affairs	20080617
Jacob	Bernard	LCPC	20080619
Jakubauskas	Grazvydas	Transport Lithuania	20080617
Janin	Olivier	CLECAT	20080619
Janin	Jean-François	Ministry of Transport (MEDAD)	20080617
Janitzek	Timmo	ETSC	20080617
Jarlsson	Assar	Kinnarps	20080619
Jeftic	Zeljao	Ertico	20080626
Johansson	Mårten	Swedish Association of Road Haulage Companies	20080617
Johansson	Jenny	Scania	20080617
Johnsen	Asbjörn	National Road Administration	20080619
Kallistratos	Dionelis	ASECAP	20080619
Kämmel	Bernd	Nieders. Ministerium für Wirtschaft, Arbeit und Verkehr	20080704
Karoly	Pongracz	Department Infrastucture Regulation, Ministry of Economy and Transport	20080619
Karvonen	Seppo	Volvo	20080619
Kaschnitz	Rudolf	Permanent Representation of Austria to the EU	20080619
Kaufmann	Guy	ADSTD	20080619
Keuchel	Stephan	University of Applied Sciences Gelsenkirchen	20080619
Keymeulen	Frederic	SAV	20080619
Kienzler	Hans-Paul	K&P Transport Consultants	20080619
Klamant	Ernst	Ministerium Bauen und Verkehr NRW	20080619
Klingender	Max	RTWH Aachen	20080619
Knight	Iain	TRL	20080626
Koepf	Helene	UNIFE	20080619
Kramer	Henk	Transport en Logistiek Nederland	20080619
Kulesza	Patrycja	ECG - The Association of European Vehicle Logistics	20080619
Kutzbach-Berger	Nora	Austrian Federal Economic Chamber	20080619
Kwantes	Denise	CER	20080619
Laan	Rogier	GE Equipment Services	20080619
Lacroix	Jacqueline	Deutscher Verkehrssicherheitsrat e.v. (DVR)	20080619

Lambrechts	Paul	Promotie Binnenvaart Vlaanderen vzw	20080619
Langlais	Gérard	Arkema	20080619
Larrieu	Jean-Claude	SNCF	20080619
Larsson	Stefan	ACEA	20080619
Laufer	Yves	Groupement Européen pour le Transport Combiné (GETC)	20080619
Leinberger	Uwe	T-systems	20080619
Lombard	Bernard	CEPI	20080619
Lopez de Leza	Luisa	ASTIC	20080619
Ludewig	Johannes	CER	20080619
Luksic	Oliver	DEKRA	20080619
Lundqvist	Anders	National Road Administration	20080619
Lundström	Anders	Scania EU Affairs	20080619
Maler	Philippe	Ministère de l'Ecologie	20080619
Marquardt	Andreas	Federal Ministry of Transports, Germany	20080619
Marteau	Jean-Pierre	French Ministry for Ecology, Sustainable Development and Spatial Planning	20080619
Martinez Sans	Fuensanta	ACEA	20080619
Mazières	Jacques	CARCOSERCO	20080619
Mazzola	Alberto	Ferrovie dello Stato	20080619
Mertel	Rainer	Kombiverkehr KG	20080619
Mesquida	Céline	France Nature Environnement (FNE)	20080619
Mievis	Laurent	MET	20080619
Morgan	Mark	ECG - The Association of European Vehicle Logistics	20080619
Nielsen	Michael	International Road Transport Union (IRU)	20080619
Olivier	Marguerite	Federal Government	20080619
Ourliac	Jean-Paul	Ministère de l'Ecologie	20080619
Paci	Giovanni	Association of European Vehicle Logistics	20080619
Pajon	Florence	Ministère de l'Ecologie	20080619
Panhaleux	Jean	Ministère de l'Ecologie	20080619
Peetermans	Eric	NMBS Holding	20080619
Peny	André	Ministère de l'Ecologie	20080619
Perkins	Stephen	OECD	20080619
Petrova-Lefilliatre	Tatiana	French Ministry for Ecology, Sustainable Development and Spatial Planning	20080619
Pflug	Hans-Christian	Daimler AG	20080619
Phillips	Steve	FEHRL	20080619
Piechaczyk	Xavier	Ministère de l'Ecologie	20080619
Pitnick	Alfred	ÖBB	20080619
Pons	Catherine	UNOSTRA	20080619
Pontzen	Sabine	Permanent Represenation of Austria to the EU	20080619
Pype	Rose-Marie	European Chemical Transport Association (EPCA)	20080619
Quintard	Fabien	SNCF	20080619
Raulet	Julien	AITF	20080619
Redoulez	Philippe	Ministère de l'Ecologie	20080619
Renshaw	Nina	The European Federation for Transport & Environment	20080619
Richter	Cornelia	University of Applied Sciences Gelsenkirchen	20080619
Rorts		Transfesa	20080619
Rose	Christian	French Association of Road Transport Users	20080619
Rosgardt	Tommy	Volvo 3P	20080619
Saile	Dirk	Bundesverband Güterkraftverkehr, Logistik und Entsorgung (BGL)	20080619
Salet	Martin	Ministry Of Transport	20080619
Sanpaolesi	Luca	University of Pise	20080619
Scherer	Michel	Kögel Fahrzeugwerke GmbH	20080619

Schmidt	Jörg	Railion Deutschland	20080619
Schoch	Dieter	Daimler AG	20080619
Schwarz	Roger	Bundesverband Güterkraftverkehr, Logistik und Entsorgung (BGL)	20080619
Seidelmann	Christoph	Allianz pro Schiene e.V.	20080619
Sennewald	Heiko	Ewals Cargo Care	20080619
Smit	Ambro	Transport en Logistiek Nederland	20080619
Sonnabend	Peter	DHL	20080626
Sturtzer	Estelle	DCSR	20080619
ten Tuijnte	Ivar	MAN truck & bus b.v.	20080619
Tiedemann	Norbert	Federal Ministry of Transports, Germany	20080619
Torchiani	Danilo	Iveco	20080619
Ulbrich	Udo		20080627
van de Paer	Erik	European Chemical Transport Association (EPCA)	20080619
van der Jagt	Nicolette	European Shippers Council	20080619
van der Sterre	Peter	EVO	20080625
Van Houtte	Ben	European Commission	20080619
van Loon	Ad	RDW	20080619
Vandamme	Olivier	BRRC	20080619
Vanhoegaerden	Chris	UPS	20080619
Vannieuwenhuyse	Bart	VIL	20080619
Verlinden	Jos	European Chemical Industry Council (Cefic)	20080619
Verweij	Kees	TNO	20080619
Vid	Andras	Hungarian Ministry of Economy and Transport	20080619
Viegas	J		20080619
Vierth	Inge	VTI	20080619
Ward	Neil	Rockwool	20080619
Ward	Tim	UK's Department for Transport freight and logistics division	20080619
Wesbeek	Wouter	European Shippers Council (ESC)	20080619
Wieczorek	Johannes	German Ministry of Transport, Building and Urban Affairs	20080619
Wijbenga	Reinout	EEA	20080619
Winters	Gijs	European Rail Infrastructure Managers (EIM)	20080619
Wohrmann	Mark	Forschungsgesellschaft Kraftfahrwesen Aachen	20080619
Yarsley	Chris	UK's Freight Transport Association	20080619

2. Stakeholder workshops

2.1. Expert workshop 10/04/08, Brussels

The consortium met with experts based in Brussels on April 10 in the offices of ACEA. The morning session was held with experts of ACEA. The discussions were focussed on the studies of VTI (TM72) and of the Nordic Road Association (S06), which were already discussed in the literature overview.

II Presentation by TML (same slides as March 4th)
III Larsson: question about the scenarios. EMS are not only 25.25 m and 60 t. Corridors can involve Spain.
IV Presentation Ehrning (Volvo + Scania)
1. A better way to combine existing standard units.
2. Why? CO2, Lisbon Agenda, Congestion, Co modular & intermodality, traffic safety, efficient logistics, flexible use of existing units.
3. The midterm review of the European White Paper says: make better use of what we already have.
4. Use longer combinations when possible, shorter when necessary.

5. Inge Vierth: competition between road and rail + economic assessment. Sweden : 64% of tonne and 74% of freight tonne-km by road by vehicles with >40 tonnes and >=7 axles.
6. Presentation by John Aurell and Thomas Wadman (Volvo). Some important parameters: axle load, gross weight, total length.
7. Different types of regulation. Basically prescriptive and some performance-based items (road-friendly suspension, turning circle, traction).
8. Implications of Directive 85/3: facilitates international transport.

After lunch, the consortium met with representatives of CEFIC (Jos Verlinden) and Transport & Environment. (Jos Dings). Interviews were also scheduled with the Belgian Federal government and Inland Navigation Europe, yet they were cancelled by the interviewees due to unforeseen circumstances.
Jos Verlinden: Questionnaire: difficult to analyse the results. Different partners may have different interests. Suggestion: what is your interest? They are in support of 60 tonnes and 44 tonnes. Their products are heavy and frequently dangerous. 44t on 16.5 meters on 5 axles. 48 and 50 tonnes in intermodal transport in 6 axles.

Table 89: List of people explicitly invited to the 10 April workshop

Name	Name	Company	Invitation date
Aust	Rainer	ERTRAC	20080403
De Munck	Liesbet	VIL	20080403
De Schepper	Karin	Inland Navigation Europe	20080403
Debauche	Wanda	BRRC	20080403
Défossé	Carole	ASECAP	20080403
Dings	Jos	Transport & Environment (T&E)	20080403
Janitzek	Timmo	ETSC	20080403
Kulesza	Patrycja	ECG - The Association of European Vehicle Logistics	20080403
Maillard	Henri	Service public fédéral Mobilité et Transports	20080403
Phillips	Steve	FEHRL	20080403
Verlinden	Jos	European Chemical Industry Council (Cefic)	20080403

2.2. Expert workshop 25/04/08, Paris

Time and venue: 25/04/2008, Paris

Chair: Bernard Jacob

Minutes by: Hervé Arki, Matthieu Bereni

Attendees:
Hervé Arki (Sétra)
Marc d'Aubreby (French Ministry of Ecology)
Antoine Averseng (French Ministry of Ecology)
Francis Babé (FNTR)
Matthieu Bereni (Sétra)
Christian Bourget (French Minisry of Ecology)
Tim Breemersch (TML)
Loïc Charbonnier (French Ministry of Ecology)
Doris Danzinger (ÖBB-Holding AG)
Daniel Fedou (French Ministry of Ecology)

Philippe Fournier (Unostra)
Gilbert Gauthier (Michelin)
Edouard Hervé (Renault Trucks)
Bernard Jacob (LCPC)
Guy Kauffmann (ADSTD)
Jean-Claude Larrieu (SNCF)
Yves Laufer (GETC)
Denise Kwantes (CER)
Jacques Marmy (IRU)
Jean-Dominique Paoli (French Ministry of Ecology)
José Maria Quijano (CETM)
Fabien Quintard (SNCF)
Christian Rose (AUTF)
Estelle Sturtzer (French Minisrty of Ecology)
Bart Van Herbruggen (TML)

Preliminary: the presentations are online on the website of TML. The term "LHV" refers to Longer and/or Heavier Vehicles, with respect to the weights and dimensions that are set in directive 96/53.

Presentation of the study and its scope by Bart Van Herbruggen (TML)

TML specifies that busses and coaches are not considered in this study but it may be included in the report it would be relevant to perform a study on this point. It is also explained that road pricing calculations are not part of this study.

Presentation of the questionnaire by Bernard Jacob (LCPC)

Presentation SNCF

The representatives of Fret SNCF, **MM. Larrieu and Quintard** attract the attendees' attention to the importance of co-modality (that intends to achieve a better use of modes that complement each other) and claim that there are no market segments that are mode captive: LHVs would directly compete with the 'single wagon' industry as well as with combined transport. According to them, customers do not choose for a mode a priori, but choose the transport modes that better suit their needs. Consequently, any evolution of the legislation or regulation of a transport mode has consequences for all other modes. SNCF will try to deliver their reports/calculations on this, in particular the ones dealing with transport elasticities, if not confidential.

Key figures concerning the single wagon market:

- most fragile segment of the rail freight
- 33% of total turnover
- France 782000 wagons / yr, 29 mio ton, 14 Gton.km
- average 37 ton / wagon
- average 450 km trip length on French network
- 42% of wagons make international trip
- Strengths of single wagon rail for transporting firms
    - 1 wagon instead of 2 trucks (simpler logistics)
    - Safer than trucks

  - wagons are used as storage room
  - better for CO_2 balance of firms
- 90% of the single wagon transport costs are fixed costs (network of terminals, etc.)
  - to cover this, turnover on a line must be high enough
  - if road costs decrease, and some modal shifts occur from the single wagon industry to road, whole lines operated by the single wagon market might be scrapped
  - t.km single wagon is decreasing since 1995
- Threats for single wagon loads
  - postponed investments in modernisation
  - UK, ES almost no single wagons, IT strong decrease
- SNCF is setting up a completely restructured single wagon system, to improve cost efficiency. However the whole effort would be lost, if LHV were allowed and take market share from the single wagon rail transport.
- Currently, the single wagon industry at SNCF is in deficit. Though, it is operating in order to attract customers towards the full train segment.
- The first decision that SNCF will take if 60 ton trucks are allowed is to completely stop its single wagon transport service.

SNCF believes that LHVs will increase road transport productivity by 10%, stimulating competition on a market segment on which the single wagon industry operates, with some difficulties. Despite a maximal of up to 65t, the average load on wagons usually equals 37t, which is much less than the maximal load transported by a truck, as long as we are not dealing with LHVs. If LHVs are allowed, it may prove fatal to the single wagon industry.

M. Rose (AUTF[78]) does not share this opinion. He suggests that shippers do not favour a mode of transport to the detriment of another one. He is not sure that there is a direct link between load capacity and traffic. Moreover, shippers feel more and more concerned about carbon emissions due to the move of their goods.

Mr. Quijano (CETM[79] and CNTC[80]) does not understand why there is so much focus on the possible consequences of the introduction of LHVs on the freight railway industry. On the behalf of the Spanish road transport industry, he explains that rail transportation does not provide a sufficient supply to an increasing transport demand. Furthermore, it seems that the transportation of freight on rail is seriously weakened because of capacity issues, than cannot be solved, either in Spain or in Europe overall. On the one hand, M. Quijano thinks that an adaptation of directive 96/53 could be useful to avoid current difficulties in international transport. On the other hand, he believes that longer vehicles will not cause a decrease in road transport prices in the current context (high pressure on the market and increasing fuel costs). Last, he considers that the main problem of combined transport is its lack of reliability, which explains its non-growth.

Ms Danzinger (ÖBB[81]) insists on the fact that the European geography is a fixed parameter. Hence, there is no point in comparing the Austrian and Dutch situations when it comes to assess the possible consequences of using LHVs in the various European countries. Road safety on steep roads is a serious matter at stake. Besides, it is very likely that the LHVs and the combined transport sector share the same

[78] AUTF = association des utilisateurs de transport de fret
[79] CETM = Confederación Española de Transporte de Mercancías
[80] CNTC = Representatitividad dentro del Comité Nacional de Transporte por Carretera
[81] ÖBB = Österreichischen Bundesbahnen

market segment. Last, she reminds the attendees the need for significant investments in the combined transport industry.

For **Ms Kwantes** (CER[82]), there is no change: making road transport cheaper would be disastrous for the freight railway industry.

Mr. Fournier (UNOSTRA[83]) states that the freight road transport sector knows a lot of difficulties to hire road drivers. Because of this problem, they are in favour of intermodality and combined transport as much as possible. Putting trucks on trains is one interesting solution. Longer vehicles are another solution to transport the same amount of tkm with less vkm.

Mr. Babé (FNTR[84]) underlines the fact there is not one freight road transport industry but several industries, for each market segment. It is therefore necessary to look from a micro-economic perspective, the situation being very different according to the type of goods that are moved and the sector of activity. There could be no general answer. One should bear in mind that CO_2 footprint is a real concern to firms when choosing between transport modes.

Mr. Fedou (CGPC[85]) puts the focus on the relationship between the economic performance of each mode and their market share. There is no doubt that a cheaper road transport would result in a modal shift to the detriment of the freight railway industry. Beyond technical questions, there are political issues that will play a crucial role.

Presentation Michelin

Mr. Gauthier shows a few slides describing the advantages that LHVs would provide. He also explains that Michelin has already thought about practical details on where an experimentation could take place. For instance, Michelin society would find it very interesting to use LHVs between one of its factories in the Massif Central and another factory in Spain. For the journey from France to Spain, Michelin transportation needs are mainly focused on the volume variable. In the opposite direction, the need for weight capacity is the most significant requirement. Michelin supports an experiment on this itinerary, based on the use of a 25.25m long and 60t heavy EMS vehicle.
Last, Mr. Gauthier is not afraid of a modal transfer from rail to road for shippers are already accustomed to one mode or another. Following the generalization of 44t vehicles in the United Kingdom, no serious change in the modal shift occurred to what he says. This generalization went with a reform of the taxing.

Presentation AUTF

Mr. Rose (AUTF[86]) presents the audience the demands of his association. They are the following:
- 44 tons on 5 axles on a general basis
- 48 to 50 tons for combined transport, on 6 axles
- 35 tons for vehicles with 4 axles of which 2 are drive axles

[82] CER = Community of European Railway and Infrastructure Companies
[83] UNOSTRA = Union nationale des organisations syndicales des transporteurs routiers automobiles
[84] FNTR = Fédération Nationale des Transports Routiers
[85] CGPC = Conseil Général des Ponts et Chaussées
[86] AUTF = Association des Utilisateurs de Transport de Fret

Sétra remarks that aggressiveness against infrastructures would then be much more important than with the current limits.

AUTF supports the 50 t weight limit since it appears that for shippers volume capacity is at least as much important as weight capacity. Today's average payload is approximately 16 tons. LHVs would enable shippers to transport 55 pallets at the same time. **Michelin** does not agree with the 50t limit, because quite often, transporters know the weight they will have to load only one hour in advance. **Mr. Marmy** (IRU[87]) has a similar opinion: it would not be interesting to allow LHVs if not used at full capacity.
Mr. Fournier says that it is more important to let the number of carried pallets increase than to focus on the total weight. **Mr. Fedou** notices that, in the medium/long term, the decrease in transport costs may cause an intensification of the industrial geographic concentration, hence an increase in the journey lengths, and consequently some induced traffic and modal shifts.

As far as road safety is concerned, several attendees want to share their opinion with the audience. The braking capability of LHVs is one point of interest, in particular on steep roads. Safety facilities exist that may be decided to be compulsory on board of LHVs. This implies a harmonization of the regulations at a European level. In **Mr. Laufer's** (GETC[88]) opinion, this would lead to abandoning the subsidiarity principle. **Mr. Babé** says that road safety is essential, but nevertheless, nothing can be said on this topic as no experiment have taken place in France and the Dutch sample was too small to draw any sensible conclusion (25 trucks, selected routes, selected drivers, etc.). Regarding speed limit for LHVs, it is argued that limiting speed for LHVs may cause problems when smaller trucks will try to overtake slower and longer trucks.

It is largely agreed that special LHV driving trainings and/or licenses would be needed. Reinforced controls could also be wished. **Mr. Fournier** is in favour of strengthened controls, especially with the help of weigh-in-motion systems rather than on-board weight measurement systems. **Mr. Jacob** explains that they are complementary. WIM systems could enable to check if on-vehicle systems are manipulated or not. On-board weight measurement systems would be helpful to drivers who do not have an accurate knowledge of the goods' weight they are asked to transport. In case of overload, **Mr. D'Aubreby** (CGPC) suggests that trucks are unloaded till they reach the maximum allowed weight. Meanwhile, **Mr. Laufer** highlights the necessity of looking for responsibilities. If shippers appear to be guilty, not only transporters or drivers should be penalized, but shippers too.

Table 90: List of people explicitly invited to the 25 April workshop

Name	Name	Company	Invitation date
Averseng	Antoine	French Ministry for Ecology, Sustainable Development and Spatial Planning	20080415
Babé	Francis	FNTR	20080415
Bichot	Lionel	Ministry of Transport (DSCR, MEDAD)	20080415
Bleck	Arnulf	MEYER & MEYER Internationale Spediteure GmbH & Co. KG	20080422
BLUMENSTEIN	Wulf	Vertretung Land Niedersachsen bei der EU	20080422
Charbonnier	Loic	Ministry of Transport (DGMT, MEDAD)	20080415
Debauche	Wanda	BRRC	20080415
DOMINGUEZ	Pedro	Equimodal	20080415
Fabian	Thomas	Bundesverband der Deutschen Industrie (BDI)	20080422
Favre	Bernard	Renault Trucks	20080415
Fline	Claude	Ministry of Transport, Division for Sciences and Research (DRAST, MEDAD)	20080415
Gaeta	Francesco	French Ministry for Ecology, Sustainable Development and Spatial Planning	20080415

[87] IRU = International Road Union
[88] GETC = Groupement européen du transport combiné

Gauthier	Gilbert	Michelin	20080415
GAUVIN	Bernard	Ministère de l'Ecologie	20080415
Glaeser	Klaus-Peter	BAST	20080415
Hausherr	Herbert	COTRANS LOGISTIC GmbH & Co. KG	20080422
Hervé	Edouard	Renault Trucks	20080415
Hessling	Thomas	Allgemeiner Deutscher Automobil Club e.V.	20080422
Kampfraath	Chris	Ministry Of Transport	20080415
Klamant	Ernst	Ministerium Bauen und Verkehr NRW	20080422
Kwantes	Denise	CER	20080415
Larrieu	Jean-Claude	SNCF	20080415
Lievens	Joke	Mobiel Vlaanderen	20080415
Marmy	Jacques	International Road Transport Union (IRU)	20080415
Niewöhner		Dekra	20080422
Peny	André	Ministère de l'Ecologie	20080415
Piechaczyk	Xavier	Ministère de l'Ecologie	20080415
Pons	Catherine	UNOSTRA	20080415
Quijano	Jose Maria	CETM	20080415
Quintard	Fabien	SNCF	20080415
Rasmussen	Ib	Ministry of Transport	20080415
Rose	Christian	French Association of Road Transport Users	20080415
Ruppert	László	KTI (Institut for Transport Sciences)	20080415
Salet	Martin	Ministry Of Transport	20080415
Sennewald	Heiko	Ewals Cargo Care	20080422
Sturtzer	Estelle	DCSR	20080415
Viegas	J		20080415
Wallentowitz		Institute of Automotive Engineering (IKA), RWTH Aachen	20080415
Wohrmann	Mark	Forschungsgesellschaft Kraftfahrwesen Aachen	20080422

2.3. Expert workshop 28/04/08, Budapest

Time and venue: 28/04/2008, Budapest

Chair: Bernard Jacob

Minutes by: Tim Breemersch, Matthieu Bereni & Kees Verweij

Attendees:
Ersek Akos (Hungarian Rail association)
Matthieu Bereni (Sétra)
Tim Breemersch (TML)
Janos Deak (KTI – Institute for Transport Services)
Balazs Farkas (Hungarian Road management Company)
Ferenc Ignacz (IbB Hungary, MKFE)
Bernard Jacob (LCPC)
Uwe Leinberger (Satellic Traffic Management GmbH)
Claudia Nemeth (BMVIT - Austrian Ministry for Transports, Innovation and Technology)
Laszlo Pavlovics (Director of Knorr Bremse)
Wolfgang Rauh (Austrian Federal Railways ÖBB)
Michel Scherer (Kögel)
Kees Verweij (TNO)

Andras Vid (Hungarian Ministry of Economy and Transport)

Outline of the study

U. Leinberger raises 2 questions:

- Q: Is the social acceptance of LHVs within the scope of the study?
  A: it is in the scope of the study along with road safety
- Q: How will the results of the study be treated?
  A: EC will take these results as an input.

C. Nemeth explains that Austria is against the idea of LHVs. Discussion has maybe gone too far. One should remain neutral when examining these topics. **B. Jacob** emphasizes that there is no a priori as to the conclusions of the study.

Questionnaire and general outline of the workshop

C. Nemeth puts forward the following question: should there not be a fair competition between modes? The issue is the internalisation of external costs. Road transport is already more efficient. Allowing LHVs will provide road transport with an additional advantage, because it does not fully pays its external costs. Counterargument from **U. Leinberger**: why should road transport not try to improve its efficiency? **C. Nemeth** replied that the first step should be internalisation of external costs.

E. Akos tells the attendees that freight rail transport in the US is working very well. Europe should try to improve its rail transport system as well, especially for carrying goods on long distances. All means of transport should be considered. Co-modality could undoubtedly be made more efficient. Furthermore, the road network in Hungary and other Eastern European countries is underdeveloped, and collisions frequently happen. **W. Rauh** agrees. The most efficient transport modes shall be used, while minimizing external costs. However, **U. Leinberger** reminds the audience that rail transportation has some problems with its infrastructure; in particular, there are some bottlenecks in international traffic that have to be solved at a political level.

Position of the Austrian Ministry for Transport, Innovation and Technology by C. Nemeth

C. Nemeth presents drawbacks (and advantages) of LHVs. The disadvantages mainly focus on
a) Infrastructure, b) road safety, c) environment and d) pricing and modal split.

a) Infrastructure

The Austrian Ministry of Transport is mainly concerned about the impact of LHVs on infrastructure: about 8% and 7% of the primary Austrian network are respectively formed of bridges and tunnels. Besides, the secondary road network would not be suitable for LHVs. It would even prove difficult for the primary road network which has not been designed for 60t-trucks. Other problems that could be mentioned concern rest areas, junctions and roundabouts, crash barriers, etc.

Some difficulties could also concern rail infrastructure and rolling material. Intermodality could prove difficult to realise, and there remains the need for transshipment to end user. Current terminals cannot accommodate 25.25m trucks. LHVs could not be used on Rolling Roads.

b) Road safety

Safety aspects have to be investigated as well. Likely problems regard overtaking times, turning left and right, road crossing, braking distances, damages in case of accidents, etc.

c) Environment

If not fully loaded, there is a risk for more exhaust emissions per load unit. And it seems from Austrian road transport figures that empty runs are quite common. Due to lower transport costs by road, modal shifts will occur to the detriment of freight rail transport. The extra noise of bigger engines could also cause environmental stress.

d) Pricing and modal split

LHVs would reduce prices of road transport and thus reinforce its competitiveness and finally cause modal shift from rail to road.

Even if some advantages do exist (less journeys for the same amount of goods and theoretically less exhaust emissions and financial advantages for transport companies), it seems that there would be much more disadvantages overall than advantages, hence the Austrian position.

U. Leinberger intervenes, saying that volume is mostly the restricting factor, not weight. Austrian transport ministry may be able to provide more information.
If current module dimensions are not changed, why would rail need to make adaptations? It would cost extra to break up the combinations.
New trial has started in one of the German Bundesländer, Thuringia.
Noise is engine related, but also axles and aerodynamics. To reduce it, aerodynamics could be improved, but determination of exact noise levels is very difficult.
But the main issue concern rail capacity: can rail increase its capacity to accommodate growing demand?
Longer vehicles do not have the same impact in congested traffic as in free flow. This will affect congestion itself, but also safety (heavier vehicles mean more damage).

Kögel presentation

2 issues: driver shortage and transportation of 45ft container
80% of transports are volume limited; only 20% are weight limited.
Kögel proposes a solution with 1.3m longer trailer, which allow to reduce emissions by roughly 10% thanks to the extra volume.
Study of prof. Wallentowitz is mentioned.
Kögel trailers can be used for combined transport. Tests with Kombiverkehr will take place on May 7-8.
They are already sold in Czech Republic, Poland and Germany. Their combinations meet the turning regulations. Another solution exists, which is apparently quite popular in the NL: double stacked pallets.

Presentation by U. Leinberger

Transportation of goods by road in urban area has always raised difficulties.
Reliability regarding time is historically one of the main advantages of road transport. Rail has improved this in recent years, and consequently gained market share.

In Australia, road trains (3 trailers+) are used only in the outback.

Intelligent access program for safety are the way to go: a combination of a brake system, suspension, and telematics.
Road pricing should be introduced, but there should also be room for local authorities to set local regulation. The key however, is enforcement of all regulations. (BaG: Bundesanstalt fur Gütervekehr)

E Akos: use of telematics is the future. It is already used for rail. Would it also be possible for the entire transport system? **C. Nemeth** comes back to question of enforcement. The risk of being caught is too small. Technical solutions are all feasible, but politics is holding back evolutions.
U. Leinberger insists on the fact that this study is limited in scope, but the subject is much broader. A remark should be made to the commission on this.

B. Jacob summarises the first presentations. Enforcement is definitely a major issue in road transport. WIM systems are a good way to start. As to rail transport, there is a much more extensive control system. One possibility could consist in allowing increased dimensions along with the implementation of new technological improvements to be made to the vehicles.
Consequently, it would perhaps be necessary to adapt other directives regarding vehicles' technical standards. These new technical measures probably also make sense under current conditions as stated in directive 96/53.
C. Nemeth believes that the Commission should rather investigate other topics (ITS, driving times, etc.) as means to satisfy the increasing demand for freight transport. Not only Directive 96/53 should be looked at, but the other directives that deal with the topics mentioned above.

Austrian rail position by W. Rauh

Relation between length of rail network per head and tkm per head is exponential. This shows clear economies of scale/network benefits (Mohring effect). Introducing LHV could lead to an increase of CO_2 emissions by 5 to 10 %. While intermodal shift from rail to road has a negative impact on the environment, the impact can be positive when it comes to intramodal shift (from smaller trucks to bigger trucks). However, losing market shares for the railway freight industry would mean more serious consequences in absolute terms in countries where significant amounts of goods are transported by rail, as it the case in Austria (market share of rail freight transport equals 33% in Austria, whereas this value only equals 8% in France).

Position of the Hungarian Ministry of infrastructure by A. Vid

Hungary is strongly opposed to LHVs. Hungarian roads are underdeveloped and would likely not be able to support trucks of increased size (bridges, pavements, narrow roads). This is probably similar in other Eastern European countries. Slovakian authorities have apparently conducted a study about the subject.
C. Nemeth proposes to provide the consortium with some contacts' details. Other issues include driver training, suitability of rest areas, roundabouts, etc.
Waterborne traffic on the Danube could also be influenced. Its share is about 2-3%. It has of course a specific market (bulk goods, containers, more recently also cars). Great investments (in locks) may be required to improve its efficiency.

Problem is raised about compatibility of Europallets with American-sized containers.

LUNCH

Discussion on infrastructure

Infrastructure in Austria: bridge maintenance would have to be intensified greatly (Asfinag statement). This is particularly true for long span bridges (i.e. longer than the vehicle's length). Although a research (U. Leinberger) has indicated all bridges would need to be replaced within 15 years, the new bridges would need to be replaced more often. As stated before, Austria has 300 km of bridges on the primary road network, and even more on the secondary network. Costs would be substantial.

Maximum axle load could decrease with LHVs, yet there would still be a negative impact on long span bridges which have to carry the entire load of the vehicle. Pressure on driving axle impacts the effect on pavement (tension, shearing). Austrian government is mainly looking for stability in allowed weights and dimensions, as this is the optimal way to go about design of infrastructure. **C. Nemeth** also asked who should pay for the extra investments for LHV. Predictably enough, it would come to public funds. **U. Leinberger** thinks it should be possible to charge this to users/companies with existing systems.
A solution would be to audit the infrastructure in order to know which parts of it would be suitable for these trucks.

Discussion on Safety

Restricting LHVs traffic to motorways is probably the ideal solution, but it is not very realistic. One should be careful not to generalize experiences from Sweden, Finland and the Netherlands. Recombination terminals are an option, but there are many practical obstacles to overcome. Even if a certain restriction is instated, enforcement is still the key.
For passenger cars, overtaking does not take much longer trucks in comparison with shorter ones. The issue could be different if overtaking would occur between two trucks one of them being a LHV. A question related to this issue is included in the questionnaire.
In snow conditions, certain configurations cause severe problems. It is mainly weight related. Length also poses problems, in terms of time to cross roads, roundabouts, rest areas, tunnels (emergency spaces).
Accident costs depend on frequency (1st order) and severity (2nd order). Net effect could go either way.
Discussion again goes to rail's ability to cope with the extra demand that could arise over the next few years (the study's horizon). Internalising external costs is one of the steps to level the playing field in transport. Austrian rail is confident that demand can be met with minor efforts. Politics will need to follow: investments from national and international authorities need to go to rail (in many countries, it went to road first).

Driver training

It is suggested to deliver a specific training to drivers for each type of vehicle. This is already the case in NL: 120h of training are required to drive LHVs, and drivers have to pass tests each year. Electronic systems (active safety equipments such as Antiblocking systems ABS, ESP, automatic braking, lane change alarm) should be made universal. It could also be possible to introduce this to current trucks (retrofit), but opposition is shown on the grounds that it would be very difficult from the political side. It would be easier to link these new requirements to new vehicles.

45ft containers

4 types exist, only one is suitable for road transport. Containers designed by the Dutch company Geest, with rounded corners are not accepted by competitors (Maersk, P&O) on international ships. Kingpin distance plays a major role as well.

Energy efficiency

In case of a 37% shift from conventional trucks to LHV, gain in efficiency would be 1.2%. This is the most "optimistic" scenario. When more "realistic scenarios" are used, the modal shift resulting from price reduction would lead to an increase of CO_2 exhaust of 6-10%.
Better use of loads (most transport operations are volume limited) could be a determining factor. Even a 25.25m truck with 40t could be beneficial in some cases.

Table 91: List of people explicitly invited to the 28 April workshop

Name	Name	Company	Invitation date
Berenyi	Janos		20080416
Bleck	Arnulf	MEYER & MEYER Internationale Spediteure GmbH & Co. KG	20080422
BLUMENSTEIN	Wulf	Vertretung Land Niedersachsen bei der EU	20080422
DEÁK	János	EU-UNECE Vehicle Development	20080416
Elsinger	Julia		20080416
Fabian	Thomas	Bundesverband der Deutschen Industrie (BDI)	20080422
Favre	Bernard	Renault Trucks	20080416
Feige	Lydia	AT Department of Transport	20080416
Gaeta	Francesco	French Ministry for Ecology, Sustainable Development and Spatial Planning	20080416
Glaeser	Klaus-Peter	BAST	20080416
Hausherr	Herbert	COTRANS LOGISTIC GmbH & Co. KG	20080422
Hessling	Thomas	Allgemeiner Deutscher Automobil Club e.V.	20080422
Kampfraath	Chris	Ministry Of Transport	20080416
Karoly	Pongracz	Department Infrastucture Regulation, Ministry of Economy and Transport	20080416
Klamant	Ernst	Ministerium Bauen und Verkehr NRW	20080422
Lievens	Joke	Mobiel Vlaanderen	20080416
Nemeth	Claudia	Austrian Ministry of Transport	20080416
Niewöhner		Dekra	20080422
Rasmussen	Ib	Ministry of Transport	20080416
Ruppert	László	KTI (Institut for Transport Sciences)	20080416
Salet	Martin	Ministry Of Transport	20080416
Sennewald	Heiko	Ewals Cargo Care	20080422
Wallentowitz		Institute of Automotive Engineering (IKA), RWTH Aachen	20080416
Wohrmann	Mark	Forschungsgesellschaft Kraftfahrwesen Aachen	20080422

2.4. Expert workshop 29/04/08, Stockholm

Time and venue: 29/04/2008, Stockholm

Chair: Bernard Jacob

Minutes by: Tim Breemersch & Matthieu Bereni

Attendees:
Jon Aurell (Volvo)
Sakari Backlund (Finnish association of road haulage companies)
Matthieu Bereni (Sétra)
Tim Breemersch (TML)
Jorgen Christensen (OECD/ JTRC)
Karsten Gade (Danish Transport And Logistics Association)
Martin Hellung-Larsen (Danish Road Transport Agency)
Marie Hermansson (Transport Group & Swedish International Freight Association)
Bernard Jacob (LCPC)
Jenny Johansson (Scania)
Marten Johansson (Swedish Association of Road Haulage Companies)
Asbjorn Johnsen (Norwegian Public Road administration)
Max Klingender (RWTH)
Anders Lundqvist (Swedish Road Administration)
Andreas Marquardt (Federal Ministry of Transport Germany)
Jan-Terje Mentzoni (Norwegian Hauliers' association)
Mark Morgan (ECG – Association of European Vehicle Logistics)
Marie Mortsell (Volvo)
Per-Olof Nilsson (GN-Transport)
Hans-Christian Pflug (Daimler & VDA Germany)
Lennart Pilskog (Volvo Trucks)
Tommy Rosgardt (Volvo 3P)
Michel Scherer (Kögel)
Hans Skat (Danish Transport And Logistics Association)
Norbert Tiedemann (Federal Ministry of Transport Germany)
Reinout Wijbenga (TNT)

Outline of the study

Questionnaire and general outline of the workshop

Q: Will you display the results of the questionnaire on your website?
A: a synthesis of the answers will be enclosed in the final report and will be presented during the July stakeholders' meeting in Brussels.

Remark: there is no mention of the tyre pressure per square meter in the questionnaire.

Presentation of the OECD/ITF study on Heavy Vehicles: regulatory, operational and productivity improvements, by J. Christensen

A significant effort in the research field has been provided by the OECD. Many studies dealing with Heavy Vehicles since 1983 have paved the way for a better understanding of the relationships between Heavy Vehicles and their environment (DIVINE, PBS for the road sector, etc.).

This study intends to evaluate how needs for increased road transport productivity can be achieved while providing significant better safety, meeting target reductions of emissions and noise and having manageable impacts and demands on road network.

Thanks to the involvement of representatives of many countries in Europe and outside Europe, different benchmarking studies will be performed on the following topics: safety, environmental impact and productivity.

Swedish background and present situation, by A. Lundqvist

It is traditional to operate long vehicles in Sweden (24m long combinations in 1968). Prior to allowing 60 t Gross Weight vehicles, investments have been made to prepare the Swedish road network. First phase included the replacement of 1100 bridges. An agreement between the Government and the Industry resulted in a considerable investment programme for bridges and roads. The bridge investments were partly financed through dedicated vehicle taxes.

Studies have shown that going from 24m to 25.25m:

- has not provoked any extra costs for infrastructure;
- has not reduced access;
- has not increased risks in traffic.

Instead, it would be beneficial for NOx and CO_2 emissions as well as for transport costs.

It is also precised that taxation does exist on heavier vehicles, based on their weight.

Position of the German Ministry of Transport, by A. Marquardt and N. Tiedemann

The German government has commissioned two studies to assess the impacts of allowing LHVs on the German road network.

The first study was carried out by the Federal Highway Research Institute (BASt) and dealt with bridges, tunnels, road traffic installations, vehicle technology and road safety. The conclusions are:

- bridges: need for reinforcement or replacement. Necessary investments: 4 to 8 billion euro in addition to the costs for the maintenance of bridges on German federal motorways;
- tunnels: investments for increased safety equipments and fire safety requirements;
- road traffic installations: no LHVs in small roundabouts and junctions within built-up areas; decreased capacity on parking spaces;
- vehicle technology: driving assistance systems are still at the development stage;
- road safety: accident severity may increase for certain accident types.

The second study, undertaken by Kessel and Partner was to investigate how LHVs would change demand and modal split. The main conclusions are:

- combined transport: loss of competitiveness. Combined transport traffic: - 14 to -30%;
- conventional rail freight services: -12% for single freight wagon system, -50 to –60% for certain categories of goods that would shift to road transport. There would be a considerable modal shift from rail to road;
- allowing LHVs would not solve the congestion problems on German roads.

Although Germany has no reason to blame other countries for using LHVs on their road networks, the German Ministry of Transport does not find the use of LHVs in Germany relevant now. However, discussions on this topic remain open.

<u>Position of the Danish Road Safety and Transport Agency, by M. Hellung-Larsen</u>

Some ideas to adapt directive 96/53 are presented to the audience that would help reducing CO_2 emissions and improving safety:

- 48t on 6 axles in international traffic (up to 20% fuel savings per tonne-km in comparison with 40t vehicles);
- rear spoiler not included in measurement of vehicle length (spoilers may reduce fuel consumption by 10%);
- FUPS[89] not included in measurement of vehicle length.

Denmark will soon start a modular concept trial. It will take place on designated roads only (motorways and primary roads connected to ports and terminals). Maximum length = 25.25 m, Maximum GVW = 60t. Significant investments have been made to adapt infrastructure.

Some special requirements for EMS may be decided on:

- Manoeuvrability (turning circle requirements);
- Braking (ABS/EBS);
- Stability (ESP);
- ADAS (Advanced Emergency Braking Systems, Lane Departure Warning Systems, etc.);
- Driver training/experience.

<u>LUNCH + DemoCentre visit</u>

<u>An insight into the practice of LHVs by GN Transport, by P.-O. Nilsson</u>

GN Transport is a Swedish transport company, specialised in transport between Scandinavia and France, with subsidiaries in France and the Luxembourg. The company is experienced in using long combinations (25.25m) and knows the resulting advantages.

Two major figures:

- The average load for long combinations equals approximately 50t;

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[89] FUPS = Front Underrun Protection System. In case of a frontal collision between a passenger car and a Heavy Vehicle, FUPS absorb kinetic energy, hence protecting passengers and the vehicles' components at the same time.

- Huge space is not needed as one could expect to achieve coupling / decoupling of modules.

Position of the Swedish Association of Road haulage companies, by M. Johansson

If both longer and heavier vehicle combinations cannot be achieved, a first step would be to at least permit longer vehicles. Besides, 25m long buses have been operated in Geneva for many years without any particular problem. However, it is reminded that investments for extension and improvement of infrastructure have been achieved appropriately.

M. Johansson also draw the attention of the audience on the fact that a vehicle may operate illegally after being unloaded (due to the moving of the centre of gravity inside of the semi-trailer); its load per axle being higher than 11.5t in some cases.

One solution would be to operate 44 t vehicles on 6 axles, enabling to distribute the weight on 2 driving axles instead of one. This kind of combination would cause 22% less road wear per transported cargo weight. It is due to the fact that tandem axles are less aggressive with roads, because the pavement does not have time to relax between the passages of the two close axles.

EMS with a GVW of 60t and a length of 25.25 m would be equally beneficial to the pavement since they would allow a 22% or 30% reduction of the road wear in comparison with the current combinations.

Last, in winter conditions, there is no indication of extra-risk with EMS driving on slippery roads.

Presentation of a trial to come in Norway, by A. Johnsen

A trial is about to start in Norway with LHVs. It would last 3 years, starting on June 1st , 2008. The crossing of borders would be authorized to link terminals. Not all routes would be suitable. Five of them have been selected with connection to Sweden and Finland. These roads are of a good standard. Following this trial and its evaluation, the Norwegian road administration will decide on its extension or not.

The effects to be assessed during the trial concern:
- The productivity of transport and logistics;
- The environmental impact;
- Road Safety.

The trial period may be finished partly or totally if negative effects are experienced before the end of the period.

Position of VDA-FAT, by H.-C. Pflug

VDA-FAT has lead a project named "Innovative Truck-Trailer concepts" that intends to propose innovative vehicle concepts which offer changes to exploit new potentials for the increasing road freight transport especially in long distance traffic. They have the following approach:
- New designed truck-trailer combinations;
- Longer truck-trailer combinations;
- Increase of the gross vehicle weight of truck-trailer combinations without increase of today's regulated axle load.

Requirements for these EMS based combinations deal with their directional stability and the respect for all German regulations regarding road area geometry.
The different combinations are compared with respect to many parameters (payload, volume, turning, fuel consumption, stability, etc.). Stability has been tested technically through simulation, with different configurations of steering axles (front and back or steering dolly).
Braking distance of 25.25m/60t could decrease in comparison to 40t, as each axle has lower weight, and needs to brake less. VDA acknowledges this to be featured in a study performed by the consultancy firm Kessel & Partner. However, other institutions, such as universities, were also involved in this study.

<u>Questionnaire discussion</u>

- 24m is still very popular in Sweden, up to 90% is still done by 24m, 10% by 25.25;
- In Germany, the market share for 25.25m combinations could be about 30%;
- There is a need for implantation of coupling points;
- Overtaking by passenger cars is not really seen as a problem. Overtaking by another truck is a question of enforcement;
- To carry heavier loads, an engine with more horsepower could be required;
- Bigger is not the same as longer, and this is not the same as heavier, they are separate but can be combined;
- ECG asks if height is considered in the study. It is included in the directive, so probably should be included;
- Braking distance is discussed again: it is asked to which extent a system is still modular if different braking or steering systems exist on modules that have the same dimensions;
- In Sweden, no extra driver education is needed, but they have a long experience with this kind of combinations. In Denmark, no extra driver certification will be needed during trial. Danish participants do say that only experienced drivers will drive the LHVs.
- Overloading in Sweden is controlled, and checks have become stricter over the years. Overloaded driving axle is mainly the biggest problem rather than gross vehicle weight overloading. WIM is applied, but mainly for statistics and not for enforcement. There is a matter of responsibility here: when overloading is observed, who is responsible for it? the driver, the manager of the transport company or the shipper?
- Coupling devices and restrictions could also be considered in the study (though it may be more related 97/27).
- The modular concept leaves all options open. It is more a question of infrastructure. Infrastructure audit to a certain extent (road approval) could be the way to prepare the use of LHVs.

Table 92: List of people explicitly invited to the 29 April workshop

Name	Name	Company	Invitation date
Backlund	Sakari	Finnish Hauliers Association	20080416
Bleck	Arnulf	MEYER & MEYER Internationale Spediteure GmbH & Co. KG	20080422
BLUMENSTEIN	Wulf	Vertretung Land Niedersachsen bei der EU	20080422
Cemat	President	CEMAT (Combined European Management and Transportation)	20080416
Christensen	Jorgen	Vejdirektoratet Denmark	20080416
Ehrning	Ulf	Volvo	20080416
Fabian	Thomas	Bundesverband der Deutschen Industrie (BDI)	20080422
Favre	Bernard	Renault Trucks	20080416
Gaeta	Francesco	French Ministry for Ecology, Sustainable Development and Spatial Plan-	20080416

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Glaeser	Klaus-Peter	BAST	20080416
Hallams	Bo	Schenker	20080416
Hausherr	Herbert	COTRANS LOGISTIC GmbH & Co. KG	20080422
HELLUNG-LARSEN	Martin	Danish Road Transport Agency	20080416
Hermansson	Marie	Swedish International Freight Association and The Transport Group	20080416
Hessling	Thomas	Allgemeiner Deutscher Automobil Club e.V.	20080422
Johansson	Mårten	Swedish Association of Road Haulage Companies	20080416
Johansson	Jenny	Scania	20080416
Johnsen	Asbjörn	National Road Administration	20080416
Kampfraath	Chris	Ministry Of Transport	20080416
Klamant	Ernst	Ministerium Bauen und Verkehr NRW	20080422
Lievens	Joke	Mobiel Vlaanderen	20080416
Lundqvist	Anders	National Road Administration	20080416
Marquardt	Andreas	Federal Ministry of Transports, Germany	20080416
Mentzoni	Jan-Terje	Norwegian Hauliers' Association	20080416
Morgan	Mark	ECG - The Association of European Vehicle Logistics	20080416
Mortsell	Marie	volvo	20080416
Niewöhner		Dekra	20080422
Nilsson	Per-Olof	GN-Transport	20080416
Pilskog	Lennart	Volvo	20080416
Rasmussen	Ib	Ministry of Transport	20080416
Ruppert	László	KTI (Institut for Transport Sciences)	20080416
Salet	Martin	Ministry Of Transport	20080416
Sennewald	Heiko	Ewals Cargo Care	20080422
Tiedemann	Norbert	Federal Ministry of Transports, Germany	20080416
Wijbenga	Reinout	EEA	20080416
Wohrmann	Mark	Forschungsgesellschaft Kraftfahrwesen Aachen	20080422

3. Other stakeholder consultations

3.1. CER, 18/03/08

Attendees
Johannes Ludewig (CER)
Denise Kwantes (CER)
Igor Davydenko (TNO)
Kees Verweij (TNO)
Bart Van Herbruggen (TML)
Tim Breemersch (TML)

Several studies were presented to demonstrate the arguments of CER. Any volume loss could be detrimental to rail, as it depends heavily on full train loads, be it collected from single wagons/combined traffic or sold as block trains, for many lines.
A decrease in profitability may deter governments to invest in infrastructure.
Demand generation is an effect that needs to be closely evaluated, as this may take time to have effect.
Elasticities need to be checked.
A corridor scenario is dangerous, as this would put political pressure on other governments to follow suit.
Slightly increased dimensions/weights would not be a problem

Driving time: rail more constant, road drivers need to rest every couple of hours
Response: illegal behaviour is systematic
Enforcement?

CO_2 emissions of new technologies in road transport are lower
Taken into account?
Advances in rail as well, should balance out.
Shift from diesel locomotives to electricity (source of electricity?)
Emission trading is incentive for rail (Deutsche Bahn), also for road? (fuel tax)
Recuperate energy from braking

Increased transport demand will necessitate expanding capacity. All modalities are needed. Response: making a decision on one part of the question (road) but leaving the other part (rail) uncertain is not rational.

3.2. Safety workshop 15/04/08, Stuttgart

Attendees
Walter Niewöhner (Dekra)
Hans-Christian Pflug (VDA)
Dieter Schoch (Daimler AG)
Hervé Arki (Sétra)
Max Klingender (RWTH Aachen)

Agenda:

11:00	Welcome
11:05	Development Safety Heavy Trucks
11:30	Experience FAT-project: Safety "EuroCombi"
12:00	Lunch in the staff restaurant
12:45	cont. Experience FAT-project: Safety "EuroCombi" and Discussion
13:00	Experience from the Ecocombi field trial in Stuttgart
13:45	Ride with the Ecocombi long combination
15:00	return to Untertürkheim/Zentralversand and end of meeting

The workshop gave an overview of safety equipment development in commercial vehicle design and of the legal constraints for driving assistance systems (Vienna convention). Very interesting artefacts were shown, which are able to lower accident numbers and, especially, their consequences. A typical driver assistance system that leads to a gain of safety is the stability control. It uses the braking system to avoid instable and critical driving manoeuvres. In his presentation Professor Pflug mentioned, that the stability control system is only available for tractor-trailer combinations, but is being developed exclusive for trailers at the moment and is expected to be ready to go into production in 2010. The lane assistant is a warning system, which warns the driver with an acoustical signal that the vehicle is driving over a lane mark. A camera in the centre of the windshield is monitoring the lane and is active when the vehicle is driving more than 78 km/h, the turn signal is turned off and if there are detectable lane marks. This driver assistance system does not intervene in driving manoeuvres and is only a warning system. The proximity control system is a safety feature, which automatically keeps a certain distance to a vehicle driving ahead, by using all braking systems that are installed in the vehicle. The system detects vehicles in a range of 0 to 150 m and a relative speed of -50 km/h up to 200 km/h. This safety feature reduces the frequency of rear-end collisions and is also a comfort function for the driver. In critical situations this system can become active and initiates a braking manoeuvre, if the driver is not reacting and risking a rear-end collision. This is done by the active brake assist function. Stationary objects cannot be detected by this system. This leads to a major problem in the context of traffic congestions, because 90 % of these are non-moving (Professor Pflug). Another problem is that collisions are possible under bad weather conditions on wet road surfaces. But even if an accident cannot be prevented under these circumstances, the severity of the impact is nevertheless lower than without the active brake assist function. To prevent collisions on all road surfaces the actual coefficient of adhesion has to be estimated. There are also juristically complications with this driver assistance system. It is not legal within the Vienna Convention, because the driver has to be fully responsible for the vehicle and has to have the control over it all the time. Therefore, the passive driver's protection systems only get active in case of an accident. The combination of all the safety features (seat belt, airbag, etc.) lead to an effective driver's protection. The driver has the final responsibility, but is supported by all of the driver assistance systems.

The background for the VDA initiative EuroCombi was explained and experiences from the field trial were shared with the attending project members (including a ride with a 60 t EMS across the Stuttgart area). In Order to minimize the risk of the relevant accident types, the "Forschungsvereinigung Automobiltechnik e.V." of VDA recommends a list of safety features the EMS has to have installed. First of all a lane departure assistant, a proximity control system and a roll stability control system are suggested. Lockable steering axles of the dolly or semitrailer are additionally requested. The braking system should be electro-pneumatic and the EMS should have disc brakes over all. A Retarder should be in the towing vehicle and a braking assistant should be installed. The EMS should have clear marks to identify them and a reverse warning system. Further there should be signs on the EMS that indicate the length of 25 m.
The driver should fulfill the following requirements: a driving experience of over 5 years and special safety training for the EMS.

The findings of the ETAC study were discussed and brought into combination with relevant shares of accident types from commercial vehicles. In this context the e-safety data was recommended as a database for the study. In addition an initiative of truck manufacturers, DEKRA and an insurance company were represented. Aim is to enhance the grade of safety equipment via insurance incentives for the carrier.

Table 93: List of people explicitly invited to the 15 April workshop

Name	Name	Company	Invitation date
Hügel	Jens	IRU	20080411
Niewöhner	Walter	Dekra	20080409
Pflug	Hans-Christian	VDA	20080409
Schoch	Dieter	Daimler AG	20080409

3.3. UIRR, 14/05/08

<u>Attendees</u>:
Rudy Colle
Rainer Mertel
Griet De Ceuster
Tim Breemersch

Kombiverkehr is the biggest member of UIRR. Fear is that decreased cost per tkm will put pressure on combined transport.
What are the data that we need? Quantitative study, so numbers, assumptions, marketshares,…
Schedule of the study: deadline in July, final report in August. Rest of legislative process is still unclear as there is no real horizon for a change in the directive.

2 questions:
1) Will there be a modal shift?
2) What is the internal logic behind bigger trucks?

Trucking companies will always go for highest capacity, since they want to be prepared for the biggest loads that are needed. Road transport is very efficient; especially for long distance full capacity is reached in almost 95% of trips.

Combined transport targets every cargo transported over more than 250km. Some types of cargo are more used: chemicals, automotive, food, pharmaceuticals. Groupage is less represented (parcel service), due to

lower reliability of rail. Norway has the most reliable combined transport system in Europe (Cargonet). They use shuttle trains, running every 2 hours.
TIM consult study was working with 25.25m/60t. 45ft container could be accommodated by these combinations as well.
With Gigaliners, points of consolidation would be needed (~=terminals=>costs?)
No local pickup and delivery of goods is assumed to be done by Gigaliners.
Combined transport has 4 market segments: Deep Sea containers, domestic and international, and continental transport, domestic and international. Combined transport to and from Italy is about 50% of total European combined transport market.
Detail of TIM consult study: e.g. Hamburg (1 origin) to Leipzig (5 destinations, with 1 terminal). 388 actual routes are investigated. Detailed cost calculations exist. Of course, data only exist for routes where combined transport exists. Truck shuttle services between Munich and Verona exist already (study assumes that where Gigaliners are not allowed, standard trucks take over).

Increasing to 44t would jeopardize about 15 to 18%, plus domino effect, total about 24% of combined transport.

Study covers 2020. How would combined transport evolve in that timeframe?
Costs is always determining factor for industries to choose. If Gigaliners are cheaper then, combined would not grow to the same extent. The effects on modal shift in 2006 or 2020 would not be very different. In 2006, driving/resting time regulations have increased road prices for the first time.
Combined transport is the way ahead for rail, not single wagons loads or full rail traffic. Gigaliners would cause combined transport to lose a big part of its advantages for at least 15 years, especially with dedicated rail freight network in the pipeline.
Introducing Gigaliners would conflict with EU targets in e.g. environmental issues.
We are invited to come to Frankfurt to see the OD excel sheet.
Reasons for combined to have market share where road is cheaper: (i) 44T (ii) Safety, environment (iii) better schedule (combined would be faster due to resting time regulation)
48t combined transport would cause problems. 6 axles would be needed, of which 2 powered axles. This would then decrease payload by 1.5 t (weight of the axle). New member states: equipment in terminals (cranes) would not be able to handle the extra loads.
45ft containers are no problem, 7cm does not cause problems. Only problem could appear with patent of Dutch company (Geest), which would be obsolete.

3.4. Deutsche Bahn, 16/06/08

Attendees:
Corinna Bonati, DB
Björn Grindberg, DB
Werner Lübberink, DB
Jörg Schmidt, Railion
Achim Weber, Railion
Igor Davydenko, TNO
Hervé Arki, Sétra
Griet De Ceuster, TML
Tim Breemersch, TML

As Deutsche Bahn (DB) has activities in every transport mode (road, rail, air, water), they support the co-modal approach and are a good representation of the German market, all within the same company.

The rail market consists of a number of segments, all of which are at risk if LHV are to be generally permitted in Europe. Intermodal and Single wagon segments are under the most pressure, block trains somewhat less. For customers, there are minimum service requirements first, but extra service is not a sales argument; only price is. Reference is made to the TIM consult study of Kombiverkehr.

The automotive division of Railion is presented.

4. Statements

4.1. Answers provided by the French Ministry in charge of Transport MEEDDAT (Ministère de l'Ecologie, de l'Energie, du Développement Durable et de l'Aménagement du Territoire) on the questionnaire

For answering the questionnaire, the MEEDDAT calls “LHVs” heavy goods vehicles that are 60t heavy and 25,25 m long vehicles.

4.1.1. Transport demand

If the LHVs were allowed, the MEEDDAT believes that road transport costs would be reduced. MEEDDAT officials do not know what would be the extent of this decrease but it would certainly depend upon the proportion of LHVs among the fleet of heavy vehicles. This cost reduction would be due to four factors: a) a employees cost reduction b) energy savings, c) a more efficient organization and d) a lower vehicle investment and maintenance cost.

MEEDDAT believes that the introduction of LHVs would contribute to increasing freight transport demand over 5 years.

During the 'Grenelle de l'Environnement', the French Government has committed itself to increase by 25% the part of freight that is not transported by road by 2012. The politic wish consists in encouraging all alternative modes. Consequently, the French Government is opposed to any decision that would result in increasing the road freight transport.

4.1.2. 45' containers

Regarding road transport of 45' containers, one must bear in mind that at the end of 2006, the European Commission made a proposal (27/11/2006 SEC (2006)1581) to guarantee the transportation of 45' containers by trucks to and from harbours in good conditions. In France, the corresponding flows are operated under the regime of exceptional transport, which has been rather satisfying so far, considering the minor utilization of the 45' containers. An evaluation of this organisation is forecast.

France intends to keep limiting, as it is the case today, the use of vehicles that transport 45’ containers on its territory. According to the MEEDDAT, the crossing of borders with 45' containers vehicles should only be allowed when the vehicles complies with the national rules on either side of the border. As a priority, the 45' land transport should use a multimodal transport scheme.

4.1.3. Size, volume and weight challenges

The main advantage provided by an adaptation of directive 96/53 would be a reduction in transport costs. When considering the advantages / disadvantages of an adaptation of directive 96/53, it is advisable to distinguish the short term from the medium and the long term.
In the short term, the introduction of LHVs would probably enable to decrease the quantity of trucks and pollution. Indeed, the MEEDDAT does not believe that an extra transport demand would immediately occur. Consequently, if the number of ton.km does not change in the short term, LHVs would help to satisfy transport demand with fewer vehicles. Besides, the renewal of trucks would contribute to modernize the vehicle fleet on the whole and thus favour the use of more modern and less polluting trucks.
In the middle or the long term, one can fear that productivity gains would cause, on the one hand, generated road traffic and, on the other hand, modal shifts from the other modes to road. The effects of both these traffics would offset the qualitative gains observed in the short term and would eventually lead to a worse situation than the reference one in the middle/long term with respect to the amount of kilometres travelled by heavy goods vehicles, road safety and pollution.

As far as disadvantages are concerned, it could be forecast that LHVs would: a) cause difficulties to overtake b) increase aggressiveness for infrastructure c) increase accident severity d) require infrastructure modifications e) increase polluting emissions.
Authorising LHVs would increase road transport competitiveness and by doing this would be an obstacle to the development of the other more environmental friendly transport modes.
Although there is not much literature about the severity of accidents that involve LHVs, many studies show that there is a link between the dimensions and weights of heavy vehicles and the accident severity. For that, it seems sensible to assume that accidents involving LHVs would be more severe.

4.1.4. Scenarios on maximum weights and dimensions

With reference to the previous arguments, the MEEDDAT is against an adaptation of directive 96/53:an increase of the authorised weight and the length of vehicles seems to introduce an competitiveness unbalance in favour of road goods transport against the other modes, especially railways, what is contrary to the current French modal shift policy. Therefore, France advocates keeping the current allowed weight and dimensions. However, regarding dimensions, some adaptations could be acceptable if other parameters were also taken into account.

If the directive were to be adapted, the MEEDDAT considers that it should not only deal with the maximum gross vehicle weight and length but that it should also treat some other important parameters such as the axle load, the axle position, the number of axles, their characteristics, etc. in order to improve road safety and decrease road wear and tear. The crossing of borders could also be clarified.

4.1.5. Intermodality

The MEEDDAT believes that LHVs will compete with the combined transport, for all kind of freight, apart maybe from high added value freight.

Access limitations for LHVs would be desired. These limitations would concern: a) the routes which may not be adapted to the traffic of LHVs because of the infrastructure characteristics b) the routes which are operated by other transport modes c) the routes for which a combined transport service exists.

It is reminded that the French Government commits itself into favouring modal shift: consequently situation where LHVs routes compete with other modes routes should be avoid. Moreover, an important part of the French road network (especially the secondary one) is not, in its current state, adapted to LHVs.

4.1.6. Technology, design, engines

According to the MEEDDAT, LHVs should be able drive at a minimum speed, so that they would be able to integrate well into the traffic mix without causing any problem. They should also be equipped with wide based tyres or twin tyres and air suspensions in order to reduce their aggressiveness on infrastructure. Likewise, various safety equipments (ABS, ESP, EBS, ASR, etc.) should be made compulsory for these vehicles as well as additional signs to warn the other drivers on their length or shape. On-board load measuring systems could also be required.

LHVs could also be tested with regard to their ability to drive in/on: roundabouts, slopes, railway crossings, wet and icy surfaces, turns to the right. They would also be inspected on shorter intervals than the current trucks, especially regarding their braking performances. In parallel, the overload screening and load controls should be increased in (space/time) and weigh-in-motion techniques should be largely used for all trucks.

4.1.7. CO_2 emissions

Road techniques are energy consuming. Consequently, the effort required to strengthen the road network in order to enable its use by LHVs would result in significant CO_2 supplementary emissions. Thus, the vehicle shapes that would be the less aggressive for infrastructure should be favoured.
In any case, it would not be seen as a sensible option to implement the strengthening of the whole network only in order to comply with the use of the LHVs.

4.1.8. Noise emissions

The MEEDDAT assumes that using LHVs would increase noise emissions due to engine considerations.

4.1.9. Infrastructures

The impact on infrastructure would vary with respect to the characteristics of the vehicles that would be allowed.
Certain combinations would undoubtedly shorten the infrastructure lifetime. Consequently, all relevant parameters should be considered along with the change in the maximum allowed length and weight (e.g. the number and position of axles, the type of axle, the axle load, etc.) so that the overall aggressiveness is not increased. Other critical consequences could also appear on safety barriers (their ability to cope with LHVs), on bridge dynamics, on the infrastructure lifespan.

Would the LHVs be authorised, the design of some road features (roundabout, parking lots, emergency stop beds, ramp access, etc.) might need to be upgraded.

4.1.10. Traffic rules

The MEEDDAT thinks that generally speaking, the rules for LHVs should be the same than the one for "normal" HGVs.
However, some rules may be stronger in order to improve safety or traffic: for example, the possibility of overtaking should be strictly limited; LHVs should respect more important safety distance with other vehicles. Would LHVs be authorised, France advocate authorising them only on a predetermined network.

4.1.11. Conclusion and position statement

As the ministry in charge of transport, but also of all issues linked to sustainable development, the MEEDDAT do not ask for a revision of the 96/53/EC directive. Especially, it seems that a number of issues – central and unclear by now – should be addressed before deciding to review the current legislation:

- What is the impact of LHVs on road safety? Obviously, the answer is linked to the characteristics of the considered LHV. We deem that the experimentation carried out within various European countries are, neither really representative (the experimentation in the field of road safety are always arduous because the very conditions of experimentation skew the results: a sample of drivers is not representative and particularly watchful, "accident" events are hopefully too scarce due to the sample size, the state of vehicles is not representative of the fleet of vehicles, etc.), nor transposable to other networks (relief, driver's behaviour). Besides, we can worry about the compatibility between the features of infrastructure (geometry, safety devices, etc.) and this new kind of vehicles.

- What is the impact of implementation of LHVs in terms of traffic from a macro-economical perspective? It deals wells with the main issue to which the major part of other issues, out of the field of road safety and infrastructure, are referring to:
    - What impact on the modal transfer?
    - What impact on the fuel consumption and gas emission responsible for global warming?
    - What impact on congestion?
    - Etc.

  As a general rule, France is against the implementation of any kind of system, which could undermine the modal transfer.

- What is the impact of the authorisation of LHVs on infrastructure? It seems that this one would be very variable depending on the characteristics allowed for LHVs, some layout can lead to a significant downsize of the life cycle of infrastructure. Thus it is agreed to emphasis on the fact that, if it is unavoidable, a review of the current directive could not be limited to lift up the weight thresholds and sizes stipulated in the current directive, but should also implement imperatively other criteria (particularly concerning the number, the position, and the kind of axles) enabling to limit as far as possible the damages induced by this kind of vehicles without undermining their advantages (volume, transportable loads).

Provided that the listed conditions below are respected, the LHVs could enable to give an interesting response to face the increase of trafic, the network overloading, the rise of energetic costs and the shortage of road drivers.

However, in the absence of in-depth and independent scientific studies on these different topics, the aware element lead us to adopt a behaviour very reserved concerning the implementation of LHVs in order to avoid negative impacts as on road safety and the state of infrastructure as on the development of alternative modes, especially the railway.

4.2. Written Ministerial Statement – Departement for Transport - Longer and Heavier Goods Vehicles

Date: 3 June 2008

The Secretary of State for Transport (Ruth Kelly): The Transport Research Laboratory has today published a report, commissioned by my Department, on the subject of longer and heavier goods vehicles (LHVs). The report highlights a number of issues that make the implementation of large 25.25 metre LHVs, sometimes referred to as 'super-lorries', impractical either on a permanent or trial basis. I will therefore not be allowing them on UK roads for the foreseeable future.

The following issues highlighted in the report have been influential in arriving at my decision:

- There is a risk (substantial in the case of 60 tonne super-lorries) of increased CO2 emissions and other environmental drawbacks due to modal shift from rail to road if these vehicles were to be permitted, which would also impact on the viability of existing rail freight services and the potential for future growth
- There are serious implications for the management of the road network, as such vehicles would be unsuitable for many roads and junctions
- Substantial investment (in the order of several billion pounds) would be needed to provide for junction improvements, the protection of bridge supports, and the provision of parking infrastructure for statutory rest periods, particularly if a new nationwide network of dedicated facilities is required
- There is uncertainty about how efficiently such vehicles could be used, particularly when sourcing loads of sufficient size to make return journeys sustainable
- Such vehicles would introduce new safety risks
- It is not currently possible for us to mandate tougher safety or manoeuvrability standards that might address some of these issues because of European trade rules

The report does show, however, that there could be worthwhile benefits from permitting a modest increase in the length of current articulated vehicles. The Department will consider these further in the context of its ongoing strategic work on freight, on which I expect to publish a summary of progress this summer.

The report will help inform Member States and the European Commission who are reviewing the rules on lorry sizes as part of the Logistics Action Plan to improve the efficiency of transport and logistics in the European Union.

Copies of the report have been placed in the libraries of the House and can also be viewed at www.trl.co.uk

4.3. Austrian statement

BMVIT – Austrian Ministry for Transport, Innovation and Technology

EU Workshop on Weights and Dimensions of Heavy Vehicles

28th April 2008, Budapest

Austrian Position

"Keep weights and dimensions stable"

BMVIT – Austrian Ministry for Transport, Innovation and Technology

Disadvantages of longer and heavier vehicles:

(1) Infrastructure
- a) Road infrastructure
- b) Rail infrastructure and rolling material
- c) Sender and recipient

(2) (Lack of) Safety

(3) Environment
- a) Exhaust emissions
- b) Noise

(4) Pricing and Modal Split

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Disadvantages of longer and heavier vehicles:

(1) a) Road Infrastructure[1]

Austria is an alpine country whose topography is characterised by high mountains and small valleys. The secondary road network, which has to be adapted in detail to the landscape, is therefore in no way suitable for gigaliners (narrow road lanes, tight corners/bends). But also the primary road network (motorways and expressways) has not been designed for 60t-trucks and would be very negatively affected by longer and heavier road vehicles, particularly with respect to

- bridges
- tunnels
- rest areas
- junctions and roundabouts and
- crash barriers.

[1] **Facts and figures regarding road infrastructure in Austria and quoted here are based in particular on a statement by ASFINAG (Autobahnen- und Schnellstraßen-Finanzierungs-Aktiengesellschaft), the Austrian Society for Financing Motorways and Expressways, adressed to the International Road Federation for the UN/ECE „Working Party on Intermodal Transport and Logistics" in Geneva on 1 and 2 October 2007 on the subject of „gigaliners" or „megatrucks".**

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Disadvantages of longer and heavier vehicles:
(1) a) Road Infrastructure

- **Bridges**
  - account for about 8% (~ 300 km) of Austrian motorways and expressways,
  - are dimensioned for limited loads (total weight on the bridge).
  - 60t-trucks would drastically shorten the lifetime of bridge-constructions, and
  - would increase reconstruction work and maintenance costs.
  - ⇨ Higher costs,
  - ⇨ more road works and associated traffic jams,
  - ⇨ and a higher environmental burden.

- **Tunnels**
  - account for about 7% (~ 300 km) of Austrian primary road network.
  - 60t-trucks would dramatically increase the fireload,
  - would require massive structural changes to the tunnel cross-sections and other (major) infrastructure adaptations (e.g. parking niches/breakdown bays), which all implies
  - ⇨ higher safety risks,
  - ⇨ higher costs for reconstruction and maintenance,
  - ⇨ more road works and associated traffic jams
  - ⇨ and a higher environmental burden

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Disadvantages of longer and heavier vehicles:
(1) a) Road Infrastructure

➢ **Rest Areas of the primary road network:**

Driving and rest periods require appropriate parking spaces and rest areas for the drivers: Since 60t-trucks are considerably longer than 40t-trucks, there are currently no such parking spaces on the ASFINAG rest areas.

- ⇨ Corresponding adaptations would be extremely costly,
- ⇨ would result in bigger, but less parking spaces or
- ⇨ else require buying additional land for bigger parking areas,
- ⇨ which would lead to even higher costs for reconstruction and maintenance.

➢ **Junctions and roundabouts:**

- Dimensioned for "standard vehicles" currently in use.
- Bigger dimensions (24 m or more) would be decisive for many design parameters and require massive adjustments of a structural and operational nature.
- ⇨ Corresponding adaptations would be very expensive for the primary network, and would imply
- ⇨ more road works, associated traffic jams and
- ⇨ a higher environmental burden.

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Disadvantages of longer and heavier vehicles:
(1) a) Road Infrastructure

➢ **Crash Barriers (of the primary road network)**

- Heavier vehicles imply, in case of crashes, higher dynamic stresses and therefore
- need to be absorbed by crash barriers of bigger dimensions
- and by massively reinforced bearing structures.
- ⇨ Expensive reconstruction,
- ⇨ more road works, associated traffic jams
- ⇨ and a higher environmental burden.

Examples for further reference:

1. A detailed analysis of the consequences of longer and heavier lorries on road infrastructure is given in the final report of "Bundesanstalt für Straßenwesen (bast): Auswirkungen von neuen Fahrzeugkonzepten auf die Infrastruktur des Budesfernstraßennetzes", Bergisch Gladbach, November 2006.

2. ADAC e.V. (Allgemeiner Deutscher Automobilclub e.V.), „ADAC Positionspapier: Die Supertrucks – Belastung statt Entlastung: Eine kritische Betrachtung aus der Sicht des ADAC e.V.", München, März 2007

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Disadvantages of longer and heavier vehicles:

(1) b) Rail Infrastructure and Rolling Material

Longer and heavier lorries would particularly affect the following aspects of rail infrastructure and rolling material:

- Terminals and transshipment points
- Rolling roads
- Unaccompanied combined transport

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Disadvantages of longer and heavier vehicles:
(1) b) Rail Infrastructure and Rolling Material

- **Terminals and transshipment points**
  Due to the success of combined transport, Austrian terminals often operate near/at maximum capacities. Enlargements sometimes are not possible due to neighbouring premises (e.g. terminal Wien-Nordwest).
  - ⇨ Parking spaces, lanes and additional installations are designed for lorries in compliance with EU-legislation on maximum weights and dimensions of heavy vehicles.
  - ⇨ At the moment, 60t-trucks with a length of 24 m or more would in most cases therefore not be able to manoeuvre in Austrian terminals.
  - ⇨ The EU-concept of co-modality and the aim of Austrian transport policy to shift traffic from road to rail would be counteracted.
  - ⇨ More road traffic would increase the environmental burden.

- **Rolling Roads**
  ÖKOMBI disposes of about 900 rolling road wagons with 8-, 10- and 12axles. These waggons can carry up to 42/44 or 48 t respectively and vehicles with a maximum length of 18.8m (as allowed by present European legislation). According to present knowledge, ÖKOMBI considers it impossible to adapt rollding road wagons to the dimensions of "gigaliners" for technical reasons, even if the extremely high costs for new investments could be covered.
  - ⇨ "Gigaliners" can not be transported by rolling roads because they are too heavy and too long.
  - ⇨ The aim of Austrian transport policy to use also rolling roads for shifting traffic from road to rail would be counteracted.
  - ⇨ More road traffic, more traffic jams, more external costs
  - ⇨ and a greater environmental burden.

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Disadvantages of longer and heavier vehicles: (1) b) Rail Infrastructure and Rolling Material

➢ **Unaccompanied combined transport**

- If "gigaliners" were to transport also longer and/or heavier ITUs (and not only a combination of 2 intermodal transport units with "normal" weights and dimensions), present waggons used for unaccompanied combined transport could not be used.
- The Umweltbundesamt for example argues that the recent advantage of special rail waggons for high-volume goods (140m³ with a tare of 27t) would, in case of the introduction of gigaliners on the road, be converted into an advantage for road transport. (Umweltbundesamt: "Länger und schwerer auf Deutschlands Straßen: Tragen Riesen-Lkw zu einer nachhaltigen Mobilität bei?", March 2007)

⇨ New wagons, for "giga-ITUs" or for transporting even more high-volume goods, would have to developed (if technically feasible!) and also require extremely high investments.

⇨ The EU-concept of co-modality and the aim of Austrian transport policy to shift traffic from road to rail would be counteracted.

⇨ More road traffic would increase the environmental burden.

(1) c) Sender and Recipient

It is highly unlikely, that the premises of senders and recipients will offer enough room for gigaliners. Therefore either costly adaptations would be required or else goods transported by longer and heavier lorries would have to be "transshipped" to "standardised" lorries at warehouses etc.

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Disadvantages of longer and heavier vehicles:

(2) (Lack of) Safety

Longer lorries need, for example,

- more time for overtaking or being overtaken
- more space for turning left or right, for taking bends and for crossing roads, thus getting closer to other vehicles and/or to the edge of the road

➔ **and therefore significantly reduce road safety.**

Heavier lorries need, among others,

- longer braking distances and
- cause more damage in case of accidents,

➔ **thus raising the risk for and the intensity of accidents**

➔ **and therefore significantly reduce road safety.**

References, e.g.:

1. ADAC e.V. (Allgemeiner Deutscher Automobilclub e.V.), „ADAC Positionspapier: Die Supertrucks – Belastung statt Entlastung: Eine kritische Betrachtung aus der Sicht des ADAC e.V.", München, März 2007
2. UIC, UIRR et al., „Mega-Trucks versus Rail Freight? What the admission of Mega-Trucks would really mean for Europe, Facts and arguments", June 2007

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Disadvantages of longer and heavier vehicles:
(3) Environment

Exhaust emissions:

- Longer and heavier lorries need less journeys for the same amount of goods, if fully utilised, but emissions in g/kWh per journey will increase due to higher weights.
- Only with an extremely high rate of utilisation will gigaliners have less emissions than lorries now in use.

In reality, full utilisation is very improbable as two examples of Austrian road transport figures show

(source: Erhebungen zum alpenquerenden Güterverkehr 1994, 1999 and 2004; information on weights is based on drivers´ indications):

- For transit traffic over the Brenner, the average effective payload (including empty runs) was 17t in 1994 (maximum authorised weight: 38t), 17.1 t in 1999 (maximum authorised weight: 40t, after accession to the European Union in 1995) and 16.2t in 2004. For inland transport, the respective figures are even lower: Over the Schober-pass for example, the average effective payload (including empty runs) was 8.1t in 1994, 7.4 t in 1999 and 9.1t in 2004.
- The share of empty runs is also an interesting figure: For transit traffic over the Brenner, empty runs accounted for 8% in 1994, and for 5% in 1999 and 2004. In inland transport over the Schober-pass, for example, empty runs accounted for 33% in 1994, for 37% in 1999 and for 31% in 2004.

- Due to lower road prices more goods will be transported by road and therefore also the absolute amount of emissions will increase.

Noise:

- Longer and heavier lorries are louder than "conventional" ones, because they have more axles and require more powerful engines.
- If gigaliners were utilised to the same extent as conventional lorries, they would not reduce noise.

Reference, e.g.:

Umweltbundesamt, „Länger und schwerer auf Deutschlands Straßen: Tragen Riesen-Lkw zu einer nachhaltigen Mobilität bei?", March 2007

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Disadvantages of longer and heavier vehicles:
(4) Pricing and Modal Split

- **Longer and heavier vehicles would reduce prices of road transport,**
- **thus reinforcing its comeptitive advantage and**
- **changing modal split in favour of road, the share of rail and combined transport would decrease.**

⇨ **Lower prices for road transport,**
⇨ **increased demand for road transport,**
⇨ **increase in noise and exhaust emissions,**
⇨ **and a waste of valuable and expensive resources in rail transport.**

Reference, e.g.:

1. K+P Transport Consultants, „Verkehrswirtschaftliche Auswirkungen von innovativen Nutzfahrzeugkonzepten", Freiburg/Frankfurt, September 2006
2. UIRR, „KV im Überblick", April 2008, quoting the TIM consult study:
Out of a sample of 800 door-to-door combined transport relations, 55% would be transferred to the road, if gigaliners were allowed. This would imply a 24% increase of road transport.

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"Advantages" of longer and heavier vehicles:

(1) Longer and heavier lorries need less journeys for the same amount of goods, if fully utilised.

(2) Fewer journeys also imply less exhaust emissions.

←→ Many journeys concern empty runs, therefore no full utilisation.

←→ More goods would be transported by road, because more attractive conditions for road transport would shift traffic from rail to road.

(3) Due to a reduction in costs/prices, road hauliers will be in a better competitive situation and therefore – perhaps – make more money.

←→ The negative effects of longer and heavier vehicles would have to be born by the public (more road transport, more exhaust emissions, extremely high investments in infrastructure …).

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Disadvantages versus advantages of longer and heavier vehicles

- **Far more disadvantages than advantages.**
- Costs of disadvantages have to be born by the public, whereas profit of (meager) adavantages goes to individual hauliers and/or other users.
- Disadvantages are even more costly for Austria due to its mountaineous regions.

"References", e.g.:

1. On 9/10th October 2007, the German „Länder" decided to finish trials for longer and heavier lorries, but not to prolong them and not to allow LHLs to circulate in the future, because (among others) of serious risks for traffic safety. („Beschluss der Verkehrsministerkonferenz", 9/10 October 2007, Merseburg)

2. European Parliament Resolution of 5 September 2007 on Freight Logistics in Europe – the key to sustainable mobility (P6_TTA(2007)0375), point 25: [The European Parliament] "… proposes that the Commission only allow the use of 60 tonne goods vehicles on certain routes at the request of, and within, a Member State; considers that, when evaluating such requests, due regard must, in particular, be paid to factors such as existing infrastructure and safety;"

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Conclusion:

Austria strongly pleads for the maintenance of existing limits for weights and dimensions of vehicles, so as not to counteract other efforts at national and European level for the concept of co-modality and for shifting traffic from the road to rail and inland waterways and/or short sea shipping.

For Austria and Austrian transport policy there can be no other alternative.

BMVIT – Austrian Ministry for Transport, Innovation and Technology

Thank you for your attention.

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Annex 4: Questionnaire

Please not that some minor differences may exist between this textual version of the questionnaire, and the version that was published online.

DG/TREN study on LHV - questionnaire

Stakeholders' Questionnaire

LHV = longer and/or heavier (commercial) vehicles. *It is reminded that the term "LHV" do not necessarily describe vehicle combinations also known as modular concept, but any kind of vehicle or vehicle combination which dimensions and/or weights deviate from those specified in the directive 96/53/EC.*

0.0 Several questions of this questionnaire refer to LHV without specifying its characteristics. In order to clarify your answers, please describe briefly the type of LHV which you will consider if not specified in the question:

0.0.1. Vehicle max. length: m 0.2. Vehicle max. weight: tons 0.3. N° of rigid units:

0.0.2. Brief description of the LHV:

0.1 For each of the following silhouette, please suggest the axle load configuration which seems to be the most realistic with respect to the current axle load limitations, and, in the last two columns, the current and expected proportions of each silhouette, if the Directive allows them

	Axle load (t)/wheel configuration [1]								Current Prop.	Future Prop.
Silhouette – Max. weight	1	2	3	4	5	6	7	8	%	%
 40t										
 44t										
 40t										
 44t										
 48t										
 60t										
 60t										

[1] **S = single wheel (standard tyre), W = single wheel wide tyre, T = twin wheels (tyres), e.g. 12W = 12 t on a single wheel wide tyre axle**

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DG/TREN study on LHV - questionnaire

Personal Identification

The personal data will remain confidential, and the answers to the questionnaire anonymous, but the analysis will take into account the origins of the answers in order to balance the different types of stakeholders or group of common interest.

Title (Mr / Mrs / Ms / Dr)

Family/ Last Name **Given/ First Name** **Middle Name**

Organisation/Affiliation

Position

Type of organisation/field of activity (Carrier, Shipper, Logistician, Consultant, Governmental organization, Association, Manufacturer, Researcher, Union, Road Agency or Operator, Road User, Other)

Address **City** **Zip code** **Country**

Telephone **Fax** **Mobile** **Email**

Password

Statement

Depending on your job, activity, position, interest and background, you may answer only to some of the following questions. Please concentrate on the most relevant questions in your field of expertise.

DG/TREN study on LHV - questionnaire

1. Economic, demand, logistics, intermodality

1.1 Transport demand and cost

1.1.1 Would the LHV change the road transport cost for any given amount of transported goods ?
a. no b. yes, increasing it c. yes, reducing it by less than 5% d. yes, reducing it by 5 to 10% f. yes, reducing it by 10 to 15% g. yes, reducing it by more than 15%

1.1.2 If the road transport cost is reduced using LHV (1.1.1 c to g), would the saving come from:
a. personal cost reduction b. energy saving c. a more efficient organisation
d. a lower vehicle investment and maintenance cost e. other (*to be specified*)

1.1.3 If the road transport cost is increased using LHV (1.1.1 b), would the extra cost come from:
a. a personal cost increase b. heavier investments and fleet renewal c. insurance
d. a non optimal use of the LHV e. some expected taxes on LHV f. other (*to be specified*)

1.1.4 Would the introduction of LHV influence road freight transport demand over 5 years:
a. no b. yes, decreasing it. c. yes, increasing it by 10% (more than the natural growth) or less c. yes, increasing it by 10-15% d. increasing it by more than 20%

1.1.5 If yes (1.1.4 b to d), would the additional demand be carried by:
a. the same number of lorries incl. LHV b. less lorries but a high proportion of LHV
c. more lorries
If c. which growth would you expect for the traffic of lorries (in %) :.........................

1.1.6 Without LHVs, if the freight demand increases (e.g. by 30%) over 10 to 15 years, to which proportion will each mode absorb this growth?
a. the growth will be refrained by a low increase of the capacity b. expected rail transport growth (in %) c. expected waterborne transport growth (in %) d. expected road transport growth (in %) e. expected growth for other modes (in %)
(*please check that the sum of the proportions equals 100%)*
Please comment ....

1.2 Fleet structure, transport types

1.2.1 For the following kinds of goods, to which extent would LHVs be efficient (1: no efficient, 2: efficient, 3: very efficient) ?
a. high (added) value freight b. heavy freight c. bulky freight d. container freight
e. palleted freight f. other (*to be specified*)

1.2.2 If you are a carrier, do you plan to buy and use LHV if (*you may choose several answers*):
a. international transport is permitted from door to door except in particular cases
b. international transport is permitted but not from door to door except in particular cases
c. only national transport is permitted from door to door except in particular cases
d. only national transport is permitted but not from door to door except in particular cases

1.2.3 Is the current situation satisfactory as regards road transport of 45' containers?
yes no
Please comment ....

1.2.4 Should the cross-border road traffic of 45' containers be uniformly allowed in the EU?
yes no
Please comment ....

1.2.5 Should the cross-border road traffic of 45' containers be authorized between member States on the basis of bilateral agreements ?
yes no Please comment: ....

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1.3 Trips, O/D, fleet management, supply chain

1.3.1 For each type of transport, could your rate the LHV's efficiency (1: no efficient, 2: efficient, 3: very efficient) ?

a. international b. national c. local d. within hinterland areas

1.3.2 For each distance, could you rate the LHV's efficiency (1: no efficient, 2: efficient, 3: very efficient) ?

a. very long distance (> 1200 km) b. long distance (> 500 km)
c. medium range (200-500 km) d. short distance (50-200 km)
e. very short distance (< 50 km)

1.3.3 Could you give the 3 Origin/Destination transport for which the LHV's would be he most efficient ?

From: a. sea harbours b. inland ports c. railway stations d. logistics centre
e. factories/commercial area f. other (*to be specified*)
To: a. sea harbours b. inland ports c. railway stations d. logistics centre
e. factories/commercial area f. other (*to be specified*)
1. O D (O and D chosen in the lists above)
2. O D (idem)
3. O D (idem)

1.3.4 Would the introduction of LHV in your company change your fleet management?

yes no
if yes, please explain how:………………..

1.3.5 Would the introduction of LHV in the carriers' fleets change your supply chain?

yes no if yes, explain how:………………..

1.4 Size, volume and weight challenges

1.4.1 Please tick the advantages and disadvantages of an increase of the vehicle permitted length and gross weight among the following lists:

Advantages	**Disadvantages**
A. lorry number reduction	a. difficulty to overtake the longer lorries
B. pollution reduction	b. pollution increase
C. congestion reduction	c. congestion increase
D. transport cost reduction	d. increased aggressivity for infrastructures
E. number of accidents reduction	e. increase of accident gravity
F. better punctuality	f. infrastructure modification needed
G. Other (*to be specified*)	g. Other (*to be specified*)

1.4.2 How would you describe the impact of increasing the vehicles' length as described in question 0 on your business ?

a. Very negative b. negative c. no impact d. positive e. very positive
Comment + justification : ….

1.4.3 How would you describe the impact of increasing the gross vehicle weight as described in question 0 on your business ?

a. Very negative b. negative c. no impact d. positive e. very positive
Comment + justification : ….

1.4.4 Scenarios on maximum weights and dimensions: with respect to your needs or concerns, which maximum limits would be the most suitable in a future European Directive?

a. max. length b. max. gross vehicle weight

Please comment/justify:………………

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1.5 Intermodality, modal transfer, competitiveness

1.5.1 Does your company have the choice of the transport mode ?
yes (go to 1.5.4) no (go to 1.5.2)

1.5.2 If not, please explain why?
a. It is the job of a subcontractor (logistician) b. An existing contract prevents my company to question the transport mode for a given time. c. For other reasons (please precise if possible): ......

1.5.3 In your company, are you involved in the choice of the transport mode ?
yes no

1.5.4 How would you rate the following criteria to choose a transport mode (1: no important, 2: important, 3: very important) ?
a. reliability b. punctuality c. speed d. security e. cost f. environment friendly g. quality of the relationship with the carrier h. other (*to be specified*)

1.5.5 Could you rate the different freight transport modes upon your needs (1: no efficient, 2: efficient, 3: very efficient) ?
a. air only b. rail only c. waterborne only d. short sea shipping only e. road only

1.5.6 Which mode combination among those listed in 1.5.5a to e would be the most efficient for your needs?

1.5.7 How does your company choose the transport mode(s)?
a. without thinking much about it (from the experience)
b. fare comparison once, at the beginning of the business
c. fare comparison, periodically
d. the lowest fare for each transport case
e. use of several modes to face possible breakdowns (e.g. strike, adverse weather conditions, technical breakdown...)
f. company policy based on .... (*to be specified*)
g. other criteria (e.g. environmental issues, etc.) (*to be specified*)

1.5.8 How would the introduction of the LHV affect your transport mode?
a. very negative b. negative c. no impact d. positive e. very positive
Please comment: ....

1.5.9 For which type of freight would the LHV compete with the combined transport?
a. none b. high (added) value freight c. heavy freight d. voluminous freight e. container freight f. palletized freight g. other (*to be specified*)

1.5.10 If the LHV are introduced, after 5 years how do you expect the modal shift :
a. no modal shift b. +5% by road c. +10% by road d. +15% by road e. +20% or more by road
and mainly from which mode(s) (*choose 3 with decreasing importance*)
(i) air (ii) rail (iii) waterborne (iv) short sea shipping

1.5.11 Would you be in favour of access limitation for LHV, and if yes why *(only motivated answers will be considered)*?
a. no limitation, except on the routes which may not be adapted to the traffic of LHVs because of the infrastructure characteristics
b. no access to the routes which are operated by other transport modes (e.g. railway or waterborne)
c. no access where a combined transport service exists
d. other (*to be specified*)
comment to support your answers:..................................

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2. Technology, design (trucks, tyres), engines

2.1 Engine power, body, wheels, suspensions...

2.1.1 Should longer and/or heavier vehicles be able to drive at a minimum speed ?
a. no b. yes if yes, which speed ? ....

2.1.2 For the following GVW, what would be the most appropriate LHVs motor power (in horsepower) ?
44t : ... 48t : ... 52t :... 55t:.......... 60t: ...

2.1.3 If heavier vehicles are allowed, should they be equipped with:
a. wide base tyres b. twin tyres c. regular tyres d. other *(to be specified)*

2.1.4 If heavier vehicles are allowed, should air suspensions be mandatory ?
a. yes b. no Please comment:

2.1.5 If longer vehicles are allowed, which are the most appropriate silhouettes among the followings:

List of proposed silhouettes……….

2.2 Safety and other on-board equipments

2.2.1 Should there be extended efforts on advanced safety features for LHV's?
a. no b. yes, on driving assistance systems c. yes, on collision mitigation
d. yes, on passive safety equipment
Comments:……………………………..

2.2.2 Should the following safety equipments be compulsory on LHV's?
a. ABS (Anti Blocking System) b. ESP (Electronic Stabilization Program)
c. EBS (Electronic Braking System) d. ECS (Electronic Control Suspension)
e. ASR (Anti Skid Regulation) f. ARS (Anti Rollover System)
g. Anti-collision radar h. Other (*to be specified*)

2.2.3 Which additional signs should be displayed by LHVs?
a. Warning signboard about the vehicle length : no/yes
b. Warning signboard about the vehicle gross vehicle weight : no/yes
c. warning signboard about the vehicle silhouette : no/yes
- other, please precise : ...

2.2.4 If heavier vehicles are allowed, should they be equipped with on-board load measuring systems ?
a. yes b. no

2.3 Vehicle checks and monitoring

2.3.1 Should all LHVs be tested with regards to their ability to drive in/on:
a. Roundabouts : no/yes
b. Slopes : no/yes
c. Railway crossings : no/yes
d. Wet and icy surfaces : no/yes
e. Turns to the right (to the left in IE and UK) : no/yes

2.3.2 Should LHVs be inspected on shorter intervals than the current trucks?
a. no b. yes if yes, please specify:………………

2.3.3 Which specific checks would you recommend for LHVs:
a. none b. Specify:……………………………………

2.3.4 Which LHV on-board equipment shall be controlled and with which period *(in months)* ?
a. The speed controller :.... b. The driving time controller :.....
c. The mass or impact force controller:……..

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2.3.5 How often should the information/data gathered on LHVs be transmitted/transferred ?
a. in real time b. after each journey c. weekly/monthly

2.3.6 If LHVs are authorized, the overload screening and load controls should:
a. be less than now b. be as now c. be increased (in space/time)

2.3.7 If LHVs are authorized, should WIM (weigh-in-motion) techniques be mandatory ?
a. no b. yes, but only for LHVs c. yes, for all trucks

2.4 Vehicle identification / communication

2.4.1 Should the LHV's drivers be continuously informed about:
a. the legal speed limit b. the road difficulties (width, clearance, skid resistance, weather conditions,…) c. load limitation (bridges, de-icing pavement,…)

2.4.2 Should the LHVs be continuously located/monitored?
a. no b. yes, everywhere c. yes, on dedicated parts of the network
if yes by: b1. a road operator/ traffic regulator/ public authorities b2. a fleet manager b3. other *(please specify)*

2.4.3 Should the LHV's be informed/monitored when:
a. approaching bridges b. approaching tunnels c. approaching railways intersection
d. approaching main road intersection e. entering or exiting highways or motorways
f. other situation *(please specify)*:……………………

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3. Environment, energy

3.1 General information

3.1.1 Your current fleet of vehicles *(for carriers, fleet managers)*:

a. Vehicle combinations : proportion of your fleet operating under the following forms (in %) :
- Single truck - unarticulated vehicle :
- Tractor + semi-trailer :
- Truck + trailer :
- Tractor + semi-trailer + trailer - EMS configuration :
- Truck + semi-trailer (with A dolly) - EMS configuration :

b. Average load factor of these truck(s) (in tonnes per vehicle) :
- Single truck : unarticulated vehicle
- Tractor + semi-trailer :
- Truck + trailer :
- Tractor + semi-trailer + trailer - EMS configuration :
- Truck + semi-trailer (with A dolly) - EMS configuration :
- overall (for the whole fleet) :

c. Average length of the trips performed with these vehicles (in kilometres) :
- Single truck : unarticulated vehicle
- Tractor + semi-trailer :
- Truck + trailer :
- Tractor + semi-trailer + trailer - EMS configuration :
- Truck + semi-trailer (with A dolly) - EMS configuration :
- overall (for the whole fleet) :

d. Average speed of the trips performed with these vehicles (in kilometres per hour):
- Single truck : unarticulated vehicle
- Tractor + semi-trailer :
- Truck + trailer :
- Tractor + semi-trailer + trailer - EMS configuration :
- Truck + semi-trailer (with A dolly) - EMS configuration :
- overall (for the whole fleet) :

e. Proportion of your fleet regarding each Euro class emissions (in %) :
- Euro O : - Euro I : - Euro II : - Euro III : - Euro IV : - Euro V :

3.1.2 Your ideal fleet of vehicles:

a. Vehicle combinations : proportion of your fleet operating under the following forms (in %) :
- Single truck - unarticulated vehicle :
- Tractor + semi-trailer : Preferred length: Preferred max. weight:
- Truck + trailer : Preferred length: Preferred max. weight:
- Tractor + semi-trailer + trailer (EMS) : Preferred length: Preferred max. weight:
- Truck + semi-trailer (with A dolly) (EMS) : Preferred length: Preferred max. weight:

b. Average load factor of these truck(s) (in tonnes per vehicle) :
- Single truck : unarticulated vehicle
- Tractor + semi-trailer :
- Truck + trailer :
- Tractor + semi-trailer + trailer - EMS configuration :
- Truck + semi-trailer (with A dolly) - EMS configuration :
- overall (for the whole fleet) :

c. Average length of the trips performed with these vehicles (in kilometres) :
- Single truck : unarticulated vehicle
- Tractor + semi-trailer :
- Truck + trailer :
- Tractor + semi-trailer + trailer - EMS configuration :

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- Truck + semi-trailer (with A dolly) - EMS configuration :
- overall (for the whole fleet) :

d. Average speed of the trips performed with these vehicles (in kilometres per hour):
- Single truck : unarticulated vehicle
- Tractor + semi-trailer :
- Truck + trailer :
- Tractor + semi-trailer + trailer - EMS configuration :
- Truck + semi-trailer (with A dolly) - EMS configuration :
- overall (for the whole fleet) :

e. Proportion of your fleet regarding each Euro class emissions (in %) :
- Euro O : - Euro I : - Euro II : - Euro III : - Euro IV : - Euro V :

3.2 Consumption and CO2

3.2.1 Current fuel consumption:
Average fuel consumption of your current vehicles (in litres per 100 km) :

3.2.2 How would the fuel consumption of your fleet be modified for the same amount of freight and mileage if using LHVs as described in 3.1.2a:
a. fuel consumption increased b. no change c. reduction by 5% c. reduction by 10%
d. reduction by 15% e. reduction by 20% or more

3.2.3 Which impact would have the additional maintenance or reinforcement of infrastructures (required by the LHVs) on the CO2 emissions?

3.3 Noxious and particulate emissions

3.3.1 Noxious emission:
Average NOx emission of your current vehicles - in mg per kWh :

3.3.2 How would the noxious emission of your fleet be modified for the same amount of freight and mileage if using LHVs as described in 3.1.2a:
a. increased b. no change c. reduction by 5% c. reduction by 10%
d. reduction by 15% e. reduction by 20% or more:

3.3.3 Particulate emission:
Average particulate emission of your current vehicles - in mg per kWh :

3.3.4 How would the particulate emission of your fleet be modified for the same amount of freight and mileage if using LHVs as described in 3.1.2a:
a. increased b. no change c. reduction by 5% c. reduction by 10%
d. reduction by 15% e. reduction by 20% or more:

3.4 Noise and vibrations

3.4.1 Which changes would you expect in noise emission if using LHVs as described in 3.1.2a:
a. reduction of noise b. no change c. increase of noise
Please justify:................................

3.4.2 Which time or space restrictions regarding LHVs traffic would you suggest in noise-sensitive areas (eg. urban areas, near hospitals, etc.) ?
a. no restriction b. restriction *(please specify)*:....................

3.4.3 Which changes would you expect in vibration induced if using LHVs as described in 3.1.2a:
a. reduction of vibrations b. no change c. increase of vibrations
Please justify:................................

3.4.4 Which space restrictions regarding LHVs traffic would you suggest in vibration-sensitive areas (eg. urban areas, near hospitals, etc.) ?
a. no restriction b. restriction *(please specify)*:....................

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4. Infrastructures

4.1 Bridge: (extreme) load capacity, fatigue

4.1.1 Can a bridge which has currently no weight limitation, accept the traffic of LHV?
Please complete the 2 tables below, on load capacity and fatigue resistance.
a. yes b. yes with counter measures (e.g. speed limitation, minimum spacing, no overtaking, etc.) c. yes after reinforcement d. no e. Do not know

Load capacity (extreme load case)

		44 t	48 t	Vehicles of 25.25 m in length			Others (to be specified)
				50 t	55 t	60 t	
length	Short span						
	Medium span						
	Long span						
materials	Steel and composite						
	Reinforced and prestressed concrete						
	Masonry						

If 2, which counter measures would you suggest ?

and

Fatigue of steel and composite bridges

		44 t	48 t	Vehicles of 25.25 m in length			Others (to be specified)
				50 t	55 t	60 t	
Longitudinal direction	Steel orthotropic deck						
	Composite bridges						
	Other bridges (please specify)						
Transversal and local							

If 2, which counter measures would you suggest ?

4.1.2 For a bridge without load limitation, would LHV traffic induce an increase of the maintenance costs?
Please complete the table below.
a. yes (give an indication on the expected cost increase in %) b. no c. Do not know

		44 t	48 t	Vehicles of 25.25 m in length			Others (to be specified)
				50 t	55 t	60 t	
length	Short span						
	Medium span						
	Long span						
materials	Steel and composite						
	Reinforced and prestressed concrete						
	Masonry						

4.1.3 Which other critical consequences would have the traffic of LHV on bridges?
a. Consequences on safety barriers b. Consequences on bridge dynamics
c. . Infrastructure lifespan d. Other (*to be specified*) e. Do not know
Comments:…………………………..

4.2 Pavement: rutting, fatigue/cracking, wear

4.2.1 Do you assess the heavy vehicle aggressivity on pavements?
a. no b. yes, using a standard c. yes, using axle loads d. yes, using strains or stresses e. other (please specify)
Comment:

4.2.2 Which data are currently available to you to design new of reinforced pavement structures?
a. Lorry n° by visual counting b. Lorry n° by automated counting using length
c. Lorry n° by automated counting using weight d. Lorry n° estimated in the total traffic flow
e. Other (Please specify):

4.2.3 Will LHV up to a gross weight of 55 or 60 tons and a total length up to 25.25m, but axle loads no more than 8 or 9 tons, increase the:
a. pavement rutting b. pavement polishing c. pavement cracking
d. nothing g. other (*to be specified*) h. Do not know

4.2.4 Will LHVs increase the pavement maintenance costs ?
a. yes (give an indication on the expected cost increase in %) b. no
c. Do not know

4.2.5 What would you suggest to maintain the impacts on pavements of LHVs up to 60t and 25,25m at the current level?

4.2.6 What would be mainly modified in the pavement design and maintenance if the LHVs are authorised in the EU member countries?

4.3 Roundabouts, curves, parking lots, toll booths

4.3.1 Would you find it necessary to up-grade some road facilities to operate LHV as described in 4.2.1 ?
a. no b. parking lots c. toll booths d. Roundabouts e. slow vehicles dedicated lanes f. exits and entrances (to motorways and freeways) g. gas stations
h. Other (*to be specified*)

4.3.2 Who should pay for these up-grades?
a. the citizen (taxes) b. all the road users c. the lorry users d. the LHV users
e. others (*please specify*) : ....

4.4 Safety equipments: barriers, signs and marks

4.4.1 If LHV as described in 4.2.1 are permitted on some road networks would you suggest to modify the following safety equipments?
a. none b. safety barriers c. road vertical signs d. road marks e. emergency lanes
f. emergency parking lots g. road lighting h. Other (*to be specified*)
If b. to h. are marked, please give more comments if needed:................................

5. Safety and operation (users)

5.1 Speed limit, congestion

5.1.1 Which speed limit should apply to LHV?
a. the same as for current lorries b. 10 km/h lower than the 40 t lorries c. 20 km/h lower than the 40 t lorries d. a variable speed limit (e.g. depending on the traffic conditions, weather conditions, road section, or vehicle length and weight…) e. Other (*to be specified*)

5.1.2 A specific LHV speed limit should be applied if:
a. no specific speed limit for LHV b. the vehicle length exceeds 18.75 m c. the gross weight exceeds 40 t d. the gross weight exceeds 44 t e. both the vehicle length and the gross weight exceed the precedent limits e. Other (*to be specified*)

5.1.3 In congested traffic and/or peak hours, the LHV should have:
a. no restriction b. some route restrictions c. some overtaking restrictions d. the obligation to stop on rest area e. Other (*to be specified*)

5.2 Spacing, overtaking, lane allocation

5.2.1 Which spacing would you recommend to LHV?
a. as for current lorries b. An increased spacing c. Other (*to be specified*)

5.2.2 How to reduce the difficulties concerning the overtaking of LHVs by the other road users if any ?
a. nothing to do b. to impose a lower speed to the LHVs c. to impose an increased spacing to the LHVs e. to impose a lower speed and an increased spacing to the LHVs f. to have overtaking lanes on the itineraries dedicated to LHV g. Other (*to be specified*)

5.2.3 Which overtaking rules should be applied to the LHV longer than 20m?
a. no specific rules (as for all lorries) b. no overtaking allowed (except in very special cases) c. overtaking restricted in some specific road sections d. Other (*to be specified*)

5.2.4 Which lane allocation should be made for the LHV longer than 20m?
a. no lane allocation (as for regular lorries) b. the slow lane only (but in specific overtaking areas) c. a dedicated marked lane d. Other (*to be specified*)

5.3 Routing (limitations): roads, period of time, etc.

5.3.1 Which time-of-the-day limitation would you recommend for LHV operation?
a. none b. permitted only at night c. permitted only at day d. forbidden during peak hours e. Other (*to be specified*)

5.3.2 Which spacing limitation would you recommend for LHV operation?
a. none b. permitted only on motorways c. permitted only on motorways and main highways d. permitted only on dedicated roads e. forbidden in urban centres f. forbidden in urban areas g. forbidden on winding or sloping roads h. Other (*to be specified*)

5.4 Meteo: winter operation, rain, fog & visibility

5.4.1 Which measures would you recommend for LHV operation under adverse weather or visibility conditions?
a. stopping all traffic b. speed reduction c. increased spacing d. operation with special signs (e.g. flashing lights, special coloured lights, etc.) e. operation under full monitoring f. Other (*to be specified*)

5.4.2 Would you recommend some specific instructions to the LHV drivers in case of adverse weather conditions?
a. yes b. no
If yes which ones: ……………………………

6. Driver training and control

6.1 Special training and driving license

6.1.1 Do you already operate LHV?
a. no b. yes
if yes, what is the proportion of your drivers who can drive LHV: .....%

6.1.2 Would you require from LHV drivers to get a special training ?
a. yes b. no

6.1.3 Would you pay more attention or give special instructions to the LHV drivers?
a. yes b. no

6.1.4 Would you modify the transport plan (routing, schedule, etc.) if using LHV?
a. yes b. no
if yes how:..

6.1.5 For road carriers only: which drivers would you choose to drive LHV in your company?
a. all trained drivers b. the most experienced drivers c. the safest drivers d. no specific criteria e: the holders of a specific safety certificate f : the holders of a specific driving license , g : other, please specify :

6.1.6 If a specific safety certificate is delivered to enable the driving of LHVs, should this certificate be :
a. time-limited b. permanent

6.2 Health control

6.2.1 How often should the health control of LHV's driver be performed ?
a. as today b. every 5 years c. every 2 years d. every year
e. more than every year

7. Miscellaneous

7.1 Performance based standard (PBS)

Would you be in favour of a future Directive based on a PBS approach ? yes/no

Please justify:...........................

7.2 Additional comments

....

Annex 5: Safety calculation tables

Costs mentioned in this annex are very detailed. Due to the amount of uncertainty attached to them, they have not been processed as such in the final CBA. However, they are displayed here as they are to provide a link between input of the safety cost calculations and the final numbers shown in chapter VIII.

Table 94: Safety costs scenario 1 details - standard risk factors

	all roads		motorways only		metropolitan / other urban	
	vkm [Mio €]	tkm [Mio €]	vkm [Mio €]	tkm [Mio €]	vkm [Mio €]	tkm [Mio €]
AT	415.659	273.417	211.572	161.871	2.528	1.149
BE	789.623	582.401	456.675	374.956	57.711	29.080
BG	321.519	213.905	91.162	69.747	5.798	2.635
CZ	985.588	582.179	211.939	162.152	39.823	18.098
DE	5 996.673	3 356.576	4 382.490	2 659.719	60.257	21.723
DK	256.535	168.251	138.759	106.163	25.953	11.795
EE	156.311	65.495	7.842	4.502	0.254	0.087
ES	5 207.883	3 217.761	1 697.809	1 298.972	40.084	18.217
FI	335.780	206.843	62.310	50.971	2.860	1.300
FR	4 874.224	2 560.227	2 636.937	1 593.812	22.397	8.041
GR	401.995	260.623	194.759	149.008	20.281	9.217
HU	430.061	258.880	110.329	84.412	7.017	3.189
IE	208.885	114.567	5.985	4.579	12.271	5.577
IT	2 453.293	1 710.706	1 695.693	1 297.353	17.131	7.785
LT	281.986	142.392	14.148	9.787	0.459	0.189
LU	49.868	27.340	10.678	8.170	24.611	11.185
LV	171.059	90.966	8.582	6.252	0.278	0.120
NL	656.660	442.697	384.020	293.809	4.728	2.149
PL	2 323.997	1 297.885	116.598	89.208	3.782	1.719
PT	222.767	144.318	104.628	80.050	4.695	2.134
RO	1 111.118	668.849	285.050	218.088	18.128	8.239
SE	464.720	310.075	178.345	147.203	2.150	0.977
SI	103.573	61.694	22.841	17.475	0.000	0.000
SK	1 017.246	298.005	34.911	14.019	0.216	0.038
UK	2 683.256	1 306.648	885.634	537.658	165.817	59.796
	31 920.279	**18 362.699**	**13 949.698**	**9 439.935**	**539.228**	**224.438**

Table 95: Safety costs scenario 1 details - reduced risk factors (30% lower)

	all roads		motorways only		metropolitan / other urban	
	vkm [Mio €]	tkm [Mio €]	vkm [Mio €]	tkm [Mio €]	vkm [Mio €]	tkm [Mio €]
AT	415.659	273.417	211.572	161.871	2.528	1.149
BE	789.623	582.401	456.675	374.956	57.711	29.080
BG	321.519	213.905	91.162	69.747	5.798	2.635
CZ	985.588	582.179	211.939	162.152	39.823	18.098
DE	5 996.673	3 356.576	4 382.490	2 659.719	60.257	21.723
DK	256.535	168.251	138.759	106.163	25.953	11.795
EE	156.311	65.495	7.842	4.502	0.254	0.087
ES	5 207.883	3 217.761	1 697.809	1 298.972	40.084	18.217
FI	322.085	183.634	57.900	43.829	2.860	1.300
FR	4 874.224	2 560.227	2 636.937	1 593.812	22.397	8.041
GR	401.995	260.623	194.759	149.008	20.281	9.217

	all roads		motorways only		metropolitan / other urban	
	vkm [Mio €]	tkm [Mio €]	vkm [Mio €]	tkm [Mio €]	vkm [Mio €]	tkm [Mio €]
HU	430.061	258.880	110.329	84.412	7.017	3.189
IE	208.885	114.567	5.985	4.579	12.271	5.577
IT	2 453.293	1 710.706	1 695.693	1 297.353	17.131	7.785
LT	281.986	142.392	14.148	9.787	0.459	0.189
LU	49.868	27.340	10.678	8.170	24.611	11.185
LV	171.059	90.966	8.582	6.252	0.278	0.120
NL	656.660	442.697	384.020	293.809	4.728	2.149
PL	2 323.997	1 297.885	116.598	89.208	3.782	1.719
PT	222.767	144.318	104.628	80.050	4.695	2.134
RO	1 111.118	668.849	285.050	218.088	18.128	8.239
SE	443.321	273.041	166.592	126.864	2.150	0.977
SI	103.573	61.694	22.841	17.475	0.000	0.000
SK	1 017.246	298.005	34.911	14.019	0.216	0.038
UK	2 683.256	1 306.648	885.634	537.658	165.817	59.796
	31 885.185	**18 302.456**	**13 933.535**	**9 412.454**	**539.228**	**224.438**

Table 96: Safety costs scenario 2 details - standard risk factors

	all roads		motorways only		metropolitan / other urban	
	vkm [Mio €]	tkm [Mio €]	vkm [Mio €]	tkm [Mio €]	vkm [Mio €]	tkm [Mio €]
AT	403.465	269.183	199.375	157.634	2.530	1.152
BE	726.568	566.691	409.060	361.157	57.891	29.259
BG	340.378	209.738	85.164	67.459	5.799	2.637
CZ	955.417	575.233	199.913	157.873	39.872	18.155
DE	5691.187	3275.023	4114.778	2584.286	60.323	21.784
DK	245.519	164.564	130.201	102.970	25.953	11.795
EE	150.719	65.208	7.542	4.419	0.254	0.087
ES	4908.721	3128.582	1542.257	1240.902	40.108	18.245
FI	336.274	209.034	61.734	51.532	2.867	1.307
FR	4580.190	2487.031	2425.182	1532.993	22.426	8.068
GR	369.123	249.177	171.816	139.882	20.283	9.219
HU	412.042	253.819	102.455	81.428	7.024	3.197
IE	208.383	114.379	5.484	4.392	12.271	5.577
IT	2284.532	1652.556	1552.405	1244.493	17.136	7.791
LT	272.771	141.103	13.252	9.489	0.460	0.189
LU	48.663	27.009	9.914	7.898	24.608	11.182
LV	165.082	90.326	7.944	6.068	0.279	0.121
NL	626.260	434.091	360.363	286.191	4.746	2.170
PL	2233.671	1281.500	106.968	85.967	3.782	1.719
PT	211.676	140.790	97.208	77.240	4.695	2.134
RO	1062.852	655.941	267.543	211.068	18.136	8.248
SE	465.823	311.748	178.940	148.103	2.154	0.982
SI	99.489	60.657	21.266	16.900	0.000	0.000
SK	1006.367	296.179	34.749	13.961	0.216	0.038
UK	2624.217	1288.338	826.570	519.323	165.843	59.820
	30429.390	**17947.899**	**12932.082**	**9113.629**	**539.656**	**224.875**

Table 97: Safety costs scenario 2 details - reduced risk factors (30% lower)

	all roads		motorways only		metropolitan / other urban	
	vkm [Mio €]	tkm [Mio €]	vkm [Mio €]	tkm [Mio €]	vkm [Mio €]	tkm [Mio €]
AT	398.270	260.192	194.180	148.643	2.530	1.152
BE	697.822	524.009	388.536	330.685	57.891	29.259
BG	333.460	197.765	82.717	63.223	5.799	2.637
CZ	940.222	549.215	194.843	149.099	39.872	18.155
DE	5559.320	3093.995	4001.840	2429.244	60.323	21.784
DK	240.754	156.316	126.671	96.861	25.953	11.795
EE	147.517	61.051	7.417	4.257	0.254	0.087
ES	4769.001	2889.377	1478.113	1129.892	40.108	18.245
FI	322.590	185.351	57.538	44.270	2.867	1.307
FR	4449.959	2308.979	2336.778	1412.127	22.426	8.068
GR	355.134	224.967	162.648	124.017	20.283	9.219
HU	403.738	239.447	99.230	75.848	7.024	3.197
IE	208.177	114.021	5.277	4.034	12.271	5.577
IT	2212.395	1527.713	1492.986	1141.661	17.136	7.791
LT	267.913	133.502	12.879	8.907	0.460	0.189
LU	48.103	26.041	9.591	7.340	24.608	11.182
LV	161.799	84.916	7.658	5.596	0.279	0.121
NL	612.285	409.905	349.971	268.206	4.746	2.170
PL	2187.325	1201.293	102.812	78.773	3.782	1.719
PT	206.781	132.319	94.169	71.981	4.695	2.134
RO	1040.267	616.854	260.578	199.014	18.136	8.248
SE	444.217	274.356	167.077	127.573	2.154	0.982
SI	97.549	57.300	20.609	15.764	0.000	0.000
SK	1000.708	286.385	34.681	13.844	0.216	0.038
UK	2600.416	1255.652	802.768	486.638	165.843	59.820
	29705.721	**16810.921**	**12491.568**	**8437.494**	**539.656**	**224.875**

Table 98: Safety costs scenario 3 details - standard risk factors

	all roads		motorways only		metropolitan / other urban	
	vkm [Mio €]	tkm [Mio €]	vkm [Mio €]	tkm [Mio €]	vkm [Mio €]	tkm [Mio €]
AT	415.458	273.386	211.372	161.840	2.527	1.149
BE	757.357	574.903	434.318	368.582	57.878	29.246
BG	355.132	213.871	91.076	69.733	5.796	2.635
CZ	984.996	582.090	211.738	162.120	39.810	18.096
DE	5829.739	3310.491	4216.362	2613.822	60.308	21.770
DK	252.036	166.836	135.222	104.907	25.953	11.795
EE	155.894	65.489	7.692	4.503	0.252	0.087
ES	5204.563	3217.244	1696.203	1298.722	40.071	18.215
FI	338.540	212.995	64.103	55.649	2.867	1.308
FR	4870.199	2559.801	2634.149	1593.514	22.357	8.041
GR	401.713	260.579	194.575	148.979	20.275	9.216
HU	429.801	258.839	110.225	84.395	7.014	3.188
IE	208.879	114.566	5.980	4.579	12.271	5.577
IT	2451.320	1710.398	1694.088	1297.103	17.125	7.785
LT	281.731	142.374	14.134	9.785	0.459	0.189
LU	49.543	27.338	10.623	8.169	24.356	11.184
LV	170.893	90.954	8.567	6.251	0.278	0.120
NL	631.472	435.959	364.704	287.845	4.745	2.168

	all roads		motorways only		metropolitan / other urban	
	vkm [Mio €]	tkm [Mio €]	vkm [Mio €]	tkm [Mio €]	vkm [Mio €]	tkm [Mio €]
PL	2322.720	1297.701	116.487	89.190	3.782	1.719
PT	222.612	144.294	104.529	80.034	4.695	2.134
RO	1110.447	668.745	284.780	218.046	18.122	8.238
SE	465.801	324.979	178.925	161.344	2.154	0.982
SI	103.512	61.684	22.820	17.472	0.000	0.000
SK	1017.106	297.983	34.909	14.019	0.216	0.038
UK	2682.364	1306.538	884.796	537.554	165.764	59.790
	31713.828	**18320.037**	**13732.377**	**9398.159**	**539.075**	**224.669**

Table 99: Safety costs scenario 3 details - reduced risk factors (-30%)

	all roads		motorways only		metropolitan / other urban	
	vkm [Mio €]	tkm [Mio €]	vkm [Mio €]	tkm [Mio €]	vkm [Mio €]	tkm [Mio €]
AT	415.458	273.386	211.372	161.840	2.527	1.149
BE	742.316	552.570	424.618	354.179	57.878	29.246
BG	355.132	213.871	91.076	69.733	5.796	2.635
CZ	984.996	582.090	211.738	162.120	39.810	18.096
DE	5758.685	3212.948	4145.675	2516.782	60.308	21.770
DK	250.041	163.384	133.729	102.324	25.953	11.795
EE	155.894	65.489	7.692	4.503	0.252	0.087
ES	5204.563	3217.244	1696.203	1298.722	40.071	18.215
FI	324.156	188.100	59.187	47.141	2.867	1.308
FR	4870.199	2559.801	2634.149	1593.514	22.357	8.041
GR	401.713	260.579	194.575	148.979	20.275	9.216
HU	429.801	258.839	110.225	84.395	7.014	3.188
IE	208.879	114.566	5.980	4.579	12.271	5.577
IT	2451.320	1710.398	1694.088	1297.103	17.125	7.785
LT	281.731	142.374	14.134	9.785	0.459	0.189
LU	49.543	27.338	10.623	8.169	24.356	11.184
LV	170.893	90.954	8.567	6.251	0.278	0.120
NL	619.686	415.563	356.085	272.928	4.745	2.168
PL	2322.720	1297.701	116.487	89.190	3.782	1.719
PT	222.612	144.294	104.529	80.034	4.695	2.134
RO	1110.447	668.745	284.780	218.046	18.122	8.238
SE	444.199	283.615	167.065	136.840	2.154	0.982
SI	103.512	61.684	22.820	17.472	0.000	0.000
SK	1017.106	297.983	34.909	14.019	0.216	0.038
UK	2682.364	1306.538	884.796	537.554	165.764	59.790
	31577.966	**18110.054**	**13625.101**	**9236.202**	**539.075**	**224.669**

Table 100: Safety costs scenario 4 details - standard risk factors

	all roads		motorways only		metropolitan / other urban	
	vkm [Mio €]	tkm [Mio €]	vkm [Mio €]	tkm [Mio €]	vkm [Mio €]	tkm [Mio €]
AT	409.821	268.832	205.745	157.290	2.516	1.145
BE	751.229	558.041	426.898	354.855	57.127	28.917
BG	350.237	210.358	89.095	68.090	5.762	2.623
CZ	970.507	572.239	206.021	157.488	39.605	18.020
DE	5836.709	3257.585	4233.311	2565.913	59.849	21.589
DK	252.264	165.005	135.309	103.421	25.953	11.795

	all roads		motorways only		metropolitan / other urban	
	vkm [Mio €]	tkm [Mio €]	vkm [Mio €]	tkm [Mio €]	vkm [Mio €]	tkm [Mio €]
EE	154.252	64.651	7.812	4.485	0.254	0.087
ES	5042.432	3097.928	1605.401	1224.910	39.685	18.045
FI	332.460	206.687	60.475	50.408	2.835	2.197
FR	4709.762	2463.016	2517.308	1518.453	22.205	7.990
GR	383.450	246.580	181.470	138.255	20.039	9.128
HU	420.223	251.965	105.856	80.823	6.966	3.173
IE	208.525	114.279	5.625	4.292	12.271	5.577
IT	2347.504	1628.628	1604.578	1224.440	16.936	7.696
LT	278.933	140.742	13.817	9.550	0.457	0.188
LU	49.108	26.797	10.213	7.801	24.610	11.184
LV	168.907	89.775	8.314	6.055	0.277	0.120
NL	639.000	429.582	369.504	282.524	4.698	2.144
PL	2275.781	1267.492	110.112	84.090	3.782	1.719
PT	216.306	139.501	100.130	76.444	4.695	2.134
RO	1094.732	657.740	279.652	213.711	18.015	8.200
SE	460.746	312.259	176.077	145.537	2.136	5.698
SI	101.977	60.604	22.177	16.950	0.000	0.000
SK	1011.364	294.436	34.814	13.942	0.216	0.038
UK	2640.295	1279.498	843.715	510.846	164.775	59.458
	31106.524	**17804.219**	**13353.433**	**9020.573**	**535.664**	**228.863**

Table 101: Safety costs scenario 4 details - reduced risk factors (30% lower)

	all roads		motorways only		metropolitan / other urban	
	vkm [Mio €]	tkm [Mio €]	vkm [Mio €]	tkm [Mio €]	vkm [Mio €]	tkm [Mio €]
AT	403.878	261.289	199.828	149.780	2.491	1.112
BE	707.344	510.257	396.703	321.976	55.803	27.475
BG	343.764	202.143	87.082	65.536	5.684	2.523
CZ	949.966	546.170	200.038	149.895	39.130	17.417
DE	5671.574	3091.340	4084.423	2416.025	59.022	20.756
DK	247.619	159.110	131.884	99.074	25.953	11.795
EE	150.814	61.377	7.779	4.453	0.254	0.086
ES	4846.454	2849.206	1515.378	1110.659	38.894	17.041
FI	314.889	178.148	55.200	41.795	2.762	2.104
FR	4525.678	2278.451	2399.437	1400.274	21.772	7.557
GR	363.148	220.815	168.803	122.178	19.514	8.463
HU	407.999	236.450	101.507	75.303	6.849	3.024
IE	208.170	113.829	5.270	3.842	12.271	5.577
IT	2237.063	1488.465	1515.506	1111.396	16.563	7.223
LT	274.265	135.385	13.488	9.172	0.451	0.182
LU	48.187	25.628	9.751	7.214	24.610	11.184
LV	165.521	85.682	8.032	5.714	0.274	0.117
NL	618.964	404.154	354.413	263.370	4.618	2.042
PL	2206.329	1179.348	103.573	75.792	3.782	1.719
PT	209.030	130.267	95.750	70.885	4.695	2.134
RO	1073.254	630.482	274.533	207.214	17.765	7.882
SE	434.099	268.524	161.892	122.090	2.105	5.658
SI	99.906	57.975	21.512	16.106	0.000	0.000
SK	1002.515	283.204	34.718	13.820	0.216	0.038
UK	2597.857	1236.761	803.404	470.251	162.649	57.316
	30108.288	**16634.463**	**12749.903**	**8333.813**	**528.127**	**220.426**

Annex 6: Emission calculation tables

Table 102: Scenario 2 NOx and PM transport emissions

Country	Truck type	NOx exhaust emissions (tonne)	PM exhaust emissions (tonne)	PM Non-exhaust emissions (tonne)
AT	HDT4	5607	76.23	55.02
BE	HDT4	10750	109.42	152.96
BG	HDT4	3282	46.15	31.11
CZ	HDT4	10636	177.82	93.14
DE	HDT4	75265	1031.54	776.76
DK	HDT4	2522	27.47	29.59
EE	HDT4	965	14.41	10.59
ES	HDT4	41255	554.80	394.06
FI	HDT4	1359	20.47	13.07
FR	HDT4	39967	473.32	474.29
GR	HDT4	3039	48.39	26.43
HU	HDT4	4177	72.05	37.81
IE	HDT4	3246	58.60	23.30
IT	HDT4	23540	299.95	256.49
LT	HDT4	2024	29.07	21.04
LU	HDT4	414	5.11	4.32
LV	HDT4	1170	16.71	12.02
NL	HDT4	6957	79.85	77.25
PL	HDT4	17416	277.02	155.98
PT	HDT4	2497	45.19	22.74
RO	HDT4	10133	145.14	95.00
SE	HDT4	2179	28.27	21.21
SI	HDT4	1327	25.40	9.00
SK	HDT4	2234	31.84	17.79
UK	HDT4	23242	232.85	324.09
AT	HDT6	1066	12.54	9.95
BE	HDT6	4726	43.28	53.83
BG	HDT6	1796	24.00	12.59
CZ	HDT6	4184	66.47	27.32
DE	HDT6	31025	414.18	249.71
DK	HDT6	983	9.71	8.92
EE	HDT6	684	9.73	5.67
ES	HDT6	35423	444.50	253.73
FI	HDT6	3405	47.42	24.39
FR	HDT6	26445	296.49	243.21
GR	HDT6	3924	58.70	26.08
HU	HDT6	2231	36.52	15.15
IE	HDT6	55	0.82	0.40
IT	HDT6	15891	192.21	136.26
LT	HDT6	1098	14.92	8.64
LU	HDT6	133	1.52	1.04
LV	HDT6	751	10.14	5.84
NL	HDT6	3082	31.58	26.16
PL	HDT6	12372	185.40	82.51

Country	Truck type	NOx exhaust emissions (tonne)	PM exhaust emissions (tonne)	PM Non-exhaust emissions (tonne)
PT	HDT6	1307	22.87	9.10
RO	HDT6	6064	83.03	40.94
SE	HDT6	5442	65.81	39.94
SI	HDT6	695	12.71	3.52
SK	HDT6	1672	23.02	10.01
UK	HDT6	3937	34.42	45.58
TOTAL		**463593**	**6069.03**	**4475.55**

Table 103: Scenario 2 NOx and PM well-to-tank emissions

Country	Truck type	NOx well-to-tank (tonne)	PM well-to-tank (tonne)
AT	HDT4	821	126.78
BE	HDT4	1955	302.11
BG	HDT4	457	70.68
CZ	HDT4	1379	213.03
DE	HDT4	9542	1474.33
DK	HDT4	416	64.27
EE	HDT4	136	21.04
ES	HDT4	6086	940.36
FI	HDT4	219	33.81
FR	HDT4	5876	907.92
GR	HDT4	406	62.73
HU	HDT4	563	87.06
IE	HDT4	416	64.22
IT	HDT4	3429	529.89
LT	HDT4	282	43.61
LU	HDT4	66	10.16
LV	HDT4	163	25.24
NL	HDT4	1173	181.28
PL	HDT4	2337	361.13
PT	HDT4	331	51.21
RO	HDT4	1386	214.09
SE	HDT4	318	49.06
SI	HDT4	161	24.86
SK	HDT4	249	38.53
UK	HDT4	4144	640.35
AT	HDT6	156	24.07
BE	HDT6	869	134.20
BG	HDT6	254	39.28
CZ	HDT6	549	84.82
DE	HDT6	3985	615.70
DK	HDT6	164	25.34
EE	HDT6	98	15.11
ES	HDT6	5289	817.27
FI	HDT6	554	85.59
FR	HDT6	3943	609.27
GR	HDT6	529	81.72
HU	HDT6	304	46.95
IE	HDT6	7	1.07
IT	HDT6	2339	361.34
LT	HDT6	155	24.02

Country	Truck type	NOx well-to-tank (tonne)	PM well-to-tank (tonne)
LU	HDT6	21	3.31
LV	HDT6	107	16.46
NL	HDT6	526	81.27
PL	HDT6	1683	260.06
PT	HDT6	175	27.02
RO	HDT6	843	130.22
SE	HDT6	803	124.03
SI	HDT6	85	13.09
SK	HDT6	190	29.37
UK	HDT6	709	109.50
TOTAL		**66647**	**10297.81**

Table 104: Scenario 3 NOx and PM transport emissions

Country	Truck type	NOx exhaust emissions (tonne)	PM exhaust emissions (tonne)	PM Non-exhaust emissions (tonne)
AT	HDT4	6811	90.72	69.42
BE	HDT4	13267	133.97	190.53
BG	HDT4	5279	74.42	49.69
CZ	HDT4	15159	253.56	132.55
DE	HDT4	91686	1257.47	944.42
DK	HDT4	3173	34.48	37.33
EE	HDT4	1690	25.27	18.38
ES	HDT4	80506	1082.88	768.20
FI	HDT4	1355	20.42	13.04
FR	HDT4	69954	828.10	830.03
GR	HDT4	7441	117.71	65.35
HU	HDT4	6646	114.65	60.14
IE	HDT4	3307	59.54	23.88
IT	HDT4	41578	527.11	456.56
LT	HDT4	3219	46.21	33.39
LU	HDT4	546	6.74	5.67
LV	HDT4	1972	28.16	20.25
NL	HDT4	7486	85.70	83.39
PL	HDT4	30775	489.38	275.62
PT	HDT4	3963	71.68	36.12
RO	HDT4	16850	242.90	155.37
SE	HDT4	2179	28.27	21.21
SI	HDT4	2086	39.91	14.16
SK	HDT4	4062	57.88	32.33
UK	HDT4	27794	276.00	391.63
BE	HDT6	2515	23.30	28.01
DE	HDT6	16636	221.59	136.01
DK	HDT6	410	4.04	3.74
FI	HDT6	3397	47.31	24.33
NL	HDT6	2612	26.87	22.04
SE	HDT6	5441	65.80	39.93
Total		479796	6382.03	4982.72

Table 105: Scenario 3 NOx and PM well-to-tank emissions

Country	Truck type	NOx well-to-tank (tonne)	PM well-to-tank (tonne)
AT	HDT4	994	153.57
BE	HDT4	2411	372.57
BG	HDT4	736	113.76
CZ	HDT4	1965	303.67
DE	HDT4	11625	1796.16
DK	HDT4	523	80.83
EE	HDT4	238	36.82
ES	HDT4	11878	1835.24
FI	HDT4	218	33.73
FR	HDT4	10285	1589.14
GR	HDT4	993	153.44
HU	HDT4	897	138.55
IE	HDT4	423	65.40
IT	HDT4	6054	935.43
LT	HDT4	449	69.36
LU	HDT4	87	13.43
LV	HDT4	275	42.56
NL	HDT4	1262	195.03
PL	HDT4	4130	638.19
PT	HDT4	526	81.27
RO	HDT4	2306	356.27
SE	HDT4	317	49.05
SI	HDT4	253	39.08
SK	HDT4	453	70.06
UK	HDT4	4952	765.15
BE	HDT6	463	71.55
DE	HDT6	2135	329.91
DK	HDT6	68	10.57
FI	HDT6	553	85.38
NL	HDT6	446	68.88
SE	HDT6	803	124.01
TOTAL		68720	10618.05

Table 106: Scenario 4 NOx and PM transport emissions

Country	Truck type	NOx exhaust emissions (tonne)	PM exhaust emissions (tonne)	PM Non-exhaust emissions (tonne)
AT	HDT4	5765	78.11	56.92
BE	HDT4	9807	99.31	140.28
BG	HDT4	3864	54.33	36.68
CZ	HDT4	10443	174.38	91.80
DE	HDT4	77028	1056.20	793.78
DK	HDT4	2816	30.62	33.11
EE	HDT4	1086	16.21	11.94
ES	HDT4	38443	516.67	367.62
FI	HDT4	495	7.40	4.83
FR	HDT4	37777	446.46	449.76
GR	HDT4	2616	41.23	23.13
HU	HDT4	3889	66.95	35.41
IE	HDT4	3227	58.32	23.13
IT	HDT4	20518	260.65	224.70
LT	HDT4	2345	33.68	24.37

Country	Truck type	NOx exhaust emissions (tonne)	PM exhaust emissions (tonne)	PM Non-exhaust emissions (tonne)
LU	HDT4	374	4.58	3.94
LV	HDT4	1336	19.08	13.73
NL	HDT4	6652	76.61	73.58
PL	HDT4	15519	246.94	138.83
PT	HDT4	2305	41.60	21.11
RO	HDT4	11976	171.44	112.48
SE	HDT4	1041	13.25	10.46
SI	HDT4	1471	28.11	10.01
SK	HDT4	1886	26.88	15.02
UK	HDT4	21650	217.11	301.47
AT	HDT5	1056	12.60	11.63
BE	HDT5	6298	60.75	83.70
BG	HDT5	1446	19.89	11.98
CZ	HDT5	4884	79.65	37.94
DE	HDT5	33493	452.77	320.77
DK	HDT5	822	8.48	8.88
EE	HDT5	633	9.26	6.21
ES	HDT5	42855	555.90	367.33
FI	HDT5	861	12.49	7.35
FR	HDT5	32247	372.34	350.20
GR	HDT5	4890	75.37	38.52
HU	HDT5	2814	47.33	22.71
IE	HDT5	80	1.22	0.69
IT	HDT5	21126	262.07	212.93
LT	HDT5	903	12.60	8.47
LU	HDT5	189	2.28	1.73
LV	HDT5	662	9.18	6.15
NL	HDT5	3755	40.16	38.36
PL	HDT5	15720	241.91	126.28
PT	HDT5	1678	29.96	13.80
RO	HDT5	4993	70.69	39.51
SE	HDT5	1138	14.44	9.67
SI	HDT5	634	11.88	3.83
SK	HDT5	2229	31.11	15.98
UK	HDT5	6104	56.21	82.57
FI	HDT6	3364	46.84	24.10
SE	HDT6	5412	65.45	39.72
TOTAL		**484615**	**6388.90**	**4909.09**

Table 107: Scenario 4 NOx PM well-to-tank emissions

Country	Truck type	NOx well-to-tank (tonne)	PM well-to-tank (tonne)
AT	HDT4	843	130.28
BE	HDT4	1783	275.47
BG	HDT4	539	83.23
CZ	HDT4	1353	209.13
DE	HDT4	9766	1508.96
DK	HDT4	464	71.74
EE	HDT4	153	23.68
ES	HDT4	5671	876.17
FI	HDT4	80	12.31

Country	Truck type	NOx well-to-tank (tonne)	PM well-to-tank (tonne)
FR	HDT4	5553	858.01
GR	HDT4	349	53.92
HU	HDT4	524	81.04
IE	HDT4	413	63.87
IT	HDT4	2988	461.70
LT	HDT4	327	50.53
LU	HDT4	59	9.17
LV	HDT4	187	28.82
NL	HDT4	1122	173.41
PL	HDT4	2083	321.81
PT	HDT4	306	47.24
RO	HDT4	1637	252.99
SE	HDT4	151	23.39
SI	HDT4	178	27.55
SK	HDT4	210	32.52
UK	HDT4	3861	596.55
AT	HDT5	153	23.70
BE	HDT5	1152	177.94
BG	HDT5	203	31.43
CZ	HDT5	638	98.55
DE	HDT5	4279	661.17
DK	HDT5	136	21.07
EE	HDT5	90	13.90
ES	HDT5	6364	983.38
FI	HDT5	140	21.56
FR	HDT5	4780	738.62
GR	HDT5	657	101.46
HU	HDT5	382	59.01
IE	HDT5	10	1.56
IT	HDT5	3096	478.43
LT	HDT5	127	19.61
LU	HDT5	30	4.69
LV	HDT5	93	14.41
NL	HDT5	636	98.30
PL	HDT5	2125	328.39
PT	HDT5	224	34.62
RO	HDT5	690	106.65
SE	HDT5	167	25.84
SI	HDT5	77	11.93
SK	HDT5	251	38.84
UK	HDT5	1092	168.80
FI	HDT6	547	84.54
SE	HDT6	798	123.37
TOTAL		**69543**	**10745.21**

Annex 7: Road tonne-kilometre volumes and traffic

The following table presents 2020 road transport volumes in ton-kilometres and traffic intensity in terms of vehicle-kilometres obtained from calculations of the TRANS-TOOLS model. Using RESPONSE™ model, we have translated ton volumes into ton-kilometres and have made a distinction between motorways (MW), rural roads (RR) and urban roads (UR). For each scenario we present data on for normal trucks (HGV) and for big vehicles (HGV). HGVs for Scenarios 2 and 3 are 25.25 metres long and 60 ton gross (max). Therefore, the reader has full information on volumes and traffic per scenario, per country, per vehicle type and per road type.

Table 108: Road tonne-km per country and road type, 2020

	Austria MW	Austria RR	Austria UR	Belgium MW	Belgium RR	Belgium UR
Scenario 1, tkm	73 804.5	0.0	220.2	95 791.7	7 094.9	497.3
Scenario 1, vkm	8 129.8	0.0	25.2	10 114.9	761.4	55.5
Scenario 2, tkm	74 478.3	0.0	221.6	96 964.7	7 167.8	502.8
Scenario 2, HGV vkm	5 613.8	0.0	17.1	6 517.2	511.9	39.6
Scenario 2, LHV vkm	1 719.2	0.0	5.5	2 472.8	170.7	11.0
Scenario 3, tkm	73 783.4	0.0	220.2	96 390.0	7 146.0	502.4
Scenario 3, HGV vkm	8 112.6	0.0	25.2	8 352.5	592.2	42.1
Scenario 3, LHV vkm	0.0	0.0	0.0	1 235.4	118.5	9.5
Scenario 4, tkm	74 111.6	0.0	220.9	96 369.3	7 132.5	500.1
Scenario 4, HGV vkm	5 565.4	0.0	17.6	5 973.2	462.7	36.6
Scenario 4, LHV vkm	2 395.3	0.0	7.1	3 827.0	276.1	17.7
	Bulgaria MW	**Bulgaria RR**	**Bulgaria UR**	**Czech RP MW**	**Czech RP RR**	**Czech RP UR**
Scenario 1, tkm	3 816.2	6 213.6	8.7	17 221.1	20 422.7	380.7
Scenario 1, vkm	407.9	663.8	0.9	1 886.6	2 261.3	42.3
Scenario 2, tkm	3 830.8	6 239.3	8.7	17 351.8	20 641.4	383.8
Scenario 2, HGV vkm	267.0	398.9	0.6	1 316.1	1 575.6	31.1
Scenario 2, LHV vkm	94.7	178.3	0.3	387.9	471.1	7.6
Scenario 3, tkm	3 815.1	6 211.8	8.7	17 216.2	20 416.9	380.6
Scenario 3, HGV vkm	407.0	662.4	0.9	1 882.6	2 256.3	42.2
Scenario 3, LHV vkm	0.0	0.0	0.0	0.0	0.0	0.0
Scenario 4, tkm	3 820.9	6 222.3	8.7	17 288.6	20 542.1	382.6
Scenario 4, HGV vkm	295.9	443.0	0.6	1 286.9	1 449.8	28.0
Scenario 4, LHV vkm	104.5	203.8	0.3	559.5	755.8	13.3
	Germany MW	**Germany RR**	**Germany UR**	**Denmark MW**	**Denmark RR**	**Denmark UR**
Scenario 1, tkm	624 382.0	7.1	2 770.3	7 439.6	658.3	0.0
Scenario 1, vkm	72 249.2	0.7	324.9	766.9	68.2	0.0
Scenario 2, tkm	629 530.0	7.1	2 790.6	7 468.7	661.1	0.0
Scenario 2, HGV vkm	48 654.4	0.5	217.7	517.8	47.3	0.0
Scenario 2, LHV vkm	16 067.2	0.1	72.7	167.3	14.0	0.0
Scenario 3, tkm	628 061.0	7.1	2 786.0	7 461.7	660.5	0.0
Scenario 3, HGV vkm	56 857.8	0.7	243.5	659.0	59.5	0.0
Scenario 3, LHV vkm	10 732.8	0.0	56.5	74.3	6.0	0.0
Scenario 4, tkm	626 700.0	7.1	2 779.8	7 451.1	659.5	0.0

Scenario 4, HGV vkm	46 368.1	0.6	204.6	542.8	48.7	0.0
Scenario 4, LHV vkm	23 959.3	0.2	111.0	208.5	18.1	0.0
	Estonia MW	**Estonia RR**	**Estonia UR**	**Spain MW**	**Spain RR**	**Spain UR**
Scenario 1, tkm	22.4	1 630.4	15.8	170 842.0	54 345.9	56.9
Scenario 1, vkm	2.4	166.5	1.7	20 047.3	6 366.8	6.4
Scenario 2, tkm	22.5	1 680.3	15.8	172 122.0	54 624.4	57.1
Scenario 2, HGV vkm	2.0	91.0	1.4	10 198.7	3 208.2	3.3
Scenario 2, LHV vkm	0.3	53.7	0.2	6 694.2	2 134.4	2.1
Scenario 3, tkm	22.4	1 630.0	15.8	170 794.0	54 330.4	56.8
Scenario 3, HGV vkm	2.3	165.3	1.6	20 004.8	6 353.3	6.4
Scenario 3, LHV vkm	0.0	0.0	0.0	0.0	0.0	0.0
Scenario 4, tkm	22.5	1 648.1	15.8	171 339.0	54 450.3	57.0
Scenario 4, HGV vkm	2.1	100.1	1.5	10 060.6	3 159.1	3.3
Scenario 4, LHV vkm	0.4	62.2	0.2	9 096.6	2 913.7	2.8
	Finland MW	**Finland RR**	**Finland UR**	**France MW**	**France RR**	**France UR**
Scenario 1, tkm	7 385.6	23 701.0	141.0	421 716.0	70 771.1	603.4
Scenario 1, vkm	882.9	2 795.1	16.6	48 519.3	8 565.2	70.9
Scenario 2, tkm	7 509.7	24 222.7	143.2	425 462.0	71 317.0	608.5
Scenario 2, HGV vkm	446.3	1 123.3	7.1	27 610.9	4 855.2	43.5
Scenario 2, LHV vkm	302.0	1 162.4	6.6	14 242.2	2 518.3	18.6
Scenario 3, tkm	7 481.8	24 172.5	143.2	421 600.0	70 751.7	603.4
Scenario 3, HGV vkm	487.1	1 207.5	7.4	48 404.5	8 545.2	70.0
Scenario 3, LHV vkm	277.7	1 120.9	6.5	0.0	0.0	0.0
Scenario 4, tkm	7 438.4	23 904.8	141.9	423 239.0	71 015.7	606.0
Scenario 4, HGV vkm	409.6	1 141.0	7.1	27 388.9	4 342.3	37.6
Scenario 4, LHV vkm	433.2	1 511.5	8.7	19 370.5	3 848.7	30.4
	Greece MW	**Greece RR**	**Greece UR**	**Hungary MW**	**Hungary RR**	**Hungary UR**
Scenario 1, tkm	78 737.0	43 637.4	345.3	38 900.4	43 542.5	214.0
Scenario 1, vkm	9 130.1	5 071.9	40.5	4 644.9	5 299.5	24.9
Scenario 2, tkm	78 829.4	43 650.1	345.5	39 083.5	43 738.7	215.4
Scenario 2, HGV vkm	3 462.0	1 994.4	16.9	2 899.4	3 327.2	15.1
Scenario 2, LHV vkm	3 803.7	2 061.9	15.8	1 175.0	1 326.8	6.6
Scenario 3, tkm	78 714.6	43 625.0	345.2	38 889.4	43 530.1	213.9
Scenario 3, HGV vkm	9 110.8	5 061.2	40.4	4 635.0	5 288.3	24.9
Scenario 3, LHV vkm	0.0	0.0	0.0	0.0	0.0	0.0
Scenario 4, tkm	78 762.5	43 639.4	345.4	38 978.3	43 639.7	214.6
Scenario 4, HGV vkm	3 801.9	2 015.6	16.5	2 799.2	3 016.6	14.4
Scenario 4, LHV vkm	4 801.3	2 750.4	21.6	1 691.5	2 086.0	9.6
	Ireland MW	**Ireland RR**	**Ireland UR**	**Italy MW**	**Italy RR**	**Italy UR**
Scenario 1, tkm	11 042.2	0.0	0.0	260 498.0	20 993.4	99.3
Scenario 1, vkm	1 296.3	0.0	0.0	30 411.9	2 440.8	12.2
Scenario 2, tkm	11 100.1	0.0	0.0	262 587.0	21 085.1	99.5
Scenario 2, HGV vkm	717.2	0.0	0.0	16 646.3	1 475.8	6.7
Scenario 2, LHV vkm	391.1	0.0	0.0	9 359.8	649.7	3.7
Scenario 3, tkm	11 039.1	0.0	0.0	260 424.0	20 987.4	99.3
Scenario 3, HGV vkm	1 293.5	0.0	0.0	30 347.4	2 435.6	12.2
Scenario 3, LHV vkm	0.0	0.0	0.0	0.0	0.0	0.0
Scenario 4, tkm	11 072.8	0.0	0.0	261 360.0	21 034.0	99.4
Scenario 4, HGV vkm	596.5	0.0	0.0	15 426.1	1 275.1	5.8

Scenario 4, LHV vkm	635.0	0.0	0.0	13 661.0	1 060.6	5.8
	Lithuania MW	**Lithuania RR**	**Lithuania UR**	**Luxembourg MW**	**Luxemburg RR**	**Luxemburg UR**
Scenario 1, tkm	873.2	6 530.3	197.1	4 693.3	3 023.5	1.8
Scenario 1, vkm	92.0	680.2	20.6	464.3	290.2	0.2
Scenario 2, tkm	878.6	6 628.4	199.0	4 738.9	3 069.0	1.8
Scenario 2, HGV vkm	61.2	423.9	13.0	286.1	185.4	0.2
Scenario 2, LHV vkm	20.8	177.7	5.2	121.5	72.5	0.0
Scenario 3, tkm	872.9	6 528.6	197.1	4 693.0	3 022.8	1.8
Scenario 3, HGV vkm	91.8	677.5	20.5	458.9	288.9	0.2
Scenario 3, LHV vkm	0.0	0.0	0.0	0.0	0.0	0.0
Scenario 4, tkm	875.3	6 565.9	197.8	4 714.3	3 049.4	1.8
Scenario 4, HGV vkm	66.2	461.7	14.0	268.0	142.8	0.2
Scenario 4, LHV vkm	24.1	204.6	6.1	180.4	135.4	0.0
	Latvia MW	**Latvia RR**	**Latvia UR**	**Netherlands MW**	**Netherlands RR**	**Netherlands UR**
Scenario 1, tkm	1 190.3	5 540.9	94.2	72 034.9	6 372.7	39.3
Scenario 1, vkm	123.3	575.6	9.7	8 176.9	716.7	3.9
Scenario 2, tkm	1 215.8	5 664.9	95.6	72 981.6	6 437.2	40.3
Scenario 2, HGV vkm	71.7	339.1	6.1	5 421.7	503.3	2.6
Scenario 2, LHV vkm	36.4	166.7	2.5	1 900.6	146.1	1.0
Scenario 3, tkm	1 190.0	5 539.4	94.2	72 948.7	6 438.4	40.2
Scenario 3, HGV vkm	122.9	573.2	9.7	5 798.7	519.5	2.9
Scenario 3, LHV vkm	0.0	0.0	0.0	1 683.9	138.7	0.8
Scenario 4, tkm	1 199.1	5 586.0	94.7	72 501.4	6 405.2	39.8
Scenario 4, HGV vkm	80.1	370.1	6.7	4 977.1	470.7	2.3
Scenario 4, LHV vkm	40.5	192.6	2.8	2 967.0	229.0	1.6
	Poland MW	**Poland RR**	**Poland UR**	**Portugal MW**	**Portugal RR**	**Portugal UR**
Scenario 1, tkm	60 273.9	142 413.0	0.0	10 578.9	8 317.1	0.0
Scenario 1, vkm	6 963.8	16 545.7	0.0	1 198.1	964.8	0.0
Scenario 2, tkm	61 221.3	144 174.0	0.0	10 628.8	8 366.7	0.0
Scenario 2, HGV vkm	3 820.8	9 355.2	0.0	749.1	603.3	0.0
Scenario 2, LHV vkm	2 169.3	4 931.7	0.0	302.8	244.5	0.0
Scenario 3, tkm	60 256.8	142 373.0	0.0	10 575.9	8 314.7	0.0
Scenario 3, HGV vkm	6 949.0	16 507.8	0.0	1 195.5	962.7	0.0
Scenario 3, LHV vkm	0.0	0.0	0.0	0.0	0.0	0.0
Scenario 4, tkm	60 720.6	143 153.0	0.0	10 603.3	8 342.6	0.0
Scenario 4, HGV vkm	3 396.5	8 655.0	0.0	698.5	539.1	0.0
Scenario 4, LHV vkm	3 270.5	7 226.8	0.0	457.6	389.5	0.0
	Romania MW	**Romania RR**	**Romania UR**	**Sweden MW**	**Sweden RR**	**Sweden UR**
Scenario 1, tkm	219.5	10 860.3	41.7	14 644.0	30 026.2	7.0
Scenario 1, vkm	23.8	1 196.9	4.5	1 741.7	3 709.6	0.8
Scenario 2, tkm	219.5	10 944.5	41.8	14 781.6	30 326.4	7.0
Scenario 2, HGV vkm	16.3	665.3	2.5	1 009.6	1 969.3	0.5
Scenario 2, LHV vkm	5.0	361.0	1.3	500.8	1 189.3	0.2
Scenario 3, tkm	219.4	10 857.2	41.7	14 778.1	30 322.5	7.0
Scenario 3, HGV vkm	23.7	1 194.4	4.4	1 178.1	2 167.7	0.6
Scenario 3, LHV vkm	0.0	0.0	0.0	395.5	1 076.1	0.2
Scenario 4, tkm	219.5	10 888.8	41.7	14 700.3	30 167.6	7.0
Scenario 4, HGV vkm	17.9	754.5	2.8	983.4	1 639.2	0.5
Scenario 4, LHV vkm	5.5	407.6	1.5	696.4	1 884.0	0.3

	Slovenia MW	Slovenia RR	Slovenia UR	Slovakia MW	Slovakia RR	Slovakia UR
Scenario 1, tkm	13 624.2	2 273.4	0.0	9 100.6	28 177.7	0.0
Scenario 1, vkm	1 441.4	236.7	0.0	1 027.6	3 273.6	0.0
Scenario 2, tkm	13 705.5	2 290.3	0.0	9 187.7	28 529.8	0.0
Scenario 2, HGV vkm	912.7	151.1	0.0	577.9	1 791.9	0.0
Scenario 2, LHV vkm	357.2	58.1	0.0	306.5	1 016.7	0.0
Scenario 3, tkm	13 620.3	2 272.7	0.0	9 098.0	28 169.7	0.0
Scenario 3, HGV vkm	1 438.3	236.2	0.0	1 025.5	3 266.7	0.0
Scenario 3, LHV vkm	0.0	0.0	0.0	0.0	0.0	0.0
Scenario 4, tkm	13 656.7	2 280.7	0.0	9 138.2	28 346.8	0.0
Scenario 4, HGV vkm	976.6	157.1	0.0	554.4	1 604.2	0.0
Scenario 4, LHV vkm	430.9	73.8	0.0	433.2	1 527.4	0.0
	UK MW	**UK RR**	**UK UR**			
Scenario 1, tkm	257 069.0	0.0	3 874.4			
Scenario 1, vkm	31 719.8	0.0	483.4			
Scenario 2, tkm	257 564.0	0.0	3 878.4			
Scenario 2, HGV vkm	20 684.2	0.0	328.8			
Scenario 2, LHV vkm	7 377.3	0.0	103.0			
Scenario 3, tkm	256 996.0	0.0	3 873.3			
Scenario 3, HGV vkm	31 652.6	0.0	482.4			
Scenario 3, LHV vkm	0.0	0.0	0.0			
Scenario 4, tkm	257 359.0	0.0	3 877.0			
Scenario 4, HGV vkm	17 648.5	0.0	311.8			
Scenario 4, LHV vkm	12 818.8	0.0	157.7			

Annex 8: Rail tonne volumes

The following table presents 2020 rail ton volumes per scenario as they are calculated by the TRANS-TOOLS model.
Note: rail transport ton volumes are defined as ton volumes originating in a country. For instance, if a shipment originates in country A and is transported to the country B possibly via country C, the volume will be assigned to the country A. This definition may lead to differences if compared with other statistical sources on rail volumes.

Table 109: Rail transport in tonne lifted in 2020

Country	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Germany	313 029 640	300 181 763	301 260 478	307 309 284
UK	84 042 927	81 627 686	84 042 927	82 658 066
France	139 964 858	130 982 866	139 964 858	136 029 187
Spain	45 517 360	41 390 782	45 517 360	43 847 559
Italy	59 563 227	55 023 876	59 563 227	57 499 590
Poland	415 167 200	406 831 080	415 167 200	411 458 090
Netherlands	38 002 414	37 056 307	37 216 232	37 600 507
Czech Republic	164 936 463	161 986 346	164 936 463	163 598 826
Portugal	10 322 461	9 708 723	10 322 461	10 037 244
Belgium	80 514 986	77 390 365	78 694 203	79 038 210
Slovakia	95 229 928	92 272 682	95 229 928	93 983 136
Austria	55 174 980	52 765 268	55 174 980	54 055 783
Sweden	27 961 905	26 357 835	26 406 807	27 278 454
Finland	31 980 815	29 540 818	29 567 293	31 023 298
Ireland	19 643 278	17 288 729	19 643 278	18 768 960
Greece	3 416 220	3 115 005	3 416 220	3 291 807
Hungary	70 305 830	67 741 178	70 305 830	69 175 686
Denmark	4 737 682	4 196 615	4 200 934	4 543 704
Lithuania	27 590 022	26 743 428	27 590 022	27 288 680
Slovenia	13 404 974	13 084 234	13 404 974	13 276 605
Latvia	13 539 894	13 116 404	13 539 894	13 381 862
Luxemburg	6 255 485	6 054 353	6 255 485	6 146 585
Estonia	33 908 897	33 551 477	33 908 897	33 783 002
Bulgaria	1 583 265	1 537 385	1 583 265	1 565 546
Romania	4 045 271	3 922 045	4 045 271	4 002 035
Total	**1 759 839 982**	**1 693 467 250**	**1 740 958 487**	**1 730 641 706**

Annex 9: Inland waterways tonne volumes

The following table presents 2020 inland waterway ton volumes per scenario as they are calculated by the TRANS-TOOLS model.
Note: IWW transport ton volumes are defined as ton volumes originating in a country. For instance, if a shipment originates in country A and is transported to the country B possibly via country C, the volume will be assigned to the country A. This definition may lead to differences if compared with other statistical sources on IWW volumes.

Table 110: Inland waterways tonnes lifted in 2020

Country	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Germany	149 259 120	144 482 168	144 659 126	146 987 772
UK	165 802	164 693	165 802	165 370
France	59 090 951	56 184 272	59 090 951	57 860 134
Spain	0	0	0	0
Italy	463 107	454 310	463 107	460 022
Poland	6 733 448	6 689 686	6 733 448	6 711 150
Netherlands	380 966 840	371 967 673	372 048 812	377 248 339
Czech Republic	2 354 114	2 269 386	2 354 114	2 322 236
Portugal	0	0	0	0
Belgium	127 886 914	123 746 807	124 338 412	126 098 121
Slovakia	3 276 296	3 270 063	3 276 296	3 273 940
Austria	3 483 171	3 373 691	3 483 171	3 441 199
Sweden	0	0	0	0
Finland	932 430	927 276	930 729	930 637
Ireland	0	0	0	0
Greece	28 485	28 175	28 485	28 383
Hungary	4 925 998	4 867 430	4 925 998	4 898 713
Denmark	0	0	0	0
Lithuania	0	0	0	0
Slovenia	0	0	0	0
Latvia	0	0	0	0
Luxemburg	5 086 973	5 002 944	5 086 973	5 035 279
Estonia	0	0	0	0
Bulgaria	510 332	509 037	510 332	509 881
Romania	336 972	334 404	336 972	336 072
Total:	**745 500 953**	**724 272 015**	**728 432 728**	**736 307 248**