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INTERNATIONAL CO_2 POLICY BENCHMARK FOR THE ROAD TRANSPORT SECTOR

Results of a pilot study

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Abstract

The idea to initiate a CO_2 policy benchmark for the transport sector was developed during a workshop on this subject in The Hague (in March 2001). The Dutch Ministry of Transport, Public Works and Water Management, supported by AVV Transport Research Centre, took the lead of this benchmark project, in which the 11 European countries participated and contributed. In addition several European institutions (CEMT, EEA, and Eurostat) contributed to the project. A consultant team of ECN and COWI performed this study.

During the first meeting in Madrid (in June 2002) the participants selected 10 policy instruments for road transport to be included in the benchmark. In the same meeting the benchmark criteria -of which CO_2 reduction effect and CO_2 cost-effectiveness are the most important- were determined. In addition it was decided to expand the benchmark by a study of the general CO_2 policies for the transport sector of the participating countries and to compare these with a number of good policy criteria.

It was decided to focus the project on examples of good practice so that lessons to improve policies could be provided. In this study the data have been gathered by using questionnaires, which were sent to the 11 countries. Based on the results of these questionnaires, complemented by information from other sources, a draft report was produced. During the second project meeting in Helsinki (in December 2002) this draft report was discussed and conclusions were drawn on good practices as well as the usefulness of benchmarking of policy instruments as an instrument itself.

With regard to the general policy on CO_2 reduction in transport, most countries are active in formulating CO_2 policies for the transport sector to meet their Kyoto targets. However, the role of evaluation of policies (especially ex-post) seems rather limited. Most countries do not provide insight in their submissions whether monitoring data are used in the policy process to adapt existing policies or implement new instruments.

For most policy instruments that are studied in this benchmark project CO_2 reduction is not the primary objective. Financial instruments, for example, generate government revenues, but at the same time can have a CO_2 reduction effect (e.g. fuel tax). However, they can be designed in such a way that they support CO_2 emission reduction (i.e. CO_2 differentiation of road and sales tax).

Of the policy instruments that are considered, CO_2 emission standards, eco-driving and highway speed limits are regarded as promising. The ACEA covenant on CO_2 emission for new cars is looked upon as an important EU-wide Kyoto measure, but rebound effects and a shift to diesel are points of attention. Eco-driving is a strikingly positive measure when extensively guided and supported by economic incentives. Lowering highway speed limits with increased enforcement reduce CO_2 emissions and have a positive effect on safety and noise.

Moderate vehicle tax or fuel tax changes, the use of telematics in freight transport and road pricing are considered to be moderately promising policy instruments. Taxation instruments are expected to have relatively little effect on mobility since it appears that travel-time-budget constraints are saturated much earlier than monetary constraints in most EU countries. Telematic systems and freight logistics are increasingly important because of the growing demand of freight transport. The CO_2 reduction effect of road pricing schemes largely depends on the instrument design.

Stimulation of biofuels and modal shift measures are regarded as less promising. Stimulation of biofuels is expensive and raises questions about other land use options and other more CO_2 efficient use of biomass. Modal split options (both for public and freight transport) need substantial investments but reduce congestion and have positive social aspects. The CO_2 effect however is often small. Finally, tradable emission permits are considered to be an effective instrument in general, but not so much so for the transport sector. This is due to the fact that reductions in other sectors of the economy are often cheaper. Due to the early stage of this instrument concept, an assessment of benchmark criteria was impossible. With regard to modal shift in freight transport, on-board devices to stimulate eco-driving, road pricing and tradable emission permits many participants felt that the EU could play an important role.

This pilot study clearly demonstrates that involvement of co-operating and supporting countries is a precondition for a successful benchmarking exercise. Full commitment and long-term involvement of country teams are required to achieve a substantial degree of efficiency and enhance the quality of individual contributions. Benchmarking as an instrument itself can only be successful if instruments can be compared on an equal base with respect to availability and quality of the data, methods that are used and assumptions that are made to produce the data. In this pilot study these aspects turned out to be difficult. A useful suggestion for a future benchmark exercise would be to have an independent (research) institution produce a discussion paper and have this paper extensively discussed and elaborated on by policy makers. In this way, an efficient method of data gathering is provided while facilitating the input of policy makers.

CONTENTS

SUMMARY

The idea to initiate a pilot for a CO_2 policy benchmark for the transport sector was developed during the workshop 'Shared policy learning on transport and the environment' that took place on 15-16 March 2001 in The Hague, the Netherlands. Growing CO_2 emissions in the transport sector (18% across the EU in the period 1990-1999) turn out to be a continuous problem. Packages of policies and measures have evidently not been sufficient to achieve a reduction in energy use. Measures to improve efficiency of transport have indeed contributed to the slowdown of the growth in energy demand, but so far they have failed to actually stop the increase of transport related CO_2 emissions.

Most Member States have already gained (some) experience with transport-related CO_2 policies and their effects, but it is essential to gain further insight in the pros and cons of various policies. Continued learning from experiences is needed to improve these policies and make them more effective and robust. In this pilot project policy experiences of different EU countries are shared.

The objectives of the pilot project are:
1. To compare the country policies of a number of European countries with respect to actual CO_2 emissions in the transport sector.
2. To benchmark a number of policy instruments that aim to reduce CO_2 in the transport sector.
3. To assess whether the instrument 'Benchmarking' can support environmental policy in the transport sector and to identify the conditions that need to be fulfilled for Benchmarking.

These objectives have been established in a joint effort of country teams (Belgium, the Czech Republic, Denmark, Finland, France, Germany, Italy, the Netherlands, Spain, Sweden and the United Kingdom), the project team at the Dutch Transport Research Centre (AVV), specialists of international organisations (CEMT, EEA, Eurostat) and the consultant-team (ECN and COWI).

The results of this project must be considered as a result of a pilot exercise. From this perspective, process results with respect to benchmarking as a useful instrument to reduce CO_2 emissions in the transport sector (third objective) are just as important as the comparison of country policies and the benchmarking of a number of CO_2 instruments.

In June 2002 a workshop was held in Madrid to discuss a practical approach to establish a benchmark while considering the existing limitations in availability of comparable country data. This led to a decision to focus on benchmarking a limited number of policy instruments and to refrain from an in-depth assessment of country policies for reducing CO_2 emissions from the transport sector. It was further decided to focus this pilot on road transport only, as it covers most of the CO_2 emissions in the transport sector and is responsible for a significant share of the growth of the emissions. This means that focus is mostly on passenger cars and trucks, which account for approximately 85% of all transport related CO_2 emissions.

In addition to the Madrid meeting another meeting with the participating countries was held in Helsinki (in December 2002) with the aim to discuss the pilot results and finalise the report.

Comparison of country policies: results

With regard to the policy ambitions, the ambition level in most countries (except for Finland), of CO_2 policy in the transport sector does not correspond with the ambition of national climate policy (Kyoto target); the embeddedness of the transport sector in national CO_2 policy seems weak. In none of the countries the CO_2 target for transport is more stringent than the Kyoto target for the whole country. To the contrary: unlike greenhouse gas emissions from other sectors, transport-related CO_2 emissions are allowed to grow. Transport-related CO_2 emissions have been and are increasing in all eleven EU countries that were considered in this study. On average emissions increased with 18% between 1990 and 2000. Countries that had relatively low transport-related CO_2 emissions per capita in 1990 (such as Spain and Czech) experienced more growth until 2000 (approximately 30%) than countries (such as Sweden and Finland) with high CO_2 emissions per capita (5-15%).

As far as the basis for CO_2 reducing instruments is concerned, all countries have policy instruments in place which were not designed to reduce CO_2 emissions in the transport sector but which were aimed at, for example, generating government revenue (fuel taxes and vehicle taxes), limiting congestion and improvement of safety (speed limits). Such policies did however have some effects on transport-related CO_2 emissions. Countries have made significant differences in their choice for policy instruments. While some countries (Belgium, France, Spain) seem to focus their CO_2 policy mainly on instruments related to public and freight transport (modal shift), other countries have a relatively strong focus on economic and fiscal instruments. These countries have started, have planned or are considering new financial instruments such as differentiated vehicles taxes, fuel tax escalators (both UK) and road pricing (Germany). Some other countries, such as Finland, the Netherlands and Sweden report that they have integrated national transport policy plans, which combine a set of complementary measures. Additional potential for policy instruments exists in all countries as no country has exhausted the large range of possible policy instruments.

When SMARTness of the policies is considered, some countries (Belgium, Denmark, Finland, Spain and the UK) have chosen to closely interact with stakeholders during the formulation of policies (bottom-up process) while in other countries it is a government decision (top-down). It seems attractive to profit from the knowledge of stakeholders in formulating realistic policies and increase their commitment by involving them in the decision-making process.

In the area of monitoring and evaluation, the role of ex-ante evaluations of policy packages seems rather limited in the policy process, although they are carried out by most countries. Ex-post evaluation of policies is not common practice. There seems to be no broadly accepted method for the evaluation of effects of policies. Therefore, results from evaluations can usually not be compared as different countries use different methods and the assumptions are often not available. In most countries, a monitoring programme for the transport sector already exists and is part of the national statistical surveys. In their submissions, most countries do not provide insight whether monitoring data (especially emission development) are used in the policy process to adapt existing policies or implement new measures.

There is no consistent information available on the impact of reduction policies on CO_2 emissions in the transport sector. In general this impact is considered to be small. In those countries that experienced only little growth in CO_2 emissions, this trend seemed largely a result of autonomous developments such as transport demand saturation effects and low economic growth (e.g. Finland). The contribution of explicit CO_2 policies to 'bending down the trend' is considered to be small. Transport policies that were originally implemented for other reasons most likely had an equal or larger CO_2 reducing effect. Consequently, one cannot compare the relative success of CO_2 policy for the transport sector simply on the basis of development of CO_2 emissions during a certain a period.

All in all, a comparison of country policies proved to be complex. However, the policy context in any one country plays a considerable role in the success of policy instruments.

Benchmarking of instruments: results
The following instruments are included in the benchmark:

- CO_2 differentiation of fuel tax
- CO_2 differentiation of road and sales tax
- Road/km/congestion pricing
- Tradable CO_2 permits
- (Highway) speed limits
- CO_2 emission standards/voluntary agreements on fuel efficiency
- Freight transport measures: telematic systems, increasing freight logistics, (allowed) load factor etc.
- Stimulation of biofuels
- Eco-driving, including on board devices
- Modal shift passenger transport
- Modal shift freight transport.

For the benchmarking of the instruments a number of criteria has been used. The CO_2 reduction effect of an instrument (as a share of total national transport emissions) and its CO_2 cost-effectiveness are considered to be the most important criteria. Other criteria used to assess the instruments are the costs for the government (budget implications) the political and public acceptance of an instrument and its speed of implementation.

The table overleaf provides a summary of the individual assessments of the instruments covered by this study. It makes maximum use of the results from the questionnaires submitted by the participating countries. The replies were however insufficient to allow for complete filling out of the table, and it should also be noted that the table overleaf is more generic than the use of the questionnaire replies would enable it to be. When interpreting the table one should consider the first two columns (CO_2 reduction and cost effectiveness) of overriding importance for the recommendation that further work on a particular measure is justified. Roughly speaking, one could argue that low cost options with high reduction potentials are obvious choices for further work whereas high cost options with low reduction potentials should be deferred.

Table S.1 *Overview of benchmark assessment of policy instruments*

Instrument	CO_2 effect[1]	CO_2 cost-effectiveness	Budget implication	Acceptance	Implementation speed	Conclusion
CO_2 emissions standards	H	high	neutral	positive	LT	++
Eco-driving	M	high	neutral	positive	ST-LT	+
Speed limits and enforcement (highway)	M	high	neutral/ positive	varies	ST	+
Fuel tax	L-M	high	positive	low	MT	0/+
Telematics; freight	L /M	high	neutral	positive	MT	0/+
Vehicle tax (incl. differentiation)	M	varies	neutral	varies	MT/LT	0
Road/km/congestion pricing	L-H	medium	varies	low	MT	0
Stimulation of biofuels	H	low	costly	positive	MT	0/-
Modal shift - Public	L	low	costly	varies	ST-LT	0/-
Modal shift - Freight	L	medium	costly	varies	LT	0/-
Tradable CO_2 permits	L	high	neutral	?	MT	?

[1] L = low, achieved reduction as a share of total national transport emissions <2%
M = medium, 2-5%
H = high, >5%

Below, the conclusions that emerge from the table are discussed in more detail.

- *CO_2 emission standards* are currently used through the (voluntary) EU agreement with the car manufacturing industry and are implemented as a target, not as a standard. Although the CO_2 effect of this measure is high, other aspects have to be mentioned. The agreement only affects the average CO_2 emissions per km per car (in a test cycle), and only new cars. The effects on driving behaviour and the possible rebound effects by the lower fuel costs in terms of an increase in mileage or the purchase of bigger cars are left aside. Furthermore, it may be worth considering what would have been the technological developments in the absence of the agreement. Finally a shift to diesel cars that could be provoked by this instrument causes more particulate emissions and might cause growth in vehicle mileage due to lower fuel costs.
- *Eco-driving* is a low cost option and is considered an attractive and promising instrument by many. The major points to note are: firstly, that campaigns and interventions need to be repeated on a regular basis to make sure that the effect does not fade out, and secondly, that the stronger the accompanying economic incentive (in terms of e.g. fines for violation of speed limits or fuel taxes) the stronger and more sustainable the effect will likely be. In-car feedback instruments can improve the effect. A first priority would be to implement eco-driving into the regular driver training and exams.
- *(Highway) speed limits* appear to be an obvious instrument choice. Depending on the strictness of enforcement and the amount of violations, it may even generate net revenue. The enforcement costs are to a large extent offset by reductions in accidents and casualties. The major and important obstacle to an intensified use of this instrument is the issue of acceptance. In some countries the CO_2 reduction potential of this instrument is large.
- *Fuel taxes* are in effect in all countries. While increasing fuel taxes is a cost-effective instrument to reduce CO_2 emissions, public acceptance is low. High fuel taxes form an important incentive to switch to transport alternatives with lower CO_2 emissions. As such they support the effectiveness of other measures such as modal shift, biofuels and eco-driving.
- *Telematics for freight transport* has a low to medium potential. This is because freight accounts for around 1/3 of transport's CO_2 emissions. In principle, applying telematics to optimise freight transport would automatically be used by the (transport) companies if there is a financial rationale to do so. In reality there is an unexploited (economic) potential, where government intervention (in terms of e.g. advice, guidance, organisation of experience sharing) can play a role to speed up the developments. A future intensified focus on CO_2 in transport planning and taxation policies may further increase the potential of telematics.
- *Vehicle taxes* include both differentiation and level of taxes in this study. Vehicle tax levels affect the amount and age of vehicles in the fleet, whereas the differentiation can be used to influence the composition of the fleet. The former has the largest potential for CO_2 reductions, but is typically assumed to involve substantial welfare losses whereas the latter can be designed so as to reduce the negative welfare effects. In other words, the latter may prove to be more cost effective, although the reduction potentials may be lower. In relation to CO_2 differentiation there may be a rebound effect if the cost per km is reduced by this instrument, and this will also affect government revenue.
- *Road/km/congestion pricing* covers a wide range of more specific instruments that are mostly not considered or developed for their CO_2 reducing merits but more so because of their ability to influence congestion and local pollution. Consequently, the potential CO_2 effect cannot be assessed as it will depend on the exact system in place. Instruments design could, for example, include some element of CO_2 differentiation (e.g. reduced rates for energy efficient vehicles) for all roads and all vehicles. CO_2 differentiation is a feature of both the German system and the system that was analysed in the Netherlands. It is important to note that this group of measures without CO_2 differentiation does not encourage energy efficient driving, but primarily aims to influence traffic volume and use of road capacity.
- *Biofuels.* The two major issues in relation to biofuels are the impacts on budgets and the issue of alternative uses. Biofuels are an expensive option and subsidisation is therefore necessary to stimulate the production and demand. Germany implemented its biofuels system

as an excise duty tax exemption, but this is not an option for other countries any more because of recent EU law. Biomass should preferably be used for other energy generation, i.e. heat and power production. It is highly questionable whether transportation is the best use of the available biomass.

- *Modal shifts* include both shifts by freight transport and shifts to public transportation. Empirical evidence suggests that substantial movements from private to public transportation are necessary to provide significant CO_2 effects. As a consequence this measure is likely to be very costly. As a stand-alone instrument to reduce CO_2 emissions it is not very efficient. Furthermore, an increase in service levels of public transportation may in itself generate new demands. If the modal shift causes extra electricity demand, it is relevant how the electricity is produced. Power production with coal power plants has a negative effect on the CO_2 reduction.
- *Tradable CO_2 permits* can be a cost-effective option. A system where transport, by means of the refineries, is included in a trade scheme may however have only a little effect on CO_2 emissions in the transport sector, and the impacts on CO_2 emissions from transport may even prove to be adverse. This is due to the fact that there are other areas of the economy where the reductions can be attained at lower costs. Applying a system of tradable CO_2 quotas vis-à-vis the vehicle users still remains to be further investigated, but it is open to discussion whether such a system will be more efficient that the mirror instrument: fuel taxes.

Benchmarking as an instrument itself: results

An important objective of this pilot project is to assess the value of benchmarking as an instrument to reduce CO_2 emissions in the transport sector.
The consultant team feels that the discussions on CO_2 reduction in the transport sector during the project meetings with all participants were one of the most valuable outcomes of this project. However, these discussions alone are not enough to make benchmarking a useful instrument. For successful benchmarking one needs:

- Full commitment of participating countries that recognise the urgency of CO_2 emission reduction in the transport sector; this commitment varied among participating countries in this project.
- Stable country teams; personnel shifts (with poor file transfer) as was the case for some countries in this pilot delay and frustrate the process.
- Participation of all involved ministries; in this project, most of the country teams were only related to the Ministry of Transport whereas - in view of the instruments studied - successful benchmarking asks for participation of all relevant ministries.

The use of questionnaires to collect the relevant data in a structured way (as was chosen in this pilot project) turned out not to be very efficient. The availability and quality of much of the data submitted by the countries turned out to be poor. The consultant team feels that in the future research institutes or national experts could take the lead in the collection of data. After production of the first results, these could then be discussed with and commented on by the involved policy makers during the benchmark process.

Since benchmarking should be based on evidence (achieved performance) and not on expectations, the consultant team emphasises the need to ex-post evaluate instruments. This turned out to be a general lack in providing information in this project. To ensure a clear and transparent comparison base, ex-post evaluations should preferably be based on the same method. If that is not feasible, at least the method that is used and the assumptions that are made should be made clear.

Discussion and Recommendations

This report summarises the main contents and results of a first attempt to benchmark CO_2 reduction instruments in the road transport sector. The benchmark was conducted on the CO_2 policies for road transport of a range of European countries, as well as on a selection of instruments in that area. This section seeks to identify the important lessons that can be learned and which are relevant for a thorough benchmark of CO_2 policies in transport. In deriving the lessons learned, the objectives of this pilot project should be kept in mind. Below, the lessons and recommendations are presented for each of these objectives separately.

Country policies: discussion
The purpose of this study was not to actually benchmark country policies but to make an in-depth comparison of several aspects of policies to support the benchmarking of policy instruments. Such a comparison appeared to be complex because of several factors:

- Starting situations to reduce CO_2 emissions from the transport sector differ between countries (e.g. population density, income per capita, economic growth, climate, composition of the car fleet, tax levels, instruments already implemented).
- All countries already apply a mix of policy instruments, which do not have the purpose to reduce transport-related CO_2 emissions, but which did have significant effects on past CO_2 emission trends. Also for many new policy instruments reduction of transport-related CO_2 emissions is only a derivative).
- Limited availability of evaluations (especially ex-post).
- No broadly accepted methods exist how to (ex-ante and ex-post) evaluate effects of policies.

Recommendation 1
Gain detailed insight in the different starting positions of countries to be able to mutually compare country policies.

Recommendation 2
Develop and use common evaluation methods (with a focus on ex-post evaluation) and exchange monitoring experiences.

Benchmarking of instruments: discussion
The results presented in Table S.1 should be carefully handled. The amount and quality of the data for some instruments is better than for others. This difference is closely linked to the pilot character of the study. Therefore this study should be seen as a first step towards a thorough benchmark of policy instruments for CO_2 reduction in the transport sector. For a fair and comprehensive comparison of instruments the amount and quality of the data should be improved. Next to considerations on the data, one should also carefully (re)consider the assessment and criteria used in this study. Scopes for extension and improvement are:

- Inclusion of explicit distributional aspects (equity). At present equity implications are integrated into the acceptance issue, but distributional issues tend to be an important political issue.
- Elaborate a stringent, common and operational definition of cost effectiveness. This is a crucial outcome of the analyses, and country contributions do often not contain much (and definitely not comparable information) on this issue.
- Use a longer time horizon in the analyses of CO_2 reductions and related CO_2 cost effectiveness in order to take into account effects that in- or decrease over time.
- For instruments aimed at influencing individual mobility, take into account trade-off issues made by individuals between time-budget constraints and monetary-budget constraints.
- For instruments aimed at influencing freight transport demand or modal split, supply-side effects of transport should be taken into account more explicitly.

Recommendation 3
Elaborate on the benchmark criteria by adding relevant other criteria, and sharpening the operational definitions.

Other important issues, which need to be more carefully and consistently addressed, are double counting and synergy effects (policy packaging). As an example of the former, congestion pricing may provide a further incentive for transport companies to use telematics in the logistic planning, and care should be taken not to attribute this effect to both measures. Similarly, synergies between various instruments (for example eco-driving, differentiation of vehicle taxes and km. charging) that result in a combined effect that is larger than the sum of each individual instrument, should be taken into account.

Recommendation 4
The issues of double counting and synergy effects (policy packaging) should be addressed explicitly (without losing the specific aspects of individual instruments).

Benchmarking as an instrument itself: discussion
The third objective of this pilot project is to assess the value of benchmarking as an instrument to reduce CO_2 emissions in the transport sector. Based on the experiences in this pilot study it becomes clear that:

- Involvement of co-operating and supporting countries is a pre-condition for a successful benchmarking exercise.
- Full commitment and long-term involvement of country teams are required to achieve a substantial degree of efficiency and enhance the quality of individual contributions (for this purpose, the urgency of CO_2 policy in the transport sectors must be recognised by policy makers).
- Since some of the CO_2 instruments are beyond the jurisdiction of the Ministries of Transport, the supportive base of a benchmarking exercise should include all relevant ministries in a country.

Recommendation 5
For effective benchmarking in the transport sector the urgency of the CO_2 problem should be recognised and policy makers should commit themselves to the benchmarking process.

An important lesson of this benchmark pilot is the limited efficiency of using questionnaires. A useful suggestion for a future benchmark exercise would be to have an independent (research) institution produce a discussion paper and discuss this paper and elaborate on it in close interaction with policy makers. In this way, an efficient method of data gathering is provided, whereas the useful input and additions of policy makers can be integrated in the research. The latter - i.e. the creation of an international forum of policy makers discussing the CO_2 problem of the transport sector - has been one of the fruitful elements of this project.

Recommendation 6
Adapt the method used for benchmark without losing the close interaction with the policy makers by preparing a document based on data gathering to provide a basis for discussions with and additions by involved policy makers.

Although the performance of a thorough benchmark seems a step too far for now, the results of this project can be used by countries to learn from each other's experiences. Based on the country submissions and additional literature, many data on specific measures have been brought together, providing information about the CO_2 effects, cost-effectiveness and other issues. Countries should however be critical when assessing measures as good practice. Successful implementation of a measure is in the opinion of the consultant team not enough. If the objective of a measure is tackling climate change, the relative CO_2 effect (reduction as a share of total emissions in the sector) has to be significant. Total costs in relation to the achieved CO_2 reduction must be assessed in comparison with other measures.

1. INTRODUCTION

1.1 Background and objectives

The idea to initiate a pilot for a CO_2 policy benchmark for the transport sector was developed during the workshop 'Shared policy learning on transport and the environment' that took place on 15-16 March 2001 in The Hague, the Netherlands. Growing CO_2 emissions in the transport sector (18% across the EU in the period 1990-1999[1]) turn out to be a continuous problem. Packages of policies and measures have evidently not been sufficient to achieve a reduction in energy use. Measures to improve efficiency of transport have indeed contributed to the slowdown of the growth in energy demand, but so far they have failed to actually stop the increase of transport related CO_2 emissions. The fuel efficiency of passenger cars, for example, has improved steadily over the last 20 years, but consumer preferences for larger, heavier and more powerful cars, in general reinforced by higher profit margins for manufacturers and distributors associated with such vehicles, have offset most of these efficiency gains.

There is a need to reduce CO_2 emissions from transport as all EU Member States have recently ratified the Kyoto Protocol and it is expected that the Protocol will come into force in 2003. The binding commitments for the reduction of greenhouse gas emissions, of which CO_2 is the main contributor, are quite ambitious and most likely cannot be achieved without reducing the emissions in the transport sector. Most Member States have already gained (some) experience with transport-related CO_2 policies and their effects, but it is essential to gain further insight in the pros and cons of various policies. Continued learning from experiences is needed to improve these policies and make them more effective and robust. In this pilot project policy experiences of different EU countries are shared.

The objectives of the pilot project are:
1. To compare the country policies of a number of European countries with respect to actual CO_2 emissions in the transport sector.
2. To benchmark a number of policy instruments that aim to reduce CO_2 in the transport sector.

To assess whether the instrument 'Benchmarking' can support environmental policy in the transport sector and to identify the conditions that need to be fulfilled for Benchmarking.

These objectives have been established in a joint effort of country teams (Belgium, the Czech Republic, Denmark, Finland, France, Germany, Italy, the Netherlands, Spain, Sweden and the United Kingdom), the project team at the Dutch Transport Research Centre (AVV), specialists of international organisations (CEMT, EEA, Eurostat) and the consultant-team (ECN and COWI).

The results of this project must be considered as a result of a pilot exercise. From this perspective, process results with respect to benchmarking as a useful instrument to reduce CO_2 emissions in the transport sector (third objective) are just as important as the comparison of country policies and the benchmarking of a number of CO_2 instruments.

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[1] In a recent report, the European Environmental Agency writes: "Attempts to control greenhouse gas emissions vary between sectors. Increases from transport are a particular problem, with carbon dioxide emissions from the sector (21% of total emissions) increasing by 18% between 1990 and 1999 due to road transport growth in almost all Member States" (EEA, 2002).

In June 2002 a workshop was held in Madrid to discuss a practical approach to establish a benchmark while considering the existing limitations in availability of comparable country data. This led to a decision to focus on benchmarking a limited number of policy instruments and to refrain from an in-depth assessment of country policies for reducing CO_2 emissions from the transport sector.

In addition to the Madrid meeting another meeting with the participating countries was held in Helsinki (in December 2002) with the aim to discuss the pilot results and finalise the report.

1.2 Project focus

It has been decided to focus this pilot project on road transport only, as it covers most of the CO_2 emissions in the transport sector and is responsible for a significant share of the growth of the emissions. This means that focus is mostly on passenger cars and trucks, which account for approximately 85% of all transport related CO_2 emissions. Effects of modal shift (from road to rail or water) are consequently also investigated, instruments that aim to improve the efficiency of modes other than road transport, for example, are however not considered.

The following instruments are included in the benchmark:[2]

- CO_2 differentiation of fuel tax
- CO_2 differentiation of road and sales tax
- Road/km/congestion pricing
- Tradable CO_2 permits
- (Highway) speed limits
- CO_2 emission standards/voluntary agreements on fuel efficiency
- Freight transport measures: telematic systems, increasing freight logistics, (allowed) load factor etc.
- Stimulation of biofuels
- Eco-driving, including on board devices
- Modal shift passenger transport
- Modal shift freight transport.

For the benchmarking of the instruments, the following criteria have been used:[3]

- CO_2 reduction effect
- Cost-effectiveness (costs per ton CO_2)
- Budget implications
- Political/public acceptance
- Speed of implementation
- Reversibility
- Transferability.

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[2] During the project meeting in Madrid (25 June 2002) this list was decided upon by the participants.

[3] These criteria were decided upon in Madrid as well. Uncertainties in the CO_2 effect and cost-effectiveness reduced will be dealt with. An extra criterion added after the Madrid meeting is the budget implication (costs for the government).

1.3 Overview of this report

Chapter 2 starts with a discussion on country policies towards limiting greenhouse gas emissions. The focus of this chapter is on policies for transport related CO_2 emissions but the ambition levels of national targets to mitigate greenhouse gas emissions are also discussed. In Chapter 3 the above benchmark criteria will be defined. Chapters 4, 5, 6 and 7 present the results from the questionnaires on the selected policy instrument. These chapters also include benchmark assessments. For these benchmark assessments information from other sources has also been added. Policy instruments have been divided into 4 categories: fiscal and financial policy instruments (Chapter 4), regulatory policy instruments (Chapter 5), policy instruments for technology and fuel (Chapter 6) and policy instrument for awareness, behaviour and training (Chapter 7). Chapter 8 presents an overview and discussions of the results. The final chapter covers the discussion and recommendations.

2. COUNTRY POLICIES

2.1 Introduction

Transport is a crucial factor contributing to people's welfare as it plays an important role in practically all economic and social activities. Transport policies are also aiming to optimise welfare. Investments in transport infrastructure for example are usually based on the expectation that it will result in a net welfare gain. While it has such a very significant role in society, it also leads to significant external effects through its impacts on land use, accidents, noise production, congestion and emissions of acidifying compounds, ozone precursors and greenhouse gases. Governments look for welfare increases through transport policies aiming at an optimal balance between welfare gains such as time savings in transport and the external effects (welfare losses) resulting from transport activities and there are inevitably trade-offs. Country policies to reduce CO_2 emissions from transport are usually regarded and evaluated with this background in mind.

This chapter presents a comparison of policies of countries with respect to CO_2 emissions in the road transport sector. Section 2.2 presents background information on trends in greenhouse emissions and Kyoto targets per country. In Section 2.3 a set criteria of 'good policy' is presented. In Section 2.4 national policies are compared based on these criteria and attention is paid to examples of good policy drawn from the country questionnaires. Section 2.5 presents the conclusions on country policies.

It should be noted that the question *how* countries decide which policy instruments to reduce CO_2 emission from the transport sector should be implemented is only partially considered in this study. Full consideration would involve questions such as how policy measures for emission reduction can be placed on the political agenda, how optimal interact with stakeholder groups can be achieved and how risks from indirect effects can be reduced. As the political process differs from country to country, it is expected that the answers to the above questions will also show differences between countries.

2.2 CO_2 emission trends and targets

National trends in CO_2 emissions and gap towards the Kyoto targets

Policies to reduce CO_2 emissions from transport are not only part of the full set of transport policies, they should also be part of national policies to reduce greenhouse gas emissions. If a national greenhouse gas emission target is relatively difficult to achieve, one would expect more ambitious targets for the transport sector. Some countries in the EU have national GHG emission targets that turn out to be relatively difficult to achieve. From Figure 2.1 it can be concluded that there is a significant gap between the projected emissions and the targets for 2010 in Spain, Portugal, Ireland, Austria, Belgium, Finland, Italy and the Netherlands. On the other hand, Germany, Sweden and the United Kingdom seem to be on track towards achieving their targets.

The relative gap can to an important extent explain possible differences in countries' ambition levels to reduce transport-related CO_2 emissions. All other things being equal, one would expect more intensive policies in the transport sector in countries with a large emission gap.

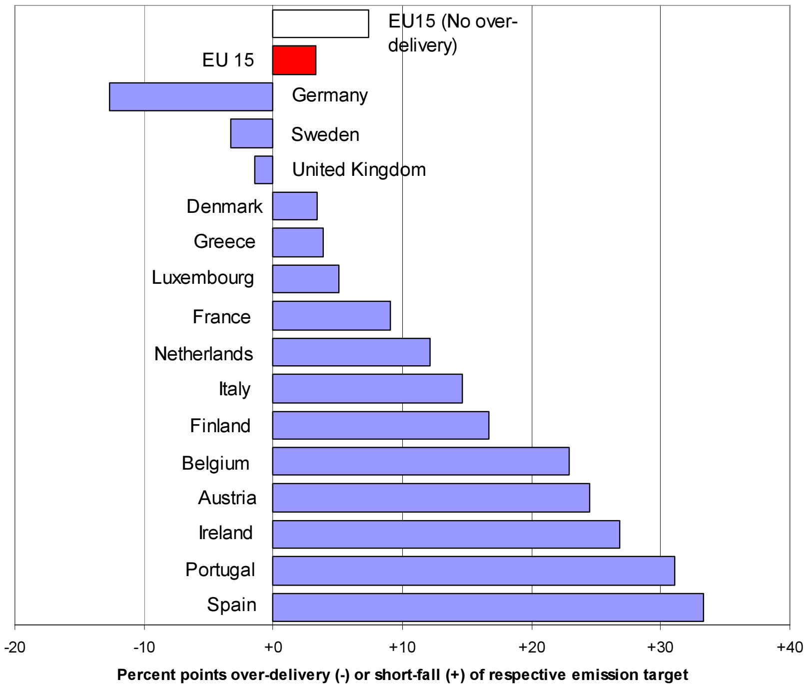

Figure 2.1 *Relative gap (over-delivery or shortfall) between measures projections of national emissions and targets for 2010 for EU 15 and Member States (EEA, 2002)*

Trends in transport related CO_2 emissions

In many EU countries a decrease in CO_2 emissions occurred in most sectors. However, without any exceptions, emissions from transport showed a significant growth, see Figure 2.2. On average the European Union's CO_2 emissions from road transport increased by 18% in the last decade. Differences between countries are significant. Transport related CO_2 emissions in the Czech Republic and Spain increased rapidly with approximately 30%. At the same time, the increases in Finland, Sweden and the UK were much smaller.

The strong increases in the Czech Republic and Spain seem to be linked with the starting situation in 1990 when CO_2 emissions per capita were significantly lower than in other EU countries (see Figure 2.3). Between 1990 and 2000 the Czech Republic and Spain were catching up with the other countries. As a result these countries had a stronger coupling between economic growth and CO_2 emissions from transport activities. In other countries some decoupling of economic growth en transport related CO_2 emissions occurred.

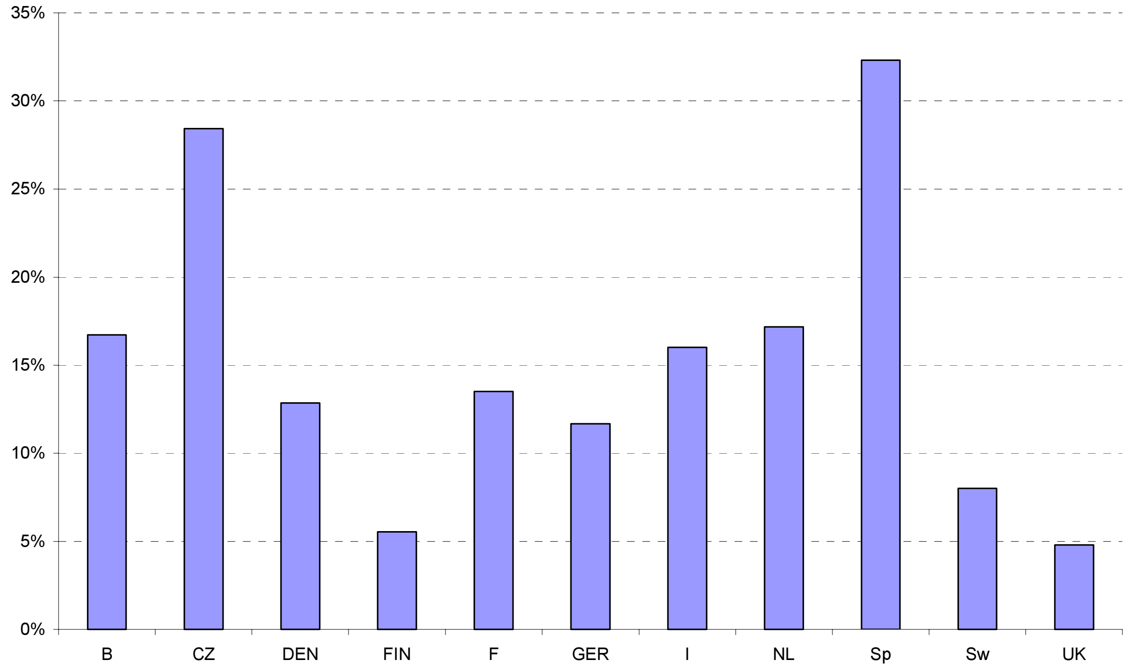

Figure 2.2 *CO_2 emission growth in the transport sector between 1990 and 2000 (based on data from country submissions)*[4]

Figure 2.2 shows that CO_2 emissions from transport increased less in Finland, Sweden and the United Kingdom during the 1990s compared to other countries. This development may be partly related to CO_2 policies but it is not possible to state what fraction was caused by such policies. Finland and Sweden already had next to Denmark the highest per capita transport emissions in 1990, so possibly some saturation effects in the demand for transport occurred. Furthermore, both countries went through a deeper recession than most other countries during the first half of the decade. For the United Kingdom the explanation is probably different, as the recession in the first half of the 90's did not hit the UK as hard. The slow increase in Britain is instead partly a result of the fuel escalator that raised diesel and petrol prices to among the highest in the world.

Reducing transport-related CO_2 emissions turns out to be difficult. In a recent report, the IEA even states that: "Yet it is apparent that measures to mitigate climate change in the transport sector have, to date, had little if any effect on GHG emissions."[5] One of the reasons for this is the inherent linkage of the transport sector with other sectors. To quote one of the countries: *"Transport [...] is more like a 'transmitting service sector' whose development depends on the other sectors [...]."* So, substantial policy effort is asked for to get things moved.

4 The latest Danish estimation gives an emission growth of 16% for Denmark, which differs from the percentage in the graph.

5 International Energy Agency, Dealing with climate change – policies and measures in IEA Member Countries - 2002 edition, IEA, Paris, October 2002.

2.3 Criteria for comparison of countries[6]

In Madrid it was decided to focus the country benchmark on examples of good policy. The following criteria of good policy were discussed.

Good policy has ambition
Ambition is related to goals. If a quantitative goal has been decided upon, chances are better that policies will have an impact. The ambition level may be considered in relation to the ambition level of the Kyoto target of a country. In relation to the effort made policies should significantly reduce CO_2 emissions. In addition, good policy should also be acceptable to the public, be sustainable, it should control negative side effects, be easy to implement (no technical, organisational and legal constraints) and preferably have more benefits than CO_2 reduction only (increase of safety, prevention of air and noise pollution etc.). Further, it should be cost-effective implying that it is:
1. effective in meeting the desired goals,
2. that the welfare benefits outweigh the welfare cost,
3. no alternative opportunities exist that will lead to more welfare benefits.

Good policy is SMART
SMART means (1) Specific (i.e. concretely formulated); (2) Measurable (to observe whether targets are achieved); (3) Agreed upon in an official document (to embed them and make them explicit); (4) Realistic (in terms of time and money) and (5) will be achieved at a fixed point in Time.

Good policy is well-grounded
It should be based on a thorough problem analysis, a theory (plausible link between problem and policy that should solve the problem), an ex-ante evaluation of direct effects and additional effects (such as rebound effects; effect in the long run, robustness), preferably showing some alternative scenarios and, finally, a cost-effectiveness analysis (including free rider effects).

Good policy is monitored frequently
Data monitoring is required in order to evaluate policies and - if reasons occur - to adjust them.

Good policy is evaluated (ex-post)
Based on monitoring data, ex-post analysis provides insight in the achievement of targets, the estimated and realised costs (including free rider effects) and an overview of the problems encountered during implementation (if any). Results can be used to fine-tune new policy (learning experience).

For the comparison of country policies, the above criteria will be used. The analysis is based on submissions by the participating countries.

2.4 Comparison of country policies

2.4.1 Are policies ambitious?

At first sight, it looks attractive to simply draw conclusions about the ambition level of policies on the basis of the CO_2 reduction targets of countries. Following that line of reasoning, countries with an absolute reduction target can be judged as being more ambitious, compared to countries that aim at stabilisation or reduced growth of emissions. However, this is not considered to be fair, since countries face different starting positions for size, structure and use of the vehicle fleet. The causes for the different starting positions include differences in income per

[6] This section is drawn from the Madrid working document with small adaptations.

capita, geographic location, population density and past transport policies. They have resulted in different levels of national road transport CO_2 emissions per capita and different trends, as Figure 2.3 clearly shows. Per capita transport related CO_2 emissions were twice as high in Finland (3 ton CO_2/capita) then in the Czech Republic (1.3 ton CO_2/ per capita). The relatively high per capita emissions in Finland seem to be linked with Finland's low population density, which leads to more transport per unit production and per person than in other more densely populated countries. The cold climate in Finland also contributes to higher CO_2 emissions. The relatively low per capita emission in the Czech Republic is a result of the Czech per capita income that is less than in Western European countries. Strikingly, a large group of countries, which also have different situations, show emission levels per capita that are quite similar. Eight out of eleven countries had in 2000 per capita CO_2 emission levels that fell in a relatively narrow range between 2 and 2.3 ton CO_2 per capita.

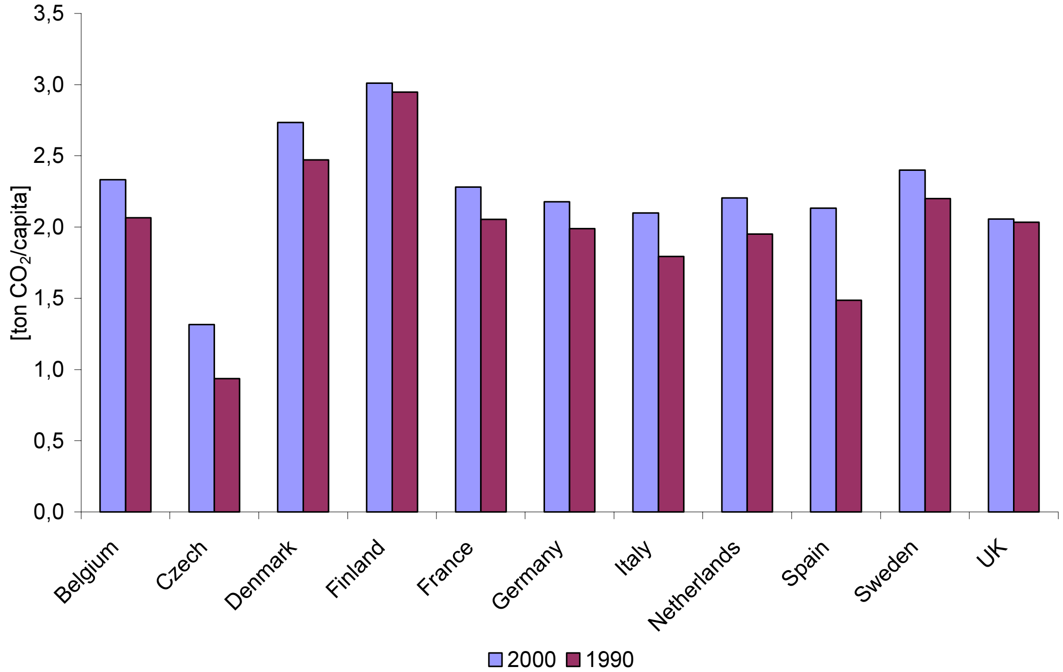

Figure 2.3 *CO_2 emissions per capita in 1990 and 2000 (total transport sector)*

Countries also have different expectations about the future emission trend. This difference in starting position can be translated in different trend developments of CO_2 emissions between 1990 and 2010. To choose the two extremes in Table 2.1, there is Spain on the one hand, with an expected 73% growth of emissions in the period 1990-2010 according to trend development and Finland on the other hand with an increase of only 4% in the same period. It seems therefore better to assess the level of ambition on the basis of the difference between trend development and the development according to the policy scenario. Table 2.1 shows that most countries attempt to lower the growth of CO_2 emissions with their policies.

From Table 2.1 it can be concluded that Belgium, Finland, Germany and Sweden show ambition in the short term (until 2010). France and Denmark show some long-term ambition. The other countries show unknown or lesser ambition. However, ambition is also related to the policy instruments already agreed upon.

In addition to the policy scenario, the actual CO_2 reduction target provides information about the level of ambition as well. Some countries do not have a specific CO_2 target for the transport sector. This makes it difficult for those countries to judge their own policy performance ("where do we aim at?"). Some countries aim at more reduction than possible according to the policy scenario: this implies that they require additional measures to achieve the target.

Table 2.1 *CO_2 emissions from (road) transport per country: trends, projections and targets*[1]

Country	CO_2 emission trend road transport 1990-2010	CO_2 emission growth 1990-2010 according to policy scenario	CO_2 target 2010 for the (whole) transport sector	CO_2 policy focus road transport
Belgium (Flemish part)	+ 32%	+ 7%	Stabilisation of emissions in 2010 at 1990 level	Modal shift
Czech Republic	?	?	?	?
Denmark	+ 32% (including ACEA)	?	No target for 2010; long term target is minus 25% in 2030 compared to 1988	Fiscal and financial instruments
Finland	+ 4%	+ 0%	Stabilisation of emissions in 2010 at the 1990 level.	Wide package of instruments (including ACEA) aiming at modal shift and reduction of transport demand
France	+ 38%	+ 24% (existing measures) + 18% (with additional measures)	Stabilisation of emissions in 2020 at the 2010 level (+ 18% compared to 1990)	Modal shift
Germany	+ 7% (1997-2015)	- 1% (1997-2015)	Reduction of 15 - 20 Mton in 2005 compared to a business usual-scenario (comprising all measures taken until 1998).	Fiscal and financial instruments/ACEA/informatio n
Italy	?	?	?	?
Netherlands	+ 34%	+ 28%	Between 1989 and 1999 the CO_2 reduction target for 2010 was -10% compared to 1986 emissions. Currently there is no CO_2 target for the transport sector.	Fiscal and financial instruments supported by regulatory instruments and information (e.g. eco-driving and highway speed limits)
Spain	+ 73%	+ 47%	No target	Modal shift
Sweden	+ 15-25%	no such scenario exists	Stabilisation of emissions in 2010 at the 1990 level	Modal shift road-rail/subsidising alternative road fuels/eco-driving campaigns
United Kingdom	+21%	+ 3%	No formal target. Anticipate 5.6 MtC saving over 2000 baseline by 2010.	Package of policies with significant role for fiscal incentives for lower emissions from road vehicles, and modal shift. ACEA.

[1] More details can be found in Table 2.2 at the end of this chapter

Based on the country submissions, it is in many cases not clear how individual instruments or packages of instruments (the policy focus) contribute to reducing or lowering CO_2 emissions.

The difference in choice for policy instruments between countries is striking. Whereas Belgium, Spain and France focus their CO_2 policy mainly on instruments related to public and freight transport (modal shift), the Netherlands does not expect so much from e.g. public transport policy: "*Public transport policy nowadays can only be seen in maintaining and expanding the relative dense train infrastructure, as well as the services of tram, metro and bus. This policy is not so much focused on 'forcing' people into public transport, but on solving capacity problems.*"

All countries have fuel taxes, but the level of these taxes differs per country. In addition significant differences in vehicles taxes exist. The United Kingdom has recently differentiated its vehicle taxes on the bases of the cars CO_2 emissions. The Netherlands, United Kingdom, Denmark and Germany have a relatively strong focus on economic instruments. These countries have started, have planned or are considering new financial instruments such as differentiated vehicles taxes, fuel tax escalators and road pricing.

Some countries, such as Finland, United Kingdom, Netherlands and Sweden report that they have (or had) integrated national transport policy plans, which combine a set of complementary measures, which are implemented synergistically. Finland reports that "*...but for use it has been* *more important to establish policy packages which do not only aim at reducing CO_2 emissions, but promote also other environmental and safety targets."* In a recent report the FCCC secretariat[7] counts the integrated national policy plans under the few effective and innovative policies.

From the information of the questionnaires it can be concluded that none of the countries considered has exhausted the wide range of possible choices for policy instruments to reduce CO_2 emissions.

2.4.2 Are policies SMART?

In Section 2.3, SMART policy is explained as being specific, measurable, agreed upon, realistic and time-related. For the purpose of this section, SMARTness is translated in four relevant issues:

- involvement of target groups in formulating policies/targets (agreed upon, support),
- relation to national Kyoto target (embedded in national policy, time-related),
- interference with other transport-related CO_2 policies (taking into account the effect of other policies, realistic),
- interference with other policies.

In this case, policies are specific as they relate to the transport sector and (overall) measurable (development CO_2 emission in the sector).

Involvement of target groups and stakeholder groups

Countries differ in their approach whether or not to involve target groups in the policy-making process, see Table 2.2. Some countries (such as Spain and Finland) choose for close interaction with target groups during the formulation of policies (bottom-up process) while in other countries (e.g. Germany) it is a government decision (top-down). Based on the country submissions, it is not possible to assess which of the two approaches is more effective (or smart). However, it seems attractive to profit from the knowledge of target groups in formulating realistic policies (without over-asking) and increase their commitment by involving them in the decision-making process.

Relation with the Kyoto target

How ambitious should policies be in relation to the Kyoto target of a country? Figure 2.4 gives an overview of the Kyoto emission reduction targets for the eleven countries participating in this benchmark study. More details are given in Table 2.2 (end of chapter).

[7] Secretariat of the United Nations Framework Convention on Climate Change.

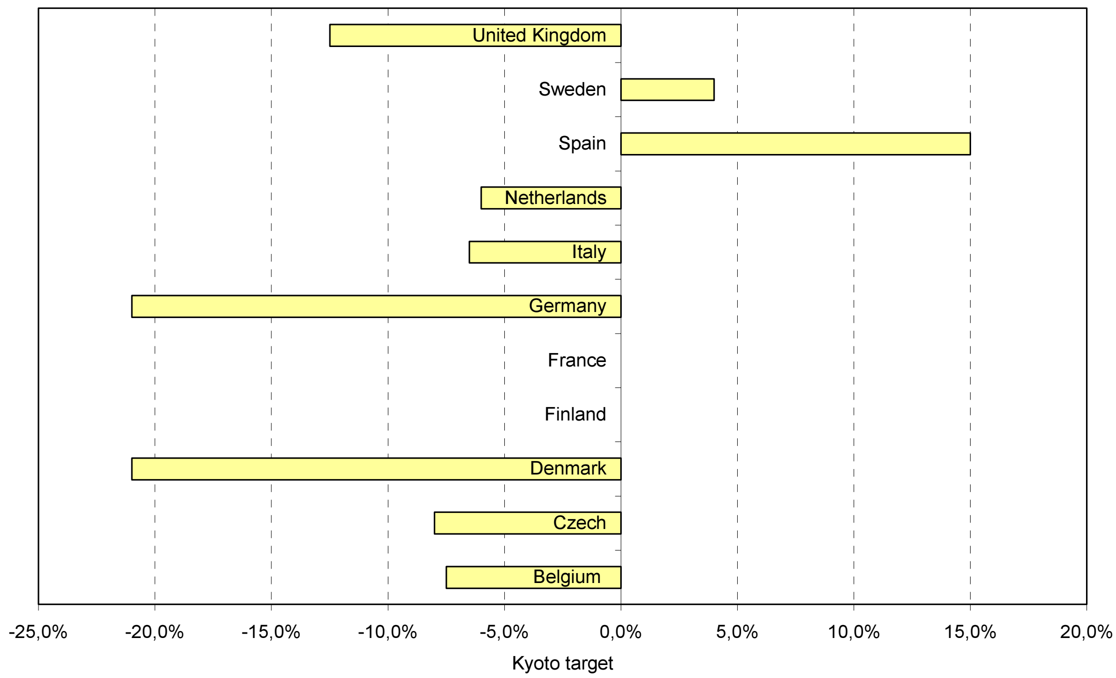

Figure 2.4 *Emission reduction targets for greenhouse gas emissions in first budget period of the Kyoto Protocol (2008-2012) compared to 1990 emission levels of CO_2, CH_4 and N_2O and 1995 emission levels of HFCs, PFCs and SF_6.*

Linking their CO_2 transport policy with national CO_2 policy (Kyoto) is difficult for most countries. Table 2.1, shows that some countries (Belgium, Finland, Sweden) aim at stabilisation of emissions in the transport sector. For Belgium, this means that the Kyoto target of minus 7% has to be realised by other sectors, but is - in theory - not frustrated by growing emissions in the Flemish transport sector (emissions did grow after 1990, so the current situation is that CO_2 emissions in the transport sector should decrease). Other countries (Denmark, Netherlands, Spain) do not have a CO_2 target for the transport sector at all and allow further (but reduced) growth of emissions. This probably means that other sectors and purchase of emission reduction abroad via Joint Implementation, CDM or emission trading have to compensate for emission growth in the transport sector.

In 2000, Czech, Finland, France, Germany, Sweden and the UK seemed to be on track to reach their burden-sharing target (EEA, 2002), despite growing emissions in the transport sector (except for Finland with a slight emission reduction). Belgium, Denmark, Italy, the Netherlands and Spain were not on track. For a large part, this is due to growing transport emissions (this is also the case for Spain where national 2010 emissions are allowed to grow compared to 1990).

Interference with other transport-related CO_2 policies

In all countries CO_2 policy for the transport sector involves various policy instruments. These policy instruments may interact. The combined effect can be larger or smaller than the sum of the effects of the two measures. Several countries, such as Finland and the UK explicitly mention the relevance to consider such interactions and to design a package of policy instruments that takes these interactions into account.

Influence of other policies

Every country has both policies that directly or indirectly drive transport-related CO_2 emissions up and policies that limit these emissions (see Table 2.2, end of chapter). When a strategy to reduce transport-related emissions is considered it is better to be aware of the fact that those policies that lead to an increase in transport volume will likely reduce the absolute CO_2 reduction of CO_2 policies. CO_2 policy can only be judged as smart if it is integrated with all other policies that have direct or indirect effects on CO_2 emissions and if the interactions between policy instruments are taken into consideration. Especially, insight in the effect of policies with a counterproductive CO_2 impact is desired. With respect to other policies that have an impact on CO_2 emissions, several countries refer to investments in road infrastructure and policies to increase safety. It is considered that under most conditions investments in road infrastructure will have a counterproductive impact on CO_2 policies as it leads to a growth in capacity that allows a latent demand for additional transport activities to become realised.

Countries hardly mention policies that are not directly related to the transport sector. Still some of these policies may have a significant impact on the CO_2 emissions of a country. Thus it appears that while transport policies seem to be integrated in most countries, there is ample room to take CO_2 emission effect into consideration in discussions on policies that are not directly focussing on transport. Finland is an exception by explicitly mentioning related policies such as land use planning, information technology and employment and regional policies.

2.4.3 Are policies well grounded?

If they are carried out in the policy preparation process, ex-ante evaluations should usually provide enough information to judge if CO_2 policies for the transport sector are well-grounded or not. The ex-ante evaluations usually provide information on several questions including:

- Is the policy based on a thorough problem analysis and backed by a theoretical framework?
- Has an ex-ante evaluation be carried out of the direct and indirect effects?
- Has a cost-effectiveness analysis been carried out to weigh welfare cost and benefits involved?

In almost all countries some ex-ante evaluations of the effect of policies have been carried out, but it is unclear if all policies are first evaluated before they can be implemented, see also Table 2.3. Limited information was also provided on how the evaluations were carried out.

Based on the country submissions, it is difficult to assess the quality of the evaluation methods used by the various countries. There is ample opportunity for countries to learn from each other's ex-ante evaluation knowledge and experiences. Questions to be considered then are: How do countries integrate developments in other sectors (possibly leading to volume growth in the transport sector) in their forecasts, for example? What major assumptions are made and how sensitive are model results for these assumptions? It would be interesting to know, for example, whether the ex-ante evaluation of emissions in the transport sector in the Netherlands would be different when using the national lowest cost approach of Denmark and Finland.

About two-thirds of the countries mention cost-effectiveness to be an issue. Little information is provided how the cost assessments are being performed. It can be based on different perspectives: the cost for the government, cost for the transport sector and cost from a national point of view. It appears that evaluation rarely included a cost-benefit analysis, with the United Kingdom being an exception.

2.4.4 Are transport data monitored so they can be used to evaluate policies?

To be able to analyse trends in the transport sector, proper monitoring is a prerequisite. A well-filled database provides insight in relevant developments (amount of vehicle-km per road type, passenger-km per mode, ton-km per mode, amount of vehicle-km, type of vehicles, fuel mix, fuel prices, traffic speeds, etc.). This insight can be used to evaluate the effect of policies (see next section). For the monitoring of some instruments additional data needs to be collected (e.g. amount of subsidy granted) in order to assess their cost effectiveness and determine the amount of free riders (if applicable).

In most countries, a monitoring programme for transport data already exists and is part of the national statistical surveys (see Table 2.4). In their submissions, most countries do not provide insight whether monitoring data (especially emission development) is used in the policy process to adapt existing policies or implement new measures. Germany does use the data. Roughly every three years, the transport sector (as well as the other sectors) has to prove what progress has been made (see next section). In Finland, monitoring data are used in the policy process (see next section), too.

Transport data should also be of sufficient quality to use. Currently the quality of such data (at least at EU level, but probably also at national levels) hinder full in depth policy benchmarking.[8]

A detailed monitoring system would also be helpful in identifying new trends such as a strong increase of the market share of sport utility vehicles, which leads to relatively high CO_2 emissions.

2.4.5 Are policies monitored and (ex-post) evaluated?

In ex-post policy evaluation, the energy use and CO_2 emissions measured or modelled after a measure is introduced are analysed and compared with original policy targets and expectations (which were formulated according to ex-ante evaluations such as scenario studies). Ex-post policy evaluation is linked to the following questions:

- What happened (trend development)?
- How did it happen (development of CO_2 intensity, specific CO_2 emission)?
- Why did it happen (relation with autonomous technical progress, energy prices, *policy instruments*)?
- What are the side-effects (cost of policy instruments, free-rider effect, effectiveness)?

Insight in the 'why' question is needed to know the effect of policies, insight in the side-effects such as the total costs of an instrument and the amount of free riders provides information about the cost-effectiveness. Monitoring information and evaluation results provide valuable information, not only for the country itself but also for other countries to learn from.

In almost all participating countries, a transport policy monitoring programme has already been implemented (Finland, France, Germany, the Netherlands, Sweden, UK) or will be implemented in the near future (Belgium, Denmark), see Table 2.5 (end of chapter). At this stage, only Finland, Germany and the Netherlands indicated that to some extent ex-post evaluations of policy packages (not individual instruments) have been carried out. In Finland, this is done every year and in Germany approximately every three years. In the Netherlands, the climate policy was evaluated recently. The evaluation made clear that evaluation and monitoring practices could significantly be improved for policies and measures in all sectors, including transport.

For most countries, it is not clear when a new policy evaluation will take place. The Netherlands has announced a new evaluation of climate policy, to be finalised in 2005.

[8] Comment by W. de Ridder (EEA).

2.5 Conclusions

Countries have different ambition levels to reduce their CO_2 emissions
Some countries have explicit CO_2 emission targets for the transport sector. In this way Belgium, Finland, Germany and Sweden show ambition in the short term (until 2010). France and Denmark have long-term reduction targets. Ambition is also related to the policy instruments already agreed upon.

In most countries, the ambition level of CO_2 policy in the transport sector does not clearly correspond with the ambition of national climate policy (Kyoto target); the embeddedness of the transport sector in national CO_2 policy seems weak. In none of the countries the CO_2 target for transport is more stringent than the Kyoto target for the whole country. Unlike greenhouse gas emissions from other sectors, transport-related CO_2 emissions are allowed to grow.

All countries have policies in place which were not designed to reduce CO_2 emissions but which had significant effects on CO_2 emissions
All countries have policy instruments in place in the transport sector which were not designed to limit CO_2 emissions but which were e.g. aiming at generating government revenue (fuel taxes and vehicle taxes), limiting congestion and improvement of safety (speed limits). Such policies did have some effects on transport-related CO_2 emissions.

Countries have different choices for policy instrument to reduce CO_2 emissions
Countries have significant differences in their choice for policy instruments. While some countries (Belgium, France, Spain) seem to focus their CO_2 policy mainly on instruments related to public and freight transport (modal shift), other countries have a relatively strong focus on economic and fiscal instruments. These countries have started, have planned or are considering new financial instruments such as differentiated vehicles taxes, fuel tax escalators and road pricing. Some other countries, such as Finland, United Kingdom, the Netherlands and Sweden report that they have integrated national transport policy plans, which combine a set of complementary measures. Additional potential for policy instruments exists in all countries as no country has exhausted the large range of possible policy instruments.

Some countries integrate stakeholders in the policy making process
Some countries have chosen to closely interact with target groups during the formulation of policies (bottom-up process) while in other countries it is a government decision (top-down). It seems attractive to profit from the knowledge of target groups in formulating realistic policies and increase their commitment by involving them in the decision-making process.

Effects of non-transport policies with effects on transport emissions are usually not considered in CO_2 policies
Reduction targets in the transport sector are likely not realistic as long as CO_2 policies are not integrated with other policies.

Evaluations of policy instruments play a small role in the policy-making processes
Although ex-ante evaluations of policy packages have been carried out by most countries, their role in the policy process seems rather limited. Ex-post evaluation of policies is not common practice. No broadly accepted method exists how to evaluate effects of policies. Therefore, results from evaluations can usually not be compared as different countries use different methods and the assumptions are often not available. In most countries, a monitoring programme for transport sector already exists and is part of the national statistical surveys. In their submissions, most countries do not provide insight whether monitoring data (especially emission development) is used in the policy process to adapt existing policies or implement new measures

CO_2 emissions from transport have increased but the level of increase differs between countries

Transport-related CO_2 emissions are increasing in all eleven EU countries that were considered in this study. On average emissions increased with 18% between 1990 and 2000. Countries that had relatively low transport-related CO_2 emissions per capita in 1990 experienced more growth until 2000 (approximately 30%) than countries with high CO_2 emissions per capita (5-15%). Transport related CO_2 emissions are expected to increase further between 2000 and 2010.

Differences in emission trends seem more related to country specific circumstances than to CO_2 policy

No consistent information is available what the impact of policies to reduce CO_2 emissions from transport was on CO_2 emissions. In general this impact is considered to be small. In those countries that experienced only little growth in CO_2 emissions, this trend seemed largely a result of autonomous developments such as transport demand saturation effects and low economic growth. The contribution of explicit CO_2 policy to 'bending down the trend' is considered to be small. Transport policies that were originally implemented for other reasons most likely had a larger CO_2 reducing effect. Consequently, one cannot compare the relative success of CO_2 policy for the transport sector simply on the basis of development of CO_2 emissions during a certain a period.

Comparison of national policies to reduce transport related CO_2 emissions appears to be complex

Benchmarking of national policies to reduce CO_2 emissions from transport appears complex. Several factors cause this complexity:

- Starting situations to reduce CO_2 emissions from the transport sector (e.g. population density, income per capita, economic growth, climate, composition of the car fleet, tax levels) differ between countries
- All countries have already applied a mix of policy instruments which did not have the purpose to reduce transport-related CO_2 emissions but which did have significant effects on past CO_2 emission trends.
- Limited availability of evaluations.
- No broadly accepted methods exist how to evaluate effects of policies. Such methods are missing both for ex-ante and ex-post evaluations.
- Policy instruments to reduce transport-related CO_2 emissions also serve different purposes. This also complicates comparison.

Table 2.2 *Overview of CO_2 policies of European countries: involvement of target groups, relation with national Kyoto target and influence of other policies*

Country	Involvement target groups in formulating policies/targets	Relation to national Kyoto target	Influence of other policies
Belgium (Flemish part)	In formulating both the Transport Policy Plan and the Climate Policy Plan, stakeholders have been involved.	So far no strict relationship with Kyoto target. When the Flemish Kyoto target will be allocated to the different sectors, the target of the Transport Policy Plan will be taken into account.	Infrastructure investments are reported to have a counterproductive impact on CO_2 policies.
Czech			
Denmark	The government's strategy is to reduce national CO_2 emissions in those sectors where measures are most cost-effective. However, each sector is expected to contribute in some way to the fulfilment of the target. Each sector sends in a list of possible measures with attached shadow prices. The list is accompanied by a projection of emissions in the sector in 2012.	?	Policies regarding safety and promotion of accessibility have a supportive impact on CO_2 policies.
Finland	The Finnish target has been defined in the National Climate Change Strategy. The transport targets and measures to be taken have been defined in a close co-operation with relevant partners (transport enterprises, operators, interest groups, NGOs).	The target of the transport sector is linked to the national Kyoto target.	Policies regarding safety, promotion of accessibility and mobility and land use are reported to have supportive impact on CO_2 policies.
France	France has a 'National Programme for tackling climate change' (PLNCC) since January 2000. Principal interest groups for the transport sector are the French members of ACEA.	French Kyoto target is to stabilise emissions in 2010 at the 1990 level. Target of transport sector allows further growth.	Policies regarding safety, other emission reduction than CO_2, land use and infrastructure investments (TGV) are reported to have supportive impact on CO_2 policies.
Germany	The decision to specify the target for the transport sector was made by the government without involving interests groups.	Germany committed to reduce ghg by 21% and has, by 2000. Before the Kyoto Protocol was agreed, back in 1990, the voluntary national target was set to reduce CO_2 emissions by 25% between 1990 and 2005. Since it is an ambitious target, it was decided to make the responsibilities more transparent per sector (such as transport).	Policies regarding other emission reduction than CO_2 (ecological tax reform), promotion of mobility (distance lump sum does no longer favour car commuting) and infrastructure investments (railway) are reported to have supportive impact on CO_2 policies. Policies regarding promotion of mobility (distance lump sum has considerable impact on the distance between living and working place) and business development policies (full deductibility of all energy/transport costs) are reported to have counterproductive impact on CO_2 policies.
Italy			
Netherlands	There has once been a discussion about targets for the transport sector with representatives of the sector, but no targets have been formulated.	National Kyoto target is -6% in 2010 compared to 1990, no allocation to transport sector.	Policies regarding safety and promotion of accessibility have a supportive impact on CO_2 policies, policies regarding land use (building of large residential areas on the outskirts of cities with poor connection by public transport) and infrastructure investments (roads) have a counterproductive impact.

-Continued-

Country	Involvement target groups in formulating policies/targets	Relation to national Kyoto target	Influence of other policies
Spain	The institutional body responsible of the future definition of a Spanish Strategy in front of Climate Change is the National Council of Climate (Consejo Nacional del Clima). This Council has headed the work of five working groups. One of them is the Transport and CO_2 group, leaded by the Secretary of Infrastructures and Transports of the Ministry of Development (and consisting of all relevant target groups). Conclusions of this Working Group are not yet integrated in the transport planning policies. A National Strategy is in course of redaction.	?	Policies regarding safety, promotion of accessibility, infrastructure investments (public transport) have a supportive impact on CO_2 policies.
Sweden	Target groups have not been involved (they were involved in the discussion of a report proposing a 15% reduction of emissions in 2020 compared to the 1990 level)	The Swedish commitment according to the EU burden sharing agreement is +4%. The Swedish parliament has adopted an overall target of -4%. Transport is the only sector to have been requested to meet a certain sectoral target.	Policies regarding to safety and promotion of accessibility are expected to have a supportive impact on CO_2 emissions. Policies regarding to emission reduction other than CO_2 (particulate filters for trucks), promotion of mobility (tax deduction for work related travelling costs), land use (out of town shopping centres), infrastructure investments (roads) and business developments policies (state subsidies for freight transport in the northern regions) are reported to have a counterproductive impact on CO_2 emissions
United Kingdom	The U.K. has promoted a working partnership with pressure groups, local communities, trade unions, local authorities and businesses. The response of these groups is deemed as critical as they can take direct action and can influence others by raising awareness of the need for action and providing practical advice.	The 5.6 MtC of CO_2 savings envisaged for transport are required to help meet the Kyoto target of a 12.5% reduction in greenhouse gases from 1990 levels and the more ambitious UK target of a 20% reduction in CO_2 emissions between 1990 and 2010.	Measures in the Government's 10 Year Plan for Transport aimed primarily at reducing congestion will also help to reduce CO_2 emissions. 10 Year Plan for Transport aimed at delivering the Government's objectives of a quicker, safer, more reliable transport system that has less of an impact on the environment

Table 2.3 *Overview of CO_2 policies of European countries - involvement of ex-ante evaluation*

Country	Ex-ante evaluation	Method	Cost analysis
Belgium (Flemish part)	A strategic environmental assessment (SEA) was carried out by a consortium of universities and Vito (Flemish Institute for Technological Research)	SEA includes all environmental, health and social aspects. Models were used to estimate the amount of kilometres travelled in 2010 and to estimate fuel consumption and emissions	?
Czech			
Denmark	No ex-ante evaluation of measures was carried out in connection with the 2001 study of the Ministry of Transport. Forecasts are taken from the basic projections of CO_2 emissions by the Danish Road Directorate. The only new measure planned by the government is a CO_2 differentiation of the registration tax on passenger cars The CO_2 reduction could be as high as 8% (i.e. is 2-3% for the sector as a whole).	The present government's strategy to reduce national CO_2 emissions is to reduce the emissions in those sectors where the lowest costs are. The model framework is primarily based on descriptions of the total economic costs of a measure. Other environmental externalities, which are particularly relevant in the case of transport will be described in qualitative terms. The method also tries to describe other aspects when possible such as welfare distribution, which includes the effect on firms and consumers.	The CO_2 differentiation of the registration tax on passenger cars is expected to be revenue neutral. The CO_2 reduction could be as high as 8% (i.e. 2-3% for the sector as a whole).
Finland	An ex-ante evaluation has been carried out in the context of the National Climate Change Strategy by the various research institutes (VTT-Technical Research Centre, ETLA-Research Institute of the Finnish Economy and Council of State and VATT-Government Research Institute on Economy).	The main principle was the macro-economic point of view, i.e. the measures in various sectors were considered as a package, starting with those measures that are most cost-efficient and proceeding towards such measures that are less cost-efficient despite of the sector where the measures are to be implemented. Such economic ex-ante analysis was carried out for the whole National Climate Change Strategy, not individually for its separate sectors.	
France	An ex-ante evaluation has been carried out to determine the effect of measures.	?	?
Germany	An ex-ante evaluation has been carried out by DIW/Öko-Institut/Forschungszentrum Jülich/FhG-ISI: Policy Scenarios for Climate Protection (1997 and 1999)	The model named IKARUS has been developed from 1990 to 1995. It consists of three different scenarios and their impacts on CO_2 emissions in 2005: 'Without measures', 'With measures' (takes into account the measures passed before October 1994), 'With further measures' (proposes additional measures helping to realise Germany's climate target for 2005).	Total economic cost for realising the CO_2 reduction of 25% ('with further measures') are 5,47 bill. DM p.a. (+ 0,8% compared to scenario 'with measures'), if a global CO_2 reduction is implemented.
Italy			
Netherlands	Effects of policy measures have been evaluated ex-ante. These evaluations were most often carried out by RIVM and/or ECN.	In short the method consist of model studies, based on scenarios that are developed by national institutes in the field of (socio)economics, spatial planning and traffic & transport. Included in those scenarios are policy instruments that are decided upon. For a more detailed, see Chapter 2 of the Fifth National Environmental Exploration (MV5).	? (specified budget for Climate Policy for the period 1998-2011)
Spain	Transport emissions are included in the energy sector forecast analysed by the Prospective Working Group MINER-I.D.A.E.-MEH.	Forecasts with a basic savings scenario (implementation of some soft measures concerning energy efficiency and environmental awareness).	?

-Continued-

Country	Ex-ante evaluation	Method	Cost analysis
Sweden	No ex-ante evaluation has been carried out.	-	-
United Kingdom	An ex-ante evaluation study has been completed to solidify the target. This was produced alongside the publishing of the Climate Change Programme and was carried out for all sectors (not just transport) with the input of all the relevant departments. The UK undertakes 'Regulatory Impact Assessments' (RIA) before the introduction of all major policies. These discuss the purpose and intended effects of any policies, along with the risks, benefits, costs and impacts of the policies.	The impact of transport policies on CO_2 emissions has been assessed using a detailed transport model. This takes account of all modes of transport, their costs and economic growth in the UK.	The estimates source is from the Ten-Year Plan rather than the Climate Change programme RIA, as the Ten-Year Plan deals with Transport solely. Total public investment is estimated at £64.7 bn with a further £58.6 bn through public resource spend. This is for the period 2001/2 - 2010/11. This is equivalent to some 1% of GDP per year on average.

Table 2.4 *Overview of CO_2 policies of European countries - monitoring of transport data*

Country	Monitoring transport data
Belgium (Flemish part)	Each year emissions, fuel consumption, amount of vehicles and amount of passenger-km and ton freight-km are reported (Report on the Environment and Nature in Flanders and the Emissions Inventory).
Czech	
Denmark	Statistics Denmark and the Danish Road Directorate have a very good database on relevant issues, but no indicator monitoring system is in place. The abandoned 2001 Plan of Action contained a set of indicators and a plan for regular monitoring them.
Finland	The statistical reviews such as 'Transport and Communications Statistical Yearbook for Finland', 'Motor Vehicle Statistics' and 'Energy Statistics' published annually by the Statistics Finland provide relevant statistical data for the monitoring purposes. Moreover, the Vehicle Administration Centre provides data on newly registered cars and their energy consumption that is needed for the EU and national monitoring purposes.
France	Data collected are: • transport demand • Amount of vehicles, vehicles-km, specified for transport model • Fuel consumption • Prices (fuels, cars, tolls, public transport) • Environmental data
Germany	A long-term monitoring is foreseen every about 3 years when the next climate change programme is being finalised (foreseen for 2003), then the various sectors, e.g. transport, have to prove what progress has been made. All the mentioned data are collected.
Italy	
Netherlands	Several institutions gather information on transport indicators. Among those are the CBS (National Bureau of Statistics), RIVM and AVV. For transport emissions, there is a yearly monitoring program. In order of the Dutch inspection on the environment ('Milieu-inspectie') several institutes (CBS, RIVM, TNO, RIZA, AVV) carry out this emission monitoring. The data are published in 'de Milieubalans' (RIVM), on statline (www.cbs.nl) and in report of the inspection itself.
Spain	For the analysis of the Working Group on Transport and CO_2 the following data was collected: • Passenger transport in vehicle-km • freight transport in ton-km • travellers by mode • freight by mode • collective passenger transport in main intercity axes • urban transport in metropolitan areas (travel/person/day and modal sharing • number of cars and average km/vehicle • driving licenses • fuel consumption
Sweden	Data covering more than a dozen relevant parameters
United Kingdom	New car fuel consumption is recorded and monitored, due to the involvement of the UK within the Voluntary agreements. The key mechanisms for monitoring progress in the delivery of new investment schemes and CO_2 reduction policies in the UK centre on the collection of data and performance indicators. Transport Statistics Great Britain is compiled annually consisting of various historical data series on passenger and freight kilometres and environment issues. In monitoring the performance of public investment in transport responsibility is diversely but suitably allocated, such as annual local authorities reports on performance of local transport plans and Rail Regulator's setting and enforcing of performance targets for Railtrack. Specific reviews are planned for individual measures, such as changes to company car taxation and annual vehicle excise duty.

Table 2.5 *Overview of CO_2 policies of European countries - monitoring and evaluation of transport policies*

Country	Monitoring transport policies	(ex-post) evaluation	Method
Belgium (Flemish part)	A complete programme to monitor the effects of measures included in the Transport Policy Plan will be set up.	?	?
Czech			
Denmark	The Danish Ministry of Transport has recently decided to set up a general indicator based monitoring system for the general transport policy.	?	?
Finland	The government prepares annually a report for the Parliament on the measures taken in the context of the implementation of the National Climate Change Programme. The Ministry of Transport and Communications (as other ministries) prepares a review on sector-specific measures for this report.	Implementation of the Strategy and its effects are evaluated annually. As the implementation of the National Climate Chance Strategy is a continuous process, the partners and various groups are also involved in the evaluation process and developing the strategy further. Based on the evaluation it is analysed whether existing measures are sufficient or whether any additional measures are needed.	The LIPASTO calculation model has been designed to serve the needs of transport sector for monitoring and managing emissions effectively. (LIPASTO also contains emission forecasts until 2020 - so-called business as usual scenario without any policy measures). More information is available on the web-site http://www.vtt.fi/rte/projects/lipasto/
France	There is an annual meeting about PLNCC and a national survey of long term policies	No ex-post evaluation has been carried out	-
Germany	The various measures adopted and/or implemented will be monitored.	Ex-post evaluations have been carried out for total policy packages, rather than for individual instruments.	The Environment Ministry launched a study on the 'Economic Effects of Climate Change Policy - Understanding and Emphasising the Costs and Benefits', March 2000, which looks into the often perceived high costs, but the often underestimated benefits in models and reality. It is not a specific study on a certain sector, but looks at methodological aspects in general. However, it provides insights in the modelling and its limitations that should be kept in mind.
Italy			
Netherlands	In 2002, the Ministry of Environment released an evaluation of the current climate policy in which a.o. realised reductions and government expenditures of the various instruments were reported (Evaluatienota Klimaatbeleid).	A study by RIVM and ECN has indicated that without climate policy in the 1990's the CO_2 emissions of the transport sector in the Netherlands would have been about 1 Mton higher in 2000. However, a real ex-post evaluation of the Dutch climate policy on the instrument level has not been carried out yet.	
Spain	?	?	?
Sweden	The different state authorities for rail, road, sea and air transport every year report their actions to reach the targets of the transport policy. Another authority, SIKA (Swedish Institute for Transport and Communications Analysis http://www.sika-institute.se/english_fr.html), every year monitor the whole transport sector.	No ex-post evaluation has been carried out	-
United Kingdom	For the UK, a transport monitoring programme is in place. There will be a regular monitoring of progress under the Transport 10 Year Plan. The first progress report was published in 2002 (18 months after the start of the programme)	The 10 Year Plan will be subject to a review before the Government's overall spending review in 2004. There will also be a formal review of the overall Climate Change Programme in 2004. In addition, evaluations are planned of individual measures, including graduated company car taxation and vehicle excise duty.	The 10 Year Plan review will involve a range of detailed studies. Transport models will be used to assess whether targets for 2010 are likely to be met.

3. CRITERIA FOR BENCHMARKING INSTRUMENTS

This chapter provides an overview of the benchmark criteria. The definitions below are ideal in the sense that much of the information contained in the country replies do not fully confirm to them. The purpose of the definitions is to establish a common basis of understanding of the criteria, and to facilitate a comparison of the analyses of the individual instruments.

CO_2 reduction
This criterion assesses the potential for *realised* reduction (compared to the hypothetical potential, which may in some cases be significantly higher). In assessing the CO_2 reduction from a specific instrument, we are thus looking for indications of how much actual reduction can be achieved through the specific instrument. When assessing the realised reduction, one should include possible rebound effect and emissions from other modes (if the effect involves modal shifts). One should however not take note of the effects from possible accompanying measures to meet for example the rebound effect. The relative measure that we use to assess the CO_2 reduction potential is: the annual percentage share that the reduction makes up out of total transport emission (in the same year).

Some instruments are phased in quicker than others, and some may have more lasting effects than others[9]. To take account of the former, the benchmark analysis should provide information for a year where the bulk of the annual reduction potential is harvested. Ideally, this would be a 100% phase-in, but in some cases, the implied time horizon of that may be fairly long. The latter issue should be mentioned when it is relevant.

Cost-effectiveness
When measuring CO_2 cost-effectiveness (ton/Euro) one should take the additional costs to society from the instrument and deduct, from that amount, the additional benefits (excluding CO_2) to society. Additional costs would include for example investments undertaken either by the private or the public sector, alternative uses of the land/harvest of raps. Welfare losses and benefits can be for example congestion reductions, other emission reductions, and reduced accidents. The measure of cost-effectiveness disregards any monetary transfers from one group in society to the other. The cost-effectiveness is, in this study, also assessed on an annual basis and should ideally relate to the same year as the one, for which the reduction potential is given.

Budget implications
Here, we look at the effects on government revenue, i.e. the net value of the possible revenue implications from using the instrument in question. The net revenue is the effect on revenue minus the possible expenditure implications. Here we differentiate solely between negative implications, neutrality or positive implications and consider the instrument per se, i.e. without taking account of any accompanying measures to for example neutralise positive revenue effects. It is important to note that while taxes always have some distortionary effects, they are not to be considered as costs to society per se, but rather as a monetary transfer within society. This criterion is solely concerned with this monetary transfer, it its measurement does in no way relate to abatement costs, compliance costs or any other invoked cost or cost saving to society.

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9 One example of that could be the ACEA agreement which is currently being phased in, and which will stabilise in 2010

Public/political acceptance
The issue of this criterion is whether the attitude towards the instrument (e.g. general perception of taxes, loss of sense of freedom, high implementation costs, distributional concerns, and the importance attached to congestion problems) of the public, policy makers or other stakeholders, e.g. car industry, constitute a barrier (or an enabling factor!) to the actual use of the instrument.

Speed of implementation
From strategy level to the instrument has its full effect, i.e. the year identified when assessing the CO_2 reduction potential.

Reversibility
This criterion is concerned with whether the instrument in question is something, which can just be abandoned again without having invoked (significant) irreversible costs onto either private actors or/and the public sector. In that sense one can say that a 'irreversibility' instrument limits the scope of action of policy makers because when they chose that instrument, they abandon other options - and it is too costly to reverse that decision to make it a realistic option.

Transferability
An assessment of whether the experience from one country is transferable to another country. It is not possible to give an exact definition of this criterion, rather than to emphasise that transferability is never complete, and the focus should thus be on identifying possible major issues of concern in relation to transferability.

Benchmarking using pre-defined criteria of efficiency can give some indications of potentially good versus potentially more problematic policies to reduce CO_2 emissions from transport. Basically, the CO_2 effect and the CO_2 cost-effectiveness both provide objective and comprehensive information on the reductions that can be achieved and the related costs to society, taking into account also other effects. The remaining criteria provide policy makers with additional and necessary information to be taken into account in their decision-making process. Budget implications and acceptance are issues that can be addressed e.g. by means of counteractive measures elsewhere in the tax system and by means of information campaigns. Implementation speed provides information on how fast the measure can be implemented and consequently also how much of the achieved reduction that can be attributed to the Kyoto period. Information on reversibility features enhances the basis of decision making. The stronger the reversibility features, the more should be decision be analysed in order for example to reduce uncertainty aspects. Lastly, transferability provides an indication of whether there is a need for (thorough) national analyses or to what extent one can rely on results from other countries.

It should be noted that it is not possible to single out policy instruments, which are the best on all criteria. Instead, it is concluded that a mix of policies is required. The reason is that changing behaviour of actors in the transport sector requires a) to provide incentives to choose less CO_2 emitting alternatives b) availability of such less CO_2 emitting alternatives and c) information on such alternatives. Consequently a mix of policy instruments is required, e.g. taxes or road pricing to give incentives, promotion of biofuels and long term agreements to provide alternatives and information campaigns to provide information. Further, as the transport sector is not homogenous, one needs to consider where policies can be generic and where they should be tailor-made (e.g. for company cars) In addition this needs to be considered with a dynamic long-term view. Some technical alternatives need to be further developed and this may require subsidies in the short term.

4. FISCAL AND FINANCIAL POLICY INSTRUMENTS

4.1 Fuel tax

4.1.1 Introduction

Fuel tax increases can be an effective way to reduce energy consumption and thereby reduce CO_2 emissions. Raising fuel prices has several effects. It leads to reductions in vehicle mileage, and over the long run encourages car drivers to choose more fuel efficient vehicles and even to switch to other modes of transport than cars. Furthermore, it also strengthens the incentive to save fuel by for example eco-driving. Country specific features however do vary from one country to the other and over time depending on for example income developments and distribution, and on urbanisation and population density. Such differences will be reflected in different price elasticities, leading to quite different effects on fuel demand as a result of the price increase. Thus, while short-term elasticities are typically lower than long termed ones, it is noteworthy that Spain reports that the fuel price increases in Spain of 2000 did not provide significant reductions in neither travel demand nor driving behaviour. The short-term elasticities are however typically lower than the long-term elasticities.

This section provides a description of two replies to the questionnaire survey, viz. the fuel tax in the German eco tax reform increasing the fuel tax by 3 cent/l each year in the period from 1999 to 2003, and the fuel tax escalator in UK increasing the fuel tax by 6% in each year from 1993 to 1999.

4.1.2 Benchmarking

The analysis of the German and UK replies points to the conclusions in Table 4.1 below.

Table 4.1 *Summary of benchmark conclusions fuel tax*

	CO_2 effect[1]	Cost effectiveness [ton/€]	Budget implications [€/ton]	Acceptance	Implementation speed [2]	Reversibility	Transferability
Fuel tax	0.5 - 3.5%	high	11.000 1.500	low	6 - 8 years	-	(+)

[1] The CO_2 reduction relates to the short run effect.
[2] The years relate to the period from when the decision is taken (building on the two cases that are considered here) and until the major part of the short run effect has been obtained (consultant's estimate).

CO_2 effect

Obviously, the effect of a fuel tax increase depends on the size of the tax increase. The effects referred in the replies from the questionnaire imply increases in the order of 15% in Germany and 35% in UK. The reported effect from this increase is a reduction in CO_2 emissions of 1 Mt in Germany and between 2.5 Mt and 6 Mt in UK, corresponding to 0.5 - 3,5% of total CO_2 emissions in the transport sector. The German reply applies an elasticity of -0.3, which corresponds to the short-term effect of fuel price changes.

In the short run, fuel tax increases cause reductions in vehicle mileage. In the long run fuel tax increases will also encourage car drivers to choose more fuel-efficient vehicles and maybe even to switch to other modes of transport than cars. When such effects are included, the elasticity is generally expected to be somewhat higher (and can be as high as -0.6 -0.7), resulting in a doubling of the CO_2 reduction. Still, income developments and rebound effects may weaken some of the long-term effects. For example, fuel shift to diesel or LPG or more energy efficient vehicles can involve lower costs/km and may lead to increased mileage.

Cost-effectiveness
Both the German and the British replies state that increasing the fuel tax is a cost effective instrument to reduce CO_2 emissions, meaning that the cost effectiveness of this instrument is high compared to other instruments[10].

Budget implication
The German reply states that the additional revenue from the fuel tax is estimated to raise revenue by approximately 56 Billion Euro in total for the period 1999 to 2003, corresponding to 11 Billion annually. Comparing this figure to the effect of 1 Mt CO_2 annually we arrive at a revenue of 11000 Euro per ton of CO_2, which seems relatively high. An alternative, and very rough calculation would indicate a revenue implication in the order of 1,500 (750 in the long term) of the increase. [11]

Acceptability
Tax increases always meet some resistance. In the UK and the German case this resistance was overcome by a gradual introduction of the tax increase. This feature gives the economy and the consumer's time to adjust to the new tax levels. Furthermore, the German fuel tax increase was compensated by a simultaneous decrease in the income tax. In the UK, public opposition to further fuel tax rises actually meant that the fuel duty escalator was not continued beyond 1999.

In the German reply it is stated that an essential barrier from a political point of view was the national solo effort, which was made when introducing the eco-tax. From an ecological and competitive point of view, an EU-wide eco-tax would be desirable.

It should be noted that acceptability may in some cases, depending on the size and the nature of the tax changes, also reflect concerns about transaction costs. For example, significantly changing the relative size of the diesel tax compared to the petrol tax, may involve substantial transaction costs, and concerns about this may be at the heart of the opposition to the change.

Fuel taxes are typically argued to be degressive, i.e. to affect the lower income groups the most. While this argument is valid to some extent, one should however also note that the ultimate effect will depend also on whether the instrument is accompanied by other instruments that pull in the opposite direction (and where the tax can be said to provide some of the revenue necessary to finance this). Such instruments could be for example improvements of the service level of public transportation (which is used the most by low income groups that do not possess a car).

Implementation speed
Both of the fuel tax increases described here were implemented gradually over a period of 5 - 6 years, plus 1 year to prepare the instrument. In addition, the two tax increases are designed so that it will take 6 - 7 years until the instrument is fully implemented. Furthermore, it will take some additional years before the full effect from the measure is obtained. As already mentioned, fuel taxes has different effects. Some of the effect on mileage would come immediately (mainly mileage related to leisure and less important trips etc), while other mileage effects like commuting takes longer to change because it may require changes in location of workplace, housing etc.

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[10] In interpreting these conclusions more generally, attention needs to be focused on the issue of transaction costs as well.

[11] A quick calculation assuming an elasticity of -0.3 shows that if we increase the fuel tax by 15 cent, corresponding to approximately 13% increase in the fuel price, then we would obtain 4% reduction of fuel consumption and CO_2 emissions. Assuming 2.5 kg CO_2 per litre fuel, the 15 cent increase would lead to a CO_2 reduction of 0.1 kg corresponding to 1500 € per ton of CO_2. Finally, it should be noted that the general perception is that the long term elasticity is somewhat higher resulting in a lower revenue effect per ton CO_2 in a long time perspective. If we apply a long run elasticity of -0.6 the corresponding revenue would reduce to 750 € per ton CO_2.

It should be noted, however, that the gradual element means that people to some extent foresee the price in the future already at the stage where the tax change is announced, meaning that some of the long term behavioural effects will take place already before the tax increase has been fully implemented.

It should be noted that implementation speeds (both in terms of preparing the tax and realising its effects) can be quite country specific.

Reversibility
Suppose we increase the fuel tax, would it be possible to reduce it again after some years and turn back to the initial situation. In principle, yes, it would be possible to reduce the tax again and after some years the situation would probably more or less be the same as before the tax. However, one should be aware of the transaction cost when the economy adapts to the new tax levels and maybe also difficulties to increase tax revenue from other taxes to obtain budget neutrality when the tax is removed again. For these reasons, the more significant changes the tax imposes to the economy, the more difficult or costly will it be to remove it again.

Transferability
There is a common understanding that fuel tax increases can be an efficient measure to reduce CO_2 emissions, in particular when they are introduced in support of other instruments, i.e. when synergies are established. However, the countries are not free to choose their own level of fuel taxation regardless of other countries. Border trading is one of the most important issues considering fuel taxes. One country cannot increase the fuel tax significantly above the level in the surrounding countries without experiencing significant border trading. Therefore it would be beneficial to implement such instrument in many countries simultaneously. However, in some countries border trading is more difficult than in other. These countries are freer to set the fuel tax level without having problems with border trading. This goes especially for the UK.

As mentioned in this section, elasticities and implementation speeds may vary substantially between countries. Such variations can be reflections of, for example, cultural differences, the availability of alternative modes of transportation, income levels, and population density and urbanisation. Consequently, care should be taken not to interpret the results anticipated for Germany and UK to be immediately transferable to other countries.

Table 4.2 in the introduction section of Section 4.2 illustrates the variations that can be observed within the EU with regard to fuel taxes as well as with regard to vehicle taxation as a whole (including however only purchase taxes, ownership taxes and fuel taxes).

4.1.3 Conclusion

Fuel taxes have been introduced in all countries. While fuel tax is a cost-effective instrument to reduce CO_2 emissions, public acceptance is low when confronted with significant increases. High fuel taxes form an important incentive to switch to transport alternatives with lower CO_2 emissions. As such they support the effectiveness of other measures such as modal shift, biofuels and eco-driving.

4.2 Vehicle taxes

4.2.1 Introduction

Vehicle taxes in this context include road taxes as well as purchase taxes. While road taxes are used in most European countries, purchase taxes are less common albeit quite often used but with substantial differences between the countries' tax level.

Table 4.2 provides an overview of the vehicle taxes that were in force in the EU countries in 1999 in relation to new private passenger cars. While changes have been undertaken since that time, the table does serve to illustrate the large variation that can be observed between EU Member States. This applies both to the structure of vehicle taxes as well as the overall tax burden that private vehicle owners are imposed with. The table has been copied from a report prepared for the EU on fiscal measures to reduce CO_2 emissions from new passenger cars (Jordal-Jørgensen, 2002). With regard to the registration tax (purchase tax) this study also shows that differences in registration taxes imply huge differences in the gross price of vehicles across the EU. For example, the average price (including taxes) of a medium passenger car ranges from € 21,500 in Spain to € 36,200 in Denmark. The table does not consider schemes in effect for company cars, but the same source indicates quite substantial variations in those schemes as well.

Table 4.2 *Car and fuel tax in different EU countries in 1999 (Jordal-Jørgensen, 2002)*

Country	Average circulation tax per car [€/year]	Registration tax yes/no	Fuel tax [€/litre] Petrol 95 RON	Diesel
Austria	228	yes	0.41	0.28
Belgium	177	yes	0.51	0.29
Denmark	404	yes	0.52	0.35
Finland	118	yes	0,56	0.30
France	109	no	0.59	0.39
Germany	88	no	0.56	0.38
Greece	118	yes	0.3	0.25
Ireland	274	yes	0.37	0.33
Italy	151	(yes - small)	0.53	0.39
Luxembourg	78	yes	0.37	0.25
Netherlands	433	yes	0.6	0.35
Portugal	35	yes	0.29	0.25
Spain	182	yes	0.37	0.27
Sweden	150	no	0.52	0.34
UK	231	no	0.76	0.76

Originally, vehicle taxes were introduced to gain revenue. Today, however, policy makers have come to realise that these taxes can also be used as environmental policy instruments.

Vehicle taxes, by their mere size, can theoretically be used to control vehicle ownership, and the size of the vehicle fleet, while their design (differentiation and choice of tax base) can be used to affect for example the energy efficiency of the vehicles. Vehicle taxes differ in size and tax base, but evidence seems to suggest[12] that there is scope for providing improved CO_2 efficiency of cars through making the taxes more CO_2 related than they are today. Properly designed vehicle taxes could also have a stimulating effect on the development of new technology. However, it may require a specially designed tax to avoid that such a tax just becomes a pillow for the car manufactures.

This section provides a description of two replies to the questionnaire survey, viz. the existing Dutch purchase tax and the new (implemented in 2001) CO_2 differentiated road tax in the UK.

Beyond these more detailed replies it is mentioned in the Finnish and Swedish replies that these countries also consider making their road tax more CO_2 differentiated in order to reduce CO_2 emissions.

[12] European Commission's Directorate-General for Environment, 2002

Furthermore, the chapter includes a very brief overview of toll systems in other European countries to put the German system into perspective. The section does not consider any congestion charges, which are in effect in some European cities (e.g. Paris-Lille A1 motorway, the Norwegian flat rate cordon pricing for entry into cities, and the Rome cordon pricing system), as none of the replies received in relation to this survey relate to such systems.

4.2.2 Benchmarking

The analysis of the Dutch and UK replies points to the conclusions in Table 4.3.

Table 4.3 *Summary of benchmark conclusions vehicle taxes*

Vehicle tax	CO_2 effect	Cost effectiveness [ton/€]	Budget implications [p€/ton]	Acceptance	Implementation speed [2)]	Reversibility	Transferability
Purchase tax (NL)	2 - 3%	low [1)]	(2500 - 4000) per tonne CO_2	low	long term	(+)	(+)
Road tax (UK)	~ 1%[3]	high [1)]	neutral	positive	6 years	(+)	+

1) Other studies (Naturvårdsverket (2002)) indicate that it is costly to reduce CO_2 emissions by means of high registration tax, while a budget neutral CO_2 differentiation of the road tax is less costly.

2) The EU study (European Commission's Directorate-General for Environment, 2002) indicates that the effect of such a measure would reduce average CO_2 emissions of new vehicles with approx. 1%.

CO_2 effect

The effect of the Dutch car taxation is estimated to be approximately 0.6 to 1 million ton CO_2 annually, corresponding to approximately 2 to 3% of total CO_2 emissions in the transport sector in the Netherlands (35 Mton). The calculation of this effect is based on a comparison of the average car size in the Netherlands compared to the average size in countries without purchase tax. However, the comparison might overestimate the effect on the car size, since there might be other factors that also contribute to the lower average car size in the Netherlands. On the other hand, it is mentioned that the present purchase tax level has not yet completely penetrated the car fleet. Therefore it should be expected that the effect would increase in the years to come.

Cost-effectiveness

There has been made no cost-effectiveness analysis of the car taxation in the Netherlands. This is due to the fact that the main purpose of the Dutch car taxation scheme is to collect revenue to the public budget. Likewise, there has been made no assessment of the UK road tax. However, other studies (Naturvårdsverket, 2002) indicate that it is costly (in terms of a cost benefit analysis) to reduce CO_2 emissions by means of high registration tax, while a budget neutral CO_2 differentiation of the road tax is less costly.

Budget implication

In the Dutch reply it is clearly stated that the vehicle taxes are mainly used as a source for revenues and *not* for CO_2 reduction. Although not explicitly mentioned, The Dutch purchase tax implies a significant contribution to the public budget. Assuming an average purchase tax of € 4000 and a car sale of 600.000 cars annually we calculate the annual revenue of approximately 2.5 billion Euro. Comparing this revenue to the CO_2 effect of 0.6 - 1Mt, we arrive at a budget implication of 2500 - 4000 € per ton CO_2. The UK road tax scheme has no budget implications in it self, since it has been designed to be revenue neutral. In both cases, to meet the definition of budget neutrality used here, the loss from reduced fuel tax should have been included in the revenue calculations.

Acceptability

The Dutch reply states that the car industry and the car purchasers opposed the purchase tax. Furthermore, the central government argued that car taxation collect money related purposes, like for instance road maintenance. However, there are still ongoing discussions if car owners pay more than a fair share of the cost they are responsible for. No implementation barriers were mentioned in the UK reply. This correspond to the general perception of the consultant, that it is much more acceptable to make an existing road tax more CO_2 differentiated relative to introducing a new car purchase tax.

Vehicle taxes affect vehicle owners and thus put a higher tax on them than on people not possessing a car. Assuming that the proportion that does not possess a car is bigger among the less wealthy people, than among the more wealthy ones, such taxes will not be regressive. On the other hand though, overall vehicle tax increases may imply that some people, who used to have a car, cannot afford it any longer. These people will suffer a welfare loss. However, feebates could be used as a remedy to meet this equity impact when seeking to (re-design) tax structures to incite the purchases of CO_2 efficient vehicles. Put simply: feebates would imply that while high emitting cars are imposed with the largest tax (increases), the low emitting cars would actually be awarded a government-funded discount.

Implementation speed
In the UK reply it is stated that the road tax supports the voluntary agreement, meaning that the implementation period for this measure is from preparation before 2002 to 2008 corresponding to 6 years. This observation corresponds to the common understanding, that a budget neutral CO_2 differentiation of an existing tax scheme can be implemented within a relatively short time horizon, while it takes a longer implementation period to make substantial changes to the tax levels (often this would require a gradual implementation over several years). Once the instruments have been implemented the dynamics of the CO_2 effect mainly depends on whether the instrument only applies to new vehicles or if the instrument also apply to second hand vehicles. If the instrument only applies to new vehicles, then it will take at least 10-15 years from the instrument is fully implemented until the full effect is obtained.

Reversibility
While vehicle taxes can be said to be reversible, there are nevertheless some modifications to this statement. The structure and size of vehicle taxes aim to affect the size and structure of the demand for vehicles, thereby inciting the supply side to accommodate these demand patterns by means of e.g. technological developments. Thus, and in particular for more significant changes to existing tax structures, there will be transaction costs involved in adapting to new structures. Changes to vehicle tax systems are, also for these reasons, often opposed, and frequent changes may erode the credibility of government policy substantially with a possible consequent weaker effect of tax changes.

Transferability
The most obvious precondition for transferability of experience with vehicle taxes is the fact that not all countries do have a purchase tax. Also, vehicle demand and its structure may be affected by other factors than price such as for example cultural differences, preferences for specific brands (e.g. domestic brands), population density and other policies that affect transportation demand. In some countries the resistance against a purchase tax is so high that this instrument is not a viable option.

4.2.3 Conclusion

Vehicle taxes here include both differentiation and taxes per se. Vehicle tax levels affect the amount of vehicles in the fleet, whereas the differentiation can be used to control the composition of the fleet. The former has the largest potential for CO_2 reductions, but is typically assumed to involve substantial welfare losses whereas the latter can be designed with a view to reducing the negative welfare effects. In other words, the latter may prove to be more cost effective, although the reduction potentials may be lower. In relation to CO_2 differentiation there may be a rebound effect as the cost/km is reduced, and this will also affect government revenue.

4.3 Road pricing

4.3.1 Introduction

Road pricing is commonly interpreted as a means of generating revenue and/or a means of controlling congestion problems and other externalities such as local air pollution and frequency of accidents. Road pricing is thus not typically seen as a CO_2 reducing measure per se, and the CO_2 reducing effects can thus be said to be additional. Road pricing includes instruments such as tolls, cordon pricing, and kilometre charging. Different rates may apply to different vehicles, depending on the environmental feature, and rates may vary according to the time of day and the place. The CO_2 reductions from a specific road pricing system depend heavily on its features and design, e.g. whether it is used on a national scale or solely in selected areas; whether it covers all vehicles or only selected segments and whether it involves some kind of differentiation based on environmental features[13]. It is therefore impossible to point to generic conclusions with respect to the CO_2 reduction potentials of road pricing. This section provides a description of two replies to the questionnaire survey, viz. the new German road tax and a detailed study of a possible system in the Netherlands. Both systems are kilometre charges. The German system applies to heavy vehicles and the Dutch system is assumed to apply for all vehicles.

Both these systems are thus relatively simple versions of road taxes. The tax to be paid depends on the kilometres driven. While the rates vary according to the environmental features of the vehicle in question, there is thus no differentiation according to time and place. Thus, these systems can be said to aim mainly at raising of revenue and reducing road transport in general rather than reducing congestion problems and local air pollution.[14]

In addition, it ought to be mentioned that tolls are commonly used in many countries including many Western European countries, and some of those do contain elements of more stringent road pricing. Table 4.4 below illustrates existing toll/road pricing systems in European countries. They all apply to motorways and the indicated average toll applies to a 5 axle vehicle: The Swiss system was implemented in 2001. It is argued to have had a major impact on the freight transport market. The revenues are earmarked for rail. The Netherlands, Belgium and Sweden are looking at the desirability of introducing systems similar to the system in Germany to replace the Eurovignette. The Czech Republic plans to adopt the German system or a similar one, while the UK considers to introduce a class differentiated distance based heavy duty charge in 2004 with an offsetting reduction in the annual tax (Perkins, 2002).

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[13] Basically, the CO_2 effect would depend on the extent to which the system affects: *Fuel choice* (biofuels, LPG/CNG, diesel or petrol), *Amount of transportation* (by encouraging modal shifts to less CO_2 emitting modes and reduced motorised travelling per se) and *Driving behaviours* (speed, accelerations etc.)

[14] Noting however that both systems involve a differentiation in favour of the most environmental friendly vehicles.

Table 4.4 *Toll ways in Western Europe (Source: ECG[15], 2002)*

Country	No. of tolled kilometres	Share of total motorway network	No.of toll stations	Average toll. [cent/km]	Price categories depending on
Austria	179	48	10	1.85	No. of axles and emission category
France	7,187	85	495	0.18	No. of axles and height
Greece	871	79	16	0.04	No of axles
Italy	5,584	86	457	0.13	No of axles and height
Norway	314	55	61	[16]	weight and length - not dependent on distance
Portugal	939	100	76	0.15	No of axles and height
Spain	2,323	31	21	0.20	No of axles
Switzerland	all roads	all roads	at border	0.44	Weight (above 3.5t) and emission category

When one considers freight transport, there are roughly speaking three options for behavioural change, viz. improved utilisation of existing road transport capacity, shifts to other modes such as rail and ships, and the use of alternative routes that are not subject to the road pricing system. Only the improved utilisation of existing capacity will per se provide a CO_2 reduction, whereas the CO_2 effect from modal shifts will depend on the CO_2 emissions of the alternative mode. A system that involves the setting of uniform km rates[17] can involve the following behavioural changes as regards passenger transport: shifts to other modes of transport, which typically leads to lower CO_2 emissions (walking, cycling, public transport), and omission of trips and replacement of some trips with alternative ones with less distant destinations, which also leads to lower CO_2 emissions (this includes home-movement and teleworking). Lastly, while the two described systems do involve some differentiation according to the environmental features of the vehicles used, the road price systems do not provide incentives for energy-efficient driving, compared to for example fuel taxes.

4.3.2 Benchmarking

The analysis of the Dutch and German replies points to the conclusions in Table 4.5.

Table 4.5 *Summary of benchmark conclusions road pricing*

km charging	CO_2 effect	Cost effectiveness [ton/€]	Budget implications [EUR/ton]	Acceptance	Implementation speed [2)]	Reversibility	Transferability
Netherlands all vehicles	4%-10%	net benefit	+<20	low	2-3 years	-	(+)
Germany heavy duty vehicles	< 1%	low (<<600€/ton)	+600 [1)]	low	4 years	-	(+)

1) This is the gross cost of the payment system including the costs of the on-board devices (Werner Rothengatter, 2002).

2) The years relate to the period from when the decision is taken and until the system is ready to run. It may take a longer time until the maximum CO_2 reductions are realised, depending on the sped by which the behavioural changes take place.

15 European Car-Transport Group of interest (http://www.eurocartrans.org/Topics/roadtolls.htm)

16 In Norway, the charge does not depend on the kilometres driven, but on the specific route/company in question (there are 28 motorway companies). The use of road infrastructure around the bigger cities is generally more expensive, a one-way may cost around € 10.

17 Disregarding the fact that the Dutch system that is assessed below does use lower rates for more environmental friendly vehicles.

CO_2 effect
A system that involves differentiation according to indicators of environmental pressure (in the Netherlands: vehicle weight and fuel type) and all vehicles will lead to rather significant CO_2 reductions. Two alternative calculations point to reductions of 9-10% and 4-5% respectively (in 2010)[18]. It should be emphasised that these reductions are estimates merely. The bulk of this reduction comes from passenger cars and mainly through reductions of trip lengths (10%) and number of trips (4%). Passenger cars typically account for the major share of vehicular CO_2 emissions. Therefore, the reductions are much smaller in a system that covers only freight transport, even if such a system involves some environmentally based differentiation (number of axles and emission category). When assessing the CO_2 reductions, attention must also be paid to the possible rebound effects. The Dutch reply does discuss some of the major ones, viz. the purchase of more and less energy efficient vehicles, and the loss of the incentive for energy-efficient driving. According to the reply, the effects tend to be small. The estimated reductions in the German system arise mainly as a result of improved capacity utilisation of transport companies and modal shifts with regard to long-distance transportation (less important). The German reply states that there will only be a small impact on parallel and alternative routes (road pricing only applies to motorways).

Care should be taken not to take the above estimates as indications that road pricing will always provide CO_2 reductions. As mentioned above, the concept is so wide that generic conclusions are difficult to identify. At the one extreme road pricing can involve a reduced pressure on the roads in question (as some drivers choose alternative routes not subject to road pricing), and consequently it will enable a higher average speed for those on the road. This pulls in the direction of increased emissions, in particular if the total demand for transport is not reduced, or even increased as a result of the improved accessibility through the tolled roads.

Cost-effectiveness
According to the Dutch reply, the kilometre charge system that applies to all vehicles is quite cost-effective[19]. This high cost-effectiveness arises mainly as a result of substantial travel time savings that result from improved accessibility. The study shows that although there is no differentiation of rates according to time and place, and thus no relation to congestion, the road tax system that is analysed will nevertheless result in significant reductions in travelling. Other important contributors to the high cost-effectiveness are reductions of casualties and of other emissions.

Budget implication
The Dutch study assesses the additional costs to public budgets of the analysed road pricing system to be approximately 20 €/ton[20]. The German system is stated to cost approximately 600 €/ton. This is a gross cost, which does not take into account the revenue from the charge itself, which is to be (infrastructure) cost recovery based.

Acceptability
The Dutch reply states that one of the main obstacles in this regard is the suspicion that the road pricing system will merely be yet another source of revenue generation. Consequently, it is suggested that this challenge should be dealt with by means of implementing a system that is

18 The lower estimate assumes a larger effect in terms of increased number of cars (as car prices decline due to the budget neutrality whereby ¼ of the purchase tax is transformed to km charge) and less sensitivity to the price change for high-income groups and lease drivers.

19 According to communication between the ministry and the parliament (23 January 2002) it is expected that the ‘mobimeters’ in the cars will be used for extra services. The income from those services, where car drivers pay for, will reduce the costs for the kilometre charge system.

20 However, the Dutch system assumes that ¼ of the purchase tax is transformed into the road tax (together with all of the ownership tax), and this will have an impact on the distribution of revenues over the years. It is not clear whether this effect is taken into account when calculating the 20 €/ton.

budget neutral and to devote resources to information campaigns on this important aspect[21]. The German reply also mentions the issue of acceptability, which was to some extent met by the condition of recycling of revenues, although there was some opposition to the fact that some of the revenue would be recycled to other modes of transportation. Other sources (e.g. Danish Ministry of Transportation, 2000) point to the distributional effects as one of the major issues to be addressed. The distributional issues may relate to for example income groups and the distribution between rural and urban population. The type and size of such effects will however be determined by the exact context of the road tax, and its specific design as well as the use of the revenue.

As regards equity, it is extremely difficult to point to generic conclusions as road pricing systems can be designed in a multitude of ways. A few examples of possible equity effects are given here. There may be a tendency for the less wealthy car users to be more affected than the wealthier ones, as monetary constraints become more binding for them. If uniform systems are applied throughout a country, there can be a risk that the urban population pays more and the rural population less than what would be proportional to their external effects. Road pricing systems in towns and urban areas provide a benefit to those living in the area, as the reduced traffic results in less noise, pollution and risks of accidents. Furthermore, road pricing systems do not favour energy efficient driving as opposed to for example fuel taxes and consequently a transfer of fuel taxes to road pricing would favour those that drive less energy efficiently.

Implementation speed
While it will take some time until the maximum annual CO_2 effect from the road pricing system is achieved, the implementation period may nevertheless be considered relatively short. There are technological options available, and once the decision is taken, the 4 year implementation period, which applied in Germany, would appear a realistic time frame for deciding on the specific systems, cost allocation models etc. However, the full CO_2 effect is likely to come somewhat later. Some of the behavioural changes are for example related to the choice of new cars, and one may expect that in the longer term, the road pricing system can affect such longer term issues as decisions on workplaces and places of living.

Reversibility[22]
In principle, tax systems can always be changed and modified. However, there are two aspects that substantially weaken this statement with regard to road pricing. First, there is the issue of credibility. Those affected by the system need to believe that it will be in place for a long period in order to let the system affect their longer-termed decisions on for example place of living and car purchases. Furthermore, if the system is implemented in a budget neutral sense and in particular if the budget neutrality involves some transfer of purchase taxes to road taxes, this has serious implications on the annual distribution of costs (for car owners) and revenues (for the government). Finally, some of the more advanced systems, which are also the most CO_2 efficient, do imply substantial investments. Such investments would be lost if the road pricing system is given up within a short time horizon.

Transferability
Country specific features may have an impact upon the exact figures of cost-effectiveness and CO_2 reductions. For example, the higher the current congestion level, the higher the population density (as stated in the Dutch reply) and the more freight transport transit, the more there is to gain from a kilometre charge. Nevertheless, it is the Consultant's conclusion that the overall direction of the conclusions is quite generic. The German system has been designed in respect of relevant EU legislation (1999/62) regarding pricing of heavy goods vehicles on European roads. The Directive, for example, allows for differentiation according to Euro standard (maximum deviation is 50% between highest and lowest emission level). The Directive also allows for dif-

[21] To this, the consultant would like to add that credibility is an important issue here.
[22] The replies did not contain reflections on this. Hence the statements here are the Consultant's own conclusions.

ferentiation according to time of day (maximum difference 100%), but this opportunity is not used in the German system. To be in compliance with EU Law, the system analysed for the Netherlands would need not to apply to foreign passenger cars and only to apply to the use of motorways.

4.3.3 Conclusion

Road pricing covers a wide range of more specific instruments that are not considered or developed because of their CO_2 reducing merits but more so because of their ability to control congestion and local pollution. Consequently, the potential CO_2 effect cannot be assessed as it will depend on the exact system in place, for example whether it covers all roads, all vehicles and whether there is some element of CO_2 differentiation embedded in it (e.g. reduced rates for energy efficient vehicles). The latter is a feature of both the German system and the system that was analysed in the Netherlands. It is important to note that this group of measures does not encourage energy efficient driving, but instead aims to control the number of kilometres driven and possibly also the choice of vehicle.

4.4 Tradable emission permits

4.4.1 Introduction

Tradable emission permits involve setting the permitted emission level and letting the market decide where the desired reductions will be obtained. Government thus issues a fixed number of permits (reflecting the desired emission level) and puts them on the market. The permits are traded and the market establishes an equilibrium permit price. The permits may be put on the market through grandfathering, performance standard rates or through auctions. Tradable emission permits can be said to be a mirror reflection of taxes in the sense that the permits set the quantities and allow the prices to adjust, whereas taxes set the prices and let the quantities adjust. Tradable emission permits in the field of transport-related CO_2 emissions are not used anywhere today. A system was used in the Netherlands with tradable coupons for car fuel during the oil crises in 1973. It however led to people going abroad to buy fuel. Later, gas stations also started to sell fuel also to people who claimed to have ‘forgotten’ their coupons. This was more or less the end of the system and coincides in time with the ending of the oil crisis. In the area of CO_2 emissions, tradable emission permits are only in force to a limited extent in Denmark (electricity sector) and the United Kingdom[23].

The European Commission is in the process to develop a CO_2 emission trading system. If it will be approved this system would start with large energy intensive industries and the electricity sector. It might already start in 2005 but it is uncertain if agreement can be reached on important elements such as rules to allocate emissions and it is questionable if emission-monitoring systems for companies will be mature enough in 2005 to allow for emission trading. The transport sector is expected to be the last sector to be involved in this CO_2 trading system (2012). As other sectors have significant potential to reduce CO_2 emissions at limited cost, it is expected that an emission trading system would lead to little or no emission reduction in the transport sector.

The replies to the questionnaire survey include a Dutch study on the hypothetical set-up of a system for tradable permits for the transport sector alone.

[23] Ignoring CDM and JI schemes, but focusing solely on national or regional schemes for tradable permits.

4.4.2 Benchmarking

The analysis of the Dutch reply points to the conclusions in Table 4.6.

Table 4.6 *Summary of benchmark conclusions tradable emission permits*

Tradable emission permits	CO_2 effect	Cost effectiveness [ton/€]	Budget implications [EUR/ton]	Acceptance	Implementation speed [3)]	Reversibility	Transferability
Dutch TEP system [1)]	3%	high (10 €/ton)	250	?	?	-	?
Tradable permits: all sectors[1)]	low	high			?		

1) This is a system where the permits that are put on the market represent the 3% reduction. Had this amount been different, the cost-effectiveness and the budget implications are likely to have been different as well.

2) This assessment is included here in order to allow for comparison. It is a system, which includes that fuel producers such as refineries would be included in a (nation-) wide system of tradable permits. The results derive from an ECN report (Sijm, 2002).

Table 4.6 summarises the results of the Dutch study, which assumes a system of TEPs (Tradable Emission Permits), which are issued annually to all households, who may then purchase and sell TEPs according to their needs and willingness to pay/sell at the emerging prices. Furthermore, the table also includes the Consultant's assessment of a wider scheme that covers all sectors, and which allocates the permits at production levels rather than end-users. The latter is argued to provide fairly small reductions in transport's emissions[24], the reason being that the emission reductions can be achieved elsewhere in the economy at lower costs. Still, the overall cost-effectiveness is argued to be high (and costs to be low). This reflects the market mechanism's ability to direct the emission reductions to sectors where they can be achieved at the lowest costs.

CO_2 effect

The achieved CO_2 reductions are not a result of the instrument, but inherent to the instrument itself. The Dutch study has analysed a system that involves a 3% reduction compared to the business-as-usual scenario[25].

Cost-effectiveness

The estimate of 10 €/ton CO_2 includes welfare losses in terms of loss of car mobility, purchase of more energy efficient vehicles than would have been chosen in the absence of the system, loss of ‘sense of freedom’ for example by means of choosing car pooling as a reaction to the system, and the use of (perceived) less comfortable public transportation. Benefits in terms of less congestion, improved safety and noise impacts and pollution reduction are not included, however. The analysed system does not include freight transport. In general, the wider the coverage of the system, the better is the cost effectiveness likely to be. This applies in terms of segments of the vehicle fleet and geographically, e.g. for an EU-wide system compared to a national system. In this regard, however, it should also be noted that the wider the coverage, the more complexities are likely to be brought into the system.

Budget implication

As a result of the reduced demand for fuel (due to the 3% emission reduction), the government will lose revenues of a corresponding size. In this case, this amounts to 250 MEUR annually. Furthermore, there are substantial risks of fraud, however, which need to be addressed through anti-fraud systems and investment and operation costs may be involved in the setting up of trading and distribution (i.e. auctioning) systems.

24 See for example (Sijm, 2002) for a study that provides this result.

25 In addition, the Consultant would like to add that the setting of the emission level necessitates considerations of cost effectiveness as well. The larger the desired reductions, the higher adjustment costs may be, and the less cost-efficient it may prove to be compared to other instruments for CO_2 reductions in transport.

Acceptability
The higher the risk of fraud, the less inclined the public probably is to accept such a system. Similarly, the issue of border trading or smuggling (depending on the legal set-up) can also erode the credibility and acceptability of such a system. People living close to the border can just fill up their cars in the neighbouring country and sell the TEPs on the national market. This way, they will have been given a windfall gain from the government.

Acceptability of a national emission trading system is expected to be high. The elegance of such a system is that it aims at emission reduction at the lowest cost possible. However, acceptability large depends on rules for the allocation of emission permits.

Implementation speed
The Dutch study is quite premature. It is mentioned that a thorough assessment would require much more detailed analyses of the scope, potentials, difficulties and barriers to the setting up of such a system. Consequently, it is difficult to assess the implementation time for a TEP system.

Reversibility[26]
The establishment of a TEP system offers the opportunity for regret. Using the regret option, however, does involve sunk costs in terms of established systems for trade and fraud control.

Transferability
Given the premature state of the analyses, transferability is not a topic for discussion.

4.4.3 Conclusion

Tradable CO_2 permits can be a cost-effective option. A system where transport, i.e. refineries, is included in a trade scheme may however have only a little effect on transport's CO_2 emissions, and the impacts on CO_2 emissions from transport may even prove to be adverse. This could indicate that there are other areas of the economy where the reductions can be attained at lower costs. Applying a system of tradable CO_2 quotas vis-à-vis the vehicle users still remains to be further investigated, but it is open to discussion whether such a system will be more efficient that the mirror instrument: the fuel taxes.

[26] The replies did not contain reflections on this. Hence the statements here are the Consultant's own conclusions.

5. REGULATORY POLICY INSTRUMENTS

5.1 Speed control/speed limitation

5.1.1 Introduction

In the countries of the EU, the maximum speed for passenger cars on highways is between 110 and 130 km/h (see appendix B). Only in Germany there is no general speed limit on motorways. The recommended speed limit is 130 km and more than half of the German highway network has a speed limit of 120 km or less. Because in general cars are more fuel efficient at 90 km/h (in top-gear)[27], lowering the maximum speed reduces fuel consumption and CO_2 emissions. Since a number of drivers exceed the maximum speed, increasing enforcement also leads to CO_2 reduction.

There are submissions from four countries. In the *Netherlands* a new set of speed limits has been introduced because of environmental reasons including a more stringent enforcement. *Swedish* speed limits based on safety are under discussion: "*The speed limits should be adjusted to the road safety standards. Theoretically this would mean maximum 70 km/h on roads with oncoming traffic and maximum 30 km/h where pedestrians and bicyclists are mixed with car traffic.*" Sweden has done an extensive test of an Intelligent Speed Adaptation system (Biding, 2002). The two other submissions come from *Belgium* and *Finland*.

A possible rebound effect of highway speed limit enforcement is an increase of travel-km due to fuel cost savings (as reported by the Dutch; fuel cost elasticity of -0.2% in the short term, -0.5% in the long term). On the other hand a decrease of travel-km can occur due to longer travel times (Sweden), see also (TUD, 1996). In our opinion, all these aspects are relatively small compared to the direct CO_2 reduction effect that results from the increased efficiency by driving slower on highways.

5.1.2 Benchmarking

The analysis of the four replies points to the conclusions in Table 5.1.

Table 5.1 *Summary of benchmark conclusions speed limits*

Speed limits	CO_2 effect[28]	Cost effectiveness [ton/€]	Budget implication	Acceptance	Implementation speed	Reversibility	Transferability
Max speed highways 10 km/h lower	2-4%	High	~ budget neutral	Low	Short Term	+	+
Enforcement	1-3%	High	+	varies	Short Term	+	+

CO_2 effect

In the Netherlands, the general highway speed limit of 100 km/h has been raised to 120 km/h, though at 16% of the highway length (which covers 33% of the highway vehicle kilometres) the 100 km/h limit was sustained for safety and environmental reasons. Since 1988 the enforcement of speed limits has been increased. The target was to change the average speed on highways from 112 to 106 km/h and a reduction of the share of non-compliant drivers to 10%. Although the level of non-compliant drivers was not reached, very high speeds were reduced. The CO_2 emission reduction at highways has been estimated at 3%-5% (0.3 -0.5 Mton CO_2) in reference

[27] Sweden responded: "To our knowledge the fuel consumption increases at speeds above 70 or 80 rather than 90km/h"

[28] Effect depends on current situation in a country and the share of highways in vehicle mobility.

to 1987. Calculations indicate that if no limits had been set at all, CO_2 emissions would have been 6.5% higher in 1989.

According to Flemish information, a small violation (<10 km/h) of the speed limit of 120 km/h increases specific vehicle consumption with 10% and consumption of the whole car fleet with 0.7%. A large violation (20 km/h) increases total fleet consumption with 1.1%.

A suggested change of the speed system in Sweden with a reduction from 110 to 100 km/h, and from 90 to 80 km/h on the most unsafe two-lane roads (totally 3300 kilometres) will reduce the CO_2 emission with 35 kton/year (0.2%). This reduction is achieved without enforcing the speed limit. Sweden reports that the speed reduction close to speed-cameras is 5-10 km/h and averaged over a longer distance, the reduction amounts to 2-3 km/h. The extra CO_2 reduction by speed limit enforcement was not calculated by the Swedish.

It is possible that an EU-wide speed limit of e.g. 120 km/h could lead to a different car design for the European market (especially engine size, power output and transmission lay-out) resulting in a more efficient passenger car and a substantially larger CO_2 reduction. Also the interest in high-speed tires, which add to fuel consumption, may decline.

Cost-effectiveness
Sweden (no estimate): the government has costs for implementing a new speed system, speed cameras, and ISA-infrastructure. There will also be a small reduction of tax income from fuels. On the other hand, there will be reduced costs for health care. Safety benefit: mln € 40/y, increased travel time - mln € 20/y. According to Swedish information (Carlsson, 1997) the optimum speed - taking socio-economic costs into account - on motor ways would be between 90 and 100 km/h (i.e. lower than the speed limits in all European countries!), see also (TUD, 1996). The Escape project reports about the effects of traffic enforcement in Europe (ESCAPE, 2002). In this project a Norwegian working paper shows that increased enforcement is cost-effective if safety benefits are taken into account and time gain from exceeding the speed limits is disregarded (Elvik, 2001).

Budget implication
The Netherlands states that the instrument is financially self-supportive. Revenues are 10 times the costs, apart from safety gains.

Acceptance
Quote from the Dutch submission: *"Nevertheless, it has been estimated that a general speed limit of 100 km/h for all highways could - if accompanied by sufficient enforcement - lead to 1 Mton (3%) extra CO_2 reduction, a policy line that is out of the question today."*

Sweden: About 60 per cent of the Swedish people accept lower speed limits in order to reach vision zero. The political acceptance is probably less than among the people; politicians listen more to special interests like industrial and business interests and motor organisations.

Implementation speed
In the Netherlands the policy change in parliament (1988) took four months. Implementation and enforcement took several years including intense networking and co-operation between the environmental ministry, the Road Adminstration, the police and judiciary, while since 1999 a larger part of the funding is from climate change policy budgets, which are to be fed, a.o., out of speed limit violations.

Sweden: adjusting speed limits to road safety standards took 4 years in Sweden. The enforcement of the speed limits is implemented step by step.

Reversibility

Speed limits can fairly easily be implemented and do not require much investment. Speed limits can relatively easily be reversed.

Transferability

Quote from Dutch submission: "*We recommend to set speed limits to a level not higher than 120 km/h for CO_2 reduction and pollution control reasons anyway - supplementary to road safety (90-100 km/h is estimated as optimal from external effects point of view). We strongly recommend the EU to play a role, though a general EU speed limit seems a bridge too far. Due to political taboos and lack of awareness national speed limit policies are as yet not linked to CO_2 reduction targets. It is recommended that at least at EU level national commitments should be established to enforce existing highway speed limits more effectively under the EU process towards implementing the Kyoto Protocol.*"

EU rules regarding heavy-duty vehicle speed retarders are being implemented already, but enforcement of this EU directive is still weak.

5.1.3 Conclusion

Road safety and CO_2 reduction are important issues for more stringent limits and enforcing the speed limits on highways. Because implementation has to deal with political, public and industrial resistance, an optimal situation, from environmental and safety views, cannot be reached in a short time period or in just one step. One may even risk raising speed limits under governments that take climate change policies less serious than accommodating the car lobby. Nevertheless highway speed limits (including enforcement) seem to be an obvious instrument choice. Depending on the strictness of enforcement and the amount of violations, it may even generate net revenue. The costs are to a large extent offset by reductions in accidents and casualties.

5.2 CO_2 emission standard

5.2.1 Introduction

One of the regulatory instruments that are dealt with in this study is the CO_2 emission standard for new passenger cars. At the European level, this instrument has only been implemented by means of a voluntary agreement between the car industry and the EU to reduce CO_2 emissions. In this so-called ACEA covenant, the European car industry committed itself to reducing the average CO_2 emissions of new cars to 140 g CO_2/km in 2008 (i.e. a 25% reduction compared to 1995), which is in fact a target and not a standard. This initiative was followed by the Japanese and Korean car industry. The voluntary agreement differs from the EU target of 120 g/km in 2005.

The information in this section is based on submissions from France and Germany, both on the ACEA covenant and not on CO_2 emission norm, as well as the following documents: (ACEA/EU, 2001 and 2002; UNEP, 2002; ACEA, 2002).

5.2.2 Benchmarking

The analysis of the French and German replies points to the conclusions in Table 5.2.

Table 5.2 *Summary of benchmark conclusions CO_2 emission standard*

CO_2 emission standard	CO_2 effect	Cost-effectiveness [ton/€]	Budget implication	Acceptance	Implementation speed	Reversibility	Transferability
Effect 1995-2000	2-3%	probably high	~ budget neutral	positive	full effect achieved after 2010	+	+
Effect 1995-2010	about 10%	probably high	~ budget neutral	positive	full effect achieved after 2010	+	+

CO_2 effect
The estimated relative CO_2 effect of the CO_2 emission standard differs per country. This is due to differences in the structure of the car fleet (range of weight, power and fuel types). France reports an efficiency improvement of the whole car fleet of 5% between 1995 and 2000 (from 8.49 liters/100 km to 8.07 liters/100 km). This is equivalent with 3.8 Mton CO_2 or 2.7% of total CO_2 emissions of the transport sector in 2000.

The German car industry estimates the CO_2 reduction resulting from the voluntary agreement to amount to 0.7 Mton/year. This corresponds with a total reduction in 2000 of 3.5 Mton CO_2, constituting 2% of total emissions in the transport sector. The estimated CO_2 effect is largely determined by the assumptions with respect to what would have happened in the absence of the covenant.

Calculations for the Flemish region show an absolute CO_2 reduction of the road transport sector with 10% in 2010 compared to 1990 due to the ACEA covenant.

Reports from ACEA show the effect of the covenant on the mean CO_2 emission. In all countries fuel efficiency of new passenger cars are increasing but the effects differ per country (ACEA/EU, 2001; ACEA/EU, 2002). Between 1995 and 2001 the average CO_2 emission for new cars declined from 185 to 164 g/km (-11%). This is based on an efficiency improvement of diesel cars with 13.1%, gasoline cars 8.5% and some shift from gasoline to diesel[29]. If efficiency improvements continue like this, the 2008 target can be met. With some assumptions a mean efficiency improvement between 1995 and 2010 of the passenger car fleet can be expected from about 16%, resulting in a reduction of the CO_2 emission from the transport sector of about 10%. As stated before the situation per country can differ.

A possible rebound effect of the CO_2 emission standard is an increase of mileage due to lower operational costs. According to France, this rebound effect is small, but taken into account in the calculations. Germany presents no indication of a possible rebound effect. It is noted that the rebound effect can be reduced or prevented by adjusting the costs of driving through fiscal measures such as raising diesel fuel taxes.

Cost-effectiveness
Both France and Germany do not provide data with respect to the additional costs and benefits for society related to the instrument. Additional costs would be the R&D efforts by the car industry (which they will probably transfer to the car consumers). Additional benefits relate to the lowering of emissions other than CO_2. Overall, it is estimated that the costs per ton CO_2 reduction will be low, so cost-effectiveness will be high.

Budget implications
From the point of view of the German government, no costs accrue in connection to the voluntary agreement. However, part of the R&D effort of the car industry is financed by the EU (ACEA, 2001).

[29] Finland reports an efficiency of new registered vehicles between 1993-2000 of 23% for diesel cars and 8% for petrol cars. In total 10.8%.

Acceptance
The CO_2 emission standard of new cars is commonly accepted. Acceptance by the car industry has been stimulated by the voluntary agreement since these are basically more widely accepted than regulations. To quote from the German response: *"Voluntary agreements are regarded as an effective instrument which on the one hand ensures a quick achievement of environmental goals and on the other hand opens up enough possibilities for the enterprises to implement these goals economically and efficiently. At the same time, they offer the opportunity to respond more quickly to new political challenges than in the normal legislative procedure and to adapt the contents to the changed framework conditions in a flexible way."*

Implementation speed
Implementation of the instrument can take place rather quickly. However, reaching its full effect can take some time, since energy efficient cars have to be developed and the replacement of old cars by new ones will only take place gradually. Even before emission standard have the force of law, they stimulate the development of technology.

Transferability
The instrument is already implemented on a European level. Currently, only the EU-15 is monitored by the ACEA. However, this can easily be extended with other countries. Such types of agreements require involvement of larger groups of countries.

Reversibility
Setting CO_2 emission standards is reversible and does not involve sunk costs. The shifting form petrol to diesel, which occurs in some countries, causes more pm10 and NO_x emissions and can make it a regret option. This fuel shift causes also 'non reversible' investments in the refinery sector.

5.2.3 Conclusion

CO_2 emission standards are currently used through the (voluntary) EU agreement with the car manufacturing industry and are in fact implemented as a target. Although the CO_2 effect of this measure is high, other aspects have to be mentioned. The agreement only affects the average CO_2 emissions/km/car (in a test cycle) and only new cars. The effects on driving behaviour and the possible rebound effects by the lower fuel costs in terms of more km driven or in the purchase of bigger cars are left aside. Furthermore, it may be worth considering what would have been the technological developments in the absence of the agreement. Finally the shift to diesel cars causes more particulate emissions.

6. POLICY INSTRUMENTS FOR TECHNOLOGY AND FUEL

6.1 Telematic systems for freight transport

6.1.1 Introduction

This measure includes telematic systems, increasing freight logistics, (allowed) load factor etc. Although telematic systems play a growing important role in, e.g., freight logistics and efficient transportation, only two countries responded with respect to this measure.

Finland reports a continuous implementation of telematic systems in the form of research and development programmes such as TETRA, FITS, DIGIROAD and NAVI. The results of these programmes are provided to the industry and operators. As a result of increasing logistic efficiency of rail and combined transport, the market share of rail transport has been maintained at a relatively high level (around 25% of freight transportation). Due to its geographic location (being surrounded by the Baltic Sea and rather long distances to the markets of other EU countries) Finland is dependent on inter-modal transportation. Thanks to increasing logistic efficiency (port functions, loading/ unloading and traffic float systems), the transport costs have still remained at a low level. This is the reason why these (rather sustainable) modes of transport have maintained their market share. The main target group consists of freight transport operators.

Spain reports on the development of a Distribution Urban Centre (CDU), close to the historical town centre of Malaga. The primary objective of this project, which is in the phase of construction, is to avoid problems of urban freight distribution in a wide Historical Centre such as congestion, traffic and parking conflicts and local specific pollution. All transport companies will join the CDU.. In the CDU incoming freight will be collected and distributed to the shops by means of electrical vehicles. The parking/resting time for lorries will be controlled by telematic devices. Although the CO_2 effect of the Spanish project is not calculated, it is estimated that some CO_2 reduction will occur, but the effect will not be substantial on a national scale. Logistic centres or good transport centres can be found in various places in Europe. They sometimes focus on distribution, as is the case for the CDU of Malaga, or on inter-modal transport (located near two or more modes) (IEA, 2001). Because the main investments focus on the infrastructure and telematics only serve as a helpful tool, we will not focus on this type of projects in this section.

The EU is also active in the field of telematics, for example in linking stand alone telematic systems to a more efficient international network (NEI, 2000). More EU information can be found in the ROSETTA project, which is an Information Society Technology Programme (IST) support measure that will compile the results and findings of the 4th and 5th Framework transport telematics and IST projects in order to support their effective application in Europe (ROSETTA, 2002).

6.1.2 Benchmarking

The analysis points to the conclusions in Table 6.1.

Table 6.1 *Summary of benchmark conclusions telematics for freight transport*

CO_2 effect	Cost-effectiveness [ton/€]	Budget implication	Acceptance	Implementation speed	Reversibility	Transferability
2%	high	neutral	positive	mid term	+	+

CO_2 effect
A Dutch study reported on the saving potential of information technology, see Table 6.2 (Bos, 2001). For the sake of comparison, the full table has been reproduced. In four applications, a rebound effect was taken into account. The saving potential in 2010 is additional to the current situation in the Netherlands and is expressed as a percentage of the energy consumption of the related traffic flow. According to this study, ICT technology can reduce the energy consumption of goods transport with 5 to 6%. This reduction must be multiplied with the percentage of freight transport in the total CO_2 emission of transport sector.

Table 6.2 *Energy saving potential of information technology (ICT)*

ICT-application	Saving potential in 2010 in %	Rebound effect	Traffic flow to which the saving potential applies
Tele-working	1.5	yes	Private cars (except business travel)
Tele-shopping	5 (-3)	yes	Shopping traffic. Between brackets: retail distribution
E-commerce (business to business)	1		Goods transport between companies
Video conference and E-mail	1	yes	Business travel
Fleet management system	5 (15)		All goods transport. Between brackets: local goods distribution
Vehicle navigation system	2		Local goods distribution
Dynamic traffic management	1.5	yes	All traffic

Cost-effectiveness
Figures on cost-effectiveness have not been found. In principle, telematics to optimise freight transport would automatically be used by the (transport) companies as long as there is a financial rationale to do so. However, in reality there is an unexploited (economic) potential where governmental intervention can play a role to speed up developments. After governmental initiation, e.g. in the case of journey planners, the market takes over the development (Kroon, 1989).

Acceptance
Because competitive companies have to work together to reach optimal effects, acceptance may be low in the beginning.

Implementation speed
System development takes several years.

Reversibility
Because telematic systems reduce transportation cost, reversibility is not an issue. If a switch has to be made from one system to a new more efficient system some regret aspects may appear.

Transferability
Systems can be implemented in other countries.

6.1.3 Conclusion

Telematics for freight transport have a low to medium potential. This is because freight accounts in most countries for about 1/3 of the CO_2 emissions of road transport. In principle, telematics to optimise freight transport would automatically be used by the (transport) companies as long as there is a financial rationale to do so. However, in reality there is an unexploited (economic) potential where governmental intervention (in terms of. e.g. advice, guidance, organisation of experience sharing) can play a role to speed up the developments. A future intensified focus on CO_2 in transport planning and tax policies may increase the potential of telematics.

6.2 Stimulation of biofuels

6.2.1 Introduction

In principle, biofuels offer an ideal alternative for fossil-based fuels. If they are based on EU-grown crops, they are practically 100% indigenous and CO_2 neutral since their carbon content is captured from the atmosphere (EU, 2001a,b,c). So biofuel is a 100% CO_2 reduction option in potential[30]. The production of biofuel is still more expensive than fossil fuel, so governmental policy is needed.

There are currently two main categories of biofuels:

- Ethanol, produced from the fermentation of beet, corn, barley or wheat, and bio-diesel, produced from rapeseed oil or sunflower.[31] Ethanol can be converted into bio-ETBE (ethyl-tertio-butyl-ether), calculated as 45% biofuel and blended with gasoline at a rate up to 15%.
- Bio-diesel. As raw rapeseed oil cannot be used in normal diesel engines it is normally converted with methanol to rapeseed oil methyl ether (RME also called bio-diesel).

If the whole production chain is taken into account, the CO_2 reduction effect is significantly smaller since the production of bio-*mass* requires input of fossil energy (agricultural machinery, fertiliser). In addition, one should take into account the energy needed for the production of biofuel from biomass. In the case of ethanol, this is substantial. According to a recent IEA report, well-to-wheel CO_2 emissions from ethanol, with a large margin, are about the same as gasoline (IEA, 2001). The well-to wheel CO_2 emissions from bio-diesel are lower as they result in approximately 50% fewer emissions than CO_2 emissions from gasoline. The CO_2 figure would be similar to the CO_2 emission figure for bio-diesel if the ethanol (or methanol) could be made from cellulose.

Five countries provided information on this measure. *Germany* started before the EU legislation and biofuels have been exempted from fuel tax for many years now. In most other countries (such as *Spain and the UK*) EU legislation allows only a reduction in excise taxes for small projects: *"…in the field of pilot projects for technological development of more environment-friendly products and in particular in the relation to fuels from renewable resources"* (EU, 2001a,b,c). The European commission and also the European Parliament have proposed to enable a reduction in fuel tax proportional to the percentage of biofuel incorporated in the fuel. *Belgium* investigates the possibilities related to the implementation of this directive, but has no results yet. In *Finland* bio-diesel has been introduced recently[32].

6.2.2 Benchmarking

The analysis of the replies points to the conclusions in Table 6.3.

Table 6.3 *Summary of benchmark conclusions biofuels*

Stimulation of biofuels	CO_2 effect	Cost-effectiveness [ton/€]	Budget implication	Acceptance	Implementation speed	Reversibility	Transferability
	high	low	very costly	positive	mid term	-	+?

30 The CO_2 reduction effect is often based on substituted fossil fuel. Because fossil fuels are also used for the production of biofuel, the CO_2 reduction effect depends on definition and system boundaries. In principle those fossil fuels can be substituted by biofuel too.

31 The positive effect of bio-degradables has negative side effects related to storage condition (preferable air-free) and keeping quality.

32 In September 2002 Nestle started selling bio-diesel at their gasoline stations.

CO_2 effect
In the EU, six countries use relative large quantities of biofuels. These countries are France, Germany, Italy, Spain, Sweden and Austria (see Table 6.4). Compared to the consumption of gasoline and diesel, the market share of biofuels in the EU is currently 0.3%. This is equivalent to 2 Mton of CO_2 reduction (if biofuel is regarded as CO_2 free). The potential market share of biofuel produced in the EU is 8% (EU, 2001a,b,c). The potential is limited due to the availability of agricultural area. In September 2002, the EU Commission proposed a target for a minimal market share of biofuels of 2% in 2005 and 5.75% in 2010 (approximately 50 Mton CO_2 reduction[30]). This results in a rather large reduction potential.

Table 6.4 *Ethanol and biodiesel production in Europe 2000 (EurObserv'er, 2001)*

In ton	Ethanol production	ETBE production (from ethanol)	Biodiesel production	Mton CO_2[33]
France	91000	1930000	328600	1.00
Spain	80000	170000		0.15
Sweden	20000			0.04
Germany			246000	0.62
Italy[34]			78000	0.20
Austria			27600	0.07
Belgium			20000	0.05
Total EU	191000	363000	700200	2.12
Czech Republic (REC, 2002)[35]			60000	0.15

Table 6.5 *CO_2 reduction costs according to country responses and literature*

	CO_2 reduction costs [€/ton CO_2]	Remarks
Germany (RME)	180	
Germany (RME)	80	Incl. tax revenue of extra jobs
United Kingdom (starting waste oil)	125	
Czech Republic (RME)	236 - 648	Fossil fuel for biofuel production is taken into account (no energy consumption related to by-products)
Sweden (Ahlvik, 2002) RME	190	Costs as if it is 100% CO_2 free
Sweden (Ahlvik, 2002) Ethanol (grain)	330	Costs as if it is 100% CO_2 free
Sweden (Ahlvik, 2002) Future alcohol	100-200	Costs as above (range from methanol- bio-syn to Ethanol-cellulosic matter)
EU	€ 115/ton CO_2	
EU Subsidy for setting aside ground from agricultural use	*€ 100/ ton CO_2*	The subsidy is also given in case of biofuel production

Cost-effectiveness
The cost-effectiveness in the answers (see Table 6.5) is often based on the public revenue effect. In the German answers one calculation was done including the tax revenue of extra jobs. The EU subsidy is probably included in the calculations. In our opinion, cost effectiveness should only be based on society costs, resulting in € 100-€ 200/ton CO_2. If a well-to-wheel approach is used, taking into account the CO_2 emissions in other sectors (agricultural, fuel processing[30]) CO_2 reduction costs for bio-diesel may increase to €200-€400/ton CO_2. For bio-ethanol the costs per ton CO_2 are even higher.

[33] Calculated by ECN using figures from the EU (2001, a,b,c,)
[34] The biodiesel in Italy is mainly used for heating purposes
[35] In Czech Republic RME is sold as a mixture of diesel oil and at least 30% RME

Acceptance
The agricultural sector is enthusiastic about this option, but the price of the product should be in line with what they can earn with food production (Atlas project, 1997). For the government it is a rather costly option due to the loss of (fuel) tax income and the costs of other subsidies needed for market penetration. On the other hand, it reduces oil dependence and has benefits with respect to air pollution as well.[36] In the public opinion, there are some comments on the (possible) decline in food production and the land use competition with nature. In our opinion, biomass for energy in Europe, as proposed by the EU commission, will not have a negative effect on world food production. An important remark is that other options for using biomass might be more interesting (especially biomass as fuel for heat or electricity production), being more cost-effective or/and having a larger CO_2 reduction potential per ha.

Implementation speed
According to the German response, countries can implement the necessary legislation for using biofuels within half a year. The necessary agricultural switch and fuel use implementation will proceed along a slowly rising path, but a great share of implementation can take place before 2010. The possibility of mixing biofuels with common motor fuels enables implementation without demand side problems.

Reversibility
The measure is very expensive and requires significant investments. Because many (agricultural) jobs are involved, a future policy change should include alternative crops. When implementing a fuel that needs dedicated cars (such as raw rapeseed oil), a flexible policy will hardly be possible (Brazil's experience).

Transferability
The measure could easily be transferred to other countries with plentiful agricultural area. However, current EU legislation should be changed (EU, 2001b).

6.2.3 Conclusion

The two major issues in relation to biofuels are the impacts on budgets and the issue of alternative uses. Biofuels are an expensive option and subsidisation is therefore necessary to stimulate the production and demand. Germany implemented its biofuels system as an excise duty tax exemption, but this is not an option for other countries because of EU Law. Biomass should preferably be used for other energy generation, i.e. heat and power production. It is highly questionable whether transportation is the best use of the available crops.

[36] Biodiesel causes less SO_2, particulate and air pollution compared to diesel. Because new regulation will lead to cleaner transport fuels (diesel, gasoline), this advantage will decline within ten years (source ECN).

7. POLICY INSTRUMENTS FOR AWARENESS, BEHAVIOUR AND TRAINING

7.1 Eco-driving

7.1.1 Introduction

In this study, eco-driving focuses on measures that make drivers change their way of driving (operating) their vehicle. The goal of these measures is to improve fuel economy and hence reduce CO_2 emissions. Reduction of car use or mobility is not included here.

Although 'fuel efficient' driving was first introduced during the Oil Crisis of 1973 and received renewed attention in the beginning of the eighties, an update seems to be necessary. Eco-driving is a (new) driving style that saves fuel, reduces noise and emissions of CO_2 and other pollutants, improves road safety and longevity of cars in general (tires, engine etc.). Eco-driving in practice means changing gears at low RPM [2000 - 2500], using top gears in town traffic, less idling, moderating speed and a fluent anticipatory driving style, avoiding high engine loads and acceleration/deceleration dynamics, without giving in on travel time.

Various measures focusing on eco-driving can be distinguished:
1. As part of the education for a driving license of new drivers.
2. As a course for experienced (professional) drivers. The fuel saving for one truck driver is 10 times that of a private car driver.
3. As an information campaign for all drivers.
4. Behaviour change with the help of in-car feedback instruments (econometer, board computer and cruise control)
5. Monitoring by employer of fuel consumption (e.g. as follow up of a course)
6. Education as part of the instruction when buying a new car (not found in country response).

Five countries (see Annex ECO-driving) replied with respect to this measure: Sweden, Germany, The Netherlands, Spain and Finland. Four of these countries (except Sweden) participate with six other countries (including Belgium) in the project Eco-Driving Europe (www.eco-drive.org).

Most countries have integrated the first three measures in their policy. The opinion is that an EU directive could stimulate technical devises. In the Netherlands in-car instruments, such as the econometre/board computer or cruise control, are stimulated by an exemption from the purchase tax (BPM). As a result, 70% of all newly sold cars are equipped with one or more feedback instruments. Tyre pressure is also part of the Dutch eco-driving campaign. Some countries also connect eco-driving with buying more fuel-efficient cars.

7.1.2 Benchmarking

The analysis of the replies points to the conclusions in Table 7.1.

Table 7.1 *Summary of benchmark conclusions eco-driving*

CO_2 effect	Cost-effectiveness [ton/€]	Budget implication	Acceptance	Implementation speed	Reversibility	Transferability
medium	high	neutral	positive	short term - long term	+	+

CO_2 effect

The country submissions show different effects of eco-driving per person who has been instructed.

- Sweden: 3-8%. Long-term effect 7-10% if continuously motivated; otherwise 0-4%.
- Germany: up to 25% (10% is used in calculations).
- Netherlands: Potential 10-20%, max. 30-40% compared to sporty driving (10% is used).
- Spain: Pilot project 2-5% (5-10% is used).
- Finland: 5-10%.
- Belgium 5% in city traffic; 25% in traffic outside cities (Mierlo, 2002).[37]

Although some reports are optimistic about the long-term effect, e.g. 10-15% (SwissEnergy, 2000), 5% or less is assumed here. Because the entire population of drivers will not be reached effectively within 10 year, the effect of the instrument on total fuel consumption will be less. The consultant team estimates the possible effect at 2-3% in 2010 (under current conditions of prices, stimuli and attitudes). This excludes an effect of buying more efficient cars and the use of in-car feedback instruments[38].

Table 7.2 *CO_2 effect of Eco-driving*

	Bases	CO_2 reduction	Remarks
Sweden: practical and theoretical course	Education5000 pp/y private cars, 6000 pp/y truck drivers from 2003	3-7% pp 2010: 0.11-0.26 Mton CO_2/y	
Sweden driving licence	96000/y private cars	5% pp 2010: 0,11 Mton CO_2/y	Period 2004-2010
Germany	Assumption of 10% reduction	10% pp; 16 Mton CO_2/y	Worthwhile to achieve at least a part of this potential
Germany	Political goal	2005: 5 Mton CO_2/y	
Netherlands	Forecast if 50% of passenger cars is eco-driving in 2010	10% pp 2010: 0.75-0.9 Mton	Of 20 Mton passenger cars upper boundary
Finland		5-10% pp 2020: 0,5 Mton CO_2/y	

Table 7.3 *CO_2 reduction costs*

	CO_2 reduction costs	Remarks
Sweden		
Eco-driving course private car € 125	Pay back in one year at 26000 km/y	5% efficiency improvement (normal petrol consumption 0.09 l/km)
Eco-driving course trucks € 300	Pay back in three months at 78000 km/y	5% efficiency improvement (normal diesel 0.5 l/km)
Germany: course private car € 70-100	Payback in 3-5 months at 12000 km/year	Assuming a fuel cost saving of €250/y
Netherlands: HNR program costs	About € 7/ton CO_2	

[37] These figures probably relate to the overall potential of eco-driving.

[38] The Dutch eco-driving site (www.hetnieuwerijden.nl) mentions a mean fuel saving effect of in-car instruments of 5%.

Cost-effectiveness
Eco-driving is a very cost-efficient CO_2 reduction measure. In case of professional drivers, an eco-driving course (if costs per hour are calculated for the employer) will pay itself back within 1 year. Positive side effects are mentioned such as reduced wear, fewer traffic d accidents, less emissions and reduced noise pollution.

Acceptance
The main barrier of this measure turns out to be a 'barrier of consciousness', because most drivers do not see that they can learn something new in a field they think they already know well enough. This can be overcome (according to the Dutch response) by using intermediary - consumer and business- organisations and through frequent communication with the public.

Implementation speed
Germany reports an implementation period of 1 year for their eco-driving programme. A national campaign can have an effect in the short-term; driving courses for professional drivers can have substantial effect before 2010. Implementation in driving license education can be done in the short term, but the effect will penetrate slowly.

Reversibility
The measure has low costs. There are many positive effects related to noise, fewer traffic incidents and accidents, less stress for the driver, emissions and costs (less wear and tear) beside fuel savings. eco-driving is a no-regret option.

Transferability
Countries can introduce the measure by themselves. An EU instrument could be a directive that all new vehicles should have on-board instruments showing the actual fuel consumption.

7.1.3 Conclusion

Eco-driving is a cheap and important measure with many positive effects. To retain the effect a procedure for an individual follow-up is necessary. A main problem is that it needs a change in behaviour of a driver who thinks that he already has a good driving style. In addition, private car owners, who have already a driving license, are difficult to reach. Campaigns and interventions need to be repeated on a regular basis to make sure that the effect does not fade out and the stronger the accompanying economic incentive (in terms of e.g. fines for violation of speed limits or fuel taxes) the stronger and more sustainable is the effect likely to be. In-car feedback instruments can improve the effect. A first priority would be to implement eco-driving into the regular driver training and exams.

7.2 Modal shift passenger transport

7.2.1 Introduction

In this study, modal shift instruments (related to passenger transport) are understood as instruments that facilitate the use of alternative modes for passenger transport. These instruments cover investments in public transport but also information campaigns supporting public transport. Not included here are instruments that aim at modal shift but do not offer public transport alternatives. From the country submissions by *Belgium, the Netherlands, Spain* and *the UK*, it becomes clear that modal shift instruments can be quite diverse and often come in packages, including supportive instruments such as fuel taxes to make transport by passenger car less attractive. In this section, the country information is discussed.

In this section we will mainly focus on public transport and not explicitly on other modalities like walking and bicycling and travel management like carpooling and taxi sharing. Those modal split options reduce CO_2 emissions with positive site effects. The potential of bicycling depends strongly in the geographical situation and weather conditions so transferability is limited. Travel management has, according to our opinion, to deal with a low acceptance by the public resulting in a big difference between theoretical and practical potential.

7.2.2 Benchmarking

The analysis of the replies points to the conclusions in Table 7.4.

Table 7.4 *Summary of benchmark conclusions modal shift passenger transport*

Modal shift passenger transport	CO_2 effect[1]	Cost-effectiveness [ton/€]	Budget implication	Acceptance	Implementation speed	Reversibility	Transferability
Investments in public transport	<1%	Probably low due to high costs and small CO_2 effect	Huge public investments necessary	Varies	Long term	-	-
Information campaigns	<1%	Probably low due to small CO_2 effect	~ Neutral	Positive	Short term	+	-

[1] Modal split as a stand-alone measure, not supported by additional instruments.

CO_2 effect

Since modal shift instruments are generally part of a package and supported by fiscal measures, it is often hard to unravel the CO_2 effect of individual instruments. In the Netherlands, for example, a number of instruments were implemented in the late 1980s and 1990s ranging from rail investments to stimulation of bicycle use. The Dutch estimates that the whole package leads to 1 Mton reduction. It is remarkable that the main share of this reduction is attributed to the fuel levy (which is not a modal shift instrument in our definition). To quote from the Dutch submission: *"The impact of the fuel levy increase on public transport use is that public transport use in 2001 would have been around 1,5% lower compared to the actual level. The amount of walking and cycling would have been around 1% lower compared to the actual level. Note that these percentages are too small to change the shares of the transport modes (in passenger km) significantly, because compared to car use, the amount of public transport use and the amount 'cycling and walking' are relatively small."* To underpin this quote, the Dutch refer to Bovy et al. (1991), stating that the overlap in the markets for car use and public transport use is relatively small.

Spain submitted two concrete projects concerning modal shift: a public transport plan for Barcelona aiming at a shift from car and buses to rail (2001-2010) (CIVITAS, 2002) and an integrated plan for the city of Granada, improving conditions for walking and public transport (1993-1998). The reported CO_2 reduction for the Granada project is 0.84 kton/year. In Barcelona the cumulative CO_2 reduction is estimated at 6.7 kton (in 9 years). In both cases, supportive instruments have been used to achieve the reductions. The supportive instruments include media campaigns, promotion of car pooling, car traffic restrictions in many areas, improvement of information and schedules of public transport, parking policies, mobility plans, reduction in the circulation tax (which is a local tax in Spain) for those willing to car. Of course, the CO_2 effect depends on the efficiency of the alternative mode.

In the UK, the modal shift package addresses railway, long distance coaches and local transport. The CO_2 reduction has not been calculated due to the integrated nature of the instrument. However, predicted outcomes of a 50% growth in passenger journeys by 2010 and a greater patronage built upon passenger transport aims to reduce congestion especially in inter-urban areas. According to the UK submission, this would have a positive CO_2 benefit.

The primary objective of many of the Belgian modal shift instruments is not CO_2 reduction but the increase of accessibility of public transport or the increase of liveability of cities. Therefore CO_2 reduction estimates are not made. However, the objective of the company transport plan (reduce individual car use for home-office trips) is closely related to CO_2 reduction. For one company (pilot project), a reduction of car use of 3% was found.

The rebound effect related to investments in (better) public transport is a transfer from walking and cycling travels or induced travels. The increase of CO_2 emission by the rebound effect of mobility generation and substitution from less polluting modes can be even bigger than the CO_2 reduction from modal split change of passengers from private cars! In the case of a substitution to electrical public transport is it relevant how this extra electricity is produced. A high CO_2 reduction appears if it is produced with hydro- or nuclear power plants, a low reduction or even an increase appears if it is produced with coal power plants.

Cost-effectiveness
Cost-effectiveness calculations are hardly made (or not reported). Only in the Spanish submission about the public transport plan for Barcelona can some interesting figures be found that should be included in cost-effectiveness calculations. Safety savings are determined at 2.12 M€ and it is estimated that almost 128 thousand hours of travelling time are saved.

Since CO_2 reduction is mostly not the main objective of public transport policies, the costs are relatively high compared to the reduction achieved. However, it is commonly recognised that investments in public transport can lead to large social benefits. This conclusion is consistent with literature (Grant, 1998).

Budget implications
The costs for the government strongly depend on the type of modal shift instrument. Information campaigns are relatively cheap, whereas the costs for investments in public transport can be huge. Since CO_2 reduction is often low, the costs per ton CO_2 reduced will be high. An example is given by the public transport plan of Barcelona having a budget of 4093 M€/9 years for 6.7 kton CO_2 reduction. This results in cost exceeding € 20,000/ton CO_2[39]. Other submissions do not give insight in the budget implications.

Acceptance
The acceptance of information campaigns[40] and investments in public transport is rather high as long as they improve the quality of travelling in terms of increased accessibility and reduced travelling time (however, one should note that the acceptance of modal shift as objective is less accepted). Local opposition may arise against these investments ('not in my backyard'). Politicians might oppose the possibly huge costs.

Implementation speed
Investments in the infrastructure of alternative modes are rather time consuming. Awareness campaigns that promote the use of these alternative modes can be implemented in quite a short time.

Reversibility
In principle, public transport investments are irreversible. If CO_2 reduction were the only objective of an investment, it would probably be regretted (since generally CO_2 reduction is small and cost is high).

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[39] Because it is an investment budget, with long term effects, the exact figure cannot be calculated. If the budget did only contain variable costs the figure would be higher (*4093 M€/9 years/6.7 kton is € 69,000/ton CO_2.)*.

[40] Information about Public Transport is still a problem: "A third of the public say that when planning bus or train journeys they currently find it difficult to access the necessary information; and four in ten say that if it were easier to obtain information about public transport services, they would use them more" (CfIT 2001).

Transferability

The transferability of modal shift instruments is limited, due to the big influence of local and national aspects[41]. With respect to information campaigns, one should be aware of cultural differences between countries. Proper ex-post evaluations of investments in public transport might help other countries in formulating their own investment plans.

7.2.3 Conclusion

Public transport has important social benefits and can have a positive effect on congestion. Increasing the availability of public transport, at high investment costs, is a very expensive CO_2 reduction measure. In other words, investment in public transport should not be made for the sole purpose of reducing CO_2 emissions, as the net climate benefit is small. Society should invest in rail and public passenger transport to the extent to which these measures can fulfil other objectives in a cost-effective way.

7.3 Modal shift freight transport

7.3.1 Introduction

In this study modal shift instruments (related to freight transport) are understood as instruments that facilitate the use of alternative modes for freight transport such as rail and water. These instruments mainly cover investments in the infrastructure but also supportive instruments. Not included here are instruments that aim at modal shift but do not offer the alternative modes (e.g. taxes that make road transport less attractive).

Information has been submitted by teams from Germany, Spain, the UK, the Netherlands, Belgium, Finland and France. The country submissions are very diverse: contributions address modal shifts from road to rail and from road to inland shipping. Some countries do not distinguish between modal shift as an objective and modal shift instruments. This means that several countries added fiscal measures to promote modal shift under this heading. In this section the country information is discussed.

According to the EU white paper (EU, 2001d) road makes up 44% of the goods transport market, 41% for short see shipping, 8% for rail and 4% for inland waterways. Because it is expected that goods transport will grow with 50% between 1998 and 2010, transport on main transit roads, which are already heavily congested, will have to handle even more traffic. EU priority is therefore given to trans-European railways.

7.3.2 Benchmarking

The analysis of the replies points to the conclusions in Table 7.5.

Table 7.5 *Summary of benchmark conclusions modal shift freight transport*

CO_2 effect	Cost-effectiveness [ton/€]	Budget implication	Acceptance	Implementation speed	Reversibility	Transferability
Small	Probably low due to small CO_2 effect; for less expensive measures cost effectiveness could be medium	Costly	Varies	Achievement of full effect after 2010	-/+	-

[41] A lot of information on local measures is available. See for instance the database of ELTIS (European Local Transport Information Service (www.eltis.org), the final report of the LEDA (Legal and Regulatory Measures for Sustainable Transport in Cities) project (LEDA 2000) or the EU knowledge Centre for results from the Fourth Framework Transport Research Programme (http://europa.eu.int/comm/transport/extra/).

CO_2 effect
CO_2 effects for this instrument are hardly reported by the various countries. In case of a substitution to electric (rail) transport CO_2 reduction depends also on the emission from extra electric power production.

The Dutch mention a bad practice experience with a new railway for freight transport (Betuwelijn). When the reduction effect was first estimated (back in 1994 by Van Wee et al.), it was expected to be between 0 and 0.2 Mton. Nowadays, some scenarios even calculate an increase in CO_2 emissions due to the huge amount of energy used to construct the railway.[42]

To shift considerable shares in goods transport from road to rail, the Germans have introduced a package of several measures. These are mainly financial measures (not taken into account here) but also some infrastructural investments have been made. For the total package, a scenario-wise development of CO_2 emissions is expressed by a comparison between 1997 and 2015. According to that comparison, the total emissions from road transport decrease, but only due to a decrease in passenger car transport. Goods road transport, along with rail transport and inland shipping, all show an increase of CO_2 emissions.

In Belgium, companies can have a scan made of their transport flows, in order to analyse the possibilities for modal shift. Furthermore, the Flemish government has set up a construction of public private partnership in order to build load and unload facilities to improve the accessibility of waterways. For both initiatives, the CO_2 emission reduction has not been calculated.

A modal split change from road to water has a positive CO_2 effect in our opinion. However, such a change is not always possible. If the change is made for international transport the CO_2 effect looks even bigger, because the fuel use for international shipping is reported as bunkering, which CO_2 emissions are excluded from the countries Kyoto limits.

Cost-effectiveness
The country submissions do not give insight in the cost-effectiveness of the various instruments. However, given the diversity of possible instruments cost-effectiveness might vary considerably.

In general, it is very hard to estimate the cost-effectiveness of mode switching (OECD/IEA, 2001).

Budget implications
The costs for the government depend on the type of modal shift instrument that is being used. Changing old or building new infrastructure is very expensive. Even when a construction of public private partnership is being used, the costs for the government are considerably high. In the Belgian example, the cost carried by the government has a maximum of 80% of the total amount of the investment.

Acceptance
As long as companies are not forced to use different modes of transport, acceptance of an instrument will be large. As is the case with investments in public transport, local opposition may arise against investments in infrastructure for freight transport. Especially if the infrastructure has a great impact on the environment, there will be much opposition

Implementation speed
Modal shifts from road transport to water or rail take a long time because of vested interests of road carriers and the sunk tradition of many companies in road transport.

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42 Normally the energy use for construction of new infrastructure is not taken into account in this kind of comparisons.

Reversibility
Investments such as the Betuwelijn in the Netherlands are irreversible in the end. If CO_2 reduction would be the only objective of such a project, one might regret it. All the other country submissions subscribe to that. In most of the cases, accessibility is by far the most important reason to take measures according the stimulation of modal shift. A problem, which might occur, is a raising of SO_2, NO_x and pm10 emissions, because the legislation for other modes than trucks is less stringent.

Transferability
The transferability of modal shift instruments is limited because of the differences between the countries. Some countries aim at transferring road transport to rail transport, road transport to inland shipping and road transport to short sea shipping. It is clear that specific measures to stimulate these aims cannot easily be transferred.

7.3.3 Conclusion
Modal shifts of freight transport is likely to be very costly. If the modal shift causes extra electricity demand, it is relevant how the electricity is produced. Power production with coal power plants has a negative effect on the CO_2 reduction.

8. BENCHMARKING RESULTS

8.1 Benchmarking of instruments: results

Table 8.1 provides a summary of the individual assessments of the instruments covered by this study.

This study assesses the selected instruments against a set of pre-determined criteria. The table overleaf provides a summary of the results. It makes maximum use of the results from the questionnaires. The replies were however insufficient to allow for complete filling out of the table, and it should also be noted that the table overleaf is more generic than the use of the questionnaire replies would enable it to be. For example, in the case of road pricing the table considers also more stringent uses of road pricing (in terms of congestion pricing) than the km. based charge that was considered in the questionnaire. Consequently, the Consultant's own assessments (established on the basis of experience and consultations with other literature) have supplemented the questionnaire information. Still, the information in the table is not contradictory to the information from the questionnaires. When interpreting the table one should consider the first two columns CO_2 reduction and cost effectiveness of overriding importance for the recommendation that further work on a particular measure is justified. Roughly speaking, one could argue that low cost options with high reduction potentials are obvious choices for further work whereas high cost options with low reduction potentials should be deferred.

In defining the ranges for the CO_2 effect, viz. Low, Medium and High reductions, the Consultant has aimed to define them in such a way that the instruments are almost equally represented (among those included in this study) in each of the ranges.

Opinions differ on the need to include the tradable quotas in this table, since they can be seen as a means to achieve a predetermined target at the least cost[43]. Nevertheless, we have chosen to include them in the table, in order to have all instruments defined during the Madrid meeting presented in it.

[43] Comment put forward by Per Kågesson, Sweden.

Table 8.1 *Overview of benchmark assessment of policy instruments*[44]

Instrument	CO_2 effect[1]	CO_2 cost-effectiveness	Budget implication	Acceptance	Implementation speed	Conclusion
CO_2 emissions standards	H	high	neutral	positive	LT	++
Eco-driving	M	high	neutral	positive	ST-LT	+
Speed limits and enforcement (highway)	M	high	neutral/ positive	varies	ST	+
Fuel tax	L-M	high	positive	low	MT	0/+
Telematics; freight	L /M	high	neutral	positive	MT	0/+
Vehicle tax (incl. differentiation)	M	varies	neutral	varies	MT/LT	0
Road/km/congestion pricing	L-H	medium	varies	low	MT	0
Stimulation of biofuels	H	low	costly	positive	MT	0/-
Modal shift - Public	L	low	costly	varies	ST-LT	0/-
Modal shift - Freight	L	medium	costly	varies	LT	0/-
Tradable CO_2 permits	L	high	neutral	?	MT	?

[1] L = low, achieved reduction as a share of total national transport emissions <2%
M = medium, 2-5%
H = high, >5%

[44] In Helsinki it was decided that the benchmark criteria reversibility and transferability would not be included in this final table.

Considering the CO_2 effect and the cost effectiveness, it would appear from the table that fuel taxes would be an obvious choice for reducing CO_2 emissions from road transport. On the other side of the scale, modal shifts would appear quite an ineffective choice in pursuit of a CO_2 reducing target. One however needs to consider the other criteria as well. Taking fuel taxes as an example: the table indicates that they would be an effective means of providing CO_2 emissions reductions, but it also shows that, in order to realise this instrument, the issue of acceptability needs to be addressed. Below, the conclusions that emerge from the table are discussed in more detail.

- *CO_2 emission standards* are currently used through the (voluntary) EU agreement with the car manufacturing industry and are implemented as a target, not as a standard. Although the CO_2 effect of this measure is high, other aspects have to be mentioned. The agreement only affects the average CO_2 emissions per km per car (in a test cycle), and only new cars. The effects on driving behaviour and the possible rebound effects by the lower fuel costs in terms of an increase in mileage or the purchase of bigger cars are left aside. Furthermore, it may be worth considering what would have been the technological developments in the absence of the agreement. Finally a shift to diesel cars that could be provoked by this instrument, causes more particulate emissions and might cause growth in vehicle mileage due to lower fuel costs.
- *Eco-driving* is a low cost option and is considered an attractive and promising instrument by many. The major points to note are: firstly, that campaigns and interventions need to be repeated on a regular basis to make sure that the effect does not fade out, and secondly, that the stronger the accompanying economic incentive (in terms of e.g. fines for violation of speed limits or fuel taxes) the stronger and more sustainable the effect will likely be. In-car feedback instruments can improve the effect. A first priority would be to implement eco-driving into the regular driver training and exams.
- *(Highway) speed limits* appear to be an obvious instrument choice. Depending on the strictness of enforcement and the amount of violations, it may even generate net revenue. The enforcement costs are to a large extent offset by reductions in accidents and casualties. The major and important obstacle to an intensified use of this instrument is the issue of acceptance. In some countries the CO_2 reduction potential of this instrument is large.
- *Fuel taxes* are in effect in all countries. While increasing fuel taxes is a cost-effective instrument to reduce CO_2 emissions, public acceptance is low. High fuel taxes form an important incentive to switch to transport alternatives with lower CO_2 emissions. As such they support the effectiveness of other measures such as modal shift, biofuels and eco-driving.
- *Telematics for freight transport* has a low to medium potential. This is because freight accounts for around 1/3 of transport's CO_2 emissions. In principle, applying telematics to optimise freight transport would automatically be used by the (transport) companies if there is a financial rationale to do so. In reality there is an unexploited (economic) potential, where government intervention (in terms of e.g. advice, guidance, organisation of experience sharing) can play a role to speed up the developments. A future intensified focus on CO_2 in transport planning and taxation policies may further increase the potential of telematics.
- *Vehicle taxes* include both differentiation and level of taxes in this study. Vehicle tax levels affect the amount and age of vehicles in the fleet, whereas the differentiation can be used to influence the composition of the fleet. The former has the largest potential for CO_2 reductions, but is typically assumed to involve substantial welfare losses whereas the latter can be designed so as to reduce the negative welfare effects. In other words, the latter may prove to be more cost effective, although the reduction potentials may be lower. In relation to CO_2 differentiation there may be a rebound effect if the cost per km is reduced by this instrument, and this will also affect government revenue.
- *Road/km/congestion pricing* covers a wide range of more specific instruments that are mostly not considered or developed for their CO_2 reducing merits but more so because of their ability to influence congestion and local pollution. Consequently, the potential CO_2 effect cannot be assessed as it will depend on the exact system in place. Instruments design could, for example, include some element of CO_2 differentiation (e.g. reduced rates for en-

ergy efficient vehicles) for all roads and all vehicles. CO_2 differentiation is a feature of both the German system and the system that was analysed in the Netherlands. It is important to note that this group of measures without CO_2 differentiation does not encourage energy efficient driving, but primarily aims to influence traffic volume and use of road capacity.

- *Biofuels***.** The two major issues in relation to biofuels are the impacts on budgets and the issue of alternative uses. Biofuels are an expensive option and subsidisation is therefore necessary to stimulate the production and demand. Germany implemented its biofuels system as an excise duty tax exemption, but this is not an option for other countries any more because of recent EU law. Biomass should preferably be used for other energy generation, i.e. heat and power production. It is highly questionable whether transportation is the best use of the available biomass.
- *Modal shifts* include both shifts by freight transport and shifts to public transportation. Empirical evidence suggests that substantial movements from private to public transportation are necessary to provide significant CO_2 effects. As a consequence this measure is likely to be very costly. As a stand-alone instrument to reduce CO_2 emissions it is not very efficient. Furthermore, an increase in service levels of public transportation may in itself generate new demands. If the modal shift causes extra electricity demand, it is relevant how the electricity is produced. Power production with coal power plants has a negative effect on the CO_2 reduction.
- *Tradable CO_2 permits* can be a cost-effective option. A system where transport, by means of the refineries, is included in a trade scheme may however have only a little effect on CO_2 emissions in the transport sector, and the impacts on CO_2 emissions from transport may even prove to be adverse. This is due to the fact that there are other areas of the economy where the reductions can be attained at lower costs. Applying a system of tradable CO_2 quotas vis-à-vis the vehicle users still remains to be further investigated, but it is open to discussion whether such a system will be more efficient that the mirror instrument: fuel taxes.

8.2 Benchmarking as an instrument itself: results

An important objective of this pilot project is to assess the value of benchmarking as an instrument to reduce CO_2 emissions in the transport sector.
The consultant team feels that the discussions on CO_2 reduction in the transport sector during the project meetings with all participants were one of the most valuable outcomes of this project. However, these discussions alone are not enough to make benchmarking a useful instrument. For successful benchmarking one needs:

- Full commitment of participating countries that recognise the urgency of CO_2 emission reduction in the transport sector; this commitment varied among participating countries in this project.
- Stable country teams; personnel shifts (with poor file transfer) as was the case for some countries in this pilot delay and frustrate the process.
- Participation of all involved ministries; in this project, most of the country teams were only related to the Ministry of Transport whereas - in view of the instruments studied - successful benchmarking asks for participation of all relevant ministries.

The use of questionnaires to collect the relevant data in a structured way (as was chosen in this pilot project) turned out not to be very efficient. The availability and quality of much of the data submitted by the countries turned out to be poor. The consultant team feels that in the future research institutes or national experts could take the lead in the collection of data. After production of the first results, these could then be discussed with and commented on by the involved policy makers during the benchmark process.

Since benchmarking should be based on evidence (achieved performance) and not on expectations, the consultant team emphasises the need to ex-post evaluate instruments. This turned out to be a general lack in providing information in this project. To ensure a clear and transparent comparison base, ex-post evaluations should preferably be based on the same method. If that is not feasible, at least the method that is used and the assumptions that are made should be made clear.

9. DISCUSSION AND RECOMMENDATIONS

This report summarises the main contents and results of a first attempt to benchmark CO_2 reduction instruments in the road transport sector. The benchmark was conducted on the CO_2 policies for road transport of a range of European countries, as well as on a selection of instruments in that area. This section seeks to identify the important lessons that can be learned and which are relevant for a thorough benchmark of CO_2 policies in transport. In deriving the lessons learned, the objectives of this pilot project should be kept in mind. The objectives are:

1. To compare the country policies of a number of European countries with respect to actual CO_2 emissions in the transport sector.
2. To benchmark a number of policy instruments that aim to reduce CO_2 in the transport sector.
3. To assess whether the instrument 'benchmarking' can support environmental policy in the transport sector and to identify the conditions that need to be fulfilled for benchmarking.

Below, lessons learned and recommendations are presented for each of these objectives separately.

9.1 Country policies

The purpose of this study was not to actually benchmark country policies but to make an in-depth comparison of several aspects of policies to support the benchmarking of policy instruments. Such a comparison appeared to be complex because of several factors:

- Starting situations to reduce CO_2 emissions from the transport sector differ between countries (e.g. population density, income per capita, economic growth, climate, composition of the car fleet, tax levels, instruments already implemented),
- All countries already apply a mix of policy instruments, which do not have the purpose to reduce transport-related CO_2 emissions, but which did have significant effects on past CO_2 emission trends. Also for many new policy instruments reduction of transport-related CO_2 emissions is only a derivative),
- Limited availability of evaluations (especially ex-post),
- No broadly accepted methods exist how to (ex-ante and ex-post) evaluate effects of policies.

Recommendation 1
Gain detailed insight in the different starting positions of countries to be able to mutually compare country policies.

Although some ex-ante evaluations of policy packages have been carried out, their role in the policy process seems rather limited. Ex-post evaluation of policies is not common practice. There is no broadly accepted method to evaluate effects of policies. Therefore, results from evaluations can usually not be compared as different countries use different methods and the assumptions are often not available. In most countries, a monitoring programme for the transport sector already exists and is part of the national statistical surveys. In their submissions, most countries do not provide insight whether monitoring data are used in the policy process to adapt existing policies or implement new instruments.

Recommendation 2
Develop and use common evaluation methods (with a focus on ex-post evaluation) and exchange monitoring experiences.

The following approach for CO_2 related transport policy is proposed:

- If not already the case, expected growth in CO_2 emissions from the transport sector must be included in the national climate policy.
- The package of policy instruments to reduce CO_2 emission from transport should preferably be SMART (specific, measurable, agreed upon, realistic and time-specific).
- An integrated approach is recommended to design CO_2 policies. Such an approach needs to address behaviour of the actors in the transport sector. These actors need incentives (financial or possibly also via regulation), various alternatives with less CO_2 emissions (e.g. low emitting vehicles, public transport, biofuels, etc) and they need information in order to be able to make informed choices from the available alternatives.
- When emission growth in the transport sector cannot be compensated by reductions in other sectors, a specific target for the transport sector must be set.
- Additional instruments must subsequently be implemented to achieve the target.
- An ex-ante evaluation of the total policy package should indicate whether the target can be achieved.
- Yearly monitoring of emissions and policies (in between evaluation) should be carried out to check if target achievement is on schedule. Monitoring should be detailed to allow for explicit consideration of particular transport segments, such as company cars and sport utility vehicles.
- If target achievement is not on schedule, the reason for this should be given (volume developments, structural developments, instruments do not work out properly, interference with other instruments occurs, indirect effects are larger than anticipated, etc.).
- Subsequently, policies should be adapted or new policies should be implemented. It is important to realise that policies will need change over time; they need to be dynamic to remain effective. This is especially the case if more drastic emission reduction will be aimed at in the longer term.

9.2 Benchmarking of instruments

In Chapter 8 the results of this pilot benchmarking exercise are presented. The applicability, use, relevance and exclusiveness of such a table and its criteria are further discussed below. This section draws extensively on the knowledge acquired through the review of the questionnaires, and combines this knowledge with other experience and expertise in order to provide an assessment of the selected instruments, which is as comprehensive as possible. It should however be noted that comprehensiveness per se has not been a criterion for determining success in this pilot study. The study instead focuses on instruments that were considered most promising with respect to CO_2 reductions by the participating countries.

The results presented in Table 8.1 should be carefully handled. The amount and quality of the data is more extensive/better for some instruments than for others (compare e.g. the data on taxes versus the data on modal shift). This difference is closely linked to the pilot character of the study. For a fair and comprehensive comparison of instruments the amount and quality of the data should be equal. In addition, it should be noted that the improvement of data quality is a continuous process fed on ex-post evaluations.

In view of the above the main lesson to be learned from Table 8.1, is to carefully consider the relevance of low CO_2 reduction/high costs instruments, whereas there should be really good arguments against a high reduction/low costs instrument. These arguments may be found in other criteria, such as acceptance and budget implications.

Next to data issues concerning amount, quality, method and assumptions, one should also carefully assess the criteria being used in this study. Scopes for extension and are:

- Inclusion of explicit distributional aspects (equity). At present equity implications are integrated into the acceptance issue, but distributional issues tend to be an important political issue.
- Elaborate a stringent, common and operational definition of cost effectiveness. This is a crucial outcome of the analyses, and the replies to the questionnaires did not contain much (and definitely not comparable information) on this issue.
- Use a longer time horizon in the analyses of CO_2 reductions and related CO_2 cost effectiveness in order to take into account effects that increase or decrease over time. It is recommended:
  - To calculate the annual CO_2 reductions over a fairly long time horizon (20 or 30 years) and calculate the annual net costs to society (over the same period). The long period is recommended in order to fully benefit from those measures that may have lasting (or even steadily increasing) CO_2 reducing effects (compared to those that have an effect over a mere few years). By setting such a long time horizon the full profile (in terms of costs as well as reductions) is in any event included in the analyses.
  - To define and use a proper rate of discount in order to attach more value to today's reductions (and related costs) than to those that occur in the (distant) future.
  - Based on the above two calculations: to calculate the Net Present Value of the CO_2 reductions (and the costs) - and by result use that to calculate the cost/ton of CO_2 reduction.
  - To calculate the accumulated CO_2 reductions to be harvested within the Kyoto period.

  The result from this exercise will be three different pieces of information for each measure: 1) accumulated CO_2 reduction until 2010, 2) average cost/ton of CO_2 reduction and 3) average annual CO_2 reduction.
- For instruments aimed at influencing individual mobility, take into account trade-off issues made by individuals between time-budget constraints and monetary-budget constraints. In most EU countries it appears that time-budget constraints are saturated much earlier than monetary constraints. As a consequence, people can afford to pay for more speed and then to increase their mobility within the same time budget.
- For instruments aimed at influencing freight transport demand supply-side effects should be taken into account more explicitly.

Based on improved criteria (and aiming at a commonly agreed methodology how to address the criteria in question) a more elaborate version of Table 8.1 should be compiled involving the ultimate users. This exercise should also involve the establishment of ranges that are commonly agreed upon, and to the extent possible, efforts should be made to replace ranges with concrete values.

Recommendation 3
Elaborate on the benchmark criteria by adding relevant other criteria, and sharpening the operational definitions.

Other important issues, which need to be more carefully and consistently addressed, are double counting and synergy effects (policy packaging). As an example of the former, congestion pricing may provide a further incentive for transport companies to use telematics in the logistic planning, and care should be taken not to attribute this effect to both measures. Similarly, synergies between various instruments (for example eco-driving, differentiation of vehicle taxes and km. charging) that result in a combined effect that is larger than the sum of each individual instrument, should be taken into account.

Recommendation 4
The issues of double counting and synergy effects (policy packaging) should be addressed explicitly (without losing the specific aspects of individual instruments).

The comparison base of data with respect to amount, quality of the data and underlying methods and assumptions - needed to benchmark instruments - will be addressed in the next section.

9.3 Benchmarking as an instrument itself

The third objective of this pilot project is to assess the value of benchmarking as an instrument to reduce CO_2 emissions in the transport sector. Based on the experiences in this pilot study it becomes clear that:

- Involvement of co-operating and supporting countries is a pre-condition for a successful benchmarking exercise;
- Full commitment and long-term involvement of country teams are required to achieve a substantial degree of efficiency and enhance the quality of individual contributions (for this purpose, the urgency of CO_2 policy in the transport sectors must be recognised by policy makers);
- Since some of the CO_2 instruments are beyond the jurisdiction of the Ministries of Transport, the supportive base of a benchmarking exercise should include all relevant ministries in a country.

Recommendation 5
For effective benchmarking in the transport sector the urgency of the CO_2 problem should be recognised and policy makers should commit themselves to the benchmarking process.

An important lesson of this benchmark pilot is the limited efficiency of using questionnaires. A useful suggestion for a future benchmark exercise would be to have an independent (research) institution produce a discussion paper and discuss this paper and elaborate on it in close interaction with policy makers. In this way, an efficient method of data gathering is provided, whereas the useful input and additions of policy makers can be integrated in the research. The latter - i.e. the creation of an international forum of policy makers discussing the CO_2 problem of the transport sector - has been one of the fruitful elements of this project.

Recommendation 6
Adapt the method used for benchmark without losing the close interaction with the policy makers by preparing a document based on data gathering to provide a basis for discussions with and additions by involved policy makers.

Although the performance of a thorough benchmark seems a step too far for now, the results of this project can be used by countries to learn from each other's experiences. Based on the country submissions and additional literature, many data on specific measures have been brought together, providing information about the CO_2 effects, cost-effectiveness and other issues. Countries should however be critical when assessing measures as good practice. Successful implementation of a measure is in the opinion of the consultant team not enough. If the objective of a measure is tackling climate change, the relative CO_2 effect (reduction as a share of total emissions in the sector) has to be significant. Total costs in relation to the achieved CO_2 reduction must be assessed in comparison with other measures.

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APPENDIX A ECO DRIVING EXPERIENCES

Sweden has EcoDrivingä, a practical and theoretical training course for economical and 'ecological' driving. Also a concept for busses and trucks was developed (Heavy EcoDriving). The targets are professional drivers and their employers. Sweden has now started to integrate economical driving in the education and examination for the driving licenses.

Germany has launched a joint campaign of training offers with several actors in the transport sector. Approach: A part of modern technology remains unused if it is operated with the style of driving of former times. Because all sides agree, it is important and necessary for eco-driving, within a voluntary agreement, the motor industry has undertaken to further increase the standard availability of fuel consumption gauges/shifting indications. Main Target passenger cars.

The *Netherlands* eco-driving program contains parallel projects: new driver training (driving schools) methods and exam standards, advanced driver training programs and support, in-car devices (econometer, board computer, cruise control, green rev counter, speed retarder), promoting fuel efficient cars (car labeling) and raising tyre-pressures.). The program was worked out in partnership with intermediary parties. In-car devices (econometer/board computer/ cruise control) are exempt from the purchase tax (BPM). As a result half of all newly sold cars are equipped with one or more feedback instruments. So eco-driving is more extend in the Netherlands compared to other countries.

In *Spain* three steps are followed. First definition of a set of guidelines with advice to drivers towards a better eco-driving. Secondly dissemination of this advice via internet and brochures. Thirdly information about CO_2 emissions and fuel consumption indicator of commercial vehicles offer on the I.D.A.E. Web site.

Since 1997 in *Finland* eco-driving has been increasingly integrated into the general driving education. Special eco-driving courses are provided especially for professional car, taxi, bus and truck drivers. It is interesting to say Finland has adopted the idea of an National Energy Awareness Week in October with special attention to transport on Tuesday (http://www.motiva.fi/).

APPENDIX B SPEED LIMITS IN EUROPEAN COUNTRIES

Table B.1 *Speed limits in European countries [km/h]*

Country	Urban roads[1]	Other roads[1]	Motorways[1]
Austria	50	100	130
Belgium	50	90	120
Germany	50	100	130[2]
Denmark	50	80	110
Spain	50	90	120
France	50	90	130
Finland	50	80	120
United Kingdom	48 (30 miles/h)	96 (60 miles/h)	112 (70 miles/h)
Greece	50	90	120
Italy[3]	50	90	130
Ireland	48 (30 miles/h)	96 (60 miles/h)	112 (70 miles/h)
Luxembourg	50	90	120
The Netherlands	50	80	100-120
Portugal	50	100	120
Sweden	50	70-110	90-110
Czech Republic	50	90	130

1 Maximum speed limits for cars in km/h, general rule. Left to right: urban roads, other roads and motorways.
2 In Germany there is no general speed limit on motorways but the recommended speed limit is 130 km (more than half the network has a speed limit of 120 km or less).
3 Recently, Italy increased the speed limit on three-lane highways to 150 km/h.

Sources:
http://europa.eu.int/abc/travel/driving/index_en.htm.
http://www1.oecd.org/cem/topics/safety/Speed.pdf (updated September 2002).