International
Transport
Forum

CUTTING TRANSPORT CO_2 EMISSIONS

WHAT PROGRESS?

Summary Document

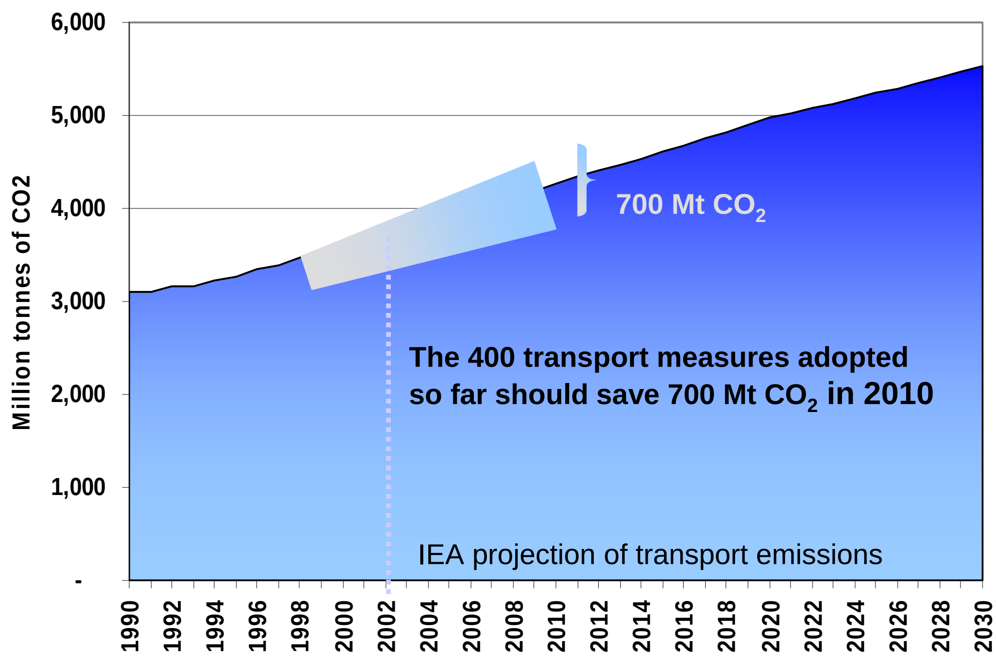
OECD

INTRODUCTION

The report "Cutting Transport CO_2 Emissions: What Progress?" reviews the progress ECMT and OECD countries have made in reducing transport sector CO_2 emissions and makes recommendations for the focus of future policies. The present paper provides a short summary of the work.

National communications under the UN Framework Convention on Climate Change and other recent policy statements were used to assemble a database of over 400 abatement policies introduced or under development. This reveals that transport sector CO_2 emissions steadily increased over the last ten years despite significant efforts to cut them in some countries. Assuming real household disposable incomes continue to grow at a faster rate than the real cost of transport this trend is likely to continue. Slowing the growth of transport sector CO_2 emissions would require more government action and an increasingly pro-active role from transport sector industries in improving energy efficiency.

Figure 1. **OECD/ECMT transport sector emissions and the potential impact of policies identified**



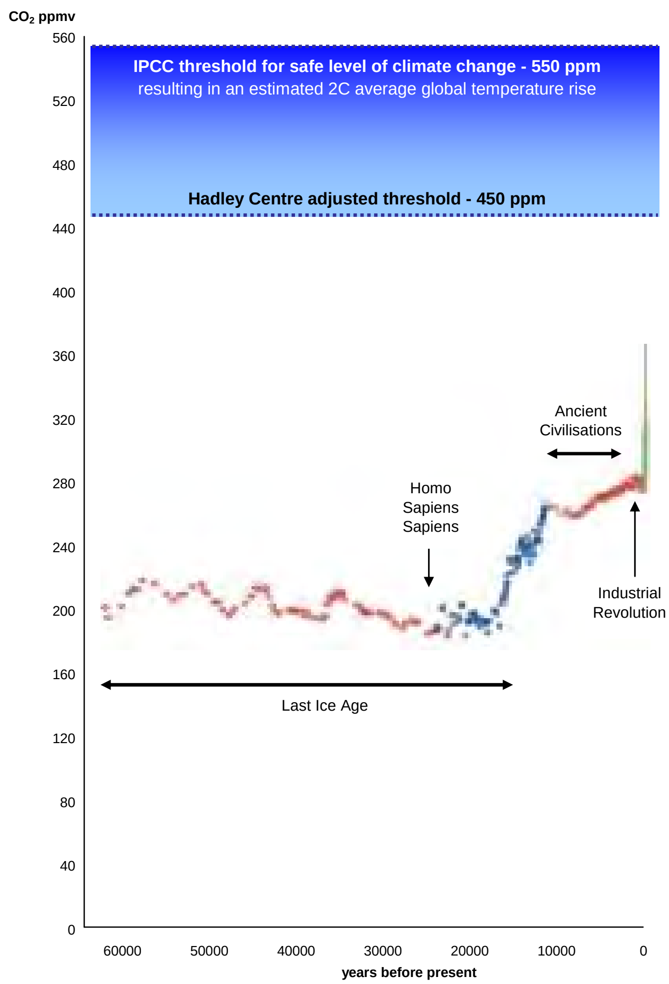
Source: ECMT, based on World Energy Outlook 2004, IEA.

Analysis of the database suggests that measures so far adopted might cut 700 million tonnes from annual CO_2 emissions by 2010, just over half the projected increase in emissions between 1990 and 2010. The accompanying figure gives a crude indication of the significance of these savings, although some of the measures identified may have been included in the business as usual projection shown and the slope of the curve incorporating CO_2 savings is difficult to determine.

CLIMATE CHANGE

If emissions of greenhouse gases, and in particular CO_2, continue unabated the enhanced greenhouse effect may alter the world's climate system irreversibly. According to the Inter-governmental Panel on Climate Change[1] (IPCC) an increase of more than two degrees Celsius in the global average surface temperature has the potential to cause significant damage to the eco-systems on which we are directly dependent.

Figure 2. **Atmospheric carbon dioxide concentrations over the last 60 000 years**

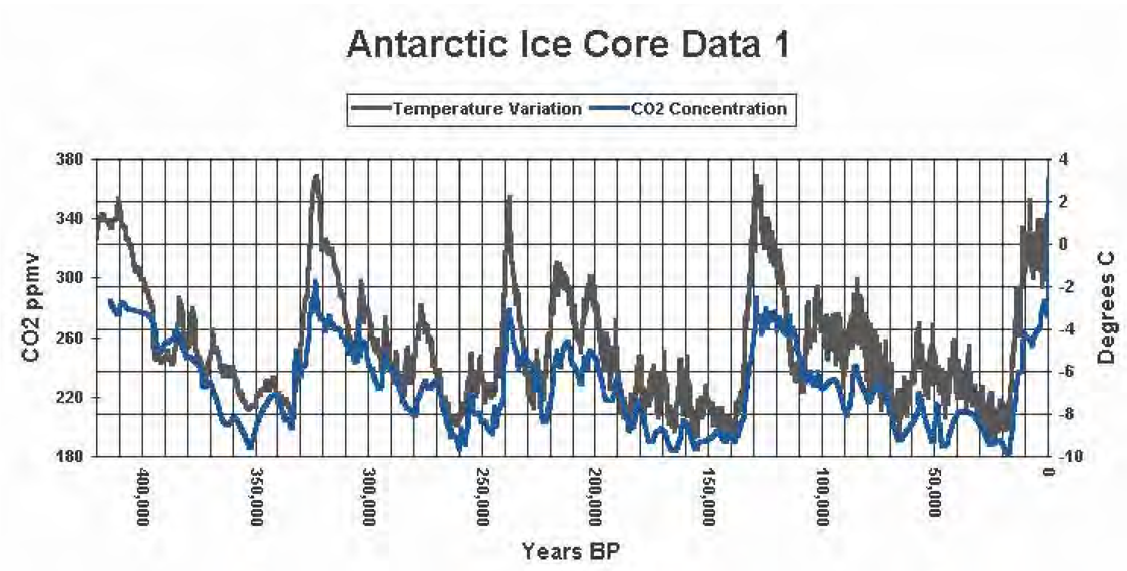


Source: School of Environmental Science, UEA.

Trends in atmospheric CO_2 concentrations and temperatures are shown in figures 2 and 3. CO_2 concentrations are now at levels never recorded in over half a million years. This makes it difficult to predict the impact on climate. CO_2 levels will continue to rise and appear likely to overshoot the IPCC threshold by a considerable margin.

The global average surface temperature has increased by approximately 0.7°C since systematic measurements began around 1850. Establishing how much of this is due to greenhouse gas emissions, and how much the global average surface temperature can increase before unacceptable impacts occur, is an extremely complex task. It is not the role of this report to examine such calculations. Instead it takes politically agreed targets as the starting point for its analysis, for example the European Union's indicative long-term global temperature target of not more than 2°C above pre-industrial levels.[2] Estimates of the reduction in greenhouse gas emissions needed to meet this target range from 15 to 50% below 1990 levels by 2050.[3] To meet such targets, concerted action to reduce greenhouse gas emissions is urgently required and progress has indeed started.

Figure 3. **Variations in temperature and atmospheric CO_2 concentrations over the last half million years**



Source: Historical Carbon Dioxide and Isotopic Temperature Records from Vostik Ice Cores, J.M. Barnola, D. Raynaud, C. Lorius, Laboratoire de Glaciologie et de Géophysique de l'Environnement, CNRS, France, and N.I. Barkov, Arctic and Antarctic Research Institute, Russia, http://cdiac.esd.ornl.gov/trends/co2/vostok.htm, http://cdiac.esd.ornl.gov/trends/temp/vostok/jouz_tem.htm

TRANSPORT SECTOR CO_2 EMISSIONS

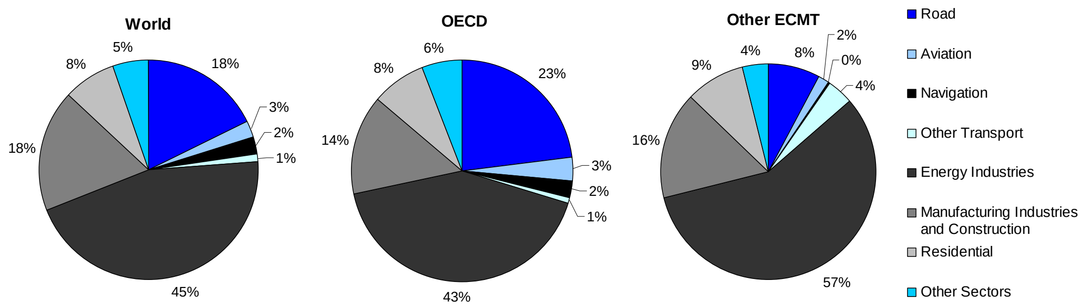
CO_2 emissions from the transport sector attract the attention of both transport and climate change policymakers because of their share of overall emissions and their persistently strong growth.

Transport sector emissions grew 1 412 million tonnes (31%) worldwide between 1990 and 2003, and increased 820 million tonnes (26%) in OECD countries. The OECD-ECMT region accounts for 71% of worldwide CO_2 emissions from transport.

Transport's share of CO_2 emissions is gradually increasing in all regions of the world; its share of world emissions increased from 22% in 1990 to 24% in 2003. Transport's share is highest in the more developed countries of the OECD (30% in 2003).

Figures 4 to 7 show emissions trends by economic sector, separating transport emissions into several sub-divisions. Emissions from energy sector industries are grouped in a single entry; the great bulk of emissions here is attributable to electricity and heat production. Of the 45% of 2003 world emissions attributable to power and energy, 40% belongs to power and heat production and 5% to refining and other energy industries. Of this 5% less than half is attributable to the production of transport fuels. In the OECD region the pattern is similar; in Russia and the other non-OECD ECMT countries power and heat accounts for 53% of emissions with refining and other energy industries making up 4%.

Figure 4. **Transport's percentage share of CO_2 emissions from combustion in 2003**



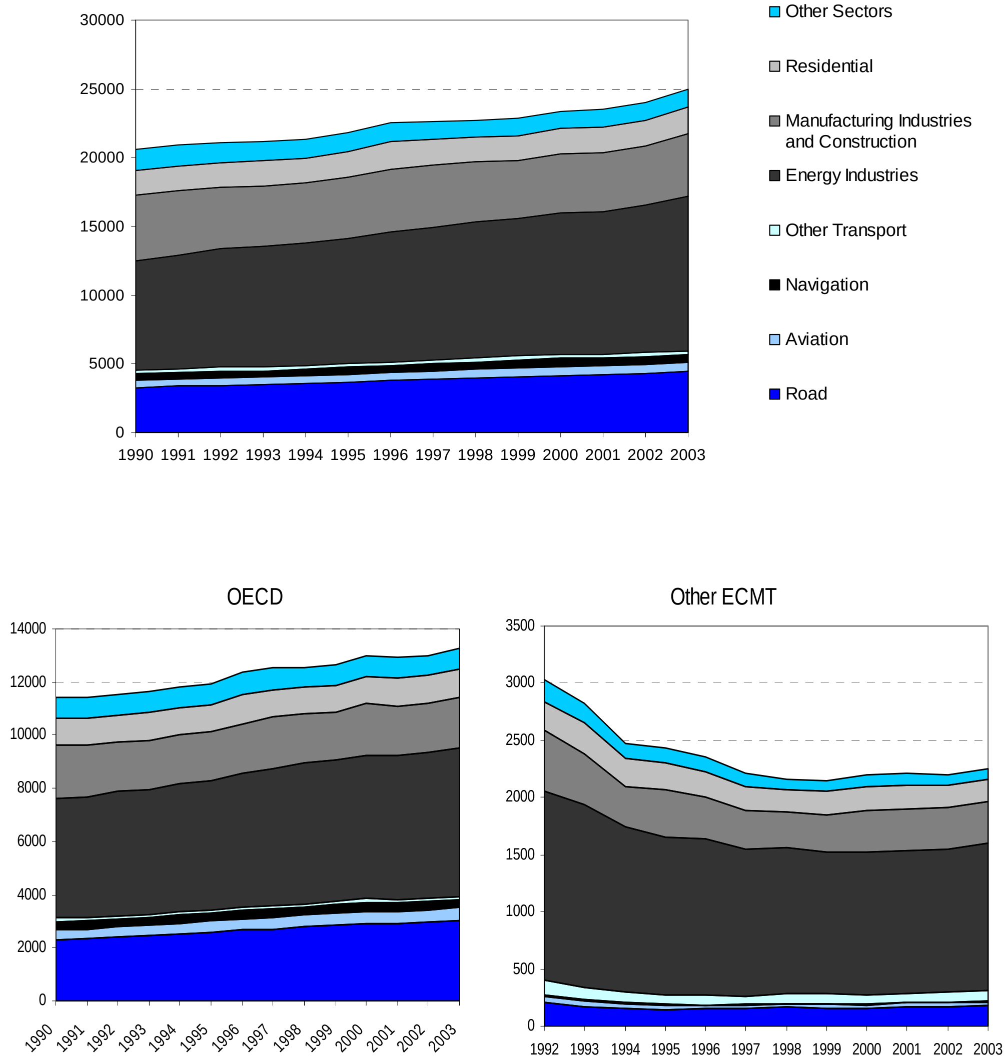
Source: IEA (2005) CO_2 Emissions from Fuel Combustion.

The IEA projections to 2030 foresee the strongest growth in world emissions coming from the power and heat sector. In the OECD countries, in contrast, growth attenuates in this sector but remains strong in the transport sector. Nevertheless, at the end of the period energy industries still account for the bulk of emissions (39%) with transport accounting for 31% of total CO_2 emissions from fuel combustion.

The split between transport services and other end users of energy in accounting for CO_2 emissions differs considerably between countries depending on the structure of the economy, the dominant types of industry and the efficiency with which firms and households use energy. The UK lies at the opposite end of the spectrum from Russia, with its service dominated economy and relatively high industrial energy efficiency, dominance of road transport for passenger and freight services and importance of maritime trade and international aviation. It *may* give an indication of the direction in which many ECMT and OECD economies are heading in terms of patterns of energy use and the transport sector's share of CO_2 emissions (see Figure 8).

Figure 5. **CO_2 Emissions trends by sector (millions of tonnes of CO_2)**

World

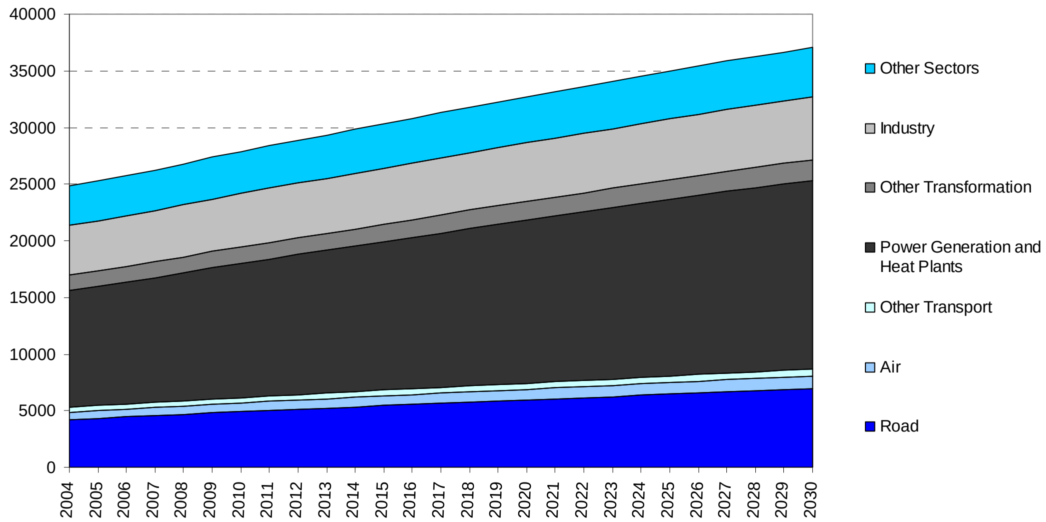


Other ECMT = Albania, Bulgaria, Malta, Romania, Armenia, Azerbaijan, Belarus, Estonia, Georgia, Latvia, Lithuania, Moldova, Russia, Ukraine, Bosnia Herzegovina, Croatia, FYR Macedonia, Serbia and Montenegro, Slovenia.

Aviation and navigation include international bunkers.

Source: IEA (2005) CO_2 Emissions from Fossil Fuel Combustion.

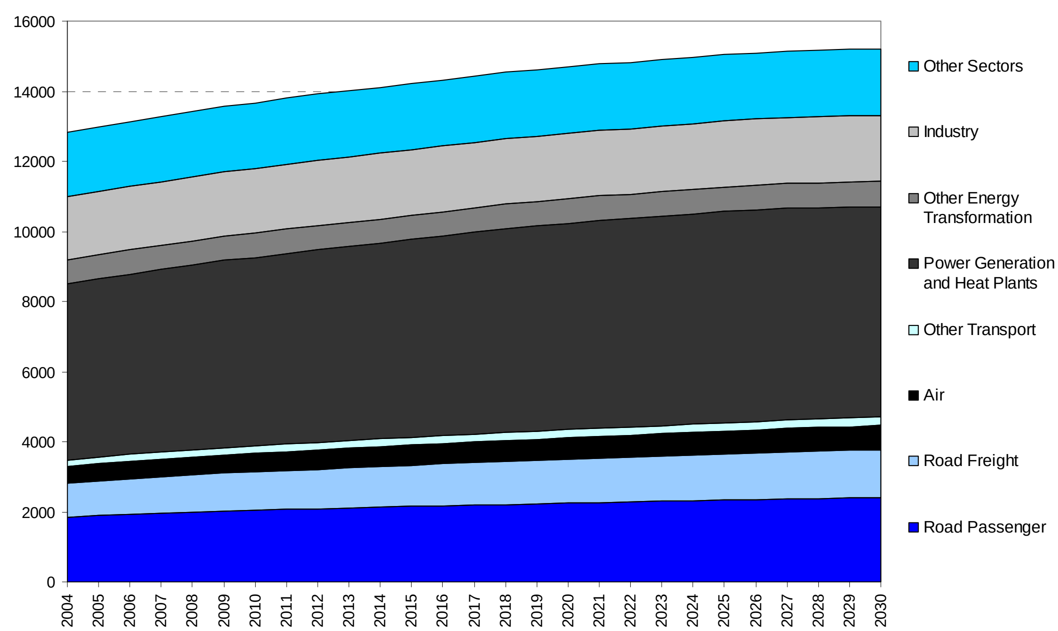
Figure 6. **Outlook for world emissions by sector – IEA base case projections (Million tonnes of CO_2)**



Note: Including international aviation and international maritime transport.

Source: Based on World Energy Outlook 2004, International Energy Agency.

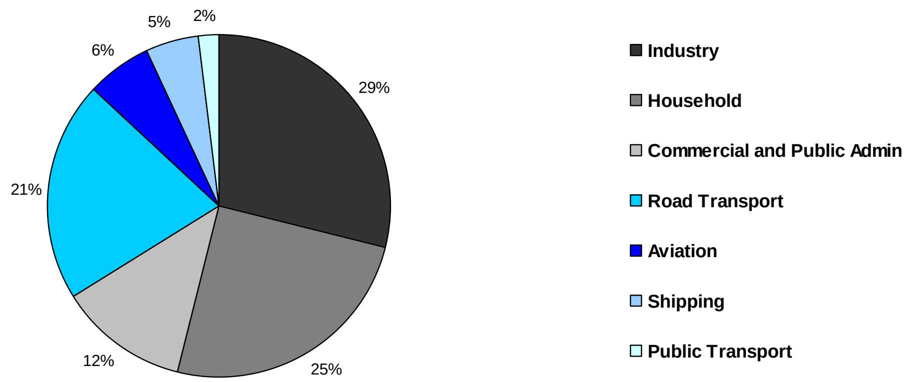
Figure 7. **Outlook for OECD emissions by sector – IEA base case projections (Million tonnes of CO_2)**



Note: Including international aviation but excluding international maritime transport.

Source: Based on World Energy Outlook 2004, International Energy Agency.

Figure 8. **Current UK CO_2 emissions by energy end-use sector**



Source: Tyndall Centre for Climate Change Research, *Decarbonising the UK.*

EMISSIONS BY MODE

Within the transport sector, private and commercial road transport has accounted for the great majority of CO_2 emissions in most countries. The countries of the Commonwealth of Independent States (CIS) have so far proved the exception with the dominance of rail transport in much of that region. Passenger transport accounts for the largest part of road emissions,

For the future, growth in maritime shipping and especially aviation may condition transport sector emissions to a larger degree. The importance of the dynamics in the development of these modes has been masked to some extent by the general exclusion of international bunkers (i.e. fuel for international shipping and aviation) from many reports on energy consumption and CO_2 emissions. The projections shown here include international bunkers for both aviation and maritime shipping in the figure for world emissions. For OECD countries the data available includes international aviation but excludes international shipping.

Road transport emissions are split two thirds to passenger transport one third to freight at present in OECD countries as a whole. The same pattern holds for the European Union countries. Freight emissions have been growing somewhat faster than passenger emissions for some time and the trend is expected to continue. For the OECD, IEA modelling foresees a 64 to 36% road passenger to freight split in 2030 (see figure 7). For the EU slightly higher freight growth and lower passenger growth is foreseen.

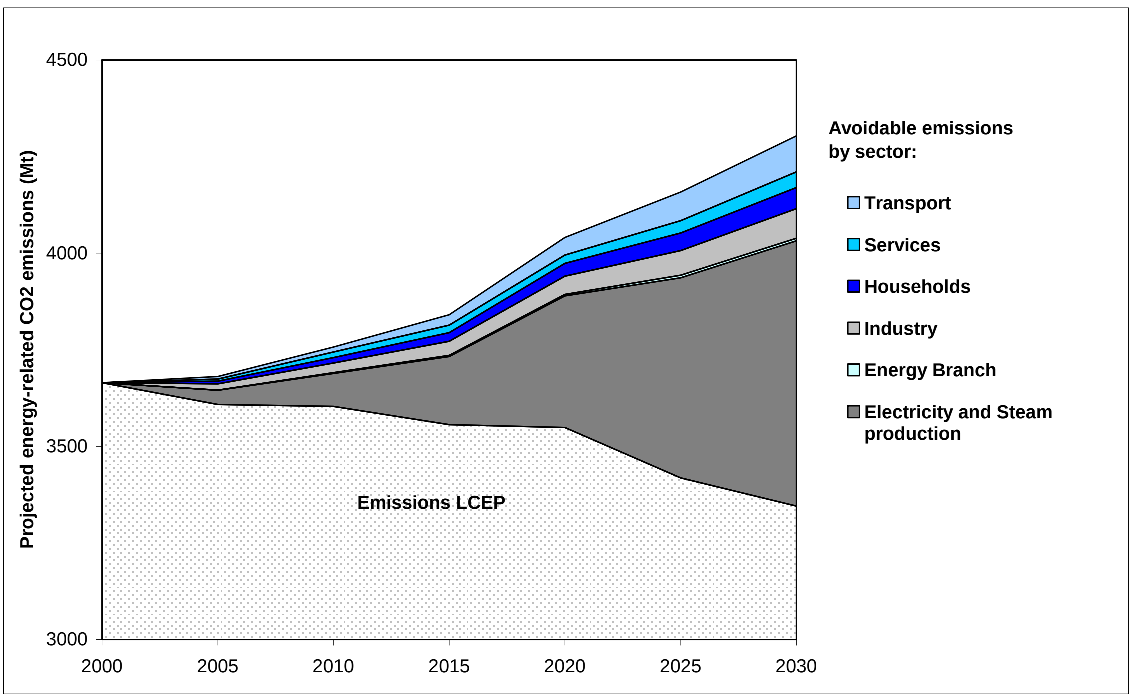
While business as usual scenarios such as the IEA projections in the accompanying figures see the relative modal shares for transport sector emissions little altered, longer term scenarios exploring aggressive abatement strategies in some cases envisage substitution of road transport fuels by hydrogen produced from nuclear or renewable electricity. Under these extreme circumstances aviation, where such fuel substitution appears more difficult, then might grow to account for over two thirds of transport sector emissions.

TRANSPORT SECTOR CONTRIBUTION TO EMISSIONS CUTS

While the transport sector accounts for around a quarter of total CO_2 emissions from fuel combustion, size is not the primary basis for selecting abatement measures in an economy. Cost-effectiveness is the most important factor. Some of the measures already adopted in the transport sector are expensive per tonne of CO_2 abated, costing upwards from Euros 100 per tonne. Some of the lowest cost opportunities for emission reductions in transport have not been exploited so far. The reasons for this are unclear and this report recommends focussing on some of them now – such as regulations for some vehicle components whose performance is not reflected in standard tests of vehicle fuel efficiency, better use of tax incentives for efficient vehicles, support for eco-driving and for the optimisation of freight logistics.

At the same time significant reductions in CO_2 emissions from ECMT countries are likely to be possible even if large cuts in transport sector emissions are not achieved. In a recent study (EEA, 2005), the European Environment Agency modelled a scenario in which CO_2 emissions in the EU were reduced to 11% below 1990 levels by 2030. The majority of these savings occurred as a result of a shift towards low or non-carbon fuels in the electricity generation sector. In this scenario transport sector emissions grew to 46% above 1990 levels (20% above 2000 levels).

Figure 9. **Energy related CO_2 emissions EU 25 (Mt)**



EEA projections showing total emissions in a low carbon scenario (lower area of the graph, coloured white) together with the contribution from each sector to reducing emissions from the business as usual trend.

Source: EEA 2005.

The EEA study concludes that if CO_2 were to be priced throughout the economy, through a system of tradable permits or a carbon tax, then the most promising and cost-effective ways to achieve emission reductions would all be found in the power sector, mainly through fuel shifts (an increase of wind power, biomass and combined heat and power generation). Carbon pricing is unlikely to stimulate fuel efficiency measures in Europe's transport sector because of the limited scope for additional actions beyond those taken in response to the voluntary targets agreed with vehicle manufacturers that the EEA assumes will be tightened over time.

HOW MUCH DOES CUTTING CAR EMISSIONS COST?

A number of ex-ante studies conclude that efficiency measures exist in the transport sector that are more cost effective than measures in other sectors, whilst other studies find transport sector efficiency measures highly uncompetitive (CE, 2006). There is a large body of literature estimating costs for fuel economy measures but remarkably little agreement in the findings. In particular, there is debate whether the benefits of fuel economy measures (i.e. saved fuel) outweigh the costs. While some studies (i.e. Greene, D.L. and Schafer, A., 2003; NRC, 2002; Department for Transport, 2003; T&E, 2005) indicate that net costs will be negative (i.e. measures for fuel economy would generate net benefits), other studies indicate moderate to substantial costs for fuel economy measures (EC, 2004; ACEA, 2006). There are a number of factors that explain these apparently contradictory results.

Fuel economy measures cover a range of approaches including engine modification, drive train modification and lowering the weight of cars, and fuel efficiency can be stimulated by three distinct types of measures:

- Type 1 **-** technical adaptations in vehicle design, such as downsizing, engine port injection, direct injection, hybrid drives, etc.
- Type 2 **-** behavioral changes in driving, i.e. more fuel efficient driving.
- Type 3 **-** behavioral changes in purchasing automobiles (consumers switch to smaller or lighter or more fuel efficient vehicles such as diesel engines).

In general, technical adaptations in engine and vehicle design tend to generate net costs while behavioral changes tend to generate net benefits. Some measures to promote efficient vehicle components (the performance of which is not reflected in tests of fuel efficiency for vehicle certification) are also expected to generate net benefits (ECMT/IEA 2005).

Several studies estimate the costs[4] of moving the European new car fleet average from 140 gCO_2/km (the current 2008 target agreed with industry) to 120 gCO_2/km (the target envisaged by EU Environment Ministers). These studies cover only vehicle technology improvements, mainly engine technologies. IEEP/TNO/CAIR (2005) investigated cost-curves for six car types in a report for the EC. A wide range of cost estimates were generated, depending on the scenarios adopted for the phasing in of different technologies, but as a general conclusion the authors state that for the most cost-effective scenarios the average CO_2 abatement costs are between 34 and 71 Euro/tonne. At the margin (i.e. moving from 121 to 120 g/km) costs were estimated to reach 175 €/t.

These findings are in line with the results reported by the EC in a 2004 Communication (COM(2004)78) that provide an overview of various technical measures in engine design that can be taken in order to lower CO_2 emissions. It found that average costs could reach 50 €/tonne for reducing average new car fleet emissions from the level in 2005 (160 g/km) by 25% to 120 g/km in 2015, after accounting for expected "autonomous" technology developments. The study also defined a more rational package of measures that would lower costs to 15 €/tonne and still result in a net reduction in emissions of nearly 20%.

ACEA (Association des Constructeurs Européennes d'Automobiles) estimates the average costs of moving to a 120 g/km target at 400 to 540 €/t (ACEA 2006)[5].

Such results are at first sight contradicted by other studies (Capros, 1998; Greene and Schafer, 2003; NRC, 2002) that conclude that net benefits can be expected from fuel economy measures. However, closer inspection reveals that these studies mainly focus on Type 3 measures; i.e. promoting smaller cars and a switch to diesel engines.

Type 2 measures also tend to generate net benefits. An ex-post evaluation of Dutch climate change policies by CE (De Bruyn, 2005) showed that information campaigns aiming at improving driving behaviour have been very cost-effective, even though the total effect has been small.

Although no study to date compares type 1, 2 and 3 measures, the existing studies suggest that policies oriented at Type 2 and 3 measures tend to be more cost-effective than policies oriented at Type 1 measures but Type 1 measures can potentially deliver more abatement.

It should be noted that type 1 measures are characterised by steep marginal increases in cost-functions. Both IEEP/TNO/CAIR (2005) and EC (2004) show that there exists a range of technical measures that can be implemented at costs below 20 €/tonne. However, the IEEP/TNO study concludes that the marginal costs of setting a 120 g/km target today could be as high as 140-180 €/tonne. Costs depend in part on the pace of change that regulations impose. And another study, TNO/IEEP (2004), concludes that a policy setting progressive targets in stages is more cost-effective than policies setting very low targets somewhere in the distant future.

It is unclear how far costs can be expected to decline in the long run due to technological developments. Some researchers expect that due to developments of alternative propulsion technologies cost curves may shift downwards cyclicly (ACEEE, 1998) and (US-DOE, 2000). Technological breakthroughs are difficult to include in cost-effectiveness analysis but there does appear to be a general trend to overestimate costs ex-ante (CE 2006).

RECOMMENDATIONS

How much should transport contribute

Cost-effectiveness (cost per tonne of CO_2 abated) is the fundamental determinant of which abatement policies to adopt and how much the transport sector should contribute towards economy-wide CO_2 abatement goals such as the 2008 – 2012 targets for Kyoto Protocol Annex I countries. It is important to achieve the required emissions reductions at the lowest overall cost to avoid damaging welfare and economic growth. Costs are minimised when the cost of saving an extra tonne of CO_2 is more or less equal for all measures in all sectors. Some of the potential measures for the transport sector have relatively low costs, others very high costs at the margin. This is also true of other sectors. By far the largest relatively low cost emission reductions are expected to be achieved in power and heat production. Transport and most other sectors are therefore expected to contribute correspondingly less to overall emissions reduction strategies. Nevertheless, the low cost transport sector measures identified below need to be implemented.

Cost- effective transport measures

Carbon and fuel taxes are the ideal measures for addressing CO_2 emissions. They send clear signals and distort the economy less than any other approach. Fuel taxes already exist in all member countries and whilst changes in tax rates are sensitive politically, because they are highly visible, developing substitute policies usually increases costs significantly. Within the transport sector, policies currently tend to focus on some of the higher cost measures available, for example subsidies for biofuels, whilst some low cost measures are neglected. The focus should now switch to the lower cost options identified in the report submitted to Ministers, notably: regulation and labelling for some vehicle components, such as tyres, not included in standard tests of vehicle efficiency; support for eco-driving and for improved freight logistics; better use of differentiated vehicle taxes, particularly in markets where stringent but voluntary emissions standards apply; tightening of vehicle emissions standards in regions where they are relatively weak in order to benefit from the technology already developed for markets elsewhere; and as noted, fuel taxes.

Co-benefits

Many of the measures that reduce CO_2 emissions from transport are also sometimes proposed for improving the security of oil supply. Since road transport accounts for the largest part of oil product consumption in the economy such oil security measures focus increasingly on road vehicles and alternative fuels (notably biofuels and hydrogen). Some policies pursued primarily for mobility goals – congestion management and access to public transport for the purpose of social inclusion – can also yield CO_2 emissions reductions. Prioritising policies that yield co-benefits makes sense but is not a reason to ignore cost-effectiveness.

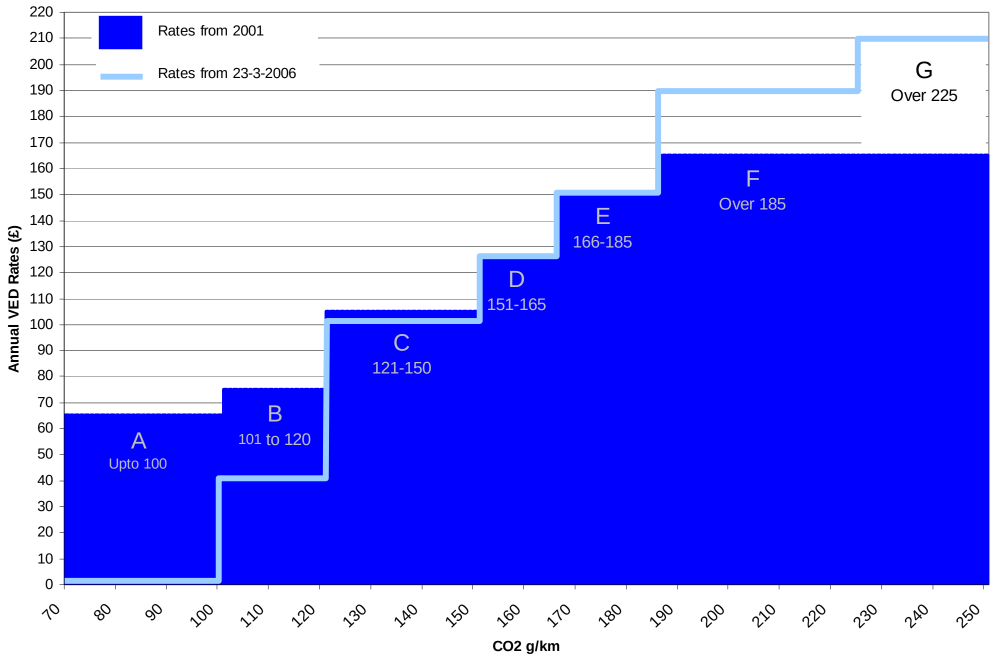
Fuel efficiency delivers most

The largest CO_2 abatement opportunities in the transport sector lie in initiatives to improve energy efficiency: improving the rated fuel efficiency of new vehicles as measured by vehicle certification testing; improving the efficiency of components and accessories not covered in current test procedures; and improving on-road vehicle performance. The most cost effective options include promoting fuel-efficient driving through training and feedback instrumentation, incentives for car buyers to chose lower emissions vehicles where stringent but voluntary emissions targets have been agreed with car manufacturers, and regulations for some currently unregulated vehicle components. No country has exploited all of the opportunities available. There is an optimal rate for improvements in energy efficiency, not easy to determine as the costs of the technology available are difficult to estimate – they generally start high and come down over time. Determining the appropriate level and rate of tightening for vehicle emissions standards is therefore complicated. Regulations for currently unregulated components could however steer the market to greater fuel economy at very little cost, for example by promoting the best performing tyres among those already available.

Differentiation of vehicle taxes top priority for Europe

Reform of vehicle taxation (purchase, registration and annual circulation taxes), so that it is based on a vehicle's specific CO_2 emissions and strongly differentiated, should be a top priority in Europe. This will maximise the abatement potential of existing voluntary CO_2 emission targets. Governments that have already differentiated taxation in this way are recommended to evaluate the effectiveness of their measures with a view to providing stronger incentives covering a broader range of the better performing vehicles (not just ultra low emission vehicles) to encourage sufficient numbers of consumers to purchase more efficient vehicles. Basing differentiation directly on CO_2 emissions in place of proxies such as engine size is also recommended.

Figure 10. **Differentiation of annual circulation tax for private cars in the United Kingdom**



Rates for petrol cars shown. £1 is approximately equal to EUR 1.4. The March 2007 budget increased differentiation further and increased the top rate to £300, rising to £400 in 2008.

Source: Department for Transport and UK Treasury Budget Statement 2006.

Vehicle components

Vehicles components that are not tested for efficiency in certification procedures, such as tyres, air conditioners, alternators, lubricants and lights should be tested and labeled. There are large differences in efficiency between equivalent components currently on the market. Regulatory standards can be designed to steer consumers and manufacturers to the better performing components at low cost and can be designed also to promote technological improvement. An industry proposal for standards for energy efficient tyres is provided in the report submitted to Ministers. Tax incentives can be used to complement standards and can also be used to promote the uptake of non-standard equipment designed to improve fuel efficiency such as tyre inflation monitoring systems.

Fuel-efficient driving and logistics

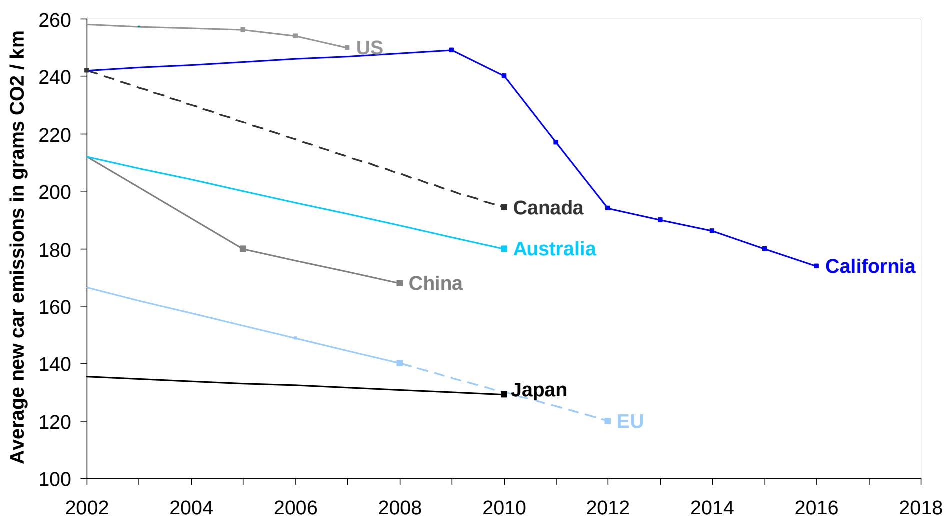
Initiatives to promote fuel efficient driving, particularly through training programmes for both car and truck drivers offer significant cost-effective savings. In the freight sector these initiatives can usefully be coupled with voluntary programmes to improve both logistic organisation and driver behaviour. (Electronic km-charges for road use by trucks also provide strong incentives for more efficient logistic organisation – see below). For cars, tax incentives for fitting fuel efficiency feedback devices such as econometers and shift indicator lights proved highly effective in an extensive Dutch programme at the beginning of the decade.

Vehicle fuel efficiency standards

The USA, Japan and China regulate passenger car fuel efficiency, and Japan also regulates heavy duty vehicle fuel economy. The EU and its Member States together with Switzerland, Australia and Canada all employ voluntary targets for car manufacturers and importers. Japan has by far the most ambitious regulatory standards, but the EU voluntary targets are of a similar order. US standards are far less ambitious, with the exception of the new standards adopted by California in 2006. Regulatory and voluntary targets will need to be progressively tightened to maintain their value. Clearly the weaker targets can be brought closer to the tighter existing targets, despite differences in the types of vehicles on sale in each market. There will also be scope for tighter targets and standards in Europe and Japan as technology improves. The issue is the appropriate time scale for achieving new standards. Any tightening of targets in Europe should, however, go hand in hand with more differentiation of vehicle taxes, as set out in the 1995 Joint Declaration between ECMT, OICA and ACEA on CO_2 emissions from new passenger cars.

Figure 11. **Worldwide passenger car fuel economy and CO_2 emissions standards and average new car emissions in 2002**

Grams CO_2/km, normalised on the basis of the New European Driving Cycle test



Note: Dotted lines indicate proposed standards or targets.

Source: Comparison of passenger vehicle fuel economy and greenhouse gas emission standards around the world, Feng An and Amanda Sauer, PEW Center on Global Climate Change, 2004.

Heavy duty vehicles

Few governments have targeted the fuel efficiency of light and heavy trucks with these policies. For heavy duty vehicles, fuel is a major item in operating costs and fuel efficiency is therefore an important factor in the choice of vehicles purchased. The market thus already drives improvements but the smaller operators face cash flow and other constraints that limit their ability to respond to fuel price signals. Because a substantial and growing proportion of transport CO_2 emissions are accounted for by trucks, Japan began regulating emissions from heavy duty vehicles in 2006. All governments are encouraged to monitor the costs and benefits of the Japanese standards to determine if a similar approach would bring benefits in other countries.

Table 7. **Japanese fuel economy standards for heavy duty vehicles**

	2002 average emissions	2015 target	Change
Trucks	415 g CO_2/km	370 g CO_2/km	12.2%
Buses	466 g CO_2/km	416 g CO_2/km	12.1%

Source: ECMT.

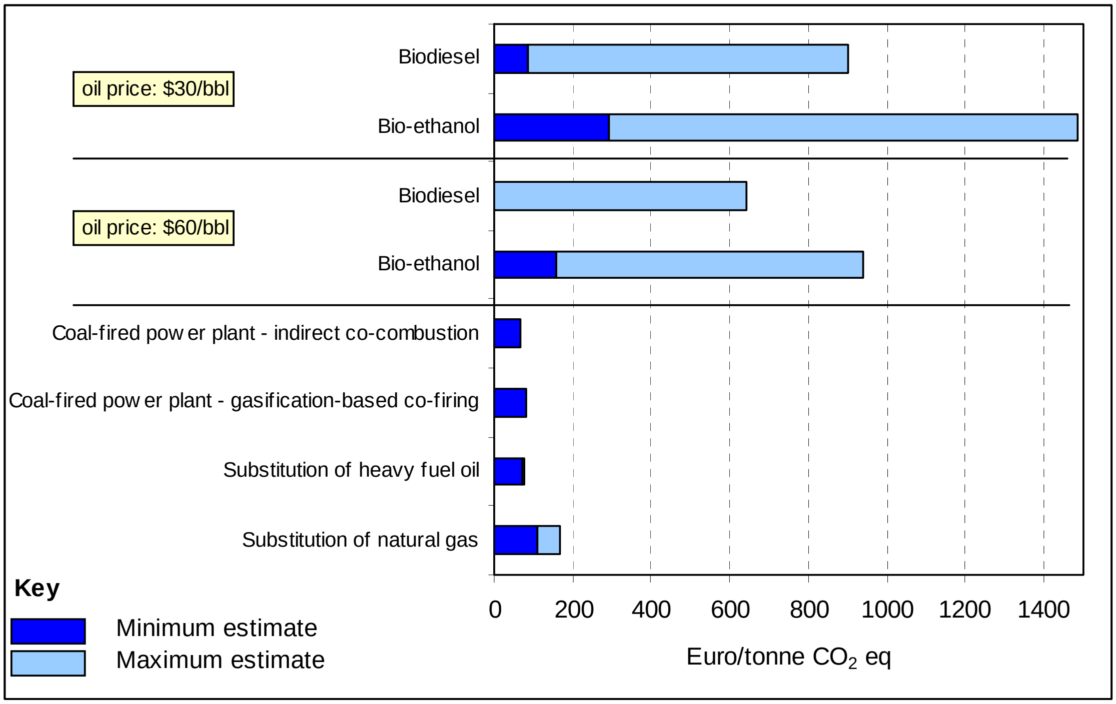
Vans

Fuel accounts for a smaller proportion of overall costs in operating light commercial vehicles. A number of Governments have adopted standards for the fuel efficiency of government owned vehicles and the US has extended CAFÉ standards to light trucks. There may be an opportunity to target a larger number of vehicles by extending voluntary and regulatory standards in other countries to all light commercial vehicle models. A voluntary agreement with manufacturers in this respect was identified as a priority under the first European Climate Change Programme in 2000 but has not so far been developed.

Biofuels

Policies to promote biofuels are prominent in national emissions abatement strategies. Biofuels offer potentially significant CO_2 abatement opportunities but, with the exception of ethanol from sugar cane, most research concludes that the cost per tonne of CO_2 saved is high. The next generation of biofuels, utilising cellulose and lignin rather than just sugars and oils to produce fuels, may offer higher levels of abatement at lower cost although much uncertainty remains. Government support for research and development is indicated for the development of second generation fuels and, given the divergence of views on the cost effectiveness of all biofuels revealed during debate in the 2006 ECMT Council Session, it would be useful to prepare a more complete examination of estimates for the cost effectiveness of biofuels produced in OECD, ECMT and developing countries.

Figure 12. **Estimates for cost effectiveness of greenhouse gas abatement with biomass – comparison of conventional biofuels with the use of biomass in the power sector (timeframe 2005-2010)**



Source: Kampman *et al*, Biofuels under Development: An analysis of currently available and future biofuels and a comparison with biomass application in other sectors, CE 2005.

Support for biofuels

Government incentives for biofuels should be tied to well-to-wheels CO_2 efficiencies. Thus preferential tax rates, subsidies and quotas for biofuel blending should be calibrated to the benefits in terms of net CO_2 savings associated with each fuel. Development of an index of CO_2 savings by fuel type would be useful and if agreed internationally could help liberalise markets for new fuels. Indexing incentives would also help avoid discrimination between feedstocks. Subsidies that support production of specific crops risk being counterproductive to emissions policies in the long run. It should also be noted that biofuels of all types yield the largest and most cost effective CO_2 emissions reductions when the biomass from which they are produced is employed to displace electricity production from fossil fuels, rather than transport fuels which require secondary processing.

Hydrogen

Hydrogen fuelled transport technologies attract significant research and development funds but they are not a CO_2 abatement policy option for the short or medium term. Hydrogen has to be produced using non fossil fuels (nuclear electricity, biomass or other renewable power) if it is to achieve CO_2 abatement. As with biofuels, abatement is maximised when these energy sources are employed directly for displacement of fossil fuelled electricity generation.

Policy mix

Examination of policies for CO_2 emissions reduction in the transport sector so far adopted by OECD/ECMT governments, in terms of the number of policies being pursued, reveals that countries place improving fuel efficiency and modal shift on an equal footing. Policies to promote alternative fuels have also been given a prominent role, while reducing demand for transport is largely ignored.

Modal shift

The large number of modal shift policies is believed to be the result of following a "co-benefits" approach to CO_2 abatement policy. That is, governments have selected abatement policies that also contribute to the achievement of other transport policy goals or wider objectives beyond the transport sector. This includes providing access to low cost public transport and reducing congestion. This is a valid approach to public policy and, indeed, was part of the recommendations of ECMT's 1997 review of CO_2 emissions from transport. The present situation may, however, reflect an over-emphasis on the co-benefits approach. Modal shift policies are usually weak in terms of the quantity of CO_2 abated and have generally been inadequately assessed in national communications on CO_2 emissions policy. Modal shift measures can be effective when well targeted, particularly when integrated with demand management measures. They can not, however, form the corner-stone of effective CO_2 abatement policy and the prominence given to modal shift policies is at odds with indications that most modal shift policies achieve much lower abatement levels than measures focussing on fuel efficiency.

Core inland transport policies

It is therefore recommended that policies now focus on fuel-efficiency: for vehicles, vehicle components and on-road vehicle operation. Policies to promote alternative fuels carry a high cost and a modal shift, co-benefits dominated approach appears unlikely to achieve sufficient abatement in the transport sector. Whenever additional opportunities to reduce CO_2 emissions from the transport sector are sought, a first step should be to investigate whether the potential for improved fuel efficiency has been fully exploited, including through the use of fuel and carbon taxes.

Fuel taxes and emissions trading

Fuel tax increases and specific fuel carbon taxes are estimated to have had a powerful impact on emissions in the small number of countries reporting them as part of CO_2 policy, though of course all member governments employ fuel taxes to raise revenues. They have the highest impact of any of the reported CO_2 abatement measures. Political sensitivities currently prevent many countries from using fuel taxes to influence CO_2 emissions, despite their effectiveness. The potential of this approach needs to be kept under review, particularly as implementation costs are much lower than for substitute approaches, including schemes that trade emission permits.

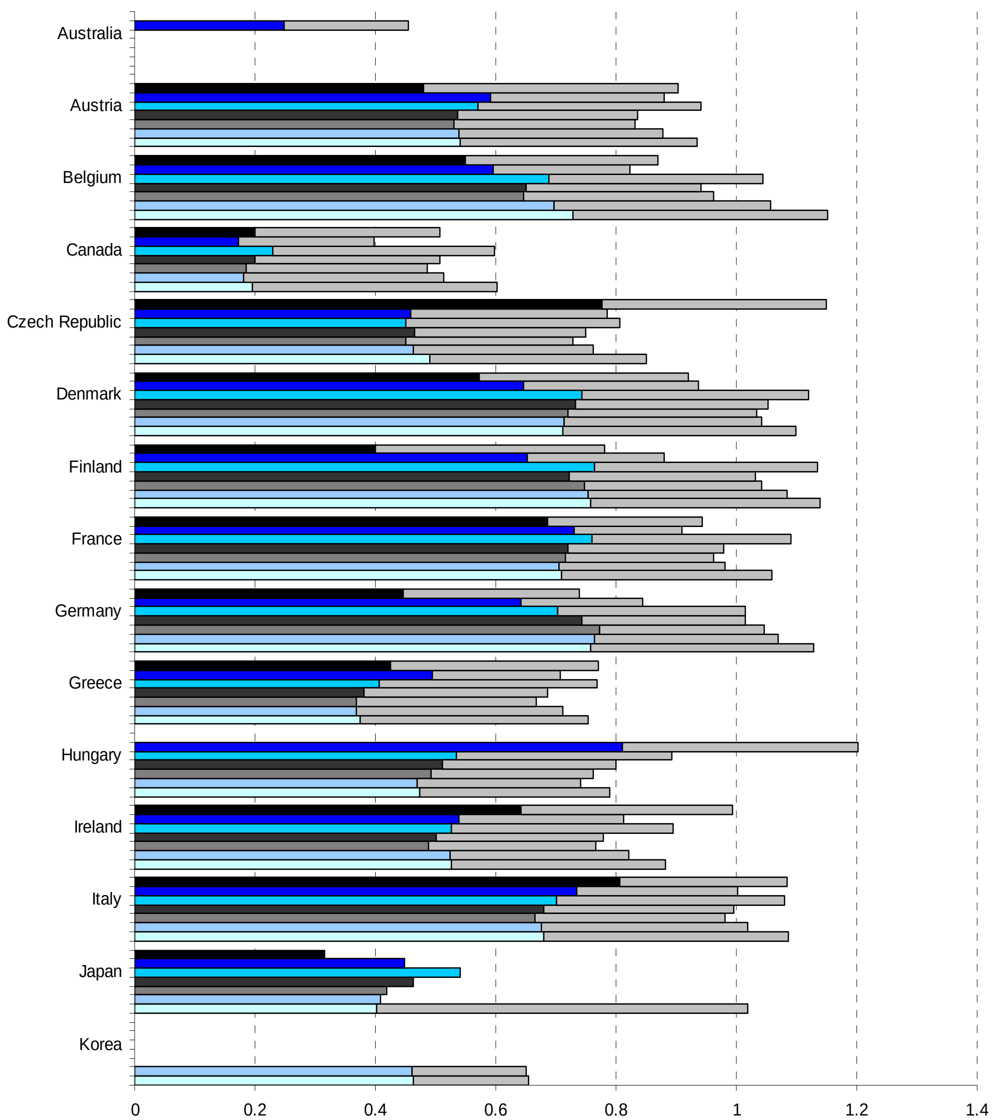
Figure 13. **Average Prices and Taxes of Premium Unleaded Gasoline (95 RON)**

Figures in real 2000 Euros per litre

Legend: 1990, 1995, 2000, 2002, 2003, 2004, 2005; Tax Component; Ex-Tax Price

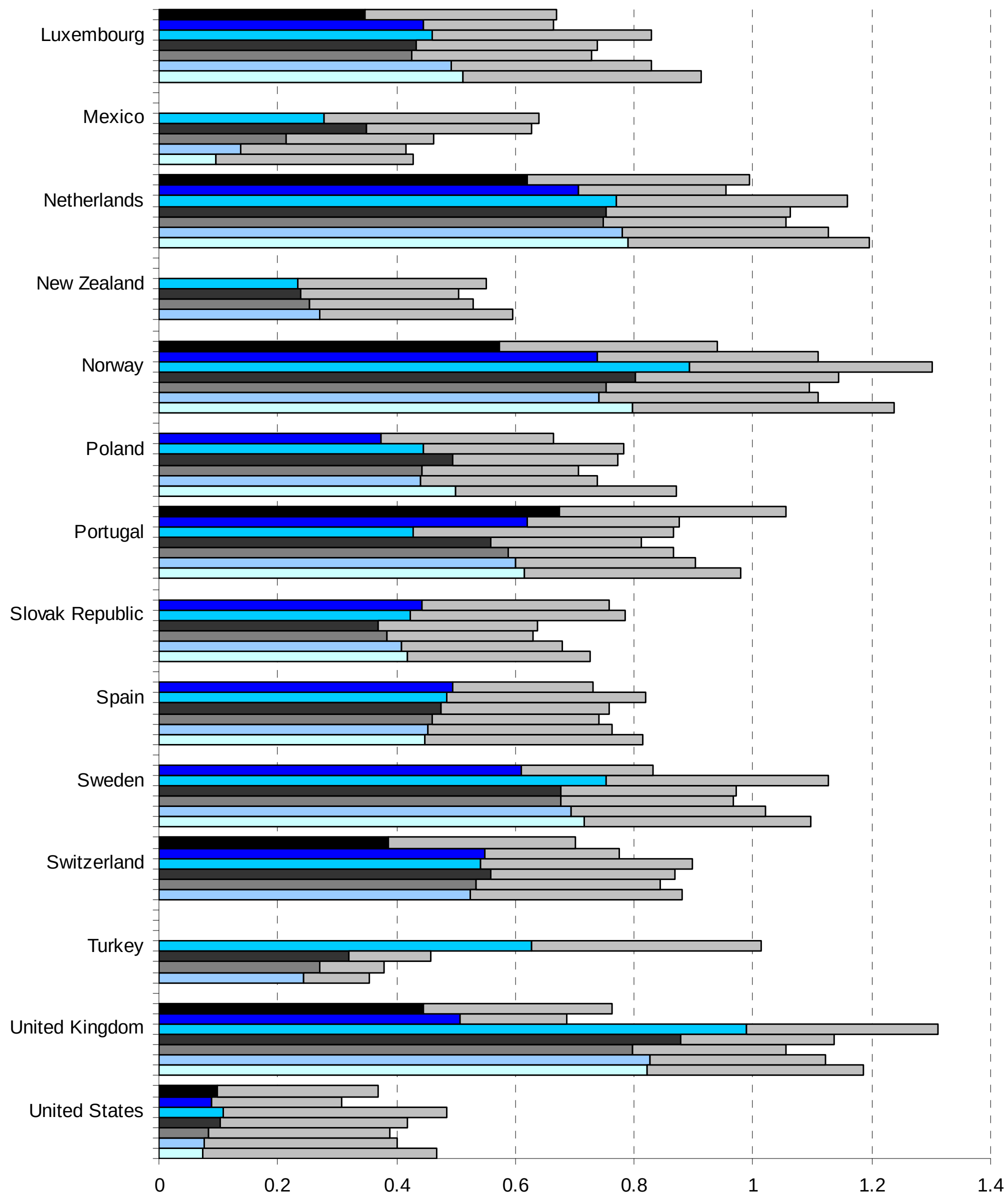
Average Prices and Taxes of Premium Unleaded Gasoline (95 RON)

Figures in real 2000 Euros per litre



Average Prices and Taxes of Premium Unleaded Gasoline (95 RON) ….. (continued)

Figures in real 2000 Euros per litre



Road pricing

The official estimates for the impact of the electronic truck km-charges introduced in Europe and the London Congestion Charge suggest they have significantly reduced emissions. Truck km-charges provide strong incentives to rationalise distribution systems and logistic organisation. Electronic charging for road use is expected to spread, albeit with the primarily aim of ensuring foreign vehicles contribute to road costs and managing congestion.

Traffic management and urban planning

Traffic management measures including congestion charges, traffic guidance systems and parking policies have an influence on CO_2 emissions but are not generally reported by national governments to be part of their CO_2 emissions policies. The same is true of efforts to integrate spatial planning with transport policy, which is fundamental to managing traffic growth without restricting the access to services that mobility provides. This appears mainly to be a consequence of the division of responsibilities between central and local government. Analysis to clarify the potential role for local government policies in reducing CO_2 emissions from transport appears warranted, even though fuel efficiency should remain the primary focus of national policy.

Walking and cycling

Policies towards walking, cycling and improving the urban environment to make non-motorised modes of transport safer, quicker and more attractive, are also neglected in national CO_2 policy reporting. They are an important part of policies to manage the demand for motorised transport and therefore influence CO_2 emissions. A small number of national governments do provide support to local governments to promote walking and cycling and include this support in reports on national CO_2 policies.

Maritime shipping

While shipping emits relatively low emissions of CO_2 per tonne km transported, ships nonetheless emit significant quantities of CO_2. Delegation of responsibility for reducing emissions to the UN International Maritime Organisation has not yielded many results so far, although guidelines on CO_2 indexing were agreed in 2005, incorporating both operational and ship design factors. Negotiations in the IMO have not yet begun to look at potential measures for reducing emissions cost effectively. It is recommended that maritime countries consider policy measures to reduce unitary CO_2 emissions from ships, building on the IMO CO_2 index. Harbour or fairway fees differentiated to promote the use of efficient engines are the tools most readily available.

Aviation

Aviation faces a similar situation. The UN International Civil Aviation Organisation was delegated responsibility for developing policies to reduce emissions from international aviation under the Kyoto Protocol. The difficulty of attributing these emissions to specific countries means they are not counted as part of national greenhouse gas inventories. So far ICAO member countries have not been able to agree on any concrete greenhouse gas abatement policies. They have, however, endorsed the concept of an open, international emissions trading system implemented through a voluntary scheme, or incorporation of international aviation into existing emissions trading systems. The European Commission has adopted a Communication indicating that it considers the incorporation of aviation into the European Union Emissions Trading System to be the best way forward. It aims to make a legislative proposal by the end of 2006. The total amount of allowances to be allocated to the aviation sector and the method for allocating allowances between operators will be key aspects in determining the effectiveness of emissions trading for reducing CO_2 emissions from aviation. A fuel tax (or CO_2 differentiated landing or km charge) would be less costly to operate and avoid problems in determining the initial allocation of permits.

Short and long term strategy

For the short and medium term, policies that target fuel efficiency offer most potential for reducing CO_2 emissions. The most effective measures available include fuel taxes, vehicle and component standards, differentiated vehicle taxation, support for eco-driving and incentives for more efficient logistic organisation, including point of use pricing for roads. For the long term, more integrated transport and spatial planning policies might contain demand for motorised transport. Ultimately higher cost energy sources, including clean energy carriers such as hydrogen and electricity, produced from renewable energy sources or from fossil fuels with carbon sequestration and storage, will be required if there are to be further cuts in transport sector CO_2 emissions. Major R&D programmes will be required to bring these technologies to commercial viability.

NOTES

1. An organisation established by World Meteorological Organisation and UN Environment Programme to assess scientific, technical and socio-economic information relevant for the understanding of climate change, its potential impacts and options for adaptation and mitigation.. .

2. European Council, 2002. *Decision on the sixth Community environment action programme*. Decision 1600/2002/EC, July 2002.

3. European Environment Agency, 2005. *Climate change and a European low-carbon energy system.*

4. All of these studies estimate costs to society: that is they take account of fuel savings to consumers. IEEP/TNO/CAIR and ACEA use a 5% discount rate, which over-estimates typical consumer perceptions of the value of future fuel savings, but this is partly compensated for as both use oil price assumptions below world prices in the first quarter of 2006.

5. Biofuels are estimated to cost from 200 to 500 €/t, see (CE 2006).

ACRONYMES

ACEA	European Automobile Manufacturers Association
ACEEE	American Council for an Energy-Efficient Economy
CAIR	Centre for Automotive Industry Research
CIS	Commonwealth of Independent States
EEA	European Environment Agency
ICAO	International Civil Aviation Organisation
IEA	International Energy Agency
IMO	International Maritime Organisation
IPCC	Inter-governmental Panel on Climate Change
OICA	International Organization of Motor Vehicle Manufacturers
TNO	TNO Mobility and Logistics
UNEP	UN Environment Programme
UNFCCC	UN Framework Convention on Climate Change
WMO	World Meteorological Organisation

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