ISBN 978-92-64-04048-9
OECD Environmental Outlook to 2030

Chapter 16

Transport

The transport sector is the second largest (and second fastest growing) source of global greenhouse gas (GHG) emissions. If developing countries follow the same path of private car dependence in the future as OECD nations have in the past, technological advances are unlikely to be able to offset the large increase in vehicle related emissions. Maritime shipping is another increasingly important source of environmental concern. Governments should prioritise policy action to reduce the energy intensity of transport. Policy options include applying carbon and fuel taxes, reforming vehicle taxation and regulating vehicle standards. Additional measures, such as implementing road pricing and investing in public transport infrastructure and spatial planning policies, can also help to improve the environmental performance of the transport sector.

KEY MESSAGES

The transport sector is the second largest (and second fastest growing) source of global greenhouse gas (GHG) emissions.

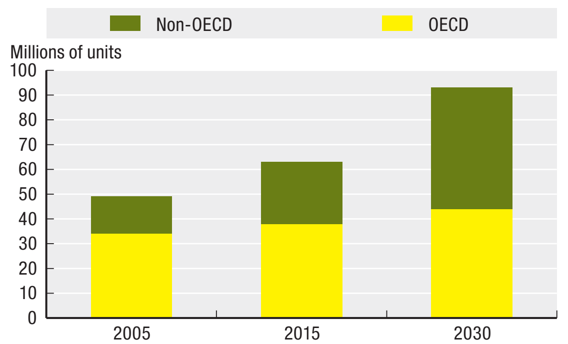
Total CO_2 emissions from transport are still increasing. Emission reductions from technological improvements are being eclipsed by the continuing growth of transport volumes (especially passenger vehicle and air transport).

If developing countries follow the same path of private car dependence in the future as OECD nations have in the past, technological advances are unlikely to be able to offset such a large increase in vehicle related emissions.

Maritime shipping is an increasingly important source of environmental concern.

Emissions of some air pollutants from transport are decreasing; others continue to rise.

Annual new vehicle sales by region to 2030



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Policy options

- Prioritise policy action to reduce the energy-intensity of transport, which appears to have the greatest potential for reducing CO_2 emissions cost-effectively. Policy options include applying carbon and fuel taxes, reforming vehicle taxation and regulating vehicle standards.
- Ensure that public incentives for biofuels reflect a full life-cycle of their effect on both greenhouse gas emissions and the economy.
- Implement road pricing, and invest in infrastructure and spatial planning policies, all of which can help to improve the environmental performance of the transport sector.

Consequences of inaction

- Poor urban air quality (much of which originates from transport) continues to have negative impacts on human health and the economy, in terms of lost productivity and medical expenses. The human health impacts of transport-related pollution are likely to increase in the next two decades, particularly in rapidly growing developing countries.

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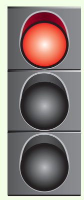
Introduction

In recent years, increased trade and investment activities (both of which are closely associated with a more globalised economy) have led to substantial increases in both the volume of goods being shipped and the distance these goods have to travel. Increasing levels of disposable income have also led to significant increases in recreational travel. The result is that total transportation activity in OECD countries has increased much faster in the past 30 years than either population or GDP.

Recent technological developments, partly triggered by the implementation of environmental policies, have helped to improve the environmental performance of the transport sector in a number of areas, in particular reducing vehicle emissions of a number of air pollutants that can damage health and the environment. Despite these developments, transport continues to create significant environmental problems.

The transport sector is the second largest (and second fastest growing) source of global greenhouse gas (GHG) emissions after energy industries. Transport accounted for about 24% of global CO_2 emissions from combustion in 2003. Of that total, road transport contributed 18%, aviation 3%, navigation 2%, and other sources 1% (ECMT, 2007a).

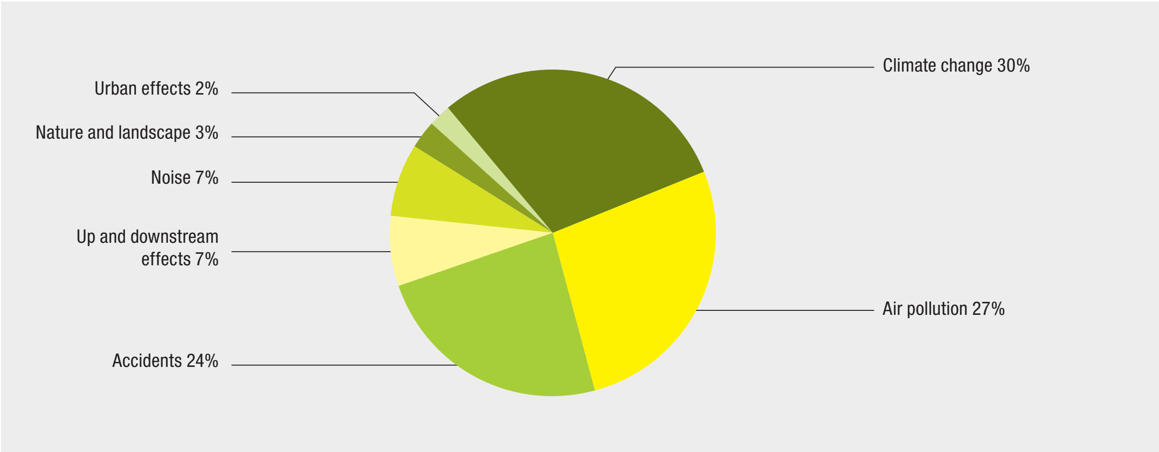
In OECD countries, road transport is responsible for most of the transport sector's impacts on the environment, accounting for over 80% of all transport-related energy consumption, and for most air pollutant emissions, noise and habitat degradation (OECD, 2006a). In Europe,* total external costs of transport (excluding congestion costs and externalities related to maritime transport) have been estimated at EUR 650 billion for 2000, or about 7.3% of total GDP (INFRAS, 2004). Climate change was the most important category, contributing 30% of total costs (Figure 16.1). Air pollution and accidents were the next most significant. In terms of transport mode, road transport has the biggest impact, generating 83% of the total estimated external costs. This is followed by aviation (14%), railways (2%), and inland waterways (0.4%). Road transport accounted for over 89% of the costs in all categories, except for climate change, in which road transport accounted for only 57% of estimated costs. Almost all the remaining costs associated with climate change came from aviation (41%). Two-thirds of all transport-related external costs are caused by passenger transport and one-third by freight transport (INFRAS, 2004).



The transport sector is the second largest (and fastest growing) source of global greenhouse gas emissions.

* This includes EU15, Norway and Switzerland.

Figure 16.1. **Transport externalities in Europe in 2004 (by impacts)**



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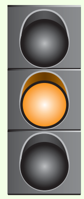
Source: INFRAS, 2004.

Maritime transport, although generally associated with lower environmental impacts, continues to raise concerns, mainly due to oil pollution from major accidents, as well as (accidental or deliberate) discharges of waste products. The maritime shipping sector is also an important contributor to NO_x and SO_2 emissions, as well as to ozone pollution. There is also growing concern over the environmental impacts of air traffic, which continues to increase rapidly mainly due to increased tourism (see also Chapter 19, section on tourism). The rail sector is generally the most environmentally benign form of transport, but is also the least used.



Maritime shipping is an increasingly important source of environmental concern.

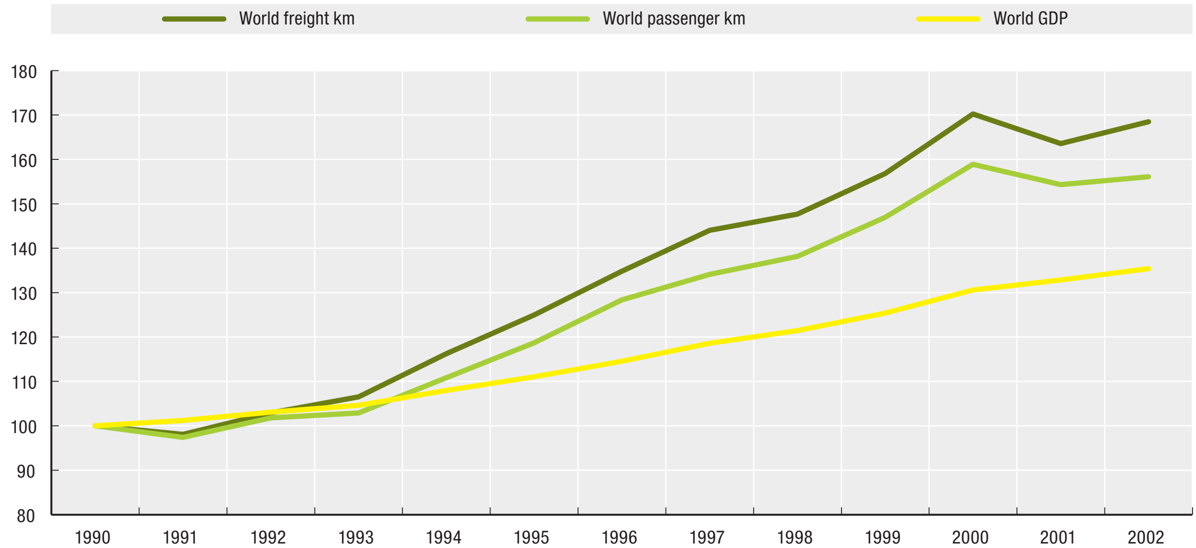
Trends and projections

The rapid increase in transportation activity seen in recent decades is expected to continue to 2030 (although see Box 16.1). Between 1970 and 2003, for example, air passenger travel in the US increased by 328% – nearly twice the rate of GDP growth during the same period. Air passenger travel in the EU increased even faster, growing by over

Box 16.1. **Key uncertainties, choices and assumptions**

There are fundamental uncertainties in projecting transport demand and simulating future transport systems. Uncertainties in demographic, economic, technological and institutional factors will affect the actual level of future transport demand, the mix of energy supplies consumed, and the associated rates of (for example) CO_2 emissions. Knowledge is limited of the complex interactions of technological, cultural and political forces that determine the development of national transport schemes. It is therefore not certain that today's relationships will persist unchanged for the next 25 years. For non-OECD countries, it is also difficult to find reliable and consistent data on which to base future projections.

Figure 16.2. **Global air transportation volumes and GDP (1990 = 100)**



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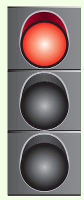
Source: Based on data from the UN Common Database, 2007.

1 200% between 1970 and 2003 (Figure 16.2). Although air travel has been the fastest growing transport mode in recent decades, other modes have increased as well. Road transport, in particular, has grown faster than GDP in both the EU and North America.

Transport growth is not only being driven by people/goods travelling further and more often, but also by an increase in the availability and use of motorised transport. In OECD countries, the private car has been the norm for decades, so only moderate increases in car ownership are predicted over the next 20 years. In non-OECD countries, on the other hand, rapidly rising incomes are expected to lead to large increases in vehicle ownership (Figure 16.3). In some cases, the increase in motorised transport is occurring at the expense of existing modes – some of which are less environmentally damaging than road transport. For example, bicycle use in China has fallen recently, as automobile use has expanded.

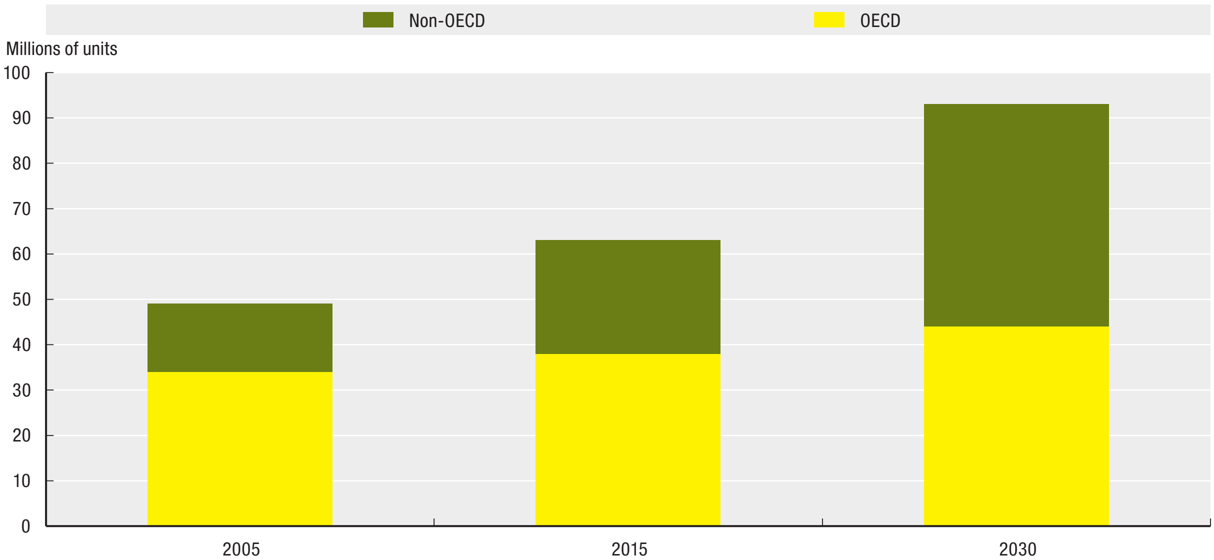


If developing countries follow the same path of car dependence as OECD nations, technological advances are unlikely to offset the large increase in vehicle related emissions.

Air pollution

The transport sector is a major source of air pollution at the local, regional and global levels. It is the dominant source of air pollution in urban areas. In 2002, transportation was responsible for 58% of total US carbon monoxide emissions and 45% of nitrogen oxide emissions. Between 1992 and 2002, however, most transport-based air pollutant emissions in the US actually declined (BTS, 2006). Within the US transportation sector, road transport was the main source of air pollutants over the 10 years ending in 2002. It accounted for 82% of NO_x emissions, 76% of volatile organic compounds (VOCs), and virtually all transport-based carbon monoxide (CO) emissions. Marine vessels and railroad locomotives contributed 11% and 9% of transportation's NO_x emissions respectively, and made minor contributions to other emissions (BTS, 2007).

Figure 16.3. **Annual new vehicle sales by region to 2030**



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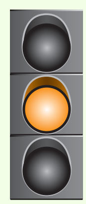
Source: IEA, 2006.

In the EU15, emissions of acidifying substances, particulate matter, and ozone precursors from transport (excluding international aviation and maritime transport) fell by 30-40% from 1990 to 2003 (EEA, 2006). Maritime sources in the EU contributed about 20% of total NO_x and 77% of SO_x emissions from the transport sector (EEA, 2006).

Global use of leaded fuel has declined significantly in recent decades. This trend is being seen in all regions. For example, nearly all countries in Africa have now shifted to unleaded petrol, after adoption of the 2001 Dakar Declaration. The widening use of unleaded petrol has reduced lead-related health problems. For example, mean blood-lead levels in children have fallen by 50% since the phase-out began in India (Singh and Singh, 2006).



Some air pollution from transport is decreasing; other forms of transport-based air pollution continue to rise.

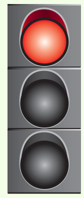
Global sulphur emissions from transport also declined by 18% between 1995 and 2005, mainly through the desulphurisation of fuels. A key barrier to the further penetration of low-sulphur fuels is the high investment costs involved for refineries, particularly in developing countries.

Transport-based emissions of nitrous oxides have decreased by 3% globally since 1995 (23% in OECD countries). This has been achieved mainly through the wider use of new engine technologies and catalytic converters.

Current trends toward reducing sulphur and nitrogen emissions are projected to continue to 2030 globally under the *OECD Environmental Outlook* Baseline, reflecting the positive impact of existing policies. However, without any new policies, some of the less developed regions, such as Africa and parts of Asia, are expected to experience increases in these pollutants in the coming two decades (see Chapter 8 on air pollution).

Exposure to air pollution (from the transport sector or elsewhere) can cause adverse health effects – most acutely in children, asthmatics, and the elderly – and can damage ecosystems and infrastructure (see also Chapter 12 on health and environment; and WHO, 1999). The health effects can range from mild irritation of eyes and lungs, to aggravation of asthma, cancer and premature death. Ground-level ozone can damage vegetation, and acid rain can damage vegetation, buildings and aquatic ecosystems.

The health costs associated with air pollution can be considerable (see Chapter 13 on cost of policy inaction), and much of this pollution is still transport-based. High concentrations of transport-related air pollutants in urban areas continue to present an important challenge (*e.g.* particulate matter, ozone) and are not showing any downward trends despite policy measures to tackle these pollutants.



Total CO_2 emissions from transport are still increasing.

Climate change

Transport currently contributes more than one-fifth of global CO_2 emissions. Among the major emitting sectors, transport has the second highest total of CO_2 emissions (after energy industries) (see Chapter 7 on climate change). Transport emissions have had the second highest growth rate over the last 15 years, and are expected to repeat this trend in the near future. If current trends continue, the *OECD Environmental Outlook* Baseline projects that energy-related carbon dioxide (CO_2) emissions from the transport sector will increase by 58% between 2005 and 2030 globally, with emissions more than doubling in China (172% increase), Africa (172%) and South Asia (131%). Increases of this magnitude are inconsistent with the goal of stabilising global atmospheric concentrations of greenhouse gases.

The share of transport in global GHG emissions is expected to remain stable at about 20% over the next 25 years. Among OECD countries, however, transport is expected to account for an increasing proportion of these emissions. In 1995, this share was 20%; by 2020, it is expected to be 30% (OECD, 2006a).

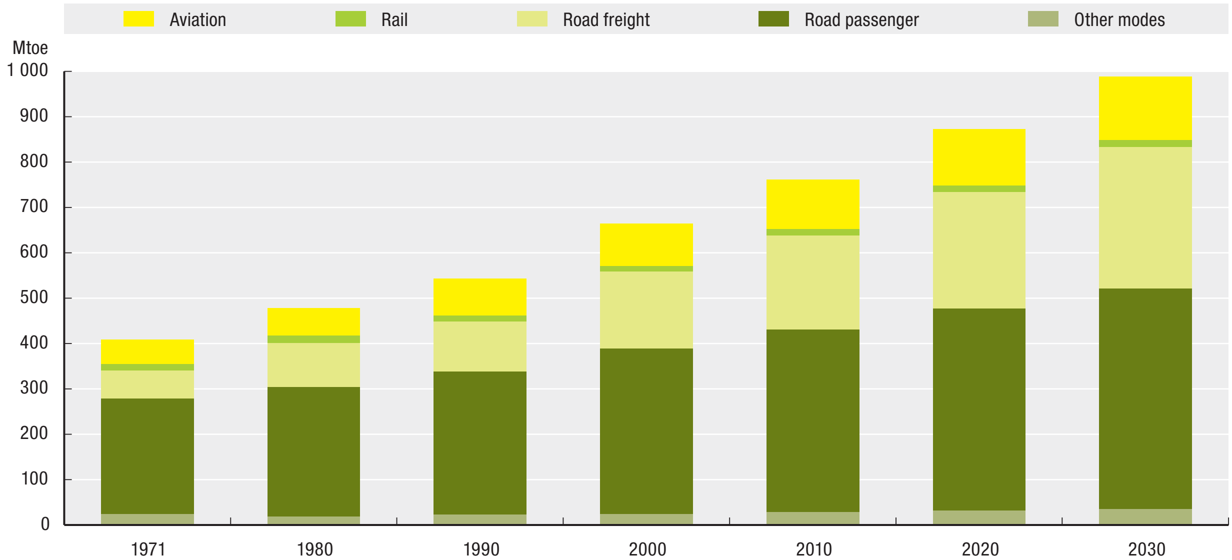
Road transport is by far the largest user of transport fuels in the US and Canada (Figure 16.4). Aviation accounts for a significant proportion, and rail uses a small (but still meaningful) amount.

The share of aviation in total CO_2 emissions from the transport sector has been growing for many years (OECD, 2006a). Emissions of NO_x at high altitudes are also believed to have a significantly larger global warming effect than surface emissions. The Intergovernmental Panel on Climate Change has estimated that the total climate impact of aviation is two to four times greater than the impact of aviation's CO_2 emissions alone (IPCC, 1999). Overall, aviation contributed about 3% of global anthropogenic radiative forcing in 2005 (IPCC, 2007).

Navigation activities (including maritime transport) presently account for about 2% of global GHG emissions. Some projections foresee growth in maritime shipping of 35-45% in absolute levels between 2001 and 2020, based on expectations of continued growth in world trade (Eyring *et al.*, 2005).

In the US, the transportation sector was responsible for 27% of total GHG emissions in 2003. Transport GHG emissions have been growing considerably faster than total US emissions. From 1990 to 2003, these emissions increased by a larger amount than any other economic sector, by 24%. GHGs from all other sectors increased by a total of 9.5% over the same time-frame. Within the transport sector, heavy-duty truck emissions have been

Figure 16.4. **Transport fuel consumption in the US and Canada by mode, 1971-2030**



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Source: IEA, 2002.

the fastest growing source of GHG emissions, growing by over 50% during the same period. Of all the major US transport modes, air travel experienced the largest reductions in per-passenger-km GHG emissions between 1990 and 2003 (EPA, 2006).

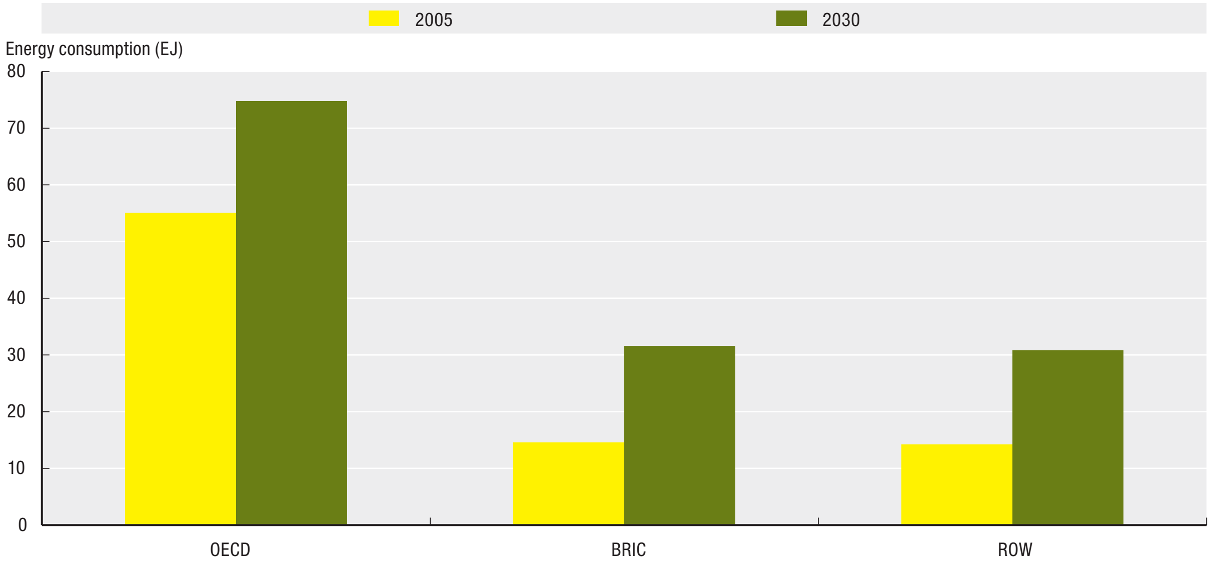
Although OECD countries currently account for the majority of global GHG emissions (both transport-related and other), growth in emissions from the transport sector over the coming years is expected to be driven to a large degree by non-OECD countries. GHG emissions are very closely related to total energy consumption in the transport sector, and this is projected to grow much faster in non-OECD countries than in the OECD (see Chapter 17 on energy).

Energy demand for transportation in the OECD economies is projected to grow at an average annual rate of 1.2% over the next 25 years according to the *Outlook* Baseline. By contrast, energy consumption in non-OECD countries is expected to grow more than three times as fast (3.1% per year). OECD countries currently account for 66% of global energy consumption for transport; by 2030, this is expected to decline to 54%. Figure 16.5 illustrates these trends.

Transport-related GHG emissions are particularly important among the BRIC countries (Brazil, Russia, India and China), who account for more than 60% of all CO_2 emissions from non-OECD countries. China alone accounts for 18% of global emissions. Since 1990, Chinese CO_2 emissions from the transport sector have increased by 156% (IEA, 2006).

Climate change itself will influence the services available within the transport sector (*e.g.* the effects of sea level rise on shipping; the effects of increased weather extremes on aviation). Policies aimed at improving the efficiency of transportation will also increasingly have to address the realities imposed by a changing climate. For example, policies aimed at shifting transport volumes from road to ships could be compromised by the lower water levels in inland waterways that are expected to follow from a warmer climate.

Figure 16.5. **Energy consumption in the transport sector to 2030**



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Source: OECD Environmental Outlook Baseline.

Nature, landscape and urban effects

A large proportion of land in built-up regions in OECD countries is already used for transportation infrastructure, mostly roads. The development and extension of transport infrastructure has numerous impacts on soils and water bodies (*e.g.* compaction, soil sealing, diffuse water pollution) and landscape separation effects, leading to habitat fragmentation and destruction, with negative effects on biodiversity. Once this process has started, land fragmentation is extremely difficult to reverse (see also Chapter 9 on biodiversity).

Congestion

In many areas, transport activity has increased much faster than infrastructure capacity has grown, creating severe congestion problems. The largest social costs associated with congestion are the time delays suffered by transport users. Congestion also imposes significant costs on the rest of society, mainly from higher emission levels. A car or truck stuck in congested traffic consumes more fuel for the same distance of travel, and therefore produces more GHG and air pollution emissions per trip. These emissions also tend to be generated in precisely those areas where human exposure levels are the highest. These issues are especially important in the context of urban air pollution, since most traffic congestion occurs in urban areas. The annual external costs of road traffic congestion in the 17 countries that include the EU15, Norway, and Switzerland were estimated at EUR 63 billion in 2004, which corresponds to about 0.7% of the combined GDP of these countries (INFRAS, 2004).

Noise

Transportation is the leading cause of urban noise. Air traffic is the major cause of nuisance noise near airports, while road traffic is the most significant source of noise elsewhere. Although less significant overall than the other externalities discussed above, transport-related noise pollution still imposes many social costs that reduce the quality of life – costs that are reflected, for example, in lower property values around airports or major roads. In OECD Europe, about 30% of the population are exposed to road traffic noise levels above 55 dB(A), and 13% to above 65 dB(A) (EEA, 2001). Persistent exposure to noise levels above 70 dB can result in long-term hearing loss, but even lower levels of exposure can cause irritation, interfere with sleep, and generally detract from the quality of life.

Policy implications

Economic instruments

When the environmental problem being targeted by a particular policy instrument can be closely linked to a taxable item, taxes or charges can be both environmentally effective and economically efficient (Box 16.2). Emissions of CO_2, SO_2, and lead – closely linked to the carbon, sulphur and lead content in various fuels – can therefore be relatively easily priced through taxes. Another example is aircraft noise in the vicinity of airports, which (with some approximation) can be addressed by take-off and landing charges which vary with the time of the day, or with the noise classification of the aircraft. Road use charges can also be linked to distances driven, the time of day (of relevance for congestion and noise impacts), and (roughly) to certain emission characteristics of the vehicle.

Box 16.2. **Efficient prices for transport**

Efficient pricing requires not only that prices reflect all the environmental costs associated with transport, but also that these prices provide incentives to conserve existing transport capacity and to develop future environmentally-sustainable transport options. The European Conference of Ministers of Transport (ECMT, 2003) has estimated that efficient pricing for all modes of inland transport in the three largest EU economies would yield net welfare benefits of more than EUR 30 billion per year.

Market-based approaches can help to ensure that, whatever the environmental objective, it will be achieved at a minimum cost. For example, in the case of fuel taxes, the people who reduce their fuel consumption the most will be those who derive the least benefit from fuel consumption. Flexible mechanisms allow producers and consumers to make the choices that are best for them, and to meet environmental objectives in the way that is least costly for them.

However, taxation is not always practical. For example, finding a suitable tax base for NO_x emissions is difficult. Whereas SO_2 emissions from (road) vehicles are closely related to the sulphur content of the fuel used (end-of-pipe cleaning of these emissions would be very costly), NO_x emissions depend much more on the combustion process being applied, the way the vehicle is driven, as well as on the existence (and maintenance) of end-of-pipe cleaning devices, such as catalytic converters. Some of these aspects can be addressed through taxes on purchases of motor vehicles, or through annual motor vehicle use taxes. For example, the tax could vary according to the type of catalytic converter that is installed. However, additional instruments will probably still be needed to cover these situations.

Fuel taxes are already widespread in OECD countries, but there is considerable variation in the rates being applied (Figure 16.6). From 2002 to 2007, several OECD countries significantly increased their fuel tax rates; nevertheless, most countries still have lower tax rates for diesel fuels than for petrol.

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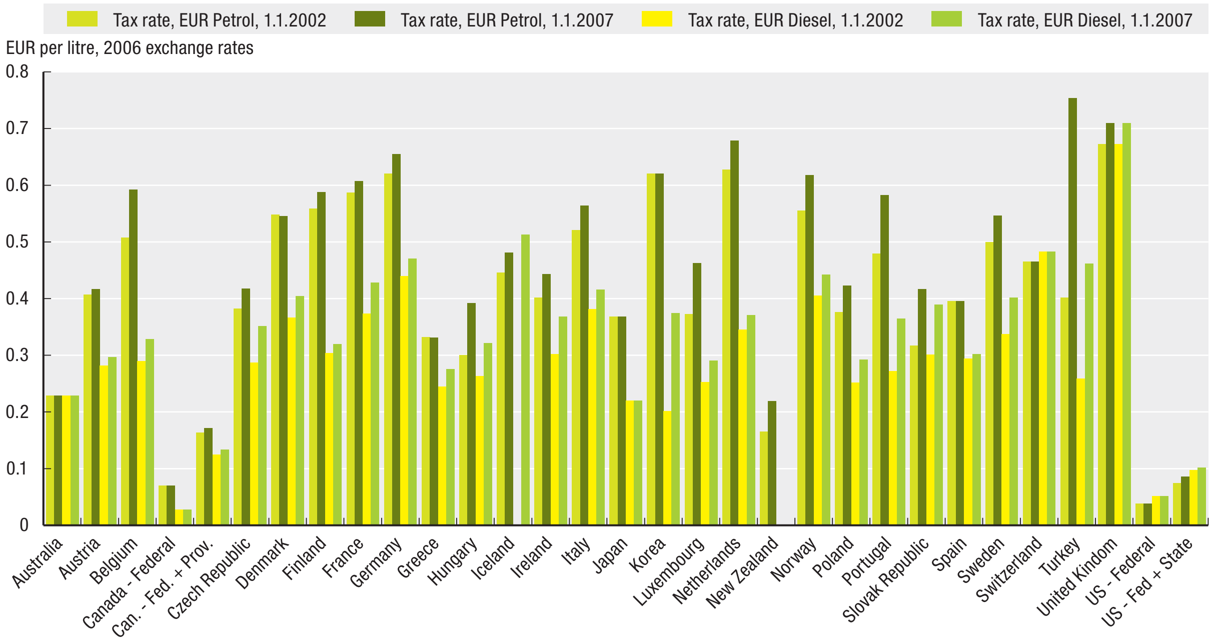
Figure 16.6. **Tax rates on petrol and diesel in OECD countries, 2002 and 2007**



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Note: The changes shown here (expressed in EUR per litre) reflect *both* changes in tax rates in national currencies *and* changes in exchange rates (see OECD, 2006b for additional detail).

Source: OECD/EEA database on instruments used for environmental policy, *www.oecd.org/env/policies/database*.

In a recent review of the use of fuel taxes in OECD countries, OECD (2006b) summarised some of the key consequences of applying these taxes as follows:

- Countries with low taxes on petrol and diesel (*e.g.* Canada and the US) tend to have much higher use of these products per unit of GDP produced than countries with higher taxes. On the other hand, countries with high fuel taxes generally have higher fuel efficiencies. Japan is a slight exception – with high fuel efficiency, despite relatively low fuel taxes.
- The recent increases in world market crude oil prices have contributed to improvements in fuel efficiency, even in countries with low fuel taxes.
- OECD countries that have increased their fuel taxes in recent years (*e.g.* Turkey and Germany) have seen very significant improvements in fuel efficiency.
- There has been a general shift from petrol to diesel use in countries that apply lower taxes on diesel than on petrol. Where the tax preference given to diesel is smaller (*e.g.* Canada and the US), the use of diesel is much lower. From the point of view of local air pollution, this is a clear advantage.
- In general, taxes on transport services will tend to affect lower-income households most; however, there are various strategies available for reducing these impacts.

At present, actions to reduce the energy-intensity of transport appear to have the greatest potential for reducing CO_2 emissions cost-effectively. Policies that promote less energy intensive transport modes (*e.g.* more public transport, bicycle use) appear to offer only a very limited potential for controlling greenhouse gas emissions (ECMT, 2006b).

Carbon and fuel taxes are ideal measures for addressing transport-based CO_2 emissions because of their effects on energy intensities. These taxes send clear signals to users, and they are likely to distort the economy less than other measures with the same goals. Significant CO_2 abatement opportunities may also include improving the fuel efficiency of new vehicles; improving the energy efficiency of individual components of vehicles; and improving on-road vehicle performance. In turn, the most cost-effective options within these approaches are promotion of fuel-efficient driving; incentives for car buyers to choose lower emissions vehicles; and regulations for some (currently unregulated) vehicle components. The reform of vehicle taxation is likely to be the highest priority in this context (ECMT, 2006b).

Biofuels also offer potentially significant CO_2 abatement opportunities, but at a high cost (except for ethanol from sugar cane; Box 16.3). Public incentives for biofuels should therefore explicitly reflect a full life-cycle ("well-to-wheel") view of both CO_2 emissions and economic consequences.

Box 16.3. **Prospects for liquid biofuels for transport**

Several countries have recently adopted targets for biofuels use in the transport fuel mix, partly on the grounds that these fuels can significantly reduce emissions of greenhouse gases and partly for energy security reasons. Large investments are therefore now being made in the biofuels option, and subsidies amounting to an estimated USD 14.3 billion were given to support biofuels in OECD countries in 2006 (see Box 14.2 in Chapter 14 on agriculture).

The environmental benefits of biofuels use are uncertain. The emissions savings from replacing conventional transport fuels with biofuels depend upon the amount of energy used in the conversion process and in transporting the raw materials to bio-refineries (see Box 17.3 in Chapter 17 on energy). The production of biofuels can have other negative impacts on the environment, and can compete for land with agricultural food crops. The recent surge in oil prices has made biofuels more cost competitive with conventional oil-based fuels. However, production costs are still above the level of international oil prices in most cases. Without subsidies or other policies to support biofuels use – such as targets for minimum use of biofuels in transport fuel – they are unlikely to be economically competitive with fossil fuels.

Overall, encouraging a switch from fossil-based transport to biofuels seems likely to be a costly way (both environmentally and economically) of addressing the problem of greenhouse gas emissions. Greater policy attention could be paid to the development and introduction of second generation biofuels, which are likely to have greater environmental benefits and lower negative environmental impacts, as well as to ensuring the performance of current generation biofuels.

Sources: ECMT (2007b); OECD and FAO (2007); Doornbosch and Steenblik (2007).

Road pricing systems require motorists to pay directly for driving on a particular road. Raising the cost of using roads discourages some drivers from using them, resulting in less congestion and fewer environmental impacts. Congestion charges have now been applied in a number of urban areas worldwide, and have reduced traffic and traffic-related externalities such as congestion, air pollution and accidents (see also Chapter 5 on urbanisation). Some European road use modelling has concluded that road pricing has a definite impact on traffic volumes, and may also help to modify the pattern of driving behaviour (trip choice, modal choice, etc.) (CANTIQUE, 2001).

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Road pricing can also improve the efficiency of road systems. For example, the Swiss distance-related fee for heavy goods vehicles depends on three factors: the distance driven on the Swiss road network (all roads); the maximum permitted weight of vehicle and trailer; and the emissions of the vehicle (there are three emission classes). The effects of the fee, used in combination with weight limits, have been the renovation of the truck fleet, more concentration in the hauler industry, and fewer heavy goods vehicles on the road (OECD, 2005).

Regulatory approaches

In cases where market-based mechanisms are not practical, direct regulation can be an important tool for reducing the environmental impacts of transport. However, regulations aimed at promoting specific transport technologies may be less efficient and effective than regulations on transport-related emissions themselves. For example, regulations that promote hybrid vehicles (on the grounds that they are more fuel efficient) may result only in the production of hybrid vehicles with more powerful engines, without producing any overall emission reductions. Regulations should therefore focus on the desired (environmental) outcome. If this desired outcome is beyond the influence of the proposed regulation, the regulation should still target the particular elements of the problem which most directly influence the desired outcome.

In the US, the EU and Japan, the standards for emissions of air pollutants from vehicles have been regularly tightened since the 1980s. Emissions standards are now in place for carbon monoxide, hydrocarbons, nitrogen oxides, smoke and particulate matter. These standards require the application of end-of-pipe devices like catalytic converters. In some Asian countries, motorised two- and three-wheeled vehicles (with two-cycle, rather than four-cycle engines) contribute disproportionally to transport emissions of particulates, hydrocarbon and carbon monoxide (Faiz and Gautam, 2004).

The availability of sufficiently high fuel quality is crucial for the proper functioning of end-of-pipe devices, and this remains a problem in many parts of Asia and Africa. Inspection and engine maintenance programmes are also important, but while such programmes are common in most OECD countries, they are less in evidence elsewhere.

Many OECD countries also have restrictions on the total number of hours per day (or on the times of day) that large trucks can be on the road. Some cities (*e.g.* Mexico) have also adopted restrictions on the days of the week on which cars can be driven (*e.g.* odd/even-numbered plates on successive days). These regulations help to reduce emissions from heavy trucks (*e.g.* by discouraging the use of trucks when fuel efficiency would be lowest, such as during rush hours). In addition to reducing fuel consumption of road transportation, these kinds of restrictions also have the added benefit of making transportation by rail a more appealing alternative.

Other policies

Infrastructure investments can also have a significant influence on both the efficiency of transport activity, and on modal shifts within the transport sector. For example:

- Improvements in roadways and traffic management can reduce congestion and associated environmental problems. However, this strategy may also lead to increased traffic, rather than to environmental improvements, unless it is properly designed and implemented.

- Investments in the speed and comfort of public transport make that option more attractive to commuters. A shift from personal vehicles to public buses or subways would produce a double environmental benefit – reduced GHG and air pollutant emissions, as well as reduced congestion problems.
- Investments in rail infrastructure, improvements in rail-road connections, and better integration of international rail networks could all make rail a more attractive option for moving freight and people.

Spatial policies (*e.g.* land use planning) can often influence transport decisions much more than transport policy itself. Integrating land use policy with environmental objectives in the transport sector can therefore generate significant environmental benefits. There may be particular advantages to be derived from institutional reforms introduced at the local (municipal) level – especially initiatives aimed at congestion problems. Changes in the regulation of land use will likely be needed to create mixed-use areas (with high density) over time.

Other supporting policies, such as better information management and the promotion of teleworking, can also support more environmentally-friendly transportation. Public outreach campaigns can make consumers aware of the environmental impacts of their actions, and encourage them to make more environmentally-friendly transport decisions. Better communication between government, firms and individuals can help policy-makers develop approaches that work best for citizens. Better communication between different regional governments, different layers of government, and different government departments, can also ensure that environmental and transport related policies in one area support policies in other areas.

The benefits associated with most of the policies discussed above could be increased if the various instruments were used in combination with each other. For example, improvements in public transport are much more likely to increase use if they are accompanied by increased road pricing. Improvement in rail infrastructure would draw more freight to the rail sector if fuel prices were also increased to make trucking less attractive. The positive effects of spatial policies can be strengthened by additional measures to increase the attractiveness of urban areas, such as measures to decrease noise pollution, or to improve cycling and pedestrian infrastructure.

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ISBN 978-92-64-04048-9
OECD Environmental Outlook to 2030

Introduction: Context and Methodology

Purpose of the report

The purpose of the *OECD Environmental Outlook* is to help government policy-makers to identify the key environmental challenges they face, and to understand the economic and environmental implications of the policies that could be used to address those challenges.

The *Outlook* provides a baseline projection of environmental change to 2030 (referred to as "the Baseline"), based on projected developments in the underlying economic and social factors that drive these changes. The projections are based on a robust general equilibrium economic modelling framework, linked to a comprehensive environmental modelling framework (see below, and Annex B, for more details). Simulations were also run of specific policies and policy packages that could be used to address the main environmental challenges identified, and their economic costs and environmental benefits compared with the Baseline.

This is the second *Environmental Outlook* produced by the OECD. The first *OECD Environmental Outlook* was released in 2001, and provided the analytical basis on which ministers adopted an *OECD Environmental Strategy for the First Decade of the 21st Century*. This second *Outlook:*

- extends the projected baseline used in the first *Outlook* from 2020 to 2030, and even 2050 for some important areas;
- is based on a stronger and more robust modelling framework;
- focuses on the policies that can be used to tackle the main challenges;
- expands the country focus to reflect developments in both OECD and non-OECD regions and their interactions.

Many of the priority issues and sectors identified in this *Outlook* are the same as those highlighted as needing most urgent policy action in the first *OECD Environmental Outlook* (2001) and in the *OECD Environmental Strategy for the First Decade of the 21st Century*. These include the priority issues of climate change, biodiversity loss and water scarcity, and the key sectors exerting pressure on the environment (agriculture, energy and transport). Added to these is a new priority issue: the need to address the health impacts of the build-up of chemicals in the environment. The 2001 *Outlook* indicated the environmental challenges expected in the next couple of decades; this *Outlook* not only deepens and extends this analysis, it also focuses on the policy responses for addressing these challenges. It finds that the solutions are affordable and available if ambitious policy action is implemented today, and if countries work together in partnership to ensure comprehensive action, avoid competitiveness concerns and share the responsibility and costs of action fairly and equitably. This latest *Outlook* analyses the policies that can be used to achieve the *OECD Environmental Strategy*. It will provide the main analytical material to support discussions on further implementation of the *OECD Environmental Strategy* at the OECD Meeting of Environment Ministers planned for early 2008.

Policy context

Why develop an environmental outlook? Many of the economic or social choices that are being made today – for example, investments in transport infrastructure and building construction, fishing fleets, purchase of solar heating panels – will have a direct and lasting affect on the environment in the future. For many of these, the full environmental impacts will not be felt until long after the decisions have been taken. These factors make policy decisions difficult: the costs of policy action to prevent these impacts will hit societies today, but the benefits in terms of improved environmental quality or damage avoided may only be realised in the future. For example, the greenhouse gases released today continue to build up in the atmosphere and will change the future climate, with serious impacts for the environment, the economy and social welfare.

But politicians tend to reflect the short-term interests of the voting public, not the long-term needs of future generations. They also tend to focus on the immediate costs and benefits to their own populations of a given policy approach, rather than on the global impacts. But many of the main environmental challenges countries face in the early 21st century are global or transboundary in nature, including global climate change, biodiversity loss, management of shared water resources and seas, transboundary air pollution, trade in endangered species, desertification, deforestation, etc. Building public understanding and acceptance of the policies that are needed to address these challenges is essential for policy reform.

These political challenges are exacerbated by uncertainty about the future. Often the exact environmental impacts of social and economic developments are poorly understood or disputed. In some cases, scientific uncertainty about environmental or health impacts is a main cause of policy inaction, while in others it is used as a justification for precautionary action. Scientific understanding and consensus about environmental change has been developing rapidly in a number of areas in recent years, for example through the 2005 Millennium Ecosystem Assessment and the 2007 IPCC Fourth Assessment Report on the Science of Climate Change. Despite the improvements in the scientific understanding of such issues, a gap remains in the development and implementation of effective environmental policies based on this scientific understanding.

This *Environmental Outlook* examines the medium to long-term environmental impacts of current economic and social trends, and compares these against the costs of specific policies that could be implemented today to tackle some of the main environmental challenges. The purpose is to provide more rigorous analysis of the costs and benefits of environmental policies to help policy-makers take better, more informed policy decisions now.

Many environmental problems are complex and inter-connected. For example, species loss is often the result of multiple pressures – including hunting, fishing or plant harvesting, loss of habitat through land use change or habitat fragmentation, impacts of pollutants – and thus a mix of policy instruments is needed to tackle the various causes of this loss. These policy packages need to be carefully designed in order to achieve the desired environmental benefits at the lowest economic cost. This *Outlook* examines the policy packages that could be used to tackle some of the key environmental challenges, and the framework conditions needed to ensure their success.

The transboundary or global nature of many of the most pressing environmental challenges identified in this *Outlook* require countries to increasingly work together in partnership to address them. The ways in which OECD environment ministries can work together in partnership with other ministries, stakeholder partners and other countries are explored in this *Outlook*.

A special focus on the emerging economies in the *Outlook*

This *Outlook* identifies the main emerging economies as the most significant partners for OECD countries to work with in the coming decades to tackle global or shared environmental problems. This is because these countries are responsible for an increasingly large share of the global economy and trade, and thus have an increasing capacity to address these challenges, in part because their economies are so dynamic. Moreover, the pressures that they exert on the environment are also growing rapidly.

In some chapters, where data are available and relevant, the BRIICS countries (Brazil, Russia, India, Indonesia, China and South Africa) are highlighted for attention as a country grouping. In other chapters, the smaller country grouping of BRIC (Brazil, Russia, India and China) is examined, or even further disaggregated to each of these four countries individually. The BRIC grouping is used for most of the modelling projections and simulations in the *Outlook*.

Modelling methodology and sources of information

The analysis presented in this *Environmental Outlook* was supported by model-based quantification. On the economic side, the modelling tool used is a new version of the OECD/World Bank JOBS/Linkages model, operated by a team in the OECD Environment Directorate and called ENV-Linkages. It is a global general equilibrium model containing 26 sectors and 34 world regions and provides economic projections for multiple time periods. It was used to project changes in sector outputs and inputs of each country or region examined to develop the economic baseline to 2030. This was extended to 2050 to examine the impacts of policy simulations in specific areas, such as biodiversity loss and climate change impacts. The economic baseline was developed with expert inputs from, and in co-operation with, other relevant parts of the OECD, such as the Economics Department, the International Energy Agency and the Directorate for Food, Agriculture and Fisheries.

The Integrated Model to Assess the Global Environment (IMAGE) of the Netherlands Environmental Assessment Agency (MNP) was further developed and adjusted to link it to the ENV-Linkages baseline in order to provide the detailed environmental baseline. IMAGE is a dynamic integrated assessment framework to model global change, with the objective of supporting decision-making by quantifying the relative importance of major processes and interactions in the society-biosphere-climate system. The IMAGE suite of models used for the *Outlook* comprises models that also appear in the literature as models in their own right, such as FAIR (specialised to examine burden sharing issues), TIMER (to examine energy), and GLOBIO3 (to examine biodiversity). Moreover, for the *Outlook* the IMAGE suite included the LEITAP model of LEI at Wageningen and the WaterGap model of the Center for Environmental Systems Research at Kassel University. IMAGE and associated models provided the projections of impacts on important environmental endpoints to 2030, such as climate, biodiversity, water stress, nutrient loading of surface water, and air quality. Annex B provides a more detailed description of the modelling framework and main assumptions used for the *Outlook* report.

The Baseline Reference Scenario presents a projection of historical and current trends into the future. This Baseline indicates what the world would be like to 2030 if currently existing policies were maintained, but *no new policies* were introduced to protect the environment. It is an extension of current trends and developments into the future, and as such it does not reflect major new or different developments in either the drivers of environmental change or environmental pressures. A number of major changes are possible in the future, however, that would significantly alter these projections. A few of these were examined as "variations" to the Baseline, and their impacts are described in Chapter 6 to show how these changes might affect the projections presented here.

Because the Baseline reflects no new policies, or in other words it is "policy neutral", it is a reference scenario against which simulations of new policies can be introduced and compared. Simulations of specific policy actions to address key environmental challenges were run in the modelling framework. The differences between the Baseline projections and these policy simulations were analysed to shed light on their economic and environmental impacts.

The simulations undertaken for the *Environmental Outlook* exercise are illustrative rather than prescriptive. They indicate the type and magnitude of the responses that might be expected from the policies examined, rather than representing recommendations to undertake the simulated policy actions. As relevant, some of the policy simulation results are reflected in more than one chapter. The table below summarises the policy simulation analyses and lists the different chapters containing the results.

Sensitivity analysis was undertaken to test the robustness of key assumptions in ENV-Linkages, and some of the results of this analysis are presented in Annex B. This, in conjunction with the Baseline variations described in Chapter 6, provides a clearer picture for the reader of the robustness of the assumptions in the Baseline.

Throughout the *Outlook*, the analysis from the modelling exercise is complemented by extensive data and environmental policy analysis developed at the OECD. Where evidence is available, specific country examples are used to illustrate the potential effects of the policies discussed. Many of the chapters in this *Outlook* have been reviewed by the relevant Committees and Expert Groups of the OECD, and their input has strengthened the analysis.

The *Outlook* is released at about the same time as a number of other forward-looking environmental analyses, such as UNEP's Fourth Global Environment Outlook (GEO-4); the IPCC Fourth Assessment Report (AR-4); the International Assessment of Agricultural Science and Technology for Development supported by the World Bank, FAO and UNEP; and the CGIAR Comprehensive Assessment of Water Use in Agriculture. Through regular meetings and contacts, efforts have been made by the organisations working on these reports to ensure co-ordination and complementarity in the studies, and to avoid overlap. The *OECD Environmental Outlook* differs from most of the others in its emphasis on a single baseline reference scenario against which specific policy simulations are compared for the purpose of policy analysis. Most of the others explore a range of possible "scenarios", which provide a useful communication tool to illustrate the range of possible futures available, but are less amenable to the analysis of specific policy options. The *OECD Environmental Outlook* also looks at developments across the full range of environmental challenges, based strongly on projected developments in the economic and social drivers of environmental change, while many of the other forward-looking analyses focus on a single environmental challenge.

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Table I.1. **Mapping of the *OECD Environmental Outlook* policy simulations by chapter**

Simulation title	Simulation description	Chapters in which the results are reflected	Models used
Baseline	The "no new policies" Baseline used throughout the *OECD Environmental Outlook*.	All chapters	ENV-Linkages; IMAGE suite
Globalisation variation	Assumes that past trends towards increasing globalisation continue, including increasing trade margins (increasing demand by lowering prices in importing countries) and reductions in invisible costs (*i.e.* the difference between the price at which an exporter sells a good and the price that an importer pays).	4. Globalisation 6. Key variations to the standard expectation	ENV-Linkages; IMAGE suite
High and low growth scenarios	Variation 1: High economic growth – examines impacts if recent high growth in some countries (*e.g.* China) continues, by extrapolating from trends from the last 5 years of growth rather than the last 20 years. Variation 2: Low productivity growth – assumes productivity growth rates in countries converge towards an annual rate of 1.25% over the long-term, rather than 1.75% as in the Baseline. Variation 3: High productivity growth – assumes productivity growth rates in countries converge towards an annual rate of 2.25% over the long-term.	6. Key variations to the standard expectation	ENV-Linkages
Greenhouse gas taxes	Implementation in participating countries of a tax of USD 25 on CO_2eq, increasing by 2.4% per annum. OECD 2008: only OECD countries impose the tax, starting in 2008. Delayed 2020: all countries apply the tax, but starting only in 2020. Phased 2030: OECD countries implement the tax from 2008; BRIC countries from 2020, and then the rest of the world (ROW) from 2030 onwards. All 2008: in a more aggressive effort to mitigate global GHG emissions, all countries implement the USD 25 tax from 2008.	7. Climate change 13. Cost of policy inaction (Delayed 2020) 17. Energy 20. Environmental policy packages	ENV-Linkages; IMAGE suite
Climate change stabilisation simulation (450 ppm)	Optimised scenario to reach a pathway to stabilise atmospheric concentrations of GHG at 450 ppm CO_2eq over the longer term and limit global mean temperature change to roughly 2 °C. A variation on this case was developed to explore burden-sharing, using a cap and trade approach to implementation.	7. Climate change 13. Cost of policy inaction 17. Energy 20. Environmental policy packages	ENV-Linkages; IMAGE suite
Agriculture support and tariff reform	Gradual reduction in agricultural tariffs in all countries to 50% of current levels by 2030. Gradual reduction in production-linked support to agricultural production in OECD countries to 50% of current levels by 2030.	9. Biodiversity 14. Agriculture	ENV-Linkages
Policies to support biofuels production and use	Demand for biofuels growing in line with the IEA *World Energy Outlook* (2006) scenario. DS: a scenario whereby growth in biofuel demand for transport is driven by exogenous changes, keeping total fuel for transport close to the Baseline. OilS: a high crude oil price scenario to determine the profitability of biofuel in the face of increasing costs of producing traditional fossil-based fuels. SubS: a subsidy scenario in which producer prices of biofuels are subsidised by 50%.	14. Agriculture	ENV-Linkages
Fisheries	Global fisheries cap and trade system, representing a 25% reduction in open fisheries catch, with trading allowed within six geographical regions.	15. Fisheries and aquaculture	ENV-Linkages
Steel industry CO_2 tax	Implementation of a carbon tax of 25 USD per tonne CO_2, applied respectively to OECD steel industry only, all OECD sectors, and all sectors worldwide.	19. Selected industries – steel and cement	ENV-Linkages
Policy mix	Three variations of policy packages were modelled, depending on the participating regions: OECD countries only OECD + BRIC Global The policy packages included: • reduction of production-linked support and tariffs in agriculture to 50% of current levels by 2030. • tax on GHG emissions of USD 25 tax CO_2eq, increasing by 2.4% per annum (phased with OECD starting in 2012, BRIC in 2020, ROW in 2030). • moving towards, although not reaching, Maximum Feasible Reduction in air pollution emissions, phased over a long time period depending on GDP/capita. • assuming that the gap to connecting all urban dwellers with sewerage will be closed by 50% by 2030, and installing, or upgrading to the next level, sewage treatment in all participating regions by 2030.	8. Air pollution 10. Freshwater 12. Health and environment 20. Environmental policy packages	ENV-Linkages; IMAGE suite

Structure of the report

The *OECD Environmental Outlook* is divided into two main parts:

i) *The World to 2030 – the Consequences of Policy Inaction:* describes the Baseline, *i.e.* the projected state of the world to 2030 in terms of the key drivers of environmental change and the developing environmental challenges, as well as analysing some possible variations to the Baseline.

ii) *Policy Responses:* focuses on the policy responses at both the sectoral level and in terms of implementing a more comprehensive and coherent policy package.

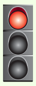
The first part describes the key elements of the Baseline to 2030, including the main drivers of environmental change (consumption and production patterns, technological innovation, population dynamics and demographic change, economic development, globalisation, and urbanisation) and the key environmental challenges (climate change, air pollution, biodiversity, freshwater, waste and material flows, health and environment). For each of these, the key recent trends and projections to 2030 are presented, as well as some of the policy approaches that are being used to address the environmental challenges. Chapter 6 describes some key variations to the Baseline – for example, how the Baseline would differ if key economic drivers (such as economic growth or global trade) were changing faster than projected in the Baseline. The chapter also explores other sources of uncertainty in the *Outlook* projections. Finally, this first part of the report examines the consequences and costs of policy inaction – essentially the environmental, health and economic impacts embodied in the "no new policies" Baseline scenario.

The second part of the *Outlook* report examines the possible policy responses to address the key environmental challenges, and assesses the economic and environmental impact of these responses. The key sectors whose activities affect the environment are examined, with a brief summary of the trends and outlook for their impacts, followed by an assessment of the policy options that could be applied in that sector to reduce negative environmental impacts. This section assesses the environmental benefits of specific policy options and their potential costs to the sector involved and/or economy-wide (and disaggregated by region where appropriate). This analysis can be used by environment ministries in discussing specific policy options for tackling environmental challenges with their colleagues in other ministries, such as finance, agriculture, energy or transport. The sectors examined include those that were prioritised in the *OECD Environmental Strategy* – agriculture, energy and transport – and also other sectors which strongly affect natural resource use or pollution, such as fisheries, chemicals and selected industries (steel, cement, pulp and paper, tourism and mining).

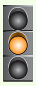
In addition to analysing sector-specific policies, this part of the *Outlook* also examines the effects of a package of policies (the EO policy package) to tackle the main environmental challenges. The analysis of this EO policy package highlights the potential synergies between policies (*i.e.* where the benefits of combining two or more policies may be greater than the simple sum of their benefits as separate policies), or potential conflicts where policies may undermine each other. Chapter 21 outlines the key framework conditions needed to ensure the successful identification and implementation of appropriate environmental policies at the national level, in particular institutional capacity and policy implementation concerns. Chapter 22, on global environmental co-operation, highlights the issues for which OECD countries will need to work together in partnership with other countries in order to reduce overall costs of policy implementation and maximise benefits. It also assesses the costs of inaction.

Traffic lights in the *OECD Environmental Outlook*

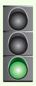
As with the 2001 *Outlook*, this report uses traffic light symbols to indicate the magnitude and direction of pressures on the environment and environmental conditions. Traffic lights are used to highlight the key trends and projections in the summary table in the Executive Summary, in the Key Messages boxes at the start of each chapter and throughout the chapters. The traffic lights were determined by the experts drafting the chapters, and then refined or confirmed by the expert groups reviewing the report. They represent the following ratings:



Red lights are used to indicate environmental issues or pressures on the environment that require urgent attention, either because recent trends have been negative and are expected to continue to be so in the future without new policies, or because the trends have been stable recently but are expected to worsen.



Yellow lights are given to those pressures or environmental conditions whose impact is uncertain, changing (*e.g.* from a positive or stable trend toward a potentially negative projection), or for which there is a particular opportunity for a more positive outlook with the right policies.



Green lights signal pressures that are stable at an acceptable level or decreasing, or environmental conditions for which the outlook to 2030 is positive.

While the traffic light scheme is simple, thus supporting clear communication, it comes at the cost of sensitivity to the often complex pressures affecting the environmental issues examined in this *Outlook*.

While each of the individual chapters discusses the regional developments for the drivers or environmental impacts analysed, Annex A also provides an easily accessible "summary" of the economic, social and environmental developments in the Baseline for each region. Annex B provides a more detailed analysis of the modelling framework used in the development of the *OECD Environmental Outlook*. A number of background working papers, which provide further information on specific issues addressed in the *Outlook*, were developed to complement the report (see: *www.oecd.org/environment/outlookto2030*).

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Acronyms and Abbreviations

BRIC	Brazil, Russia, India and China
BRIICS	Brazil, Russia, India, Indonesia, China and South Africa
CBD	Convention on Biological Diversity
CCS	Carbon capture and storage
CDM	Clean Development Mechanism
CFC	Chlorofluorocarbon
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2eq	Carbon dioxide equivalents
CSD	Commission on Sustainable Development
DAC	OECD Development Assistance Committee
EJ	Exajoules
EU15	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom
EU25	Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom
EUR	Euro (currency of European Union)
FAO	Food and Agriculture Organization of the United Nations
GBP	Pound sterling
GDP	Gross domestic product
GHG	Greenhouse gas
GJ	Gigajoules
GNI	Gross national income
Gt	Giga tonnes
GW	Gigawatt
HFC	Hydrofluorocarbon
IEA	International Energy Agency
IMAGE	Integrated Model to Assess the Global Environment
IPCC	Intergovernmental Panel on Climate Change
LULUCF	Land use, land use change and forestry
MAD	Mutual Acceptance of Data
MDGs	Millennium Development Goals
MEA	Multilateral environmental agreement
MNP	Netherlands Environmental Assessment Agency
MSA	Mean species abundance

Mt	Million tonnes
MWh	Megawatt-hour
NO_2	Nitrogen dioxide
N_2O	Nitrous oxide
NO_x	Nitrogen oxides
ODA	Official development assistance
ppb	Parts per billion
ppm	Parts per million
PFC	Perfluorocarbon
PM	Particulate matter
$PM_{2.5}$	Particulate matter, particles of 2.5 micrometres (µm) or less
PM_{10}	Particulate matter, particles of 10 micrometres (µm) or less
ppmv	Parts per million by volume
ROW	Rest of world
RTA	Regional trade agreement
SO_2	Sulphur dioxide
SO_x	Sulphur oxides
SF_6	Sulphur hexafluoride
TWh	Terawatt hour
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States dollar
VOC	Volatile organic compound
WHO	World Health Organization
WSSD	World Summit on Sustainable Development
WTO	World Trade Organization

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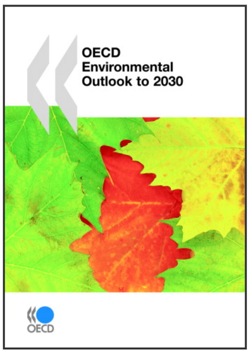

From:

OECD Environmental Outlook to 2030

Access the complete publication at:

https://doi.org/10.1787/9789264040519-en

Please cite this chapter as:

OECD (2008), “Transport”, in *OECD Environmental Outlook to 2030*, OECD Publishing, Paris.

DOI: https://doi.org/10.1787/9789264040519-18-en