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OECD Environmental Outlook to 2030

Chapter 19

Selected Industries

– STEEL AND CEMENT
– PULP AND PAPER
– TOURISM
– MINING

This chapter outlines the projected growth, environmental impacts and policy implications for four other industries: steel (and cement), pulp and paper, tourism and mining. The steel sector, a major contributor to several environmental problems (e.g. air pollution and climate change), is projected to increase production significantly to 2030, especially in Brazil, Russia, India, Indonesia, China and South Africa (BRIICS countries). The pulp and paper sector is also expected to grow in the coming decades. Regulatory approaches, economic instruments, voluntary approaches, cleaner production and other instruments are explored as possible means to offset negative environmental impacts of this growth. Tourism has an impact on the environment in the destination country and at the global level (e.g. through air travel). This chapter reviews sustainable tourism policies and other initiatives to reduce the environmental impact of tourism activities. The rapid expansion of mining activity in developing countries constitutes an important challenge. Host governments will need to put in place policies to strengthen the capacity and institutional set-up to effectively manage the environmental risks associated with this development.

STEEL AND CEMENT

KEY MESSAGES

The steel sector is a major contributor to several environmental problems, including air pollution and climate change. It accounts for about 7% of anthropogenic emissions of CO_2. When mining and transportation of iron ore are included, the share may be as high as 10%. A strong increase in the production and use of steel is projected up to 2030, especially in the BRIICS countries.

Almost 60% of steel worldwide is produced using basic oxygen furnace (BOF) technology, which emits over four times as much CO_2 per unit of steel produced than standard electric arc furnace (EAF) technology.

Use of the heavily-polluting open hearth (OH) process to produce steel has declined significantly in recent decades worldwide, and now accounts for about 5% of total production.

Policy options

- Implementing a tax of USD 25 per tonne of CO_2 emitted from the sector would have a small impact on steel production in 2030, since demand for steel is relatively price inelastic, but would substantially reduce carbon emissions (see table).

Estimated changes in CO_2 emissions in the steel sector from a USD 25 tax

(% change in 2030 compared to the *Outlook* Baseline)

	The tax applies only to the steel sector in OECD	The tax applies to all sectors in OECD	The tax applies to all sectors globally
OECD	–34.0	–33.3	–31.4
BRIICS	0.5	1.4	–54.6
ROW	0.9	2.3	–46.4
WORLD	–7.4	–6.5	–48.0

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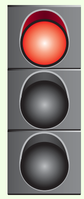
- Applying such a tax globally would lead to a 15% reduction in SO_2 emissions from the sector in OECD countries, and a reduction of over 50% in non-OECD regions.
- Measures could be taken to reduce some of the competitiveness effects of such a tax (*e.g.* recycling the tax revenue back to the steel industry, or applying border tax adjustments), while maintaining at least some of the environmental benefits.
- Scaling back steel sector subsidies to close down unprofitable steel plants could be a low- or no-cost option for Annex I countries (the industrialised nations) to meet their CO_2 emission reduction targets under the Kyoto Protocol.

Introduction

Steel production causes emissions of a number of pollutants, such as SO_2, NO_x, CO_2, particles, mercury, etc. According to the OECD (2003), the sector accounts for about 7% of anthropogenic emissions of CO_2. When mining and transportation of iron ore are included, the share may be as high as 10%. Cement production also has environmental consequences (explored in Box 19.2).

The CO_2 emissions associated with iron and steel production differ according to the different technologies used. The two main technologies are basic oxygen furnaces (BOF) and scrap-based, standard electric arc furnaces (EAF) (Table 19.1). In addition, some steel is produced in electric arc furnaces based on directly reduced iron (DRI). Steel is also produced in heavily-polluting open hearth (OH) processes, especially in certain Central and East European countries. Figure 19.1 illustrates the significance of BOF in particular, but EAF has also increased considerably over time, while OH and the now out-dated Bessemer furnaces (included in "Other Processes") have ceased to be of importance.



Almost 60% of steel worldwide is produced using BOF technology, which emits over four times as much CO_2 per unit of steel produced than EAF technology.

In general, the integrated BOFs are more energy-intensive than the EAFs, which rely on smelting of iron and steel scrap. The emissions produced by each also vary between countries and regions, depending on the energy-efficiency of the plants and the CO_2-intensity of the energy used. Globally, about 75% of the steel sector's CO_2 emissions are related to the use of coke and coal in iron making in the BOFs. Other important emission sources are the use of electricity, particularly in the EAFs, and the use of natural gas in the production of DRI.

Table 19.1. **Characteristics of different steel production technologies globally (2000)**

Technology	Share of world production (%)	Major inputs	Average CO_2 emissions per tonne steel (tonnes)
Basic oxygen furnace (BOF)	58	Ore, coal, scrap (10-30%)	2.5
Standard electric arc furnace (EAF)	27	Electricity, scrap (> 90%)	0.6
EAF based on directly reduced iron (DRI)	7	Ore, gas, electricity, scrap (20-50%)	1.2

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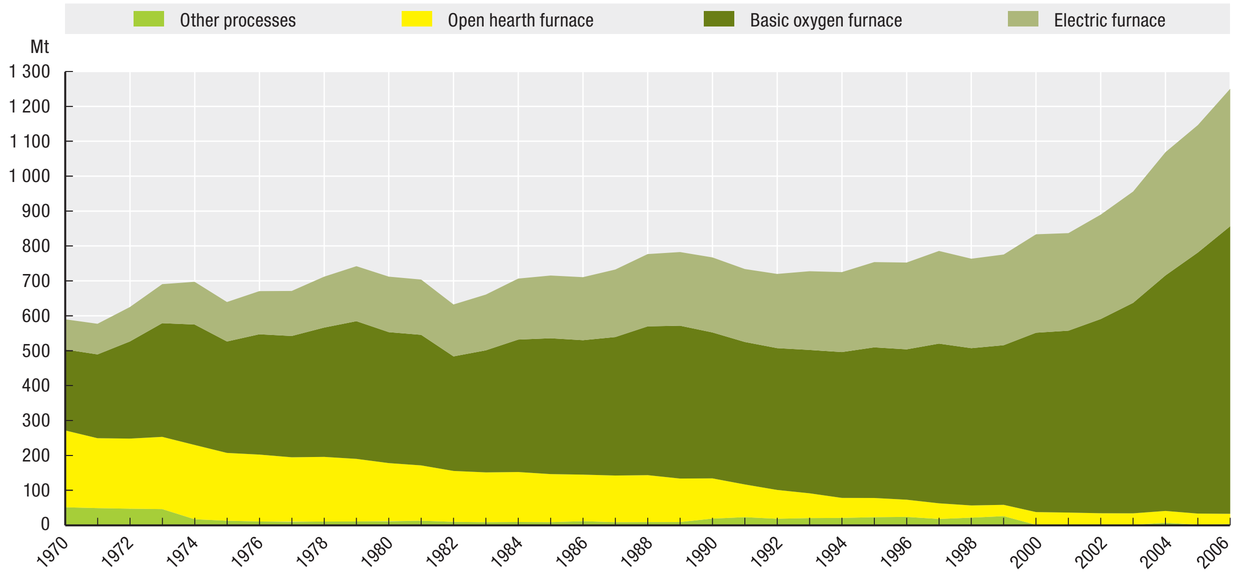
Source: OECD (2003).

On the other hand, mercury emissions to the air are higher from EAF plants than from BOF plants in countries where mercury-containing switches in end-of-life motor vehicles are melted down in the EAF plants. The use of such switches has been phased out in many countries. Programmes to remove them before the vehicles are recycled are also in place in countries where these switches are still in use. Hence, remaining mercury emissions from EAF plants are likely to decrease significantly in the future.

Figure 19.1. **World crude steel production by process, 1970-2006**



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Source: Based on data from the International Iron and Steel Institute (IISI), (2008).

Key trends and projections

According to the International Iron and Steel Institute, global steel production increased from 562 million tonnes in 1980 to 1 106 million tonnes in 2005 (IISI, 2006). Growth in world steel production was 1.8% annually between 1980 and 1995, and 4.2% between 1995 and 2005. Within the OECD, the growth in steel production was much more modest: 0.8% a year between 1995 and 2005.

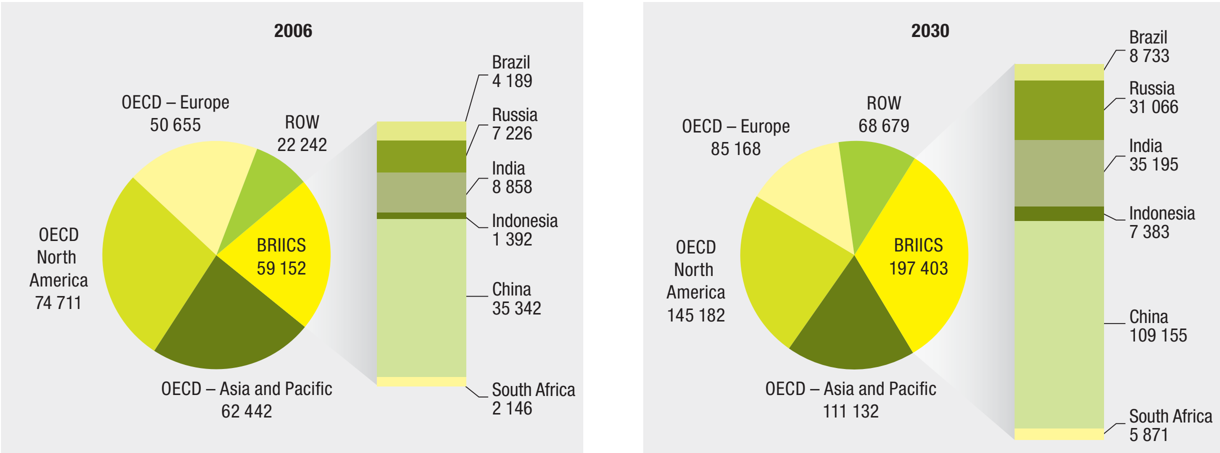
The Baseline produced for the *OECD Environmental Outlook* indicates a 3.4% annual growth in real value added[1] (at basic prices) in the iron and steel sector between 2006 and 2030 globally. This growth is estimated to be particularly strong in the BRIICS countries, which start out with an annual growth rate of 6.9% between 2006 and 2010. This is projected to decline gradually to 4.4% per year between 2020 and 2030, leading to an average growth rate in real value added of 5.1% per year between 2005 and 2030. In 2006, the share of the BRIICS countries in global steel production was just above 20%. This share is projected to increase to 32% by 2030 (Figure 19.2). A large part of this increase is estimated to take place in China, whose share of value added in the sector is projected to increase from 13 to 18% between 2006 and 2030.

The estimated growth rates in domestic demand for iron and steel are also particularly strong in the BRIICS countries. These are projected to average 5.1% annually for the period 2006-2030 as a whole; an annual growth of 7.2% per year between 2006 and 2010 is expected to gradually decline to 4.2% between 2020 and 2030. While steel demand in these countries represented 25% of the world total in 2006, this share is estimated to increase to 36% in 2030. The share of the rest of the world in total steel demand is estimated to increase from 13% in 2006 to 17% in 2030, while the share of OECD country demand decreases from more than 60% to below 50% (Figure 19.3).

In China, the demand for steel is estimated to grow particularly strongly. In 2006, China represented 17% of the global demand for steel. This share is estimated to increase to 26% in 2030. This strong demand increase in China is likely to lead to a large increase in

Figure 19.2. **Real value added in the iron and steel sector, 2006 and 2030**

At basic prices (2001), million USD



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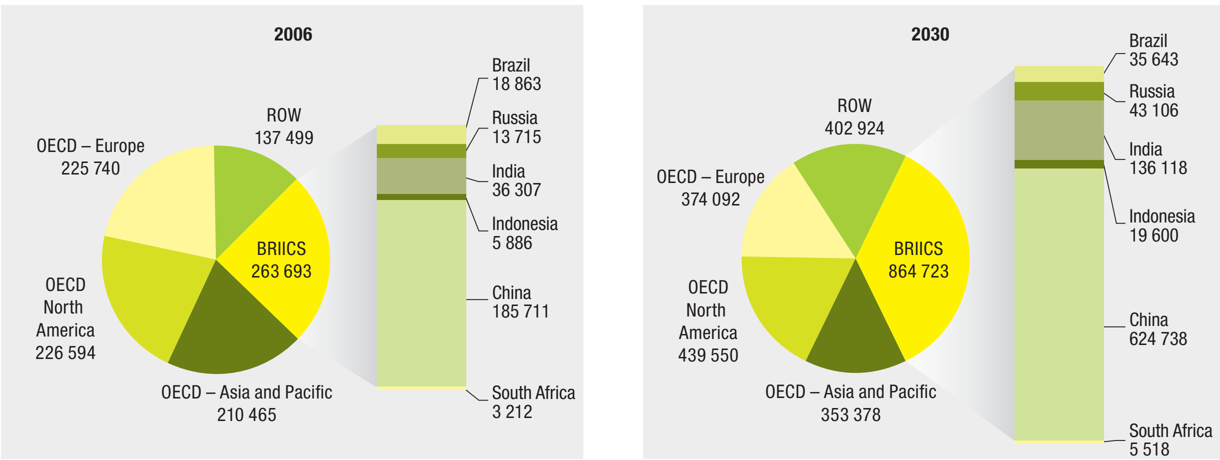
Note: OECD – A&P: Australia, Japan, Korea and New Zealand; OECD – NA: Canada, Mexico and the United States; OECD – E: OECD Europe.

Source: *OECD Environment Outlook* Baseline.

Figure 19.3. **Domestic demand for iron and steel, 2006 and 2030**

Million 2001 USD



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Note: Iron and steel products that are used as inputs in the iron and steel sector itself are double-counted in domestic demand. The totals are hence much higher for domestic demand than for value added. (Due to relatively low steel use, South Africa is not visible in the graph.)

Source: *OECD Environment Outlook* Baseline.

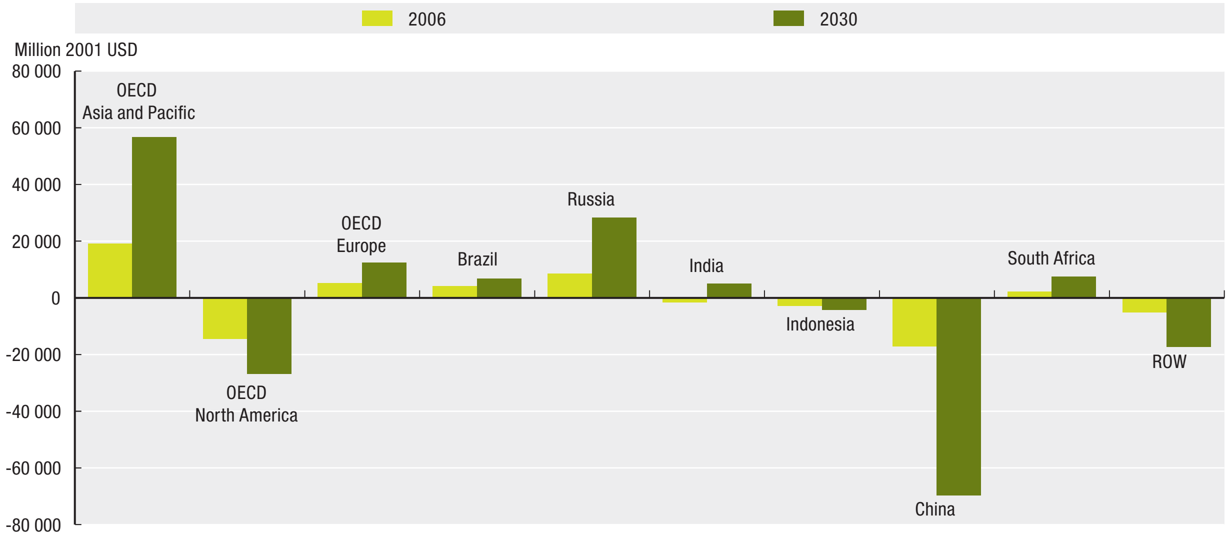
that country's trade deficit for iron and steel (Figure 19.4). The OECD countries of North America are also estimated to remain net importers of iron and steel products, whereas the export surpluses of the other OECD regions are estimated to increase significantly.

Policy simulations

Taxes or tradable permits

OECD (2003) explored the impacts of a hypothetical tax on CO_2 emissions levied on steel production and on electricity used in the sector. Within the context of that study, the

Figure 19.4. **Balance of trade in iron and steel products, 2006 and 2030**



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Source: *OECD Environment Outlook* Baseline.

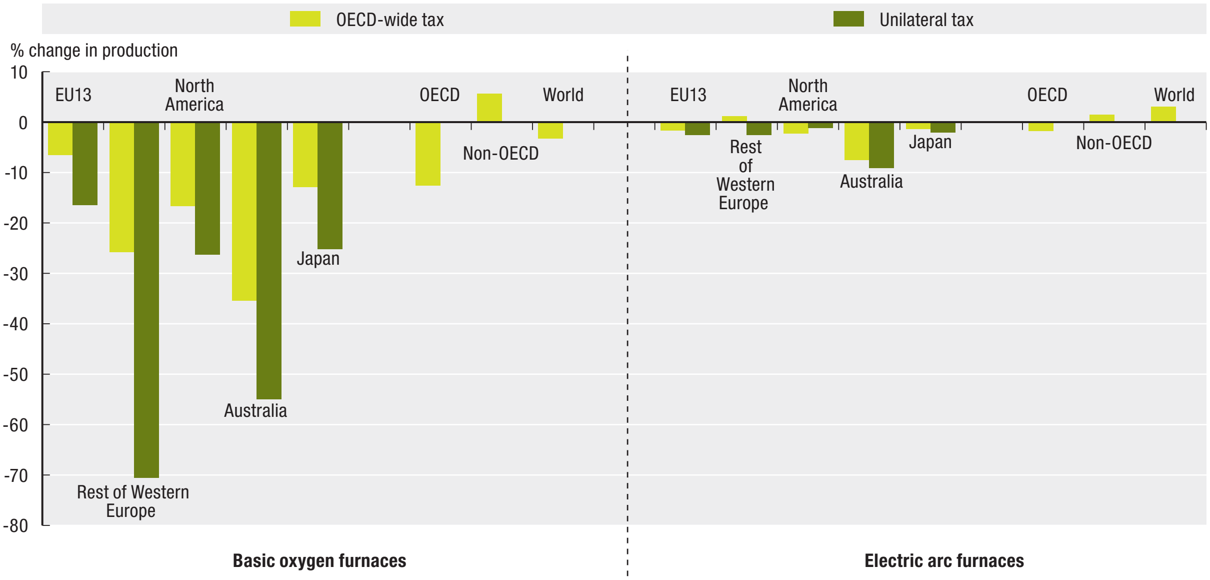
simulated impacts would largely have been the same if an emission trading system had been applied instead of a tax. The purpose of the simulations was to examine the magnitude of the sectoral competitiveness problems related to environmental policy instruments, and to analyse possibilities for limiting such impacts, while still maintaining a positive impact on the environment (the goal was not to "single-out" the steel sector in particular for taxation).

Although significant changes have taken place in the steel sector since the base year of those simulations (1995), the study highlighted a number of points that are still valid. Emphasis should, however, be placed more on the qualitative findings of the study than on the exact numerical values estimated.

The study found that an OECD-wide carbon tax of USD 25 per tonne CO_2 (applied to emissions from steel plants and from the generation of electricity used in the steel sector) would reduce OECD country steel production by about 9%. While the exact magnitude of the total reduction in steel production in OECD countries in response to such a hypothetical tax is uncertain, the conclusion that the reduction in production would be much greater for the heavily polluting BOF plants (–12%) than for the scrap-based EAF plants (–2%) does seem robust. The simulations suggested that non-OECD production would increase by almost 5%, implying a fall in world steel production of 2%. The carbon tax would induce some substitution from the use of pig iron towards more use of scrap also in BOF steel-making. Due to limited supply, scrap prices would then rise, thereby – in isolation – weakening the relative competitiveness of the scrap-based EAF steel producers.

The study found that unilateral policies by single regions or countries could lead to quite dramatic cut-backs in the production of BOF steel (Figure 19.5), because unilateral approaches leave fewer opportunities to shift the tax burden over to suppliers or customers. For EAF steel producers, the net effect of unilateral policies was not found to differ much from an OECD-wide approach, partly because unilateral policies would lead to a smaller increase in scrap prices.

Figure 19.5. **Estimated changes in steel production in response to OECD-wide and unilateral taxes**



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Note: EU13 comprises Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain and United Kingdom.

Source: OECD, 2003.

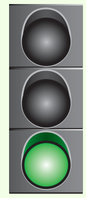
An OECD-wide tax of USD 25 per tonne of CO_2 emitted from the steel sector and from the related electricity generation would, according to OECD (2003), reduce these emissions in OECD countries by about 19%. Despite relatively high emission intensities in non-OECD countries, global emissions from the sector were estimated to decline by 4.6%, *i.e.* more than twice the reduction in global steel production. This is due to substitution towards a cleaner input-mix and cleaner processes in the OECD area, in response to the simulated tax.

Because steel demand is relatively price-inelastic, and because steel produced in different ways has different qualities, a significant share of the gross tax burden was estimated to be carried by the steel users. The shift of the tax burden to steel users was found to be possible due to an increase in marginal production costs in non-OECD countries, as steel producers outside the OECD would be pushed closer to their capacity limits.

OECD (2003) also looked at various options to limit the negative impacts on the competitiveness of the steel sector of an OECD-wide tax. One possibility could be to recycle the tax revenue back to the steel industry, in accordance with current production levels (*i.e.* equivalent to an output subsidy). In this case, the decline in OECD steel production was estimated to be less than 1%. If the tax refund were uniform across processes, however, the OECD would see quite a significant restructuring towards the relatively clean EAF steel-making process. On the other hand, maintaining the competitiveness of the sector in this way would come at an environmental cost, as global CO_2 emission reductions in the sector would drop from an estimated 4.6%, to around 3%.

Another potential way of limiting the competitiveness impacts of the tax would be to apply border tax adjustments. The impacts of doing so would depend crucially on the scope and the design of the adopted scheme. If both import taxes and export subsidies were implemented, if these were differentiated between BOF and EAF steel-makers, and if the border tax rates were linked to emission levels in non-OECD countries, the decline in OECD steel production in response to an OECD-wide tax was estimated to be as small as 1%. At the same time, the reduction in global emissions was found to be slightly *larger* than without border tax adjustments. This was because border tax adjustments would keep a higher share of world steel production within the OECD area, thereby making more steel producers subject to the OECD-wide carbon tax.

To explore the long-term impacts of policies to limit carbon emissions from a sector like steel, a number of *hypothetical* taxes with a tax rate of 25 USD per tonne CO_2 were simulated for the *OECD Environmental Outlook*. These simulations indicate that by 2030, large reductions in CO_2 emissions (averaging roughly 30-35% in OECD countries) could be obtained for modest losses in output of iron and steel production (see Figures 19.6 and 19.7). Since the losses in output occur on a baseline that is increasing, the iron and steel industry in *all* regions would still be expected to be substantially larger than it is today.

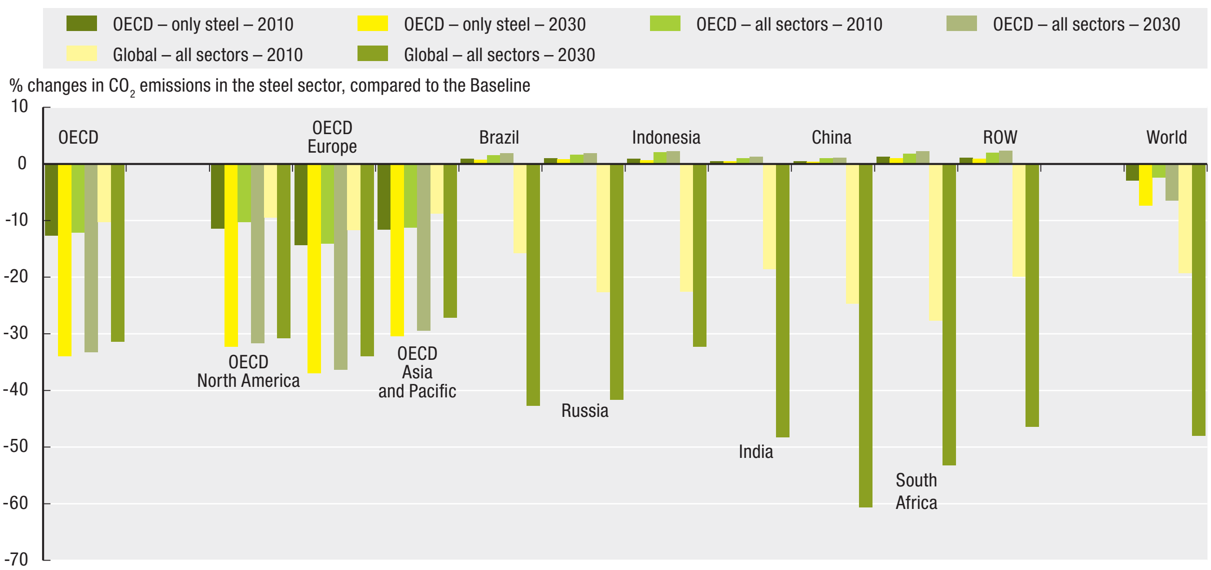


A tax on energy use in the steel sector would lead to a shift towards EAF production, with a reduction in the level of CO_2 emissions per unit of production and globally from the sector.

To the extent one can compare the simulations that were made (see Box 19.1), the simulations for the *OECD Environmental Outlook* seem to confirm some of the main findings made in OECD (2003). For example, whereas some "carbon leakage" could be expected if a tax was applied only in OECD countries, both sets of simulations indicate that *net* global emission reductions would occur. And while one should not place too much emphasis on the exact numerical production changes

Figure 19.6. **Effect of carbon tax on CO_2 emissions in the steel sector, 2010 and 2030**

% changes compared to the Baseline



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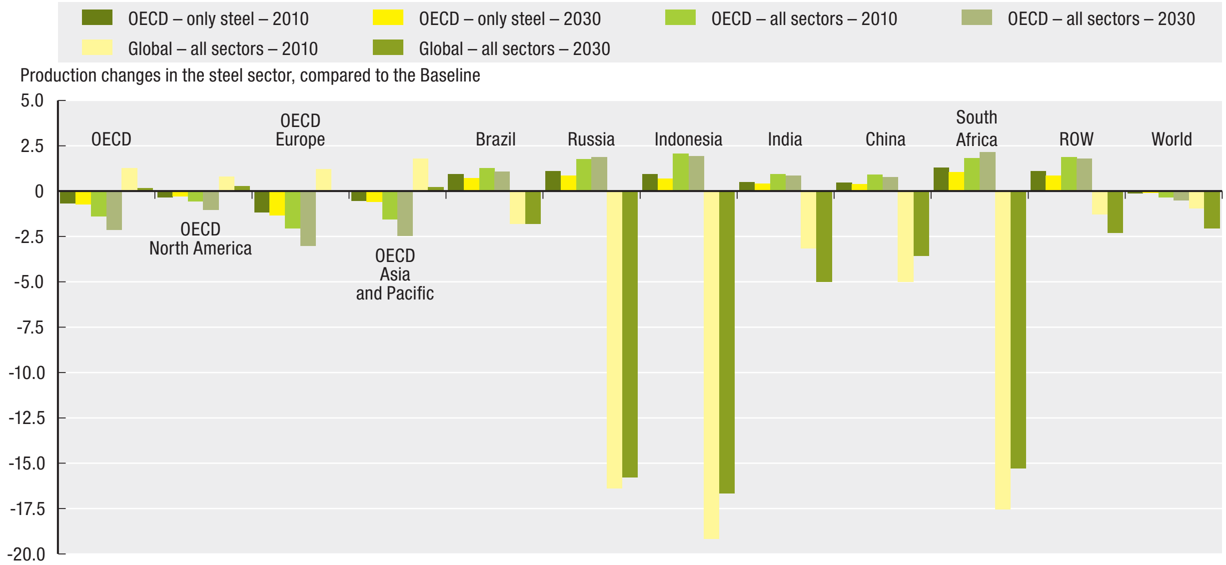
Note: In the simulations marked "OECD – Only steel", a tax of 25 USD per tonne CO_2 is applied only to emissions within the steel sector (*not* including emissions from the generation of electricity used in this sector). In the simulations marked "OECD – All Sectors", the tax is applied to all sectors within OECD, but this figure only shows changes in emissions in the steel sector. In the simulations marked "Global – All sectors", a 25 USD tax per tonne CO_2 is applied in all sectors in all regions; but, again, this figure only shows estimated impacts on emissions in the steel sector.

Source: *OECD Environmental Outlook* Baseline and policy simulations. Model used: OECD ENV-Linkages.

Figure 19.7. **Effect of carbon tax on production in the steel sector, 2010 and 2030**

% change compared to the Baseline



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Note: For an explanation of the labels, see Figure 19.6.

Source: *OECD Environmental Outlook* Baseline and policy simulations.

that have been estimated, both sets of simulations seem to indicate that significant emission reductions can be achieved at a modest "cost" in terms of reduced production.

The reason why the estimated reduction in production in (and in emissions from) the steel sector is not much larger when a tax is applied *only* to that sector, compared to when a tax is applied to *all sectors* in the OECD, is linked to the assumed inflexibility in usage of materials-inputs in all production sectors that is built into the ENV-Linkages model used in the *Outlook* simulations (see Box 19.1).

A tax applied only to the steel sector in OECD countries would, according to these simulations, not have any macroeconomic impact. In 2030, real GDP in the OECD as a whole would be 0.0077% lower than in the Baseline; in the shorter term the impact would be even smaller. On the other hand, such a tax would only reduce total CO_2 emissions in the OECD countries by some 0.5%; globally, the emissions would fall by 0.3%. The macroeconomic impacts of an OECD-wide or a global carbon tax are discussed in Chapter 7 on climate change.

The estimated production reductions in the steel sector in the case of a hypothetical global carbon tax are much larger in *some* of the BRIICS countries than in the OECD regions and in the rest of the world. As can be seen from Figure 19.8, this is partly linked to the very high energy intensities of the iron and steel sector in these countries, and partly to their high reliance on fossil fuels for electricity generation.

The policy simulation also indicates that applying a 25 USD per tonne CO_2 tax to the steel sector would have a significant impact on SO_2 emissions from the sector. If the CO_2 tax were applied only in the steel sector in OECD countries, SO_2 emissions in these countries are estimated to decrease by almost 19% in 2030 compared to the Baseline (Table 19.2). If the tax were applied globally to all sectors, SO_2 emissions in OECD countries are estimated to decline by almost 15% in the sector, while these emissions in non-OECD countries are estimated to decrease more than 50%.

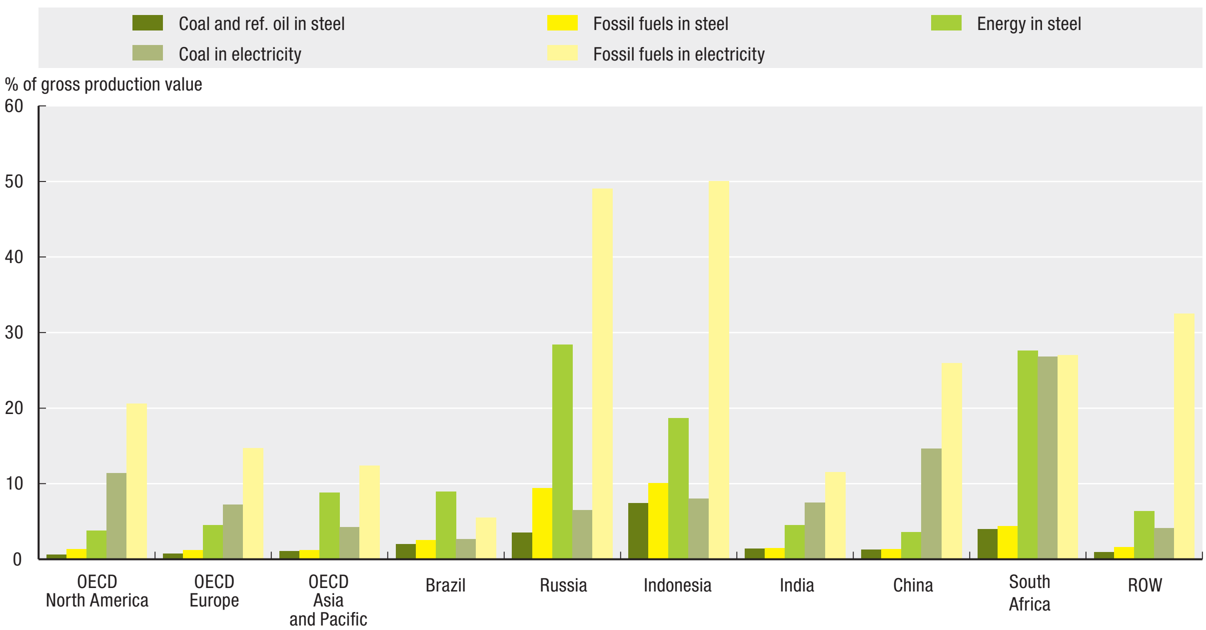
Box 19.1. **Model specifications and limitations**

The simulations in OECD (2003) focused on short to medium-term impacts of a hypothetical carbon tax, *i.e.* too short a time period to see any increases in production capacity in response to the simulated policies. The model used was a *static, partial* equilibrium model, focusing on the steel sector itself, and on sectors closely related to the steel sector (maritime transport, electricity generation, the scrap-iron market, etc.). The ENV-Linkages model used for this *Outlook* is, on the contrary, a *dynamic*, *general* equilibrium model, covering all sectors of the economy, but best suited to simulate longer-term impacts of a given policy shock. Whereas the model used in OECD (2003) distinguished between the main technologies for steel production, the ENV-Linkages model groups all iron and steel making into one sector. A direct comparison of all relevant results is thus not possible.

A drawback of the ENV-Linkages model (and many similar models) is that it assumes that the non-energy materials inputs into any production sector are *used in fixed proportions*. Hence, while changes in relative prices (*e.g.* due to the introduction of a tax) will trigger changes in households' demand for different products, they will in this model not trigger changes in the relative use of different materials for the production of a given final good or service. This means that the impacts of a given policy change could be underestimated. In reality, one would expect that an increase in the relative price of steel (compared to *e.g.* aluminium and other metals, plastics, cement, wood, etc.) would lead to a partial replacement of steel by other materials where possible. For example, in the building sector, wood or cement might replace steel in some applications – but wood could hardly replace steel in the car industry. In the car industry, substitution towards other metals or plastics would be more likely. Hence, the results of these simulations should be interpreted with caution.

Figure 19.8. **Input intensities in the steel and electricity sectors**

Value of inputs as % of gross production value, 2005.



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Note: These input intensities should be interpreted with caution. They are calculated as the value of certain inputs to either the "iron and steel" sector or to the "electricity" sector, as % of the gross production values of these sectors. In the GTAP database that is used as a basis for the model simulations, coke (which is largely used in basic oxygen furnaces) is classified in the sector "refined oil". "Fossil fuels" here includes the *value* of outputs from the sectors "coal", "crude oil", "natural gas", "gas distribution" and "refined oil" used as input in the iron and steel and the electricity generation sectors respectively, with no adjustment for the differences in carbon content of the different fuels. "Energy" includes "electricity" in addition to "fossil fuels".

Source: OECD Environment Outlook Baseline.

Table 19.2. **Estimated impacts on SO_2 emissions**

Changes in SO_2 emissions in the steel sector compared to the Baseline in 2030

	OECD – Only steel	OECD – All sectors	Global – All sectors
OECD	–18.7%	–17.1%	–14.5%
BRIICS	0.5%	1.0%	–52.6%
ROW	0.8%	2.0%	–54.0%
World	–1.9%	–1.2%	–48.5%

StatLink http://dx.doi.org/10.1787/257586111141

Source: OECD Environmental Outlook Baseline and policy simulations.

Reduction of environmentally harmful subsidies

For many years, there was very large over-capacity in the iron and steel sector. Hufbauer and Goodrich (2001) estimated that in 1998, the global over-capacity in the sector was at least 275 million tonnes, out of a production level of 775 million tonnes. This over-capacity put downward pressure on prices in the sector, which in turn stimulated demand, but nevertheless contributed to a very low profitability for many firms. Without any interventions in the market, unprofitable firms would gradually have been forced to close down, and many producers in the sector have historically therefore relied on large public subsidies for their survival. On top of various grants, preferential loans, loan guarantees, preferential tax provisions, etc., the sector has also benefited from a large number of trade-restricting practices (import quotas, anti-dumping measures, etc.)

In addition to examples of subsidies in the iron and steel sector, there are also instances of significant subsidies directed at their suppliers – such as coal mines and electricity generators – and to some of their customers, such as the shipbuilding sector. Likewise, some of the protection measures directed initially to the steel sector are passed backwards or forwards in the supply chain.

While there is broad agreement that subsidies to the iron and steel industry are still large and widespread, comprehensive quantitative estimates of their magnitude in different countries are hard to find. (A number of examples of subsidies and of trade-distorting practices are provided in UNCTAD, 2006.)

Two comments on the environmental impacts of a subsidy removal can nevertheless be noted. First, scaling-back subsidies in a way that would lead to the closure of unprofitable steel plants could be a low- or no-cost option for society as a whole in Annex I countries[2] to meet their CO_2 emission reduction targets under the Kyoto Protocol. In such a case, some of the financial resources that previously were provided as subsidies to steel producers could be used to help former employees find other employment and/or temporarily alleviate any social problems caused by the plant closures.

Second, the impacts on global CO_2 emissions of a reduction in subsidies to the iron and steel sector would depend on which subsidies were reduced and where, and on the emission intensities of the plants most affected by the subsidy reduction. Reducing subsidies to plants with high emission intensities would be particularly cost-efficient from an environmental point of view.

Box 19.2. **The cement sector**

OECD (2005) explored the impacts of a hypothetical OECD-wide tax carbon tax on the cement sector. This box briefly presents the main findings, which were largely similar to those made for the steel sector (OECD, 2003), which is an indication of the "robustness" of both studies.

Cement manufacturing consists of three main steps. Raw materials are first mined, ground and homogenised. Then they are burned at high temperatures: calcination and clinkerisation then take place to produce "clinker". Finally, the clinker is ground or milled and mixed with additional materials to produce cement. The calcium oxides required for the clinkerisation are provided by calcareous deposits, such as limestone, clay or chalk. These materials are the most common raw materials. The raw materials have to be homogenised, ground and crushed to the required fineness. Some other materials are required for the clinkerisation process: silica, iron oxide and alumina that are found in various ores and minerals, such as sand, shale, clay and iron ore. Power station ash, blast furnace slag, and other process residues can also be used as partial replacements for the natural raw materials.

The production of one tonne of clinker requires about two tonnes of raw materials and 25-30 kWh of energy, mostly electricity. The calcination of the calcium carbonate takes place at a temperature above 900°C, producing the calcium oxide required for the clinkerisation step. There are CO_2 emissions not only from the fuel combustion, but also from the process itself. Due to the CO_2 emissions, more than one third of the weight of the raw materials is lost.

The model used to study the cement sector was of a dynamic kind, and because of an embedded investment function, it was suited to analysis of long-term impacts. The cement model also took explicitly into account the high costs of transporting cement over long distances, especially inland – which tend to limit the impacts on production levels in OECD countries of potential climate policies in the sector.

The model's Baseline scenario projected an important increase in cement production (2% per year on average until 2030), entailing a strong rise in CO_2 emissions (1.5% per year). The CO_2 efficiency of cement production would thus rise by 0.5% per year, thanks to more intensive use of waste and wood fuels, and to an increasing share of modern and more energy-efficient technologies.

Several policy shocks were simulated:

- A CO_2 tax or an emission trading scheme, with auctioned allowances implemented in the countries that have ratified the Kyoto Protocol, assuming a CO_2 price of EUR 15 per tonne.
- The same policy implemented with border tax adjustments (BTA) (*i.e.* a rebate on cement exports and taxation of imported cement). There were two versions modelled: 1) exported production was completely exempted from the climate policy, and imports of cement from the rest of the world were taxed according to the CO_2 intensity of the cement production in the exporting country; 2) exports benefit from a rebate corresponding only to the least CO_2 intensive technology available at a large scale, and imports were taxed to the same level.

The implementation of a CO_2 tax was found to significantly decrease CO_2 emissions from the sector in these countries (around 20%), through more retrofitting toward energy-efficient technologies, a decrease in the rate of clinker (the CO_2 intensive input) in cement, a quicker switch to low-carbon fuels (gas, waste and wood fuels) and a decrease in cement consumption. The impact on cement production in these countries was significant (minus 7.5% in 2010), because of both a cut in their domestic consumption level, and because of a loss in competitiveness. For the latter reason, production and thus emissions in the rest of the world are projected to increase.

In the first BTA version, the loss of production in these countries was limited to 2% and the leakage was replaced by a spill-over, since emissions in the rest of the world also decrease. The decrease in world emissions is a bit higher than without BTA. The second BTA version was also found to prevent carbon leakage, with a leakage rate of around 4% in 2010.

PULP AND PAPER

KEY MESSAGES

Pollution from transportation in the pulp and paper sector remains a major environmental issue.

It is projected that the market for paper and board will continue to grow globally at 2.3% a year to 2030, with particularly rapid increases in developing and emerging economies. There will be significant differences among world regions, which will change the flows of trade.

There is room to improve paper recycling and to use more recovered paper in some regions of the world; this would reduce raw material and energy consumption in the industry.

The pulp and paper industry already generates approximately 50% of its own energy from biomass residues, and could eventually become a clean energy supplier.

New technologies have enabled a decoupling of environmental pressures from production. For instance, in Europe, Japan and North America, processes have been developed to eliminate the formation of chlorinated dioxins and furans, and to reduce formation of compounds containing organically bound chlorine. Further progress depends on the pace of diffusion of best available technologies around the world.

Policy options

- Ensure consistent government policies and industry action to maintain and further improve recent reductions in air and water emissions from the sector, and further increase the recycling of paper and board and the use of recovered paper.
- Design policy packages to reduce environmental pressures throughout the life-cycle of the products (from logging to recycling) whilst ensuring resource efficiency. These might include voluntary approaches, economic instruments, and command and control policies to stimulate R&D and the dissemination of innovation.
- Disseminate the best available techniques (*e.g.* to reduce the use and release of harmful chemicals in the bleaching process), especially within developing and emerging economies.

Introduction

The whole life-cycle of paper production and consumption is significant from an environmental point of view, from harvesting of forest to conversion to paper and reuse. The type of feedstock (predominantly woodchips, but also recovered paper and to a lesser extent, rice and cotton), pulping process (mechanical or chemical) and final product determine the direct environmental impacts, which may include chemical, air and water pollution, deforestation and forest degradation. Progress has been made at each stage of the cycle, although at a different pace in different regions. At the same time, the industry can be the key enabler to meet biomass targets and produce biofuels, biodiesel and biochemicals.

The harvest of forests has an impact on ecosystems and biodiversity, depending on how forests are managed, which species are used for plantation, etc. (see also Chapter 9 on biodiversity). The industry contributes to the conversion of high conservation natural forests to managed forests (plantation or natural regeneration systems) in Southeast Asia (Indonesia) and Australia. Sustainable use of old growth forest is an issue in Canada and Russia. The environmental impact can be reduced and resource use efficiency increased through sustainable forest management. The industry indicates that only a portion of the timber harvested worldwide is used for paper-making; often, this is small dimension wood, sawmill waste and woodchips, as well as timber from forest thinning (extracted to enable remaining trees to grow).

The conversion of wood to pulp involves two preliminary methods: *i)* the mechanical grinding of woodchips, which is electricity intensive; and *ii)* the chemical separation of the wood fibres from the lignin which binds them; this produces a variety of atmospheric pollutants. The most polluting stage is the bleaching of the resulting pulp. This used to be done with chlorine-based bleaches, a process which is no longer used in Europe and which is also significantly reduced around the world. Outputs from this process include large volumes of water (for washing), which may contain highly toxic organic compounds, including furans, dioxins and other chlorinated organic compounds.

Cleaner technologies have radically improved the environmental performance of the industry in most regions of the world. Table 19.3 illustrates process evolution and performances: in the 1990s, a modern paper mill used about 85% less water than it did three decades ago; reductions in total suspended solids (TSS) and in five-days biological oxygen demand (BOD5) have also been considerable (FAO, 1996).

Recovered paper is an alternative input to timber in the production process (see Box 19.3); it helps lessen pressures on forests. Europe leads the way in the use of recovered paper, with Asia and North America trailing behind. Recovered paper is the most important raw material for the British paper and board industry, representing 68% of the fibre throughout this sector in 2004. The Confederation of European Paper Industries (CEPI) has set a target of 66% paper recovery by 2010 (see ERPC, 2006), up from roughly 55% in 2004 (CEPI, 2005). The US industry has set a paper recovery goal of 55% by 2012 for domestic use and export.

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Table 19.3. **Integrated kraft mill wastewater, TSS waste load and BOD5 waste load**

Technology	Waste water discharge (gal/tonne)		TSS waste load (lb/tonne)		BOD5 waste load (lb/tonne)	
	Bleached	Unbleached	Bleached	Unbleached	Bleached	Unbleached
1964 older	110 000	90 000	200	170	200	160
1964 current	45 000	27 000	170	130	120	90
1964 new	25 000	16 000	90	80	90	80
1990 design	16 000	8 000	50	45	60	50
% reduction 64/90	85%	91%	75%	73%	70%	69%

StatLink http://dx.doi.org/10.1787/257614204873

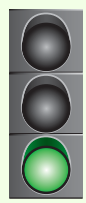
Source: K. Ferguson, cited in FAO, 1996.

Box 19.3. **The procurement issue in perspective**

The industry has engaged in sustained efforts to diversify its fibre base and, in particular, to substitute virgin raw material with recovered paper. However, this policy has its limitations as, at least in Western Europe, most quality recovered paper sources are already tapped; the challenge now is to increase the quality of recovered paper (see CEPI, 2006a) and the recyclability of paper products, via an integrated environmental approach. Recovered paper is now increasingly traded around the world, in particular between the EU/US and China.

Another challenge is looming. Wood supply may well be influenced by the increasing demand for biofuels. A number of governments are enacting policies to support the development of bio-energies, including biomass, thus increasing competition for raw and recovered resources for the pulp and paper industry. According to a recent European Environment Agency report (EEA, 2006), increasing market values for bio-energy would lead to substantial mobilisation of wood biomass resources for bio-energy from other competing industries, including pulp and paper (for a more detailed discussion of the consequences of EU energy policy on forest-based industries, see EC-DG Environment, 2000). With a woodchip price of EUR 70/m^2, chemical pulp production in Europe might decline by around 10-15%. If the price increases to EUR 100/m^2, the reduction could be up to 50%. Since pulp and paper are produced globally and widely traded, higher production costs in Europe may not be reflected in pulp and paper prices, unless similar developments occur in the world market.

In Europe and in North America, at least, energy-efficiency has become a key issue for the industry, not least as a means to reduce energy costs (Jokinen, 2006). However, some energy savings achieved through improved production processes have been counteracted by demand for increasing quality paper products. However, the pulp and paper industry already generates approximately 50% of its own energy from biomass residues, and in the long term it could develop into a clean energy supplier.

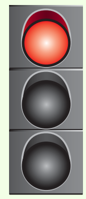


The pulp and paper industry already generates approximately 50% of its own energy from biomass residues, and could become a clean energy supplier.

It is notable that the European industry sets the world standards via the European reference document on best available technologies (BREF)[3] and the leading machine manufacturers are established in Europe. The BREF identifies new technologies which have not yet materialised but which are likely to have substantial environmental benefits over the *Outlook* period. For instance, black liquor gasification will yield higher returns on energy; new technologies for boilers will save energy; and biotechnologies will enable the production of by-products (ethanol), thus increasing the value-added from raw materials.

The diffusion of best available technologies (BAT) is indicated by the fact that in 2005, pulp manufactured without the use of any chlorine gas accounted for 85% of total world output (Alliance for Environmental Technology, 2005). The diffusion of BAT follows the investment cycle (including rebuilds): the industry is capital intensive and some equipment lasts over 20 years. Pulp and paper mills in many OECD countries will need to be replaced in the next 10-15 years, and this is an opportunity to install new technology.

Industry leaders consider that pollution from transportation in the pulp and paper sector remains a major environmental issue (see Ernst and Young, 2007); the modal choices vary from country to country, depending on distance, infrastructure and costs.



Pollution from transportation in the pulp and paper sector remains a major environmental issue.

Key trends and projections

Demand for paper products comes from a number of sectors:

- Printing and publishing, though this is being challenged by electronic media.
- Packaging, though paper competes with alternative materials (aluminium, plastic, etc.).
- Sanitary and household sectors, which have a high demand for paper products.

Since 1990, the global market has been growing steadily, but it has been rocked by the rapidly changing demand and supply in Asia and Latin America. The consumption of paper and board in OECD countries increased by 27% (in volume) between 1990 and 2004. Over the same period, consumption in Southeast Asia has been booming: Chinese consumption increased by 213% and now amounts to one-quarter of the consumption of OECD countries;[4] over the same period, Indonesian consumption increased by 265%, though from a much lower level. Chinese imports of paper and board represented 10% of world trade in 2004 (6% in 1990); as for pulp, China's share of world imports rocketed from 3% in 1990 to 18% in 2004 (FAO data, at *http://faostat.fao.org*). World production has followed a parallel path with a 32% increase in OECD countries and a 207% increase in China for paper and board.

At the moment, the industry is characterised by fragmentation, overcapacity and low profitability (due to slow market growth, cost increases and capital intensity) (Ernst and Young, 2007). Some segments are in a better shape. In the value chain, the most profitable firms are those which create the most value; customers and suppliers of the industry are better off than the pulp and paper producers and merchants.

The *OECD Environmental Outlook* Baseline anticipates sustained growth of the market to 2030 (2.3% per annum – see Box 19.4 for key assumptions). The BRIC countries deserve particular attention:

- China[5] is already the second largest producer of pulp and paper worldwide (third, if EU member countries count as one). It is expected that rapidly growing demand (from

54.7 million tonnes in 2004 to 68.6 by 2010) will be mainly covered by domestic production. Over the same period, 50% of the demand for pulp and recovered paper will have to be imported, as China lacks domestic resources. Land use, energy and transportation issues are increasing and are driving up wood costs. The industry comprises old mills (small, family-owned, based on non-wood material, polluting) and recent ones (large, using primarily imported fibre, complying with international standards).

- The Indian market for paper and paperboard remains small, but it is expected to grow by 6% per annum until 2020 (Ernst and Young, 2007). Demand is led by printing/writing papers (India has become a hub for high quality printing at low cost) and containerboard. It is estimated that the industry will restructure heavily due to trade liberalisation and modernisation. The industry is expanding and investing in new technologies for cleaner and brighter paper. However, limited access to raw material prevents mills from growing and achieving economies of scale.
- Russia supplies raw material to Europe and China. Investment has remained minimal since 1990, but both production and consumption of newsprint are expected to increase by 7% per year until 2020 (see UNECE/FAO, 2005), allowing the Confederation of Independent States (CIS) countries to export newsprint to Europe and Asia. The Russian industry is highly consolidated, with five companies producing over 40% of all pulp and paper products. In the future, it will strive to retain the value-added (Russia is restricting its wood exports through additional export duties) and attract more investment from multinational companies.
- Pulp production is developing in Brazil (the annual growth rate for the 2002-2006 period is above 8%), based on large-scale plantations. Paper production is expanding less rapidly (data available at *www.bracelpa.org.br/eng*). The industry is expected to generate more value-added in the future.

Europe is expected to become a net importer of printing and writing paper by 2020 as a result of new demand in Eastern Europe and the reduction of growth in production in Western Europe (UNECE/FAO, 2005).

Box 19.4. **Key uncertainties, choices and assumptions**

The chapter relies on a number of assumptions. One is the continuation of the current trends in world production: it is assumed that *i)* no major upheaval will significantly change the way paper competes with other materials in the different markets, and *ii)* demand management will not dramatically impair demand for paper products.

Another set of assumptions relates to the environmental performance of the pulp and paper mills. We lack recent, comprehensive data on the environmental impacts of the pulp and paper industry, in particular as regards energy-efficiency (see Jokinen, 2006). The difference between the environmental performance of front runners and laggers in the sector is probably very large. There are key uncertainties about the pace of dissemination of best available technologies, and the role the multinational companies and supply chain management play in these dynamics.

The industry is taking initiatives to enforce compliance, such as wood tracking systems, codes of conduct and forest certification (see for instance the Confederation of European Paper Industries' Position Paper on Forest Certification; CEPI, 2006b).

In the future, the key location criteria for pulp and paper mills are expected to be access to the final market, access to the resource (but transport costs are still low and alternative, recycled resources are available worldwide) and energy costs. In this context, production capacity is expected to shift from North America and Western Europe to emerging markets (China, India, and Latin America). Additional criteria also gain importance, and will influence investment decisions, such as increasing transportation costs (due to high energy prices), non-tariff barriers to trade, and social and environmental requirements.

These dynamics have consequences for trade flows. In their review of forest product markets, UNECE/FAO (2005) claim that trade barriers continue to exist in the sector. These include technical barriers, such as antidumping measures and retaliatory tariffs, as well as uneven trade advantages that stem from divergent tax rules and labour standards. This is clearly not in line with GATT/WTO regulations which abolished paper and paperboard tariffs as of 2004, at least in trade between major industrialised countries.

Policy implications

The industry is subject to a wide array of policy instruments which aim to support cleaner production, more efficient processes (to save on energy, water and material usage) and end-of-pipe pollution abatement. Other options are being considered, such as demand management which encourages reduction of wasteful consumption of paper in OECD countries (see, for example, efforts by the Australian Conservation Foundation, 1992). The industry is also influenced by energy policies, which subsidise the use of renewable energy sources (including biomass), constraining the availability of raw materials and decreasing the incentives for separate collection of paper and recycling (see CEPI/WWF, 2006); energy-related taxes and emission trading schemes also affect the industry's competitiveness.

The impacts of these instruments have different time horizons: it can take decades before sustainable harvest of primary forests restores some biodiversity quality in a given territory, whereas changes in production processes can have an almost immediate impact on energy consumption.

Paper and pulp are traded globally and prices are set at the global level, whereas cost factors (some raw materials, energy, employment, compliance with environmental legislation) vary locally, which can affect competitiveness. Policy packages need to be designed and implemented in a way which addresses competitiveness concerns, at least at a regional level.

Regulatory approaches

Command and control instruments have been used widely in the industry. Typically, norms on emissions have been used to abate pollution.

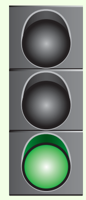
The World Bank has issued *Environmental, Health, and Safety Guidelines* for pulp and paper mills, which guide proponents requiring financial assistance to set up mills; the initial document was drafted in 1998 and was under review in 2007.[6] Such approaches help to disseminate the best available technologies.

Economic instruments

Economic instruments at industry level are also appropriate. These include incentives for industry and households to recycle and use recovered materials; or green taxes targeting particular operations in the production process. As an illustration, a United

Nations Environment Programme (UNEP) report on economic instruments for environmental protection proposes an effluent charge to abate pollution in the pulp and paper industry in Indonesia (see UNEP, 2005). In Europe, pulp and paper mills that produce more than 20 tonnes per day are included in the EU Emission Trading System for greenhouse gas emissions. These instruments have to be regularly adapted to changes in the structure of markets and their impacts have to be monitored.

The Confederation of European Paper Industries (CEPI) assumes that green public procurement will become an incentive for environmental performance in the next five years or so. The public sector can represent up to 20% of the demand for some paper grades.



New technologies and further uptake of existing ones enable a decoupling of environmental pressures from production.

Voluntary approaches

The pulp and paper industry has been taking steps to reduce its environmental footprint. In France, the industry was among the first to sign a voluntary agreement to cut environmental impacts, back in 1972. Voluntary approaches at a global level are illustrated by the commitment by forest industry leaders to action on global sustainability (see ICFPA, 2006). In Europe, as in Canada, voluntary approaches are flourishing, for example on illegal logging (*e.g.* ICFPA's Statement of Support for WBCSD/WWF Certification and Illegal Logging Activities, ICFPA, 2006), on recycling (*e.g.* the European Declaration on Paper Recycling, ERPC, 2006), on biomass-based energy consumption (the European pulp and paper industry also committed to increase the use of biomass in on-site primary energy consumption to 56% by 2010), or on eradicating the emission of chlorinated organic and sulphur dioxide compounds.

Progress is monitored and reported by the Confederation of European Paper Industries, which publishes a set of performance indicators, most of them corresponding to Global Reporting Initiative indicators (see for instance CEPI, 2007).

R&D and cleaner production

In 2006 the industry spent an estimated 0.7% of its turnover on R&D, and industry leaders agree that this should increase strongly (Ernst and Young, 2007). The industry builds upon research all along the value chain. In 2004, the European industry reportedly invested EUR 560 million in environmental improvements (7% of its total capital expenditures) (Pöyry, quoted in CEPI, 2005). Suppliers, research institutes and other stakeholders invest in R&D as well.

In Europe, a platform has been established which brings together stakeholders in the forest and paper sectors around a long-term strategy and a vision of the industry for 2030 (see Forest-Based Sector Technology Platform, 2006). The platform emphasises research on modern timber breeding techniques (which will improve wood characteristics and fibre biomass, and reduce forest losses) and on "tailor-made" wood supply (adapting raw materials to customer demands and optimising the allocation of raw materials to different industrial applications).

The diffusion of best available technologies (BAT) can accelerate progress. According to the Worldwide Fund for Nature (WWF, 2006), most pulp mills meet BAT levels, but not all paper mills use the latest technologies. Action is needed by companies and governments, in particular in regions where the oldest part of the industry fails to meet the best industry standards (*e.g.* in some countries of continental Europe, parts of China and India). Resource use (procurement, resource efficient technologies) and cleaner production (closed loop processes, chlorine-free processes, elimination of persistent organic pollutants) are expected to attract attention in the future.

Other instruments

Other instruments include:

- Labelling, based on the life-cycle of the product, including reference to the raw material (the EU in particular has set up a partnership process with timber exporting countries, to support compliance enforcement in that sector).
- Extended producer responsibility (as an attempt to ensure coherence across the product life-cycle). Again, the industry can play a leading role, as is illustrated by the renewed commitment by CEPI in the field of recycling: it entails qualitative (and quantitative) targets throughout the value chain, and it passes responsibility to producers for ensuring waste prevention and better recycling.
- Monitoring and reporting. Reports from companies allow their performance to be assessed against the permits they hold, their commitments, or against best available technologies (see WWF, 2006); some reporting requirements are defined in permitting and certification schemes. Many companies also produce sustainability reports.

In addition, the UN Food and Agriculture Organization makes a strong case for environmental impact assessment and environmental auditing in the pulp and paper industry (FAO, 1996). According to the World Bank guidelines referred to earlier, large new pulp and paper mills and large expansions and projects located in or affecting a sensitive area require an environmental impact assessment to be submitted; the assessment includes a statement on the use of best available technologies.

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TOURISM

KEY MESSAGES

According to some estimates, tourism contributes up to 5.3% of global anthropogenic greenhouse gas emissions, with transport accounting for 90% of this. Travel for tourism purposes is expected to grow significantly to 2030, with international tourism growing by over 4% per year, accompanied by increasing environmental pressures.

Tourism development can generate unsustainable pressures on the local environment, in particular if insufficient infrastructure is in place to cope in an environmentally sustainable way with large numbers of visitors and their activities.

Tourism and the environment can be mutually supportive. In a number of destinations, tourism is a driver of enhanced water quality and the protection of nature. In rural areas, it can contribute to the sustainable development of traditional activities (handicraft, agriculture, etc.). In urban settlements, it can generate additional resources to invest in environmental infrastructures and services.

Policy options

- Implement appropriate policies to support the development of sustainable tourism (including transport). These should involve an array of stakeholders (public and private), at international, domestic and local levels. Efficient mechanisms are needed to harness tourism for economic, environmental and social developments.
- Scale up innovative approaches to encourage environmental sustainability in the tourism sector. Certification and labelling schemes can help promote eco-tourism opportunities, for which there is a rapidly growing market.
- Increase the use of economic instruments to internalise the measurable externalities of tourism. Instruments can include price incentives, fees and subsidies to sustainable tourism activities.
- Adopt and promote the principles enshrined in declarations such as those on *Harnessing Tourism for the Millennium Development Goals* and *Action for More Sustainable European Tourism*.

Consequences of inaction

Tourism itself will be affected by changes in the environment. For example, climate change is expected to decrease the number of snow-reliable skiing days in the European Alps, and sea level rise will affect tourism operations in coastal areas and small islands.

Introduction

Tourism has an impact on the environment in the destination country and at the global level. According to a classification developed by the United Nations Environment Programme (see UNEP webpage: *www.unep.fr/pc/tourism*), the potential environmental pressures of tourism at the destination include:

- The depletion of natural resources: tourism often overuses water resources and requires oversized infrastructure (especially when demand fluctuates seasonally); it also affects local resources (*e.g.* energy, food stuffs), including land and scenic landscapes.
- Pollution: as with any other industry, tourism can generate air emissions, noise, solid waste, release of sewage, oil and chemical pollution, and visual pollution.
- Physical impacts: degradation of ecosystems, with coastal and mountain areas being particularly vulnerable.

At the global level, tourism can have an impact on biological diversity, the ozone layer and climate. It has been estimated that tourism contributes up to 5.3% of global anthropogenic greenhouse gas emissions, with transport accounting for 90% of this (Gössling, 2002 and Box 19.5).

Box 19.5. **Tourism, transport and the environment**

The OECD has recently explored the relationship between tourism and transport. Experts usually distinguish between tourism travel to and from destinations and tourism travel at destinations. The former usually, but not always, has the greater overall environmental impacts. Impacts of the latter may be lower when the quality of the destination facility is high.

Most tourism travel is by car. This is more the case in Europe than in North America, although the frequency and extent of all types of tourism travel in Europe is much lower. However, tourism travel is driven by the growth in availability of inexpensive air transport.

Tourism is estimated to account for about 75% of the demand for aviation, which is growing rapidly. Low-cost carriers have been moving passengers over longer distances for shorter and more frequent holidays, with 10-20 times the environmental impact per trip-day compared with tourism by road or rail. The low-cost-carrier phenomenon may be particularly evident in Europe, although North Americans continue to make many more longer-distance trips than Europeans. The tentative nature of these statements reflects the lack of reliable data, which in part reflects the lack of accepted definitions of leisure travel and tourism travel.

Current efforts towards reducing the environmental impacts of tourism travel include the marketing of packages involving both eco-tourism and eco-mobility. Several examples exist in Japan, Germany and Austria (*e.g.* Lake Neusiedl Region, and eco-mobility in the Alps).

Source: OECD, 2005a.

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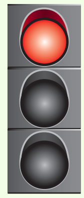
In turn, tourism can be affected by changes in the environment. For example, climate change will affect winter tourism in mountainous regions, and sea level rise will have potential consequences for tourism in coastal areas and small islands. These effects are ambivalent: they may generate new demands and change the geographical location of tourism supply and infrastructure. In many cases, tourism operators are beginning to adapt to these changes, for example by increasing the development of year-round tourism activities in skiing resorts and greater use of artificial snow-making machines (OECD, 2006). The degradation of the environment can diminish the capacity of a destination to attract tourists.



Climate change may adversely affect tourism opportunities – for example in coastal zones and ski areas.

Tourism and the environment can be mutually supportive: tourism is an opportunity to finance environmental infrastructure (water supply and sanitation, waste treatment) and it can contribute to the conservation of sensitive areas and habitat. Tourism can reduce poverty, depending on how revenues from the industry are shared and distributed along the value chain and among local communities. This is the objective of eco-tourism (see Box 19.9 below), which is emerging as a market segment.

Key trends and projections

By 2020, the United Nations World Tourism Organization (UNWTO) estimates that most industrialised countries will have come close to their upper limits in terms of supplying domestic tourism. Growth in that domain is expected to come from developing countries in Asia (in particular in China, see Box 19.6), Latin America, the Middle East and Africa.

Box 19.6. **Tourism in China**

China travel and tourism (encompassing transport, accommodation, catering, recreation and visitor services, for both domestic and international tourists) is estimated to have generated USD 265 billion of economic activity (total demand) in 2005, and is expected to grow (in nominal terms) to USD 875 bn by 2015. This represents an annual growth rate of 9.2%, in real terms, between 2006 and 2015 and would make China the second largest travel and tourism economy, after the US, by 2015. China travel and tourism capital investment for 2005 is estimated at USD 100 billion (9.9% of total investment); by 2015, this should reach USD 329 billion (10.7% of the total). The rise of disposable incomes has already fuelled domestic tourism. However, there is concern that these massive flows jeopardise the environment and generate excessive demand for environmental services (water, waste).

Source: World Travel and Tourism Council, 2005.

International tourism is characterised by steady growth in the recent past and in the foreseeable future. The UNWTO estimates that only 7% of the world's population currently capable of engaging in tourism has travelled abroad. Prospects for further growth are likely to be considerable. In OECD countries, the development of tourism is related to demographic changes, such as the ageing of populations and the resulting growth in the number of healthier, wealthier, car-driving older people. Outside the OECD, rising living standards are fuelling tourism. Growth is only temporarily and regionally sensitive to upsets (such as acts of terrorism or natural disasters).

Over the 1995-2004 period, international tourist arrivals grew by 3.8% annually. The receipts from international tourism rose even more steadily, from USD 405 billion to USD 622 billion. Table 19.4 shows how the different regions of the world have benefited from these trends. The focus of UNWTO data collection on international tourism provides a misleading impression that there is more tourist activity in Europe than in North America, where domestic tourism is particularly significant. Table 19.5 shows that tourists spend relatively more on tourism activities in the USA than in European countries.

Table 19.4. **International tourist arrivals by tourist receiving region (millions), 1995-2020**

	Base year	Forecasts		Market share (%)		Average annual growth rate (%)
	1995	2010	2020	1995	2020	1995-2020
World	565	1 006	1 561	100	100	4.1
Africa	20	47	77	3.6	5.0	5.5
Americas	110	190	282	19.3	18.1	3.8
East Asia, Pacific	81	195	397	14.4	25.4	6.5
Europe	336	527	717	59.8	45.9	3.1
Middle East	14	36	69	2.2	4.4	6.7
South Asia	4	11	19	0.7	1.2	6.2

StatLink http://dx.doi.org/10.1787/257658165751

Source: United Nations World Tourism Organization, 2001.

Table 19.5. **Trends for inbound tourism, 1995-2004**

	Number of tourist (overnight) arrivals			Tourism receipts		
	Rank 2004	Million	1995-2004	Rank 2004	USD billion	1995-2004
France	1	75.1	↘ –	3	40.8	↘ –
Spain	2	53.6	↗ +	2	45.2	↗ +
USA	3	46.1	↘ –	1	74.5	↘ –
China	4	41.8	↗ +	7	25.7	↗ +
Italy	5	37.1	↘ –	4	35.7	↘ –

StatLink http://dx.doi.org/10.1787/257672843555

Source: UNWTO, 2001.

The UNWTO anticipates that international tourism will continue to grow to 2020 (though see Box 19.7 for some methodological challenges to the projections). The number of international arrivals worldwide is expected to increase to almost 1.6 billion, 2.5 times the number recorded at the end of the 1990s; but the pace of growth will slow down to a forecasted 4% annually. Europe is expected to continue to be the most visited region (Table 19.4), but the anticipated growth rate is below the world average. East Asia and the Pacific will overtake the Americas as the second largest receiving region; China is likely to become the first destination country (in number of arrivals), ahead of France

Box 19.7. **Key uncertainties and assumptions**

The trends presented here are based on available data published by the UN World Tourism Organization, which regularly publishes market analyses and outlooks. Some major uncertainties remain. One major uncertainty is the pace of development of tourism from China.

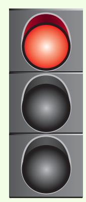
Another example of uncertainty is the impact of climate change on the development of tourism. Recent work on the European Alps indicates that climate change can significantly affect the capacity of a region to sustain tourism (OECD, 2006). Adaptations are required, the magnitude of which are still unclear at the global level.

The qualitative shifts in tourism consumption may have severe impacts on long-haul travel, which could significantly change the environmental footprint of the industry.

Present data collection is inadequate for the kinds of analysis required, especially for domestic tourism. The data collected by the UNWTO focus on international tourism. Such a focus yields few insights for large OECD countries (*e.g.* United States) where most tourism is domestic.

and the USA. In the Americas, Northern America should perform less well than the other sub regions. Africa and the Middle East should perform above average, with a particularly notable increase in visitors to South Africa.

Annual receipts from international tourism (excluding transport) are projected to reach USD 2 trillion in 2020. The main driver of this expansion is expected to be rising incomes, spread across larger and new layers of the world's population, a growing share of which will be spent on travelling abroad.



International arrivals are projected to reach almost 1.6 billion in 2020, increasing the environmental impacts of air travel.

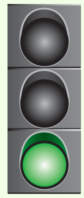
According to UNWTO (2005a), tourism consumption is changing qualitatively; consumers are favouring destinations closer to home, taking a "wait-and-see" approach to travel plans and leaving bookings until the last minute. Tourists will travel more often, for shorter periods of time (see the multiplication of shorter holidays in Europe, North America and recently in Asia). The UNWTO notes that some products and sectors have benefited from these trends. These include non-hotel accommodation such as apartments and bed-and-breakfasts, and special interest trips with high motivation factors related to culture, sports or visits to family and friends. Long-haul destinations have been most affected by these trends. Short-haul travel is expected to enjoy comparatively stronger growth.

Policy implications

Tourism markets have not succeeded in systematically valuing the environment properly. There has been some progress, for example in valuing the contribution of Australia's biodiversity to the tourism industry (see Australian Government, 2004), but this remains slow and piecemeal. Active policies are needed to reverse unsustainable trends and market failures in the tourism industry.[7]

An agenda for sustainable tourism policies

The active role played by the United Nations Environment Program (UNEP), UNWTO and other international organisations such as the European Commission and the OECD is increasing recognition of the concept of sustainable tourism and clarifying actions required to support it. A representative group of government, industry, UN specialised agencies and civil society leaders met in New York, at the invitation of the UNWTO, on 13 September 2005 and adopted a declaration on *Harnessing Tourism for the Millennium Development Goals*. The declaration considers that tourism can make a substantially greater contribution than at present to poverty elimination, economic growth, sustainable development, environmental conservation, inter-cultural understanding and peace among nations.



Eco-tourism is a rapidly growing industry, with potential benefits for the environment, economy and local communities.

UNEP/UNWTO (2005) outline the environmental agenda of sustainable tourism policies (see Box 19.8 for a social agenda):

- To maintain and enhance the quality of landscapes and avoid degradation of the environment.
- To support the conservation of natural areas, habitats and wildlife, and minimise damage to them.
- To minimise the use of scarce and non-renewable resources in the development and operation of tourism facilities and services.
- To minimise the pollution of air, water and land and the generation of waste by tourism enterprises and visitors.

Box 19.8. **The social agenda of sustainable tourism**

In addition to its environmental agenda, sustainable tourism also aims to avoid the potentially adverse social consequences of tourism (sexual exploitation, exploitation of women and local staff, long working hours and low seasonal wages, etc.) by:

- Creating jobs, creating capacity and generating income for local staff.
- Bringing benefits for local communities.
- Respecting and supporting regional cultures and habits.
- Ensuring the informed participation of all stakeholders, etc.

Compliance with domestic and international regulations (*e.g.* International Labour Organization regulations) is an issue. Codes of ethics and corporate social sustainability have been developed to address these issues, but their dissemination needs to be supported and monitored.

The European Commission has engaged in similar work: the Tourism Sustainability Group (TSG) was established in 2004 to support sustainability in European tourism. Its conclusions and recommendations were published in February 2007 and will serve as a basis for communicating an agenda for the sustainability of European tourism (see Tourism Sustainability Group, 2007).

The multi-layered governance structure

The UNEP/UNWTO agenda requires structures and institutions. The trend towards decentralisation, as well as the treatment of broader issues related to development, employment or the environment, means that the relevant institutions have to adapt their governance. The industry structure should be taken into account when considering policies to make the most of the economic and social impact of tourism on business and the local community, while at the same time minimising the adverse effects on the environment.

The rapidly changing structure of tourism-related industries and the dual nature of the industry (comprising some large multinational enterprises but a majority of small and medium-sized enterprises, SMEs) have paved the way for new modes of co-operation and participation in supply chains and distribution networks. Co-operation between companies and destination governments is playing a growing part. Thus national, regional and local authorities can play an important role in enhancing the development and diffusion of tourism best practices and innovation, *e.g.* in the areas of environment, education, information and communication technologies, notably in small enterprises. An OECD report on trends in innovation and tourism policies (OECD, 2005b) illustrates the need to push the diffusion of innovative practices, and the part played by competition and co-operation to stimulate structural change and innovation in a fragmented industry.

Sustainability at the destination relies on the capacity of those involved to work together. Stakeholders include the state, local jurisdictions and communities, as well as the business sector, whether international tour operators or SMEs. Agenda 21 and local charters, although they are non-binding documents, can foster forward-thinking dialogues among these groups.

A consistent set of policy instruments

Measurement instruments

Indicators and data are used to measure the environmental impacts of tourism and to support outlooks and anticipations. They play a key part in designing, implementing and enforcing sustainable tourism policies at the destinations. UNWTO (2004) has published a guidebook on this subject.

However, a major constraint to sustainable tourism is the inadequate knowledge of the interactions between tourism and the environment. Considerable research is required to develop the knowledge base needed to underpin a sustainable tourism industry.

Regulatory instruments

Typical regulatory instruments in the industry are licensing for tourism enterprises (*e.g.* tour operators), land use planning and development control. These will remain important for governments' capacity to control operations by the business community. Land use planning can be used to take account of the value added by the environment to the activity and the environmental impact of the activity.

Economic instruments

Economic instruments can be used to internalise the measurable externalities of tourism. However, the sector does not make sufficient use of such incentives.[8] Relevant instruments could include:

- Reviewing capital investment programmes for tourism development and tourism-related infrastructure; in particular, public investment in infrastructure (such as transport, water supply and sanitation) can be used to make tourism more sustainable, if costs are shared according to the externalities of the public good.

- Price incentives, to ensure that the cost of an activity includes the positive/negative externalities. In some cases, admission fees would make it possible to reduce impacts on protected and/or sensitive areas and to generate revenues which could be redistributed to protect the environment.
- Fines for illegal activities in protected zones (*e.g.* illegal camping or picking flowers).
- Subsidies in the field of tourism development; they too often fail to take the environmental and social dimension into account, or do so insufficiently.

Voluntary agreements and eco-labelling schemes

Tourism firms, and especially the international tourism industry, have come to realise that the environment is an essential resource for the growth of the industry. As a result, major international investors have exerted considerable pressure on destination countries to make their tourism products greener in response to demand.

The International Tourism Partnership is an example of a voluntary initiative in the industry. It claims that the industry as a whole needs to design, develop, refurbish and operate a new generation of tourism destinations which have a minimal ecological footprint and which support and strengthen the communities in which they operate. Such initiatives, however, often fail to reach the less elaborate tour operations, accommodation and services which are most frequently used worldwide.

Dissemination of technologies (*e.g.* sun and wind generated energy, co-generation, wastewater and sewage treatment plants and buildings designed for recycling) can contribute to the development of sustainable tourism. Case studies from Australia and around the world demonstrate that initial upfront costs can often be recovered from savings in reduced energy, water, waste disposal costs and improved staff morale and productivity (see UNEP/UNWTO, 2005). Promoting the financial benefits of implementing sustainable tourism is therefore an integral part of sustainable tourism programmes.

Certification schemes (such as Eco Management and Audit Scheme, ISO 14001) and eco-labelling (based on initiatives such as Global Reporting Initiative, Corporate Social Responsibility, or on more industry-specific codes of conduct) can help consumers choose sustainable tourism options and provide incentives to tour operators to ensure sustainability. A contribution to this is the creation of an international task force on sustainable tourism development (UNDESA/UNEP/UNWTO), chaired by France, within the framework of the UN Marrakech process on sustainable production and consumption patterns.

Transport and sustainable tourism policies

Addressing the environmental impacts of tourism requires giving appropriate attention to travel for tourism purposes (including impacts at tourism destinations) and, where necessary, to the need for co-ordination between travel service providers, tourism providers, tour operator associations, hotel operators, municipalities and public and private transport enterprises (bus, rail, car-sharing, taxis, etc.). In Germany, sustainable transport systems are part of a policy on sustainable tourism at all levels (federal, Land, local).

Instruments to mitigate the impacts of tourism travel include internalising environmental costs of all transport modes, including aviation, and increasing the availability and convenience of more environmentally friendly transport modes (see also

Box 19.9. **The potential of ecotourism**

According to the Quebec Declaration on Ecotourism,* ecotourism "embraces the principles of sustainable tourism... and.... contributes actively to the conservation of natural and cultural heritage, includes local and indigenous communities in its planning, development and operation, contributing to their well-being, interprets the natural and cultural heritage of the destination to visitors, lends itself better to independent travellers, as well as to organized tours for small size groups".

In a joint publication, UNEP and WTO (UNEP/UNWTO, 2005) note that, as a development tool, ecotourism contributes to the three main goals of the Convention on Biological Diversity: conserve biological and cultural diversity, promote the sustainable use of biodiversity, and share the benefits equitably with local communities and indigenous people.

Ecotourism is a field for experiment and innovation. It is a growing niche market, but its elusive and multifaceted nature makes it difficult to measure its size and market share. An extremely rough estimate of the world's international ecotourism arrivals (notwithstanding the domestic visitors to natural areas) would be 7% of all tourism arrivals (Lindberg, quoted in UNEP/UNWTO, 2005), which is expected to amount to 70 million visitors in 2010.

Ecotourism raises a number of expectations. It generates risks as well, that the fragile ecosystems it is based on will be threatened by its very development, if not properly managed. This is one reason why ecotourism certification is a fundamental tool to ensure businesses are meeting ecotourism standards. Efforts in this direction have been led by Australia, which launched the first ecotourism specific certification programme in 1996.

* See *www.world-tourism.org/sustainable/IYE/quebec/anglais/declaration.html.*

Chapter 16 on Transport). Innovative projects have been identified, *e.g.* at the European Expert Conference on Environmentally Friendly Travelling in Europe, and recommendations have been drafted for future action by the transport sector, the tourism industry, the destinations, and policy-makers, to scale up these experiences (see European Expert Conference, 2006).

Sustainability certification schemes for the travel and tourism industry could make an important contribution towards improving tourism's environmental performance, but only if they also consider transport to, from and in the destination. Such schemes can include provision for travellers' participation in carbon-offset programmes, whereby revenues support projects in non-Kyoto countries – to avoid double-counting of emissions reductions – which reduce greenhouse gas emissions (*e.g.* through reforestation or installation of household biogas digesters).

UNWTO recommends *a)* providing incentives for tourists to use local public transport in tourism cities instead of personal cars; *b)* developing rail networks able to compete with air transport for short and medium distances; *c)* raising awareness about the consequences of travel; *d)* encouraging the further development of environmental voluntary initiatives and certification in the passenger transport sector (including transport to, at and from destinations); *e)* developing a set of indicators to monitor the impacts of tourism transport; and *f)* including transport in general tourism plans (see OECD, 2005a).

MINING

KEY MESSAGES

Small and medium-sized mining operators, particularly in developing countries, often lack the know-how and resources to apply sufficient health and environmental safeguards. As most of the additional production of mined materials to 2030 will originate in non-OECD countries, which often also have weak environmental policies, it is likely that the environmental impacts of mining may increase on average across countries.

Worldwide consumption of key mined commodities has been increasing steadily in recent years, and is expected to continue, due to strong demand in emerging economies. Production of mined metal commodities is expected to increase by about 250% to 2030.

There is potential for considerable environmental impact from most exploration, mining, and mineral processing, although significant progress has been achieved in developing ways of avoiding or reducing these impacts. Most of these impacts are local, but they also include climate change and loss of biodiversity.

The mineral and metal-intensity of OECD economies are continuing to decrease, reflecting a decoupling in the material intensity of the economy.

Policy options

- Implement policies to encourage more efficient use of minerals and metals, greater recycling and reuse of scrap metals, and substitution by other materials to further decrease the mineral and metal-intensity of economies.
- Address environmental impacts through national mining and environmental policies, as most impacts are local.
- Spread international best practices in the operation of mines more widely across the industry.
- Strengthen and support initiatives by the industry to develop and apply corporate governance approaches to the mining sector internationally.
- Work together to strengthen the capacity and institutional set-up for managing the environmental risks of rapidly expanding mining activity in developing countries. OECD countries can provide technical assistance and financial support where necessary.

Consequences of inaction

Without new policies, the environmental impacts of global mining activity per unit of output are likely to increase in the coming years. This is because the additional mining activity is expected to take place in countries with relatively lower environmental protection practices. To address this challenge, countries hosting the new mining activity might develop and implement best practice environmental and mining policies, and/or encourage use of corporate environmental best practices.

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Introduction

Mining operations worldwide are responsible for providing vast quantities of coal, metals and industrial materials for use in industrial processes, energy production and in consumer products. Without appropriate policies and precautions, mining operations can lead to negative impacts on the environment and on human health. Many of these impacts are local, while a few are global (such as climate change and loss of biodiversity).

While mining may have many potential environmental impacts (Box 19.10), it does not follow that all of these will occur – industry performance varies from responsible operations, concerned to minimise impacts as far as possible, to those that exhibit no concern at all.[9] With modern practices many of these effects can be avoided, or at least greatly reduced. Much of the damaging impact can be minimised through careful project planning, choice of appropriate mining technologies, and careful ongoing operation (UNEP, 1993).

Box 19.10. **Potential environmental impacts of mining**

Environmental impacts:

- Destruction of natural habitat at the mining site and at waste disposal sites
- Destruction of adjacent habitats as a result of emissions and discharges
- Destruction of adjacent habitats arising from influx of settlers
- Changes in river regime and ecology due to siltation and flow modification
- Alteration in watertables
- Change in landform
- Land degradation due to inadequate rehabilitation after closure
- Land instability
- Danger from failure of structures and dams
- Abandoned equipment, plant and buildings

Pollution impacts:

- Drainage from mining sites, including acid mine drainage and pumped mine water
- Sediment runoff from mining sites
- Pollution from mining operations in riverbeds
- Effluent from minerals processing operations
- Sewage effluent from the site
- Oil and fuel spills
- Soil contamination from treatment residues and spillage of chemicals
- Leaching of pollutants from tailings and disposal areas and contaminated soils
- Air emissions from minerals processing operations
- Dust emissions from sites close to living areas or habitats
- Release of methane from mines

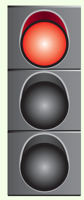
Source: UNEP (1993).

There are a number of phases in a mining operation which affect the environment in different ways (UNEP, 1993):

- **Exploration:** including surveys, field surveys, drilling and exploratory excavations. Some pollution can already be produced at this stage from land disturbance and from the wastes produced.
- **Project development:** includes development of the site by construction of roads and buildings, underground work on access tunnels, erection of treatment plants, overburden stripping and placing, preparation of disposal areas, construction of service

infrastructure such as power lines or generating plants, railways, water supplies and sewerage, laboratories and amenities.

- **Mine operation:** operations can be extremely varied, including underground mining, surface mining from open-pits or placer deposits, hydraulic mining in or near river beds. Newer processes may also include heap-leaching of tailing dumps, bio-leaching of surface heaps or deposits, and solution mining of buried deposits.
- **Beneficiation:** on-site processing may include comminution to reduce particle size, flotation using selected chemicals, gravity separation or magnetic, electrical or optical sorting and ore leaching with a variety of chemical solutions.
- **Associated transport and storage of ore and concentrates:** these may be a handling risk and can result in localised site contamination.
- **Mine closure:** this is an important and sometimes neglected aspect of mine operation. Rehabilitation is best done progressively rather than at the end of life of the mine, and accordingly needs to be a part of ongoing operation. While closure and rehabilitation are intended to mitigate environmental and social impacts, it is important that they do not create secondary effects such as excessive fertiliser use, spread of weeds, siltation and incompatible landscape features. Ongoing monitoring and maintenance may be important in some situations.



Small-scale mining operations, particularly in developing countries, often lack the know-how and resources to apply sufficient health and environmental safeguards.

The large multinational mining companies have been making significant progress in applying management methods and technologies that minimise the environmental impacts of mining. These corporations explore, mine, smelt, refine, and sell metals on world markets. About 30-40 companies are in this category. However, there are many actors in the industry that do not perform to these best practices, in particular some of the "junior" and "small-scale" miners.

In many instances, junior companies find new ore bodies and sell them on to larger companies. Intermediates offer growth potential through mergers between themselves or by being taken over by the largest corporations. Junior companies now spend more than 50% of the global exploration budget and their importance looks set to continue to grow. Artisanal and small-scale mining plays an important role in some minerals, especially gold and gemstones. These actors often lack know-how and resources to apply sufficient environmental and social safeguards.

Key trends and projections

Most of the increase in mining activity to 2030 is expected to take place in developing regions, due to the rapidly increasing demand in these economies and because of decreasing ore grades of marketable commodities in more mature mining regions (see Box 19.11). Already, China has become the world's largest miner or refiner of a number of metals (World Bank, 2006).

Global trends and the demand for mining products

There is enormous diversity in minerals, with mining commodities grouped into three broad categories: coal, metals and industrial minerals.[10] The production volumes and

Box 19.11. **Key uncertainties and assumptions**

The chapter relies on a number of assumptions. A key one is the continuation of current trends in the production and consumption of mined commodities. It is assumed that there are not going to be any major technological innovations leading to the massive substitution of mined commodities by other materials. This assumption is relatively robust, given the broad array of minerals that this chapter is considering. It is therefore assumed that the demand for mined minerals would grow in parallel with growth of GDP.

Another assumption is that the shift of minerals production away from the OECD towards less developed countries is going to result in a deterioration on average of the environmental performance of mine operators compared to today, as generally environmental standards in those countries tend to be lower for mining activities. This assumption could be proven wrong if large mining corporations in emerging markets embrace international corporate social responsibility standards more rapidly than expected.

dollar values of these minerals vary widely (see Table 19.6). It is estimated that the production of aggregates and construction materials exceeds 15 billion tonnes per year (2000). This is followed by coal mining, with 4.973 billion tonnes in 2005. Of the metalliferous ores, iron (used mainly in the form of steel) is the largest volume.

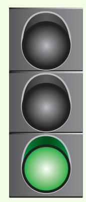
Table 19.6. **Production and prices of some major mineral commodities, 2000-2005**

Mineral commodity	2000 production[a] (thousand tonnes)	Price 2000[b] (USD/tonne)	2005 production[c] (thousand tonnes)	Price 2005 (USD/tonne)	Annual value (USD million)
Finished steel	762 612	300	1 012 000[d]	n.a.	n.a.
Coal	3 400 000	40	4 973 000[e]	99[f]	492 327
Primary aluminium	24 461	1 458	31 900	2 007.52[g]	64 039
Refined copper	14 676	1 813	15 000	3 681.72[h]	55 225
Gold	2 574	8 677 877	2 470	12 979 166.67[i]	32 058
Refined zinc	8 922	1 155	9 800	1 388.91[j]	13 611
Primary nickel	1 107	8 642	1 490	14 744[k]	21 968
Phosphate rock	141 589	40	147 000	27.76[l] (2004 price)	4 108
Molybdenum	543	5 732	185	71 672.28[m]	13 259
Platinum	0.162	16 920 304	0.239	21 145 833[n]	5 053
Primary lead	3 038	454	3 270	976[o]	3 191
Titanium minerals	6 580	222	5 200	n.a.	n.a.
Fluorspar	4 520	125	5 260	n.a.	n.a.

StatLink http://dx.doi.org/10.1787/257703582223

a) Source: CRU International (2001), *Precious Metals Market Outlook*, CRU International, London.
b) Source: CRU International (2001), *Precious Metals Market Outlook*, CRU International, London.
c) US Geological Survey, *Mineral Commodity Summaries*, January 2007 unless otherwise noted.
d) *www.unctad.org/infocomm/*.
e) *www.worldcoal.org/pages/content/index.asp?PageID=188*.
f) Teck Cominco Limited (2005), Annual Report, Vancouver, *www.teckcominco.com*.
g) *http://minerals.usgs.gov/minerals/pubs/commodity/aluminum/alumimyb05.pdf*.
h) Teck Cominco Limited (2005), Annual Report, Vancouver, *www.teckcominco.com*.
i) Teck Cominco Limited (2005), Annual Report, Vancouver, *www.teckcominco.com*.
j) Teck Cominco Limited (2005), Annual Report, Vancouver, *www.teckcominco.com*.
k) *www.outokumpu.com/29679.epibrw*.
l) *http://minerals.usgs.gov/minerals/pubs/commodity/phosphate_rock/phospmyb04.pdf*.
m) *www.outokumpu.com/29679.epibrw*.
n) *www.kitco.com/scripts/hist_charts/yearly_graphs.plx*.
o) *www.xstrata.com/annualreport/2005/review/page67*.

The prices of minerals and metals vary widely, affecting demand for their production and substitution between materials (Table 19.6). Platinum prices averaged nearly USD 26 million per tonne in 2005, while coal averaged USD 99 per tonne. While low value minerals (per unit of weight), such as sand, gravel and stone, are mainly marketed locally, high value minerals are sold in the global market.[11] Finished steel is the largest mineral commodity traded in sales value, followed by coal. These are the only minerals or metals for which the value of sales exceeded USD 100 billion in 2005. Copper, aluminium, zinc and gold were all in the USD 10-100 billion range, while fluorspar, at the low end, was well below USD 1 billion in value (Table 19.6). International metals prices have risen substantially in the last three years and are at all time highs in nominal terms, and in some cases match or exceed the highest real levels seen in the last 30 years. Prices have been driven up by strong global economic growth, and particularly strong metal demand in China that caught the industry by surprise (World Bank, 2006).



The mineral-intensity of OECD economies is continuing to improve.

In the last four decades, production of the six major industrial metals[12] grew on average by about three-and-a-half times. More recently growth has varied from 2.1% to 3.9% per annum. This growth is expected to continue in the future, despite consumption growing more slowly or levelling off in most OECD countries. This is because most of the increase in demand for metals in the future will come from rapidly industrialising developing countries, continuing recent trends (World Bank, 2006). For instance, over the 15 years since 1990, Chinese metals demand growth has averaged 10% a year and in the last five years it has accelerated to 17% a year. For a number of metals, China accounted for 70% or more of global demand growth in the last five years, and the country is now the world's single largest user of almost all metals (World Bank, 2006).

Several studies have suggested that the intensity of use of a mineral (the use of a mineral commodity divided by GDP) depends on the level of economic development as measured by GDP per capita, and that the pattern of intensity of use follows an inverse U-shape as economies develop (Malenbaum, 1975; Altenpohl, 1980; Tilton, 1990). As development takes place, countries focus on building infrastructure (such as rails, roads, and bridges, housing and other buildings and water supply and electricity transmission) and people buy more durable goods, which rapidly increases the demand for mineral commodities. As economies mature, all other things being equal, they move to a less materials-intensive phase, spending more on education and other services, which reduces the intensity of minerals use. Other factors that affect the intensity of use include government policies, shifts in demographics, materials substitution and new technologies.

Empirical research in resource economics has shown that metal use intensity (defined as metal consumption per unit of GDP) is also a function of per capita income. This function varies across countries and materials, but again often follows an inverse U-shaped curve. Metal requirements change in different phases of economic development – from agriculture-based economies (low intensity), to manufacturing-based economies (high intensity), to services-based economies (low intensity) (Tilton, 1986). They also change following substitution with other materials, or changes in metal requirements as a result of technological development, leading to more efficient raw materials use in the production of final goods (Bernardini and Galli, 1993). As a result of these trends, the inputs in metals required for the production of one unit of GDP have been constantly decreasing in the OECD, reflecting a decoupling in the material intensity of the economy.[13]

At the same time, many developing countries with large populations have recently been accelerating their economic growth, moving from agriculture to more manufacturing-based activities, which has led to a strong increase in the demand for metals. For instance, the annual per capita usage of refined copper was less than a kilo in India in 2003, while it was about 10 kg in Japan and other OECD countries. In India, copper-intensive applications such as the telecommunications industry are predicted to grow by a factor of 10 over 2000 levels (Mining Minerals and Sustainable Development, 2002). Another example is aluminium, of which Africans currently use only 0.7 kg per capita per year, compared with 22.3 kg in the US. Expectations are similar for many other mined commodities. Over the next 25 years, the World Bank expects that China's demand for metals could grow to two to four times current levels depending on the metal, implying annual increases in demand of about 2.5% to 4.8% (World Bank, 2006).

Hence, if current trends continue (Table 19.7), global extractive activity is expected to increase by a factor of 2.5 to 2030 under the *OECD Environmental Outlook* Baseline, roughly in line with projected growth in world GDP. Growth in trade of metals and minerals will be strongest in the BRIICS[14] countries, with imports increasing by a factor of six by 2050, while imports in the OECD are predicted to "only" double.[15]

Table 19.7. **Trends in the production of metals, 1995 to 2005**

	Production 1995[a] (thousand tonnes)	Production 2005[b] (thousand tonnes)	Average annual growth in production 1995-2005 (%)
Copper	10 000	15 000	4.14
Aluminium	19 400	31 900	5.10
Iron ore	1 000 000	1 540 000	4.41
Lead	2 710	3 270	1.90
Nickel	1 040	1 490	3.66
Silver	14.6	19.3	2.83
Tin	194	290	4.10
Zinc	7 120	9 800	3.25

StatLink http://dx.doi.org/10.1787/257774142575

a) US Geological Survey *Commodity Statistics and Information*, *http://minerals.usgs.gov/minerals/pubs/commodity/* 1997 statistics.
b) US Geological Survey *Commodity Statistics and Information* *http://minerals.usgs.gov/minerals/pubs/commodity/* 2007 statistics.

Source: US Geological Survey US Geological Survey *Commodity Statistics and Information*, *http://minerals.usgs.gov/minerals/pubs/commodity/*.

Global trends and the environment

As the *OECD Environmental Outlook* estimates that the demand for metals and other mined commodities will more than double over the next 25 years, significant additional pressures on the environment are to be expected from the sector, due to the simple expansion of the scale of mining operations that will be needed to meet steeply increasing world demand.

The location of future mine production will be determined by the economic geological resource base, but other factors, such as investors' capacity to access resources, government policies and so on will also play a part. As high grade ore deposits in the OECD are being depleted, and environmental regulation becomes more stringent, mineral deposits in developing and transition countries become more competitive (IIED, 2002).

While traditional mining centres in Australia and North America – which currently account for 30-40% of mine production and exploration – will continue to play an important role, other parts of the world are likely to gain in importance. Already, China has become one of the largest metals producers, with 17% of world production in 2005. Africa's share of production is also likely to expand significantly, as suggested by data on planned projects and exploration spending (World Bank, 2006).

Increases in the production of industrial minerals – such as sand, stone and gravel, which are too expensive to transport over long distances – are expected to occur mostly in rapidly developing economies, where most of the demand will be generated. Hence, the environmental impacts that are linked to mining activity will increasingly occur outside of OECD countries.[16]

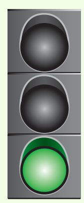
Some mineral commodities can be recycled. Recycling reduces the demand for primary metals and requires considerably less energy than producing primary metal (see also Chapter 11 on waste and material flows). For example, scrap aluminium requires about 5% and scrap steel about 25% of the energy required to produce primary metals. Already, about 50% of total steel use is being derived from recycled material and the situation is similar for other metals. Overall recovery of lead in the US stands at about 55%. But for most minerals, at least in the medium term, while the overall demand for mineral products continues to rise, the effect on primary production of increased recycling is likely to be minimal due to limited supply of the secondary materials, and hence the potential for avoiding mining related environmental impacts through improved recycling policies is also limited (IIED, 2002).

The environmental impacts of global mining activity are likely to be more than proportional to growth in production, unless countries hosting the additional mining activity develop and implement best practice environmental and mining policies and/or corporate environmental best practices spread to a much wider array of mining companies.

Policy implications

Most environmental impacts of mining are local and need to be addressed in the framework of national mining and environmental policies in the host countries. The rapid expansion of mining activity in developing countries constitutes an important challenge. Host governments will need to put in place policies to strengthen their capacity and institutional set-up to effectively manage the environmental risks associated with this development. OECD countries can support them by providing technical assistance and financial support where necessary.

It is also to be expected that an increasing share of operations will be overseen by companies headquartered in the countries generating much of the additional demand for mined commodities (*i.e.* China and India). Those involved in mining from these regions should be included in voluntary approaches, such as the OECD's Guidelines for Multinational Enterprises or the UN's Global Compact.[17] This would be a useful complement to efforts to improve national mining and environmental policies in host countries. This is particularly relevant when mining takes place in "weak governance zones", where national mining and environmental policies are non-existent or not properly implemented.



Some of the larger mining companies are working together towards better environmental practices in mining operations.

In addition to policies governing activities in the mining sector within countries, a number of large mining companies internationally are working to strengthen corporate governance in the sector, including environmental management (Box 19.12).

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Box 19.12. **Corporate governance in the mining sector**

Many large mining corporations are acknowledging the fact that successful company strategies need to integrate the concepts of sustainable development into core business practice. In 2000, nine of the largest mining companies decided to initiate a project to examine the role of the minerals sector in contributing to sustainable development and explore how that contribution could be increased. Through the World Business Council for Sustainable Development, they contracted with the International Institute for Environment and Development to undertake a two-year independent process of research and consultation: the Mining, Minerals and Sustainable Development Project (MMSD; IIED, 2002). The work was presented at the World Summit on Sustainable Development in Johannesburg in 2002. It lays out a vision of how the sector would look if it were to maximise its contribution to sustainable development. In 2001, the International Council for Mining and Metals (ICMM), representing 16 of the largest corporations and associations, was formed to take forward the agenda identified in this report.

Through 10 mandatory sustainable development principles (*www.icmm.com/icmm_principles.php*), ICMM members are committed to continual improvement of their performance. Members have been given numerous awards by government agencies and other independent bodies. ICMM has published guidance to assist members to improve their performance in several areas, including most recently, biodiversity. This guidance was prepared with the assistance of and through a dialogue with the World Conservation Union (IUCN).

The member companies of ICMM have committed themselves to implementing a sustainable development framework comprising 10 principles, reporting in accordance with the Global Reporting Initiative framework (including a Mining and Metals Sector Supplement, which was developed jointly by ICMM and the GRI), and independent assurance.

Notes

1. Value added equals gross production in the sector, minus the use of intermediate products.
2. The industrialised nations who have specific emission limits agreed under the Kyoto Protocol (see Chapter 7 on climate change).
3. Available on the European IPPC webpage, at *http://eippcb.jrc.es/pages/FActivities.htm*; the initial document was adopted by the European Commission in 2001.
4. Part of Chinese consumption is due to the boom in manufacturing and export of goods to the US and Europe.
5. This paragraph relies on documents presented by the FAO Advisory Committee on Paper and Wood Products, 47th Session, 6 June 2006.
6. See World Bank, 1998 and latest information at *www.ifc.org/ifcext/enviro.nsf/Content/EnvironmentalGuidelines#note*.
7. Currently exotic but potentially high-impact concepts such as space-tourism are not discussed here, although they may become relevant by 2030.
8. According to most chapters on tourism in the OECD country Environmental Performance Reviews.
9. *www.mineralresourcesforum.org/aboute.htm#Overview*.
10. Iron, copper, lead and zinc, gold and silver are metals. Potash, soda ash, borates, phosphate rock, limestone, and other crushed rock are grouped into industrial minerals. See: *www.eere.energy.gov/industry/mining/pdfs/overview.pdf*.
11. This section focuses on mined commodities that are traded internationally, due to data limitations on minerals that are mostly produced and used locally, such as construction materials.

12. Aluminum, copper, lead, nickel, tin and zinc.
13. There are questions, however, as to what extent the reduction in metals intensity is linked to shifts in production and environmental burden to less developed countries, from where manufactured products are exported to the OECD.
14. Brazil, Russia, India, Indonesia, China and South Africa.
15. It should be noted though that predicting future demand for mined commodities over such a long time frame is very difficult, since technological innovations and substitution of materials are impossible to predict (see Box 19.11 for more).
16. It should be noted that while mining generates environmental impacts, it also creates opportunities for economic growth, and therefore might have an overall positive effect on social welfare in these countries (see ICMM's Resource Endowment Initiative, *www.icmm.com*).
17. *www.oecd.org/daf/investment/guidelines*.

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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.

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.

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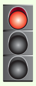
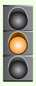
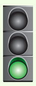
Traffic lights in the *OECD Environmental Outlook*

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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II. Impacts of Environmental Change

POLICY RESPONSES

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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