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ENVIRONMENTAL BENEFITS OF REMOVING TRADE RESTRICTIONS AND DISTORTIONS: THE ENERGY SECTOR

Item 6 of the work programme

Note by the Secretariat

1. This Note has been prepared in response to a request by the Committee on Trade and Environment (CTE) for an update of the energy section of document WT/CTE/W/67 on *The Environmental Benefits of Removing Trade Restrictions and Distortions*. It surveys the most recent literature on the subject, and is divided into the following sections: (1) overview of energy sector; (2) trade aspects;[1] and (3) the environmental benefits of removing trade restrictions and distortions.

I. OVERVIEW OF THE ENERGY SECTOR

A. PRIMARY SOURCES OF ENERGY AND RESERVES[2]

2. The main sources of primary energy are oil, coal and natural gas (which are together known as "fossil fuels"), as well as nuclear energy and renewables (such as solar and hydroelectric power). Electricity, while also a fuel, is itself generated using primary energy.

3. According to the projections of the International Energy Agency (IEA) for world primary energy demand between 1997 and 2020, demand will rise at an average rate of 2% per annum over the projection period, and increase by a total 57% in 2020.[3] Despite expected demand growth, the World Energy Council (WEC) confirms that energy resources are plentiful and not expected to be a limiting factor in global economic growth.[4]

4. Proven oil reserves are concentrated in the Middle East, which is home to 64% of world reserves, followed by South America (8.3%), North America (8%), Africa (6.9%), Europe (6.6%), Asia (5.9%), and Oceania (0.3%). Coal, on the other hand, is much more concentrated, with 75% of all proven reserves falling in only six countries. However, these countries are widely spread geographically. They are: the United States (25%), Russia (16%), China (12%), Australia (9%), India (8%) and Germany (7%). Proven natural gas reserves exist in Europe (36.9%), the Middle East (34.1%), Asia (10.9%), Africa (6.8%), North America (6.2%), South America (4%), and Oceania (1.1%).

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[1] Energy services are not dealt with in this Note. On where energy services stand vis-à-vis the WTO's General Agreement on Trade in Services (GATS), see WTO document S/C/W/52 on *Energy Services*, dated 9 September 1998.

[2] Proven reserves constitute only a small sub-set of potential reserves.

[3] IEA. World Energy Outlook 2000. Paris, 2000, p. 47. These projections are themselves based on (1) economic growth, (2) populations growth, and (3) energy price forecasts. Forecast is a global economic growth rate of more than 3% per annum, a slowdown in the rate of population growth, and flatness of fossil fuel prices throughout the first decade of the projection period, with oil and gas prices increasing after 2010 in response to supply-side pressures. The projections also take account of a range of major new policy initiatives adopted in OECD countries, particularly under the Kyoto Protocol, enacted or announced up to mid-2000. For further information on these forecasts, consult pages 33-41 of the Outlook.

[4] WEC. Energy for Tomorrow's World – Acting Now. London, 2000, p.1.

5. With respect to nuclear energy, there are a total of 435 commercial nuclear units in operation in 31 countries with an installed capacity of 352 gegawatt (GW) (or 11% of world power generating capacity). The United States has the largest share of global installed nuclear capacity (29% of world total), followed by France (18%) and Japan (12%). In Lithuania, 83% of all electricity is produced from nuclear energy, and in France 77%.

6. Hydroelectric power is the most widely used source of renewable commercial energy worldwide. A total of 158 countries generate hydroelectric power: 42 countries in Africa, followed by 38 in Europe, 31 in Asia, 18 in North and Central America, 14 in South America, nine in Oceania and six in the Middle East. A total of 700 GW of hydro capacity are said to exist worldwide (about half of this capacity is in Europe and North America), and generate approximately 19% of the world's commercial energy production. Approximately ten countries obtain all their commercial electricity from hydro power, and include Norway, several African countries, Bhutan and Paraguay.[5]

B. TRENDS IN PRIMARY ENERGY DEMAND

7. According to the projections of the IEA, the main sources of primary energy in the year 2020 will be oil (40%), followed by natural gas (26%), coal (24%), nuclear power (5%) and renewables. Relative to 1997, that will mean that oil will maintain its same 1997 share of the primary energy mix, while the shares of gas and non-hydro renewables will rise. The sources of energy whose shares is expected to decline are coal, nuclear and hydroelectric power.

8. Between 1997 and 2020, the IEA forecasts that demand for **oil** will grow at annual rate of 1.9%, allowing it to remain the dominant fuel in the primary energy mix (representing 40% of total energy demand). In member countries of the Organization for Economic Cooperation and Development (OECD), the transportation sector will account for all oil-demand growth. In other sectors, oil will lose market share to other fuels, in particular gas. In non-OECD countries, while growth in oil demand is due mainly to transportation, the household, industry, and power generation sectors will contribute as well. China and India will account for one-third of all incremental oil demand in non-OECD countries.

9. **Natural gas** will be the second fastest-growing energy source, after non-hydro renewables, in the primary energy mix. Gas demand will rise at 2.7% per annum between 1997 and 2020, and its share of world primary energy demand will increase from 22 to 26% over that period. Most of this increase will come at the expense of nuclear energy and coal. Technological advances in combined-cycle gas turbines (CCGTs) will shift the economics of power generation in favour of gas. In fact, demand for gas will grow primarily in order to meet the needs of power generation. Its relative environmental cleanliness as a fuel will make it attractive.

10. Demand for **coal** will rise by only 1.7% per annum over the projection period, with its share of the primary energy mix declining from 26% to 24% by 2020. Most of the rise in demand in OECD countries will come from power generation. However, the switch from coal to gas in industrial applications and heating will continue. Contributing to two thirds of the increase in world coal demand, are China and India, which have abundant coal reserves, and strong electricity demand-growth. In general, coal use will increasingly be confined to power generation, which will account for 85% of the increase in coal demand between 1997 and 2020. Industrial demand will increase only slightly, being driven mainly by the iron and steel sectors in developing countries. Demand for coal in residential/commercial sectors will fall slightly.

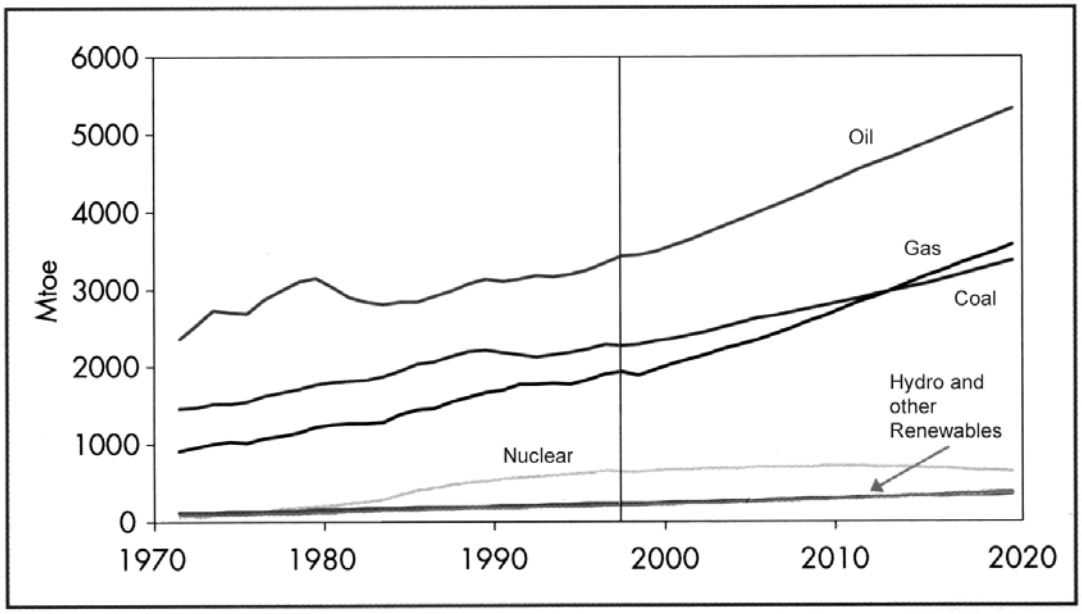
11. **Nuclear power**, whose share in total primary energy demand is around 7% in 1997, will peak around 2010, but then decline. Its share will fall to 5% in 2020. It is only in a few countries that demand for nuclear power will increase, mostly in Asia. In OECD countries the expected retirement

[5] WEC. Survey of Energy Resources 1998. London, 1998, chapters 1,2,5,6,7.

of a number of reactors and the safety concerns associated with nuclear power (particularly after the Chernobyl accident of 1986) will result in a decline.

12. **Hydropower**, whose share of the primary energy mix amounts to 3% in 1997, will decline to 2% by 2020. While it is the only renewable electricity source that has been exploited on a large-scale until today, its share will decline because most of the best sites in OECD countries have already been exploited and environmental/social concerns (such as the displacement of people for new dam construction) will limit its expansion. In 1960, hydro accounted for 82% of electricity generation in Italy, 51% in Japan, and 18% in the United States. In 1997, these shares dropped to 16%, 9% and 8% respectively. **Other renewables**, such as geothermal, solar, wind, tidal, wave energy, combustible renewables ("biomass"), and waste, are expected to be the fastest growing primary energy source, with an annual growth rate averaging 2.8% over the projection period. Power generation in OECD countries will account for most of the increase, particularly due to environmental concerns.[6] Figure 1 demonstrates these trends.

Figure 1: World Primary Energy Demand by Fuel, 1971-2020



Source: IEA (Mtoe stands for million tons of oil equivalent)

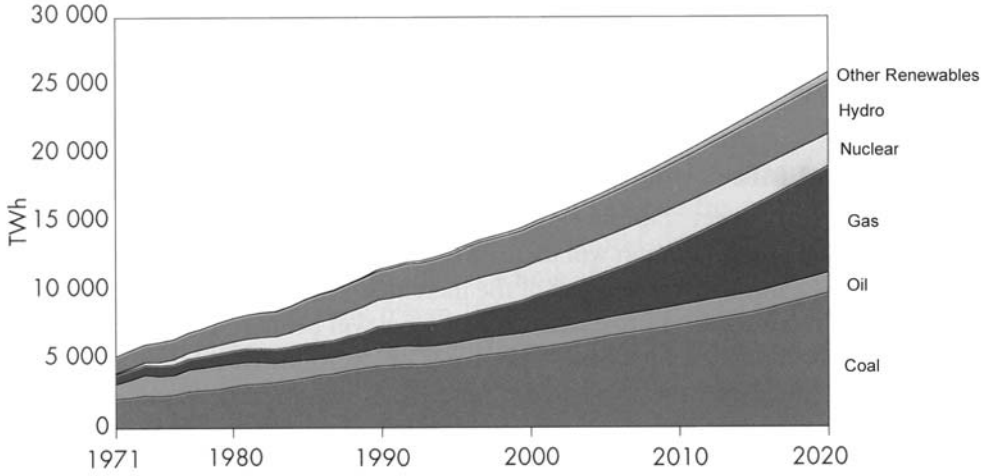
13. The power sector's share of primary energy demand will rise from 36% in 1997 to 38% in 2020, with world electricity generation increasing by an average of 2.7% per annum. Coal will maintain its dominant position as the world's largest single source of electricity generation. While coal's share will decline in the OECD area, it will rise in developing countries. It accounts for three quarters of total electricity generation in China and for approximately 70% in India. Natural gas-fired power generation will grow to more than three and a half times its current level, with OECD countries accounting for nearly half of the increase. The share of oil in power generation will fall slightly, while that of nuclear power will drop dramatically. World hydro-electricity and other renewable sources of energy will continue to grow (see Figure 2).

14. The IEA projects that nearly 3000 GW of new generating capacity will be installed around the world from now to 2020. More than half of that capacity will be in developing countries, particularly in Asia.[7] More competitive markets will govern the future development of the power-generation

[6] IEA. World Energy Outlook 2000. Paris, 2000, p. 48-9.
[7] Ibid, p. 24.

sector. In the OECD and some developing countries, electricity markets are undergoing rapid reform. This is likely to promote economic efficiency and ensure that prices reflect the costs of supply.

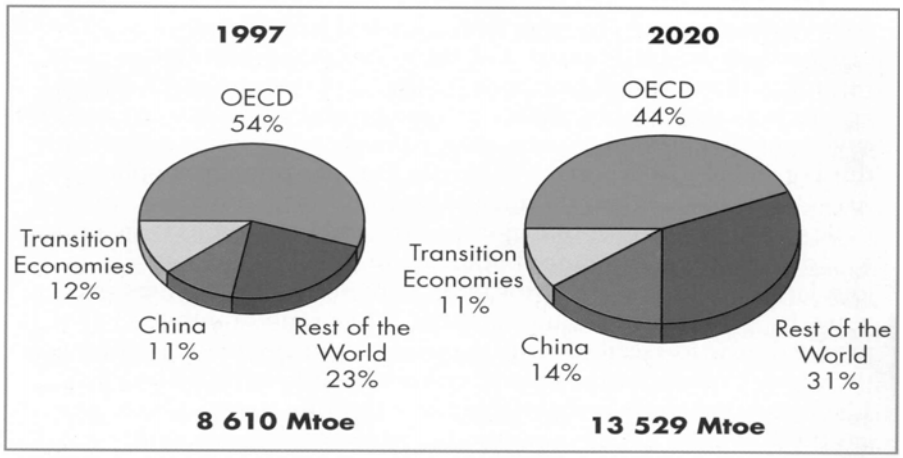
Figure 2: World Electricity Generation, 1971-2020



Source: IEA (TWh stands for terawatt-hour)

15. Most of the projected increase in world primary energy demand will come from developing countries. They will account for 68% of the increase between 1997 and 2020, while OECD countries will account for only 23%. The share of OECD countries will therefore fall from 54 to 44% by 2020, while that of developing countries will rise from 34 to 45% (see Figure 3). The rise in developing country demand can be explained by a number of factors, such as rapid economic growth and industrial expansion, and population growth and urbanization.[8]

Figure 3: World Primary Energy Demand by Region, 1997 and 2000



Source: IEA (Mtoe stands for million tons of oil equivalent)

16. The Commission on Sustainable Development (CSD) cautions that the increase in primary energy will not result in more equitable access to energy between industrialized and developing countries. It indicates that in Africa, per capita energy use barely increased in the 1990s and remains at less than 10% of average per capita use in North America. In the majority of Asian countries, the

[8] Ibid, p. 51.

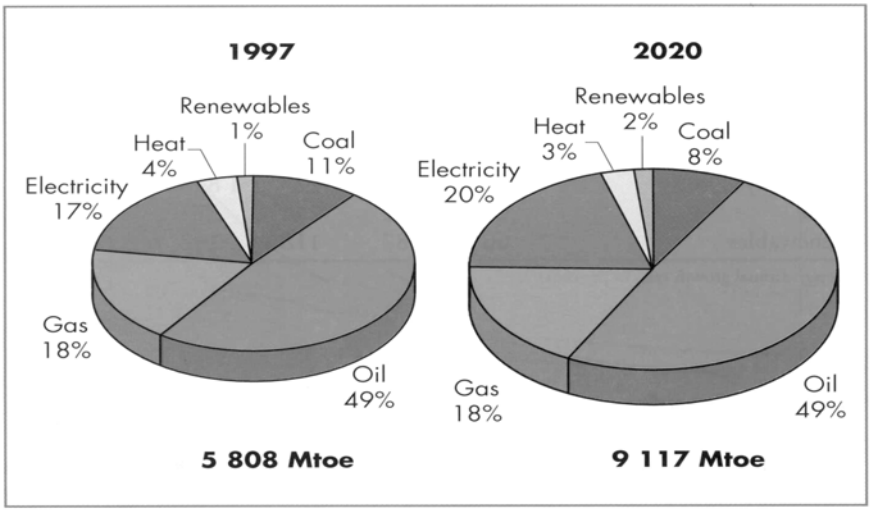
same is true. It adds that Latin America saw little improvement in access to energy, while China and Western Asia made above average progress in providing access to modern energy services.[9]

C. TRENDS IN FINAL ENERGY DEMAND

17. In terms of "final" energy demand (which is demand for primary energy in addition to electricity and heat), in 1997 oil was the dominant source, followed by gas, *electricity*, coal, heat and renewables. According to IEA projections for 2020, while the share of oil and natural gas will remain the same, gas will be overtaken by electricity (whose share is expected to rise from 17% to 20%). The shares of coal and heat will decline, while renewables will increasingly be used.

18. Electricity will grow faster than any other fuel (at 2.8% per annum). It will rise in both OECD and non-OECD countries (see Figure 4). In OECD countries, which currently use 63% of the world's electricity, projected demand will grow about half as fast as it did in the 1971-97 period, mainly due to the saturation of end-use markets. Electricity demand will grow much faster in developing countries than in the OECD area. [10] With respect to access to electricity, the CSD states that regional energy use is extremely inequitable when viewed in terms of per capita electricity use. It points out that there is a difference of two orders of magnitude between least developed countries (83 kilowatt hours per capita) and the OECD average (8,053 kilowatt hours per capita).[11]

Figure 4: Fuel Shares in World Total Final Consumption, 1997 and 2000



Source: IEA (Mtoe stands for million tons of oil equivalent)

D. TRENDS IN THE END-USE OF ENERGY

19. The IEA classifies the uses to which energy is put into four different categories: (1) electrical services (total consumption of electricity by the final consumer, excluding heating services); (2) mobility (non-electricity fuels used in all forms of transport); (3) stationary services (mainly fossil

[9] CSD, acting as the preparatory committee for the World Summit on Sustainable Development (E/CN.17/2001/PC/20). "Energy and Transport; Report of the Secretary-General." Organizational Session, 30 April – 2 May 2001, p.2.

[10] IEA. World Energy Outlook 2000. Paris, 2000, p. 62.

[11] CSD, acting as the preparatory committee for the World Summit on Sustainable Development (E/CN.17/2001/PC/20). "Energy and Transport; Report of the Secretary-General." Organizational Session, 30 April – 2 May 2001, p.2.

fuels consumed for heating in homes, commercial establishments and industrial processes); and (4) fuels used in power generation. In general, energy use for all four purposes rises, with power generation being the main use in 2020, followed by fossil fuel use in stationary services, mobility and the consumption of electrical services.[12]

20. Most of the expected incremental demand for oil for the next two decades will come from the transport sector. As previously stated, in both OECD and non-OECD countries, transportation will account for most of the demand for oil.[13] According to the United Nations Environment Program (UNEP), the single most important change with respect to transport in the 20th century has been the dramatic rise in personal mobility in developed countries, brought on by cheap oil, affordable motor cars, and lifestyles dependent on commuting, shopping out-of-town, dispersed families and leisure activities. Since World War II, the number of cars on the road has risen from 40 to approximately 680 million. If current rates continue, there will be more than one billion vehicles on the road by 2025. Air transport is also rising rapidly.[14]

E. ENERGY INTENSITY AND EFFICIENCY

21. Two useful concepts in energy policy are those of energy intensity and energy efficiency. Energy efficiency is a technical concept which refers to the ratio between energy output (such as light, heat and mobility) and input (fuels). Energy intensity is a statistical concept defined as energy consumption per unit of output. Energy intensity depends on a number of factors, which include: stage of economic development, energy efficiency, energy prices, climate, geography, culture and lifestyles.[15] According to the IEA, world energy intensity is expected to decline by 1.1% per annum, between 1997 and 2020. There are, however, substantial differences between regions. In OECD countries, intensity falls more slowly compared with past trends, whereas in non-OECD countries intensity improvements will accelerate relative to past trends.[16] The OECD explains that the energy intensity of its economy has been declining since the oil price rises of 1973/74 and 1979. Although the rate of decrease of energy intensity slowed after 1985, when oil prices went down to their pre-shock levels, energy use did not rise very sharply since certain energy efficiency improvements had been "locked-in."[17]

II. TRADE ASPECTS

A. TRENDS IN ENERGY TRADE

22. As fossil fuels dominate world energy supply and final consumption, they represent the vast majority of internationally traded energy (see Annex I for Net Energy Imports by Country). Oil is the most heavily traded of the three fossil fuels. Crude oil represents three-fourths of internationally traded energy, while petroleum products represent four-fifths of international trade in energy products. Whereas coal releases the highest amount of environmentally harmful emissions per unit of heat, oil is responsible for the highest amount of CO2 emissions woldwide due to its dominant share in consumption.

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[12] IEA. World Energy Outlook 2000. Paris, 2000, p. 54-55. For more information on this concept also see IEA's World Energy Outlook of 1998.

[13] Ibid. p. 72.

[14] UNEP. Global Environment Outlook 2000. London, 1999, p. 13.

[15] According to the IEA: "A more energy-intensive country is not necessarily less energy-efficient. The United States and Japan, for instance, have comparable technological knowledge and technical energy efficiency. Due to differences in energy prices, climate, geography and lifestyles, however, the energy intensity (energy consumption per unit of output) of Japan is roughly half of that of the US."

[16] IEA. World Energy Outlook 2000. Paris, 2000, p. 56-7.

[17] OECD. OECD Environmental Outlook. Paris, 2001, p.149.

23. The IEA projects a substantial increase in energy trade over the next 20 years. The expansion will encompass all fossil fuels and electricity, but to different degrees. A particularly sharp increase will take place in trade in oil and gas. The cost and facility with which energy is transported are important determinants of international trade. Gas and electricity, which are largely grid-bound, will require enormous infrastructure outlays before trade can take place. However, the liberalization of energy markets, which will allow consumers to shop for the cheapest source of electricity, is likely to stimulate both demand and cross-border trade.[18]

24. The OECD states that whereas energy self-sufficiency reached a peak of 78% in the 1980s, it has been gradually declining ever since. Today, the energy self-sufficiency of different fuels varies substantially. While OECD countries are self-sufficient in the use of nuclear and renewable energy, and import only 3% of all the coal they use, over 15% of gas and 50% of oil used are imported from non-OECD countries.[19]

25. According to the IEA, net inter-regional **oil** trade is projected to increase from its current level of 28 million barrels per day (mb/day) in 1997 to over 60 mb/day by 2020. Due to declining oil production in OECD countries, OECD import dependence is likely to jump from around 58% in 1996 to 70% in 2020. Outside the OECD, Asia will become increasingly dependent on imports. While China only became a net importer of oil in 1993, it is projected to import more than three-quarters of its needs by 2020. All other regions will remain net exporters. Demand growth is likely to boost the market power of the Organization of the Petroleum Exporting Countries (OPEC), particularly that of its Middle East members. Their production will mount from 26 to 41% over the projection period. Table 1 demonstrates the oil import dependence of OECD and certain non-OECD countries and regions.

Table 1: Oil Import Dependence (per cent)

	1997	2010	2020
OECD	**54.3**	**63.3**	**70.0**
North America	44.6	52.4	58.0
Europe	52.5	67.2	79.0
Pacific	88.8	91.5	92.4
China	22.3	61.0	76.9
India	57.4	85.2	91.6
Rest of South Asia	87.2	95.1	96.1
East Asia	53.7	70.5	80.7

Source: IEA

26. IEA holds that because of how costly the transportation of **gas** is, a truly global market for it cannot be said to have emerged. It is mostly transported in pipelines or in the form of liquified natural gas (LNG). LNG transportation is only economic, however, over long distances because of the high costs of liquefaction and regasification, and of carriers. International trade is likely to increasingly rely on pipelines (especially where they can pass over land), which is the most economic way to transport large volumes of gas. Although the world gas resource base is immense and reserves are abundant, gas is not always located near centers of demand, and long-distance transportation will therefore have to take place.

[18] IEA. World Energy Outlook 2000. Paris, 2000, p. 50.
[19] OECD. OECD Environmental Outlook. Paris, 2001, p.149.

27. Trade in gas will expand rapidly, mostly in Europe and the Asia-Pacific region. In Europe, rising demand is likely to lead to further increases in gas imports and intra-European cross-border trade. European demand will be driven by the increased use of CCGTs, new technologies, liberalization in the gas and power markets, and environmental pressure. Russia, which provides more than one third of total world gas exports, will remain Europe's primary supplier. China, Japan, Korea, and possibly India, are likely to become major importers of gas. In North America, a rapid rise in imports is not foreseen. Cross-border trade in Latin America, on the other hand, is likely to increase significantly. Table 2 demonstrates the gas import dependence of OECD and non-OECD countries.

Table 2: Gas Import Dependence (per cent)

	1997	**2020**
OECD	**15**	**32**
North America	0	6
Europe	31	62
Pacific	59	38
Non-OECD	**-16**	**-25**
Transition Economies	-17	-36
Asia	-18	10
Latin America	6	4
Africa & Middle East	-28	-74

Source: IEA (negative figures indicate net exports)

28. Today, most **coal** production is for local use and coal trade accounts for only 13% of total world demand. According to the IEA, world trade in coal is unlikely to expand much, mainly because overall demand for coal will rise relatively slowly. There is some chance, however, that trade patterns may change. Projected imports by the Asia-Pacific region will continue to grow, with Japan remaining the world's largest importer. Imports of most European countries will decline due to a greater efficiency in the use of coal (particularly in steel production), and environmental concerns. There is a possibility however, that imports will displace subsidized domestic coal in Germany and Spain.[20]

29. Cross-border and inter-regional **electricity** trade in Europe is likely to increase substantially over the IEA projection period, although from a relatively low base. Helped by the relatively short distances between countries, liberalization of the European electricity market, and European Union (EU)-led initiatives to promote the integration of grids, electricity trade is likely to expand. It will probably do so in most other regions as well, particularly Latin America, but will remain small relative to total production.[21]

B. TRADE RESTRICTIONS AND DISTORTIONS

1. Introduction

30. Historically, governments have intervened in the energy sector through a variety of direct and indirect financial and administrative instruments. Regulations, taxes, charges, budgetary transfers, tariffs and quotas have all formed part of the instruments used. Generally, intervention has been

[20] One of the main questions, however, in the coal subsidy reform debate is whether the closing down of German coal mines will lead to an increase in total coal consumption or a decline. While imports will increase, will they displace all domestic production is the question.

[21] IEA. World Energy Outlook 2000. Paris, 2000, p. 50-1 and 71-108.

justified on the basis of the following policy goals: (1) achievement of energy security through maintenance of certain levels of domestic energy production and diversification of sources, (2) maintenance of certain levels of employment, furtherance of regional development, and guaranteeing minimum access to energy by different income groups (i.e. social concerns), (3) avoidance of the inefficiencies associated with leaving the so-called "natural monopolies" of energy production and distribution to unregulated ownership by private entities,[22] (4) generation of revenue,[23] and (5) environmental protection, which is a more recent concern.[24]

31. According to the United Nations Conference on Trade and Development (UNCTAD), governments have generally subordinated trade policy in this sector to energy security concerns.[25] Tariffs and other instruments of trade policy have been primarily geared towards energy security. UNCTAD states that: "Energy-importing and energy-exporting countries have both found reasons in the past to isolate this sector from the normal set of [trade] rules, and to retain the sovereign ability to impose special restrictions for political, strategic or diplomatic reasons. It may even be deceptive to define security considerations as an influence on trade calculations, when one could easily suggest the reverse order." [26] While there are numerous trade restrictions and distortions in the energy sector, it is energy subsidies (defined in some studies to include differential energy taxation and several other forms of governmental intervention) that are focused on in the literature on environmentally harmful trade measures.

2. Subsidies[27] and Other Governmental Intervention

32. Subsidies are defined differently in different studies, and numerous methodologies for their measurement exist (such as producer/consumer subsidy equivalents (PSE/CSE) and "price gap" methodologies). The narrowest, and perhaps most common, definition of a subsidy used in the literature is a "direct payment by a government to a producer or consumer." Broader definitions have been employed, however, by certain regional and international organizations (see Annex II). The IEA, for instance, uses the following definition: "An energy subsidy is any government action that concerns primarily the energy sector and that lowers the cost of energy production, raises the price received by energy producers or lowers the price paid by energy consumers." Its definition is broad enough to capture measures that range from grants and credit instruments for energy production and consumption as well as public funding for research and development (R&D), to differential taxation to encourage or discourage the production and use of certain fuels.[28] UNEP/IEA state that since governmental intervention in many different sectors (such as in transportation) can have a subsidizing effect on energy, it is particularly important to use a broad definition of a subsidy.[29]

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[22] As the production and network-based distribution of electricity and gas involve large fixed costs and the expectation of increasing returns to scale, some argue that these are natural monopolies that require government intervention.

[23] It has been argued that because consumers change their behaviour only little in response to changes in energy prices, taxing energy to raise revenue generates relatively fewer distortions than taxing goods with higher demand elasticities.

[24] IEA. World Energy Outlook. Looking at Energy Subsidies: Getting the Prices Right. Paris, 1999, p.43-44.

[25] Although some argue that the objectives of greater energy "security" is often used as a smokescreen to conceal the real motive of protecting inefficient or infant domestic industries.

[26] UNCTAD. Trade Agreements, Petroleum and Energy Policies. Geneva, 2000, p. 105.

[27] For environmental, including energy-related, subsidies notified to the WTO in the year 2000 see pages 28-49 of document WT/CTE/W/195 entitled *Environmental Database for 2000*.

[28] IEA. World Energy Outlook. Looking at Energy Subsidies: Getting the Prices Right. Paris, 1999, p.43 and 47.

[29] UNEP/IEA. "Energy Subsidy Reform and Sustainable Development: Challenges for Policy Makers." Synthesis Report. Submission to the 9th Session of the United Nations Commission on Sustainable Development, April 2001, p. 5.

33. While subsidies in the energy sector have been employed by both OECD and non-OECD countries, UNEP/IEA explain that they have been used for completely different purposes. In OECD countries, producer subsidies are the most widely used and are designed to encourage energy production, and protect domestic industries and employment (they tend to hold energy prices above world level). It was following the oil crises of 1973/74 and of 1979/80 that much support was given to the energy sector, in particular to alternatives to oil, as a means of reducing demand for oil imports. Support was mainly given to coal and nuclear power with the objective of achieving greater energy self-sufficiency and keeping indigenous sources of energy alive.[30] In non-OECD countries and transition economies, consumer subsidies prevail, and are intended to facilitate the access of consumers and the poor to energy (they tend to hold energy prices below world level).[31]

34. Estimates of the scale of subsidies provided to the energy sector at the global level vary. In fact, only a few studies have been conducted on this due to serious data deficiencies. One of the most widely quoted estimates (although fairly dated) comes from the pioneer work of Larhsen and Shah in 1992. It put global fossil fuel consumption subsidies at US$230 billion per year. The former Soviet Union accounted for two thirds of the total (around US$153 billion), while non-OECD countries for most of the rest (around US$76 billion).[32] This indicates that consumption subsidies in OECD countries are relatively small. A recent study conducted by IEA confirms that pervasive underpricing of energy resources occurs in eight of the largest energy consuming countries outside the OECD: China, India, Indonesia, Iran, Kazakhstan, Russia, South Africa and Venezuela. End-use prices in these countries are, on average, approximately 20% below their opportunity-cost and market-based reference levels, despite the substantial progress that has been made in energy sector reform.[33] OECD energy production subsidies are estimated to be around US$82 billion per annum.[34]

35. In an OECD study on the world's 27 largest fossil fuel producing and consuming nations, an attempt at quantifying the distortions created by governmental intervention in the energy sector is made. Evidence of widespread price distortion is found, totalling nearly US$60 billion per year. The study finds that while large energy exporters tend to subsidize domestic fuel consumption, large energy importers tend to keep domestic fuel prices artificially high. Moreover, trade distortions associated with coal and natural gas are found to exceed those related to oil, and coal to receive substantial subsidies.[35]

OECD Countries

36. According to the IEA, most OECD countries have reduced or eliminated direct energy subsidies and lifted price controls over the past two decades in an attempt to move towards more market-oriented policies. Remaining subsidies are mainly geared towards the protection of domestic industries and employment. This is particularly the case with subsidies for coal mining in Germany, Japan and Spain; for peat in Finland and Ireland, and biofuels in France. Some subsidies are also used to encourage environmentally friendly sources of energy and technologies.[36]

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[30] Support to the nuclear energy has also been given for various other reasons. For example, it was seen as cleaner than alternatives, at least in terms of noxious air pollutants, and it often formed part of a broader strategy to develop domestic capabilities in various other nuclear technologies (e.g. weapons).

[31] Ibid; and OECD. Reforming Energy and Transport Subsidies. Paris, 1997, p. 25.

[32] Ibid (UNEP/IEA), p. 7.

[33] IEA. World Energy Outlook. Looking at Energy Subsidies: Getting the Prices Right. Paris, 1999, p.9.

[34] UNEP. Global Environment Outlook 2000. London, 1999, p. 208.

[35] OECD Council at Ministerial Level (C/MIN(99)14). "Report on Trade and Environment." May 1999, p.12.

[36] IEA. World Energy Outlook. Looking at Energy Subsidies: Getting the Prices Right. Paris, 1999, p.46-7.

37. In the OECD area, subsidies take the form of: (1) grants and credit instruments, such as soft loans and interest-rate subsidies, applied as government transfers to producers or consumers of energy, as well as grants for energy services or appliances to encourage energy efficient technologies; (2) regulations requiring or encouraging consumers to purchase a given fuel from a particular source, usually domestic, sometimes at a regulated price (e.g. Denmark requires utilities to buy minimum amounts of straw or wood in power stations); (3) differential taxation to encourage or discourage the production and use of certain fuels (increasingly energy taxes are being restructured to penalize the most carbon-intensive fuels); (4) public funding for R&D. Generally, R&D is directed towards the sources of energy produced in the country, or towards more environmentally friendly technology; and (5) price controls to promote supply and consumption of particular energy sources (although few OECD countries use the latter however for social, economic or environmental objectives, preferring other instruments instead).[37] Implicit support to energy producers in the OECD is also given in terms of government-brokered agreements with electricity generators to use specific domestic fuels. These have generally favoured coal, creating a disincentive to use other fuels.[38]

38. According to the United States Department of Energy (DOE), federal energy subsidies take three principal forms: (1) direct payments to producers or consumers, (2) tax expenditures, which are provisions in the US tax code that reduce the tax liability of firms or individuals who take specified actions that affect energy production, consumption or conservation in ways that are deemed to be in the public interest, and (3) research and development expenditures. Federal subsidies for primary energy were estimated to be at US$4 billion in 1999, down by $1 billion from 1992. Of the primary sources of energy, natural gas benefitted the most, followed by oil and coal. Federal R&D appropriations related to energy totalled US$1.6 billion in 1999, down from $2 billion in 1992, mainly due to declines in spending on coal and nuclear power research (although they continue to be the largest recipients of funds).[39]

39. The OECD states that support to energy probably constitutes the second most significant area of support in OECD countries after agriculture, although available indicators show declines in its overall level.[40] Direct support measures to different fuel types and R&D support have been biased towards coal and nuclear power. It has been estimated that support to nuclear and fossil fuel power constituted a total of 75% of direct support to energy in the EU over the period 1990-95, while support to conservation, renewables and electricity accounted for the remaining 25%.[41]

40. Coal subsidies have been particularly well studied because of their environmental impact. In 1999 Member countries of the IEA[42] produced 1,121 millions tons of coal equivalent (tce) of hard coal. Of this 59 million tce, or 5.3%, received state aid as measured by the PSE. Subsidized production took place in France, Germany, Japan, Spain and Turkey (see Table 3 below).[43]

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[37] Ibid.

[38] OECD. Improving the Environment through Reducing Subsidies. Part II, Analysis and Overview of Studies. Paris, 1998, p. 23.

[39] United States DOE, Energy Information Administration. "Federal Financial Interventions and Subsidies in Energy Markets 1999: Primary Energy." Washington D.C., September 1999, p. vii-x.

[40] OECD. Improving the Environment through Reducing Subsidies. Part I, Summary and Policy Conclusions. Paris, 1998, p.11.

[41] OECD. Improving the Environment through Reducing Subsidies. Part II, Analysis and Overview of Studies. Paris, 1998, p. 21.

[42] These include: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

[43] IEA. Energy Policies of IEA Countries, 2000 Review. Paris, 2000, p.55.

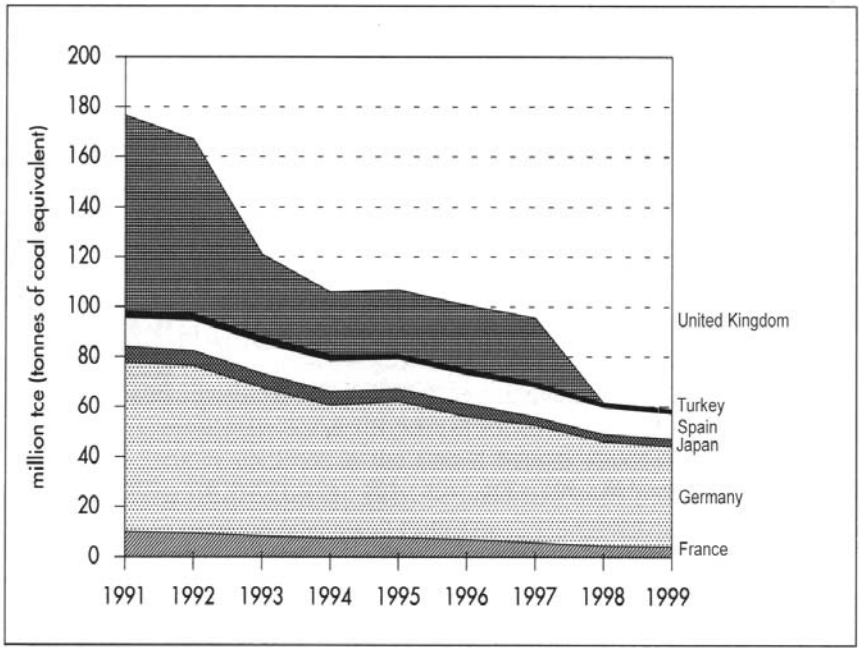
Table 3: Subsidized Hard Coal Production in the IEA, 1999

	Million "tce"	Percentage of Total
France	4.1	0.4
Germany	40.1	3.6
Japan	3.0	0.3
Spain	10.3	1.0
Turkey	1.5	0.1
Total	**59.0**	**5.3**

Source: IEA

41. However, the amount of IEA hard coal production receiving government financial assistance has declined over the past decade (see Figure 5). Subsidized production in IEA countries fell by 66% from 1991 to 1999 largely because of programmed decreases in domestic coal production, and the complete elimination of subsidies in the United Kingdom, Belgium and Portugal. Germany now accounts for two-thirds of subsidized production and for 75% of PSE assistance, while Spain accounts for 17% of subsidized production and 11% of PSE.[44]

Figure 5: Assisted Hard Coal Production in IEA Countries, 1991-99



Source: IEA

42. While Germany is expected to reduce subsidized output and PSEs by one-third by 2005, Spain to reduce production by 20% by 2005, France to close its coal industry by 2005, and Japan to eliminate coal subsidies by 2006, the IEA argues that the total elimination of coal production subsidies is not foreseeable in the near future due to the new mechanisms that have been developed to

[44] Ibid, p. 56-7.

support the coal industry.[45] For instance, both Spain and France have transposed certain provisions of the EU Electricity Directive into their national electricity legislation, which permits EU member states to give priority of up to 15% of primary energy used in electricity production to indigenous fuels. As a balancing force, however, a number of factors are expected to push countries towards the elimination of subsidies. These include electricity market liberalization which is already under way, and the expiry of the European Coal and Steel Community Treaty (ECSC) in 2002.[46] The IEA argues that the latter may lead EU members to reconsider the case for continued coal subsidies.[47]

43. Looking at R&D expenditures in IEA member countries, it is clear that they have undergone significant changes in recent years. The total expenditures of IEA countries on energy R&D fell from US$9billion in 1990 to US$7.1 billion in 1998. The decline has mainly been caused by reduced spending on nuclear research, and on technologies related to fossil fuel extraction and transformation. Nuclear technologies still remain, however, the core of public R&D spending in IEA countries. With respect to fossil fuel R&D, research expenditures on oil and gas did not suffer a visible reduction, whilst the brunt of the reduction has fallen on coal.[48] The share of renewable energy in R&D budgets grew. Between 1990 and 1998, two countries (Japan and the United States) have accounted for more than 65% of total energy R&D expenditures in IEA countries.[49]

44. The OECD points out that the unequal incidence of fossil fuel taxes has also acted as a subsidy on some fuels. In most countries, these taxes fall most heavily on the cleanest fuels and least heavily on coal, acting as a subsidy to coal. This is due to the fact that taxation had been imposed to raise revenue rather than to internalize negative environmental costs.[50] In its study of the world's 27 largest fossil fuel producing and consuming nations (which includes 17 OECD countries), the OECD finds that tax rates vary (sometimes significantly) across fuels. With the exception of Denmark, it finds that rates on coal are actually lower than those on gas and oil. Aside from Germany, it finds that rates on oil are generally higher than those on gas.

45. Another study on energy taxes finds oil to be the most heavily taxed source of energy in the OECD. Oil taxes accounted for 45% of the total value of oil sold in 1999. Taxes on natural gas are rising, although gas continues to be taxed much less heavily than oil. Coal taxes are either absent or negligible. The study demonstrates that energy taxes in Europe are significantly higher than in other parts of the OECD, and the gap in levels of taxation between northern European and other OECD countries to have widened in the 1990s.[51]

Non-OECD Countries

46. In several non-OECD countries, the energy sector is still dominated by monopoly, state-owned, enterprises which implement government policies. The structure of these enterprises and their

[45] See the article recently published in the Financial Times (Thursday 26 July 2001) entitled "Germany may pay billions in subsidies under EU coal plan," which indicates that coal subsidy reform may slow down.

[46] ECSC is the first treaty organization of what became the European Union, and was established by the Treaty of Paris in 1952. In the ECSC, member states pledge to pool their coal and steel resources by providing a unified market for their coal and steel products, lifting restrictions on imports and exports, and creating a unified common market.

[47] IEA. Energy Policies of IEA Countries, 2000 Review. Paris, 2000, p.58-9.

[48] While reduced research coal reflects the decline in coal use in IEA countries, coal use for electricity generation in developing countries is expected to increase. Research on coal combustion (high efficiency technologies for power generation) and conversion remain important, therefore, particularly in light of technology transfer to developing countries.

[49] IEA. Energy Policies of IEA Countries, 2000 Review. Paris, 2000, p.73-79.

[50] Ibid, p. 20-1.

[51] ECON Center for Economic Analysis. "Energy Taxes, Trends and Structure in OECD Countries." Oslo, 2000, p. 3.

relationship to the state often masks the different types of governmental interventions made, rendering them difficult to identify and measure.[52]

47. In the IEA study on the eight largest energy consuming countries outside the OECD, it was previously stated that end-user prices were found to be approximately 20% below their market-based reference levels. Price distortion is found to be greatest in Iran, followed by Venezuela, Russia, Indonesia, Kazakhstan, India, China and South Africa, although it differs by fuel (see Table 4). Coal, which is the most carbon intensive fossil fuel, is found to be heavily subsidized in China and India. China, which the world's leading producer of coal, and which derives 60% of its total primary energy supply from this fossil fuel, distorts the price of coking coal by 73%. In India, where most fuels are sold at administered prices, the price of coking coal is distorted by some 42%.[53]

Table 4: Estimated Energy Subsidy Rates as a Percentage of Reference Price (weighted average)

	China	**Russian Fed.**	**India**	**Indonesia**	**Iran**	**South Africa**	**Venezuela**	**Kazakh-stan**
Gasoline	0	9.3	0	0	59.4	0	26.6	0
Auto Diesel	0	0	0	40.2	93.9	0	35.9	0
Liquified petroleum gas (LPG)	0	0	31.6	0	89.7	0	26.1	0
Kerosene	0	0	52.6	55.2	89.5	2.0	4.9	0
Light Fuel Oil	0	1.5	0	45.5	82.3	0	19.3	0
Heavy Fuel Oil	0	0	0	7.8	88.1	0	39.4	0
Electricity	38.2	42	24.2	0	48.1	20.3	63.0	56.6
Natural Gas	18.7	46.1	22.5	28.4	77.8	0	85.6	55.7
Steam Coal	8.3	0	13.1	0	0	8.1	91.9	20.7
Coking Coal	73.1	0	42.3	0.35	0	0	--	2.7
Total	**10.9**	**32.5**	**14.2**	**27.5**	**80.4**	**6.4**	**57.6**	**18.2**

Source: IEA

48. The IEA explains that artificially low energy prices caused by heavy subsidies are not meeting their stated objective of helping the poor. They are at the root of the poor financial performance of many state-owned energy companies in developing and transition economies. This point has also been made by the World Bank. While Indonesia has for many years had a policy of subsidizing kerosene to encourage its use by the poor for cooking, and its policy has accomplished its

[52] ECON Center for Economic Analysis. "Energy Taxes; Trends and Structure in OECD and Selected Non-OECD Countries." Oslo, 1996, p. 33-48.

[53] IEA. World Energy Outlook. Looking at Energy Subsidies: Getting the Prices Right. Paris, 1999, p.104-5and 136-39.

stated objective, the World Bank argues that many free-riders from the upper and middle classes take advantage of the subsidy as well.[54]

49. In the OECD study on the world's 27 largest energy consuming and producing countries, three developing countries (Brazil, Saudi Arabia and Ukraine) are studied in addition to those looked at by the IEA.[55] The study concludes that large energy producers such as Saudi Arabia, Iran, Russia, Venezuela and Mexico tend to provide substantial energy subsidies to their domestic consumers and, of the countries studied, have some of the largest price gaps (i.e. maintain prices below world level). In addition, it argues that while large energy subsidies are administered in Eastern Europe, these tend to be understated since in countries such as Russia and Ukraine there is widespread non-payment of energy bills. The IEA adds that non-payment and theft in Russia, Ukraine and India can affect up to two-thirds of distributed electricity, to the point of actually bankrupting energy companies.[56]

50. With respect to energy taxes, a study conducted on 14 non-OECD countries finds that taxes in these countries tend to follow the same pattern as in the OECD (i.e. are heaviest on the cleanest fuels), although are generally lower.[57] Another study on Brazil, China, India, Indonesia, and Russia finds that the power and industrial sectors pay relatively little tax, that value-added taxes in these two sectors are refundable (except in China), and that taxes on gasoline and diesel are significant, and are major contributors to governmental revenue.[58]

C. ONGOING ENERGY SECTOR REFORM

51. According to the IEA, the energy sector is undergoing market-oriented reform in both OECD and non-OECD countries. In OECD countries, there is a clear trend towards a new organization of the electricity industry to allow for greater competition between generators (i.e. to move away from vertically integrated utilities), and to allow consumers to choose their own suppliers. Virtually all OECD countries have opened up their electricity markets for big industrial users and, in a number of countries, for households and small companies as well. By 2007, the IEA forecasts that roughly 500 million consumers (and all large industrial users) in the OECD will be entitled to choose their electricity supplier. Several OECD countries have also taken steps towards liberalizing their natural gas markets, at least for large industrial users (e.g. power generators). With respect to coal, while subsidy reform is underway, the IEA does not expect total subsidy elimination in the near future.[59]

52. In response to the 1992 United Nations Framework Convention on Climate Change (UNFCCC), a number of policies have been set by OECD countries to bring their emissions of greenhouse gases (GHG) to their 1990 levels. Fiscal policies include the removal of subsidies and the imposition of energy taxes. While subsidy reform to mitigate the effects of climate change is underway in a number of OECD countries, 15 IEA countries have reported tax policy changes to deal with the phenomenon. A third of these changes relate to the transportation sector, and the other two-thirds have to do with power generation and broad-based energy or carbon taxation. A number of regulatory instruments are also being used.[60]

53. In non-OECD countries, energy sector reform is also proceeding along the following lines: (1) de-monopolisation of state-owned energy utilities, (2) deregulation (removal of subsidies and price

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[54] World Bank. Energy Services for the Poor. Energy and Development Report 2000. Washington D.C., 2000, p. 62.

[55] With the exception of Kazakhstan.

[56] IEA. Energy Policies of IEA Countries, 2000 Review. Paris, 2000, p.83.

[57] ECON Center for Economic Analysis. "Energy Taxes; Trends and Structure in OECD and Selected Non-OECD Countries." Oslo, 1996, p. 33-48.

[58] ECON Center for Economic Analysis. "Carbon Based Energy Taxes in Developing Countries." Oslo, 2001, p. 9.

[59] IEA. Energy Policies of IEA Countries, 2000 Review. Paris, 2000, p.45-59.

[60] Ibid, p. 59-67.

controls, as well as the lowering or removal of trade and investment barriers), and (3) privatization. Price decontrol, the IEA states, is the thorniest reform issue in non-OECD countries, mainly because of the social hardships that may result from the lifting of subsidies. In some non-OECD countries, particularly in Asia and Latin America, there also signs of a shift from the use of coal to oil and natural gas.[61]

54. According to the IEA, in the former Soviet Union and Central/Eastern Europe painful efforts are under way to replace centrally planned economic systems with market-based economies. However, Russia's long-term energy strategy does call for a doubling of coal output by 2010 and for 38 new nuclear power reactors to be built by 2020. The IEA sums up the state of energy sector reform in various non-OECD countries in the following terms: "China has made considerable progress in energy price reforms, but many deep-seated structural problems remain, notably in China's huge coal mining industry. India has started liberalizing its energy sector, but has made little progress in removing price controls and reducing subsidies. Brazil and South Africa have all made impressive strides in cutting fossil-fuel consumption subsidies, although significant production subsidies remain. Argentina and Chile are, in many respects, at the forefront of non-IEA countries in energy-sector liberalization and structural reform. By contrast Indonesia has made little headway in reducing its enormous oil-sector subsidies."[62] Moreover, in some countries coal is an expanding sector, such as in Indonesia and Colombia, and new nuclear power generation capacity is being commissioned. New nuclear power plants are also nearing completion in India, Brazil, Korea and Slovakia.[63]

55. In both OECD and non-OECD countries regulatory instruments are increasingly being used to promote energy efficiency. They include: (1) "labels", which are markings that show a product's energy use or efficiency according to a common measure, (2) "standards", which are mandatory programs that stipulate minimum efficiency levels acceptable for products sold in a particular country or region, and (3) "targets", which are voluntary arrangements in which governments or utilities persuade, but do not require, manufacturers to lower their energy use or raise the energy efficiency of their products (IEA definitions). Regulatory instruments have so far targeted home appliances, office and lighting equipment, electric motors, and home entertainment electronics. In June 2000, energy efficiency labels existed in 37 countries, and standards in 34 (see Annex III).[64] Under the Agreement on Technical Barriers to Trade (TBT) a large number of energy efficiency measures have also been notified.[65]

III. ENVIRONMENTAL BENEFITS OF REMOVING TRADE RESTRICTIONS AND DISTORTIONS

A. ENERGY AND THE ENVIRONMENT

56. Energy production and consumption may have harmful environmental effects at the local, regional and global levels. These effects differ by energy type and include: air pollution, GHG emission, the generation of radioactive waste, land and water pollution, noise and visual pollution, and ecosystem alteration and degradation. All of these effects can have consequences for human health. In reviewing the impact of different fossil fuels on the environment it is important to consider their entire "fuel cycle", in other words their effects throughout the different stages of mining/extraction, production, transportation, distribution, combustion, and disposal. In general, the impact of energy on the environment depends on: (1) the total amount of energy consumed, (2) the

[61] IEA. Energy Policies of IEA Countries, 2000 Review. Paris, 2000, p. 79-86.

[62] IEA. World Energy Outlook. Looking at Energy Subsidies: Getting the Prices Right. Paris, 1999, p.16-17.

[63] IEA. Energy Policies of IEA Countries, 2000 Review. Paris, 2000, p. 79-86.

[64] IEA. Energy Labels and Standards. Paris, 2000, p. 10-11 and 15-16.

[65] See pages 17-24 of document WT/CTE/W/195 entitled *Environmental Database for 2000* for TBT energy-related measures of the year 2000 (for example, notifications number G/TBT/Notif.00/368 and G/TBT/Notif.00/444).

specific mix fuels used (since different environmental problems are linked to different fuels and to their cycles), (3) the efficiency at which primary energy is converted into useful energy, and (4) the technologies in use (e.g. car fuel efficiency).

57. Coal mining can have negative environmental consequences, such the loss of forests and agricultural land, and the potential pollution of surface and groundwater. Coal, which is also the most carbon intensive fossil fuel and an emitter of sulphur dioxide (SO_2), can result in local air pollution, acid rain and climate change which have regional and global impacts.

58. Environmental problems, such as natural habitat destruction, can result from oil and natural gas exploration and drilling. Leakages and spills during the transportation of oil and natural gas can also have negative environmental consequences. Several water bodies have been polluted as a result of oil spills, and marine life degraded. Leakages in natural gas pipelines can result in the dangerous releases of gas into the atmosphere. Natural gas, which is primarily composed of methane, is a much more potent GHG than carbon dioxide (CO_2). Moreover, as harnessing gas and transporting it to distant markets requires significant infrastructure, natural gas flaring and venting takes place in significant amounts in many parts of the developing world to allow for oil exploitation. This wastes a valuable natural resource and contributes to climate change. While coal is the most carbon intensive fossil fuel, oil is responsible for most CO_2 emissions worldwide due its dominant share in world consumption.

59. Nuclear energy production raises the risks of nuclear accidents and the need to dispose of radioactive waste. The expansion of nuclear energy also raises risks of the proliferation of nuclear weapons. Renewable sources of energy also have environmental and social impacts. Hydropower may degrade ecosystems by altering the natural state of river basins, with effects on flora and fauna, as well as result in the displacement of people for dam construction Other renewable energy systems, such as wind, can have visual as well as noise impacts.[66]

60. At the global level, climate change has been identified as one of the most pressing environmental concerns. International cooperation to deal with the phenomenon is embodied in the 1992 UNFCCC. The Kyoto Protocol of 1997 incorporates legally binding commitments for the implementation of the UNFCCC. The objective of the Framework Convention is to stabilize GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.[67] According to the IEA, OECD countries were responsible for 51% of global CO_2 emissions in 1997, while developing countries for 38% and transition economies for 11%. By 2020, developing countries will account for 50%, OECD countries for 40% and transition economies for 10%. Per capita emissions in developed countries, however, will continue to be much higher than in the developing world. Power generation and transportation are the two main sources CO_2 emissions worldwide (see Annexes IV and V).[68]

B. POSSIBLE RESULTS OF TRADE POLICY REFORM

61. Much of the literature argues that subsidy reform and the restructuring of energy taxes are necessary for environmental improvement. Key to sustainable development is to ensure that price and incentive structures reflect the true costs and benefits of production and consumption. By distorting prices, subsidies encourage the inefficient use of energy resources, and discourage energy

[66] World Bank. Fuel for Thought; An Environmental Strategy for the Energy Sector. Washington D.C., 2000, p.27-30; and OECD. OECD Environmental Outlook. Paris, 2001, p.145; and OECD. Reforming Energy and Transport Subsidies. Paris, 1997, p. 30.

[67] For signatories of the UNFCCC and its Kyoto Protocol see pages 38-40 of document CTE/WT/W/160/Rev.1 entitled "Matrix on Trade Measures Pursuant to Selected MEAs." As of 20 July 2001, 84 parties have signed and 37 have ratified or acceeded to the Kyoto Protocol.

[68] IEA. World Energy Outlook 2000. Paris, 2000, p. 65.

conservation and the expanded use of renewable sources of energy. Moreover, some encourage obsolete and environmentally inefficient technologies to remain in operation. Subsidy reform is therefore required. While some argue that certain kinds of energy taxes offset the environmentally damaging effects of subsidies when they fall on the very same fuels, much has been written in the literature on the fact that their imposition is no alternative to subsidy reform.[69] This is the case as taxes generally do not fall on the same part of the production/consumption chain as subsidies and do not affect, therefore, the same decisions.

62. In addition to subsidy reform, environmental policy is required to bring the private benefits associated with energy production and consumption in line with its social costs. Various environmental policies are used to internalize negative externalities linked to energy production and consumption, and include command and control measures (such as the setting of emissions standards) as well as economic instruments (such as taxes, charges, tradeable pollution permits, and property rights).

The environmental effects of removing trade restrictions and distortions of the type identified in section II will depend on: (1) how the removal of restrictions and distortions will affect energy prices, (2) how energy consumption will respond to change in prices (in terms of total consumption and the mix of fuels used), and (3) how the focus of R&D will shift in response to these developments. With respect to the latter, numerous new technologies, which are under development today, can significantly transform the relationship between energy production and use and its environmental effects. According to the OECD, in addition to electricity systems based on renewable energy, such technologies include the use of cellulose ethanol in motor vehicles, and the development and use of hybrid vehicles, hydrogen fuel cells and CO_2 capture technologies.[70]

63. However, WT/CTE/W/67 had already cautioned that "While it is usually assumed that the removal of energy subsidies would result in decreased energy consumption and an improved environmental situation, to reduce subsidization may not substantially reduce energy consumption because: (a) as energy is an input to virtually all forms of economic activity, subsidy removal is likely to have general equilibrium effects, making predictions about the impact of reforms on the environment difficult to make; and (b) where inter-fuel substitution is possible, reduced subsidies may affect the composition rather than the quantity of fuel used (environmental damage would in this case depend on the composition of the fuels that continue to be used)."[71] Simplistic conclusions about "win-win" situations for trade and the environment must therefore be avoided since one set of problems associated with a particular fuel mix may simply be substituted for another following trade liberalization. It must also be remembered that while trade policy reform can contribute to environmental improvement, it is not a substitute for environmental policies, which will always be needed.

64. It is important to note that subsidy reform does not necessarily mean subsidy removal, since there are environmentally harmful as well as environmentally beneficial subsidies. Environmentally sound ones capture positive environmental externalities. UNEP explains that fossil fuel subsidies do not always lead to adverse environmental effects. "For example, encouraging the use of oil products can reduce deforestation in developing countries as poor rural and peri-urban households switch from firewood. This is a major reason for the maintenance of subsidies to kerosene and LPG [liquified petroleum gas] in many countries. Public funding of fossil-fuel R&D activities could actually yield positive environmental effects to the extent that it results in development and deployment of more efficient, cleaner burning technologies. Also, subsidies to indigenous fuel production do not systematically lead to higher consumption if their removal simply results in increased imports on a

[69] See for instance: OECD (COM/TD/ENV(2000)38/Final). "Environmental Effects of Liberalizing Fossil Fuels Trade: Results from the OECD Green Model." Paris, 2001, p. 27.

[70] OECD. Environmental Outlook. Paris, 2001, p.145.

[71] See page 24 of WT/CTE/W/67.

one-for-one basis. Subsidies to support renewables, nuclear power and energy-efficient technologies may help noxious greenhouse gas emissions depending on how the subsidies are structured and on market conditions."[72]

65. In examining the environmental benefits of removing trade and restrictions and distortions, much emphasis has been placed in the literature on CO_2 emissions reductions due to the importance of climate change. The results of various simulations on trade policy reform and its effects on CO_2 emissions are shown below. However, it must be remembered that climate change is not the only environmental consequence of energy use, and that some of the local and regional problems that production and consumption may cause can have just as serious a health and an environmental impact as global ones.

1. Energy Subsidy Removal in Eight Developing Countries[73]

66. A recent IEA study attempts to determine the effects of the removal of all subsidies for energy end-use on CO_2 emissions in eight of the largest energy consuming developing countries (see Table 4). Most of the subsidies in these countries are geared towards consumption. The study demonstrates that, following subsidy removal, energy consumption drops by approximately 13% and CO_2 falls by around 16%, and reaches the conclusion that a close relationship holds between measured subsidy rates and the potential for energy savings and GHG emissions reduction. CO_2 emissions fall, in part, due to the removal of heavy subsidies on coal. Table 5 below contains these results.

67. The study also finds that because subsidies distort prices and encourage economically inefficient decisions to be made, economic efficiency gains in all eight countries are made through removal. Moreover, as the removal of what are essentially consumption subsidies leads to reduced overall energy consumption, energy import demand declines in those countries which were previously energy importers, and this increases the availability of energy exports. The result is an improvement in world energy security. The study does not provide clear indication, however, of what the final fuel mix in the eight countries under study becomes following subsidy removal.

[72] UNEP/IEA. "Energy Subsidy Reform and Sustainable Development: Challenges for Policy Makers." Synthesis Report. Submission to the 9th Session of the United Nations Commission on Sustainable Development, April 2001, p. 10.

[73] IEA. World Energy Outlook. Looking at Energy Subsidies: Getting the Prices Right. Paris, 1999, p.62-9.

Table 5: The Results of Subsidy Removal – IEA Simulation

	Average Subsidisation (Per cent of reference price)	Annual Economic Efficiency Gains (Per cent of GDP)	Reduction in Energy Consumption (Per cent)	Reduction in CO_2 Emissions (Per cent)
China	10.89	0.37	9.41	13.44
Russia	32.52	1.54	18.03	17.10
India	14.17	0.34	7.18	14.15
Indonesia	27.51	0.24	7.09	10.97
Iran	80.42	2.22	47.54	49.45
South Africa	6.41	0.10	6.35	8.11
Venezuela	57.57	1.17	24.94	26.07
Kazakhstan	18.23	0.98	19.22	22.76
Total Sample	**21.12**	**0.73**	**12.80**	**15.96**

Source: IEA

2. Removal of Energy Price-Distortions in OECD and Non-OECD Countries[74]

68. In a model run on a large number of OECD and non-OECD countries, the GHG emissions effect of liberalizing trade in fossil fuels is studied. The model removes fossil fuel price distortions, and measures the effect on CO_2 emissions.[75] Three scenarios are looked at: an "OECD only liberalizes", a "non-OECD only liberalizes" and an "all countries liberalize" scenarios.

69. The model shows that for some countries, although not all, liberalization of fossil fuels reduces GHG emissions. For other countries, in particular Japan, the simulations show adverse effects on emissions which offset emission reductions elsewhere in the OECD. The "OECD-only liberalizes" scenario tends to increase fossil fuel demand (and hence imports), as the above world market prices that currently prevail in Japan and Europe fall. However, CO_2 emissions remain basically stable (-0.0% in 2005 or +0.1% in 2010). Since price distortions in non-OECD countries keep energy prices artificially low, the "non-OECD only liberalizes" scenario results in higher energy prices, leading to decreased consumption and emissions. In the "all countries liberalize" scenario, CO_2 emissions drop the same amount in 2005 (-3.9%), or slightly less in 2010 (a -6.2%, rather than a -6.3%, drop relative to the "business as usual" scenario), than they would have had the OECD not liberalized.

70. Trade patterns change as result of energy policy reform. As prices drop in the OECD, there is a rise in consumption, which also translates into a rise in imports. In non-OECD countries the opposite takes place. As consumption subsidies are removed, consumption as well as import demand decline. Exports, on the other hand, rise in most of the big exporting countries when trade is liberalized. Overall fossil fuel trade increases by 4.4% in 2010.

71. On the import side, the European Union begins to import more coal (to replace German and Spanish coal once support is removed), substantial declines in fuel imports are experienced in Eastern Europe, the former Soviet Union, India and China as domestic prices are reformed, and a sharp increase of oil imports takes place in Japan and Brazil (as more competitive suppliers replace domestic ones). On the export side, energy exporting countries (such as the former Soviet Union) begin to export energy that was previously consumed domestically because of support.

[74] OECD (COM/TD/ENV(2000)38/Final). "Environmental Effects of Liberalizing Fossil Fuels Trade: Results from the OECD Green Model." Paris, 2001, p. 16-26.

[75] The simulations focus on distortions in fossil fuel prices for the industry and power generation sectors, but do not look at subsidies to commercial, agricultural or retail users.

72. With respect to interfuel substitution in trade, the results of the model are mixed. With respect to coal for instance, while there is reduced demand for coal imports in some regions, there is increased demand in others (because weakening demand in some parts of the world makes coal affordable in others). The model also concludes that because of the inefficiencies that price distortions create, improvement in welfare take place upon their correction (for the results of the model, see Table 6). What the model does not indicate is whether a change takes place in world total fossil fuel consumption following liberalization and what the exact mix of fossil fuels used in different parts of the world becomes. Moreover, it does not consider non-fossil fuel sources of energy.

Table 6: Results of OECD Simulation (Changes relative to a "Business as Usual" scenario)

	OECD only liberalise	**Non-OECD only liberalise**	**All countries liberalise**
CO_2 Emissions			
2005	-0.0%	-3.9%	-3.9%
2010	+0.1%	-6.3%	-6.2%
Larger Impacts	OOE-5%, JPN+10%	CHN-15%, EET-15%, FSU-13%, DAE-10%, EEX-10%, IND-8%, BRA+11%	CHN-15%, EET-15%, FSU-13%, DAE-10%, EEX-9%, IND-8%, BRA+10%, JPN+10%
Welfare Effects			
2005	+0.0%	+0.0%	+0.0%
2010	+0.1%	+0.0%	+0.1%
Larger Impacts	EEX+0.8%	FSU-0.7%, EEX-0.5%, EET+0.7%, ROW+0.8%	ROW+0.8%, EET+0.9%
Imports			
2005	+4.8%	-1.9%	+2.8%
2010	+7.2%	-2.6%	+4.4%
Larger Impacts	EEC+18%, JPN+19%	ROW-20%, EET-14%, EEX-13%, FSU-11%, BRA+29%	ROW-21%, EET-14, EEX-10%, FSU-9%, BRA+28%, JPN+18%, EEC+17%
Exports			
2005	+4.8%	-1.9%	+2.8%
2010	+7.2%	-2.6%	+4.4%
Larger Impacts*	EET+15%, USA+16%, OOE+17%,CHN+17%, DAE+24%	CHN-11%, DAE-11%, EET-12%,	USA+11%, OOE+12%, DAE+14%

Key: + or – sign after regional abbreviations denotes significantly higher or lower values within the particular region as compared to the global totals. Percentages shown in the "Larger Impacts" section represent values in 2010. **Abbreviations:** EEC (European Union 15); JPN (Japan); OOE (other OECD); USA (United States): BRA (Brazil); CHN (China); DAE (Dynamic Asian Countries); EET (Eastern Europe); EEX (Oil Exporting Countries); FSU (Former Soviet Union); IND (India); ROW (Rest of World).

Source: OECD Secretariat

3. Fossil Fuel Subsidy Removal and Tax Use in OECD Countries[76]

73. In a different simulation, fossil fuel subsidies in OECD countries are removed and an *ad valorem* tax on fuel use is imposed. The *ad valorem* tax increases by 2 percentage points per annum for coal, 1.6 percentage points for crude oil and 1.2 percentage points for natural gas, reaching a total tax levy of 50%, 40% and 30% of pre-tax prices by the year 2020. The increase in taxes is linked to the carbon content of the different fuels.[77] This results in a decline in global coal, oil and natural gas consumption, and the environmental effects of the subsidy removal and imposition of a tax are significant. The policy reform leads to a 25% reduction in both SO_2 and CO_2 emissions, leading to an improvement in local air quality and a reduction in the effect of global warming. Gross domestic product (GDP) in OECD countries declines by an insignificant 0.1% (possibly due to the contraction of OECD energy production). These results are contained in Table 7 below.

Table 7: Effects of Subsidy Removal and Energy Tax Use in OECD Countries (% change from a reference scenario in 2020)

Effect on demand in OECD countries for:			GDP	SO_x emissions	CO_2 emissions
Coal	Oil	Gas			
-32%	-18%	-17%	-0.11%	-25%	-25%

Source: OECD

4. The Simulations Compared

74. The different simulations considered in this Note demonstrate that there can be environmental benefits (in terms of climate change mitigation) to the removal of trade restrictions and distortions in the energy sector. In all models CO_2 emissions drop. While the OECD model shows that when the OECD liberalizes on its own, CO_2 emissions in the long-run rise, the last simulation demonstrates that accompanying environmental policies (i.e. taxes linked to the carbon content of specific fuels) have an important role to play. The imposition of these taxes in the last simulation, shows that they have the potential to bring down overall levels of energy consumption and, therefore, emissions as well. There is a broad array of instruments that countries may use to internalize negative environmental externalities, many of which are already in use. These will always prove indispensable in giving value to environmental resources.

[76] OECD. Environmental Outlook. Paris, 2001, p.154.
[77] However, this is not intended to simulate a "carbon tax".

ANNEX I - NET ENERGY IMPORTS BY COUNTRY

(in thousands of metric tons of oil equivalent)

Country	Net energy imports* % of commercial energy use	
	1980	**1997**
Albania	-12	13
Algeria	-440	-374
Angola	-149	-505
Argentina	7	-30
Armenia	-18	70
Australia	-22	-96
Austria	67	71
Azerbaijan	1	-17
Bangladesh	11	10
Belarus	-8	87
Belgium	83	77
Benin	11	13
Bolivia	-85	-40
Bosnia and Herzegovina	"	64
Botswana	"	"
Brazil	43	30
Bulgaria	73	52
Burkina Faso	"	"
Burundi	"	"
Cambodia	"	"
Cameroon	-58	-95
Canada	-7	-52
Central African Republic	"	"
Chad	"	"
Chile	41	65
China	-2	1
Hong Kong, China	99	100
Colombia	5	-122
Congo, Dem. Rep.	0	1
Congo, Rep.	-370	-990
Costa Rica	50	57
Côte d'Ivoire	34	12
Croatia	"	48
Cuba	73	49
Czech Republic	9	22
Denmark	95	4
Dominican Republic	62	74
Ecuador	-126	-168
Egypt, Arab Rep.	-114	-47
El Salvador	25	35
Eritrea	"	"
Estonia	-11	32

Country	Net energy imports* % of commercial energy use	
	1980	**1997**
Ethiopia	5	5
Finland	73	54
France	75	48
Gabon	-532	-1,110
Gambia, The	"	"
Georgia	66	70
Germany	48	60
Ghana	19	15
Greece	72	62
Guatemala	33	21
Guinea	"	"
Guinea-Bissau	"	"
Haiti	11	27
Honduras	30	37
Hungary	49	50
India	8	12
Indonesia	-116	-60
Iran, Islamic Rep.	-116	-108
Iraq	-1,306	-129
Ireland	78	77
Israel	98	97
Italy	86	82
Jamaica	91	85
Japan	88	79
Jordan	100	96
Kazakhstan	0	-69
Kenya	19	18
Korea, Dem. Rep.	"	"
Korea, Rep.	77	86
Kuwait	-884	-618
Kyrgyz Republic	-28	50
Lao PDR	"	"
Latvia	54	63
Lebanon	93	96
Lesotho	"	"
Libya	-1,248	-423
Lithuania	95	55
Macedonia, FYR	"	"
Madagascar	"	"
Malawi	"	"
Malaysia	-50	-53
Mali	"	"
Mauritania	"	"
Mauritius	"	"
Mexico	-51	-58
Moldova	"	98
Mongolia	"	"

Country	Net energy imports* % of commercial energy use	
	1980	**1997**
Morocco	82	88
Mozambique	8	9
Myanmar	-1	6
Namibia	"	"
Nepal	3	8
Netherlands	-11	13
New Zealand	41	15
Nicaragua	42	41
Niger	"	"
Nigeria	-181	-115
Norway	-196	-778
Oman	-1,415	-662
Pakistan	18	26
Panama	72	65
Papua New Guinea	"	"
Paraguay	23	-66
Peru	-25	19
Philippines	50	57
Poland	2	4
Portugal	86	89
Puerto Rico	"	"
Romania	19	30
Russian Federation	2	-57
Rwanda	"	"
Saudi Arabia	-1,408	-395
Senegal	46	40
Sierra Leone	"	"
Singapore	"	100
Slovak Republic	84	73
Slovenia	62	55
South Africa	-12	-33
Spain	77	71
Sri Lanka	29	39
Sudan	16	14
Sweden	61	36
Switzerland	66	58
Syrian Arab Republic	-78	-124
Tajikistan	-20	-63
Tanzania	8	5
Thailand	51	42
Togo	"	"
Trinidad and Tobago	-239	-66
Tunisia	-79	2
Turkey	45	61
Turkmenistan	-1	-54
Uganda	"	"
Ukraine	-12	46
United Arab Emirates	-995	-397
United Kingdom	2	-18
United States	14	22
Uruguay	71	62
Uzbekistan	4	-15
Venezuela, RB	-277	-255
Vietnam	7	-11
West Bank and Gaza	"	"
Yemen, Rep.	96	-469
Yugoslavia, FR (Serb./Mont.)	"	"
Zambia	8	7
Zimbabwe	12	18

* Net energy imports are calculated as energy use less production, both measured in oil equivalents. Negative value indicates that a country is a net exporter. All forms of commercial energy are included in this table.
Source: World Bank. World Development Indicators 2000. Washington D.C., 2000, p. 138-140.

ANNEX II

Policies that can be interpreted as "supports" or "subsidies"

I. DIRECT PAYMENTS THAT SUPPORT CURRENT PRODUCTION

- Deficiency payments (grants to cover losses) and operating subsidies to producers
- Consumer subsidies provided via retailers
- Price premiums

II. TAX POLICIES

- Preferential treatment under the general tax code
- Exemption from excise tax
- Tax credits
- Preferential treatment in local rates and franchise fees

III. POLICIES THAT REDUCE THE COSTS OF INPUTS AND COMPLEMENTS

- Budgetary subsidies to inputs and complements
- Price controls for inputs and complements
- Land expropriation for roads, plant sites

Investment subsidies

- Equity participation
- Loans at preferential rates
- Loan guarantees
- Habitual debt forgiveness
- Infrastructure financing
- R & D funding
- Liability guarantees (sometimes combined with rate-of-return controls)

IV. POLICIES THAT CREATE TRANSFERS THROUGH MARKET PRICES

Trade policies

- Import and export taxes and subsidies
- Non-tariff trade barriers, e.g. import and export quotas; procurement preference

Domestic energy and related policies

- Procurement preference
- Managed non-commercial contracts
- Energy planning
- Price regulation (ceilings, floors, rate-basing)
- Protection for monopolies

Source: OECD. Reforming Energy and Transport Subsidies. Paris, 1997, p.18.

ANNEX III

USE OF LABELS, STANDARDS AND TARGETS FOR MAJOR HOME APPLIANCES
(as of June 2000)

	Number of Countries & EU		Countries & EU
	Labels	Standards or Targets	**l** = mandatory label; **s** = mandatory standard; **t** = target; **vl** = voluntary label; **vs** = voluntary standard
Refrigerators and Freezers			
IEA	8 + EU	6 + EU	Australia (l,s); Canada (l,s); European Union (l,s); Hungary (l,s) Japan (vl,s); New Zealand (vl); Norway (l); Switzerland (l,t); United States (l,vl,s)
Non IEA	15	10	Brazil (l,vs); Bulgaria (l,s); China (s); Chinese Taipei (vl,s); Hong Kong China (vl); India (l,vs); Indonesia (vl); Iran (l,s); Korea (l,s); Lithuania (l); Mexico (l,vl,s); Philippines (l); Poland (l,s); Romania (l); Russia (s); Singapore (vl); Thailand (vl)
Clothes Washers			
IEA	7 + EU	4	Australia (l); Canada (l,s); European Union (l,vs); Hungary (l); New Zealand (vl); Norway (l); Switzerland (l,t); United States (l,vl,s)
Non-IEA	8	2	Bulgaria (l); China (s); Chinese Taipei (vl); Hong Kong China (vl); Lithuania (l); Mexico (l,s); Poland (l); Romania (l); Singapore (vl)
Clothes Dryers			
IEA	6 + EU	3	Australia (l); Canada (l,s), European Union (l); Hungary (l); New Zealand (vl); Norway (l); Switzerland (l,t); United States (s)
Non-IEA	4	-	Bulgaria (l); Lithuania (l); Poland (l); Romania (l)
Dishwashers			
IEA	7 + EU	3	Australia (l); Canada (l,s); European Union (l); Hungary (l); New Zealand (vl); Norway (l); Switzerland (l,t); United States (l,vl,s)
Non-IEA	4	1	Bulgaria (l); Lithuania (l); Poland (l); Romania (l); Russia (s)

Room Air Conditioners			
IEA	5	3	Australia (l); Canada (l,s); Japan (vl,t,s); New Zealand (vl); United States (l,vl,s);
Non-IEA	8	8	Brazil (l); China (s); Chinese Taipei (vl,s); Hong Kong China (vl); India (vs); Korea (l,s); Mexico (l,vl,s); Philippines (l,s); Russia (s); Singapore (vl,s); Thailand (vl)
Electric Water Heaters			
IEA	2	3	Australia (s); Canada (s); New Zealand (vl); United States (l,s)
Non-IEA	-	3	Chinese Taipei (s); Mexico (s); Russia (s)
Lighting Equipment			
IEA	5 + EU	3	Canada (s); European Union (l); Hungary (l); Japan (l,s); Norway (l); Switzerland (l); United States (l,s)
Non-IEA	11	5	Bulgaria (l); Chinese Taipei (vl,s); Hong Kong China (vl); Korea (l,s); Lithuania (l); Malaysia (s); Mexico (vl,s); Philippines (l,s); Poland (l); Romania (l); Singapore (vl); Thailand (vl)

Source: IEA. Energy Standards and Labels. Paris, 2000, p. 15-6.

ANNEX IV

Global CO_2 Emissions by Region and by Sector

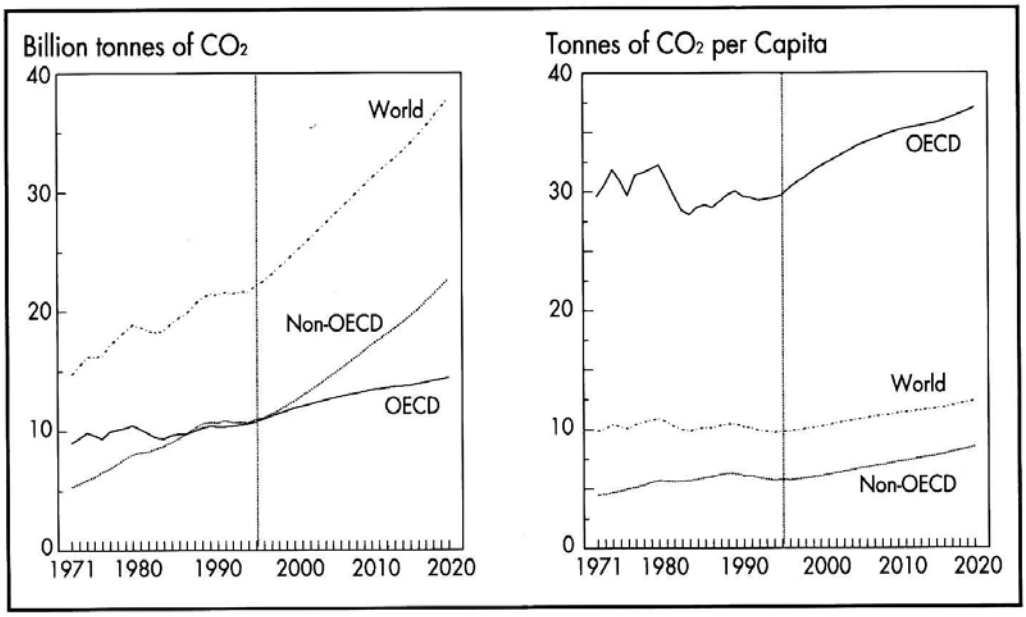
(Million tons of CO_2)

Emissions	**World***		**OECD**		**Transition Economies**		**Developing Countries**	
1990	20 878		10 640		4 066		6 171	
1997	22 561		11 467		2 566		8 528	
2010	29 575		13 289		3 091		13 195	
2020	36 102		14 298		3 814		17 990	
Increase	**1990 -2010**	**1997 -2020**	**1990 -2010**	**1997 -2020**	**1990 -2010**	**1997 -2020**	**1990 -2010**	**1997 -2020**
Power Generation	4 012	5 816	1 202	1 369	-200	446	3 009	4 001
Industry	892	1 698	-157	-91	-244	193	1 294	1 597
Transport	2 469	3 577	1 215	1 285	-164	254	1 418	2 038
Other	1 324	2 450	388	268	-367	354	1 303	1 826
Total	8 697	13 541	2 648	2 831	-976	1 247	7 024	9 462

*Excluding international marine bunkers
Source: IEA. World Energy Outlook 2000. Paris, 2000, p. 66.

ANNEX V

World Energy-Related CO_2 Emissions



Source: IEA. World Energy Subsidies. Looking at Energy Prices: Getting the Prices Right. Paris, 1999, p. 38.

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