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DEFINING AND MEASURING ENVIRONMENTALLY-HARMFUL SUBSIDIES IN THE ENERGY SECTOR

This paper is distributed for background iinformation in Session [2.1] at the OECD Workshop on Environmentally Harmful Subsidies, held at the IEA, (International Energy Agency) 9 rue de la Fédération, 75739 Paris Cedex 15. Registration is from 8h30-9h30 on 7th November 2002. The workshop is organised by the Directorate of Agriculture, Food and Fisheries; in close co-operation with the Environment; Trade; and Science, Technology and Industry Directorate; the IEA and ECMT. This paper was written by Kristi Varangu, IEA Energy and Environment Division and Trevor Morgan, Menecon Consulting. The views expressed in this paper are those of the authors and do not necessarily reflect those of the OECD or its Member countries.

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DEFINING AND MEASURING ENVIRONMENTALLY-HARMFUL SUBSIDIES IN THE ENERGY SECTOR

Definitions of an Energy Subsidy

1. No consensus definition exists. A 1999 IEA study[1] defined energy subsidies as *any government action that concerns primarily the energy sector that lowers the cost of energy production, raises the price received by energy producers or lowers the price paid by energy consumers*.

2. The form in which subsidies are administered can be classified in different ways. Some have a direct effect on price, like grants and tax exemptions, while others act indirectly, such as regulations that skew the market in favour of a particular fuel or government-sponsored technology research and development.

3. Types of energy subsidy include:

- *Direct financial transfers*: such as grants to producers; grants to consumers; and low-interest or preferential loans. These may take the form of soft loans, or grants for energy services or appliances to encourage the use of energy efficient technologies. Such an approach is practised extensively in some countries, notably Denmark. The Danish government offers subsidies of up to 30 per cent for investments in energy efficiency or conservation in industry and commerce, in addition to tax rebates on such investments for energy-intensive firms. A number of countries, including the United States and Australia, use tax credits to foster industry research and development. Several countries, including Australia and Denmark, offer cash subsidies to producers of renewable energy.

- *Preferential tax instruments*: such as rebates or exemptions on royalties, duties, producer levies and tariffs; tax credits and reliefs; and accelerated depreciation allowances on energy-supply equipment. Differential taxation is sometimes used to encourage or discourage the production and use of certain fuels or to lower the effective cost of heating fuels to end-users. In the latter case, such subsidies are intended to benefit the poorest end-users, for whom heating represents a significant proportion of household expenditure.[2] Some countries, such as the United States, continue to offer tax benefits to oil producers. Canada has traditionally differentiated royalties on oil and gas production to encourage development of resources in specific regions. Several OECD countries have restructured their energy taxes to penalise the most carbon-intensive fuels, in

[1] IEA, *World Energy Outlook 1999 Insights: Looking at Energy Subsidies – Getting the Prices Right*, 1999.

[2] In practice, however, better-off consumers who tend to consume more energy may benefit the most in absolute financial terms.

some cases through a carbon tax. All the Scandinavian countries have introduced explicit carbon taxes and other European countries are planning either carbon taxes or so-called green taxes that take account of other environmental factors.

- *Trade instruments*: such as quotas, technical restrictions and trade embargoes.

- *Energy-related services provided directly by government at less than full cost*: such as direct investment in energy infrastructure; and public research and development. The governments of almost all OECD countries undertake energy R&D, either directly or indirectly through support for private sector programmes. Generally, publicly funded R&D is directed to those sectors where the country has a strong domestic production capability or to more environmentally friendly technologies. Although much of R&D funding goes to fossil fuels, programmes are often aimed at improving combustion efficiency and therefore lowering fossil-fuel use and related emissions.

- *Regulation of the energy sector*: through demand guarantees and mandated deployment rates; price controls; environmental regulations; and market-access restrictions. Regulations requiring or encouraging consumers to purchase a given fuel from a particular, usually domestic, source, sometimes at a regulated price have been introduced in several countries (see discussion below on renewable energy). Most countries have adopted energy efficiency standards for a range of energy-using equipment and appliances.

Measuring Energy Subsidies

4. Energy subsidies are widespread, but they vary greatly in importance and type according to the fuel and country. Estimating their size depends heavily on definitions and methodologies. The following are some of the methods used in studies that have attempted to quantify energy subsidies and the economic and environmental impacts of their reform.

5. The effective rate of assistance (ERA) is a basic measure of subsidy, covering any direct or indirect action that affects the price of the good in question. While it has the virtue of capturing the full extent of subsidy, such a measure is difficult to use in practice because it requires information on subsidies to industries upstream of the good being examined.

6. A more limited yet practical approach is the producer subsidy equivalent (PSE), which was developed by the OECD and has been used by the IEA to quantify coal subsidies. The PSE defines the nominal cash transfers to domestic producers equivalent to the total value of existing support, provided at current levels of output, consumption and trade. PSEs do not, however, capture all subsidies since they focus solely on the supply side. Other interventions, which have the effect of reducing end-user prices and thus raising energy use and related emissions, are picked up by the consumer subsidy equivalent (CSE) approach. A CSE is defined as the algebraic sum of the difference between domestic and world prices times the quantity consumed plus any direct financial payment to consumers that reduced the price paid for domestic consumption.

7. The price-gap approach involves comparing actual end-user prices of energy products with reference prices, defined as those prices that would prevail in undistorted markets in the absence of subsidies. The difference between the two is the "price gap". Combining the percentage change in prices (the price gap divided by the reference price) with the elasticity of demand yields the change in consumption that would result from the complete elimination of subsidies that cause the price gap. This approach has the attraction of conceptual and analytical simplicity. But it also has limitations. It only captures the effects of subsidies on economic efficiency to the extent that they lower or increase the end-use price of the good. Moreover, the price-gap measures only the net price effect of all the different subsidies; a mix of subsidies may result in a zero net price-gap but still involve significant efficiency losses. However, this approach is an appropriate basis for estimating the impact of subsidies on consumption levels and, therefore, the potential reduction in greenhouse gas emissions from subsidy removal.

Trends in Energy Subsidies in IEA/OECD Countries

8. Subsidies to any economic activity can in principle be rationalised on the basis of theoretical arguments concerning market failure or imperfections that lead to economically sub-optimal outcomes, and on the basis of social and environmental policy considerations.

9. Among the common justifications for subsidies are:

- protecting a particular indigenous industry against international competition and promoting jobs;
- stimulating regional or rural economic development in the interests of national and social cohesion;
- reducing dependence on imports for energy security reasons;
- making modern energy services more affordable for specific social groups;
- raising incomes and living standards for rural communities; and
- protecting the environment.

10. Most OECD countries have reduced or eliminated direct and indirect subsidies over the past two decades as part of a general move away from heavy government intervention in energy markets and other sectors of the economy. Examples include cuts in direct grants and payments to consumers and producers, the lifting of price controls, cuts in direct financing of R&D programmes, privatisation and deregulation of energy companies, and the removal of trade barriers. Few OECD countries now use price controls to achieve social, economic or environmental goals, preferring in general to use grants, taxes, regulatory instruments and support for R&D. These trends largely reflect a profound shift in government attitudes resulting from the perceived failure of past interventionist policies. This stems from an assessment that in many cases the economic and sometimes environmental costs outweigh any social or environmental benefits.

Renewable Energy Subsidies

11. On the other hand, subsidies to encourage the development and deployment of renewable energy sources are rising, driven mainly by local, regional and global environmental concerns and, in some cases, by regional employment objectives. Over the past three years alone (1999-2001), twenty of the twenty-six IEA Member countries introduced new fiscal incentives or subsidies for the promotion of renewable energies.[3]

12. One such widely used mechanism for renewable energy is feed-in tariffs. Feed-in tariffs are based on actual energy production, providing an incentive to maximise capital use and reduce the costs of energy production. In doing so, they reduce costs to consumers; they thus may be contrasted with capital incentives, which reduce initial costs of obtaining capital for plant construction.

13. Straight feed-in tariffs set a pre-determined buy-back rate for all electricity produced under certain conditions. Where bidding systems are used, regulatory authorities decide on an amount of electricity to be produced from renewable energy and invite project developers to bid for that capacity. Successful bidders are guaranteed their bid price for a specified period – fifteen years in the case of the UK's Non Fossil Fuel Obligation (NFFO).[4]

14. To date, fourteen IEA countries subsidise renewable electricity production through feed-in tariffs. Those that boast the highest deployment rates for renewable energy (Table 1) are the ones that have chosen to implement stable, long-term feed-in tariffs. United Kingdom has chosen a bidding system but has not issued any bids beyond NFFO 5[5] and has now introduced a Renewable Obligation, combined with TRCs. France, too, has chosen a feed-in tariff system to overcome low deployment from existing incentives provided to wind energy.

[3] IEA database developed from *Dealing With Climate Change: Policies and Measures in IEA Member Countries, 2000, 2001and 2002 editions*, IEA.

[4] The Non-Fossil Fuel Obligation (NFFO), a policy developed in the United Kingdom in 1990 (replaced in 2000 by the Renewables Obligation), is a scheme by which electricity companies are obliged to buy a fixed amount of power from producers of non-fossil fuels. This capacity was secured through contracts which paid premium rates to electricity generators using renewable energy sources. The Non Fossil Purchasing Agency (NFPA) selected the eligible technologies when they showed the potential of becoming competitive (and also excluded technologies which were approaching competitiveness in the open market and no longer required financial support). The NFPA then invited renewable-energy generators to compete in a tender process.

[5] NFFO 5 was the fifth bidding round of the NFFO.

Table 1

Impact of Incentive Schemes on the Installed Wind-Power Capacity in Europe

Incentives	Country	Installed capacity	Additional capacity
Fixed feed-in tariffs	Germany	4445	1668
	Denmark	1742	555
	Spain	1530	872
	Total	**7717**	**3095**
Bidding systems	United Kingdom	356	53
	Ireland	73	45
	France	23	56
	Total	**452**	**154**

Source: *Wind Power Monthly*, The Windindicator (www.wpm.co.nz)

15. Some feed-in programmes fail to recognise that costs can drop as markets grow. In newer programmes, "technology learning" is reflected as buy-back rates for successive fifteen-year contracts decrease from year to year. The EEG (Erneubare Energiengesetz) introduced such a system in Germany; it became effective in April 2000.

16. A comparison of markets nonetheless shows that in countries with feed-in tariffs, maximum reductions in technology costs have not always been attained. Yet these are the countries which have developed the most vibrant renewable-energy industries. It would appear difficult to simultaneously achieve high rates of market growth, promote industry development and meet cost-competitiveness goals, despite continuous innovation in policies.

Energy Research and Development

17. The total level of energy R&D funding in IEA/OECD countries has been declining in recent years: total reported energy R&D budgets in IEA countries fell by 15.1 per cent in real terms over the period 1990-1998 (see Table 2).[6] Substantial cuts in overall spending on coal and nuclear research (have been offset to a small extent by increases in end-use energy efficiency and conservation R&D (a 68 per cent increase between 1990-98). Nevertheless, nuclear power (conventional, breeders and fusion) still accounts for just over 50 per cent of total spending, due mainly to large programmes in France, Japan and the United States. Nevertheless, and particularly in North America, governments have maintained energy R&D as a significant feature of their policy mix in addressing climate change. IEA's database of energy policies and measures to mitigate climate change shows that .government funding in this area is particularly frequent in North America, where such measures represent close to a quarter of newly implemented policies. This trend reflects a policy approach centred more strongly on technology development, than the use of regulatory or fiscal instruments.

6 IEA, *Energy Policies of IEA Countries, 2002 Review* (forthcoming).

TABLE 2

IEA Government R&D Budgets

(US$ million at 2001 prices and exchange rates)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2001 exch. rates Unit per $
Canada	292.6	272.8	273.1	231.1	233.2	228.1	209.3	183.4	173.2	169.8	161.4	156.2	1.548
United States	3 158.0	3 169.1	2 695.3	2 632.1	2 782.4	2 686.6	2 352.0	2 108.3	2 146.2	2 394.5	2 317.6	2 759.7	1.0
Australia	..	..	..	65.1	..	67.0	..	87.5	..	..	..	..	1.935
Japan	3 053.7	3 097.0	3 121.9	3 197.8	3 422.2	3 538.3	3 697.9	3 515.2	3 538.3	3 499.3	3 580.5	3 568.0	121.50
Korea	..	..	..	..	..	..	..	..	..	..	..	..	1 290.0
New Zealand	1.0	1.0	..	2.2	1.8	2.0	2.4	2.3	2.8	2.7	2.8	3.7	2.382
Austria	11.2	19.2	15.8	20.9	23.0	23.0	22.9	23.8	25.2	24.2	..	..	1.117
Belgium [1]	..	9.7	10.1	16.8	17.3	42.8	54.5	52.0	66.0	46.2	..	..	1.117
Czech Republic	..	..	..	..	..	..	..	..	..	..	..	..	38.02
Denmark	33.1	39.2	45.1	43.3	36.5	34.0	29.4	34.4	41.2	39.7	40.4	41.7	8.321
Finland	35.5	38.7	40.7	41.3	49.1	56.9	55.0	76.3	76.3	52.4	59.9	50.0	1.117
France	488.6	480.6	449.2	443.1	411.5	478.6	453.9	453.2	485.5	566.3	..	..	1.117
Germany [2]	486.4	472.0	369.8	359.6	287.5	246.2	265.0	238.9	255.4	169.6	242.8	252.6	1.117
Greece	9.8	8.7	5.8	4.7	4.3	7.2	8.2	14.6	..	..	5.2	6.2	1.117
Hungary	..	..	..	..	..	0.3	0.1	..	0.5	0.3	..	..	286.5
Ireland	1.1	..	..	..	..	..	..	..	..	..	..	..	1.117
Italy	548.4	503.3	..	261.3	247.8	255.2	236.4	215.4	209.9	..	240.3	253.4	1.117
Luxembourg [3]	-	-	-	-	-	-	-	-	-	-	-	-	1.117
Netherlands	157.9	153.8	148.1	164.2	173.1	124.2	128.7	143.9	133.8	133.9	132.6	..	1.117
Norway	54.5	60.6	64.8	59.5	57.8	48.0	43.6	41.4	41.0	51.6	44.3	42.8	8.993
Portugal	11.2	7.2	6.0	3.9	3.1	1.5	1.8	1.2	1.6	1.9	1.4	1.0	1.117
Spain	44.7	100.0	79.3	66.8	70.9	63.4	60.5	60.2	46.2	47.4	45.4	44.7	1.117
Sweden	72.7	64.8	80.6	60.8	64.2	47.0	42.2	47.2	43.9	58.5	62.1	..	10.34
Switzerland	132.2	132.5	143.0	141.0	137.1	132.2	126.5	120.8	111.7	109.5	112.5	118.6	1.687
Turkey	1.2	1.4	2.0	2.1	1.0	2.5	2.0	6.6	3.2	2.1	2.7	6.8	1228 300
United Kingdom	334.0	268.1	241.0	173.6	88.2	89.4	59.4	78.3	67.6	64.4	70.8	75.6	0.694
Total Reported [4]	8 927.9	8 899.5	7 791.6	7 991.1	8 112.0	8 174.2	7 851.7	7 504.9	7 469.6	..	..	..	
European Commission [5]	..	..	..	..	..	..	..	..	..	..	..	..	1.117

1. Figures for 1991 refer to Wallonia only. From 1991 to 1994, nuclear data are not available and therefore are not included in the budget.
2. Data do not include the new Länder of Germany prior to 1992.
3. Luxembourg has no energy R&D programme.
4. Yearly totals are not comparable due to missing data.
5. No information on R&D budgets has been provided by the European Commission.

Sources: OECD Economic Outlook, OECD Paris, 2001, and country submissions.

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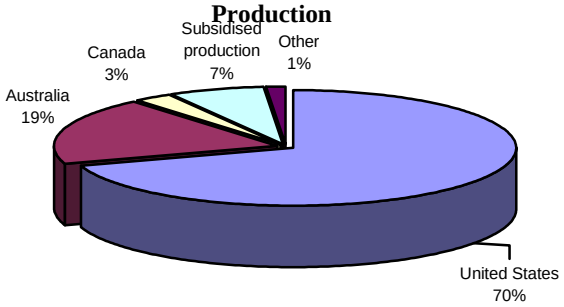
18. Often, energy subsidies are employed to meet many policy objectives at the same time. For example, several OECD countries subsidise the production of fuels derived from agricultural products. These subsidies are often aimed at protecting farming jobs and incomes as well as contributing to better air quality and combating climate change – to the extent that the production and use of such fuels involve lower full fuel-cycle emissions of noxious and greenhouse gases.

Coal Subsidies in IEA countries

19. The IEA has been monitoring the level of hard coal industry subsidy on an annual basis (and bi-annually since 2001), and the results are published in IEA Coal Information.

20. The Producer Subsidy Equivalent (PSE) methodology, originally applied within the OECD to measure the value of financial support for the domestic production of agricultural products, has been applied by the IEA from 1987 onwards to estimate financial assistance to indigenous hard coal production in IEA countries. PSE analysis has focussed on IEA countries with relatively large subsidised industries (France, Germany, Japan, Spain, Turkey and the United Kingdom), but there have been other examples of subsidised production at a much smaller scale (Canada, Norway and Hungary). The Czech Republic also has a significant subsidised industry. As Poland was not a member of the IEA (although a Member of the OECD), no PSE tables were prepared.

Figure 1. Subsidies in IEA Coal Production



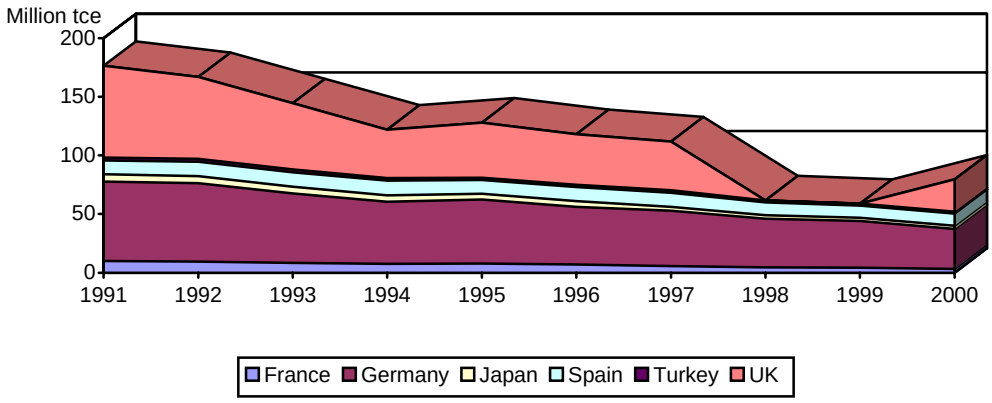
Source: IEA, *Coal Information (2001)*

21. There is a wide variation between the level of aid and the level of coal production. For example, Germany now accounts for 68 per cent of the PSEs and 43 per cent of the subsidised production, whereas the UK accounted for less than 1 per cent of the PSEs but 35 per cent of the production in 2000. In quantitative terms, the European Commission agreed[7] in 2001 to allow Euro 4.693.7 billion worth of aid for the German coal industry: Euro 1.121.1

[7] Since 1965, given the severe problems in the industry, a series of temporary framework decisions have enabled financial assistance to be given. It requires all countries to seek prior authorization for aid measures from the EC on an annual basis.

billion for Spain; Euro 991.4 million for France; and 81.3 million under the "UK Coal Operating Aid Scheme". [8] Government aid to the European coal industry thus totalled Euro 6.267.5 billion in 2001, or Euro 162.39 per tonne of coal produced (including all types of aid, including operating and scaling down activities). This compares with an international market reference price of about Euro 47 per tonne.

Figure 2. Assisted Hard Coal Production in IEA Countries *



* Assisted sub-bituminous production in Spain is included. Belgium (production halted in 1992) and Portugal (production halted in 1994) have not been included.

22. Subsidised coal production is expected to continue to fall in IEA countries. France expects to close its domestic industry by 2005. Japan now expects to phase out subsidies by 2006. Germany is expected to reduce subsidised output and Spain is expected to reduce production a further 20 per cent by 2005. Despite this trend, total elimination of coal production subsidies in IEA countries is not expected in the foreseeable future. Security of supply appears to be the main rationale for continued subsidisation; an argument accepted by the EC in agreeing on the text of a Regulation on state aid to the industry in June 2002. The existing EC Decision, which entered into force at the beginning of 1994, was set to expire on 23 July, 2002, and after that date, coal would have been subject to the normal state aid rules of the EC.

23. The new Regulation applies from 24th July 2002 onwards and expires on 31st December 2010. It will, however, be reviewed by the Commission in 2007, when it will assess the effectiveness of indigenous base of primary energy sources and the actual contribution of indigenous coal to the EU's long-term energy security. There is no clear evidence of a realistic security of supply justification, when coal reserves are widely distributed in geopolitically stable countries, including within the IEA/OECD. The Commission must also take account of the social and regional issues involved in restructuring the coal industry. Again, an argument can be made that there are other, more efficient, methods of targeting scarce financial resources to regions affected by the decline of the indigenous hard coal industry.

[8] The recent reintroduction of state aid for coal in the UK is for a limited period, covering from April 2000 to July 2002.

24. Electricity market liberalisation should also support the trend towards reducing subsidies, as electric utilities will be increasingly reluctant to take on obligations to purchase domestic coal when this is not competitive with either imported coal or with power generation by other means.

Are All Energy Subsidies Bad?

25. Depending on the type and form of subsidy, the loss of economic efficiency may be reflected in some of the following ways. Subsidies to producers, by cushioning them from competitive market pressure, tend to reduce incentives to minimise costs, resulting in less efficient plant operation and sub-optimal investment. Subsidies to consumption and/or production, by lowering end-use prices, lead to higher energy use and reduced incentives to conserve or use energy more efficiently. Subsidies to specific energy technologies will tend to undermine the development and commercialisation of other technologies that might ultimately become more economically and environmentally attractive.

26. But fossil fuel subsidies do not necessarily always lead to adverse environmental effects. Public funding of fossil-fuel R&D activities could actually yield positive environmental effects to the extent that it results in the development and deployment of more efficient, cleaner burning technologies. Subsidies to support renewable energy, nuclear power and energy-efficient technologies may help to reduce noxious and GHG emissions depending on how the subsidies are structured and market conditions.

27. There is also a good case to be made for retaining an element of subsidy (particularly in non-OECD countries) to improve access to modern energy sources for the poor – especially where the social welfare infrastructure for distributing income support to the poor does not exist. This argument is particularly strong for electricity, because of the key role it plays in economic and social development, in alleviating poverty and reducing indoor air pollution. They should not, however, lead to excessive levels of energy consumption and environmental damage. Such subsidy programmes need to be well-targeted, efficient, soundly based, practical, transparent and limited in time.

The Impacts of Energy on the Environment

28. The energy system is a major emitter of the three most important greenhouse gases -- carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) -- behind human-induced climate change. Fossil fuel combustion, and to a lesser extent production and transformation, contribute nearly all (97 per cent) of the man-made CO_2 emissions, 28 per cent of CH_4 emissions and 17 per cent of N_2O emissions in OECD countries (Table 3)[9]. With the global warming potentials of the various gases factored in, energy use is the source of 83 per cent of OECD greenhouse gas emissions.

[9] Fossil fuel production and transformation release methane through the venting of natural gas in oil operations and coal mining.

Table 3
Contributions of Energy Use to Human-Induced Greenhouse Gas Emissions in OECD Countries, 1998

	CO_2 (81.7%)	**CH_4 (9.7%)**	**N_2O (6.6%)**	**HFCs, PFCs and SF_6* (2.0%)**	**Total (100%)**
Energy Sector					
Share of GHG Emissions	79.2%	2.7%	1.1%	0%	83.0%
Main Sources	Fossil fuel combustion	Fugitive emissions from coal, oil and gas extraction and transport	Fossil fuel combustion	Not applicable	
Non-energy Sector					
Share of GHG Emissions	2.5%	7.0%	5.5%	2.0%	17%
Main Sources	Industrial processes	Livestock and waste	Agriculture and industrial processes	CFC substitutes*	

* HFCs = hydrofluorocarbons; PFCs = perfluorocarbons; SF_6 = sulphur hexafluoride; CFC = chlorofluorocarbons

Source: UNFCCC, *National Communications from Parties included in Annex I to the Convention: Greenhouse Gas Inventory Data from 1990 to 1998, FCCC/SBI/2000/11*, 5 September 2000.

26. Without proper controls, combustion of fossil fuels leads to emissions of particulate matter, sulphur oxides (SO_x), nitrogen oxides (NO_x) and volatile organic compounds (VOCs). Total suspended particulates refer to smoke, soot, dust and liquid droplets from combustion that are in the air. Particulate levels indicate the quality of the air people breath, and emissions are dangerous to human health, causing respiratory problems. Sulphur dioxide is an air pollutant produced when fossil fuels containing sulphur are burned. It is a precursor to acid rain, which causes acidification of lakes, streams and groundwater (resulting in damage to fish and other aquatic life), damage to forests and to agricultural crops, as well as deterioration of man-made materials (such as buildings, metal structures and fabrics). The soil deposition of nitrogen from NO_x emissions and nitrogenous fertilisers can lead to nitrogen

run-off, which can stimulate the growth of algae and other aquatic plants leading to algal bloom or entrophication of lakes, rivers and streams. Nitrous oxides and VOCs contribute to the formation of photochemical smog (primarily ozone). In addition, lead pollution from combustion in motor vehicles is still a problem in a few OECD countries and an ongoing problem in many developing countries, causing mental health disorders particularly in children.

Table 4
Contribution of Energy Use to Air Pollutants, Mid-1990s
(Percentage of total emissions in OECD countries deriving from energy use)

Air Pollutant	Transport	Electricity Production	Other Combustion (industry and residential)	Non-Energy
SO_x	7%	55%	25%	13%
NO_x	53%	22%	19%	6%
CO	72%	1%	12%	16%
VOC	39%	0%	6%	54%
Particulates	17%	11%	25%	47%

Source: OECD, *OECD Environmental Data: Compendium 1999*, Paris.

27. Whereas the air pollution associated with energy is caused mostly by fossil fuel use (combustion), water pollution and ecosystem impacts derive mostly from the production, transformation and transport of energy. Land-use pressure in the energy sector — when energy activities are sited in conflict with agriculture and housing opportunities, or where natural ecosystems could be lost — has focused on mining sites and hydroelectric reservoirs. New efforts to find suitable sites for large-scale wind or solar photovoltaic fields are facing some of the same pressures.

28. Global demands for oil and gas have led to exploration and production in some areas of high environmental sensitivity. Energy extraction activities, such as oil and gas drilling and open-pit coal mining in ecologically sensitive areas, pose problems for local fauna and flora. Acid drainage problems can occur from existing or abandoned coal mines. Uranium mining and milling releases radon and radon compounds, which are potential occupational hazards. The overall scale of their impact is limited though, because of the high energy density of uranium. Process effluent and tailings may cause groundwater contamination.

29. Fuel transport also presents environmental, health and security concerns (e.g. from leaking oil tankers, and oil and gas pipelines, as well as transport of radioactive materials). Because of the very visible environmental consequences and the number of accidents involving marine-based pollution, much attention has centred on oil discharge and spills. Spills can occur in coastal waters important to fishing, tourism or industry, and cause damage to marine ecosystems. Oil and gas pipelines present additional environmental (e.g. methane leakage and land use implications) and political (e.g. siting and construction of transboundary pipelines) challenges.

30. Nuclear power has unique environmental and safety issues. The transport and disposal of high-level nuclear waste is an issue of particular public concern. The volumes of wastes produced by nuclear power plants are small compared to those produced by fossil-fuelled electricity plants. However, high-level nuclear wastes have potential health effects much more acute and severe than wastes from fossil fuel plants. They are deadly if not shielded; they cannot be chemically or physically neutralised like many other toxic wastes, and they cannot be dispersed safely. Furthermore, nuclear wastes must be transported (often long distances) to the few sites suitable for their disposal, increasing the opportunities for transportation mishaps. All in all, the costs of properly handling and disposing of high-level wastes, on a unit basis, are very high.

Environmentally Harmful Subsidies

31. Coal production subsidies have come under particular scrutiny because of their potential environmental impact. Their removal could lead to a reduction in GHG emissions if the removal leads to decreased coal use rather than substitution by imported coal. However, for the most part, remaining coal production subsidies in IEA countries do not lead to subsidised end-user prices. Hence the removal of subsidies would not lead to direct increases in prices paid by consumers of coal. An indirect effect could result from the loss of this production from world coal markets leading to a tightening of supply and hence an increase in price. As the quantity of subsidised production is relatively small (less than 2 per cent of world production and about 10 per cent of internationally traded coal) the effect on hard coal prices by the removal of this production is expected to be limited.

32. A recent analysis prepared by the OECD[10] looked at ending coal production subsidies as part of a broader study of the environmental effects of liberalising trade in fossil fuels. The analysis forecasts that the elimination of such producer subsidies would lead to both substitution by imported coal and an increase in gas-fired power generation over a "business as usual" case.

[10] OECD, *Environmental Effects of Liberalising Fossil Fuels Trade: Results from the OECD Green Model COM/TD/ENV(2000)38 21 April 2000.*

33. The impact of subsidy removal will depend on country-specific circumstances. These can be very different, in terms of energy policies, the state of development of the electricity markets, and on the performance of competitors in the market. In the UK, the reduction and eventual elimination of the obligations of the large power producers to purchase domestic coal led to a rapid increase in gas-fired generation at the expense of existing coal-fired generation. However, the conditions under which the market was liberalised and increases in nuclear output also played a role in this rapid reduction of coal use. The recent reintroduction of state aid for a limited period will likely not change these dynamics significantly.

34. In Spain, many of the existing coal-fired generation stations using domestic coal would incur significant transportation costs to use imported coal and may not be competitive with other generation sources. Gas-fired generation is poised to take a significant market share with over 14 GW of projects announced to meet expanding demand and falling output from domestic coal-fired plants. Increased output at existing coal-fired plants using imported coal can also be expected if domestic coal requirements are reduced. The emissions benefits of replacement of the domestic coal plants by gas-fired generation may be offset to a limited degree by a reduction in electricity prices, as electricity consumers would no longer be paying incentives to utilities to use domestic coal.

35. By contrast, the situation in Germany appears quite different. There, consumers of coal are already free to choose suppliers. So the effect of eliminating the subsidies on demand for coal is unclear as coal consumers might be expected to switch to imported coal. Even this transition, however, could have some limited environmental benefits if the substituted coal is of higher grade. Other energy policy initiatives and increasing competition in European electricity markets can also be expected to have an impact on coal-fired generation in Germany.

36. Very few studies have examined the overall level of OECD energy subsidies – excluding coal – and the impacts of their removal on the environment. Those that are available, are dated, and market situations have changed considerably since these were undertaken. Further, there is a considerable range in the results of the studies depending on approach used and the definition of what constitutes a subsidy. A good example is found in a recent paper that examined the results from ten studies on fossil fuel subsidies in the United States.[11] The range of estimates for fiscal subsidies to fossil fuels in the United States was found to be between $2.6 and $121 billion (including tax preferences, general agency support for energy and spending related to energy security). When "aggregate" subsidies were shown (including externalities, and such things as roadway construction, maintenance and operation and in one case an attribution of the entire cost of the military presence in the Persian Gulf as a subsidy to oil), the numbers range even wider – from $200 million per year to $1.7 trillion!

37. In general though, various studies have demonstrated that gross energy subsidies in OECD countries are generally much smaller than in developing countries and the transition economies and, in most countries, are more than offset by taxes. For example, the 1998

[11] Koplow, Doug and Dernbach, John, *Federal Fossil Fuel Subsidies and Greenhouse Gas Emissions: A Case Study of Increasing Transparency for Fiscal Policy* in Annual Review of Energy and Environment, 2001.

OECD study [12] estimated that Member countries' energy subsidies amounted to US$19-24 billion per year. The bulk of these go to oil and coal producers, although the nuclear industry receives significant sums mainly through support to R&D. The results of a US Government study completed in 2000 are broadly in line with those of the OECD study: total US federal subsidies to the energy sector were estimated at US$6.2 billion in 1999.[13] The US Department of Energy studies have also concluded that, even though there are a wide range of direct and indirect subsidies, they are not large in relation to the total value of energy production – equivalent to just over 1 per cent of the total value of energy supply in the US in 1999.

38. But other studies carried out by NGOs have produced significantly larger estimates. For example, a 2000 study by Koplow and Martin estimated the cost of US federal subsidies to the oil industry alone at US$5.2-11.9 billion in 1995, excluding the costs of defending Persian Gulf oil supplies. The largest single elements were stockpiling of oil in the Strategic Petroleum Reserve to protect against supply disruptions and tax breaks for domestic oil exploration and production.[14]

39. The OECD together with the IEA conducted a study in 1997 for the Annex I Expert Group to the UNFCCC. The study is based on a asset of country case studies, using a range of energy market, energy systems, and macroeconomic models to evaluate the effects of removing various types of government interventions that can be classified as subsidies in the coal and electricity sectors. It concluded that it is not possible to generalise about the environmental and economic effects of removing subsidies, but they do identify particular types and combinations of policies whose removal or reform would probably reduce GHG emissions. The results of the different case studies on energy subsidy removal are summarised in Table 5.

[12] Burniaux, Martin and Oliveira-Martins, *The Effects of Existing Distortions in Energy Markets on the Cost of Policies to Reduce CO2 Emissions: Evidence from GREEN, OECD Economic Studies* (Paris, Winter, 1992).

[13] US Department of Energy/Energy Information Administration, Federal Energy Market Interventions 1999 (Washington 1999 and 2000).

[14] Koplow and Martin, Fuelling Global Warming: Federal Subsidies to Oil in the United States, commissioned and published by Greenpeace (Washington: 2000).

Table 5
Summary Results from OECD/IEA Case Studies of Energy-Subsidy Removal in OECD

	Subsidies removed	Monetary equivalent of distortion ($ million)	Reduction in CO_2 emissions relative to reference scenario in 2010 (million tonnes)
Australia	State procurement/planning	133	0.3
	Barriers to gas and electricity trade	1 400	0.8
	Below-market financing cost	NQ	NQ
Italy	Net budgetary subsidies to ESI	4 000	12.5
	VAT below general rate	300	0.6
	Subsidies to capital	1 500	3.3
	Tax exemptions on fossil fuel inputs to ESI	700	5.9
Norway	Barriers to trade	NQ	8.0 (Nordic region)
United Kingdom	Grants/price supports to coal and nuclear producers	2 500	0.0 to 40.0
		NQ	NQ
	Below-market required rate of return in ESI	1 200	0.2
	VAT on electricity below general rate		

Note: Subsidies are defined in different ways and so results are not strictly comparable. NQ = not quantified.

Source: OECD, *Reforming Energy and Transport Subsidies* (1997).

40. A 1992 OECD study focused on the effects of policies that artificially maintained domestic end-use prices for energy below comparable prices on world markets.[15] Neither market-price support to production nor budgetary support to either production or consumption were considered. Using 1985 data, the study calculated $235 billion in global transfers to consumers of primary fossil energy through lower prices. Such consumption subsidies were concentrated in non-OECD countries (subsidies of $254 billion), though the United States was found to have a small net subsidy for oil and gas. Small net taxes (i.e. negative subsidies) on primary energy in the OECD amount to $19 billion. The authors used the OECD GREEN model to estimate the impact of removing distortions that keep prices below world levels (over the 1990-2000 period) on real GDP and carbon emissions. The *no-price distortion* case also re-prices energy to world prices in countries with domestic primary energy product prices higher than world prices. Results were derived relative to a *business-as-usual* case, where existing subsidy levels were maintained. Simply removing existing energy price distortions improves cumulative discounted world real income by 0.7 per cent over the 1990-2050 period, while reducing 2050 carbon emissions by 18 per cent, caused principally by a 16 per cent fall in energy use.

Energy Taxes

41. Taxes, which are the opposite of subsidies, must be taken into account in any calculation of subsidies and their impact since they can offset the effect of subsidies. Very few OECD countries impose taxes on the production or sale of coal; in those countries that do, such as the United States (where special taxes and levies are imposed at the federal and state levels), the level of taxation is generally very low compared with oil products.

42. Historically, the main role of taxes on energy products has been to raise revenues for governments. In OECD countries, these taxes represent, on average, slightly less than 6 per cent of total tax revenues [16] (6.5 per cent for the EU15). About 90 per cent of total energy taxes come from motor fuel taxes.

43. OECD countries in general levy substantial taxes on oil products (in addition to general sales or consumption taxes), more than offsetting the effect of any subsidies on the final price in most cases. Table 6 shows aggregate tax revenues from oil product sales alone, excluding general sales taxes in selected OECD countries for 1998. In 1998, special taxes on oil product sales alone in the United States amounted to more than US$35 billion.[17] In almost all OECD countries, tax revenues from the sale of oil products and other forms of energy over and above those from general sales taxes far exceed public spending on direct financial

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15 J-M Burniaux, J. Martin, J. Oliveira-Martins, The Effects of Existing Distortions in Energy Markets on the Cost of Policies to Reduce CO_2 Emissions: Evidence from GREEN, OECD Economic Studies, Winter, 1992, pp. 141-165.

16 OECD/ENV: Environmentally-Related Tax Database. http://www.oecd.org/env/policies/taxes/index.htm. Note that the definition that the OECD uses for environmentally-related taxes includes "any compulsory, unrequited payment to general government levied on tax bases deemed to be of particular environmental relevance." This definition includes all energy taxes (which represent around 90 per cent of the total) as well as vehicle taxes, but the database also covers fees and charges for environmental services provided by the government.

17 IEA, Energy Subsidies in OECD Countries (Economic Analysis Division Working Paper Paris: 2000).

subsidies, such as grants, soft loans and interest rate credits, and energy R&D. This is particularly the case with road transport fuels. The share of taxes in the final pump price of unleaded gasoline across the OECD varies from 13.0 per cent in Mexico and 26.5 per cent in the United States, to 78.9 per cent in the United Kingdom (based on fourth quarter 2001 data).[18]

Table 6
Revenues from Special Duties and Levies on Sales of Oil Products in Selected OECD Countries, 1998 ($ million)

Country	*Revenues*
Canada	4 482
France	26 718
Germany	37 906
Italy	57 604
Japan	25 095
United Kingdom	34 556
United States	35 148

Note: Revenues exclude general sales tax receipts. Source: OECD databases.

44. Some countries also impose special taxes such as excise duties or local taxes on other forms of energy, including natural gas, coal and electricity, but in almost all cases the rate of taxation is lower than for oil products. This is largely because of the low price elasticity of demand for oil-based transport fuels (which provides a stable source of tax revenue), concerns over the international competitiveness of industry and distributional considerations (which limit the extent to which governments tax household heating fuels). Favourable taxation of non-oil energy sources aimed at distorting the fuel mix away from oil has also been motivated in most OECD countries by concerns over energy supply diversity and oil security. For example, relatively low taxes on natural gas have been used in several European countries to promote rapid switching from other fuels.

Conclusions

45. One of the biggest barriers concerning energy subsidies in the OECD countries is a lack of up-to-date empirical data and analysis. Studies that have been undertaken on energy subsidies in OECD countries, show results with remarkably large variance, due to

[18] IEA, *Energy Prices and Taxes, 1st Quarter 2002* (2002); taxes on premium unleaded (95 RON) gasoline prices. Taxes include general sales and consumption taxes.

methodologies used and the variety of definitions of energy subsidy incorporated. The notable exception is the case of coal subsidies, where both the IEA and the European Commission keep close track of levels of subsidies to their Member countries.

46. In general, most OECD countries can be seen to have reduced direct subsidies to energy in recent years, with the notable exception of renewable energies. Coal subsidies, in particular, have been reduced significantly. Energy subsidies in OECD countries are in large part offset by heavy taxation levels, particularly for oil products. Coal, on the other hand, is currently not subject to similar taxation rates. However, the introduction of climate change policies, in particular carbon taxes and emissions trading mechanisms, will result in some internalisation of environmental externalities for coal and other fossil fuels.

47. This paper has focussed on energy subsidies in IEA/OECD countries. It has not, for example, provided information on the effects of subsidy reform in Member countries on the global environment. For example, the effects of production shifts to lower cost developing country suppliers where environmental standards would not be at OECD norms. Further, energy subsidy reforms in developing countries and in economies in transition where subsidy levels are higher and prices not maintained at market levels, could have profoundly greater environmental benefits than reforms in IEA/OECD countries. IEA's 1999 study shows that the removal of consumption subsidies in eight of the largest non-OECD countries would reduce primary energy use by 13 per cent, lower CO2 emissions by 16 per cent and raise GDP by almost 1 per cent.[19]

48. Finally, energy subsidies cannot be globally characterised as all-bad or all-good, when it comes to environmental damage. Renewable energy support mechanisms and R&D programmes for energy-efficient technologies, are some examples of subsidies which are not per se environmentally damaging and may help reduce emissions of GHG and other pollutants. However, subsidies may not be the most efficient way of achieving this. It is not clear whether reduced spending on fossil-fuel R&D would lead to lower emissions, since much of this effort is aimed at improving combustion efficiency and therefore reducing fuel requirements. On the other hand, some NGOs have argued that any use of fossil fuels is environmentally damaging and thus any support to those fuels must be termed environmentally harmful. There is also the special case of nuclear energy – while nuclear power emits relatively low GHG and other emissions, it has other potential environmental impacts including issues of radio-active waste transport and disposal.

49. While energy subsidy reform, involving a reduction in certain types of subsidy to fossil fuels, may yield positive environmental effects, it can also have significant social implications. Dealing with distributional effects, in particular, is often a major element in overcoming political obstacles to subsidy reform. In some cases, energy security may be affected. This explains the difficulties some OECD governments face in trying to reform remaining environmentally damaging subsidies.

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19 The IEA and the United Nations Environment Programme conducted a series of regional workshops on energy subsidy reform, the results of which are available at www.iea.org. See also IEA, *World Energy Outlook 1999 Insights: Looking at Energy Subsidies – Getting the Prices Right*, 1999.