

Energy and environment in the European Union

Executive summary



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Note

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Introduction

This is the first indicator-based report produced by the European Environment Agency on energy and the environment. It covers the European Union (EU), and is designed to provide policy-makers with the information necessary for assessing how effectively environmental policies and concerns are being integrated with energy policies, in line with the environmental integration process initiated by the European Council's Cardiff Summit in 1998. The report aims to support the EU sixth environmental action programme and in this way to provide input, from an environmental perspective, to sustainable development in the EU.

Energy is central to social and economic well-being. It provides personal comfort and mobility, and is essential to most industrial and commercial wealth generation. However, energy production and consumption place considerable pressures on the environment, including contributing to climate change, damaging natural ecosystems, tarnishing the built environment and causing adverse effects to human health.

EU energy policy reflects these wide-ranging issues and has three main goals:

- security of supply
- competitiveness
- environmental protection.

While these areas may be considered separately, they are strongly interrelated. For example, improvements in energy efficiency both benefit security of supply by reducing the amount of energy consumed and reduce emissions of greenhouse gases and pollutants by reducing the consumption of fossil fuels. On the other hand, energy market liberalisation and more price competition benefit competitiveness through reduced costs, but unless external costs are fully internalised and energy demand management

improves, the reduction of costs may bring price reductions that are likely to act as a disincentive to energy saving and even encourage energy consumption.

In line with the energy policy goals, the specific environmental objectives of EU energy policy on environmental integration (as detailed in the European Commission communication on environmental integration within Community energy policy, 1998) are to:

- reduce the environmental impact of energy production and use
- promote energy saving and energy efficiency
- increase the share of production and use of cleaner energy.

This report provides an assessment, based on indicators, of progress by the energy sector towards environmental integration. These examine performance in the EU as a whole, as well as in individual Member States, and are supported, where possible, by an analysis of progress towards quantitative targets. Factors that have affected change are examined and quantitative analysis is provided where feasible. The indicators examine trends over the period 1990–99 and compare these with baseline projections to 2010, which originate from European Commission studies and assume both a continuation of policies adopted by 1998, and that the EU voluntary agreement with the car industry on reducing carbon dioxide emissions from new passenger cars will be honoured.

In line with the sectoral reporting strategy adopted by the Agency, the report addresses six policy questions to provide a systematic evaluation of all aspects of the environmental integration of the energy sector.

1. Is the use of energy having less impact on the environment?
2. Are we using less energy?
3. How rapidly is energy efficiency being increased?
4. Are we switching to less-polluting fuels?
5. How rapidly are renewable energy technologies being implemented?
6. Are we moving towards a pricing system that better incorporates environmental costs?

Overall, while there have been some successes, there has been insufficient progress in most of the areas of environmental integration covered by this report. In relation to the above six questions, the following conclusions can be drawn:

1. (a) Emissions of greenhouse gases in the EU fell between 1990 and 2000, but without additional measures are unlikely to fall further to 2010 and beyond because of increased energy-related emissions. Ongoing successful initiatives in some Member States appear to point the way forward.
(b) Measures taken to reduce atmospheric pollution from energy use are proving successful, with a number of Member States on track to meet the reduction targets set for 2010.
(c) Oil pollution from coastal refineries, offshore installations and maritime transport has been reduced, but still places significant pressures on the marine environment.
2. Energy consumption is increasing, mainly because of growth in transport but also in the household and services sectors. However, the rate of increase is expected to slow by 2010 as fuel efficiency improvements in transport are realised.

3. Improvements in energy efficiency have been slow, but improvements in some Member States are showing the potential benefits of good practices and strategies.
4. The EU is switching from coal to the relatively cleaner natural gas, but after 2010 no further switching is expected. Furthermore, some nuclear installations will retire and, if these are replaced by fossil fuel plants, increases in carbon dioxide emissions are likely. This underlines the need to further strengthen support for renewable energy sources.
5. Renewable energy targets are unlikely to be met under current trends, but experience in some Member States suggests that growth could be accelerated by appropriate support measures.
6. Despite increases in energy taxation, most energy prices in the EU have fallen, as a result mainly of falling international fossil fuel prices but also of the liberalisation of energy markets. In the absence of appropriate policies to internalise the external costs of energy and improve energy demand management, reduced prices are likely to act as a disincentive to energy saving and may encourage energy consumption.

The following sections provide an assessment of each of the key energy and environment policy questions.

1. Is the use of energy having less impact on the environment?

1.a. Greenhouse gas emissions

Greenhouse gas emissions in the EU related to the use of energy fell proportionately less than total greenhouse gas emissions between 1990 and 2000, increasing their share of the total to 82 %. The reduction in energy-related emissions can be partly attributed to one-off reductions in Germany and the UK. Nevertheless, the EU achieved its commitment to stabilise carbon dioxide emissions in 2000 at 1990 levels.

However, it will be difficult for the EU to meet its Kyoto Protocol target of reducing total greenhouse gas emissions by 8 % from 1990 levels by 2010. Without additional measures, total emissions in 2010 are likely to be about the same as in 1990, with a further fall in non-energy related emissions being offset by a rise in energy-related emissions, driven mainly by the transport sector.

Assuming that the Kyoto Protocol target will be met using only domestic measures, the majority of Member States have not made sufficient progress to ensure meeting their targets under the EU burden-sharing agreement. Distance-to-targets analysis performed on the basis of 1999 data shows that Finland, France, Germany, Luxembourg, Sweden and the UK reduced total emissions at least enough to be on track to achieve their 2010 targets. However, in all Member States, with the exception of Sweden, energy-related emissions between 1990 and 1999 either fell less than or increased more than total emissions.

Beyond 2010 energy consumption levels are expected to continue to increase, at least to 2020. Meeting the European Commission's proposed EU total emission reduction target of 1 % per year from 1990 levels up to 2020 would require long-term changes in energy production and consumption patterns (power plants, buildings, transport, etc.). These patterns will be determined by decisions taken imminently, so reducing future energy-related emissions requires policy action now.

- ☺ Total EU greenhouse gas emissions fell between 1990 and 2000, but energy-related emissions, by far the largest component, fell considerably less, making significant reductions in total emissions in coming decades unlikely.
- ☹ Most Member States have failed to reduce greenhouse gas emissions in line with their share of the EU commitment under the Kyoto Protocol.
- ☹ The reduction in energy-related greenhouse gas emissions over the last decade was achieved through considerable reductions by the manufacturing and energy supply sectors, mostly offset by growth in transport.

A number of initiatives to pave the way for long-term greenhouse gas emission reductions from energy use are ongoing in Member States. For example, seven Member States have already introduced carbon taxes.

Figure 1: Change in energy-related greenhouse gas emissions by economic sector, 1990–99

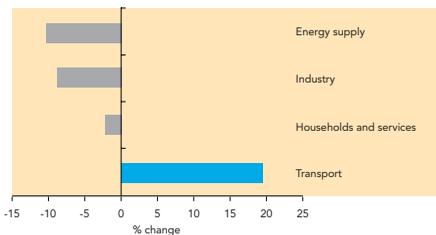
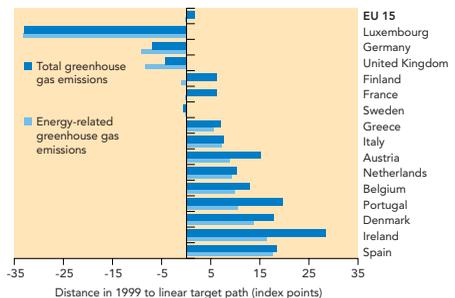


Figure 2: Performance in reducing total and energy-related greenhouse gas emissions to meet Kyoto Protocol targets, 1999



Note: The diagram indicates whether a Member State was on track in 1999 to meet its shared Kyoto Protocol target. A negative value suggests an over-achievement and a positive value an under-achievement against the linear target path from 1990 to 2010. For the purpose of this analysis it is arbitrarily assumed that energy-related emissions will be reduced proportionately with total emissions. **Source:** EEA.

1.b. Air pollution

Energy use is a major source of atmospheric pollutants. It contributes just over 90 % of EU sulphur dioxide emissions, almost all emissions of nitrogen oxides, about half the non-methane volatile organic compound emissions and around 85 % of particulates.

Measures taken to reduce atmospheric pollution from the use of energy have been successful. These include the introduction of catalytic converters, the use of pollution abatement technologies encouraged by the large combustion plant directive and the use of best available techniques required by the integrated pollution prevention and control directive. Fuel switching from coal and oil to natural gas has also made an important contribution to the reduction of atmospheric pollution.

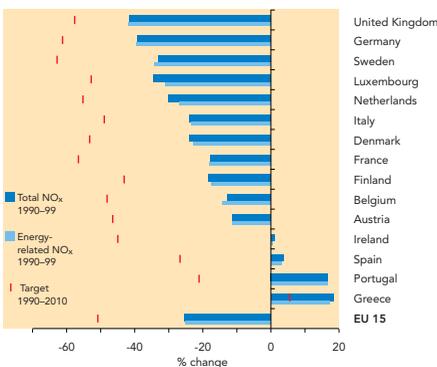
In the electricity sector, more than half of the reductions in emissions of sulphur dioxide and nitrogen oxides resulted from the introduction of emission-specific abatement measures, about a quarter from changes in the fossil fuel mix, and the rest from improved efficiency of fossil-fuelled electricity production and increased shares of nuclear and renewables.

Target reductions for total (energy and non-energy related) emissions of sulphur dioxide, nitrogen oxides and non-methane volatile organic compounds for 2010, relative to 1990, have been set in the national emissions ceilings directive. Overall, the EU is on course to meet these targets and is also making good progress in reducing particulate emissions. The energy-related emissions of all these pollutants have been reduced more quickly than total emissions.

Most Member States have contributed to all these reductions but Greece, Ireland, Portugal and Spain need to take further action to ensure that they meet their targets.

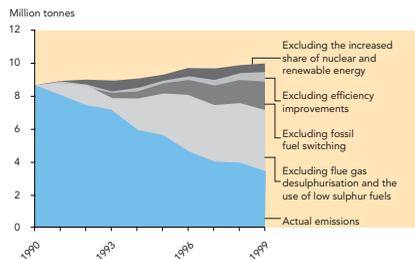
- ☺ Energy-related sulphur dioxide emissions fell considerably between 1990 and 1999. This is the main reason that the EU and most Member States are expected to achieve their 2010 targets for reducing total sulphur dioxide emissions, as set in the national emission ceilings directive.
- ☺ Energy-related emissions of nitrogen oxides also fell, placing the EU and some Member States on track to achieve their 2010 reduction targets for total nitrogen oxide emissions, as set in the same directive.
- ☺ The reduction in energy-related emissions of non-methane volatile organic compounds (NMVOCs) has greatly helped to put the EU and some Member States on course to achieve their 2010 targets for reducing total NMVOC emissions, as set in the national emission ceilings directive.
- ☺ Energy-related emissions of particulates fell by 37 % between 1990 and 1999, mainly as a result of reductions from power plant and road transport.

Figure 3: Change in total and energy-related emissions of nitrogen oxides, 1990–99



Note: Target values are for total emissions.
Source: EEA.

Figure 4: Explanations for the reduction of emissions of sulphur dioxide in the electricity sector, 1990–99



Source: EEA.

1.c. Other energy-related pressures

Other environmental pressures from energy production and consumption include wastes from mines and nuclear plant, water contamination from mining, oil spills and discharges to marine waters, soil damage from spills and leakages of liquid fuels, and impacts on ecosystems from the construction and operation of large dams.

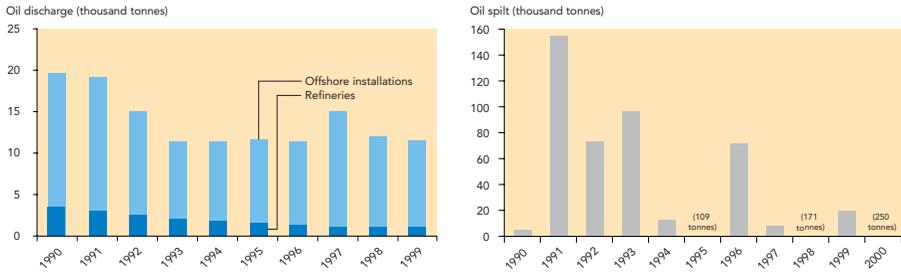
This report provides information on spills and discharges of oil to the marine environment, and nuclear waste. Trends in these areas warrant monitoring, and data, though not comprehensive, are of sufficient quality to indicate pressures from marine oil pollution and radioactive waste production.

Tanker oil spills continue to occur, although both their frequency and the volumes involved have declined over the past decade. This may reflect the irregular occurrence of such accidents, but it is encouraging that the apparent improvement has come despite the increasing maritime transport of oil. Strengthened safety measures, such as the introduction of double-hulled tankers, have contributed to this. Additionally, oil discharges from offshore installations and coastal refineries have diminished, despite increased oil production, as a result of the increased application of cleaning and separation technologies.

Spent nuclear fuel is the most highly radioactive waste, in many cases taking up to several hundred thousand years to decay. As the amount produced is determined mainly by the quantity of electricity generated from nuclear plants, the annual quantities of spent fuel are likely to decrease as nuclear power production starts to decline. Work is ongoing to try to establish final disposal methods that alleviate technical and public concerns over the potential threat that this waste poses to the environment. In the meantime, the wastes accumulate in stores. The European Commission has proposed more support for research and development on nuclear waste management in its sustainable development strategy.

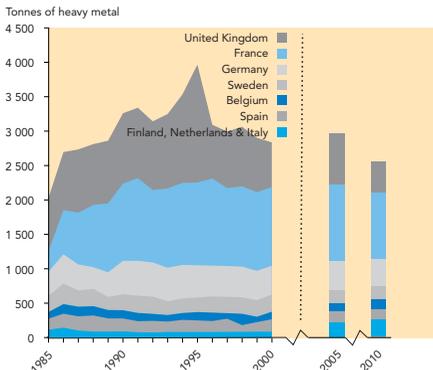
- ☹️ Oil pollution from offshore installations and coastal refineries has been reduced, but major oil tanker spills continue to occur.
- ☹️ Highly radioactive waste from nuclear power production continues to accumulate. A generally acceptable disposal route is yet to be identified.

Figure 5a/5b: Marine environment oil pollution from refineries and offshore installations, and from accidental oil tanker spills (above 7 tonnes per spill)



Sources: Eurostat, OSPAR, CONCAWE, DHI, ITOFF.

Figure 6: Annual quantities of spent nuclear fuel from nuclear power plant



Notes: The vast majority of highly radioactive waste consists of spent fuel and spent fuel reprocessing wastes. 2000 figures for Spain, Sweden and the UK are based on provisional data. Projected data is taken from national projections with the exception of Sweden for 2010, which is a projection from the OECD. Austria, Denmark, Greece, Ireland, Luxembourg and Portugal do not have nuclear power plants. Italy phased out commercial nuclear power in 1987. The projected increase attributed to Finland, Italy and the Netherlands is due to a projected increase from Finland only.

Source: OECD.

2. Are we using less energy?

One of the aims of the EU strategy for integrating environmental considerations into energy policy is to increase energy saving. Cost-effective energy saving has many benefits: it decreases pressure on the environment, improves competitiveness and allows countries to be less dependent on energy imports.

Energy consumption by final energy users increased between 1990 and 1999 in all but one sector, with the fastest growth coming from transport. Manufacturing industry's small decline in energy consumption reflects some improvements in energy efficiency but mainly reveals the effect of structural changes, including a shift towards low energy-intensive industries, relocation of energy-intensive industries away from EU countries, and the post-unification restructuring of German industry.

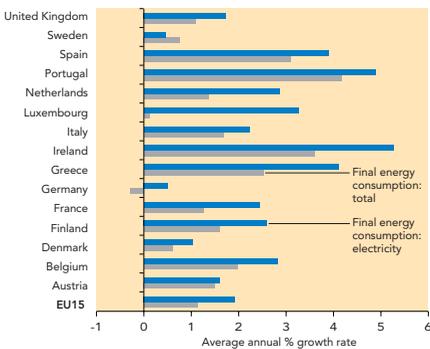
Baseline projections to 2010 indicate continued growth in energy consumption, but at a lower rate than between 1990 and 1999, mainly because of a slower rate of increase in energy consumption by the transport sector. This is due to expected improvements in road vehicle fuel efficiency as a result of the voluntary agreement between the car industry and the EU, rather than a slowdown in road transport growth.

Electricity continues to take an increasing share of final energy consumption in all EU countries, both as a result of more electrical appliances in the services and household sectors, and a greater use of electrically based production processes in industry. Electricity is produced from other fuels and the consumption of each unit of electrical energy requires the consumption of two to three units of another energy source. Growth in electricity consumption will therefore result in a disproportionately greater increase in environmental pressures, especially in carbon dioxide emissions, unless it comes from high-efficiency, low-emission technologies that reduce sufficiently the environmental consequences of electricity production.

- ☹ Energy consumption in the EU continued to grow between 1990 and 1999; this trend is expected to continue.
- ☹ Electricity consumption in the EU grew faster than final energy consumption between 1990 and 1999; this trend is expected to continue.

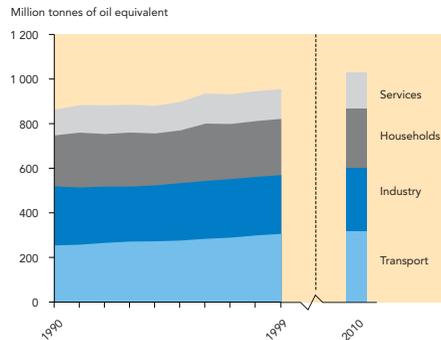
The use of electrical energy for heating is a particularly inefficient use of the original energy resource. In Denmark, the Electricity Saving Fund, financed by a levy on domestic electricity consumption, enables the government to grant subsidies for the conversion of electrically heated dwellings to district heating or natural gas. Also, natural gas companies encourage customers to choose gas rather than electricity for cooking, with each new installation being supported by a government subsidy.

Figure 7: Final energy consumption and electricity consumption growth, 1990–99



Source: Eurostat.

Figure 8: Final energy consumption



Source: Eurostat.

3. How rapidly is energy efficiency being increased?

The EU as a whole has an indicative target to decrease the energy intensity of final consumption (energy consumption per unit of gross domestic product) by an average of 1 % per year, between 1998 and 2010, above 'that which would have otherwise been attained'. The energy intensity of the EU economy decreased by 0.9 % per year during 1990–99, with little apparent influence from policies on energy efficiency and energy saving. The slow pace with which energy intensity decreased is due to a combination of a generally low priority for such policies, abundant energy supplies and low fossil fuel prices. Only the substantial reduction in Germany, helped by energy efficiency improvements, prevented an increase in overall energy intensity. There were impressive reductions in Luxembourg due to one-off changes (the closure of a steel plant) and in Ireland due to high growth in low energy-intensive industries and the services sector. The implementation of energy efficiency policies in Denmark and the Netherlands played an important role in the reductions in these countries.

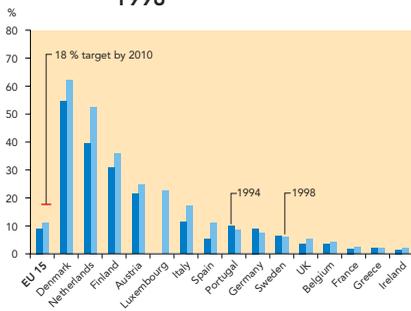
The overall efficiency of conversion of primary to usable energy did not improve between 1990 and 1999 because efficiency gains in conversion processes were offset by a larger share of converted fuels (e.g. electricity, petroleum products) in final energy consumption, a trend that is expected to continue.

Combined heat and power (CHP) avoids much of the waste-heat loss associated with electricity production as it produces both heat and electricity as useful outputs. The EU has an indicative target to derive 18 % of all electricity production from CHP by 2010. This target may not be reached because CHP investment across the EU, and in particular in Germany, the Netherlands and the UK, has been hindered by increasing natural gas prices (the preferred fuel for new CHP), falling electricity prices and uncertainty over the evolution of electricity markets as liberalisation is extended. The German

- ☹ Economic growth is requiring less additional energy consumption, but energy consumption is still increasing.
- ☹ With the exception of industry, no EU economic sector has decoupled economic/social development from energy consumption sufficiently to stop growth of its energy consumption.
- ☹ The efficiency of electricity production from fossil fuels improved between 1990 and 1999, but electricity consumption from fossil fuels grew more rapidly, outweighing the benefits to the environment from these improvements.
- ☹ The share of electricity from combined heat and power (CHP) increased across the EU between 1994 and 1998, but faster growth is needed to meet the EU target.

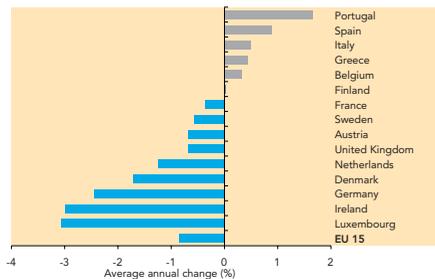
CHP law, passed in early 2002, provides an example of how to alleviate this situation through a number of support mechanisms, including agreed electricity purchase prices for existing CHP installations and for new, small-scale units.

Figure 9: Share of gross electricity production from combined heat and power plant, 1994 and 1998



Source: Eurostat.

Figure 10: Annual change in final energy intensity, 1990–99



Source: Eurostat.

4. Are we switching to less-polluting fuels?

The European Commission strategy to strengthen environmental integration within energy policy stresses the need to increase the share of cleaner energy production and use. This is reflected in the sixth environmental action programme which, as part of the climate change priority actions, encourages the use of renewable and low-carbon fossil fuels for power generation.

The share of fossil fuels in total energy consumption declined only slightly between 1990 and 1999. However the environment benefited from a major change in the fossil fuel mix, with coal and lignite losing about one third of their market share and being replaced by relatively cleaner natural gas, resulting in reduced emissions of greenhouse gases and acidifying substances. This was due mainly to fuel switching in power generation, encouraged by the high efficiency and low capital cost of combined-cycle gas plants, the liberalisation of electricity markets, low gas prices in the early 1990s and the implementation of the EU large combustion plant directive. Oil retained its share of the energy market, reflecting its continued dominance in the ever-growing road and air transport sectors.

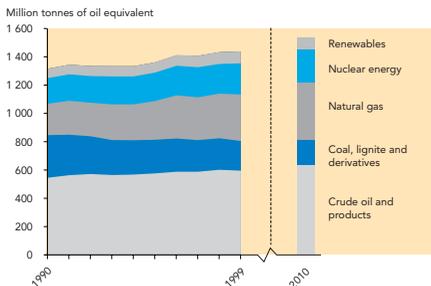
Baseline projections suggest only limited changes in the energy mix of total energy consumption by 2010, highlighting the need to strengthen support for renewable energy (see next section). The projections also indicate that fossil fuels will take a larger share of increasing electricity production while the switch to gas-fired electricity production is expected to continue.

The switch from coal to natural gas is not expected to continue beyond 2010. Increased electricity production from fossil fuels, slow growth of electricity production from renewable sources and the decrease in nuclear-powered

- ☹️ Fossil fuels continue to dominate energy use, but environmental pressures have been limited by switching from coal and lignite to relatively cleaner natural gas.
- ☹️ Fossil fuels and nuclear power continue to dominate electricity production, but the environment has benefited from the switch from coal and lignite to natural gas.
- 😊 Carbon dioxide emissions from electricity production fell by 8 % between 1990 and 1999 despite a 16 % increase in the amount of electricity produced.

electricity production as nuclear plants start to be decommissioned, are then likely to lead to increased carbon dioxide emissions.

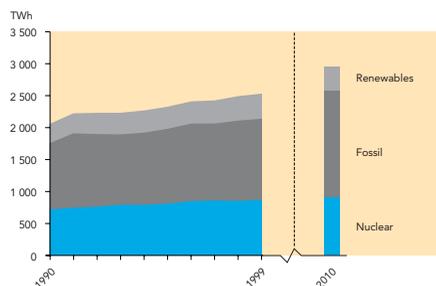
Figure 11: Total energy consumption by source



Note: Fuels other than those listed in the legend have been included in the diagram but their share is too small to be visible.

Source: Eurostat, NTUA.

Figure 12: Electricity production by source



Source: Eurostat, NTUA.

5. How rapidly are renewable energy technologies being implemented?

Meeting the renewable energy targets will be challenging. Taking account of the projected increase in energy consumption, the growth rate of renewable energy (both electricity and heat) will have to more than double compared with that between 1990 and 1999 if the EU's indicative target of a 12 % share of renewable energy sources in total energy consumption by 2010 is to be met. Similarly the growth rate in electricity from renewable energy sources will have to increase roughly twofold to meet the EU indicative target of 22.1 % of gross electricity consumption from renewable energy sources by 2010.

Financial, fiscal and administrative barriers, the low economic competitiveness of some renewables and the lack of information and confidence amongst investors all hinder the development of renewable energies.

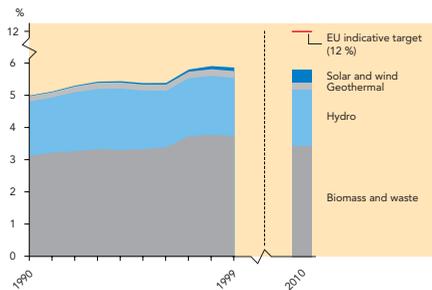
There are, however, encouraging signs that growth in renewable energy can be considerably accelerated with the right mix of support measures. For example the rapid expansion of EU wind and solar electricity was driven by Denmark (wind only), Germany and Spain and resulted from support measures such as 'feed in' arrangements that guaranteed a fixed favourable price. Similarly, Austria, Germany and Greece contributed 80 % of new solar thermal installations in the EU between 1990 and 1999. Solar thermal developments in Austria and Germany benefited from proactive government policy coupled with subsidy schemes and communication strategies, while in Greece the developments were helped by government subsidies.

Renewable energy contributes very little to the growing consumption of the transport sector. The draft EU directive on the promotion of the use of biofuels for transport would require almost 6 % of gasoline and diesel sold for transport

- ☹ The share of total energy consumption met by renewable energy grew only slightly between 1990 and 1999. Projections of future energy demand imply that the growth rate of energy from renewable sources needs to more than double to attain the EU indicative target of 12 % by 2010.
- ☹ The share of renewable energy in EU electricity consumption grew slightly between 1990 and 1999. Projections of future electricity demand imply that the rate of growth of electricity from renewable sources needs to double to attain the EU indicative target of 22.1 % by 2010.

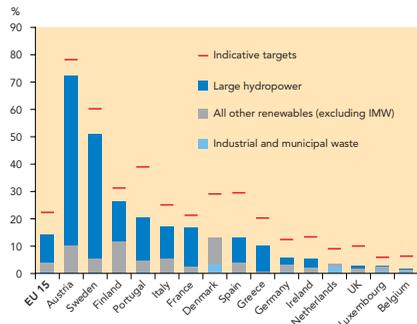
purposes to come from biofuels by 2010. However, the production of these fuels is energy intensive and may compete with other energy crops for growing land. There is also some concern over the level of nitrogen oxides emissions and particulates from biofuels.

Figure 13: Share of total energy consumption provided by renewable energy sources



Note: Biomass/wastes include wood, wood wastes, other biodegradable solid wastes, industrial and municipal waste (of which only part is biodegradable), biofuels and biogas.
Source: Eurostat, NTUA.

Figure 14: Share of electricity consumption met by renewable energy sources, 1999



Notes: Industrial and municipal waste (IMW) includes electricity from both biodegradable and non-biodegradable energy sources, as there are no separate data available for the biodegradable part. The EU 22.1 % target for the contribution of electricity from renewable sources to gross electricity consumption by 2010 only classifies biodegradable waste as renewable. The share of renewable electricity in gross electricity consumption is therefore overestimated by an amount equivalent to the electricity produced from non-biodegradable IMW. National targets shown here are reference values that Member States agreed to take into account when setting their targets by October 2002, according to the renewable electricity EU directive.
Source: Eurostat.

6. Are we moving towards a pricing system that better incorporates environmental costs?

Energy prices currently do not always reflect the full costs to society, because prices often do not totally take account of the impacts of energy production and consumption on human health and the environment. Estimates of these external costs for electricity, for example, are about 1–2 % of EU gross domestic product and reflect the dominance of environmentally-polluting fossil fuels in its production.

The sixth environmental action programme stresses the need to internalise these external environmental costs. It suggests a blend of instruments that include the promotion of fiscal measures, such as environment-related taxes and incentives, and the undertaking of a review of subsidies that counter the efficient and sustainable use of energy, with a view to gradually phasing them out.

Energy subsidies between 1990 and 1995 remained focused on the support of fossil fuels and nuclear power, despite the environmental impacts and risks associated with these fuels. Energy research and development expenditure by Member State governments fell between 1990 and 1998 but still concentrated on nuclear power. The share of the research and development budget devoted to renewable energy sources and energy conservation increased, but diminished in absolute terms. More recent data are needed to see whether these energy subsidy patterns have continued.

With the exceptions of diesel and unleaded gasoline for transport, energy prices fell between 1985 and 2001. This reflected trends in international fossil fuel prices and the move towards liberalised gas and electricity markets which stimulated greater price competition. The reductions occurred despite increases in energy taxation — other than that for industrial electricity where the energy tax fell.

- ☹ Energy prices generally fell between 1985 and 2001, offering little incentive for energy saving.
- ☹ Despite increases in taxation from 1985 to 2001, energy prices for most fuels dropped and the overall demand for energy increased.
- ☹ With fossil fuels supplying more than half the EU's electricity, price levels would need to be increased to include the estimated external costs of electricity production.
- ☹ Subsidies continue to distort the energy market in favour of fossil fuels despite the pressures these fuels place on the environment.
- ☹ EU energy research and development expenditure has been reduced at a time when innovation is needed to develop less-polluting technologies.

In the absence of an appropriate policy framework that aims at the full internalisation of external costs to the environment, and at improved management of energy demand, the reduction of energy prices is likely to act as a disincentive to energy saving investments and may encourage energy consumption.

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