2.1. Energy

Energy use contributes to a range of environmental pressures and is the major source of greenhouse and acid gas emissions in Europe. Options for reducing environmental pressures include using less-polluting energy sources, using energy more efficiently, and using less of the energy-consuming services such as transport, space heating and manufactured products.

Total energy consumption in Europe fell over the review period (1992–1999). This was due in part to increased energy efficiency across the region, but mainly to reduced consumption in eastern Europe, the Caucasus and central Asia (EECCA), linked to economic difficulties and restructuring.

Energy use continues to be dominated by fossil fuels, but the proportion of both total energy and electricity supplied from renewable sources increased in all three regions between 1992 and 1999. Fastest growth occurred in western Europe due to successful support programmes in a number of countries, but its share remains small. Output also increased in central and eastern European (CEE) countries, while the decline in the 12 countries of EECCA was less than for other energy sources.

Energy efficiency improved, but in western Europe this was not enough to prevent further growth in total energy consumption. Energy efficiency in the CEE countries also improved as a result of a combination of positive measures and economic restructuring. There has been little improvement in EECCA. In these latter two regions energy consumption per unit of gross domestic product remains considerably higher than in western Europe, indicating a substantial potential for further efficiency improvements.

Overall, energy-related greenhouse gas emissions fell substantially, mainly as a result of economic difficulties and restructuring that led to reduced energy use in CEE and EECCA. This improvement may be lost as these economies recover, unless stronger action is taken to improve energy efficiency and switch to low-carbon energy sources.

Energy-related acid gas emissions decreased substantially, helping put all three regions on track to achieve their 2010 emission targets.

Nuclear power, which does not emit greenhouse gases, raises concerns over safety and the long-term management of radioactive wastes.

2.1.1. Introduction

Energy is vital to social and economic well-being. It provides personal comfort and mobility, and is essential to most industrial and commercial activities. Although emissions of pollutants have fallen, today's energy production and consumption practices place considerable pressures on the environment, including contributing to climate change, damaging natural ecosystems, agriculture and the built environment, and adversely affecting human health.

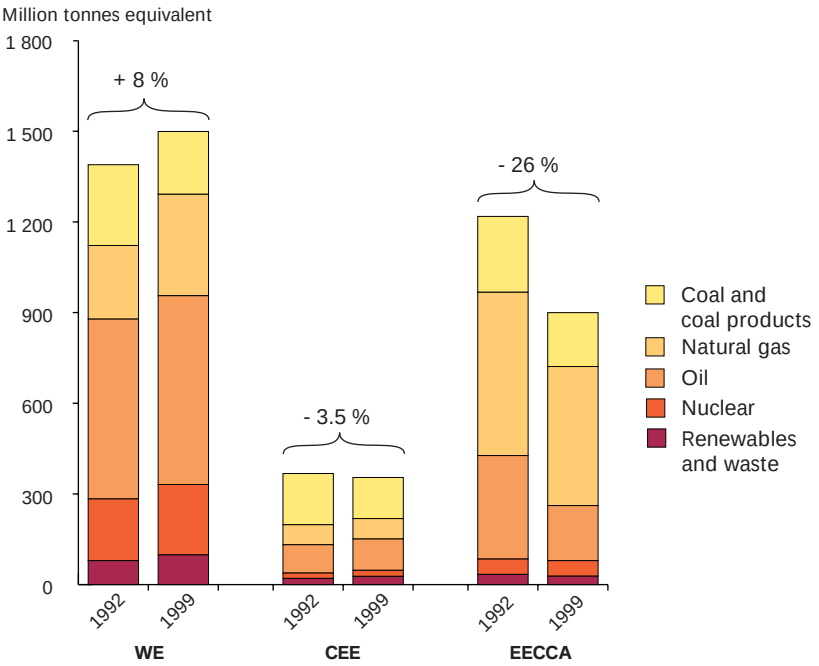
The main determinant of these pressures is the source of the energy. Generally, coal use exerts the greatest pressures because of the high levels of greenhouse gas, acid gas (unless end-of-pipe clean-up or advanced technology is used) and particulate emissions associated with its use. Coal use also produces considerable solid and liquid pollution as a result of its extraction and the disposal of ash. Oil typically exerts less pressure on the environment than coal because of its lower carbon content and reduced solid waste combustion products. Natural gas is the cleanest of the fossil fuels because of its even lower carbon content and lower propensity to cause acid emissions. Nonetheless, natural gas is still a major source of carbon dioxide emissions, and natural gas production facilities and pipelines leak methane, a potent greenhouse gas. Nuclear and renewable energy sources exert the least pressure in terms of greenhouse gas emissions and air pollution. With nuclear sources, however, there is a risk of radioactive releases in the event of an accident, and highly radioactive wastes are accumulating for which no generally acceptable disposal route has yet been established. Renewable energy resources offer the cleanest source of energy, but they can have some adverse impacts on the environment such as loss of natural amenities, loss of habitat, visual intrusion and noise.

Certain European countries and the European Union (EU) have adopted policies to reduce the environmental pressures associated with energy. These include support for energy-saving measures, increased efficiency measures in energy conversion and consumption, switching to less-polluting fuels,

removal of subsidies that favour more-polluting fuels, and the promotion of renewable energy sources and price structures that are more representative of the full cost to society of the energy being used.

But environmental pressures are not the only factors that affect international and national energy policies, which are also concerned with security of supply, competitive energy prices, market liberalisation, social factors and job creation (EEA, 2002). In some cases these concerns move in harmony with the environment, for example increased energy efficiency is beneficial to most, if not all, energy policy goals. But there are also conflicts. For example concerns over job creation and security of supply may prompt financial support for indigenous energy production, acting as a disincentive to energy saving through lower prices, and preventing the import of cleaner alternatives. Energy prices may also be kept low to support economic recovery and reduce social impacts. Market liberalisation, which can help attract international investment to modernise energy systems, can deliver lower energy costs in the long run, which, in the absence of appropriate policies to internalise the external costs of energy and improve energy demand management, may lead to reduced energy prices and even increased energy consumption.

Total energy consumption in Europe, 1992–1999 Figure 2.1.1.



Notes: Total energy consumption is also known as total primary energy supply or gross inland energy consumption. It is a measure of the energy inputs to an economy and can be calculated by adding total indigenous energy production, energy imports minus exports and net withdrawals from existing stocks. Waste includes wood wastes, other biodegradable solid wastes, and industrial and municipal wastes which contain both biodegradable and non-biodegradable components. Only biodegradable waste is considered to be a renewable energy source.

Source: IEA, 2001

2.1.2. Consumption and sources of energy

2.1.2.1. Total energy consumption

Total energy consumption fell by 7.5 % in Europe between 1992 and 1999 (Figure 2.1.1). This was mainly the result of reduced energy consumption in eastern Europe, the Caucasus and central Asia (EECCA), attributed to economic decline rather than increased energy efficiency. Energy consumption in central and eastern Europe (CEE) also fell due to a combination of economic restructuring and the implementation of energy efficiency measures. Turkey, a major energy consumer within the CEE region, increased its energy consumption substantially over the period as a result of high economic growth and only limited measures to improve energy efficiency. Energy consumption in western Europe (WE) increased, roughly in line with economic growth, a trend that is expected to be followed by CEE and EECCA as the countries in these regions complete their transition to market-based economies. To minimise the environmental impacts associated with energy use in Europe, a substantial switch to less-polluting energy sources and large improvements in energy efficiency is needed (see Section 2.1.3).

Total energy consumption fell in Europe but the environmental impacts of energy use seem destined to increase unless fossil fuels become less dominant and large improvements in energy efficiency are made.

2.1.2.2. Sources of energy

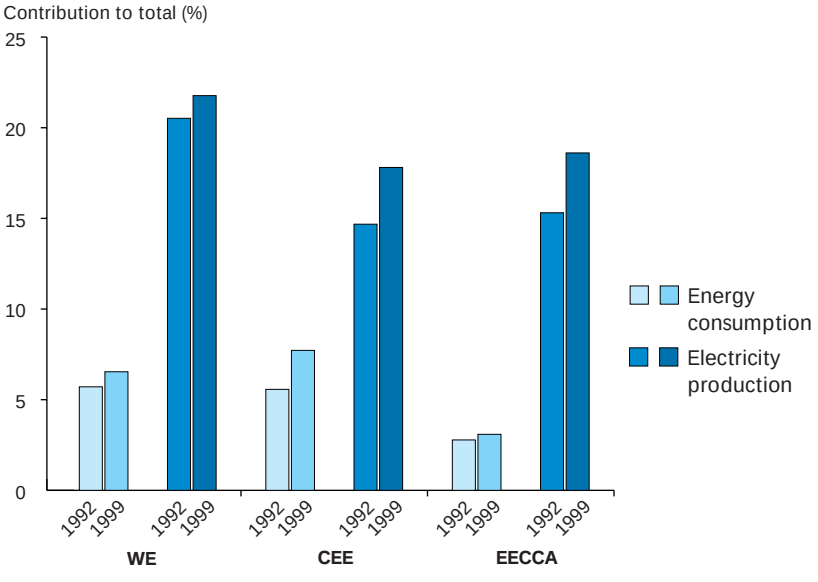
There have been overall reductions in coal and oil consumption with a growth in natural gas use. The reduction in coal use in CEE and EECCA is linked to the reduction of government support and the closure of a number of uneconomic mines. However, there is a risk of renewed growth in coal consumption if the Russian Federation turns to coal for electricity production to free up more natural gas and oil for export (European Commission, 2002). In WE the reduction in coal use is mainly the result of one-off fuel switching in favour of natural gas. European oil consumption fell entirely as a

result of reduced consumption in EECCA. Oil consumption increased in the countries of WE and CEE, mainly as a result of growth in transport demand, particularly road transport.

Nuclear power production increased in CEE and WE, and to a much lesser extent in EECCA. This trend is not expected to continue as nuclear plants start to be decommissioned throughout Europe and few new plants are in preparation. This is expected to result in a further growth in combustion-related emissions in the long term, including carbon dioxide, if the shortfall in capacity is replaced by fossil-fuelled plant. This highlights the importance of policies and measures to stimulate the development and deployment of renewable energy sources (see Box 2.1.1), i.e. the general problem of phasing out nuclear with timely and non-emitting replacements.

Overall, the proportion of renewable energy sources in total energy consumption increased slightly. Total renewable energy consumption (both electricity and heat) increased by 15 % between 1992 and 1999, increasing its share of total energy consumption from 4.5 to 5.6 %. Electricity production from renewable sources increased by 15 %, thus bringing its share of total production from 18 to 20 % (see Figure 2.1.2). In WE this growth was supported by a range of policy interventions, mainly aimed at stimulating the growth of new renewable technologies for electricity production. In CEE most growth came from an expansion of biomass/waste combustion and hydropower, but this does not appear to be linked to any coordinated policy initiatives. Renewable energy production decreased in EECCA due to a decrease in production from combustible renewable sources and hydropower. However, due to falling overall energy consumption, the proportion of renewable energy sources in total energy consumption actually increased.

Figure 2.1.2. **Contribution of renewable energy sources and waste to total energy consumption and electricity production, Europe 1992–1997**



Notes: Waste includes wood wastes, other biodegradable solid wastes and industrial and municipal wastes which contain both biodegradable and non-biodegradable components. Only biodegradable waste is considered to be a renewable energy source.

Source: IEA, 2001

Renewable electricity production continues to be dominated by hydropower in all regions, and it accounts for about 90 % of production in CEE and EECCA. This source is unlikely to increase in WE since the majority of the most suitable sites have already been exploited and because damage to the environment through loss of land and the resultant destruction of natural habitats and ecosystems impedes further development. There are still a number of exploitable sites in CEE and EECCA. The use of 'new renewable' sources such as wind and solar remains small for countries outside WE. Western Europe made some headway in wind power increasing its share to 2.4 % of total renewable electricity production in 1999. This growth was greatly helped by the 'feed-in' arrangement implemented during that period by Denmark, Germany and Spain, according to which the utilities were obliged to purchase electricity from renewable electricity producers at a fixed, commercially favourable price. The share of electricity production from wind for EECCA and CEE was below 0.1 % of total renewable electricity production in 1999. Solar electricity production is reported only in WE, where it represented just 0.01 % of total renewable electricity production in 1999, with Germany and Spain driving its growth with the help of feed-in arrangements and state financial support (EEA, 2001).

2.1.3. Energy efficiency

One way to reduce the environmental pressures of energy use is to reduce the demand for energy-consuming services or to deliver these services with more efficient devices. The importance of using energy efficiently is recognised in a number of policy agreements and measures including

Box 2.1.1. Renewable energies: success stories

Renewable energy sources are seen as an increasingly important option for reducing the pressures placed on the environment by energy production and consumption, and can contribute to the security of energy supply by replacing imported fossil fuels.

The European Energy Agency (EEA) has found that the extent to which renewable energy technologies are successfully deployed depends on the cumulative benefits of a series of supportive measures. While no single factor has been identified as being of overwhelming significance, there are certain essential components which, when combined, allow the successful exploitation of renewable energy sources.

- **Political support**. Countries which showed a rapid expansion of renewable energy during the 1990s are most commonly those with long-established policies in support of renewable energy in general or of a particular renewable energy.
- **Legislative support**. Producers of electricity from renewable sources need access to electricity networks to be able to distribute the electricity produced. This requires the establishment of transparent and reasonable charging structures so that they can operate successfully within the electricity supply system. The 'feed-in law system' has given a great impetus to developments in electricity produced from renewable sources, in particular wind energy. This system combines commercially favourable guaranteed feed-in tariffs with an obligation on utilities to purchase renewable electricity at these tariffs.
- **Fiscal support**. Taxation is increasingly being used as a mechanism to reward the environmental benefits of renewable energy compared with energy generated from fossil sources.
- **Financial support**. The capital costs of renewable energy projects, which are often high, can be a significant barrier to development, especially for newer technologies. Subsidies or favourable loans for renewable energy developments are common where the successful market penetration of renewable technologies occurs.
- **Administrative support**. Successful replication of renewable energy projects can be achieved on a wide scale only where there is active support for renewable energy at the level at which individual projects are brought forward for approval. In most cases this is the local or regional level. Administrative support at the national level is also important.
- **Technological development**. The development of renewable energy technologies requires support at all stages - research, demonstration and implementation - to help achieve strong and competitive indigenous industry capabilities in renewable energy.
- **Information, education and training**. Activities that raise awareness of the benefits of renewable energy among the general public are a vital component of national, regional and local renewable energy support programmes. Energy agencies at local or regional level are one of the most successful initiatives to help raise public awareness of the benefits of renewable energy and increase public acceptance of new renewable energy developments.

Case study: Biomass district heating in Austria

District heating is very common in Austria, and the use of biomass as a fuel increased by more than 60 % in five years as a result of a series of supportive measures.

Austria has few indigenous fossil fuel resources, and so its energy policy addresses a number of security of supply issues including stimulating the use of renewable energy sources. The government and, in particular, the regions provide active political support for biomass energy and several regions have biomass-related targets.

In addition, Austrian energy taxes favour renewable energy schemes, and financial support for biomass installations, particularly for district heating schemes, is provided at both national and regional level. Local and regional authorities support the use of biomass as a fuel resource and, in some cases, demonstrate the benefits by taking the lead in its implementation in public buildings.

New technological developments for biomass production processes are supported in universities and in association with industry. To meet the demand for new biomass district heating plants, there is already indigenous manufacturing expertise, including boiler and pipework manufacture, and installation services.

Farmers are supportive of new biomass projects as they gain additional income, and wood users such as sawmills also benefit from the additional market for their wood wastes. Together with local energy agencies, these actors have been key in promoting the economic and environmental benefits of using biomass as a fuel.

Source: EEA, 2001

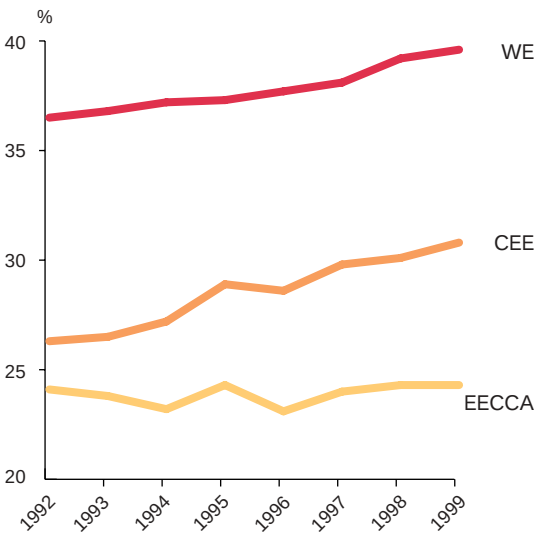
the Energy Charter Treaty and Protocol on Energy Efficiency and Related Environmental Aspects (ECS, 2002). In addition, the EU has developed an action plan which aims to deliver a 1 % per year reduction in energy intensity, over and above 'that which would have otherwise been attained' (Council of the European Union, 1998). In this case the energy intensity of a country is defined as its final energy consumption divided by its gross domestic product (GDP). The measures contained in this plan should encourage developments in countries that have applied for EU membership, as well as in current Member States.

2.1.3.1. Efficiency of fossil-fuelled electricity production

The electricity production sector is of particular importance. Experience shows that the proportion of electricity in final energy consumption increases as economies

Figure 2.1.3. **Efficiency of electricity production from fossil-fuelled power plant, Europe 1992–1999**

Source: IEA, 2001



😐 The efficiency of electricity production from fossil fuels improved slightly, but only in western Europe and central and eastern Europe

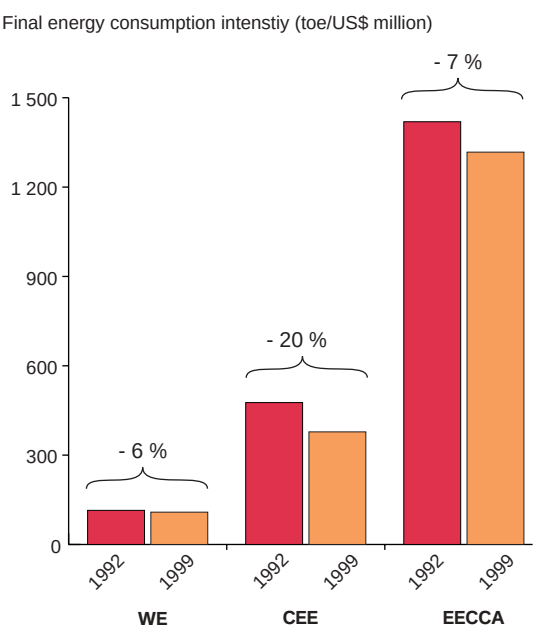
develop. This is because greater automation in industrial production usually requires a greater use of electricity, while increased wealth results in more electricity use by households and services. Between 1992 and 1999 Europe's share of electricity in final energy demand increased by more than 11 %, reaching 19 % in WE, 15.5 % in CEE and 12.6 % in EECCA. Since this trend is likely to continue, it is vital for the environment that electricity is produced with maximum efficiency, especially when produced from fossil fuels that release substantial quantities of greenhouse gases and other pollutants.

On average, the efficiency of fossil-fuelled electricity production in Europe increased from 29 % to 32 % between 1992 and 1999 (see Figure 2.1.3). This was due mostly to plant replacement in WE (especially switching to inherently more efficient systems such as gas turbines), and technical improvements and refurbishment in CEE. However, production efficiency in both CEE and EECCA remains substantially below WE levels. In CEE countries this is due to high reliance on coal (the source of 74 % of fossil-fuelled electricity production in 1999, compared with 48 % in WE), which is intrinsically less efficient for electricity production than gas, and to the age and low technical standard of many of the plants. In EECCA, 59 % of fossil-fuelled electricity production comes from natural gas, which is capable of higher production efficiencies, but the low efficiency observed in the region indicates the age and poor technical performance of such plant. Significant efficiency improvements in CEE and EECCA will only come from investment in new plant, but few national utilities can afford this. Consequently, many countries are implementing or are planning market liberalisation measures in order to attract private investment.

Figure 2.1.4. **Final energy intensity, Europe 1992–1999**

Note: Final energy consumption is the energy consumption of the transport, industry and other (household, services and agriculture) sectors. It includes the consumption of converted energy (i.e. electricity, publicly supplied heat, refined oil products, coke, etc.) and the direct use of primary fuels such as natural gas or renewables (e.g. solar heat, biomass). It excludes petrochemical feedstocks. The final energy consumption of Turkey remained almost constant during the period 1992-99. Excluding Turkey, the largest CEE country, from the aggregated CEE total indicates that in the rest of the region final energy consumption intensity fell by an average of 25 % over this period. Due to incomplete data, western Europe excludes Andorra, Liechtenstein, Monaco and San Marino, and central and eastern Europe excludes Bosnia and Herzegovina and Serbia and Montenegro.

Source: IEA, 2001; World Bank, 2002



😐 Energy is being used more efficiently throughout Europe, mainly as a result of changes in central and eastern Europe, the Caucasus and central Asia, but this may not be sustained in the long run without more active support for energy efficiency.

2.1.3.2. Efficiency of energy use

Improvements in the way end-use sectors use energy can be tracked by measuring final energy intensity (i.e. final energy consumption per unit of GDP). The lower the intensity the less energy is used per unit of wealth created.

Energy intensities in CEE and EECCA are substantially higher than in WE (see Figure 2.1.4). This reflects lower efficiency in all end-use sectors due to a combination of factors including older, less efficient industrial plant, inadequate maintenance, older, less efficient vehicle fleets, and the combined effect of poorly insulated building stock, a lack of heating controls in buildings and the comparatively longer and colder winters experienced in some parts of CEE and EECCA. Historically, this situation developed as a result of countries' access to relatively abundant, low-cost energy resources, which made them less exposed to the energy price shocks of the 1970s, and provided less incentive to invest in energy efficiency. The situation persisted due to a shortage of investment, especially in EECCA.

Most EECCA and CEE countries developed policies to encourage and support rational energy saving. This, together with one-off economic restructuring, contributed to reduced energy intensities, particularly in CEE. However, in many countries, the implementation of energy efficiency measures has been weak because priority has been given to economic recovery and social issues, and the institutions needed to drive energy efficiency policies were poorly supported. Consequently in a number of countries, particularly in EECCA, the improvements have been due mainly to deprivation rather than rational energy saving, and may therefore be reversed as economies develop, unless stronger measures to support energy efficiency are implemented. The slow pace with which energy intensity decreased in WE is the result of low prioritisation of energy efficiency policies due to abundant energy supplies and low fossil fuel prices.

Table 2.1.1 shows that there is considerable potential for energy savings in all sectors throughout Europe and especially in CEE and EECCA. In CEE, improvements in industrial energy intensity resulted from a combination of the closure of some less-efficient plant and investment in new production facilities by international companies. Energy efficiency improvements in households and services resulted from a combination of measures including increased prices, reduced subsidies, metering and billing by consumption, all of which provided a financial incentive to reduce energy consumption. In EECCA, industrial energy intensity actually increased between 1992 and 1999, indicating that, on average, the economic decline and restructuring in these countries has not yielded any improvement in efficiency. The improvements in energy intensity in households and services were due mainly to supply limitations and self-deprivation as price and market reforms have proved difficult to introduce at a time of economic recession and high unemployment.

Energy intensities of individual economic sectors Table 2.1.1.

(tonnes of oil equivalent /US$ million)	Industry		Transport		Households and services	
	1992	**1999**	**1992**	**1999**	**1992**	**1999**
Western Europe	126	124	33	33	43	40
Central and eastern Europe	622	418	73	73	202	164
Eastern Europe, the Caucasus and central Asia	924	1 281	242	223	751	615

Notes: The table presents energy intensity data for regional comparison only. Comparisons between different economic sectors should not be made since industrial energy intensity is calculated as the ratio of energy consumption to value added, while the energy intensity of the transport and household and services sectors is calculated as the ratio of energy consumption to GDP. These energy intensities are also not comparable with the final energy intensity of Figure 2.1.3, which is defined as the ratio of final energy consumption to GDP.

Western Europe excludes Andorra, Liechtenstein, Monaco and San Marino, and additionally excludes Iceland, Ireland, Luxembourg and Switzerland from the calculation of industrial energy intensity due to incomplete data. Central and eastern Europe excludes Bosnia and Herzegovina and Serbia and Montenegro, and additionally excludes Cyprus and Malta from the calculation of industrial energy intensity due to incomplete data. Eastern Europe, the Caucasus and central Asia exclude Azerbaijan and Georgia from the calculation of industrial energy intensity due to incomplete data.

Source: IEA, 2001; World Bank, 2002

Box 2.1.2. Energy efficiency: success stories

Case Study — hospital heating system refurbishment in the Czech Republic

The Bulovka teaching hospital in Prague needed a significant upgrade of the central heating system, but the hospital had no available funds. The necessary upgrades were obtained through a performance contract with an energy services company (ESCO). The ESCO provided the finance, which was paid off using the energy savings achieved at the hospital over an eight-year contract period.

The ESCO made four energy saving changes:

- Switching the existing central heating system to district heating that provided space heating and hot water in a more efficient way.
- Installing a small high-efficiency gas boiler for specific uses (other than heating and hot water) including sterilisation and laundry services. Heat had previously been taken from the hospital's main boiler plant.
- Putting in place a new computerised energy management system that gave more precise control of indoor temperatures, hot water and space heating. It also facilitates on-line performance monitoring, which together with preventative maintenance, ensures the long-term efficiency of the system.
- Installing a new air handler recovery system that was more efficient because it used heat exchangers to preheat intake air by absorbing the heat from vented air.

This project cost US$ 2.7 million and will produce savings of US$ 0.7 million/year, illustrating the high potential for energy savings through innovative financial arrangements. The project was awarded best practice status by the World Energy Efficiency Association.

Source: Energy Charter Secretariat, Brussels

2.1.4. Environmental impacts

Greenhouse gas emissions

The reduction of global greenhouse gas emissions is a priority action area for industrialised countries, as agreed under the UN Kyoto protocol (see Chapter 3). There is a clear need for action to reduce emissions arising from energy use since they account for more than 80 % of total emissions. Moreover they only represent a first step, since it is estimated that global emissions need to be reduced by about 70 % in the long term to stabilise greenhouse gas concentrations at an acceptable level (IPCC, 2001). It is therefore important for emissions reductions to be based on lasting measures and actions.

Total energy-related greenhouse gas emissions fell substantially in Europe between 1990 and 1999, due mainly to economic difficulties and restructuring in EECCA and CEE. This improvement may be lost as these economies develop unless economic growth is accompanied by strong energy efficiency measures and the implementaion of low-carbon energy supply options.

Overall, energy-related greenhouse gas emissions in Europe fell considerably between 1990 and 1999 (Figure 2.1.5). This was due mainly to the Russian Federation and Ukraine, two of the biggest energy consumers in Europe, which reduced their total emissions by 36 % and 50 % respectively over the period. These reductions were mostly the result of economic difficulties and restructuring, which resulted in a substantial reduction in the energy use of these two countries over this period. CEE countries achieved a reduction of 4 % due to large cuts in most countries, mainly as a result of economic restructuring, which were partly offset by increased emissions from Turkey (54 %) and Croatia (11.7 %). Energy-related emissions in WE fell by only 1.6 %. Nevertheless, this was achieved against a background of an 18 % increase in economic growth over the same period.

Figure 2.1.5 shows that transport contributes a substantial proportion of greenhouse gas emissions in WE countries but much less in CEE countries. The low energy consumption of the transport sector in EECCA indicates that the contribution of transport emissions in this region is also much less. Transport growth is strongly driven by economic growth and transport emissions are expected to grow substantially in CEE and EECCA as economies recover and the demand for transport increases.

Fugitive methane emissions from energy production amounted to almost 15 % of total greenhouse gas emissions in the Russian Federation and Ukraine in 1999 (reflecting the substantial oil and gas production in these countries) compared to an average of almost 2 % and 4 % in WE and CEE respectively. Other significant oil and gas producers such as the United Kingdom have much lower fugitive emissions (i.e. about 3 % of total emissions in 1999) which indicates the potential for improvement in the Russian Federation and Ukraine.

One option for achieving a lasting reduction in energy-related greenhouse gas emissions is to reduce the greenhouse gas intensity of energy use by switching to energy sources that contain less carbon (e.g. from coal to natural gas or renewable energy sources), and/or by reducing the emissions associated with the production and use of these sources. Figure 2.1.6 shows that all three regions achieved reductions in greenhouse gas intensity between 1992 and 1999. In fact, with total energy consumption growing in

WE, the reduction in its energy-related greenhouse gas emissions was largely due to switching from coal to oil and gas which lead to this cut in greenhouse gas intensity. However, greenhouse gas intensities in CEE and EECCA remain substantially higher than in WE, mainly as a result of a large use of coal in CEE and of substantial fugitive methane emissions in EECCA.

2.1.4.2. Other environmental pressures

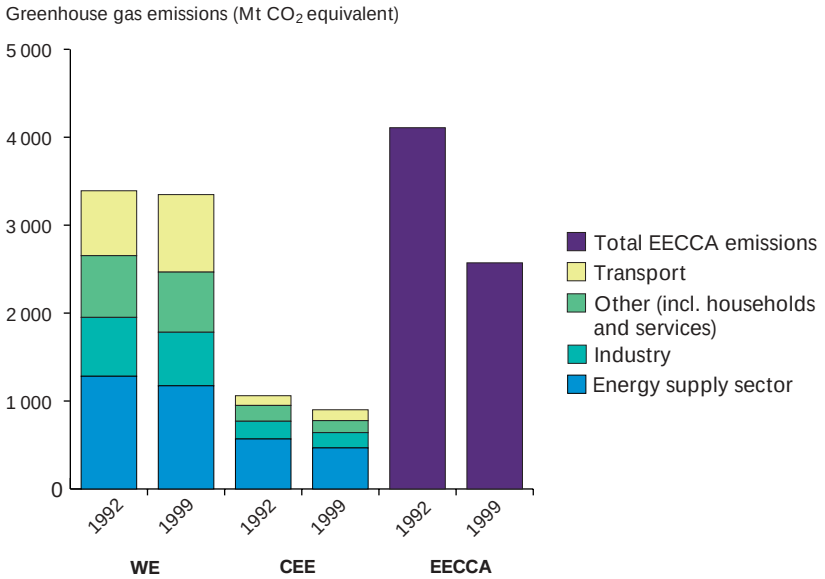
In addition to being the most important source of greenhouse gases, energy production and consumption place other pressures on the environment. Fossil fuel combustion is a major source of air pollution (see Chapter 5). Energy production also damages land and water resources through excessive dumping and unplanned discharges of a range of substances such as crude oil, mine tailings, polluted mine waters and coal ash. Nuclear power poses a potential threat to the environment, as there is a risk of radioactive releases (see Chapter 10).

Energy use is the major source of sulphur dioxide (SO_2) and nitrogen oxide (NO_X) emissions, accounting for over 90 % of both emissions in Europe in 1999. Considerable progress has been made in reducing these energy-related acid gas emissions and this has greatly helped all three regions to be on track to achieve their aggregate targets under the UNECE Convention on Long-Range Transboundary Air Pollution (see Chapter 5).

The reductions in acid gas emissions in WE, shown in Figure 2.1.7, were achieved mainly by direct actions including switching to lower sulphur fuels, installing flue gas clean-up systems, introducing catalytic converters in cars and modifying combustion processes. The reductions in CEE were also greatly helped by direct actions. However, the reduction in energy use in CEE, in particular of coal use, also played an important role. Data problems for some EECCA countries prevent precise conclusions being drawn, but judging from the energy consumption data, it is likely that the reduction in acid gas emissions was mostly the result of reduced energy use, with direct actions also contributing.

Energy-related acid gas emissions have been reduced substantially, placing all three regions on track to meet the total emissions targets for 2010.

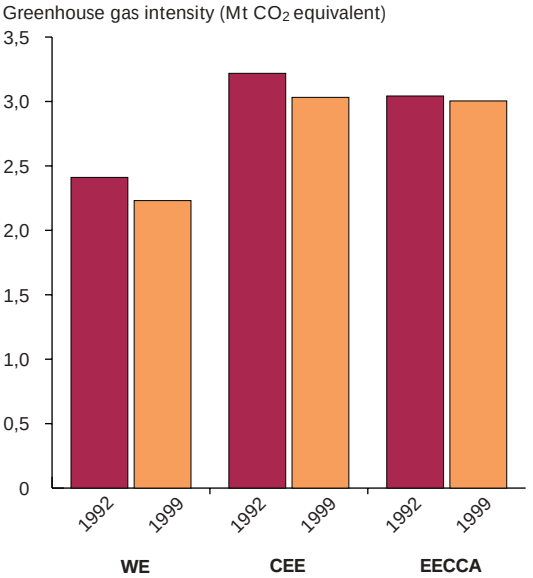
Energy-related greenhouse gas emissions, Europe 1990–1999 — Figure 2.1.5.



Notes: Due to an incomplete sectoral breakdown, data for EECCA cover all sources of carbon dioxide, methane and nitrous oxide, but estimates indicate that energy use accounts for over 80 % of these emissions. CEE excludes Albania, Bosnia and Herzegovina, the former Yugoslav Republic of Macedonia, Romania and Serbia and Montenegro due to missing or incomplete data. EECCA excludes Kyrgyzstan, Tajikistan and Turkmenistan due to missing or incomplete data. Due to an incomplete sectoral breakdown, data are for all greenhouse gas emission sources, not just those from energy-related activities. The Russian Federation and Ukraine accounted for over 82 % of the greenhouse gas emissions from EECCA countries. Energy supply sector emissions include those from coal mining, oil and gas exploration and extraction, public electricity and heat production, oil refining and other industries engaged in converting primary energy into energy products. It also includes fugitive emissions from the exploration, production, storage and transport of fuels. The data are for emissions of carbon dioxide, methane and nitrous oxide, and exclude the fluorinated gases.

Source: EEA/ETC on Air and Climate Change

Greenhouse gas intensity of total energy consumption, Europe 1992–1999 — Figure 2.1.6.



Note: Greenhouse gas intensity is defined as the amount of greenhouse gas emissions, expressed in units of carbon dioxide equivalent, released per unit of total energy consumption. EECCA: based on total emissions because energy-related emissions data are not available for most countries in the region.

Sources: IEA, 2001; EEA/ETC on Air and Climate Change

The fact that direct actions contributed significantly to the reductions in Europe, particularly in WE and CEE, is encouraging. Nevertheless, a number of regions in Europe, mostly in CEE and EECCA countries, face serious air pollution problems that need to be addressed urgently and the potential for improvement through direct actions in CEE and EECCA remains large. In addition, the potential for further improvement through energy efficiency measures remains to be explored by all three regions.

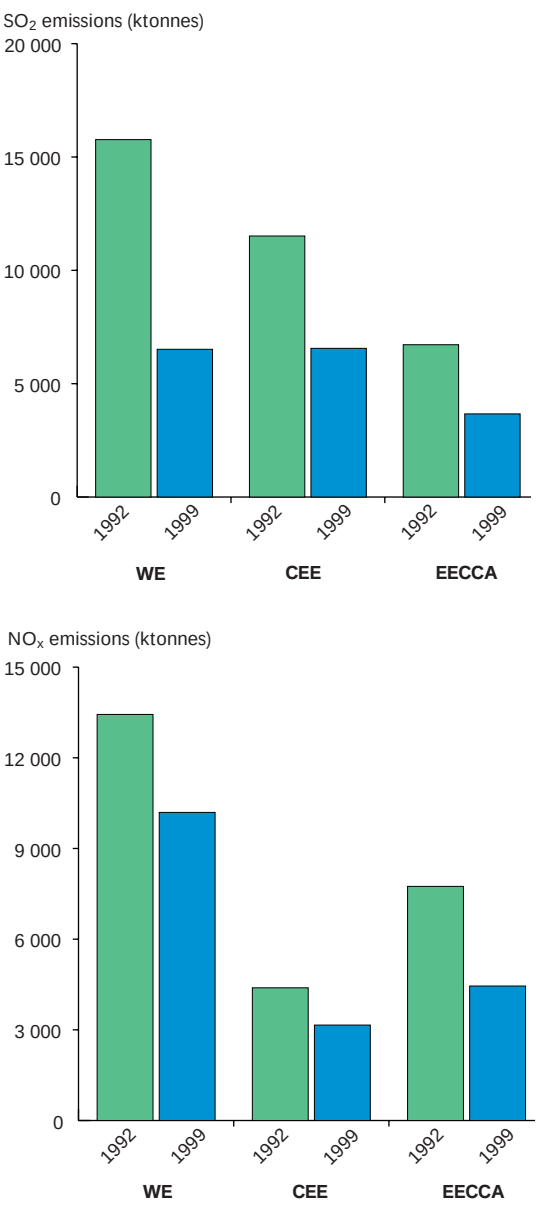
Nuclear power is responsible for a steady accumulation of highly radioactive waste which could release radioactivity into the environment if not carefully managed. Some radioactive waste will remain radioactive for hundreds of thousands of years and the favoured long-term solution is at present deep geological disposal. Progress towards this objective has been slow, mainly because of societal concerns. No generally acceptable disposal route has been found.

Nuclear power can have a large impact on human health and the environment, but the risk of operational accidents, such as that experienced at Chernobyl, is reduced with improved safety systems and management procedures. The success of these measures is indicated by a fall in the number of 'unusual events' reported to the incident reporting system operated jointly by the International Atomic Energy Agency (IAEA) and OECD. This shows the number of incidents reported in Europe varying between 177 and 76 during the period 1992–2001, but with no clear improvement trend. Nevertheless, 2000 and 2001 had the lowest number of incidents (see Chapter 10).

The risks need to be balanced against the potential benefits of nuclear power. At the point of electricity production, nuclear power plants do not emit greenhouse or acid gases, but neither does the production of electricity from renewable sources.

Data on the accumulation of radioactive wastes across all three regions is not consistently available. However, OECD (Organisation for Economic Co-operation and Development) data for WE show on average an annual removal of nearly 3 000 tonnes of highly radioactive used nuclear fuel from reactors to stores during the 1985–2010 period (OECD, 1999) (see also Chapter 7).

Figure 2.1.7. **Energy-related emissions of sulphur dioxide (a) and nitrogen oxides (b), Europe 1992–1997**



Notes: Energy-related emissions include emissions from transport. SO_2 emissions for EECCA exclude emissions from Azerbaijan, Georgia, Kyrgyzstan, Kazakhstan, Tajikistan and Turkmenistan, due to incomplete data coverage. SO_2 emissions for CEE exclude emissions from Albania, Bosnia-Herzegovina, Malta and Romania, due to incomplete data coverage. NO_x emissions for CEE exclude emissions from Albania, Malta and Romania, due to incomplete data coverage.

Source: EEA/ETC on Air and Climate Change

2.1.5. Policy responses

For at least the next 20–30 years, European energy policy will primarily be driven by the energy policies that result from the Green Paper of the European Commission 'Towards a European strategy for the security of energy supply' and the energy strategy of the Russian Federation for 2020.

☹ No generally acceptable disposal route has yet been established for the continued build-up of highly radioactive waste from nuclear power production and the risk of radioactivity being released into the environment causes additional concern.

These two main actors launched the EU-Russia Energy Dialogue at the sixth EU-Russian summit on 30 October 2000 in Paris. This cooperation allows the EU and the Russian Federation to pursue areas of 'common interest' by establishing a strategic energy partnership. This will aim to 'share the same concerns for ensuring stable energy markets, reliable and growing imports and exports, a pressing need to modernise the Russian energy sector, to improve energy efficiency and to reduce greenhouse gas emissions from energy production and use in their respective economies'.

A joint declaration adopted at the sixth EU-Russian summit notes that the planned ratification of the Energy Charter Treaty by the Russian Federation will be an important aspect for introducing 'cooperation on energy saving, rationalisation of production and transport infrastructures, European investment possibilities, and relations between producer and consumer countries'. The Energy Charter Treaty has been ratified by most European countries and strives 'towards open, efficient, sustainable and secure energy markets', and 'to promote a constructive climate conducive to energy interdependence on the basis of trust between nations'.

The 'Northern Dimension' aims to address the special regional development challenges of northern Europe (the Baltic Sea region, the Arctic Sea region and the northwest of the Russian Federation). The Northern Dimension action plan includes actions for addressing environmental problems in the region including atmospheric pollution, improving nuclear safety and nuclear waste management, and facilitating cooperation in the energy sector.

Nuclear safety and the management of spent nuclear fuel and radioactive waste remain contentious issues. As yet there are no common rules on nuclear reactor safety or radioactive waste disposal although the European Commission has proposed directives on the safety of nuclear installations and on the management of used nuclear fuel and radioactive waste (European Commission, 2003). Most WE countries that operate commercial nuclear power stations have declared that they will not increase their nuclear power capacity and four countries have declared that their reactors will be phased out. Seven candidate countries use nuclear power. To a large extent, nuclear power replaces the electricity that would otherwise be produced by fossil fuels (and in particular coal), and so commitments to reducing greenhouse gas emissions make it difficult for some countries to reduce their nuclear power production without a more sustainable alternative energy source. However, the Russian Federation's energy strategy plans to increase coal and nuclear-based electricity production in order to reduce dependence on natural gas.

The three main goals of EU energy policy - security of supply, competitiveness and environmental protection (Council of the European Union, 1995) — are strongly interrelated. Improvements in energy efficiency should benefit security of supply, by reducing the amount of energy consumed, and abate emissions of greenhouse gases and other pollutants, by reducing the consumption of fossil fuels. Market liberalisation and additional price competition will benefit competitiveness through reduced prices, but may act as a disincentive to energy saving and encourage consumption unless external costs are fully internalised and energy demand is better managed.

The environmental integration process was initiated at the European Council Cardiff summit when all relevant formations of the Council were invited to establish their own strategies for giving effect to environmental integration and sustainable development within their respective policy areas. The specific objectives of EU energy policy in the area of environmental integration (European Commission, 1998) are to reduce the environmental impact of the production and use of energy, to promote energy saving and energy efficiency, and to increase the use of cleaner energy and its share of total energy production.

The EU sixth environmental action programme (6EAP) (European Parliament and Council, 2002) encourages renewable and low-carbon fossil fuels for power production as part of the priority actions for reducing greenhouse gas emissions in the energy sector.

The significance of renewable energy sources was recognised at the Johannesburg United Nations World Summit on Sustainable Development (UN, 2002) and in a number of EU policy documents. Notable among these were a renewable energies White Paper (European Commission, 1997) and a directive on the promotion of electricity from renewable energy sources (European Parliament and Council, 2001). The

EU documents set overall targets to derive 12 % of the EU's total energy consumption and 22.1 % of the EU's electricity from renewable sources by 2010. This should also encourage the development of renewable energy sources in countries that have applied for EU membership. Some CEE countries and EECCA have also developed energy and environment policies that include the development of renewable sources, but in most countries this has had a low priority, the necessary investment resources are lacking and the strong institutional structures needed to drive the process have not yet been established.

The Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects has been ratified by most European countries and 'defines policy principles for the promotion of energy efficiency as a considerable source of energy and for consequently reducing adverse environmental impacts of energy systems'.

In addition, the EU 6EAP identifies the promotion of energy efficiency as a priority action to reduce greenhouse gas emissions in the energy sector (European Parliament and Council, 2002) and the Barcelona European Council in 2002 stressed the need to show substantial progress in energy efficiency by 2010. The European Commission's multiannual Intelligent Energy for Europe Programme should support the promotion of renewable energies and energy saving, taking account of the EU strategy for sustainable development approved by the Gothenburg European Council in 2001.

2.1.6. References

Council of the European Union, 1995. 1850th meeting, 1 June 1995. *Council resolution on the Green Paper 'For a European Union energy policy'*.

Council of the European Union, 1998. *Council Resolution 98/C394/01 on energy efficiency in the European Community.*

EEA (European Environment Agency), 2001. *Renewable energies: success stories.* Environmental issue report No 27. EEA, Copenhagen.

EEA (European Environment Agency), 2002. *Energy and environment in the European Union.* Environmental issue report No 31. EEA, Copenhagen.

ECS (Energy Charter Secretariat), 2002. *The Energy Charter Treaty — a reader's guide.* ECS, Brussels.

European Commission, 1997. *Energy for the future: Renewable sources of energy.* White Paper for a Community strategy and action plan. COM(97) 30 final. Commission of the European Communities, Brussels.

European Commission, 1998. *Strengthening environmental integration within Community energy policy.* Communication from the Commission. COM(1998) 571 final. Commission of the European Communities, Brussels.

European Commission, 2002. 2001 *annual energy review.* European Commission, Luxembourg.

European Commission, 2003. *Proposal for a Council (Euratom) directive setting out basic obligations and general principles on the safety of nuclear installations. Proposal for a Council directive (Euratom) on the management of spent nuclear fuel and radioactive waste.* COM (2003) 32 final. Commission of the European Communities, Brussels.

European Parliament and Council, 2001. Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources in the electricity market, September 2001.

European Parliament and Council, 2002. *Decision 1600/2002/EC laying down the sixth Community environment action programme.*

IEA (International Energy Agency), 2001. *Energy balances of OECD countries and energy balances of non-OECD countries.* IEA, Paris.

IPCC (Intergovernmental Panel on Climate Change), 2001IPCC Working Group I. *Third assessment report, summary for policy makers.*

OECD (Organisation for Economic Co-operation and Development), 1999. *Environmental data compendium 1999.* OECD, Paris.

UN (United Nations), 2002. *World Summit on Sustainable Development — Plan of implementation.* UN, Johannesburg.

World Bank, 2002. *World development indicators 2002.* The World Bank.