11 Environment and energy

There is general international consensus that the planet is exhibiting a number of transformations that appear to be linked to climate change and scientists state that this is very likely connected to human activities. International negotiations for reaching a global agreement related to reducing greenhouse gas emissions for the period after 2012, when key provisions of the Kyoto Protocol expire, have been at the forefront of policy activity in recent months. The EU formulated a policy response to help reduce greenhouse gas emissions in the shape of an integrated energy and climate change policy, which was adopted in December 2008 and includes the following three key targets:

- cut greenhouse gases by at least 20 % of their 1990 levels (30 % if other developed countries commit to comparable cuts) by 2020;
- increase the use of renewables (wind, solar, biomass, etc.) to 20 % of total energy production by 2020, including a 10 % biofuel target for transport;
- cut energy consumption by 20 % in relation to projected 2020 levels – by improving energy efficiency.

The intention of this integrated energy and climate change policy is to move Europe towards a sustainable future with a low-carbon, energy-efficient economy. These changes will in turn contribute towards preventing the world's temperatures rising by more than 2 °C, a threshold identified by scientists, beyond which the effects of climate change may be catastrophic and irreversible.

To achieve these goals, households as well as enterprises will need to act. Changing lifestyle and consumption behaviour will be necessary – for example, by reducing consumption of goods with high levels

of embedded emissions, reducing transportation-related emissions and trying to conserve energy in homes and buildings. Enterprises should also continue to reduce their use of natural resources, including energy, and switch to more renewable forms of energy. New technologies and applications of existing technologies such as capturing and storing carbon dioxide could become an important way of treating and eliminating carbon dioxide emissions from being released into the atmosphere. Reversing deforestation is also considered one of the most cost-effective ways of capturing carbon but there are many challenges connected to the protection of forests and rainforests.

Sustainable development is described as meeting the needs of present generations without jeopardising the ability of future generations to meet their own needs. In this way, today's social, economic and environmental concerns need to consider long-term, intergenerational objectives.

In July 2009, the European Commission adopted a review of its updated (2006) Sustainable Development Strategy, which highlighted the mainstreaming of sustainable development issues into a broad range of policy areas, in particular, by taking the lead internationally in the work related to climate change. Complementary to climate change and energy policy, the revised Sustainable Development Strategy also stresses the importance of education, research and public funding to achieve sustainable production and consumption patterns.

The sixth Community environment action programme (sixth EAP), laid down by the European Parliament and Council Decision 1600/2002/EC of 22 July 2002, is the EU's ten-year (2002-2012) policy programme for the environment. It identifies four key priorities:

- **tackling climate change:** to achieve the EU's target of reducing greenhouse gas emissions by 8 % by 2008-2012;
- **nature and biodiversity:** to avert the loss of species and their habitats in Europe by completion of the Natura 2000 network and by developing new sectoral biodiversity action plans, to pay greater attention to protecting landscapes, the marine environment and soils, and to establish measures to prevent industrial and mining accidents;
- **environment and health:** to completely overhaul the EU's risk-management system for chemicals, to develop a strategy for reducing risks from pesticides, to protect water quality, to encourage noise abatement, and to develop a thematic strategy for air quality;
- **sustainable use of natural resources and the management of waste:** to increase resource efficiency and decouple resource use from economic growth, to increase recycling and waste prevention with the aid of an integrated product policy, and to encourage measures targeting specific waste streams such as hazardous waste, sludge and biodegradable waste.

In order to implement the sixth EAP, the European Commission adopted seven thematic strategies; these are air pollution (adopted in September 2005), marine environment (October 2005), the pre-

vention and recycling of waste (December 2005), the sustainable use of natural resources (December 2005), urban environment (January 2006), soil (September 2006) and the sustainable use of pesticides (July 2006). A mid-term review of the sixth EAP was adopted by the European Commission in April 2007 ([1]).

A competitive, reliable and sustainable energy sector is essential for an economy, and this has been put under the spotlight in recent years by a number of issues, including the volatility in oil prices, interruptions to energy supply from non-member countries, blackouts aggravated by inefficient connections between national electricity networks, the difficulties of market access for suppliers in relation to gas and electricity markets, and increased attention to climate change. These issues have pushed energy towards the top of national and European political agendas.

The use of renewable energy sources is seen as a key element in energy policy, reducing the dependence on fuel from non-member countries, reducing emissions from carbon sources, and decoupling energy costs from oil prices. The second key element is constraining demand, by promoting energy efficiency both within the energy sector itself and at end-use.

As noted above, the EU has already adopted a comprehensive package of measures to reduce its contribution to greenhouse gas emissions, promote the sustainable use of natural resources and the management of waste, and ensure reliable and sufficient supplies of energy through far-reaching reforms contained within the integrated energy and climate change policy. Among others, this aims to boost the use of renewable energy and curb energy consumption, such that the EU becomes a world leader in renewable energy and low-carbon technologies.

11.1 Air pollution

Introduction

Air pollution often results from human activities, although there are also natural events which can potentially lead to air pollution – for example, volcanic eruptions; it has the potential to cause serious health problems.

Ozone (O_3) is present in small concentrations throughout the atmosphere; most (about 90 % of all ozone) exists in the stratosphere, a layer that sits between 10 and 50 km above the surface of the earth. This ozone layer performs the essential task of filtering out most of the sun's biologically harmful ultraviolet (UV-B) radiation. At ground-level, ozone is harmful: it is formed by the chemical reaction of a number of emissions arising primarily from the burning of fossil fuels such as in the production of energy and provision of transport (road, rail, air and water), industrial processes, and the use of solvents. Ground-level ozone is a secondary pollutant caused by the oxidation of nitrogen oxides and volatile organic compounds reacting in sunlight and is the primary constituent of smog. High levels of ground-level ozone interfere with the ability of plants to produce and store food making them more susceptible to diseases, insects and harsh weather. Reduced forest growth and crop yields and reducing species diversity in ecosystems can also result

([1]) Commission Communication on the mid-term review of the Sixth Community Environment Action Programme, for more information: http://eur-lex.europa.eu/lexuriserv/lexuriserv.do?uri=com:2007:0225:fin:en:pdf.

from high concentrations of ground-level ozone. People living in urban areas are most at risk from ground-level ozone, as a result of high levels of urban traffic emissions; this problem may be exacerbated by particular climatic conditions. Breathing high concentrations of ground-level ozone can have harmful effects on the respiratory tract, causing breathing difficulties (coughing, throat irritation, and congestion), damage or even scar lung tissue, or trigger asthma attacks and worsen bronchitis and emphysema.

Since the early 1970s, the EU has been working to improve air quality by controlling emissions of harmful substances into the atmosphere, improving fuel quality, and integrating environmental protection requirements into the transport and energy sectors. The EU acts at many levels: at an international level in order to reduce cross-border pollution, through work with national/regional authorities and NGOs, to work with individual industrial sectors, as well as providing funding to help support research.

Environment and health is one of four target areas within the sixth environment action programme (sixth EAP). The sixth EAP aims to achieve levels of air quality that do not give rise to unacceptable impacts on, and risks to, human health and the environment. Most of the legislation establishes health-based standards (limits) for pollutants, with action required if levels exceed these limits. In 2008, a Directive ([2]) of the European Parliament and of the Council on ambient air quality and cleaner air for Europe was adopted, setting binding limits on emissions of fine particles. These microscopic particles are principally released by cars and trucks (diesel-engine exhaust smoke) or from the burning of wood (soot). Under the new law, which takes effect in 2011, Member States will have to reduce exposure in urban areas by an average of 20 % during the following decade (in relation to 2010 levels). In 2008 there was also a Directive ([3]) of the Council concerning integrated pollution prevention and control of stationary source emissions.

The emissions of acidifying substances that result in acid rain are to a large extent regulated by the Gothenburg Protocol under the convention on long-range transboundary air pollution – CLRTAP. Sources of acidifying substances come from agriculture (ammonia), from the combustion of fuels by industry and road traffic (nitrogen oxides) and the combustion of fuels and metal production (sulphur dioxide). Emissions of sulphur dioxide occur at the time of emission but then react in the atmosphere to form different sulphur oxides (SO_x). All of these gases may be transported over long distances so the emissions from one country may be transported by the winds and be deposited in other countries. For this reason acidification is considered a regional problem rather than a global problem since the effects are more localised, rather than influencing global climate as do greenhouse gases.

Definitions and data availability

Eurostat, in close partnership with the European Environment Agency (EEA) and the Joint Research Centre (JRC), provides statistics, indicators and meta-information on environmental pressures and the state of the environment to support the implementation and monitoring of the sixth

([2]) Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008; for more information: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008L0050:EN:NOT.

([3]) Directive 2008/1/EC of the Council of 15 January 2008; for more information: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008L0001:EN:NOT.

EAP. This is done through ten topic-specific data centres: the EEA is responsible for the European topic centre on air and climate change. The European pollutant emission register (EPER) provides public access to emissions of key air pollutants in the EU ([4]), and a near to real-time ozone information system is also available on the EEA website ([5]).

Data on air pollution is officially reported under the CLRTAP, with information on: ammonia (NH_3), sulphur oxides (SO_2 and SO_3 as SO_x), nitrogen oxides (NO and NO_2 as NO_x), non-methane volatile organic compounds (NMVOC), carbon monoxide (CO), and particulate matter.

In 1996, the Environment Council adopted framework Directive 96/62/EC on ambient air quality assessment and management, which was followed by four daughter directives detailing limits for specific pollutants. The first daughter Directive (1999/30/EC) limits values for particulate matter, the second (2000/69/EC) deals with emissions of carbon monoxide and benzene, the third (2002/3/EC) relates to ozone, while the fourth (2004/107/EC) covers polyaromatic hydrocarbons, arsenic, nickel, cadmium and mercury. Annual reporting must follow Commission Decision 2004/224/EC which lays down arrangements for the submission of information in relation to limit values for certain pollutants in ambient air.

Particulates whose diameter is less than 10 micrometres (PM10) typically come from smoke, dust, pollen, mould and spores. These enter the body through breathing and can cause inflammation and a worsening of the condition of people with heart and lung diseases. *Ozone* is a strong photochemical oxidant, which can cause serious health problems and damage to ecosystems, agricultural crops and forests. Human exposure to elevated ozone concentrations can give rise to inflammatory responses and decreases in lung function.

Two indicators are presented for **urban population exposure to air pollution** – covering particulate matter and ground-level ozone. These show the population weighted annual mean concentrations of air pollutants at urban background stations in agglomerations. In 1999 an annual limit on PM10 and other pollutants in ambient air was fixed at 40 micrograms of PM10 per cubic metre. For ozone, the indicator is based on maximum daily 8-hour mean ozone concentrations above the threshold of 70 micrograms of ozone per cubic metre.

The indicator for **weighted emissions of acidifying substances** tracks trends in anthropogenic (human-induced) atmospheric emissions of acidifying substances (sulphur dioxide, nitrogen oxides and ammonia) by source; these emissions are combined in terms of their acidifying effects, and expressed in terms of tonnes of acid equivalents.

Main findings

From 1997 to 2006 the EU-27 recorded a 28 % decline in weighted emissions of acidification gases (aggregated using acidification potentials of each gas). Of the EU-27 Member States, only Greece (1 %) and Romania (18 %) showed increases of weighted emissions of acidification gases over this period. In contrast, the Czech Republic, Luxembourg, Malta, Hungary and Slovenia all had decreases of 50 % or more. Norway, Switzerland and Turkey also showed decreases in emissions of 14 % to 15 %.

([4]) For more information: http://eper.ec.europa.eu/eper.

([5]) For more information: http://www.eea.europa.eu/maps/ozone/welcome.

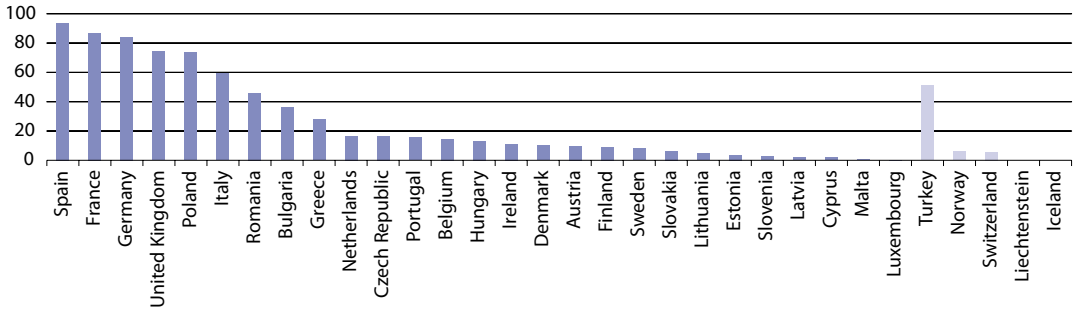
For specific acidification and tropospheric ozone precursors there were substantial reductions in the past decade across the EU. For nitrogen oxides there was a reduction of 21.0 %, for carbon monoxide the reduction was 40.7 % and for sulphur oxides the reduction was 45.2 % (to 2006). These declines were spread across Member States, as between 1997 and 2006/2007 the only exceptions were: higher emissions of carbon monoxide in Romania and Finland; higher emissions of methane in Spain and Portugal; higher emissions of sulphur oxides in Greece and Romania; and higher emissions of nitrogen oxides in Bulgaria, Greece, Spain, Lithuania and Austria. The EFTA countries of Norway and Switzerland reduced emissions for all three of these air pollutants.

There was a relatively stable trend to EU-27 emissions of coarse particulate matter (PM10) within urban areas during the period 1999 to 2007, with annual mean concentrations ranging from 27.0 micrograms per m^3 (2001) to 31.2 micrograms per m^3 (2003); the latest figure for 2007 was 28.1 micrograms per m^3. The highest concentrations of particulate matter were recorded in Bulgaria (with values more than double the EU-27 average), Romania, Italy and Poland (more than 20 % above the EU-27 average).

There was a considerable spike in ozone concentrations in 2003 (associated with exceptionally dry and hot weather), with some of the highest concentrations being recorded in Belgium, south west Germany, central Spain, and parts of France and Italy. Exposure to ozone pollution in 2007 was highest among the urban populations of Greece and Malta (more than double the EU-27 average), while Hungary, Italy, Slovenia and Austria recorded values that were more than 50 % above the EU-27 average.

Emissions of acidifying substances contribute to acid deposition, leading, among other things, to potential changes in soil and water quality and damage to forests, crops and other vegetation. Total EU-27 emissions amounted to 727 420 tonnes of acid equivalents in 2006. Almost one third (31.3 %) of these were from agriculture, while a quarter (24.7 %) could be attributed to energy industries (in particular, coal-based activities).

Figure 11.1: Weighted emissions of acidifying substances, 2006 (1 000 tonnes acid equivalent)



Source: Eurostat (tsdpc260), European Environment Agency, Topic Centre on Air and Climate

Table 11.1: Air pollutants

	Weighted emissions of acidifying substances (thousand tonnes acid equivalent)		(million tonnes)					
			Emissions of carbon monoxide		Emissions of sulphur oxides		Emissions of nitrogen oxides	
	1997	2006	1997	2007	1997	2006	1997	2007
EU-27	1 012.5	727.4	47.08	27.92	14.49	7.95	13.84	10.94
Belgium	21.7	14.7	1.01	0.75	0.23	0.14	0.34	0.26
Bulgaria	48.6	36.0	0.53	0.25	1.31	0.88	0.14	0.19
Czech Republic	45.6	16.5	0.98	0.51	0.98	0.21	0.47	0.28
Denmark	15.2	10.1	0.56	0.45	0.10	0.03	0.26	0.17
Germany	117.2	84.3	6.11	3.75	1.21	0.56	1.94	1.28
Estonia	5.2	3.4	0.24	0.17	0.12	0.07	0.04	0.03
Ireland	15.1	10.9	0.31	0.17	0.17	0.06	0.13	0.12
Greece	27.6	27.9	1.36	0.73	0.52	0.54	0.33	0.37
Spain	105.8	93.7	3.49	2.55	1.74	1.17	1.35	1.48
France	107.1	87.0	8.38	4.67	0.80	0.45	1.70	1.35
Italy	97.8	59.2	6.28	3.33	1.13	0.39	1.73	1.15
Cyprus	2.2	1.8	0.03	0.02	0.05	0.04	0.02	0.02
Latvia	2.9	1.9	0.31	0.30	0.04	0.00	0.04	0.04
Lithuania	5.7	4.7	0.35	0.21	0.08	0.04	0.06	0.07
Luxembourg	0.7	0.3	0.00	0.00	0.00	0.00	0.02	0.01
Hungary	29.2	13.0	0.64	0.51	0.66	0.12	0.20	0.19
Malta	1.2	0.6	0.03	0.00	0.03	0.01	0.01	0.01
Netherlands	22.2	16.6	0.72	0.53	0.10	0.06	0.39	0.28
Austria	9.7	9.7	1.14	0.77	0.04	0.03	0.19	0.22
Poland	113.0	73.6	4.70	2.60	2.18	1.20	1.11	0.88
Portugal	19.5	15.6	0.81	0.60	0.29	0.19	0.25	0.23
Romania	38.9	45.8	1.43	1.49	0.59	0.86	0.38	0.33
Slovenia	6.4	2.7	0.24	0.10	0.12	0.02	0.06	0.04
Slovakia	11.3	6.2	0.36	0.28	0.20	0.09	0.13	0.08
Finland	10.9	9.0	0.48	0.50	0.10	0.09	0.26	0.18
Sweden	11.1	8.1	0.79	0.57	0.06	0.04	0.24	0.17
United Kingdom	120.8	74.3	5.80	2.11	1.66	0.68	2.07	1.49
Croatia	:	:	:	0.36	0.00	0.00	:	0.08
Turkey	59.6	50.9	:	:	1.26	0.88	:	:
Iceland	0.0	0.0	:	:	:	:	:	:
Liechtenstein	0.0	0.0	:	:	:	:	:	:
Norway	7.2	6.1	0.67	0.40	0.03	0.02	0.22	0.19
Switzerland	6.8	5.8	0.45	0.29	0.03	0.02	0.11	0.08

Source: Eurostat (tsdpc260), annual European Community greenhouse gas inventory and annual European Community LRTAP convention emission inventory reports (http://www.eea.europa.eu)

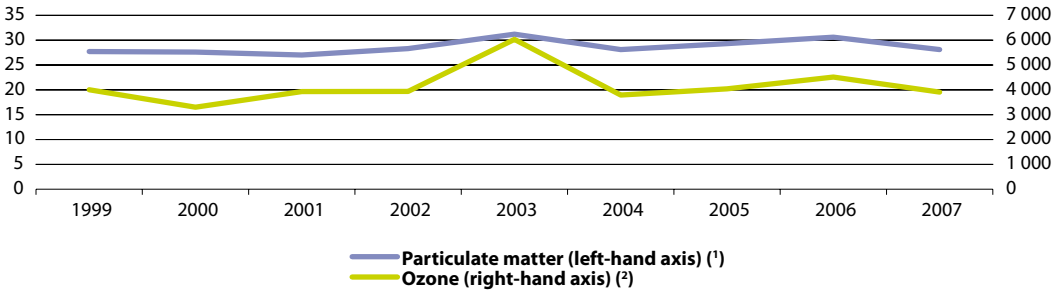
Table 11.2: Urban population exposure to air pollution

	Urban population exposure to air pollution by PM10 particulate matter (micrograms per m³) (¹)					Urban population exposure to air pollution by ozone (micrograms per m³) (²)				
	1999	2001	2003	2005	2007	1999	2001	2003	2005	2007
EU-27	27.7	27.0	31.2	29.3	28.1	4 003	3 929	6 031	4 041	3 909
Belgium	34.5	33.9	36.5	28.8	25.1	3 804	3 380	5 136	2 722	2 371
Bulgaria	:	:	59.5	55.6	59.0	117	192	1 838	2 186	2 555
Czech Republic	28.0	35.7	47.0	39.6	32.0	4 760	3 464	7 041	5 532	4 870
Denmark	:	:	24.6	22.8	21.0	:	:	2 816	1 415	2 376
Germany	25.0	24.3	29.0	24.2	22.5	3 545	3 336	5 872	3 285	3 142
Estonia	:	18.2	19.4	20.7	18.6	:	4 255	2 524	1 321	2 308
Ireland	15.8	20.4	13.9	13.8	12.6	:	:	:	:	:
Greece	:	40.9	39.1	41.1	32.3	7 154	12 247	13 827	9 601	9 006
Spain	33.9	30.9	31.4	33.3	32.9	5 028	3 951	5 862	4 891	4 108
France	:	21.9	23.7	20.4	27.3	3 964	4 095	6 842	4 276	3 434
Italy	:	32.2	42.3	45.1	36.6	8 706	8 149	9 852	6 752	7 356
Cyprus	:	:	:	:	:	:	:	:	:	:
Latvia	:	:	:	:	:	3 801	:	863	308	:
Lithuania	:	:	:	22.9	20.2	:	:	:	5 048	1 995
Luxembourg	:	:	:	:	:	:	:	:	:	:
Hungary	:	:	40.1	37.7	29.7	:	:	:	5 091	7 622
Malta	:	:	:	:	29.3	:	:	:	:	8 156
Netherlands	33.1	29.0	32.9	28.5	29.6	2 300	1 888	2 880	1 490	1 157
Austria	:	32.0	32.2	28.9	23.8	5 344	5 299	8 318	5 711	6 043
Poland	45.6	38.5	45.3	38.9	34.0	3 308	3 812	5 232	4 037	3 610
Portugal	37.6	35.7	34.1	34.0	30.4	1 361	3 660	4 112	4 116	3 969
Romania	:	:	:	46.2	43.1	:	:	:	4 500	3 784
Slovenia	:	:	43.8	36.4	32.4	4 636	5 919	11 461	6 017	6 514
Slovakia	36.5	26.7	31.4	33.2	26.3	:	2 873	7 938	7 423	5 735
Finland	15.7	16.4	16.3	15.3	16.8	2 427	1 339	1 800	1 687	1 136
Sweden	14.1	17.9	19.6	19.6	17.5	2 196	1 362	3 276	2 920	1 728
United Kingdom	24.2	24.2	25.9	23.6	23.9	1 439	1 062	2 197	1 250	938
Iceland	:	:	21.3	19.6	11.5	:	:	2 645	66	:
Norway	:	:	19.6	24.0	20.7	:	:	:	:	380

(¹) Population weighted annual mean concentration of particulate matter.
(²) Population weighted yearly sum of maximum daily 8-hour mean ozone concentrations above a threshold of 70 microgram of ozone per m³.

Source: Eurostat (tsien110 and tsien100), European Environment Agency, European Topic Center on Air and Climate Change

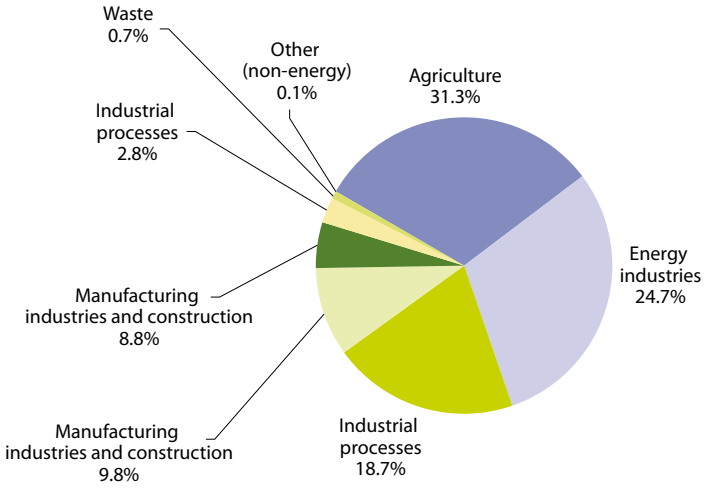
Figure 11.2: Urban population exposure to air pollution - population weighted, EU-27



(1) Population weighted annual mean concentration of particulate matter (micrograms per m^3).
(2) Population weighted yearly sum of maximum daily 8-hour mean ozone concentrations above a threshold of 70 microgram of ozone per m^3 (micrograms per m^3).

Source: Eurostat (tsien110 and tsien100), European Environment Agency, European Topic Center on Air and Climate Change

Figure 11.3: Weighted emissions of acidifying substances, by source sector, EU-27, 2006 (1) (%, based on tonnes of acid equivalents)



(1) Total emissions were 727 420 tonnes of acid equivalent; Figures do not sum to 100 % due to rounding.

Source: Eurostat (tsdpc260), European Environment Agency, Topic Centre on Air and Climate

11.2 Air emissions

Introduction

The term 'climate' covers meteorological phenomena over a lengthy period of time, for example, trends in temperature, storm activity or rainfall. Climate change results from natural phenomena and has occurred periodically throughout history – sometimes with catastrophic effects, such as the extinction of various species during the different ice ages. Over the past two decades a growing body of scientific evidence has been established that suggests that the most recent changes in the earth's climate have been substantially influenced by human activity, so-called anthropogenic effects.

Solar energy (heat from the sun), arrives in the earth's atmosphere as short wavelength radiation. Some of this is reflected by the earth's surface (especially from snow and ice covered areas) and atmosphere; however, the vast majority is absorbed, warming the planet. As the earth's surface gains heat, it starts to emit long wavelength, infra-red radiation back into the atmosphere. Despite their relative scarcity (less than 0.1 % of the total atmosphere, which consists mostly of nitrogen and oxygen), greenhouse gases are vital to life on earth because of their ability to act like a blanket, trapping some of this infra-red radiation and preventing it from escaping back into space; without this process the temperature on the earth's surface would be a lot colder. This layer of greenhouse gases has become thicker as a result of human activity and this process would appear to be disturbing the natural balance between incoming and outgoing radiative energy.

Substantial amounts of human-induced greenhouse gas emissions have come from the increased use of fossil fuels burned to power new machines, generate electricity and related to transport. The amount of emissions has accelerated in the last 200 years, reflecting increases in the world's population, economic development, and increased production and consumption in a globalised economy.

The Kyoto Protocol is an international agreement that committed industrialised nations to reduce or at least limit the growth of their greenhouse gas emissions. The protocol was adopted in 1997, setting legally-binding targets with the goal to reduce greenhouse gas emissions in developed countries by 2008-2012. However, it was not until 18 November 2004 when the Russian Federation ratified the protocol that the prescribed conditions were met and the Kyoto Protocol entered into force on 16 February 2005.

Kyoto established different commitments for each country according to their economic development. Globally, developed countries were required to reduce their collective emissions from 1990 base year levels by at least 5 % during the first commitment period (average emission levels for the period 2008-2012). Political negotiation and compromise resulted in different national targets: hence, while cuts of 8 % (relative to 1990 levels) were agreed for the EU-15, Switzerland and many central and eastern European countries, a number of other countries only agreed to stabilise their emission levels (New Zealand and Russia), while some countries were allowed to increase emissions (Australia and Iceland by 8 % and 10 % respectively).

The European Community agreed to an 8 % reduction in its greenhouse gas emissions for the EU-15 by 2008-2012. The reductions for each of the EU-15 Member States were agreed under the so-called 'burden sharing agreement', which allowed some countries to increase emissions, provided these were offset by reductions in others. Among the EU-15 Member States these range from decreases of 28 % for Luxembourg and 21 % for Denmark and Germany, to increases of 25 % and 27 % for Greece and for Portugal. Of the 12 Member States that have joined the EU since 2004, Cyprus and Malta are not party to the Kyoto Protocol, while the remaining ten countries have their own individual reduction targets, generally set at 8 %, although for Hungary and Poland the target is 6 %, and there are also base years other than 1990.

In an attempt to find alternative ways to reduce emissions, three market-based mechanisms were introduced to help countries meet their Kyoto commitments: joint implementation (JI); the clean development mechanism (CDM), and; international emissions trading (IET). These initiatives seek to aid those countries for which it may be easier and/or more cost-effective to enhance carbon sinks or cut emissions abroad – rather than on their national territory, based upon the premise that the overall effect of such actions (for the atmosphere) is the same regardless of where (geographically) the action is taken. Emissions trading schemes enable developed countries to acquire assigned amount units (AAUs) from other developed countries that are more able to reduce their emissions. This form of trading allows countries that have achieved emission reductions beyond those required by the Kyoto Protocol to sell their excess reductions to other countries that are finding it more difficult or expensive to meet their commitments.

One cornerstone of the EU's climate change strategy is an emissions trading system (ETS). The scheme covers about 12 000 factories and plants that together are responsible for about half of the EU's greenhouse gas emissions. Under the system, governments set limits on the amount of carbon dioxide and other greenhouse gases to be emitted by energy-intensive industries (such as utilities and steel producers) or other industries with high levels of greenhouse gas emissions arising from their production systems such as the cement industry. If these enterprises need to emit more greenhouse gases than their permits allow, they have to buy spare permits from the marketplace.

A revised Directive to improve and extend the greenhouse gas emission allowance trading scheme of the Community was adopted on 6 April 2009 ([6]). This is designed to achieve greater emissions reductions in energy-intensive sectors from the start of a third ETS period as of 1 January 2013. To stimulate the adoption of clean technologies, the new ETS provides that emissions permits will no longer be given to industry for free, but instead they will be auctioned. Each Member State will determine the use of its revenues from auctioning pollution permits (although at least half of the proceeds should be used to fight climate change in the EU and abroad and to alleviate the social consequences of moving towards a low-carbon economy).

([6]) Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009; for more information: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0063:0087:EN:PDF.

Definitions and data availability

Data on **greenhouse gas emissions** are officially reported under the United Nations Framework Convention on Climate Change – UNFCCC ([7]). The Kyoto Protocol covers legally binding commitments in relation to the reduction of the following six types of greenhouse gases: carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); sulphur hexafluoride (SF_6); hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs). Note that while chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) are greenhouse gases, they are not included in the Kyoto Protocol (as they were previously covered by the Montreal Protocol on substances that deplete the ozone layer).

Each greenhouse gas has a different capacity to cause global warming, depending on its radiative properties, molecular weight and the length of time it remains in the atmosphere. The **global warming potential (GWP)** of each gas is defined in relation to a given weight of carbon dioxide for a set time period (for the purpose of the Kyoto Protocol a period of 100 years). GWPs are used to convert emissions of greenhouse gases to a relative measure (known as carbon dioxide equivalents: CO_2 equivalents), the following weighting factors are currently used: carbon dioxide = 1, methane = 21, nitrous oxide = 310, and sulphur hexafluoride = 23 900; hydrofluorocarbons and perfluorocarbons comprise a large number of different gases that have different GWPs.

The European Environment Agency (EEA) compiles an annual European Community greenhouse gas inventory report for submission to the UN. Within the inventory reporting requirements of Kyoto, estimates of greenhouse gas emissions are produced for a number of IPCC defined sectors which are delineated primarily according to process-technologies. The five main IPCC sectors include: energy (fuel combustion); industrial processes; solvent and other product use; agriculture; and waste. Note that the use of fuel in ships or aircraft engaged in international transport is excluded from the reporting mechanism. Information pertaining to land use changes and forestry are also reported but the view taken in this publication focuses only on the (gross) emissions rather than the emissions and the removals or sinks (net emissions).

Main findings

Greenhouse gas emissions in the EU-27 stood at 5 045 million tonnes of CO_2 equivalents in 2007. This figure marked an overall reduction of 9.3 % when compared with 1990, or some 519 million tonnes of CO_2 equivalents. There was generally a downward trend to emissions during the period 1990 to 1997 (aside from a relative peak in 1996, when a cold winter led to an increase in heating requirements). Since 1998, the evolution of greenhouse gas emissions within the EU-27 has remained relatively unchanged.

Carbon dioxide accounted for 83.0 % of EU-27 greenhouse gas emissions in 2007, followed by methane (8.2 %), nitrous oxide (7.3 %) and fluorinated gases (1.5 %). Fluorinated gases were the only group to record an overall increase in their amount of emissions between 1990 and 2007 (up 31.1 %); this may be entirely attributed to hydrofluorocarbons (HFCs),

([7]) For more information: http://unfccc.int.

which have, in recent years, been increasingly used as substitutes for ozone-depleting compounds such as chlorofluorocarbons (CFCs) in refrigeration, air conditioning, or the manufacture of insulating foams.

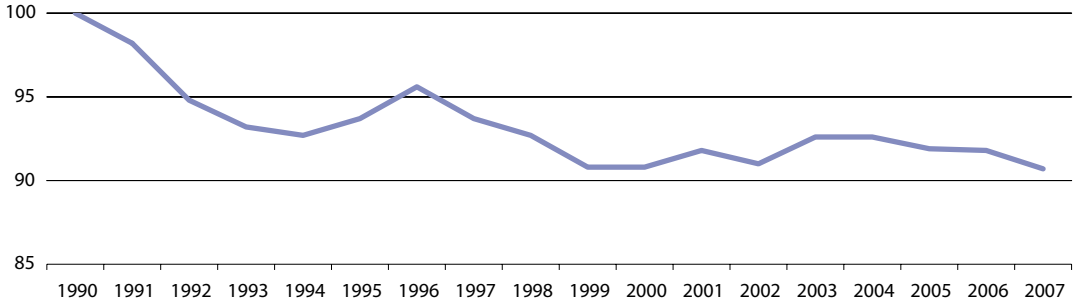
Across the Member States, greenhouse gas emissions were highest in Germany (19.0 % of the EU-27 total or 956.1 million tonnes of CO_2 equivalents in 2007), while the United Kingdom (12.6 %), Italy (11.0 %) and France (10.5 %) were the only other countries to record double-digit shares. EU-15 Member States accounted for 80.3 % of total greenhouse gas emissions within the EU-27 in 2007, some 4.2 percentage points above their corresponding share of 1990. The 'burden-sharing agreement' between EU-15 Member States foresees that four countries (Ireland, Spain, Greece and Portugal) may increase their emission levels through to the first commitment period (2008-2012). Some of the biggest overall increases in greenhouse gas emissions between 1990 and 2007 were recorded on the Iberian Peninsula, with gains of 53.5 % and 38.1 % in Spain and Portugal; Cyprus and Malta also recorded significant increases in their emission levels (although they are not parties to the Kyoto Protocol).

By far the most important source of greenhouse gas emissions across the EU-27 was energy use (in particular, oil and gas-fired power stations). This category was consistently the principal source of emissions throughout the period 1990 to 2007; the latest data available shows energy with a 59.8 % share of total emissions (or more than 3 000 million tonnes of CO_2 equivalents).

The transport sector (a subsector of the IPCC energy sector) was the next largest contributor (19.5 % of the EU-27's greenhouse gas emissions in 2007), and was also the IPCC sector where emissions were increasing at their fastest pace – within the confines of Kyoto reporting (road freight and passenger cars).

Agriculture accounted for 9.2 % of all greenhouse gas emissions in the EU-27 in 2007; contrary to other areas, where carbon dioxide was the principal greenhouse gas emitted, agricultural emissions are largely composed of nitrous oxide and methane. Emissions from industrial processes, solvents and product use accounted for a slightly lower share (8.8 %), while emissions from waste (which includes disposal, landfill sites and water treatment) accounted for the remaining 2.8 % of the EU-27's greenhouse gas emissions in 2007.

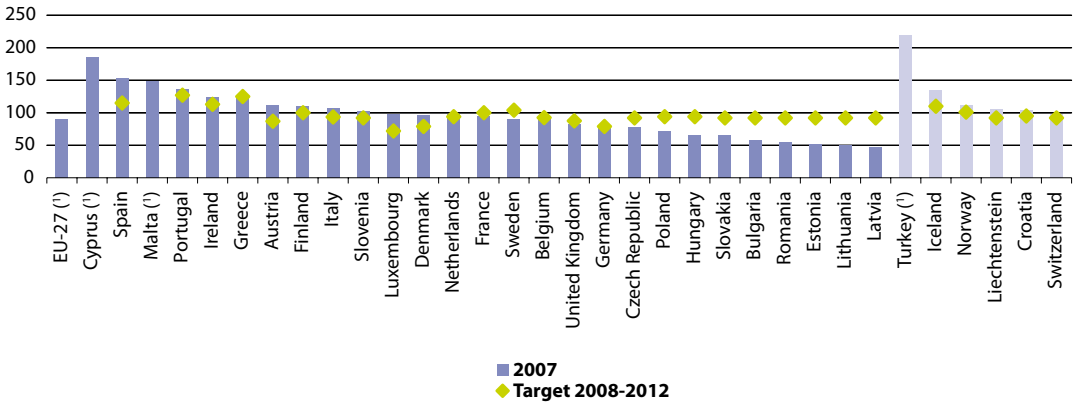
Figure 11.4: Greenhouse gas emissions, EU-27 ([1])
(1990=100)



([1]) Weighted emissions of greenhouse gases represented 5 045 million tonnes in 2007.

Source: Eurostat (env_air_ind and ten00072), European Environment Agency, European Topic Center on Air and Climate Change

Figure 11.5: Total greenhouse gas emissions
(Kyoto base year=100)



([1]) No target under the Kyoto Protocol (1990=100).

Source: Eurostat (tsien010), European Environment Agency, European Topic Center on Air and Climate Change

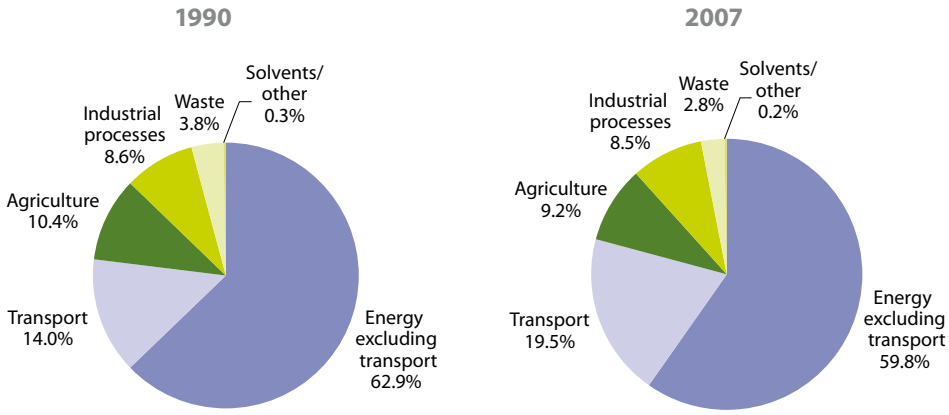
Table 11.3: Greenhouse gas emissions

	Total greenhouse gas emissions (Kyoto base year=100) (1)				Weighted emissions of greenhouse gases (million tonnes of CO_2 equivalent)			
	1997	2002	2007	Target 2008-2012	1997	2002	2007	Share in EU-27 (%)
EU-27	93.7	91.0	90.7	:	5 214.1	5 065.7	5 045.4	-
Euro area	:	:	:	:	3.365.1	3 414.5	3 364.1	66.7
Belgium	99.6	98.1	90.1	92.5	145.1	142.9	131.3	2.6
Bulgaria	63.2	50.2	57.2	92.0	83.8	66.5	75.8	1.5
Czech Republic	78.8	74.7	77.6	92.0	153.0	145.1	150.8	3.0
Denmark	115.1	99.0	96.1	79.0	79.8	68.6	66.6	1.3
Germany	86.6	81.7	77.6	79.0	1 067.6	1 006.4	956.1	19.0
Estonia	50.0	42.4	51.7	92.0	21.3	18.1	22.0	0.4
Ireland	113.0	123.7	124.5	113.0	62.8	68.8	69.2	1.4
Greece	110.4	119.4	123.2	125.0	118.1	127.8	131.9	2.6
Spain	114.8	139.1	152.6	115.0	332.7	403.1	442.3	8.8
France	100.1	97.4	94.2	100.0	564.6	549.3	531.1	10.5
Italy	102.3	107.5	106.9	93.5	528.7	555.8	552.8	11.0
Cyprus	136.4	170.6	185.3	:	7.5	9.3	10.1	0.2
Latvia	46.5	41.5	46.6	92.0	12.0	10.7	12.1	0.2
Lithuania	45.7	41.7	50.1	92.0	22.6	20.6	24.7	0.5
Luxembourg	74.7	86.1	98.1	72.0	9.8	11.3	12.9	0.3
Hungary	69.3	67.6	65.8	94.0	79.9	78.0	75.9	1.5
Malta	127.2	134.9	149.0	:	2.6	2.8	3.0	0.1
Netherlands	106.0	101.1	97.4	94.0	225.9	215.5	207.5	4.1
Austria	105.2	110.1	111.3	87.0	83.1	87.0	88.0	1.7
Poland	79.7	65.9	70.8	94.0	449.1	371.5	398.9	7.9
Portugal	118.8	147.6	136.1	127.0	71.4	88.8	81.8	1.6
Romania	59.9	52.7	54.7	92.0	166.7	146.7	152.3	3.0
Slovenia	96.4	98.5	101.8	92.0	19.6	20.1	20.7	0.4
Slovakia	69.3	68.0	65.2	92.0	49.9	49.0	47.0	0.9
Finland	106.6	108.2	110.3	100.0	75.7	76.8	78.4	1.6
Sweden	100.6	96.4	90.7	104.0	72.6	69.6	65.4	1.3
United Kingdom	91.2	84.5	82.0	87.5	708.1	655.8	636.7	12.6
Croatia	79.2	89.7	103.2	95.0	24.8	28.1	32.4	-
Turkey	150.3	159.1	219.1	:	255.5	270.6	372.6	-
Iceland	101.4	110.6	134.9	110.0	3.4	3.7	4.5	-
Liechtenstein	109.1	113.0	106.1	92.0	0.3	0.3	0.2	-
Norway	106.1	107.4	110.9	101.0	52.7	53.3	55.1	-
Switzerland	96.5	97.5	97.1	92.0	50.9	51.5	51.3	-

(1) EU-27, Cyprus, Malta and Turkey, 1990=100 as there is no target (and therefore no base year) under the Kyoto Protocol.

Source: Eurostat (tsien010 and ten00072), European Environment Agency, European Topic Center on Air and Climate Change

Figure 11.6: Greenhouse gas emissions by source sector, EU-27 (%, based on data in million tonnes CO_2 equivalent)



Source: Eurostat (env_air_emis), European Environment Agency

11.3 Waste

Introduction

Waste refers to materials for which the generator has no further use for their own purpose of production, transformation or consumption; the majority is landfilled, incinerated, composted or recycled. In some circumstances there may be statutory requirements on a producer to dispose of waste in a certain manner, for example, when waste materials are hazardous. The disposal of waste can have a serious environmental impact: for example, landfill takes up space and may cause air, water or soil pollution, while incineration can also result in emissions of dangerous air pollutants; both landfill and incineration result in the generation of greenhouse gas emissions.

In 2008, a revised Waste Framework Directive ([8]) was adopted by the European Parliament and the Council, with the dual aim of promoting the use of waste as a secondary resource, as well as simplifying existing legislation. The directive set new recycling targets: by 2020 each Member State should recycle 50 % of their household and similar waste and 70 % of their construction and demolition waste. The directive lays down a five-step hierarchy of waste management options (in descending order):

- waste prevention;
- re-use;
- recycling;
- recovery (including energy recovery); and
- safe disposal.

([8]) Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008; for more information: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:312:0003:0003:EN:PDF.

Waste prevention can be achieved through the use of cleaner technologies, eco-design, or more eco-efficient production and consumption patterns. Waste prevention and recycling can also reduce the use of resources by limiting raw materials' extraction and transformation. The EU's approach underlines that any waste that cannot be recycled or reused should, where possible, be safely incinerated, with landfill only used as a last resort.

The European Commission has defined several specific waste streams for priority attention, including: packaging waste, end-of-life vehicles, batteries, electrical and electronic waste. Member States are required to introduce legislation concerning the collection, reuse, recycling and disposal of these waste streams.

The EU's sixth environment action programme (EAP) identifies waste prevention and management as one of four priorities, underlining the relationship between the efficient use of resources and waste generation and management. The objective is to decouple the resource use and the generation of waste from economic growth, while ensuring that sustainable consumption does not exceed environmental capacity.

Economic growth and globalisation have led to an increase in the volume of waste that is shipped across borders (whether by road, rail or ship). The waste shipment Regulation ([9]) has introduced certain procedures and requirements to control the international movement of hazardous waste from Member States and by this ensure sound management of the waste. Shipments abroad for disposal are generally prohibited, as are exports of hazardous waste to developing countries (even if for recovery). Shipments for recovery are usually permitted and these are governed by a series of annexes to the Regulation (which has been amended on three occasions to take account of scientific and technical developments).

Definitions and data availability

Waste statistics present data on the amounts and types of waste produced, as well as waste treatment methods. Regulation (EC) 2150/2002 on waste statistics ([10]) was adopted in 2002, creating a framework for harmonised statistics on waste; the Regulation requires Member States to provide data on the generation, recovery and disposal of waste every two years from 2004 onwards. The statistics collected within this framework are used to monitor the implementation of policy objectives across the EU, in particular compliance with the principles of recovery and safe disposal. The statistics are classified according to the economic activity (NACE Rev. 1.1) of the business responsible for handing over waste for treatment, such that waste flows from agriculture, mining, industry, construction, services and households may be distinguished.

Municipal waste consists of waste collected by or on behalf of municipal authorities. Such collection systems may well extend beyond waste from households to include waste collected from offices or small businesses. The treatment of municipal waste can be classified into three principal categories:

- **landfill:** which is defined as the depositing of waste into or onto land, including specially engineered landfill, and temporary storage of over one year on permanent sites;

([9]) Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006; for more information: http://eur-lex.europa.eu/LexUriServ/site/en/oj/2006/l_190/l_19020060712en00010098.pdf.

([10]) Regulation (EC) No 2150/2002 of the European Parliament and of the Council of 25 November 2002; for more information: http://eur-lex.europa.eu/LexUriServ/site/en/consleg/2002/R/02002R2150-20050614-n.pdf.

- **incineration:** which refers to the thermal treatment of waste in specifically designed plant;
- **recovery:** which refers to any waste management operation that diverts a waste material from the waste stream and which results in a certain product with a potential economic or ecological benefit (for example, composting or recycling).

Main findings

On average, each individual in the EU-27 generated the equivalent of 524 kg of municipal waste in 2008, some 28 kg (or 5.3 %) more than a decade earlier; however, the amount of municipal waste generated per inhabitant has remained almost unchanged in the EU-27 since 2000.

Denmark recorded the highest level of municipal waste generated per inhabitant in 2008, at 802 kg per inhabitant; with waste volumes rising by more than one third (35 %) between 1998 and 2008. On a per capita basis, there were also relatively high levels of municipal waste generated in Ireland, Cyprus, Luxembourg, Malta and the Netherlands. Note these figures may reflect municipal waste collection policies, whereby local authorities seek to collect a growing volume of waste, based on the premise that waste represents additional resources and value (for example, the recycling of metals, glass, plastics or paper). The only Member States to report less than 400 kg of municipal waste per inhabitant in 2008 were Romania, Latvia, Poland, Slovakia and the Czech Republic; these relatively low figures may reflect lower levels of consumption per inhabitant or a limited collection rate (for example, no municipal disposal facilities for used vehicles, hazardous goods or garden refuse).

During the period 1998 to 2008 the way in which municipal waste was treated changed significantly. In 1998 some 60 % of the municipal waste treated in the EU-27 was put into landfill, with a further 16 % being incinerated, the rest being treated in other ways, such as recycling (13 %) or composting (8 %). By 2008, the proportion of municipal waste that was put into landfill had declined to 40 %, while 20 % was incinerated. In contrast, the share of municipal waste treatment that was recycled (23 %) or composted (17 %) became increasingly important.

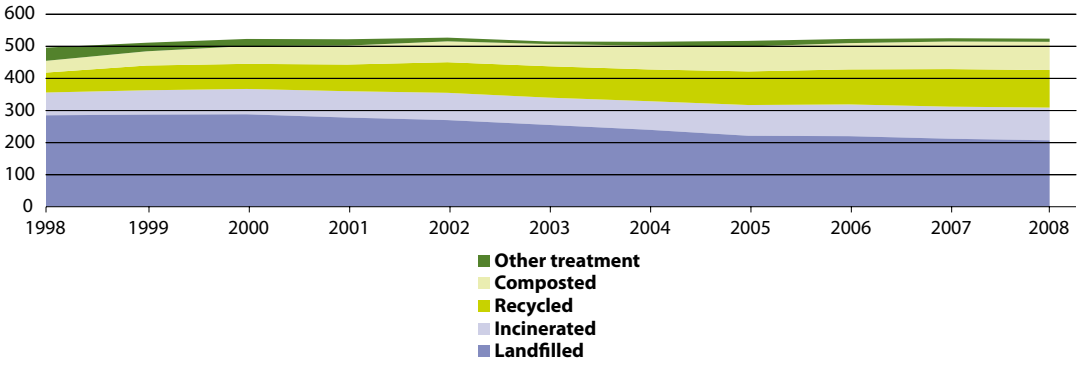
In Germany, the amount of municipal waste going into landfill shrank from 199 kg per inhabitant in 1998 to only 3 kg in 2008; there were also significant reductions in the Netherlands, Sweden, Austria and Belgium, where the volume of municipal waste sent to landfill was reduced to less than 25 kg per inhabitant. Those countries that reduced the use of landfill tended to have relatively high levels of waste incineration; note that newly installed waste incinerators are equipped with systems for energy recovery.

According to data collected through the waste statistics Regulation, some 2 953 million tonnes of waste were generated in the EU-27 by economic activities and households in 2006; this equated to an average of 6 tonnes per inhabitant. A high proportion of the total was generated by mining and quarrying industries (25 %) and by construction (including demolition) activities (also 25 %). Mining waste is spread particularly unevenly

across the Member States as a function of indigenous supplies of raw materials and mining facilities. The share of mining and quarrying activities ranged from less than 5 % of the total volume of waste generated in 14 of the Member States to around one third of the total in Estonia, Greece and Finland, more than half of the total in Sweden and Romania, and as much as 93 % of the total in Bulgaria. The relative importance of construction and demolition activities in total waste also displayed a wide range, as nine Member States recorded shares below 10 %, while more than half of the waste generated in Germany, Ireland, Austria and the Netherlands was from construction and demolition activities, peaking at 71 % of the total in Luxembourg and 87 % in Malta. Services accounted for 5 % of the waste generated in the EU-27 in 2006, with nine Member States recording double-digit shares. The relative importance of services as a source of waste was highest in Slovakia (22 % of the total waste generated) and Portugal (27 %).

More than 71 million tonnes of metallic waste were recovered across the Member States (excluding Luxembourg) in 2006, with a further 36 million tonnes of wood waste, 35 million tonnes of paper and cardboard, and 12 million tonnes of glass (2004). As may be expected, the highest levels of waste recovery were generally recorded among the largest Member States (Germany, Spain, France, Italy, Poland and the United Kingdom). Austria, Finland and Sweden together accounted for almost half (48 %) of the paper and cardboard recovery in the EU-27.

Figure 11.7: Municipal waste, EU-27 ([1]) (kg per inhabitant)



([1]) Data extracted on 2 February 2010.

Source: Eurostat (tsien120 and tsien130)

Table 11.4: Municipal waste ([1])
(kg per inhabitant)

	Municipal waste generated ([2])			Municipal waste landfilled ([3])			Municipal waste incinerated ([4])		
	1998	2003	2008	1998	2003	2008	1998	2003	2008
EU-27	496	515	524	285	255	207	71	85	102
Euro area	538	555	558	256	221	177	91	107	127
Belgium	*457*	468	*493*	101	*44*	*25*	*162*	*162*	*165*
Bulgaria	495	499	467	382	407	440	0	0	0
Czech Republic	293	280	306	*272*	201	218	*17*	39	34
Denmark	593	672	*802*	67	34	*35*	312	363	*433*
Germany	*647*	601	*581*	199	115	*3*	112	137	*193*
Estonia	400	*418*	*515*	399	274	248	0	0	1
Ireland	557	736	733	478	480	440	0	0	19
Greece	378	428	453	344	393	347	0	0	0
Spain	566	655	*575*	*317*	364	*327*	*38*	42	*53*
France	508	508	*543*	230	193	*193*	167	172	*172*
Italy	472	524	*561*	365	314	*276*	34	55	*69*
Cyprus	664	724	*770*	601	653	*672*	0	0	0
Latvia	*247*	298	331	*230*	248	310	0	5	1
Lithuania	443	383	407	443	328	367	0	0	0
Luxembourg	629	684	*701*	146	129	*131*	288	266	*248*
Hungary	484	*463*	453	396	390	333	35	24	39
Malta	*470*	581	696	*388*	520	648	0	0	0
Netherlands	593	610	*622*	54	17	*7*	198	197	*203*
Austria	532	609	*601*	186	183	*19*	55	73	*163*
Poland	*306*	260	*320*	300	251	228	0	1	2
Portugal	423	447	*477*	310	293	*307*	0	96	*91*
Romania	277	*350*	*382*	224	277	*287*	0	0	0
Slovenia	584	418	459	512	348	341	0	3	7
Slovakia	259	297	332	181	233	254	34	30	29
Finland	466	466	522	294	278	265	28	49	90
Sweden	431	471	515	121	64	15	165	212	250
United Kingdom	543	593	*565*	456	440	*308*	37	45	*55*
Turkey	510	445	*428*	371	363	*356*	0	0	*0*
Iceland	452	485	*555*	338	364	*380*	70	45	*54*
Norway	647	403	490	417	86	88	85	131	184
Switzerland	613	670	741	66	8	0	279	343	371

([1]) Data extracted on 2 February 2010.
([2]) Breaks in series: Estonia, 2001; Latvia, 2006; Lithuania, 1999; Hungary, 2000; Malta, 1999; Portugal, 2002; Slovenia, 2002; Slovakia, 2002; Turkey, 2004; Switzerland, 2004.
([3]) Breaks in series: Estonia, 2001; Latvia, 2006; Lithuania, 1999; Hungary, 2000; Malta, 1999; Portugal, 2002; Turkey, 2004.
([4]) Break in series: Italy, 2002.

Source: Eurostat (tsien120 and tsien130)

Table 11.5: Generation of waste, total arising and by selected economic activities (1 000 tonnes)

	Total waste from economic activities and households		Mining and quarrying activities		Manufacturing industry		Construction and demolition activities		Other economic activities (services)	
	2004	2006	2004	2006	2004	2006	2004	2006	2004	2006
EU-27	*2 913 252*	*2 953 087*	*862 157*	*740 745*	*380 021*	*364 206*	:	:	*146 439*	*154 094*
Belgium	*52 809*	*59 352*	*384*	*159*	*18 177*	*15 308*	*11 037*	*13 090*	*8 689*	*7 039*
Bulgaria	252 058	242 489	222 231	225 338	5 611	4 316	2 999	1 023	9 181	1 473
Czech Republic	29 276	24 746	708	472	8 618	5 932	8 131	8 380	933	1 025
Denmark	12 589	14 703	2	2	1 553	1 643	4 274	5 802	1 290	1 486
Germany	364 022	363 786	55 880	47 222	30 163	31 705	191 563	196 536	16 343	15 107
Estonia	20 861	18 933	5 306	5 961	6 288	3 981	489	717	1 720	*1 601*
Ireland	24 513	*30 005*	4 046	*4 793*	*5 356*	*4 067*	11 287	16 599	1 184	1 327
Greece	34 953	51 325	1 902	14 888	4 554	5 285	3 324	6 829	*1 518*	1 518
Spain	160 668	160 947	21 780	26 015	28 377	22 427	46 320	47 323	14 194	15 376
France	429 153	445 865	166	1 040	21 434	22 973	:	:	*24 158*	*24 158*
Italy	139 806	155 025	761	1 005	39 472	39 997	49 151	52 316	3 860	5 534
Cyprus	2 242	1 771	119	60	557	412	488	307	*313*	313
Latvia	1 257	1 859	0	0	349	570	8	19	99	239
Lithuania	7 010	7 665	4	6	2 632	2 948	357	349	158	586
Luxembourg	8 322	9 586	46	56	725	604	6 985	6 775	179	243
Hungary	*24 661*	*22 287*	*1 640*	*27*	*5 071*	*5 528*	*1 736*	*3 045*	*1 965*	*2 445*
Malta	2 482	2 861	0	0	*10*	50	2 206	2 493	160	173
Netherlands	88 099	93 808	296	213	16 086	15 562	49 612	56 610	5 276	5 349
Austria	53 021	54 287	622	1 043	15 073	11 470	27 935	31 322	2 856	3 458
Poland	251 243	266 741	38 311	38 671	61 514	61 131	1 993	14 141	1 965	3 512
Portugal	*29 272*	*38 714*	*4 761*	*3 563*	*10 123*	*14 699*	*2 626*	*3 607*	*4 202*	*10 352*
Romania	371 503	331 863	326 553	199 138	11 156	9 184	54	34	3 096	3 841
Slovenia	5 771	6 036	129	377	1 960	2 385	908	995	426	429
Slovakia	10 668	14 502	211	332	3 878	5 527	1 404	916	761	3 236
Finland	69 708	72 205	23 819	21 501	18 613	17 976	20 843	23 146	1 276	1 668
Sweden	109 741	115 583	58 600	62 084	27 614	30 363	10 272	8 943	*1 517*	1 517
United Kingdom	357 544	346 144	93 883	86 779	35 056	28 161	99 234	109 546	39 120	41 088
Croatia	7 209	:	347	:	3 695	:	646	:	116	:
Turkey	58 820	46 092	:	:	16 325	:	:	:	62	:
Iceland	501	:	1	:	61	:	19	:	6	:
Norway	7 454	9 051	116	136	2 956	3 519	1 101	1 248	865	1 472

Source: Eurostat (env_wasgen)

Table 11.6: Waste treatment (non-hazardous), recovery, 2006
(1 000 tonnes)

	Metallic waste	Glass waste	Paper and cardboard waste	Rubber waste	Plastic waste	Wood waste	Textile waste
EU-27 (1)	*63 453*	*11 948*	*34 932*	*1 451*	*6 429*	*36 181*	*1 717*
Belgium	2 711	282	630	8	130	440	10
Bulgaria	1 148	47	125	2	24	0	3
Czech Republic	1 307	50	201	13	89	120	18
Denmark	643	131	788	54	54	862	0
Germany	7 648	2 024	5 922	192	1 119	2 502	68
Estonia	4	7	6	6	10	398	0
Ireland	31	14	26	9	25	180	7
Greece	2 599	54	425	31	42	63	9
Spain	5 083	1 412	3 346	352	1 450	573	79
France	10 136	2 174	6 050	230	435	3 727	388
Italy	8 228	2 083	4 143	128	1 156	4 378	264
Cyprus	13	4	45	1	26	5	0
Latvia	9	1	18	1	8	0	0
Lithuania	15	26	141	11	36	34	1
Luxembourg	:	:	0	0	:	:	0
Hungary	760	21	344	10	49	174	1
Malta	0	1	3	1	0	1	0
Netherlands	1 928	495	2 731	71	252	705	92
Austria	1 160	249	1 425	30	164	2 282	34
Poland	8 004	136	212	785	446	419	1 294
Portugal	2 842	405	781	90	178	681	144
Romania	2 319	80	335	9	198	109	4
Slovenia	750	:	373	:	22	:	:
Slovakia	509	11	108	11	29	421	3
Finland	1 266	149	734	24	5	4 122	0
Sweden	1 866	:	1 846	35	:	10 916	0
United Kingdom	10 538	*1 198*	*4 174*	25	*426*	*2 747*	117
Croatia (2)	16	13	4	1	3	35	0
Turkey	9	7	23	2	13	0	1
Iceland (2)	0	*6*	*8*	*4*	2	23	1
Norway	880	91	670	39	36	348	13

(1) Metallic waste, glass waste, rubber waste and textile waste, 2004.
(2) 2004.

Source: Eurostat (env_wastrt)

11.4 Water

Introduction

Water is essential for life, as well as an indispensable resource for the economy, while playing a fundamental role in the climate regulation cycle. The management and protection of water resources, of fresh and salt water ecosystems, and of the water we drink and bathe in are therefore major concerns all around the world. These issues often transcend national boundaries, and it is therefore often necessary for actions to be taken at EU or global level in order to ensure effective protection.

A study conducted for the European Commission ([11]) estimated that water use efficiency could be improved by nearly 40 % through technological improvements alone and that changes in human behaviour or production patterns could increase such savings further. In a scenario based on no changes in practices, it was estimated that water use by the public, industry and agriculture would increase by 16 % by 2030. Conversely, the use of water saving technologies and irrigation management in the industrial and agricultural sectors could reduce excesses by as much as 43 %, while water efficiency measures could decrease water wastage by up to a third.

In a Communication on water scarcity and droughts ([12]) adopted in July 2007, the European Commission identified an initial set of policy options to be taken at European, national and regional levels to address water scarcity within the EU. This set of proposed policies aims to move the EU towards a water-efficient and water-saving economy.

Aside from the availability of water, another major concern is water quality: the pollution of rivers, lakes and groundwater remains of worldwide concern. Water quality in Europe may be affected by human activities such as industrial production, household discharges, or arable farming (a report on the protection of waters against pollution by nitrates from agricultural sources was issued in March 2007 ([13]). Another aspect of water quality relates to coastal bathing waters. The European Commission and the European Environment Agency present an annual bathing water report – the latest of these covers 2008 ([14]) and shows that 96.3 % of Europe's coastal bathing waters and 92 % of inland bathing waters met the minimum water quality standards. New legislation on bathing water was adopted in 2006 ([15]) and will provide for a more proactive approach to informing the public on water quality; it was transposed into national law in 2008 but Member States have until December 2014 to implement it.

Increasingly variable weather patterns and catastrophic floods (such as the those along the Danube and Elbe in 2002) prompted a review of flood risk management, which culminated in a European

([11]) For more information: http://ec.europa.eu/environment/water/quantity/pdf/water_saving_1.pdf.

([12]) COM(2007) 414 final; for more information: http://eur-lex.europa.eu/LexUriServ/site/en/com/2007/com2007_0414en01.pdf.

([13]) For more information: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2007:0120:FIN:EN:PDF.

([14]) For more information: http://ec.europa.eu/environment/water/water-bathing/report2009/report.pdf.

([15]) Directive 2006/7/EC concerning the management of bathing water quality and repealing Directive 76/160/EEC; for more information: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:064:0037:0051:EN:PDF.

Commission Directive ([16]) in November 2007 that aims to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity.

The majority of the EU's population is connected to public water supplies, with the proportion rising close to 100 % in most Member States. Looking at the 'other end of the pipe', namely the treatment of wastewater, a number of countries reported that less than half of their population was connected to urban wastewater treatment; the European Commission releases regular reports on the implementation of the urban wastewater treatment Directive ([17]).

Definitions and data availability

Water statistics are collected through the inland waters section of a joint OECD/Eurostat questionnaire which is continuously adapted to the EU policy framework. It currently reports on the following:

- **freshwater resources** in groundwater and surface waters – these can be replenished by precipitation and by external inflows (water flowing in from other territories);
- **water abstraction** – a major pressure on resources, although a large part of the water abstracted for domestic, industrial (including energy production), or agricultural use is returned to the environment and its water bodies, but often as wastewater with impaired quality;
- **water use**, analysed by supply category and by industrial activities;
- treatment capacities of **wastewater treatment plants and the share of the population connected to them** – this gives an overview of the development status of the infrastructure, in terms of quantity and quality, that is available for the protection of the environment from pollution by wastewater;
- **sewage sludge production and disposal** – an inevitable product of wastewater treatment processes; its impact on the environment depends on the methods chosen for its processing and disposal;
- **generation and discharge of wastewater** – pollutants present in wastewater have different source profiles, and similarly the efficiency of treatment of any pollutant varies according to the method applied.

Statistics on water resources are usually calculated on the basis of long-term annual averages for at least 20 years, to take account of the fluctuations in rainfall and evaporation/transpiration from one year to the next.

Precipitation is defined as the total volume of atmospheric wet precipitation (mainly rain, snow and hail) and is usually measured by meteorological or hydrological institutes. **Evapotranspiration** is the volume of water that is transported into the atmosphere by evaporation from the ground, wetlands and natural water bodies or by transpiration of plants. **Internal flow** is defined as the total volume of river run-off and groundwater generated, in natural conditions, exclusively by precipitation into a territory; it is equal to precipitation less evapotranspiration and can be calculated or measured. **External inflow** is the volume of inflow derived from rivers and groundwater that originate in a neighbouring territory. Total

([16]) Directive 2007/60/EC of 26 November 2007: for more information: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:288:0027:0034:EN:PDF.

([17]) For more information: http://ec.europa.eu/environment/water/water-urbanwaste/implementation/pdf/implementation_report_summary.pdf.

freshwater resources refer to the volume of water resulting from internal flow and external inflow. **Outflow** is the volume of water that flows from rivers and groundwater into the sea and into neighbouring territories.

Water abstraction covers groundwater abstraction and surface water abstraction. **Surface water** is defined as water which flows over, or rests on the surface of a land mass; it may be a natural watercourse (such as rivers, streams, brooks and lakes), or an artificial watercourse (such as irrigation, industrial and navigation canals, drainage systems and artificial reservoirs). **Groundwater** is defined as water which is being held in, and can usually be recovered from, or via, an underground formation, including permanent and temporary deposits of water, both artificially charged and naturally, in the subsoil, of sufficient quality for at least seasonal use. Groundwater includes springs, both concentrated and diffused, which may also be subaqueous.

Wastewater is defined as water which is of no further immediate value to the purpose for which it was used or in the pursuit of which it was produced because of its quality, quantity or time of occurrence. However, wastewater from one user can be a potential supply to another user elsewhere. **Urban wastewater** is domestic wastewater or the mixture of domestic wastewater with industrial wastewater and/or run-off rain water. **Urban wastewater treatment** is all treatment of wastewater in urban wastewater treatment plants, which are usually operated by public authorities or by private enterprises working by order of public authorities. This includes also treatment plants in non-urban environments but fulfilling the conditions of the definition.

The **population connected to urban wastewater treatment** relates to persons who are connected to any kind of sewage treatment that is carried out in municipal treatment plants by public authorities or private enterprises on behalf of local authorities. There are three broad types of urban wastewater treatment that are distinguished in statistical information in this area: primary, secondary and tertiary wastewater treatment. **Primary treatment** of wastewater involves physical or chemical processes (such as sedimentation) in which the biological oxygen demand (BOD) and suspended solids are reduced by at least 20 % and 50 %, respectively. **Secondary treatment** generally involves biological treatment, with a secondary settlement procedure that should result in a BOD removal of at least 70 % and a chemical oxygen demand (COD) removal of at least 75 %. **Tertiary treatment** goes further and removes important percentages of nitrogen and/or phosphorous and/or any other pollutants affecting the quality of the water.

Main findings

The three main users of water are agriculture, industry and the domestic sector (households and services). The overall abstraction and use of water resources is generally considered to be sustainable in the long-term in most of Europe. Specific regions may face problems associated with water scarcity, especially in southern Europe, where it is likely that efficiency gains will need to be achieved especially in relation to agricultural water use in order to prevent seasonal water shortages.

Otherwise, regions associated with low rainfall, high population density, or intensive industrial activity may also face sustainability issues, which can be exacerbated by natural resource endowments, geographical characteristics and freshwater management systems. A number of Member States receive a significant proportion of their water resources as inflows from upstream rivers: this is particularly the case in the Danube basin and for the Netherlands, and to a lesser extent in Latvia, Germany and Portugal.

One measure of sustainability is the water exploitation index, calculated as water abstraction divided by long-term annual resources. The European Environment Agency (EEA) uses 20 % as a warning threshold for this indicator, while a ratio of more than 40 % indicates unsustainable water use. Using this measure and subject to data availability, a relatively high pressure exists on water resources in Spain, Bulgaria and Cyprus; although Cyprus was the only country to record a ratio of more than 40 %.

In absolute terms, total freshwater resources were broadly similar in Germany, France, Sweden, the United Kingdom and Italy, as each of these Member States reported a long-term average of annual freshwater resources of between 188 000 and 175 000 million m^3. When expressed in relation to population size, Finland and Sweden recorded the highest freshwater annual resources per capita (more than 20 000 m^3 per inhabitant). In contrast, relatively low levels (below 3 000 m^3) were recorded in the six largest Member States (Germany, Spain, France, Italy, Poland and the United Kingdom), as well as Belgium, Bulgaria, Denmark, the Czech Republic and Romania, with the lowest level in Cyprus (420 m^3 per inhabitant).

There are considerable differences in the amount of groundwater that is abstracted by the Member States, in part reflecting the resources available, but also abstraction practices for public water supply, industrial and agricultural purposes, as well as land drainage and land sealing. These differences are also apparent when looking at the breakdown of water abstraction between groundwater and freshwater resources. In Hungary surface water abstraction accounted for 32 times the volume of water abstracted from groundwater resources, while the difference was more than ten-fold in Bulgaria, Lithuania and Romania. At the other end of the range, larger volumes of water were abstracted from groundwater resources in Latvia, Slovakia, Cyprus and Malta.

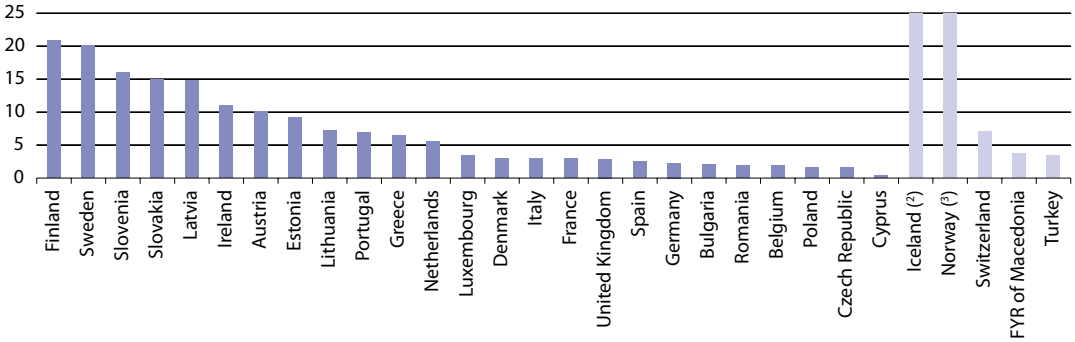
Spain and France recorded the highest amounts of groundwater extracted in 2006 (subject to data availability), both with in excess of 6 000 million m^3. Looking at the evolution of groundwater abstraction during the ten-year period to 2007, the volume of groundwater extracted generally fell, although Greece and Slovenia recorded abstraction levels that were between 15 % and 20 % higher, and Spain reported an increase of 41.7 %.

Spain and France also headed the ranking of Member States in relation to surface water abstraction, with more than 25 000 million m^3 in 2006. Developments in surface water abstraction levels were even more contrasting than for groundwater, with the Netherlands reporting an increase of 68 % in the nine-year period to 2006, while the volume of surface

water abstracted in Latvia, Lithuania and Slovakia in 2007was almost half its 1997 level.

The proportion of the population connected to urban wastewater treatment covers those households that are connected to any kind of sewage treatment. This proportion was equal to or greater than 80 % in ten of the 24 Member States for which data are available (mixed reference years), with shares up to 99 % in the Netherlands where also some 95 % of the population was connected to a tertiary wastewater treatment facility. At the other end of the range, less than one in two households were connected to urban wastewater treatment in Bulgaria, Cyprus, Romania and Malta, where the lowest connection rate was recorded at 13 %; in the latter, however, new treatment plants are under construction.

Figure 11.8: Freshwater resources per capita – long-term average ([1])
(1 000 m^3 per inhabitant)



([1]) The minimum period taken into account for the calculation of long term annual averages is 20 years; population data are as of 1 January 2007; Hungary and Malta, not available.
([2]) Y-axis is cut, 552 500 m^3.
([3]) Y-axis is cut, 83 200 m^3.

Source: Eurostat (ten00001 and tps00001)

Table 11.7: Water resources – long-term annual average (1)
(1 000 million m^3)

	Precipitation	Evapotrans-piration	Internal flow	External inflow	Outflow	Freshwater resources
Belgium	28.9	16.6	12.3	7.6	15.3	19.9
Bulgaria	68.2	52.9	15.3	0.5	15.8	15.8
Czech Republic	54.7	39.4	15.2	0.7	16.0	16.0
Denmark	38.5	22.1	16.3	0.0	1.9	16.3
Germany	307.0	190.0	117.0	75.0	182.0	188.0
Estonia	29.0	:	:	:	12.3	12.3
Ireland	80.0	32.5	47.5	:	:	47.5
Greece	115.0	55.0	60.0	12.0	:	72.0
Spain	346.5	235.4	111.1	0.0	111.1	111.1
France	485.7	310.4	175.3	11.0	168.0	186.3
Italy	296.0	129.0	167.0	8.0	155.0	175.0
Cyprus	3.1	2.7	0.3	0.0	0.1	0.3
Latvia	42.7	25.8	16.9	16.8	32.9	33.7
Lithuania	44.0	28.5	15.5	9.0	25.9	24.5
Luxembourg	2.0	1.1	0.9	0.7	1.6	1.6
Hungary	:	:	:	:	:	:
Malta	:	:	:	:	:	:
Netherlands	29.8	21.3	8.5	81.2	86.3	89.7
Austria	98.0	43.0	55.0	29.0	84.0	84.0
Poland	193.1	138.3	54.8	8.3	63.1	63.1
Portugal	82.2	43.6	38.6	35.0	34.0	73.6
Romania	154.0	114.6	39.4	2.9	17.9	42.3
Slovenia	31.7	13.2	18.6	13.5	32.3	32.1
Slovakia	37.4	24.3	13.1	67.3	81.7	80.3
Finland	222.0	115.0	107.0	3.2	110.0	110.0
Sweden	313.9	141.2	172.7	11.8	194.6	183.4
United Kingdom	283.7	111.2	172.5	2.8	175.3	175.3
Croatia	63.1	40.1	23.0	:	:	:
FYR of Macedonia	19.1	:	1.4	6.3	:	7.6
Turkey	501.0	273.6	227.4	6.9	178.0	234.3
Iceland	200.0	30.0	170.0	:	170.0	170.0
Norway	470.7	112.0	377.3	12.2	389.4	389.4
Switzerland	60.1	20.0	40.2	13.1	53.5	53.3

(1) The minimum period taken into account for the calculation of long term annual averages is 20 years.

Source: Eurostat (ten00001)

Table 11.8: Groundwater and surface water abstraction

	Groundwater abstraction (million m³)			Surface water abstraction (million m³)		
	1997	2002	2007	1997	2002	2007
Belgium	646	662	:	6 929	6 076	:
Bulgaria	798	493	473	6 735	6 096	5 708
Czech Republic	587	540	381	1 906	1 368	1 589
Denmark	917	650	:	16	18	:
Germany (1)	6 710	6 204	:	33 880	31 802	:
Estonia	322	236	:	1 306	1 177	:
Ireland	:	:	213	:	:	517
Greece (2)	3 119	3 188	3 651	4 603	6 072	5 821
Spain (3)	4 250	5 310	6 022	30 353	32 210	27 738
France (3)	:	6 240	6 184	:	26 923	26 368
Italy	:	:	:	:	:	:
Cyprus (4)	143	145	145	34	62	64
Latvia	167	115	108	196	142	104
Lithuania	234	158	175	4 552	2 966	2 094
Luxembourg	:	:	:	:	:	:
Hungary (3)	851	730	541	:	20 303	17 432
Malta	20	16	14	0	0	0
Netherlands (5)	1 153	977	1 059	5 354	7 938	8 720
Austria	1 148	:	:	2 496	:	:
Poland	2 871	:	:	9 928	:	:
Portugal	:	:	:	:	:	:
Romania	1 260	860	508	8 000	6 379	5 426
Slovenia	159	208	191	:	691	745
Slovakia	498	410	358	812	684	330
Finland	:	*285*	:	:	:	:
Sweden	654	628	346	2 057	2 048	2 285
United Kingdom	:	:	:	:	:	:
Croatia	:	:	1 162	:	:	29 154
FYR of Macedonia	31	:	:	3 676	:	:
Turkey (6)	9 330	10 990	12 096	*26 222*	33 780	:
Iceland	154	160	:	6	5	:
Norway	:	:	:	:	:	:
Switzerland (3)	880	854	788	1 678	1 674	:

(1) 1998 instead of 1997; 2001 instead of 2002.
(2) 1996 instead of 1997.
(3) 2006 instead of 2007.
(4) 1998 instead of 1997.
(5) 1996 instead of 1997; 2001 instead of 2002; 2006 instead of 2007.
(6) 2001 instead of 2002 for surface water abstraction.

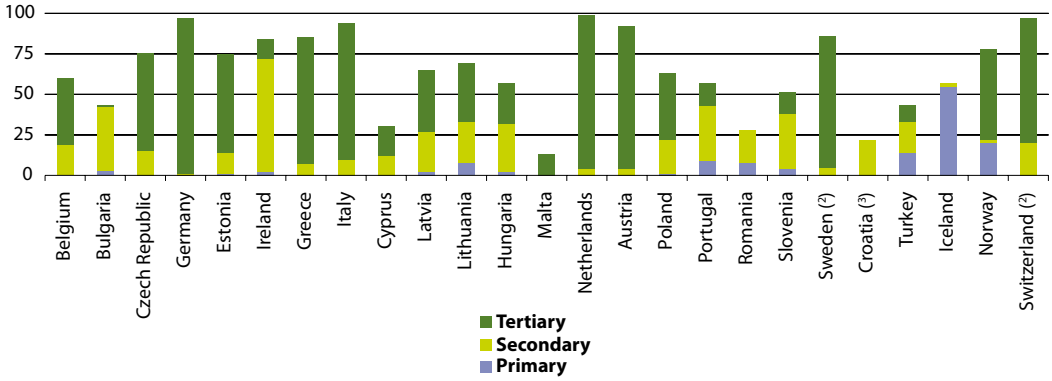
Source: Eurostat (ten00004 and ten00005)

Table 11.9: Population connected to urban wastewater treatment
(% of total)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Belgium	35	38	39	41	46	48	52	53	55	56	60
Bulgaria	36	36	37	37	38	39	40	40	41	41	42
Czech Republic	59	62	62	64	65	70	71	71	73	74	75
Denmark	88	89	:	:	:	:	:	:	:	:	:
Germany	:	91	:	:	93	:	:	94	:	:	:
Estonia	72	69	69	69	69	70	70	72	74	74	74
Ireland	:	:	66	:	70	:	:	:	84	:	:
Greece	:	:	:	:	:	:	:	:	:	:	85
Spain	:	:	:	:	:	:	:	:	:	:	:
France	:	77	:	:	79	:	:	80	:	:	:
Italy	:	:	:	:	:	:	:	:	:	:	:
Cyprus	12	13	13	14	16	18	23	28	30	:	:
Latvia	:	:	:	:	:	65	70	66	66	65	65
Lithuania	:	:	:	:	:	57	59	:	69	69	69
Luxembourg	:	:	93	:	:	:	95	:	:	:	:
Hungary	24	26	29	46	50	57	59	62	54	57	:
Malta	13	13	13	13	13	13	13	13	13	13	13
Netherlands	98	98	98	98	98	99	99	99	99	99	:
Austria	:	81	:	85	86	86	89	89	:	92	:
Poland	47	49	52	54	55	57	58	59	60	61	62
Portugal	:	42	:	:	:	57	60	:	65	:	68
Romania	:	:	:	:	:	:	:	27	28	28	28
Slovenia	:	19	36	39	39	40	41	50	51	52	51
Slovakia	49	49	50	51	51	52	53	54	55	55	57
Finland	78	79	80	80	81	81	:	:	:	:	:
Sweden	:	93	:	86	:	85	86	86	86	86	:
United Kingdom	:	:	:	:	:	:	:	:	:	:	:
Turkey	14	17	*23*	*26*	27	28	30	36	39	42	:
Iceland	4	8	16	33	33	50	50	50	57	:	:
Norway	70	73	73	73	74	74	75	76	77	78	78
Switzerland	95	96	96	96	96	96	:	:	97	:	:

Source: Eurostat (ten00021)

Figure 11.9: Population connected to wastewater treatment, 2007 (1)
(% of total)



(1) Hungary, the Netherlands, Austria, Sweden and Turkey, 2006; Germany, Ireland, Italy, Cyprus, Romania (only tertiary treatment), Iceland and Switzerland, 2005; Denmark, Spain, France, Luxembourg, Slovakia, Finland and the United Kingdom, not available.
(2) Primary, not available.
(3) Primary and tertiary, not available.

Source: Eurostat (ten00022, ten00023 and ten00024)

11.5 Environment and economy

Introduction

Resources are the backbone of every economy: in using and transforming them, capital stocks are built-up which add to the wealth of present and future generations. However, the extent of our current resource use may endanger economic growth for future generations and developing countries as they may face difficulties in accessing scarce resources. At the same time, the pace at which resources are being used may result in serious consequences for the environment. Such changes are only likely to accelerate as newly-industrialised countries and developing countries increase their economic activity.

In June 2006, the European Council adopted a comprehensive renewed Sustainable Development Strategy, the aim of which was to 'identify and develop actions to enable the EU to achieve continuous improvement of quality of life both for current and for future generations, through the creation of sustainable communities able to manage and use resources efficiently and to tap the ecological and social innovation potential of the economy, ensuring prosperity, environmental protection and social cohesion'. In response, a set of resource productivity indicators have been developed by Eurostat; these consider both the efficiency

with which an economy uses energy and materials and an economy's ability to produce goods and services relative to environmental impacts.

In the absence of mechanisms and policies that require the polluter to pay, the costs resulting from pollution are met by society at large. However, policy development in relation to environmental and sustainable development initiatives has led to this financial burden being increasingly shifted to those enterprises or individuals who are causing/producing pollution; the 'polluter pays' principle.

Environmental accounts have been developed to analyse the environmental consequences of production and consumption patterns. From a production perspective, such accounts can be used to distinguish the environmental performance of different economic activities, an approach that can be extended through linking environment and economic output data, thereby providing measures of 'environmental performance', for example, emission intensities per unit of output.

A key component of the EU's environment and health action programme within the sixth environment action programme (sixth EAP) is the need for a complete overhaul of EU policy on chemicals management. A European Regulation ([18]) on the registration, evaluation, authorisation and restriction of chemicals (REACH) came into force in June 2007. The major objective of REACH is to ensure a high level of protection for human health and the environment, by increasing knowledge about the hazardous properties of chemicals.

The EU's eco-management and audit scheme (EMAS) is a management tool for enterprises and other organisations to evaluate, report and improve their environmental performance. Enterprises have been able to participate in the scheme since 1995 ([19]). It was originally restricted to enterprises within the industrial economy, however, since 2001 EMAS has been open to all economic sectors including public and private services. In addition, EMAS was strengthened by ISO 14001 an international standard for environmental management. These management systems aim to help organisations identify their procedures related to the environment and to minimise harmful effects on the environment caused by their activities, and continually improve their environmental performance ([20]). Organisations participating in EMAS are committed to evaluate and improve their own environmental performance, comply with relevant environmental legislation, prevent pollution, and provide relevant information to the public (via verified environmental audits). In July 2008 the European Commission proposed to revise EMAS to increase the participation of companies and reduce the administrative burden and costs, particularly for small and medium-sized enterprises. On 2 April 2009, the Council and the European Parliament reached agreement on the text for a revised EMAS Regulation ([21]); at time of writing, formal adoption of the Regulation and entry into force had yet to happen.

([18]) For more information: http://ec.europa.eu/environment/chemicals/reach/reach_intro.htm.

([19]) Council Regulation (EEC) No 1836/93 of 29 June 1993; for more information: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31993R1836:EN:HTML.

([20]) Commission Regulation (EC) No 196/2006 of 3 February 2006 amending Annex I to Regulation (EC) No 761/2001 of the European Parliament and of the Council to take account of the European Standard EN ISO 14001:2004, and repealing Decision 97/265/EC;
for more information: http://eur-lex.europa.eu/LexUriServ/site/en/oj/2006/l_032/l_03220060204en00040012.pdf.

([21]) For more information: http://ec.europa.eu/environment/emas/index_en.htm.

Definitions and data availability

Resource productivity measures the efficiency with which the economy uses energy and materials (the natural resource inputs needed to achieve a given economic output). Sometimes resource productivity is used as a proxy for environmental impacts, using the reasoning that if less goes into the economic system then less waste and pollution will be discharged into the environment. Using this approach it is thought that resource productivity also measures the economy's ability to produce goods and services relative to its environmental impacts. Resource productivity is defined as GDP divided by **domestic material consumption** (DMC), which in turn is related to the consumption activities of residents in the national economy (DMC = domestic extraction plus imports minus exports). It is important to note that the term consumption as used in DMC denotes apparent consumption and not final consumption.

Data on **environmental protection expenditure** are collected through a joint OECD/Eurostat questionnaire. Environmental protection expenditure covers all expenditure on activities directly aimed at the prevention, reduction and elimination of pollution or nuisances resulting from production or consumption. Note that activities which may be beneficial to the environment, but that primarily satisfy technical needs, or health and safety requirements, are excluded. These expenditures may be classified according to the economic sector (agriculture, industry, services, public sector, and households) carrying out the expenditure, according to a financial breakdown of the expenditure (treatment and prevention investment, current expenditure, subsidies), or according to the environmental domain covered (air, waste, water, etc.) – of which there are nine areas distinguished in the classification of environmental protection activities (CEPA 2000) ([22]). Investment expenditure includes outlays in a given year (purchases and own-account production) for machinery, equipment and land used for environmental protection purposes. Non-core expenditure consists of administrative costs such as labour costs associated with running environmental departments or government funded agencies.

Eurostat has developed a **production index of toxic chemicals**, broken down into five toxicity classes, presenting the trend in aggregated production volumes of chemicals which have been classified as toxic substances according to EU legislation. The toxicity classes, beginning with the most dangerous, are: carcinogenic, mutagenic and reprotoxic (CMR-chemicals); chronic toxic chemicals; very toxic chemicals; toxic chemicals; and harmful chemicals. These classes are derived from the risk phrases assigned to individual substances in annex 6 of the dangerous substance Directive, as last amended in 2001 ([23]). Production volumes are extracted from PRODCOM (statistics on the production of manufactured goods) and are aggregated to the five classes according to their toxicity.

The **eco-management and audit scheme (EMAS)** is an EU voluntary instrument: organisations participating in EMAS are committed to evaluate and improve their own environmental performance, comply with relevant environmental legislation,

([22]) For more information: http://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=ACT_OTH_DFLT_LAYOUT&StrNom=CEPA_2000&StrLanguageCode=EN.

([23]) Commission Directive 2001/59/EC of 6 August 2001 adapting to technical progress for the 28th time Council Directive 67/548/EEC on the approximation of the laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances; for more information: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32001L0059:EN:NOT.

prevent pollution, and report on their environmental performance through the publication of an independently verified environmental statement. The scheme allows the use of ISO 14001 (international standard for environmental management system) as its environmental management system element. EMAS registered organisations are recognised by the EMAS logo, which guarantees the reliability of the information provided. To receive EMAS registration an organisation must comply with the following steps: conduct an environmental review; establish an effective environmental management system; carry out an environmental audit; and provide a statement of its environmental performance.

The EU's **eco-label scheme**, as laid down in a Regulation of the European Commission ([24]) is now part of a wider approach on integrated product policy (IPP). The Community eco-label is awarded to products and services with reduced environmental impacts. The existing scheme has been in operation since 1993. It is administered by the European eco-labelling board (EUEB), which includes representatives from industry environmental protection groups and consumer organisations.

Main findings

The efficient use of natural resources (many of which come from outside of the EU) contributes to economic growth, whereas disruption in supplies, inefficiencies and over-consumption are likely to put the sustainable future of economic systems under threat. Although the GDP of the EU-15 increased on average by 2.3 % per annum between 1995 and 2005, domestic material consumption grew at a much slower pace, rising on average by 0.7 % per annum (with two main surges in 2000 and 2004); as a result, resource productivity in the EU-15 rose by 16.5 % overall between 1995 and 2005. This could be seen as a relative decoupling of the use of materials in relation to the economy, however, much of the economic growth during this time was due to a growth in services so any conclusions about the increasing efficiency of the EU-15 economies should only be made taking this into consideration.

An analysis of EU-27 environmental protection expenditure in 2004 within manufacturing industries shows that relatively similar amounts of expenditure were dedicated to tackling environmental concerns relating to wastewater (30.9 %), waste (27.2 %) and air pollution (25.9 %), while the remaining share (16.1 %) was used for none-core domains.

The chemicals industry is one of the largest European manufacturing sectors and it has a pivotal role in providing innovative materials and technological solutions which have a direct impact on Europe's industrial competitiveness. Manufactured chemicals can, however, have an environment impact on soil, water and air quality, and some chemicals such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) were included in the Kyoto Protocol because they contribute to global warming. Between 1997 and 2007 the total production of all chemicals in the EU-15 grew by 15.7 %. The output of all toxic chemicals increased at a much slower pace, rising 7.0 %, while the level of production for the most dangerous, carcinogenic, mutagenic and reprotoxic (CMR) chemicals expanded by 10.0 %; the out-

([24]) Regulation (EC) No 1980/2000 of the European Parliament and of the Council of 17 July 2000; for more information: http://eur-lex.europa.eu/LexUriServ/site/en/oj/2000/l_237/l_23720000921en00010012.pdf.

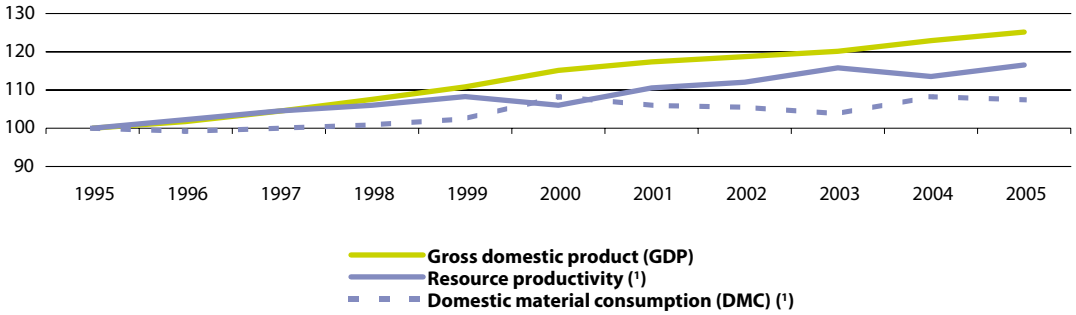
put of toxic and CMR chemicals peaked in 2004, since when both indices followed a downward trend.

Statistics on the production of toxic chemicals are available from 2004 onwards for the EU-25 (data for Bulgaria and Romania are not yet available). Toxic chemicals accounted for 58.2 % of the total output of the EU-25's chemicals industry in 2007. The volume of CMR chemicals produced in the EU-25 was around 36 million tonnes, equivalent to 10.2 % of total chemicals' production.

The eco-management and audit scheme (EMAS) is a management tool for companies and other organisations to evaluate, report and improve their environmental performance. In the EU-27 there were almost 6 000 sites that had implemented EMAS by 2007 (an average of 11.9 sites per million inhabitants). The highest uptake of EMAS (relative to population size) was recorded in Austria, with 58.9 sites per million inhabitants, followed by Denmark (45.7) and Belgium (31.7); the only other countries to have ratios in double figures were Spain, Germany and Italy.

Denmark and Austria were also at the forefront of eco-label awards: with 5.3 and 3.0 awards per million inhabitants in 2007, compared with an EU-27 average of 1.0); the only other countries to have ratios above 2.0 awards per million inhabitants were Ireland, Italy and Malta.

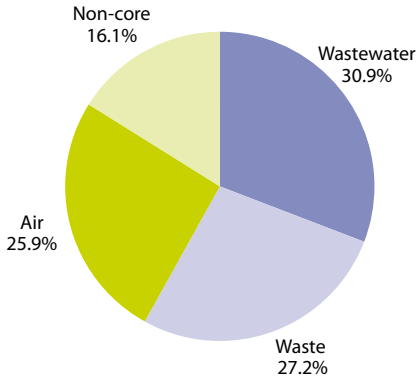
Figure 11.10: Resource productivity, EU-15 (1995=100)



(1) Estimates.

Source: Eurostat (nama_gdp_k, tsien140 and tsdpc230)

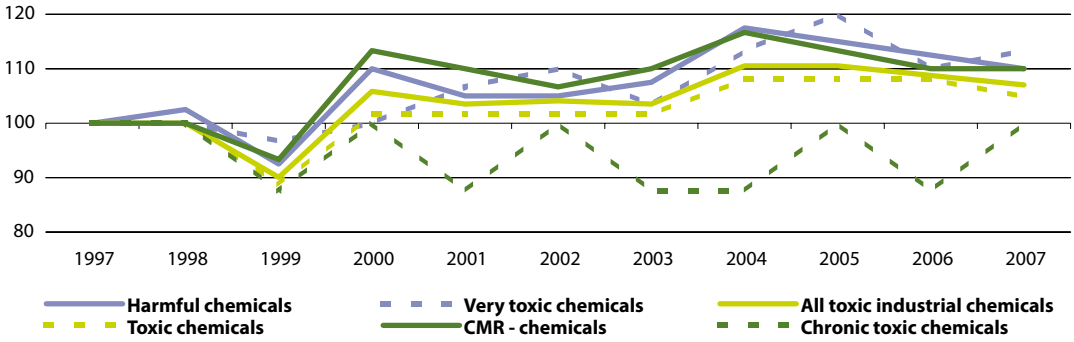
Figure 11.11: Environmental protection expenditure within manufacturing industries, EU-27, 2004 (1) (% of total)



(1) Figures do not sum to 100 % due to rounding.

Source: Eurostat (env_ac_exp1)

Figure 11.12: Production volume of toxic chemicals, EU-15 (1) (1997=100)



(1) In 2007, the volume of toxic chemicals produced in the EU-15 was: 317 million tonnes (EU-25: 354 million tonnes; an EU-25 time series is only available from 2004 to 2007). The share of substances classified as toxic was 183 million tonnes (EU-25: 206 million tonnes). Of the EU-25 production volume, starting with the most toxic substances, 36 million tonnes were classified as 'CMR-chemicals', 8 million tonnes as 'chronic toxic' chemicals, 39 million tonnes as 'very toxic', 74 million tonnes as 'toxic' and 49 million tonnes as 'harmful' chemicals in 2007.

Source: Eurostat (tsdph320)

Table 11.10: Environmental expenditure, EMAS and eco-label

	Environmental expenditure by the public sector, 2005 (% of GDP) (1)	Environmental expenditure by total industry, 2005 (% of GDP) (2)	Sites having implemented an eco-management and audit scheme, 2007 (number)	Eco-label awards, 2007 (number)
EU-27	:	*0.44*	5 888	478
Belgium	0.62	0.53	336	6
Bulgaria	0.38	0.78	0	:
Czech Republic	:	0.87	30	7
Denmark	1.05	:	249	29
Germany	:	:	1 954	61
Estonia	0.24	0.35	2	0
Ireland	:	:	6	11
Greece	:	:	59	17
Spain	0.31	0.26	1 090	27
France	0.33	:	13	88
Italy	0.71	0.78	1 046	145
Cyprus	0.31	0.23	0	1
Latvia	0.06	0.19	13	3
Lithuania	:	0.42	0	0
Luxembourg	:	:	0	0
Hungary	0.64	0.64	16	1
Malta	:	:	1	1
Netherlands	:	:	15	8
Austria	0.47	0.36	488	25
Poland	0.43	0.74	7	5
Portugal	0.49	0.30	66	7
Romania	0.23	0.60	1	:
Slovenia	0.79	0.73	1	2
Slovakia	0.26	1.13	5	0
Finland	0.39	0.39	49	5
Sweden	0.27	0.39	72	17
United Kingdom	0.49	0.28	369	12
Croatia	0.08	0.73	27	:
Turkey	0.54	:	:	:
Iceland	:	:	:	0
Norway	:	:	27	6
Switzerland	:	0.29	:	:

(1) Belgium, Spain, France, Cyprus, Portugal, Slovenia, Finland, Sweden and the United Kingdom, 2004.
(2) EU-27, Belgium, Spain, Italy, Portugal, Slovenia, Finland and the United Kingdom, 2004; Switzerland, 2003.

Source: Eurostat (ten00049, ten00052, tsdpc410 and tsdpc420)

11.6 Biodiversity

Introduction

Biodiversity, a contraction of biological diversity, reflects the number, variety and variability of living organisms, including mankind. We depend on natural resources and the variety of species found on the planet for tangible items that make life possible and drive economic development (food, energy, wood, raw materials, clean air and water). Many aspects of our natural environment are predominantly public goods (in other words, there are no markets or prices), as such the loss of biodiversity can often go undetected by economic systems. However, the natural environment also provides a range of intangibles, such as aesthetic pleasure derived from viewing landscapes and wildlife, or recreational opportunities. In order to protect this legacy for future generations, policies need to be developed in a range of areas to ensure that biodiversity is protected through the sustainable development of, among others, agricultural, regional, urban, energy and transport policy. Many of these issues were touched upon by a meeting of the G8 environment ministers held in Potsdam in March 2007, which launched an extensive study on the economic significance of the global loss of biological diversity ([25]).

Indeed, the global scale of the biodiversity issue has led to international action within this domain, the framework for which is the United Nations (UN) convention on biological diversity (CBD), which the EU ratified in 1993. At the United Nations world summit on sustainable development in Johannesburg in 2002, governments committed themselves to significantly reducing the rate of biodiversity loss by 2010. At a UN conference in Bonn in May 2008 decisions were taken on a number of concrete measures and a programme of funding to help achieve this goal.

In 1998 the EU adopted its own biodiversity strategy. Four action plans covering: the conservation of natural resources, agriculture, fisheries, and economic and development cooperation were subsequently agreed as part of this strategy in 2001. The European Commission released a Communication on stopping the decline of endangered species and habitats by 2010 ([26]); this underlined the importance of biodiversity protection as a prerequisite for sustainable development and set out an action plan. The biodiversity action plan addresses the challenge of integrating biodiversity concerns into other policy sectors. It also contains indicators to monitor progress and a timetable for evaluations, whereby the European Commission has undertaken to provide annual reporting.

EU policy on the conservation of natural habitats is part of the overall biodiversity strategy. It is essentially based on the implementation of two directives: the 'birds Directive' ([27]) for the conservation of wild birds and the 'habitats Directive' ([28]) which covers the conservation of natural habitats, wild fauna and flora; together these provide the legal basis for setting-

([25]) For more information: http://www.teebweb.org.

([26]) COM(2006) 216 final; for more information: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2006:0216:FIN:EN:PDF.

([27]) Council Directive 79/409/EEC of 2 April 1979; for more information: http://eur-lex.europa.eu/LexUriServ/site/en/consleg/1979/L/01979L0409-20070101-en.pdf.

([28]) Council Directive 92/43/EEC of 21 May 1992; for more information: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1992L0043:20070101:EN:PDF.

up an ecological network of sites under the title Natura 2000 – the largest network of protected areas in the world. The EU wants to expand Natura 2000, which currently counts around 25 000 different sites (and an area of almost 880 000 km²) where plant and animal species and their habitats must be protected.

Most of the work in this area has so far focused on the establishment of the Natura 2000 network which may be seen as the first pillar of action, relating to the conservation of natural habitats and habitats of various species. However, the legislation also foresees actions in relation to the establishment of a second pillar through the implementation of a strict protection regime for animal species (for example, the Arctic fox and Iberian lynx are both under serious threat of extinction).

Definitions and data availability

Annual data are available on **protected areas under the habitats Directive** and these are presented as a percentage of total country area. The indicator on protected areas is based on areas proposed by countries to be designated for the protection of natural and semi-natural habitats, wild fauna and flora according to the habitats Directive. **The index of sufficiency** measures the extent to which sites of Community importance proposed by the Member States adequately cover the species and habitats listed in the annexes I and II of the habitats Directive.

Birds are considered good proxies for biodiversity and the integrity of ecosystems as they tend to be at, or near, the top of the food chain, have large ranges and migrate, and thus reflect changes in ecosystems rather rapidly. By focusing attention on the population trends of relatively large groups of abundant European species associated with different habitats, these indicators are designed to capture the overall, average changes in population levels of common birds and to reflect the health and functioning of ecosystems. For example, farmland and forest bird species have a high dependence on their habitats during the nesting season and for feeding during most of the year. The **population index of common birds** is an aggregated index (with base year 1990 or the first year the Member State entered the scheme) for population estimates of a selected group of common bird species. Indices are calculated for each species independently and are then combined by averaging with an equal weight used for each species. The EU index is based on trend data from 18 Member States, derived from annually operated national breeding bird surveys obtained through the pan-European common bird monitoring scheme (PECBMS) ([29]).

Main findings

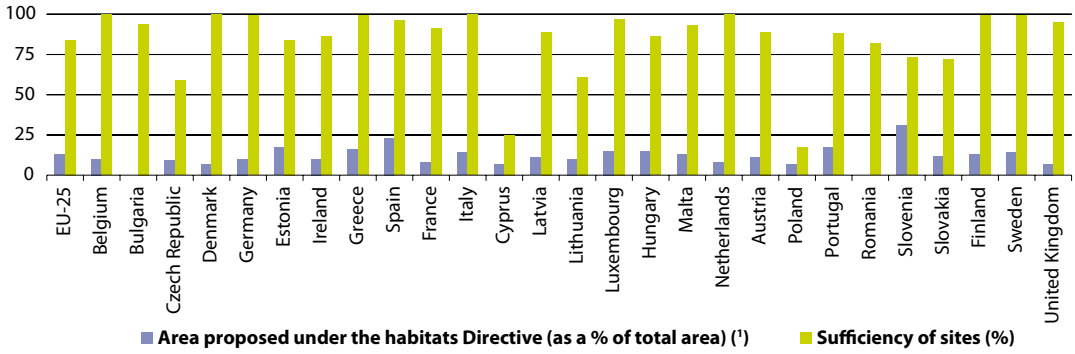
About 13 % of the EU-25's territory was proposed as a protected area under the habitats Directive in 2007. Figures for the Member States show that protected areas account for a little above 30 % of the total area in Slovenia, while seven Member States reported shares below the threshold of 10 %. The protected sites generally provided an adequate level of cover for the species and habitats listed in the Directive, with an EU-25 average of 84 %; only Poland and Cyprus reported sufficiency ratios under 50 %.

Since 1990 there has generally been a downward trend in the evolution of common bird indices within the EU, in particular for common farmland species.

([29]) For more information: http://www.ebcc.info/pecbm.html.

Part of the relatively steep decline (-25 % between 1990 and 2006) in numbers of common farmland birds may be attributed to changes in land use and agricultural practices. More recently, these indices have stabilised, with both the farmland and the forest bird index fluctuating around 80 % (of 1990 base year values), while the common bird index stands at around 90 % (of its 1990 level).

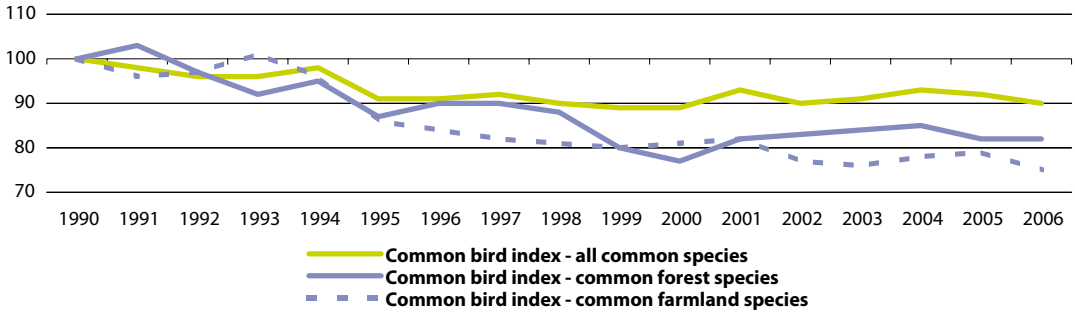
Figure 11.13: Protected areas for biodiversity: habitats Directive, 2007



(1) Bulgaria and Romania, not available.

Source: EEA/European Topic Centre on Biodiversity, Eurostat (env_bio1)

Figure 11.14: Common bird indices, EU (1)
(aggregated index of population estimates of selected groups of breeding bird species, 1990=100)



(1) EU-12 up to 1994; EU-15 up to 2004; EU-25 up to 2006; 'all common species' covers information on 135 different bird species; 'common farmland species' covers 36 bird species; 'common forest species' covers 29 bird species.

Source: EBCC/RSPB/BirdLife/Statistics Netherlands, Eurostat (env_bio2)

11.7 Energy production and imports

Introduction

The EU's dependency on energy imports, particularly of oil and more recently of gas, forms the backdrop for policy concerns relating to the security of energy supplies. More than half of the EU-27's energy comes from countries outside the Union – and this proportion is rising. Much of this energy comes from Russia, whose disputes with transit countries have disrupted supplies in recent years – for example, between 6 and 20 January 2009, gas flows from Russia via Ukraine were interrupted.

The EU has set out plans for a new energy strategy based on a more secure, sustainable and low-carbon economy. In a Communication from November 2007, the European Commission put forward a strategic energy technology plan (SET-plan), titled 'towards a low carbon future' ([30]). This encouraged the development of carbon-free energy technologies, such as wind power, solar power (thermal, photovoltaic and concentrated), hydropower, tidal power, geothermal energy and second generation biomass. Aside from combating climate change through a reduction in greenhouse gas emissions, the use of renewable energy sources is likely to result in more secure energy supplies, greater diversity in energy supply, less air pollution, as well as the possibility for job creation in environmental and renewable energy sectors.

The European Commission adopted its second strategic energy review in November 2008. This addressed how the EU could reduce its dependency on imported energy, thereby improving its security of supply, as well as reducing its emissions of greenhouse gases. This agenda encourages energy solidarity among Member States, proposes an action plan to secure sustainable energy supplies, and adopts a package of energy efficiency proposals aimed at making energy savings in key areas, such as buildings and energy-using products.

Renewable energy has an important role to play in reducing carbon dioxide emissions. A sustainable energy policy is, in part, reliant upon increasing the share of renewable energy, which may at the same time help to improve the security of energy supply by reducing the Community's growing dependence on imported energy sources.

The integrated energy and climate change strategy adopted in December 2008 provided a further stimulus for increasing the use of renewables to 20 % of total energy production by 2020 (including a 10 % biofuels target for transport), while calling for energy consumption and greenhouse gas emissions to both be cut by 20 %. A Directive on the promotion of the use of energy from renewable sources ([31]) requires Member States to develop national action plans for the development of their renewable energy sources, as well as establishing sustainability criteria, for example, ensuring that the use of biofuels does not put food supply or forest protection at risk (either in the EU or in non-member countries).

The European Commission made a proposal at the end of 2008 to repeal Directive 2004/67/EC concerning measures to safeguard security of natural gas supply ([32]). In response to the Russian-Ukrainian

([30]) For more information: http://ec.europa.eu/energy/res/setplan/index_en.htm.

([31]) Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009; for more information: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:EN:PDF.

([32]) COM(2008) 769 final; for more information: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0769:FIN:EN:PDF.

gas crisis of January 2009, the European Council and the European Parliament called for an accelerated revision of the directive, arguing that the crisis demonstrated the need to define more clearly the roles of the gas industry, Member States and the Community institutions to deal with potential supply disruptions. As a result, the Council adopted a Directive in the second half of 2009 imposing an obligation on Member States to maintain minimum stocks of crude oil and/or petroleum products ([33]). These new measures for oil and gas markets are designed to ensure that all parties take effective action to prevent and mitigate the consequences of potential disruptions to supplies, while also creating mechanisms for Member States to work together to deal effectively with any major oil or gas disruptions which might arise; a coordination mechanism has been set-up so that Member States can react uniformly and immediately in emergency cases.

Definitions and data availability

In order to meet the increasing requirements of policymakers for energy monitoring, the legislation relating to energy statistics has in recent years undergone a period of renewal. The legal basis for energy statistics is a Regulation of 22 October 2008 on energy statistics ([34]). The data collection exercise covers all 27 Member States, Croatia, Turkey, Iceland, Norway and Switzerland; although not presented in this yearbook, monthly data are also available for certain indicators.

Energy commodities extracted or captured directly from natural resources are called primary energy sources, while energy commodities which are produced from primary sources in transformation plants are called derived products. **Primary energy production** covers the national production of primary energy sources and takes place when the natural sources are exploited, for example, in coal mines, crude oil fields, hydropower plants or in the fabrication of biofuels. Transformation of energy from one form to another, like electricity or heat generation from thermal power plants or coke production from coke ovens is therefore not considered as primary production.

Primary production of solid fuels (coal and lignite) consists of quantities of fuels extracted or produced, calculated after any operation for removal of inert matter. Primary production of crude oil covers all production within national boundaries, including offshore production. Natural gas is measured as the dry marketable production, after purification and extraction of NGLs (natural gas liquids) and sulphur; it does not include quantities re-injected, extraction losses, or quantities vented and flared. The heat produced in a reactor as a result of nuclear fission is regarded as primary production of nuclear heat. Renewable energy sources cover the production of energy from biomass, hydropower, geothermal energy, wind and solar energy:

- biomass is the heat content of the produced biofuels or biogas; heat produced after combustion during incineration of renewable wastes; this covers organic, non-fossil material of biological origin, which may be used for heat production or electricity generation, comprising wood and wood waste, biogas, municipal solid waste, and biofuels.

([33]) Council Directive 2009/119/EC of 14 September 2009; for more information: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:265:0009:0023:EN:PDF.

([34]) Regulation (EC) No 1099/2008 of the European Parliament and of the Council; for more information: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:304:0001:0062:EN:PDF.

- hydropower covers potential and kinetic energy of water converted into electricity in hydroelectric plants (the electricity generated in pumped storage plants is not included);
- geothermal energy comprises energy available as heat emitted from within the earth's crust, usually in the form of hot water or steam;
- wind energy covers the kinetic energy of wind converted into electricity in wind turbines;
- solar energy covers the solar radiation exploited for solar heat (hot water) and electricity production.

Imports represent all entries into the national territory, while exports cover all quantities exported from the national territory. **Net imports** of primary energy are calculated as imports minus exports; they exclude transit quantities (notably via gas and oil pipelines), except for electrical energy whose transit is recorded under external trade statistics.

The **energy dependency rate** is defined as net imports divided by gross consumption; gross consumption is equal to gross inland consumption plus the energy supplied to international marine bunkers. A negative dependency rate indicates a net exporter of energy. A dependency rate in excess of 100 % indicates that energy products have been stocked.

Main findings

Production of primary energy in the EU-27 totalled 849.6 million tonnes of oil equivalent (toe) in 2007. This continued the generally downward trend of EU-27 production, as supplies of raw materials become exhausted and/or producers considered the exploitation of limited resources uneconomical. Production was dominated by the United Kingdom with a 20.4 % share of the EU-27 total, although this marked a considerable reduction when compared with a decade earlier (27.3 % of the EU-27 total in 1997). Indeed, the United Kingdom and Poland experienced the most significant reductions in their output of primary energy, with reductions of 88.8 million toe and 27.5 million toe respectively. France and Germany, in contrast, maintained their levels of production broadly in line with 1997; they were the only other Member States to report production of primary energy in excess of 100 million toe.

Primary energy production in the EU-27 in 2007 was spread across a range of energy sources, the most important of which was nuclear energy (28.4 % of the total); the significance of nuclear fuel was particularly high in Belgium, France, Lithuania, Slovakia and Sweden – where it accounted for more than half of the national production of primary energy. Around one fifth of the EU-27's total production of primary energy was accounted for by solid fuels (largely coal) and by natural gas, with shares of 22.0 % and 19.7 % respectively, while renewable energy sources (16.3 %) and crude oil (13.6 %) made up the remainder of the total.

The growth of primary production from renewable energy sources exceeded that of all the other energy types, with particularly strong growth since 2002. Indeed, there would appear to be something of a watershed since this date, as the production of renewables accelerated, rising by 38.4 % overall between 2002 and 2007. In contrast, the production levels of the other sources of primary energy all fell during

the period considered, with the largest reductions for crude oil (-28.7 %), natural gas (-18.1 %) and solid fuels (-11.1 %).

Among renewable energies, the most important source was biomass and waste, accounting for 96.2 million toe of primary production in the EU-27 in 2007. Hydropower was the only other significant contributor to the renewable energy mix (26.7 million toe). Although production still remains small, there has been a particularly rapid expansion in the production of wind energy, reaching 9.0 million toe in the EU-27 in 2007.

The downturn in the primary production of hard coal, lignite and crude oil has led to a situation where the EU-27 is increasingly reliant on primary energy imports in order to satisfy demand. The EU-27's imports of primary energy exceeded exports by some 988.4 million toe in 2007. The largest net importers of primary energy were generally the most populous Member States, with the exception of the United Kingdom and Poland (where some indigenous reserves of oil/natural gas and coal remain). Since 2004 the only net exporter among the Member States has been Denmark.

The origin of EU-27 energy imports has changed rapidly in recent years. In 2007, almost one third (30.3 %) of the EU-27's imports of crude oil were from Russia; this was 11.6 percentage points higher than seven years earlier. Russia also became the principal supplier of hard coal, its share of EU-27 imports rising from 7.9 % in 2000 to 22.6 % by 2007. In contrast, Russia's share of EU-27 imports of natural gas declined from 40.4 % to 30.7 % between 2000 and 2007; note, however, that during this period the volume of natural gas imports from Russia remained relatively unchanged.

The security of the EU-27's primary energy supplies may be threatened if a high proportion of imports are concentrated among relatively few partners. Almost two thirds (63.6 %) of the EU-27's imports of natural gas in 2007 came from Russia, Norway or Algeria. A similar analysis shows that 64.5 % of EU-27 imports of hard coal were from Russia, South Africa, Australia or Colombia, while 59.5 % of crude oil imports came from Russia, Norway, Libya or Saudi Arabia. Although their import volumes remain relatively small, there was some evidence of new partner countries emerging between 2000 and 2007. This was notably the case for crude oil imports from Libya and Kazakhstan, coal imports from Indonesia and Ukraine, or natural gas imports from Nigeria and Libya.

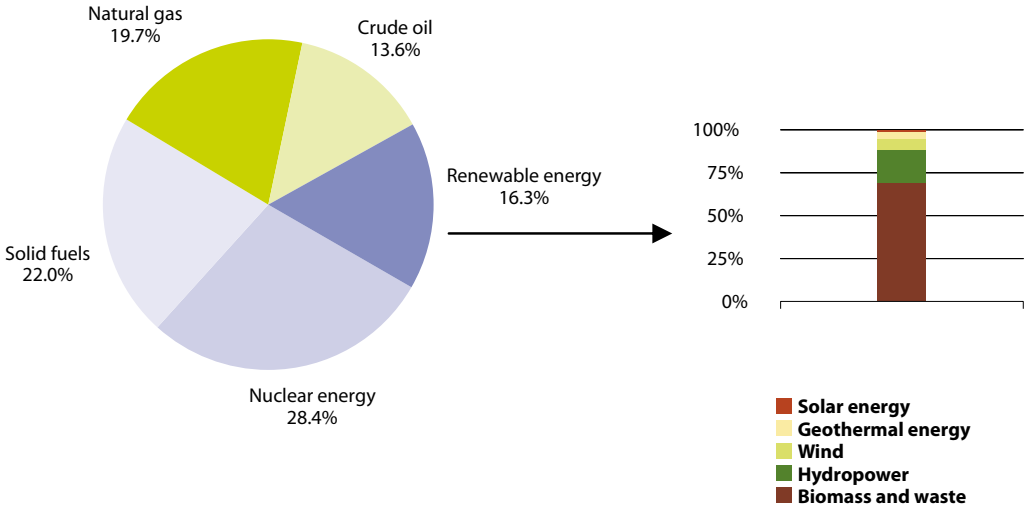
EU-27 dependency on energy imports increased from less than 40 % of gross consumption in the 1980s to 53.1 % by 2007, with the highest dependency rates recorded for crude oil (82.7 %) and for natural gas (60.3 %). The dependency on non-member countries for supplies of solid fuels and natural gas grew at a faster pace in the last decade than the dependency on oil (which was already at a high level). Since 2004, the EU-27's net imports of energy have been greater than its primary production; in other words, more than half of the EU-27's gross inland energy consumption was supplied by net imports. As it was a net exporter, Denmark was the only Member State in 2007 with a negative dependency rate. Among the other Member States, the lowest dependency rates were recorded by Poland, the Czech Republic and the United Kingdom; meanwhile, Cyprus, Malta and Luxembourg were almost entirely dependent on primary energy imports.

Table 11.11: Energy production
(million tonnes of oil equivalent)

	Total production of primary energy		Share of total production, 2007 (%)				
	1997	2007	Nuclear energy	Solid fuels	Natural gas	Crude oil	Renewable energy
EU-27	962.4	849.6	28.4	22.0	19.7	13.6	16.3
Euro area	453.0	453.6	41.6	16.3	17.3	3.2	21.5
Belgium	12.6	13.7	90.7	0.0	0.0	-	9.3
Bulgaria	9.8	9.8	38.5	48.7	2.4	0.3	10.1
Czech Republic	32.3	33.3	20.2	71.4	0.4	0.7	7.2
Denmark	20.2	27.0	-	-	30.6	57.5	11.8
Germany	138.5	135.3	26.8	40.4	9.5	2.5	20.8
Estonia	3.8	4.4	-	81.6	-	-	16.8
Ireland	2.8	1.4	-	42.0	26.2	-	31.7
Greece	9.9	12.2	-	85.4	0.2	0.7	13.8
Spain	30.7	30.2	47.1	18.1	0.3	0.5	34.1
France	127.9	134.0	84.6	0.0	0.7	0.8	13.9
Italy	30.3	25.9	0.0	0.4	30.7	23.0	46.0
Cyprus	0.0	0.1	-	-	:	-	100.0
Latvia	1.6	1.8	-	0.2	-	-	99.8
Lithuania	3.9	3.5	72.0	0.4	-	4.5	23.1
Luxembourg	0.0	0.1	-	-	-	-	100.0
Hungary	12.8	10.2	37.2	17.4	19.7	11.9	13.8
Malta	-	-	-	:	:	-	:
Netherlands	65.7	61.0	1.8	-	89.8	4.3	4.1
Austria	8.5	10.4	-	0.0	15.2	9.6	75.2
Poland	99.1	71.6	-	86.5	5.4	1.0	7.0
Portugal	3.8	4.6	-	0.0	-	-	100.0
Romania	31.6	27.6	7.2	24.8	33.4	17.5	17.1
Slovenia	3.0	3.4	42.7	36.0	0.1	0.0	21.1
Slovakia	4.6	5.6	70.3	9.8	1.9	0.4	17.5
Finland	14.8	15.7	38.4	6.9	-	-	54.6
Sweden	32.0	33.1	52.2	0.5	-	0.0	47.3
United Kingdom	262.3	173.6	9.4	5.6	37.4	45.1	2.5
Croatia	4.1	4.0	:	0.0	58.5	23.2	18.3
Turkey	28.0	27.3	:	54.2	2.7	7.9	35.2
Iceland	1.7	:	:	:	:	:	:
Norway	212.7	216.0	:	1.2	36.1	56.7	6.0
Switzerland	10.5	12.2	58.8	:	0.0	:	41.2

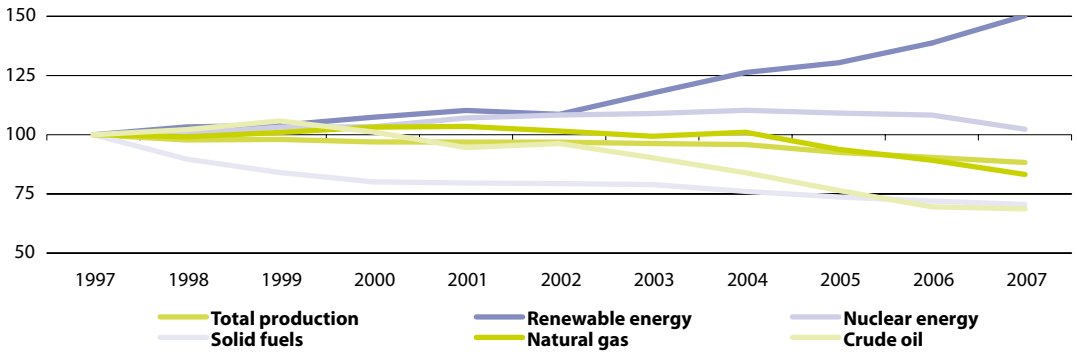
Source: Eurostat (ten00076, ten00080, ten00077, ten00079, ten00078 and ten00081)

Figure 11.15: Production of primary energy, EU-27, 2007
(% of total, based on tonnes of oil equivalent)



Source: Eurostat (ten00080, ten00077, ten00079, ten00078, ten00081 and ten00082)

Figure 11.16: Development of the production of primary energy (by fuel type), EU-27
(1997=100, based on tonnes of oil equivalent)



Source: Eurostat (ten00077, ten00081, ten00080, ten00077, ten00079 and ten00078)

Table 11.12: Primary production of renewable energy

	Primary production (1 000 toe)		Share of total, 2007 (%)				
	1997	2007	Solar energy	Biomass & waste	Geothermal energy	Hydropower energy	Wind energy
EU-27	92 390	138 831	0.9	69.3	4.2	19.2	6.5
Euro area	61 722	97 741	1.2	66.5	5.7	18.7	7.9
Belgium	633	1 273	0.4	93.4	0.2	2.6	3.3
Bulgaria	488	995	-	71.5	3.3	24.8	0.4
Czech Republic	673	2 404	0.2	91.9	-	7.5	0.5
Denmark	1 752	3 193	0.3	79.8	0.4	0.1	19.3
Germany	7 712	28 121	2.1	78.7	0.8	6.4	12.1
Estonia	587	745	-	98.7	-	0.3	1.1
Ireland	181	447	0.2	48.8	0.4	12.8	37.6
Greece	1 340	1 677	9.5	67.0	0.8	13.3	9.3
Spain	6 737	10 288	1.3	52.4	0.1	23.2	23.0
France	17 646	18 645	0.2	70.2	0.7	27.1	1.9
Italy	8 412	11 901	0.5	30.9	42.0	23.7	2.9
Cyprus	42	65	83.1	18.5	-	-	-
Latvia	1 530	1 794	-	86.7	-	13.1	0.3
Lithuania	542	813	-	94.2	0.2	4.4	1.1
Luxembourg	46	82	2.4	79.3	-	11.0	7.3
Hungary	513	1 404	0.2	91.7	6.1	1.3	0.6
Malta	:	:	:	:	:	:	:
Netherlands	1 547	2 496	0.9	86.9	-	0.4	11.9
Austria	5 985	7 839	1.4	56.5	0.4	39.5	2.2
Poland	3 873	5 018	0.0	94.9	0.2	4.0	0.9
Portugal	3 750	4 610	0.6	68.9	4.2	18.8	7.5
Romania	4 865	4 717	0.0	70.5	0.4	29.1	0.0
Slovenia	500	726	-	61.3	-	38.7	-
Slovakia	438	983	0.0	59.9	1.0	39.0	0.1
Finland	6 752	8 589	0.0	85.6	-	14.2	0.2
Sweden	13 774	15 639	0.1	62.8	-	36.4	0.8
United Kingdom	2 071	4 368	1.1	78.5	0.0	10.0	10.4
Croatia	854	737	0.1	49.7	0.4	49.4	0.4
Turkey	11 228	9 604	4.4	52.3	10.9	32.1	0.3
Iceland	1 682	:	-	:	:	:	:
Norway	10 670	12 876	0.0	10.0	-	89.4	0.6
Switzerland	3 947	5 040	0.6	36.0	3.2	60.1	0.0

Source: Eurostat (ten00081 and ten00082)

Table 11.13: Net imports of primary energy

	(1 000 tonnes of oil equivalent)					(tonnes of oil equivalent per inhabitant)				
	1999	2001	2003	2005	2007	1999	2001	2003	2005	2007
EU-27	790 677	858 357	905 367	986 618	988 354	1.64	1.77	1.86	2.01	2.00
Euro area	764 393	805 688	836 266	867 551	842 511	:	2.57	2.63	2.70	2.59
Belgium	49 161	51 272	53 244	53 775	51 452	4.81	5.00	5.14	5.15	4.86
Bulgaria	8 914	9 023	9 306	9 518	10 594	1.08	1.11	1.19	1.23	1.38
Czech Republic	9 880	10 721	11 397	12 887	11 592	0.96	1.04	1.12	1.26	1.13
Denmark	-3 434	-5 777	-6 850	-10 408	-5 486	-0.65	-1.08	-1.27	-1.92	-1.01
Germany	203 681	216 654	212 969	215 281	201 840	2.48	2.63	2.58	2.61	2.45
Estonia	1 887	1 785	1 580	1 671	1 877	1.37	1.31	1.17	1.24	1.40
Ireland	11 740	13 688	13 578	13 661	14 120	3.15	3.57	3.43	3.32	3.27
Greece	19 810	22 410	22 592	23 448	24 705	1.82	2.05	2.05	2.12	2.21
Spain	95 296	99 798	109 080	123 972	123 337	2.39	2.47	2.62	2.88	2.77
France	132 750	136 771	138 857	144 346	137 548	2.21	2.24	2.25	2.30	2.17
Italy	144 210	148 250	156 360	160 955	159 505	2.53	2.60	2.73	2.75	2.70
Cyprus	2 435	2 504	2 663	2 816	2 872	3.57	3.59	3.72	3.76	3.69
Latvia	2 194	2 534	2 796	2 995	3 039	0.91	1.07	1.20	1.30	1.33
Lithuania	4 354	3 923	4 105	5 119	5 778	1.23	1.13	1.19	1.49	1.71
Luxembourg	3 356	3 697	4 154	4 622	4 537	7.85	8.42	9.27	10.02	9.53
Hungary	13 942	13 895	16 346	17 514	16 589	1.36	1.36	1.61	1.73	1.65
Malta	984	1 626	1 818	1 600	1 786	2.60	4.15	4.58	3.97	4.38
Netherlands	26 929	32 644	36 691	38 390	38 784	1.71	2.04	2.27	2.35	2.37
Austria	19 175	19 979	23 098	24 661	23 347	2.40	2.49	2.85	3.01	2.81
Poland	9 558	9 408	11 933	16 600	25 064	0.25	0.25	0.31	0.43	0.66
Portugal	22 342	21 848	22 393	24 414	21 847	2.20	2.13	2.15	2.32	2.06
Romania	7 974	9 507	10 236	10 839	12 821	0.35	0.42	0.47	0.50	0.59
Slovenia	3 565	3 389	3 698	3 825	3 882	1.80	1.70	1.85	1.91	1.93
Slovakia	11 673	12 232	12 648	12 481	12 476	2.16	2.27	2.35	2.32	2.31
Finland	17 285	18 926	22 420	19 306	20 473	3.35	3.65	4.31	3.69	3.88
Sweden	18 234	19 293	22 835	20 179	18 976	2.06	2.17	2.55	2.24	2.08
United Kingdom	-47 220	-21 645	-14 583	32 152	44 999	-0.81	-0.37	-0.25	0.54	0.74
Croatia	4 361	4 174	4 996	5 252	5 336	0.96	0.94	1.12	1.18	1.20
Turkey	43 511	46 188	56 776	62 143	76 101	0.66	0.68	0.81	0.87	1.09
Iceland	972	947	937	1 063	:	3.53	3.34	3.25	3.62	:
Norway	-182 018	-203 323	-207 111	-200 643	-188 453	-40.95	-45.15	-45.50	-43.56	-40.26
Switzerland	14 082	15 262	14 739	16 244	14 120	1.98	2.12	2.02	2.19	1.88

Source: Eurostat (ten00083 and tps00001)

Table 11.14: Main origin of primary energy imports, EU-27
(% of extra EU-27 imports)

	Hard coal							
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Russia	7.9	9.8	11.4	12.6	17.6	21.2	22.5	22.6
South Africa	21.3	23.2	26.8	27.1	23.6	22.7	21.5	18.6
Australia	15.1	13.9	14.6	14.8	13.4	11.9	11.0	11.7
Colombia	12.2	10.7	10.6	10.9	10.6	10.6	10.6	11.7
United States	10.8	9.5	7.0	6.0	6.7	6.9	7.0	8.4
Indonesia	4.8	4.8	5.7	6.2	6.1	6.5	8.5	7.1
Canada	3.4	3.3	2.7	1.8	1.9	2.9	2.5	2.9
Ukraine	1.1	1.4	1.7	1.1	1.9	1.8	1.3	1.5
Venezuela	1.8	1.4	1.7	2.3	1.0	0.9	0.8	1.0
Others	21.6	22.1	17.9	17.2	17.1	14.6	14.2	14.7
	Crude oil							
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Russia	18.7	22.7	26.1	28.1	30.0	29.9	30.4	30.3
Norway	19.3	17.9	17.4	17.5	17.3	15.5	14.3	13.8
Libya	7.6	7.3	6.6	7.6	7.9	8.0	8.5	9.1
Saudi Arabia	10.8	9.5	9.0	10.1	10.2	9.7	8.2	6.4
Iran	5.9	5.2	4.4	5.7	5.7	5.6	5.8	5.6
Iraq	5.2	3.4	2.7	1.4	2.0	2.0	2.7	3.1
Kazakhstan	1.6	1.5	2.3	2.6	3.5	4.2	4.3	3.0
Nigeria	3.7	4.3	3.1	3.8	2.4	3.0	3.2	2.5
Algeria	3.6	3.2	3.0	3.1	3.4	3.6	2.7	2.2
Others	23.7	25.0	25.4	20.2	17.5	18.5	20.0	24.1
	Natural gas							
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Russia	40.4	38.5	36.7	37.2	35.9	33.5	31.9	30.7
Norway	17.7	18.6	20.9	20.5	20.3	18.1	18.4	20.1
Algeria	19.6	17.0	17.2	16.4	14.8	15.3	13.8	12.8
Nigeria	1.5	1.9	1.8	2.6	3.0	3.0	3.6	3.9
Libya	0.3	0.3	0.2	0.2	0.3	1.4	2.1	2.5
Egypt	0.0	0.0	0.0	0.0	0.0	1.4	2.1	1.5
Qatar	0.1	0.2	0.7	0.6	1.2	1.3	1.5	1.8
Trinidad and Tobago	0.3	0.2	0.2	0.0	0.0	0.2	1.1	0.7
Croatia	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2
Others	20.0	23.3	22.4	22.4	24.4	25.8	25.3	25.9

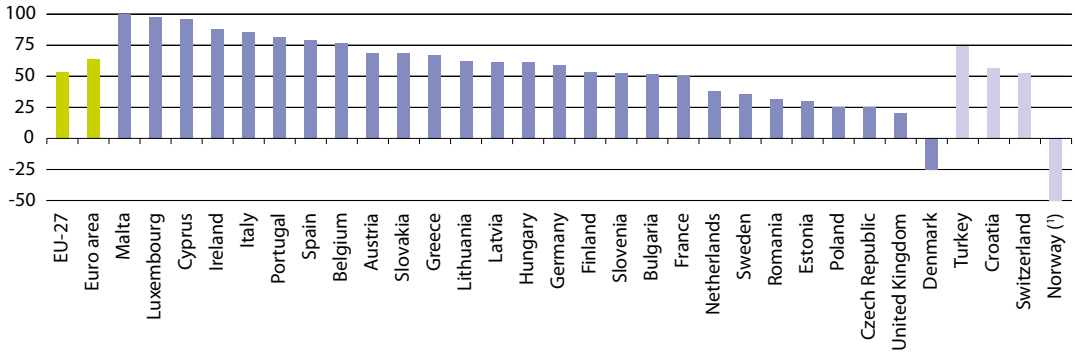
Source: Eurostat (nrg_122a, nrg_123a and nrg_124a)

Table 11.15: Energy dependency rate, EU-27
(% of net imports in gross inland consumption and bunkers, based on tonnes of oil equivalent)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
All products	45.0	46.1	45.1	46.8	47.5	47.6	49.0	50.3	52.6	53.8	53.1
Solid fuels	25.1	26.6	27.8	30.7	33.8	33.1	34.9	38.1	39.6	41.2	41.2
Crude oil	76.0	77.2	73.1	76.1	77.6	76.3	78.7	80.1	82.6	83.8	82.7
Natural gas	45.2	45.7	47.9	48.9	47.3	51.2	52.5	54.0	57.7	60.8	60.3

Source: Eurostat (nrg_100a, nrg_101a, nrg_102a and nrg_103a)

Figure 11.17: Energy dependency rate – all products, 2007
(% of net imports in gross inland consumption and bunkers, based on tonnes of oil equivalent)



(1) Y-axis is cut, -664.9.

Source: Eurostat (tsdcc310 and nrg_100a)

11.8 Consumption of energy

Introduction

As well as supply-side policies, there is a growing trend for policy initiatives to focus on improving energy efficiency in an attempt to reduce energy demand and decouple it from economic growth. This was given further impetus by the integrated energy and climate change strategy that committed the EU-27 to cut energy consumption by 20 % in relation to projected 2020 levels; by doing so, the EU hopes to cut greenhouse gas emissions by almost 800 million tonnes a year, while improving sustainability and security of supply.

To achieve these goals, the EU seeks to engage public opinion, decision-makers and market operators, while setting minimum energy efficiency standards and rules on labelling for products, services and infrastructure, in order to encourage significant reductions in consumption – for example, through the promotion of co-generation, improving the energy performance of buildings, or improving the information given to consumers with respect to the energy consumption of domestic appliances.

Daily life is becoming increasingly dependent on energy-consuming devices. Without compromising standards of living, there are a range of actions that could be employed to reduce energy consumption across many European households. Aside from making efficiency savings, these measures could also cut average fuel bills, for example, by: turning the thermostat down by one degree; using thermostatic radiator valves; not leaving televisions, videos, music systems or DVD players on stand-by; defrosting fridges and freezers regularly; turning off lights when leaving rooms; using low-energy light bulbs; insulating hot-water tanks and heating pipes; or using loft insulation and cavity wall insulation.

The transport sector is the fastest growing consumer of energy and producer of greenhouse gases, even if advances in transport technology and fuel have resulted in marked decreases in emissions of certain pollutants. There are many factors that impact on energy use within the transport sector, for example, overall economic growth, the efficiency of individual transport modes, the take-up of alternative fuels, and lifestyle choices. The globalised nature of the economy has fuelled demand for international freight movements (principally by ship), while within the Single Market there has been a considerable expansion in the use of road freight transport (see Chapter 10 for more details concerning transport). This growth in the demand for energy from the transport sector is not confined to business, as it has been accompanied by an expansion in personal travel. The development of low-cost airlines, an increase in motorisation rates (the average number of motor vehicles per inhabitant), a trend for living in suburban areas, or the expansion of tourism (more frequent breaks, and more long-haul destinations) are among some of the factors that have contributed to an increase in the demand for energy as a result of personal travel.

In 2001, the European Commission adopted a policy to promote biofuels for transport, and a number of targets were set. The integrated energy and climate change strategy agreed at the end of 2008 foresees the share of renewables (such as biofuels) in total fuel consumption rising to at least 10 % by 2020.

Definitions and data availability

Gross inland energy consumption represents the quantity of energy necessary to satisfy inland consumption of the geographical entity under consideration. It may be defined as primary production plus imports, recovered products and stock changes, less exports and fuel supply to maritime bunkers (for seagoing ships of all flags). It describes the total energy needs of a country (or entity such as the EU), covering: consumption by the energy sector itself; distribution and transformation losses; final energy consumption by end users; and statistical differences.

Final energy consumption includes the consumption by all users except the energy branch itself (whether deliveries for transformation and/or own use), and includes, for example, energy consumption by agriculture, industry, services and households, as well as energy consumption for transport. It should be noted that the fuel quantities transformed in electrical power stations of industrial autoproducers and quantities of coke transformed into blast-furnace gas are not part of overall industrial consumption but of the transformation sector.

Energy intensity is measured as the ratio between gross inland consumption of energy and gross domestic product (GDP) for a given calendar year. It measures the energy consumption of an economy and its overall energy efficiency. The ratio is expressed as kgoe (kilogram of oil equivalent) per EUR 1 000, and to facilitate analysis over time the calculations are based on GDP in constant prices (currently using 1995 prices). If an economy becomes more efficient in its use of energy, and its GDP remains constant, then the ratio for this indicator should fall. The economic structure of an economy plays an important role in determining energy intensity, as post-industrial economies with large service sectors will, a priori, display relatively low intensity rates, while developing economies may have a considerable proportion of their economic activity within industrial sectors, thus leading to higher intensity.

Main findings

Gross inland energy consumption within the EU-27 in 2007 was 1 806 million tonnes of oil equivalent (toe), which marked a decline in consumption to a level not seen since 2003. The gross inland consumption of each Member State depends, to a large degree, on the structure of its energy system and the availability of natural resources for primary energy production; this is true not only for conventional fuels and nuclear power, but also for renewable energy sources. For example, although small in absolute levels, the use of solar power is relatively high in Mediterranean countries such as Cyprus, while the use of biomass is of increasing importance in some Member States with considerable forest areas, for example, Latvia, Finland and Sweden. In a similar vein, hydropower is particular-

ly important in mountainous countries with ample water supplies, such as Austria or Sweden.

Over the period 1997 to 2007 there was a gradual decline in the gross inland consumption of crude oil and petroleum products and solid fuels, while increasing amounts of natural gas and renewable energy sources were consumed. The combined share of crude oil, petroleum products and solid fuels fell from 58.8 % of total consumption to 54.1 %, reflecting changes in the EU-27's energy mix and a move away from the most polluting fossil fuels. Renewable energy sources accounted for 7.8 % of EU-27 gross inland consumption in 2007; however, their relative importance rose to almost one third of the total in Sweden and Latvia, and was close to one quarter of the total in Austria and Finland.

Final energy consumption in the EU-27, i.e., excluding energy used by power producers, was equivalent to just under two thirds (64.1 %) of gross inland consumption, at 1 158 million toe in 2007. An analysis of the final end-use of energy shows three dominant categories: as industry, road transport and households each accounted for around one quarter of the EU-27's final energy consumption in 2007; adding the figures for the different transport modes together, their total energy consumption amounted to 377.2 million toe in 2007, or approximately one third of the total.

There were, however, considerable differences in the evolution of energy consumption across transport modes in the EU-27, with the most rapid growth for aviation (42.3 % between 1997 and 2007) and a steady upward trend for road transport (17.0 %), while the energy consumption of rail was relatively unchanged (-2.9 %). The largest increase, in absolute terms, was however recorded for road transport, where EU-27 energy consumption rose by 44.8 million toe between 1997 and 2007, compared with a 15.9 million toe increase for aviation. These changes in energy consumption reflect the popularity of each transport mode, but can also be influenced by technological changes, especially when these relate to fuel-efficiency gains.

In 2007, a minimum target was set for renewable energy sources (such as biofuels), requiring that they should account for at least 10 % of the petrol and diesel used within the road transport sector by 2020. Data for 2007 show that biofuels made the biggest contribution to fuel consumption in Germany (7.4 %) and Slovakia (4.9 %), while the EU-27 average was 2.5 %.

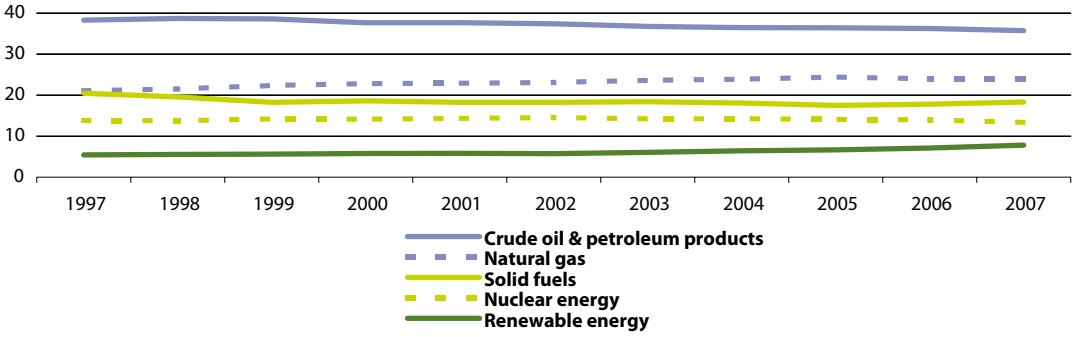
The lowest levels of energy intensity – a measure of an economy's energy efficiency – were recorded for Denmark and Ireland in 2007, while the most energy-intensive Member States were Bulgaria and Romania. It should be noted that the economic structure of an economy plays an important role in determining energy intensity, as post-industrial economies with large service sectors will, a priori, have considerably lower energy use than economies characterised by heavy, traditional industries, such as steel-making. Between 1997 and 2007, substantial energy savings were made in the Baltic economies of Estonia, Latvia and Lithuania, as the amount of energy required to produce a unit of economic output (as measured by GDP) was almost halved; the energy intensity of the Bulgarian and Romanian economies also fell at a rapid pace, by almost 40 %.

Table 11.16: Gross inland consumption of primary energy (million tonnes of oil equivalent)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Share in EU-27, 2007 (%)
EU-27	1 704	1 723	1 711	1 724	1 763	1 758	1 803	1 824	1 826	1 826	1 806	100.0
Euro area	1 154	1 177	1 182	1 197	*1 227*	*1 228*	1 258	1 276	1 277	1 273	1 263	69.9
Belgium	59.0	60.1	61.1	61.5	60.3	58.4	61.6	61.5	61.1	60.4	57.4	3.2
Bulgaria	20.3	20.1	18.2	18.6	19.4	19.0	19.5	19.0	20.0	20.5	20.3	1.1
Czech Republic	42.8	41.2	38.5	40.5	41.5	42.0	45.6	45.9	45.3	46.4	46.2	2.6
Denmark	21.3	20.8	20.1	19.5	20.2	19.8	20.8	20.2	19.7	20.9	20.5	1.1
Germany	347.6	346.7	340.8	342.4	353.3	345.6	348.3	350.3	347.1	348.8	339.6	18.8
Estonia	5.7	5.4	5.0	5.0	5.1	5.0	5.5	5.7	5.6	5.4	6.0	0.3
Ireland	12.1	13.0	13.7	14.4	15.0	15.3	15.0	15.8	15.1	15.5	15.9	0.9
Greece	25.7	27.0	26.9	28.2	29.1	29.9	30.3	30.8	31.4	31.5	33.5	1.9
Spain	106.6	112.6	118.4	123.7	127.3	130.8	135.3	141.5	144.6	144.0	146.8	8.1
France	248.3	256.3	256.0	259.5	267.2	267.3	271.9	276.1	277.1	273.8	270.3	15.0
Italy	164.1	168.8	171.7	173.0	173.7	174.2	183.3	184.7	187.3	186.1	183.5	10.2
Cyprus	2.1	2.2	2.3	2.4	2.4	2.4	2.7	2.5	2.5	2.6	2.7	0.2
Latvia	4.4	4.3	4.0	3.7	4.1	4.0	4.3	4.4	4.5	4.6	4.8	0.3
Lithuania	8.9	9.3	7.9	7.1	8.1	8.6	9.0	9.1	8.6	8.4	9.2	0.5
Luxembourg	3.4	3.3	3.4	3.6	3.8	4.0	4.2	4.6	4.7	4.7	4.7	0.3
Hungary	25.8	25.6	25.5	25.0	25.5	25.9	27.1	26.6	28.0	27.8	27.0	1.5
Malta	0.9	0.8	0.9	0.8	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.1
Netherlands	76.3	76.2	75.7	77.0	*79.1*	*79.7*	81.9	83.8	82.5	80.5	84.5	4.7
Austria	28.8	29.2	29.3	29.1	30.8	31.5	33.2	33.5	34.3	34.8	33.8	1.9
Poland	102.5	96.2	93.8	90.8	90.8	89.4	91.8	92.2	93.6	98.1	98.0	5.4
Portugal	21.7	23.2	24.9	25.1	25.2	26.3	25.7	26.4	27.0	25.3	26.0	1.4
Romania	45.4	41.5	36.9	37.1	36.9	38.5	40.2	39.6	39.3	40.7	40.1	2.2
Slovenia	6.5	6.4	6.4	6.4	6.7	6.8	6.9	7.1	7.3	7.3	7.3	0.4
Slovakia	17.8	17.5	17.4	17.5	19.3	19.3	19.2	19.1	19.1	18.8	18.1	1.0
Finland	32.9	33.4	32.9	32.5	33.2	35.2	37.2	37.5	34.7	37.8	37.6	2.1
Sweden	50.3	50.8	50.4	47.9	51.4	51.1	50.5	52.6	51.7	50.3	50.6	2.8
United Kingdom	223.1	230.7	229.2	231.9	232.7	226.8	231.2	232.5	232.8	229.1	221.1	12.2
Croatia	7.8	8.0	8.0	7.8	8.0	8.3	8.8	8.9	8.9	9.0	9.4	-
Turkey	71.2	72.5	71.2	77.6	71.6	75.5	79.4	82.0	85.3	94.7	101.5	-
Iceland	2.5	2.7	3.1	3.2	3.4	3.4	3.4	3.5	3.6	*4.3*	:	-
Norway	24.5	25.6	26.8	26.1	27.0	24.3	27.3	28.3	32.3	25.0	27.7	-
Switzerland	25.8	26.1	26.1	25.9	27.4	26.5	26.6	26.9	26.9	28.1	26.9	-

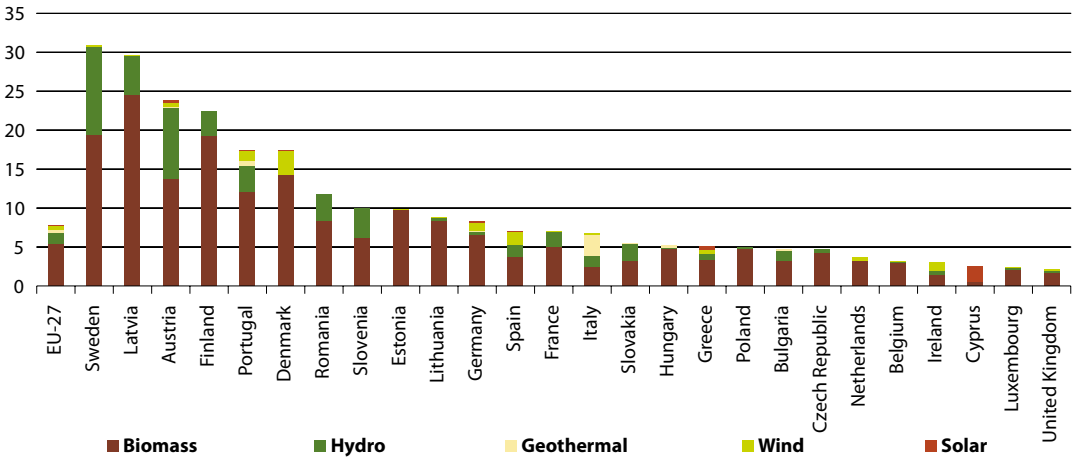
Source: Eurostat (ten00086)

Figure 11.18: Gross inland consumption, EU-27
(% of total consumption)



Source: Eurostat (nrg_102a, nrg_103a, nrg_101a, nrg_104a and nrg_1071a)

Figure 11.19: Share of renewables in gross inland energy consumption, 2007 (1)
(%)



(1) Malta, not available.

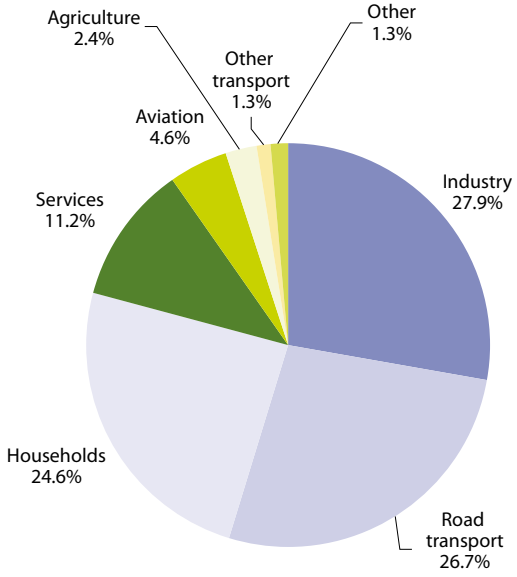
Source: Eurostat (tsdcc110)

Table 11.17: Final energy consumption
(million tonnes of oil equivalent)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Share in EU-27, 2007 (%)
EU-27	1 104	1 111	1 109	*1 114*	*1 140*	*1 127*	*1 160*	*1 173*	*1 172*	*1 176*	*1 158*	100.0
Euro area	752	767	770	*778*	*801*	*793*	*817*	*825*	*823*	*825*	*810*	*70.0*
Belgium	38.4	39.0	39.0	39.1	39.4	37.7	40.0	39.4	38.4	38.2	34.9	3.0
Bulgaria	9.3	9.9	8.8	8.6	8.6	8.7	9.4	9.2	9.6	10.0	9.8	0.8
Czech Republic	25.5	24.5	23.8	23.9	24.0	23.6	25.6	26.1	25.9	26.3	25.8	2.2
Denmark	15.0	15.0	15.0	14.6	15.0	14.7	15.1	15.3	15.4	15.6	15.7	1.4
Germany	225.3	223.5	218.7	218.1	223.9	219.2	222.3	220.7	217.3	221.6	*210.3*	*18.2*
Estonia	2.9	2.6	2.4	2.4	2.5	2.5	2.6	2.7	2.8	2.8	3.0	0.3
Ireland	8.6	9.3	9.9	10.7	11.1	11.2	11.5	11.8	12.5	13.1	13.2	1.1
Greece	17.3	18.2	18.2	18.6	19.2	19.5	20.5	20.3	20.8	21.5	22.0	1.9
Spain	68.2	71.9	74.5	*79.6*	*83.5*	*85.6*	*90.7*	*94.5*	*97.5*	*96.2*	*98.7*	*8.5*
France	147.6	152.7	152.5	152.5	158.3	153.8	157.7	159.7	159.2	157.7	154.0	13.3
Italy	115.7	118.9	123.5	123.5	126.2	124.7	130.3	131.2	132.6	130.7	132.1	11.4
Cyprus	1.5	1.5	1.6	1.6	1.7	1.7	1.8	1.8	1.8	1.8	1.9	0.2
Latvia	3.7	3.6	3.4	3.2	3.6	3.6	3.8	3.9	4.0	4.2	4.4	0.4
Lithuania	4.5	4.5	4.0	3.7	3.9	4.0	4.1	4.3	4.5	4.7	5.0	0.4
Luxembourg	3.2	3.2	3.4	3.6	3.7	3.7	4.0	4.4	4.4	4.4	4.4	0.4
Hungary	15.6	15.7	15.9	15.7	16.5	17.0	17.6	17.5	18.1	18.0	16.9	1.5
Malta	0.6	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.4	0.4	0.0
Netherlands	49.5	49.7	48.9	50.2	50.9	50.7	51.6	52.5	51.6	50.8	51.3	4.4
Austria	22.3	22.9	22.9	23.2	24.5	25.2	26.5	26.6	27.3	27.4	26.5	2.3
Poland	65.5	60.0	58.8	55.4	56.0	54.3	56.2	57.6	57.9	60.9	61.2	5.3
Portugal	15.3	16.2	16.7	17.7	18.1	18.4	18.4	20.2	18.7	18.5	18.8	1.6
Romania	28.7	26.2	22.4	22.5	23.0	23.1	24.2	25.5	24.7	24.8	24.0	2.1
Slovenia	4.5	4.3	4.4	4.4	4.6	4.6	4.7	4.8	4.9	4.9	4.9	0.4
Slovakia	10.7	10.5	10.3	10.3	10.9	11.1	10.7	10.8	10.6	10.7	10.5	0.9
Finland	23.5	24.3	24.7	24.2	24.1	25.1	25.6	26.1	25.2	26.8	26.6	2.3
Sweden	34.0	34.3	33.6	34.5	33.4	33.5	33.6	33.6	33.7	33.2	33.5	2.9
United Kingdom	147.5	148.5	151.5	152.2	153.3	149.0	150.8	151.9	152.3	150.4	147.9	12.8
Croatia	5.1	5.2	5.4	5.3	5.5	5.6	6.0	6.1	6.3	6.4	6.5	-
Turkey	50.3	49.9	49.2	55.5	50.2	54.7	58.7	60.4	63.2	69.0	72.8	-
Iceland	1.8	1.9	2.0	2.1	2.1	2.2	2.2	2.2	2.2	*2.4*	:	-
Norway	17.5	18.2	18.7	18.1	18.6	18.3	18.0	18.4	18.5	18.4	18.8	-
Switzerland	19.6	20.3	20.6	20.4	20.9	20.3	20.9	21.3	21.7	21.7	21.1	-

Source: Eurostat (ten00095)

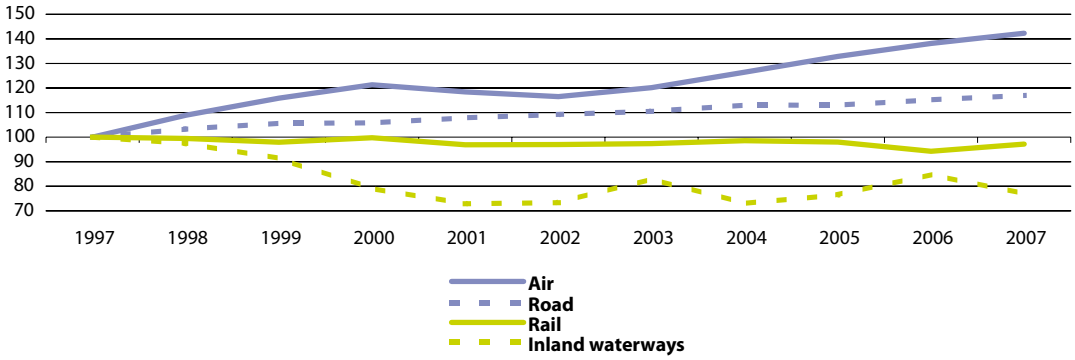
Figure 11.20: Final energy consumption, EU-27, 2007 (1)
(% of total, based on tonnes of oil equivalent)



(1) Provisional.

Source: Eurostat (tsdpc320 and tsdtr100)

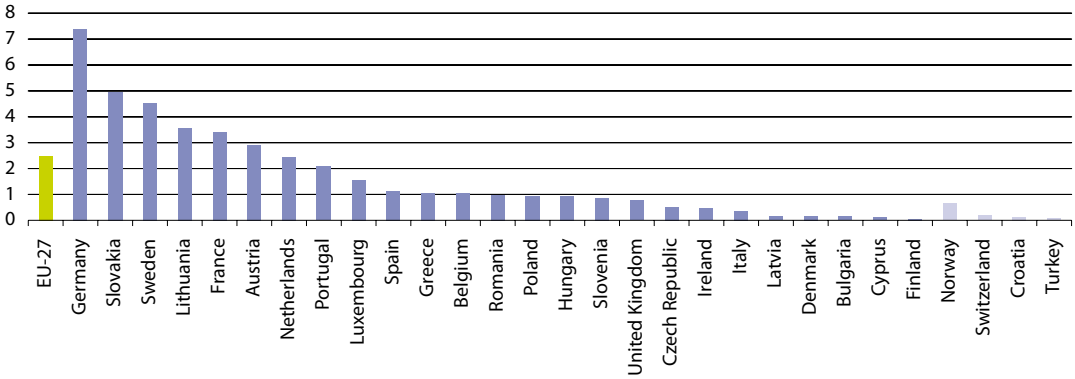
Figure 11.21: Energy consumption by transport mode, EU-27 (1)
(1997=100)



(1) Provisional for all transport modes, 2002; provisional for road transport, 2006 and 2007.

Source: Eurostat (tsdtr100)

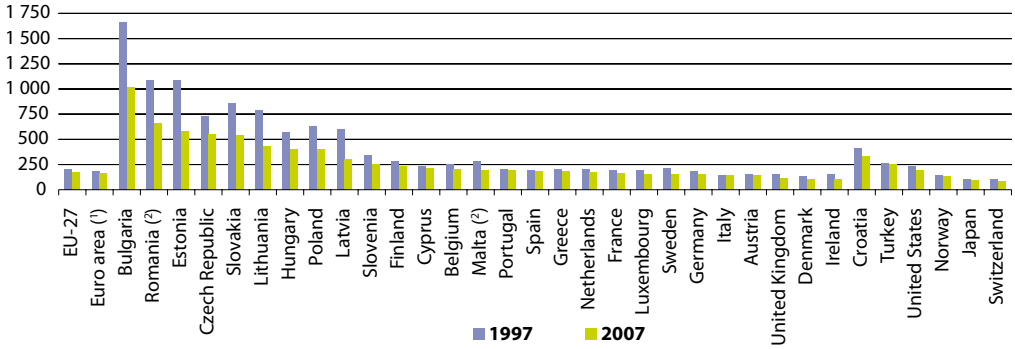
Figure 11.22: Share of biofuels in total fuel consumption of transport, 2007 ([1])
(%)



([1]) Estonia and Malta, not available.

Source: Eurostat (nrg_1073a and nrg_100a)

Figure 11.23: Energy intensity of the economy
(kg of oil equivalent per EUR 1 000 of GDP)



([1]) EA-15 instead of EA-16.
([2]) Provisional, 1997.

Source: Eurostat (tsien020)

11.9 Electricity

Introduction

One of the reasons for the EU's increased dependency on imports of natural gas is a shift in the fuel mix towards this energy source for the purpose of electricity generation. Natural gas offers power generators the possibility to lower their greenhouse gas emissions (when contrasted with electricity generated from coal, lignite or oil). There has also been an increase in the use of renewable energy sources for electricity generation, particularly wind turbines (although their contribution remains relatively small). The use of nuclear power for electricity generation has also received renewed attention amid concerns about an increasing dependency on imported primary energy, rising oil and gas prices, and commitments to reduce greenhouse gas emissions; some Member States have recently started construction or have planned new nuclear reactors. These concerns are balanced against long-standing reservations concerning the safety of nuclear power plants and how to dispose of nuclear waste.

Since July 2004, small business consumers in the EU have been free to switch their gas or electricity supplier, and in July 2007 this right was extended to all consumers. Independent national regulatory authorities have been established across the Member Sates to ensure that suppliers and network companies operate correctly. However, a number of shortcomings were identified in the opening-up of markets, and it was therefore decided to embark upon a third legislative package of measures with the aim of ensuring that all users could take advantage of the benefits provided by a truly competitive energy market. A raft of legislation will come into effect as of March 2011, including:

- Regulation (EC) No 713/2009 of the European Parliament and of the Council of 13 July 2009 establishing an agency for the cooperation of energy regulators ([35]);
- Regulation (EC) No 714/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No 1228/2003 ([36]);
- Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC ([37]).

By opening-up European energy markets to competition, it is hoped that both households and industrial users will benefit from more choice, fairer prices, cleaner energy production, better services and improved security of supply. These issues are at the heart of the third legislative package, which proposes:

- to separate production and supply from transmission networks;
- to facilitate cross-border trade in energy;
- more effective national regulators;
- to promote cross-border collaboration and investment;
- greater market transparency on network operation and supply;
- increased solidarity among the EU Member States.

([35]) For more information: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:211:0001:0014:EN:PDF.

([36]) For more information: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:211:0015:0035:EN:PDF.

([37]) For more information: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:211:0055:0093:EN:PDF.

Definitions and data availability

Gross electricity generation at the plant level is defined as the electricity measured at the outlet of the main transformers. In other words, it includes the consumption of electricity in plant auxiliaries and in other transformers. **Gross national electricity consumption** comprises total gross national electricity generation from all fuels (including auto-production), plus electricity imports, minus exports. **Final consumption of electricity** covers the electricity delivered to the consumer's door (industry, transport, households and other sectors). It excludes deliveries for transformation and/or own use of energy producing activities, as well as network losses.

Electricity generated from renewable energy sources is the ratio of electricity produced from renewable energy sources compared with gross national electricity consumption. Electricity produced from renewable energy sources comprises that generated from hydropower plants (excluding pumping), wind, solar, geothermal installations, and biomass/wastes.

The indicator for the **market share of the largest generator in the electricity market** is based on net electricity production, and as such the electricity used by generators for their own consumption is not taken into account.

Main findings

Total gross electricity generation in the EU-27 was 3.4 million Gigawatt hours (GWh) in 2007, of which 29.5 % came from nuclear power plants. Natural gas-fired power stations accounted for around one fifth (20.1 %) of the total; while coal-fired, lignite-fired and oil-fired power stations accounted for 18.3 %, 10.3 % and 3.9 % respectively. Among renewable energy sources, the highest share of total electricity generation in 2007 was from hydropower, providing 10.2 %, followed by biomass-fired power stations and wind turbines, which generated 2.7 % and 2.4 % of the total respectively.

Germany and France were the principal electricity generators in the EU-27 in 2007, with shares of 19.0 % and 17.0 % respectively, while the United Kingdom was the only other Member State to report a share in double-digits (11.8 %). The relative weight of Spain in EU-27 electricity generation rose quickly between 1997 and 2007, gaining 2.3 percentage points to reach 9.0%.

Electricity generation in the EU-27 grew, on average, by 1.7 % per annum between 1997 and 2007. Some of the highest growth rates were recorded within the Czech Republic, Ireland, Greece, Malta and Portugal – all of which reported average increases of between 3 and 4 % per annum over the period under consideration. However, the most rapid growth in electricity generation was in Spain, Cyprus and, in particular, Luxembourg, where annual rates of change averaged 4.8 %, 6.0 % and 12.2 % respectively; the high rate for Luxembourg was largely due to a significant increase in generating output in 2002 as new gas-fired capacity was introduced. Lithuania and Denmark were the only Member States to generate less electricity in 2007 than in 1997.

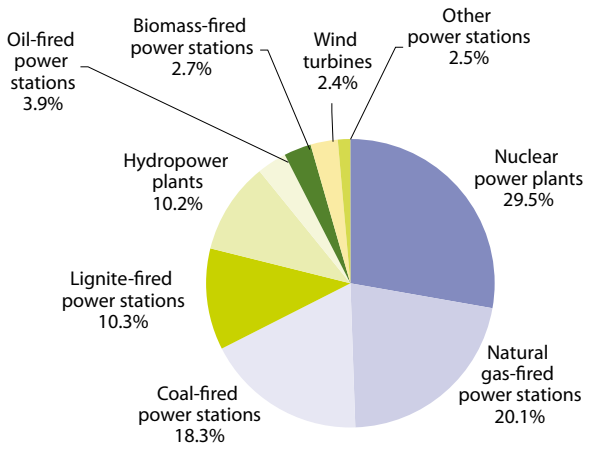
Renewable energy sources can potentially play an important role in reducing greenhouse gas emissions. The European

Parliament and Council set indicative targets in 2001 for the promotion of electricity from renewable energy sources: according to these, 21 % of the EU-27's gross electricity consumption should be sourced from renewables by 2010. The latest information available for 2007 shows that electricity generated from renewable energy sources contributed 15.6 % of the EU-27's gross electricity consumption. In Austria (59.8 %), Sweden (52.1 %) and Latvia (36.4 %) the share of renewable energy sources in gross electricity consumption was particularly high, largely as a result of hydropower and biomass, while in Denmark just over a quarter (26.9 %) of the electricity consumed came from renewables, largely from wind power and to a lesser extent biomass.

The growth in electricity generated from renewable energy sources during the period 1997 to 2007 reflects an expansion in two renewable sources; namely, wind turbines and biomass. Although hydropower remained the single largest source for renewable electricity generation in the EU-27 in 2007, the amount of electricity generated was almost the same as a decade earlier (-2.9 %). In contrast, the volume of electricity generated from biomass increased by 249 %, while that from wind turbines rose by 1 322 %.

One measure that is used to monitor the success of electricity market liberalisation is the market share of the largest generator. The small island nations of Cyprus and Malta were both characterised by a complete monopoly in 2007, with 100 % of their electricity being generated by the largest (sole) generator. Two other Member States – Estonia and Greece – reported shares for the largest generator of more than 90 %. In 11 of the 24 Member States for which data are available, the largest generator provided less than 50 % of the total electricity generated, with the share below 20 % in the United Kingdom and Poland.

Figure 11.24: Electricity generation by fuel used in power stations, EU-27, 2007 (% of total, based on GWh)



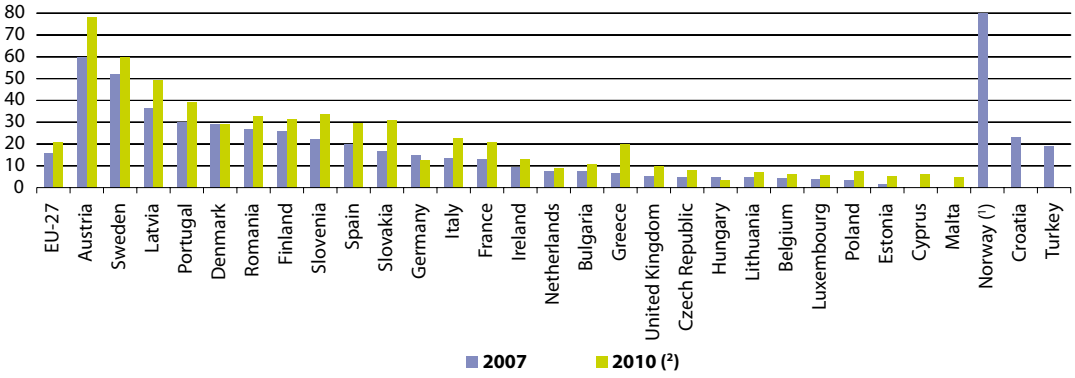
Source: Eurostat (nrg_105a)

Table 11.18: Gross electricity generation
(1 000 GWh)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Share in EU-27, 2007 (%)
EU-27	2 841	2 910	2 940	3 021	3 108	3 117	3 216	3 288	3 309	3 354	3 362	100.0
Euro area	1 930	1 976	2 018	2 091	2 142	2 159	2 234	2 297	2 307	2 350	2 354	70.0
Belgium	78.9	83.2	84.5	83.9	79.7	82.1	84.6	85.4	87.0	85.5	88.8	2.6
Bulgaria	42.8	41.7	38.2	40.9	44.0	42.7	42.6	41.6	44.4	45.8	43.3	1.3
Czech Republic	64.6	65.1	64.7	73.5	74.6	76.3	83.2	84.3	82.6	84.4	88.2	2.6
Denmark	44.3	41.1	38.9	36.0	37.7	39.3	46.2	40.4	36.2	45.6	39.2	1.2
Germany	551.6	556.7	555.5	571.6	586.3	571.6	599.5	616.8	620.3	636.6	637.1	19.0
Estonia	9.2	8.5	8.3	8.5	8.5	8.5	10.2	10.3	10.2	9.7	12.2	0.4
Ireland	20.0	21.2	22.0	24.0	25.0	25.2	25.2	25.6	25.4	27.5	28.2	0.8
Greece	43.5	46.3	49.9	53.8	53.7	54.6	58.5	59.3	60.0	60.8	63.5	1.9
Spain	190.3	195.2	209.0	225.2	238.0	246.1	262.9	280.0	294.0	299.5	303.3	9.0
France	504.5	511.0	524.0	540.7	549.8	559.2	566.9	574.3	576.2	574.6	569.8	17.0
Italy	251.4	259.8	265.6	276.6	279.0	284.4	293.9	303.3	303.7	314.1	313.9	9.3
Cyprus	2.7	3.0	3.1	3.4	3.6	3.8	4.1	4.2	4.4	4.7	4.9	0.1
Latvia	4.5	5.8	4.1	4.1	4.3	4.0	4.0	4.7	4.9	4.9	4.8	0.1
Lithuania	14.9	17.6	13.5	11.4	14.7	17.7	19.5	19.3	14.8	12.5	14.0	0.4
Luxembourg	1.3	1.3	1.0	1.2	1.2	3.7	3.6	4.1	4.1	4.3	4.0	0.1
Hungary	35.4	37.2	37.7	35.2	36.4	36.2	34.1	33.7	35.8	35.9	40.0	1.2
Malta	1.7	1.7	1.8	1.9	2.0	2.1	2.2	2.2	2.2	2.3	2.3	0.1
Netherlands	86.7	91.1	86.7	89.6	93.7	96.0	96.8	100.8	100.2	98.4	103.2	3.1
Austria	56.9	57.5	60.9	61.5	62.4	62.4	60.1	64.1	65.7	63.5	63.4	1.9
Poland	142.8	142.8	142.1	145.2	145.6	144.1	151.6	154.2	156.9	161.7	159.3	4.7
Portugal	34.2	39.0	43.3	43.8	46.5	46.1	46.9	45.1	46.6	49.0	47.3	1.4
Romania	57.1	53.5	50.7	51.9	53.9	54.9	56.6	56.5	59.4	62.7	61.7	1.8
Slovenia	13.2	13.7	13.3	13.6	14.5	14.6	13.8	15.3	15.1	15.1	15.0	0.4
Slovakia	24.5	25.5	27.7	30.7	32.0	32.4	31.2	30.6	31.5	31.4	28.1	0.8
Finland	69.2	70.2	69.4	70.0	74.5	74.9	84.2	85.8	70.6	82.3	81.2	2.4
Sweden	149.4	158.3	155.2	145.6	161.6	146.7	135.4	151.7	158.4	143.3	148.8	4.4
United Kingdom	345.4	362.0	368.4	377.1	384.8	387.2	398.2	393.9	398.4	397.9	396.1	11.8
Croatia	9.7	10.9	12.2	10.7	12.2	12.3	12.7	13.3	12.5	12.4	12.2	-
Turkey	103.3	111.0	116.4	124.9	122.7	129.4	140.6	150.7	162.0	176.3	191.6	-
Iceland	5.6	6.3	7.2	7.7	8.0	8.4	8.5	8.6	8.7	9.9	:	-
Norway	111.7	117.0	122.7	143.0	121.9	130.7	107.4	110.7	138.1	121.6	137.5	-
Switzerland	63.1	63.5	69.7	67.5	72.4	67.2	67.4	65.6	59.6	64.0	68.0	-

Source: Eurostat (ten00087)

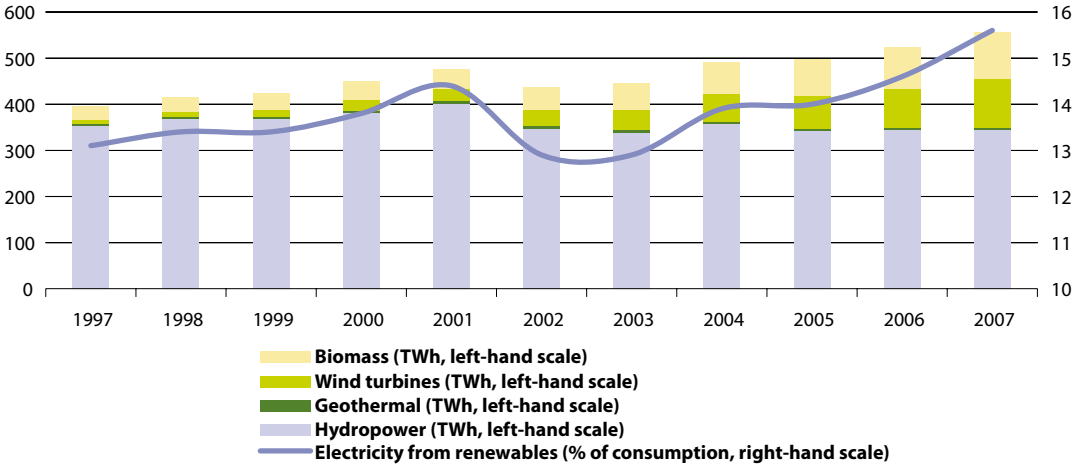
Figure 11.25: Proportion of electricity generated from renewable energy sources (% of gross electricity consumption)



(1) Y-axis is cut, 106.1.
(2) Indicative targets for 2010 are not available for Croatia, Turkey and Norway.

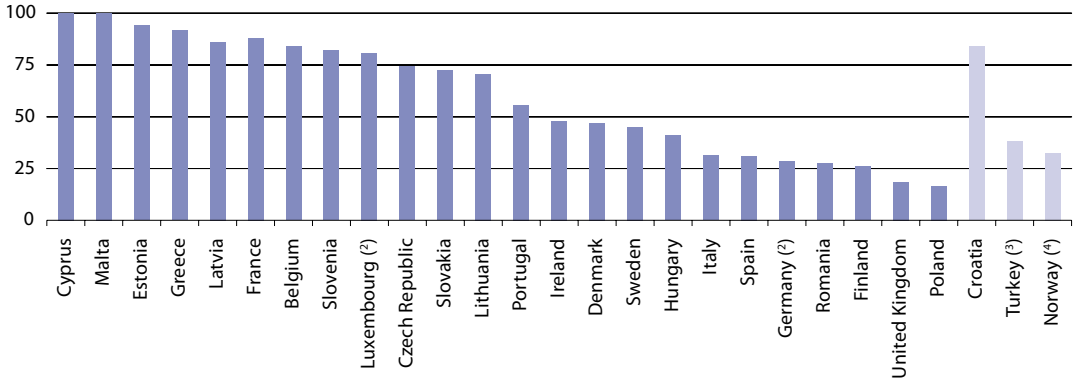
Source: Eurostat (tsien050)

Figure 11.26: Electricity generated from renewable energy sources, EU-27



Source: Eurostat (nrg_105a and tsdcc330)

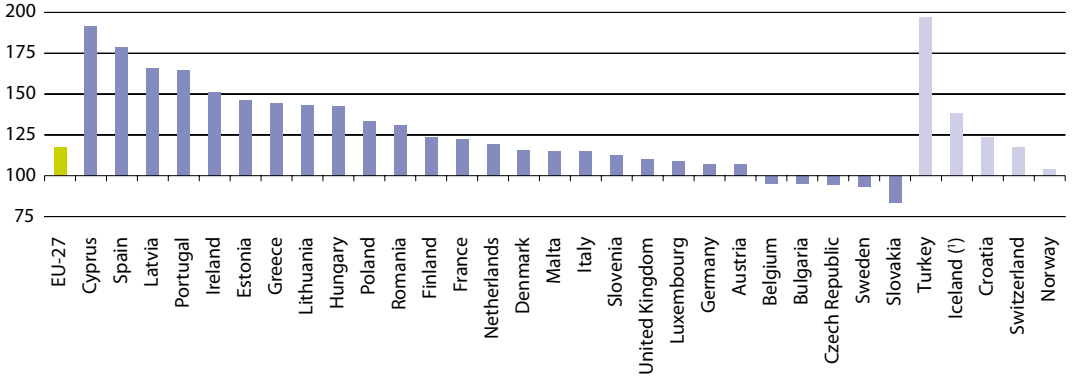
Figure 11.27: Market share of the largest generator in the electricity market, 2007 ([1])
(% of total generation)



([1]) Bulgaria, the Netherlands and Austria, not available.
([2]) 2004.
([3]) 2005.
([4]) 2006.

Source: Eurostat (tsier060)

Figure 11.28: Electricity consumption by households, 2007
(1997=100)



([1]) 2006.

Source: Eurostat (tsdpc310)

11.10 Energy prices

Introduction

Increasing energy demand, the global geopolitical situation, and severe weather conditions may all play a part in shaping energy prices. With rapid growth in demand for fossil fuels from the fast-growing developing economies of Brazil, Russia, India, and China (BRICs), imbalances arose between supply and demand, leading to crude oil prices rising significantly from 2004 to the middle of 2008. The price of crude oil later subsided somewhat, in part due to weaker demand as a result of the economic downturn, although there were signs of a rally in oil prices in the second half of 2009. Changes in oil prices have an impact on the price of energy substitutes, notably natural gas, and also feed into prices for other sectors that are heavy users of energy or use energy products as raw materials.

The price and reliability of energy supplies, electricity in particular, are key elements in a country's energy supply strategy. The price of electricity is important for a country's international competitiveness, as electricity usually represents a high proportion of total energy costs to businesses and households. In contrast to the price of fossil fuels, which are usually traded on global markets with relatively uniform prices, there is a particularly wide range of prices within the EU for electricity. The price of electricity is, to some degree, influenced by the price of primary fuels and more recently also by the cost of carbon dioxide emission certificates, and it is possible that resulting higher prices for electricity will provide an incentive for greater energy efficiency and lower levels of carbon emissions.

These issues were touched upon in a Communication from the European Commission titled, 'facing the challenge of higher oil prices' ([38]), which called on the EU to become more efficient in its use of energy, and less dependent on fossil fuels – in particular by following the approach laid out in the climate change and renewable energy package.

The EU has acted to liberalise electricity and gas market since the second half of the 1990s. Directives adopted in 2003 established common rules for internal markets for electricity and natural gas. Deadlines were set for opening markets and allowing customers to choose their supplier: 1 July 2004 for all business customers and 1 July 2007 for all consumers (including households). Certain countries anticipated the liberalisation process, while others were much slower in adopting the necessary measures. Indeed, significant barriers to entry remain in many electricity and natural gas markets as seen through the number of markets that are still dominated by (near) monopoly suppliers. In July 2009, the European Parliament and Council adopted a third package of legislative proposals ([39]) aimed at ensuring a real and effective choice of suppliers, as well as benefits for customers.

Definitions and data availability

The transparency of gas and electricity prices should help promote fair competition, by encouraging consumers to choose between different energy sources (oil,

([38]) COM(2008) 384 final of 13 June 2008; for more information: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0384:FIN:EN:PDF.

([39]) For more information: http://ec.europa.eu/energy/gas_electricity/third_legislative_package_en.htm.

coal, natural gas and renewable energy sources) and between different suppliers. For energy price transparency to be truly effective, prices and pricing systems must be published and broadcast as widely as possible.

The transparency of energy prices is guaranteed within the EU through the obligation of gas and electricity suppliers to send Eurostat information relating to prices for different categories of end-consumer (businesses and households), market shares, conditions of sale, and pricing systems. Electricity and gas tariffs or price schemes vary from one supplier to another. They may result from negotiated contracts, especially for large industrial consumers. For smaller consumers, they are generally set according to the amount of electricity or gas consumed along with a number of other characteristics; most tariffs also include some form of fixed charge. There is, therefore, no single price for electricity or gas. In order to compare prices over time and between countries, this publication shows information for two 'standard consumers' – one for domestic consumers and the other for industrial users. There are in total five different types of households for which electricity prices are collected following different annual consumption bands, while for natural gas prices statistics are collated for three different types of household. Across business/industrial users, electricity prices are collected for a total of seven different types of user, while for natural gas prices there are six different types of user distinguished.

Statistics on **electricity and natural gas prices** charged to industrial end-users are collected under the legal basis of Commission Decision 2007/394/EC of 7 June 2007 amending Council Directive 90/377/EEC with regard to the methodology to be applied for the collection of gas and electricity prices. Directive 2008/92/EC of the European Parliament and of the Council of 22 October 2008 concerns procedures to improve the transparency of gas and electricity prices charged to industrial end-users. Note that gas and electricity prices for household end-users are collected on a voluntary basis.

The prices presented cover average prices over a period of six months (half-year/semester) from January to June and from July to December. The prices include the basic price of electricity/gas, transmission, system services, distribution and other services. Electricity prices for households are normally shown including taxes and value added tax (VAT) as this generally reflects the end price paid by consumers at home. All electricity price data are given in euro per kilowatt hour (kWh); a similar set of criteria are used for gas prices, except the unit changes to euro per gigajoule (GJ). For the purpose of comparison, industrial gas and electricity prices are also shown including taxes, although in practice enterprises can deduct the VAT paid.

Automotive fuel prices shown are at the pump prices of premium unleaded gasoline (petrol) 95 RON and automotive diesel oil. The prices are supplied to the Directorate-General for Energy and Transport of the European Commission by the Member States as being the most frequently encountered on the 15th of each month; as with gas and electricity prices these are averaged for a period of six months (half-year/semester); equally,

the prices that are shown are inclusive of all taxes. Eurostat also publishes price information on heating oil and residual fuel oil.

Main findings

Due to a change in methodology, there is a break in series and hence a relatively short-time series available in relation to electricity and gas prices (from 2007 onwards). Nevertheless, even in this relatively short timeframe, electricity and gas prices have increased rapidly – in particular, gas prices. Between the second half of 2007 and the second half of 2008, both electricity and gas prices increased for households and industrial users in nearly all of the Member States. On average across the EU-27 the price of electricity for households rose by 9.6 %, while gas prices increased by 21.1 %. The price increases experienced by industrial users in the EU-27 over the same period were even higher – 13.8 % for electricity and 28.9 % for gas. There were a few notable exceptions to these trends, as the price of electricity for households fell in Poland (-6.2 %), Romania (-3.3 %), Luxembourg and Portugal (both -2.2 %), while gas prices fell in Denmark (-28.0 %), Portugal (-3.6 %) and Romania (-1.9 %).

In the second half of 2008, the price of electricity for households was nearly three and a half times higher in the most expensive Member State, Denmark (EUR 0.28 per kWh), than in the cheapest Member State, Bulgaria (EUR 0.08 per kWh). The range of prices for gas was similar in magnitude, as the highest prices for households were registered in Sweden (EUR 28.82 per GJ), at more than three times the lowest price recorded in Romania (EUR 9.33 per GJ). Household gas prices were also significantly higher in Denmark (EUR 26.57 per GJ) than in any of the other Member State (except Sweden), despite considerable price reductions. A large part of the energy price differences between the Member States may be attributed to taxes, as the range in prices between countries is narrower when taxes are excluded.

As with electricity and gas prices, petrol and diesel prices have also risen in recent years. The highest prices for unleaded petrol in the EU-27 during the first half of 2008 were found in the Netherlands, Belgium, Portugal and the United Kingdom, while the United Kingdom had, by some margin (EUR 0.20 per litre), the most expensive pump price for automotive diesel oil. While petrol and diesel prices rose considerably between the second half of 2004 and the first half of 2008, reflecting the evolution of crude oil markets, the range between the highest and lowest pump prices in the Member States narrowed (as variable taxes accounted for a lower share of the overall price). The lowest prices for petrol and diesel were recorded in the Baltic Member States, the islands of Cyprus and Malta, and in Slovenia, while diesel oil was also relatively cheap in Luxembourg and Spain.

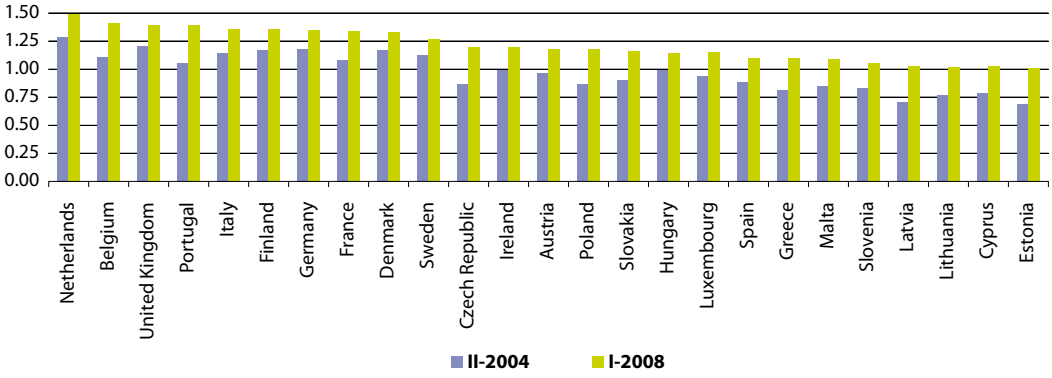
Table 11.19: Half-yearly electricity and gas prices – including taxes
(EUR)

	Electricity prices (per kWh)						Gas prices (per GJ)					
	Households (1)			Industry (2)			Households (3)			Industry (4)		
	II-2007	I-2008	II-2008	II-2007	I-2008	II-2008	II-2007	I-2008	II-2008	II-2007	I-2008	II-2008
EU-27	0.15	0.16	0.17	0.11	0.12	0.12	14.44	15.12	17.48	9.94	11.07	12.82
Euro area (5)	0.16	0.17	0.17	0.11	0.12	0.13	16.55	17.07	19.69	10.35	11.59	13.34
Belgium	0.17	0.20	0.21	0.11	0.13	:	13.89	16.26	20.24	9.46	11.06	12.67
Bulgaria	0.07	0.07	0.08	0.07	0.07	0.08	8.98	9.85	10.86	6.02	6.86	8.91
Czech Republic	0.11	0.13	0.13	0.11	0.13	0.13	10.06	12.20	14.69	8.11	10.56	13.03
Denmark	0.24	0.26	0.28	0.21	0.21	0.22	*36.89*	:	26.57	*9.18*	:	21.13
Germany	0.21	0.21	0.22	0.14	0.14	0.14	17.04	17.81	21.17	12.84	14.76	16.43
Estonia	0.08	0.08	0.09	0.06	0.07	0.07	7.30	9.30	10.30	5.94	8.23	10.34
Ireland	0.19	0.18	0.20	0.14	0.15	0.16	16.85	15.09	18.05	10.86	12.48	12.20
Greece	0.10	0.10	0.11	0.09	0.09	0.10	:	:	:	:	:	:
Spain	0.14	0.14	0.16	0.11	0.11	0.12	16.15	15.98	18.14	8.21	8.86	10.48
France	0.12	0.12	0.12	0.07	0.08	0.07	14.30	14.46	16.06	10.05	10.92	12.84
Italy	:	*0.21*	*0.22*	:	*0.16*	*0.17*	17.15	17.47	19.99	9.19	10.27	12.45
Cyprus	0.16	0.18	0.20	0.16	0.16	0.21	:	:	:	:	:	:
Latvia	0.07	0.08	0.10	0.07	0.08	0.09	8.65	8.70	13.88	9.10	9.33	12.99
Lithuania	0.09	0.09	0.09	0.09	0.10	0.10	6.52	9.15	10.63	7.98	10.37	14.33
Luxembourg	0.16	0.16	0.16	0.11	0.11	0.11	10.95	16.75	:	9.96	11.97	:
Hungary	0.13	0.15	0.16	0.14	0.14	0.15	10.62	11.24	12.93	10.29	11.62	14.06
Malta	0.10	0.10	0.15	0.13	0.13	0.17	:	:	:	:	:	:
Netherlands	0.17	0.17	0.18	0.12	0.12	0.12	19.14	19.37	21.03	10.83	11.44	12.66
Austria	0.17	0.18	0.18	0.11	0.13	0.13	16.95	16.88	17.72	:	:	:
Poland	0.14	0.13	0.13	0.11	0.11	0.11	11.15	11.56	14.30	8.80	10.20	11.39
Portugal	0.16	0.15	0.15	0.09	0.09	0.09	18.13	17.37	17.48	8.61	9.13	9.67
Romania	0.11	0.11	0.11	0.11	0.11	0.11	9.51	9.21	9.33	9.39	9.27	9.24
Slovenia	0.11	0.11	0.12	0.11	0.11	0.12	14.14	15.51	19.77	10.61	12.14	15.19
Slovakia	0.14	0.14	0.15	0.13	0.14	0.15	11.57	11.42	12.92	9.50	10.61	15.62
Finland	0.11	0.12	0.13	0.07	0.08	0.08	:	:	:	8.30	9.70	11.40
Sweden	0.16	0.17	0.17	0.07	0.07	0.08	25.56	26.53	28.82	20.94	17.95	18.37
United Kingdom	0.15	0.15	0.16	0.13	0.11	0.13	9.91	10.99	13.29	8.42	9.07	10.21
Croatia	0.10	0.10	0.12	0.09	0.09	0.11	7.60	7.59	7.70	7.77	7.72	7.82
Norway	0.15	0.16	0.17	0.09	0.10	0.11	:	:	:	:	:	:

(1) Annual consumption: 2 500 kWh < consumption < 5 000 kWh.
(2) Annual consumption: 500 MWh < consumption < 2 000 MWh.
(3) Annual consumption: 20 GJ < consumption < 200 GJ.
(4) Annual consumption: 10 000 GJ < consumption < 100 000 GJ.
(5) EA-15 instead of EA-16.

Source: Eurostat (nrg_pc_204, nrg_pc_205, nrg_pc_202 and nrg_pc_203)

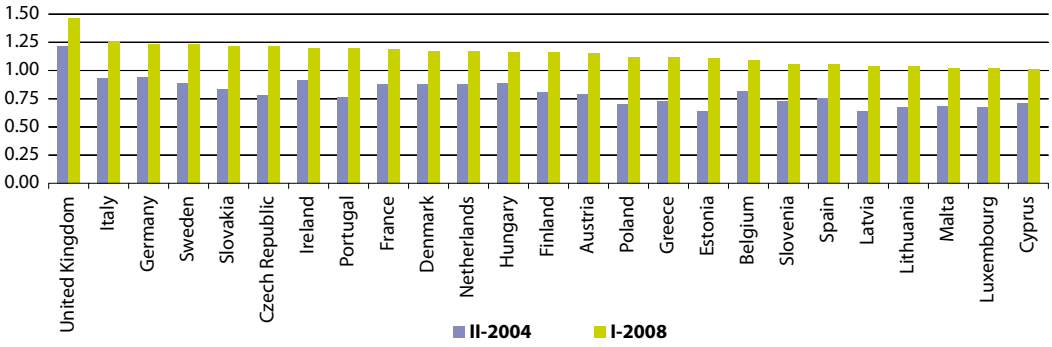
Figure 11.29: Half-yearly prices, premium unleaded gasoline (Euro-super 95) – including taxes (1) (EUR per litre)



(1) Bulgaria and Romania, not available.

Source: Eurostat (nrg_pc_201)

Figure 11.30: Half-yearly prices, automotive diesel oil - including taxes (1) (EUR per litre)



(1) Bulgaria and Romania, not available.

Source: Eurostat (nrg_pc_201)